ECONOMIC ANALYSIS

A. Introduction

1. The Fergana Valley is home to about 9 million people—close to a third of the country's population. The valley is home to Uzbekistan's largest industrial plants including General Motors Uzbekistan, Fergana and Altiarik refineries, and Quartz JSC. The region's fertile soil and mild climate make it ideal for growing cotton, which has resulted in the development of the textile industry. Improved rail connectivity to and within the Fergana Valley will help open markets for both agriculture and industry to the rest of Uzbekistan and to the wider region, creating jobs and improving the economic wellbeing of the people.

2. In September 2016, O'zbekiston Temir Yo'llari (UTY) and the government completed the construction of a new 124 km railway line between Pap and Angren, including a 19.2 km tunnel through the Kamchik Pass. Prior to its opening, freight traffic from Tashkent and the rest of Uzbekistan was brought to the Angren international logistics center by rail and transshipped onto road vehicles to continue their journey to their final destinations in the Fergana Valley (and vice versa for traffic originating in the Fergana Valley). With the new Pap–Angren rail link, a bulk of freight to and from the Fergana Valley has started to be transported directly by rail. The line connecting Pap with Andijan via Kokand and Margilan was electrified in 2016. This leaves only the Pap–Namangan–Andijan line as the only non-electrified section in the Fergana Valley.

3. Without the project, the Pap–Namangan–Andijan section of the railway network in the Fergana valley will remain unelectrified, and dependent on diesel traction. The majority of trains would bypass the Pap–Namangan–Andijan section, in favor of the southern loop from Andijan–Margilan–Kokand–Pap. Demand for passenger and freight trains would remain suppressed.

4. With the project, the Pap–Namangan–Andijan line becomes electrified, linking to the rest of the electrified network. Diesel locomotives would be replaced by more efficient electric locomotives. This will lead to (i) development of an economic corridor between the Fergana Valley and Tashkent, (ii) improvement in the mobility of goods and people in the Fergana Valley, (iii) improvement of regional connectivity, and (iv) improvement of operational efficiency and environmental performance.

B. Freight and Passenger Traffic Forecasts

5. The current and forecast traffic with and without the project was assessed, based on analysis conducted by the World Bank in 2015 for the recently completed Pap–Angren Railway Project,[1] validated and updated wherever required with information from the feasibility study conducted by UTY and its design institute for the project.[2] Table 1 outlines the historic annual growth in rail freight and passenger traffic in Uzbekistan.

Table 1: Annual Growth in Uzbekistan's Rail Traffic (%)

	2007	2008	2009	2010	2011	2012	2013	2014
Freight	16.0	8.3	4.5	-13.3	4.0	3.9	3.6	3.1
Passenger	-5.0	13.0	8.5	2.8	2.8	6.7	9.4	9.8

Source: O'zbekiston Temir Yo'llari estimates.

[1] World Bank. 2015. *Pap-Angren Railway Project, Project Appraisal Document.* Washington DC.
[2] UTY. 2016. *Electrification of the Pap-Namangan-Andijan Railroad.* Tashkent.

6. **For freight traffic**, the World Bank estimated that the total annual volume of freight using the Pap–Angren rail line would increase from 4.6 million tons in 2016, to 13.4 million tons in 2030, and to 19.8 million tons in 2040 (footnote 1). From Pap onwards, a proportion of this rail traffic would be transported along the Pap–Namangan–Andijan route (referred to as the 'northern loop'), while the rest would be transported along the 'southern loop' via Kokand and Margilan. To ascertain this split, an updated assessment was undertaken on the drivers of freight traffic growth in Namangan, Andijan and Fergana provinces. Indicators considered were (i) agricultural production (ii) industrial production, (iii) capital investment, (iv) external trade, and (v) gross regional product. The average proportionate contributions of these indicators by the three regions are given in Table 2.

Table 2: Economic Indicators in Fergana Valley
(2010–2015 proportions by region, %)

	Andijan	Namangan	Fergana
Agriculture Production	39	29	32
Industrial Production	54	12	34
Capital Investment	30	28	42
External Trade	64	8	28
Gross Regional Product	35	24	40
Average Economic Activity	44	20	35

Source: O'zbekiston Temir Yo'llari. 2016. Electrification of the Pap–Namangan–Andijan Railroad, Economics of the Catchment Area. Unpublished.

7. The northern loop is 48 km shorter than the southern loop, and will therefore result in shorter journey times for traffic bound for Andijan. Other major cities in the Andijan region are served by the northern loop. Taking into account these factors, this analysis assumed that, initially, 35% of the total rail freight traffic will use the northern loop (to be electrified with the project), and 65% of the traffic will be transported via the southern loop.

8. Uzbekistan's GDP is expected to grow at 5% annually between 2018–2030.[3] Studies have shown that the GDP elasticity for freight is between 0.66 and 1.49, with higher values for developing countries.[4] Based on this, a background freight traffic growth estimate of 4% per annum has been assumed (Table 3).

Table 3: Forecast Annual Freight Traffic Volumes
(million tons)

2020	2025	2030	2035	2040	2046
2.37	3.82	4.75	5.77	7.02	7.02

Source: Asian Development Bank estimates.

9. **For passenger traffic,** the World Bank estimated that the number of annual passenger journeys to and from the Fergana Valley would increase from 0.7 million in 2016, to 1.7 million in 2030, and to 2.6 million in 2040.[5] A proportion of these journeys will be on the electrified northern loop. The World Bank forecasts assume an annual growth rate of 3.5% up to 2030,

[3] ADB. 2016. *Long-Term Projections of Gross Domestic Product (GDP) for Developing Member Countries (DMCs).* Manila.
[4] Dunkerley Rohr and Daly. 2014 *Road Traffic Demand Elasticities, A Rapid Evidence Assessment*. Cambridge; and World Bank. 1992. *What Determines Demand for Freight Transport.* Washington D.C.
[5] World Bank. 2015. *Pap-Angren Railway Project. Project Appraisal Document*. Washington D.C.

and increasing to 4.3% per annum after that. Table 1 shows that the average annual growth in passenger journeys on the UTY network has been above 4.3% for 5 out of 8 years between 2007 and 2014. Given this, and an expected annual GDP growth of 5%, the World Bank estimates of rail passenger journeys and annual growth rates in the Fergana Valley have been adopted for this analysis.

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10. According to the World Bank, UTY will have to operate five train pairs a day (10 trains in total) in the Fergana Valley by 2040 to meet the expected passenger forecasts. Based on current traffic levels in the northern and southern loops, it has been estimated that four trains per day will operate on the northern loop, and six per day on the southern loop. Based on these assumptions, the forecast annual passenger journeys for the project railway is given in Table 4.

Table 4: Forecast Annual Passenger Traffic Volumes
(million journeys)

2020	2025	2030	2035	2040	2046
0.38	0.55	0.66	0.82	1.07	1.07

Source: Asian Development Bank estimates.

C. Economic Costs

11. The economic costs of the project comprise (i) investment costs, which includes installation of the electrification system, supervision consultants, land acquisition and resettlement, and (ii) incremental operations and maintenance costs. Costs related to taxes, duties, and financing charges during implementation have been excluded. Table 5 provides a breakdown of the investment costs by expenditure category, in financial prices.

Table 5: Investment Cost Estimate
($ million, 2017 prices)

Item	Total Cost
A. Investment Costs	
1. Electrification System Installation	121.64
2. Supervision Consultants	3.50
3. Administrative expenses including land acquisition and resettlement	5.22
B. Taxes and Duties	**38.50**
C. Contingencies	
1. Physical	3.20
2. Price	2.80
D. Financial Charges During Implementation	**2.59**
Total Project Cost (A+B+C+D)	**177.45**

Source: Asian Development Bank and O'zbekiston Temir Yo'llari estimates.

12. Financial costs were converted to economic costs in line with ADB guidelines.[6] The project costs were revalued in economic terms by separating the cost items into tradable materials and equipment, non-tradable materials, skilled labor, and unskilled labor. A standard conversion factor (SCF) of 0.96 was used to convert domestic market price values to border price equivalent values.[7] A shadow wage rate factor of 0.7 was estimated and applied to

[6] ADB. 1997. *Guidelines for the Economic Analysis of Projects.* Manila.

[7] Using ADB's simplified method based on merchandise imports of $13.9 million, exports of $13.3 million, and estimated taxes on trade of $973.0 million (import and export data are derived from the World Bank, and tax estimates are based on weighted average tariff rates).

unskilled labor. A shadow wage rate factor of 1.0 was applied to skilled and professional labor. The economic value of acquired land was derived from revenue lost over a 40-year period for its current use (mainly agricultural), and resettlement costs were estimated from actual costs incurred minus taxes.

D. Economic Benefits

13. The following economic benefits have been estimated as part of the economic evaluation: (i) time savings for freight traffic, (ii) time savings for passenger journeys, (iii) savings in CO2 emissions, (iv) energy cost savings, and (v) locomotive maintenance cost savings. A standard conversion factor (SCF) of 0.96 was used to convert all non-traded benefits to border price equivalent values.

14. **Time savings for freight traffic:** Currently rail freight to destinations along the Pap–Namangan–Andijan corridor are brought to Kokand using electric traction, then switched to diesel traction. As a result, the current total journey time for a freight train between Pap and Andijan through Kokand is approximately 7 hours. Electrification will cut delays to freight journey time caused by this switch, and trains will travel directly from Pap to Andijan via the northern loop. Further, electric traction results in higher train speeds, reducing journey times. Overall, this will result in a 4.5-hour time saving, which equates to a 30% reduction in the overall point-to-point freight journey time to and from destinations along the Pap–Andijan route and Tashkent. Estimation of the value of time savings for freight transport followed the same methodology adopted for the CAREC Corridor 6 (Marakand–Karshi) Railway Electrification Project.[8] The average economic value of cargo was calculated at $332 per ton in 2016 prices. It was assumed that the 30% reduction in overall freight journey time would result in a 2.5% increase in the economic value of the cargo. This assumption is consistent with international research.[9]

15. **Time savings for passenger journeys:** Passenger journeys between Pap and Andijan by rail currently takes 1 hour 30 minutes. Electrification is expected to reduce this journey time by 30 minutes per journey, to 1 hour. This analysis used a value of time of $2 per hour, as estimated by the World Bank (footnote 5) to calculate the total value of journey time savings.

16. **Reductions in carbon dioxide emissions:** Electric locomotives emit less carbon dioxide (CO_2) than diesel locomotives and are more environmentally friendly. This is particularly true given that the source of electricity generation in Uzbekistan is predominantly natural gas.The CO_2 emissions savings were calculated based on the differences in emissions from diesel and electric locomotives of 31.32 grams per ton-km for diesel and 12.73 grams per ton-km for electric. CO_2 emission reductions were valued at $30 per ton, consistent with the value used by the World Bank for the Pap–Angren project (footnote 5), and conservative against estimates made by the Intergovernmental Panel on Climate Change.

17. **Energy cost savings:** The unit energy cost for electrical locomotives is cheaper than that of diesel locomotives. Energy cost savings was calculated by comparing unit fuel costs of electrical and diesel locomotives. The unit costs for diesel and power were estimated by calculating the fuel and power consumption of diesel and electric locomotives, using the average diesel cost of $0.61 per kg and the average power cost of $0.04 per kilowatt-hour

[8] ADB. 2011. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Republic of Uzbekistan for the Central Asia Regional Economic Cooperation Corridor 6 (Marakand–Karshi) Railway Electrification Project* (Loan 2781-UZB). Manila.

[9] Institute for Transport Studies, University of Leeds. 2010. *Updating Appraisal Values for Travel Time Savings.* Leeds.

(kWh). Energy use per 10,000 ton-km was assumed to be 98.3 kg for diesel traction, and 471.6 kWh for electric traction. This equates to energy cost savings of approximately $41 per 10,000 ton-km of freight carried.

18. **Locomotive maintenance cost savings:** Electric locomotives ($0.18 per locomotive km) are cheaper to maintain than diesel locomotives ($0.30 per locomotive km). These cost savings were estimated based on past project experience (footnote 8).

E. Economic Appraisal Results

19. An economic analysis of the project was carried out in accordance with the *Guidelines for the Economic Analysis of Projects* of the Asian Development Bank (ADB) (footnote 5), comparing the incremental costs of the project with the incremental benefits. The assessment was conducted for a 30-year period (2017–2046), with 10% residual value of capital assets. The economic evaluation uses constant 2016 economic prices, the world price numeraire, with all costs and benefits expressed in US dollars ($).

20. The results of the economic analysis are summarized in Table 6, expressed in terms of key economic indicators, namely the benefit–cost ratio, economic internal rate of return, and net present value at a 12% discount rate. The results indicate that the project has an economic internal rate of return well above the opportunity cost of 12%.

Table 6: Results of the Economic Analysis

Economic Internal Rate of Return	Net Present Value	Benefit–Cost Ratio
19.7%	$92.12 million	1.89:1

Source: Asian Development Bank estimates.

21. Sensitivity analysis tested three scenarios to assess the robustness of the results of the economic analysis: (i) a 10% decrease in freight traffic; (ii) a 10% decrease in passenger traffic, and (iii) a 10% increase in capital costs. As shown in Table 7, the project's economic viability is robust against key parameters.

Table 7: Sensitivity Analysis

	EIRR	**Switching Value**
10% reduction in freight time savings	18.3%	-52%
10% reduction in passenger time savings	19.6%	N/A
10% increase in capital costs	18.3%	89%

EIRR = Economic Internal Rate of Return, N/A = not applicable.
Source: Asian Development Bank estimates.