ECONOMIC ANALYSIS

1. The economic analysis aims to assess the viability of the project from a societal perspective, i.e., whether the project utilizes scarce resources in an optimal way for society. The analysis was carried out in accordance with the *Guidelines for the Economic Analysis of Projects* of the Asian Development Bank (ADB).[1] Costs and benefits are quantified and then valued in societal terms and the benefits are compared with the costs.

2. **Project description.** Myanmar's power system plays an important role in supporting economic development, rural electrification, and industrialization. Current challenges include insufficient power supply, low generation efficiency, and very high transmission and distribution system losses. The distribution system is characterized by overloading, poor reliability, and extremely high losses.

3. The project aims to rehabilitate the deteriorated power distribution system in Yangon, Mandalay, Sagaing, and Magway regions. In particular

   (i) five townships in Yangon region: Hlaingthaya, Insein, Kamayut, Mayangone, and Mingalone;
   (ii) four districts in Mandalay region: Kyaukse, Meikhtila, Myingyan, and Yameethin;
   (iii) five districts in Sagaing region: Kalay, Katha, Monywa, Sagaing, and Shwebo; and
   (iv) two townships in Magway region: Aunglan and Magway.

As a result of the project, the distribution losses in the project areas will decrease from 18.2% in 2013 to 14.2% in 2018, representing a 4 percentage point reduction.

4. **Economic cost.** The costs to society over the entire life of the project include investment, and operation and maintenance costs. Since the project will improve the existing system, it will likely reduce operation and maintenance costs for systems in the project areas. Investment costs are mainly equipment costs (para. 4), but also installation and engineering service costs, and physical contingencies (Table 1). They exclude taxes, price contingencies, and financial charges during construction. The analysis was carried out in dollars. All values in kyat are converted to dollar values using the exchange rate of $1 = MK980.

5. In this analysis, the domestic price numeraire is used. To translate the financial costs into an economic value, the costs are allocated into appropriate categories, such as traded goods and services (applied to equipment costs), foreign skilled labor, local skilled labor (applied to engineering consulting services), and local unskilled labor (applied to installation costs). These costs are adjusted by the appropriate economic conversion factors. In the absence of the well-established shadow factors for Myanmar, the analysis considers factors used in a project in Viet Nam.[2] The resulting project investment costs are shown in Table 1. The investment costs will be utilized over a period of 3 years, from 2014 to 2016. This investment layout will be used to calculate the project economic parameters.

[1] ADB. 1997. *Guidelines for the Economic Analysis of Projects.* Manila; and ADB. 2013. *Key Areas of Economic Analysis of Investment Project.* Manila.

[2] ADB. 2007. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Socialist Republic of Viet Nam for the Mong Duong 1 Thermal Power Project*. Manila.

Table 1: Economic Value of Investment Costs

Item	Cost ($ million)	SERF[a]	Shadow Value ($ million)
Investment costs			
Cost of equipment and materials	50.50	1.1	55.55
Cost of installation	5.60	1.0	5.60
Cost of safeguard measures	0.20	1.0	0.20
Consulting services	3.73	1.1	4.10
Physical contingencies	6.32	1.1	6.95
Total investment cost[b]	**66.34**		**72.40**

SERF = shadow exchange rate factor.
[a] Referring to SERF values as established in Asian Development Bank. 2007. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Socialist Republic of Viet Nam for the Mong Duong 1 Thermal Power Project*. Manila.
[b] Without taxes, price contingencies, and financial charges.
Source: Asian Development Bank estimates.

6. **Economic benefits.** The project will reduce distribution losses by 4 percentage points from 18.2% in 2013 to 14.2% in 2018. For the base year 2013, when electricity sales in the project areas are 1,930.2 gigawatt-hours (GWh), this loss reduction is equivalent to 109 GWh. This is the benefit in physical terms for the with-project scenario compared with the without-project scenario. To estimate future benefits, total sales for the project areas are first projected using the Ministry of Electric Power (MOEP) sale growth rates, then a 4% loss reduction is applied to the sale values. With electricity consumption increasing in future years, electricity savings from the project are expected to increase (e.g., from 184 GWh in 2017—the year the project begins operating) to almost 395 GWh in 2025. Without the project, Yangon City Electricity Supply Board and Electricity Supply Enterprise would lose the saved electricity.

7. According to MOEP, in 2012 per capita electricity consumption was 140 kilowatt-hours (kWh) and the electrification ratio was 28%. The government is determined to reach an electrification rate of 45% in 2020 and 60% in 2025; correspondingly achieving per capita consumption of 500 kWh in 2020 and 850 kWh in 2025. According to MOEP, difficulty in investing in generation means that the supply of electricity does not meet and catch up with demand. For example in 2012 domestic supply was less than 10 terawatt-hours (TWh), while demand was 12.5 TWh. As a result, load shedding still occurs every month.[3] With such a shortage, consumers are left either without electricity or have to generate electricity by means available to them.

8. In the without-project scenario, most large industrial and business enterprises have to use diesel generators as backup electricity sources. Small business enterprises and wealthy households in cities could also purchase small portable generators. For poor households in cities and for households and small businesses in rural areas, power shortages usually mean they are left without electricity. Thus, the economic benefit of the project is a sum of the benefits resulting from not having to run backup diesel generators or not having to experience power blackouts.

9. The project improves reliability and efficiency of power supply for existing systems, so assuming the benefits are nonincremental is reasonable.[4] For industrial and commercial consumers, the benefits are evaluated as avoided costs (e.g., not having to run backup

[3] ADB. 2012. *Myanmar Energy Sector Initial Assessment.* Manila.
[4] The economic benefits of a few new connections in terms of kWh would be similar for the existing consumers—the value of electricity not served.

generators). For households, the benefits are evaluated as the estimated value of unserved electricity.

10. A recent study in India, which surveyed 1,031 electricity end-users (including households and small businesses in various locations) found that the households and businesses are willing to pay a premium of 2 to 4 times the rate that they pay for electricity to ensure electricity availability for 24 hours, 7 days a week.[5] The premium comes in the form of buying and using backup equipment. This supports findings in Viet Nam: according to an Electricity of Vietnam report, in 2010 the production cost of electricity using fuel oil was $0.14/kWh. The cost with diesel generators was higher (about 40%–50% more, e.g., $0.21/kWh). In 2010, the costs of backup generators ranged from 2 to 3 times the average electricity tariff in Viet Nam.

11. The electricity tariff in Myanmar is set at MK35/kWh for households and MK75/kWh for business and industry.[6] Applying the findings in India and Viet Nam to Myanmar provides proxies for the premium that various consumer categories are willing to pay to ensure the availability of electricity.

12. The share of electricity consumption among consumers is as follows: industry 36%, business 22%, and households 42% (MOEP 2011). This share is likely to evolve over time, with the share of business increasing, while the share of households reduces. However, this analysis uses the share in 2011.

13. Applying the economic value per kWh for each consumer category, the economic benefits of the project can be determined (Table 2).

14. **Economic internal rate of return and economic net present value.** The economic internal rate of return (EIRR) is estimated at 35% and a net present value (NPV) of $216.8 million at a discount rate of 12%. Given that currently power supply does not meet demand and the growth rate of consumption is high, the savings of electricity resulting from the loss reduction would have significant economic value for society. Thus, the value of investing in loss reduction in this project is quite high.

15. **Unquantifiable benefits.** The project entails some unquantifiable benefits. One is the benefit of reduced greenhouse gas emissions compared with the without-project scenario. As the project will reduce distribution loss, this means that less fuel is required for the same amount of consumed electricity. The project is expected to reduce greenhouse gas emissions by more than 31,990 tons of carbon dioxide by 2018. The literature on climate change suggests that avoided global damage from reducing carbon dioxide emissions, or the social value of carbon, is likely to be significantly greater than the carbon market value.[7] The project's EIRR would improve dramatically when the social value of carbon is included in the benefits.

16. **Sensitivity analysis.** The economic robustness of the project was investigated in relation to two key parameters: variation in estimated costs and estimated benefits. The project EIRR and NPV are sensitive to both. An unorthodox approach was applied in looking into

[5] Wärtsilä India Limited. 2009. *The Real Cost of Power.* Mumbai.

[6] The government recently announced the increase in electricity tariff to become effective from 1 April 2014: MK35/kWh for households (until 100 kWh) and MK50/kWh (for 101 kWh and above); MK100/kWh for industry, enterprise, and lumpsum (until 5,000 kWh) and MK150/kWh for industry, enterprise, and lumpsum (for 5,001 kWh and above); MK50/kWh for government offices; and MK100/kWh for industrial use of government departments.

[7] The social value of carbon is estimated as the present value of the total damage inflicted or reduced globally when an additional unit of carbon dioxide is emitted into or taken out of the atmosphere.

sensitivity cases. The analysis bases its evaluation of the benefits from the consumer's perspective as in Myanmar all savings resulting from loss reduction would be fully consumed. In testing the project's economic sensitivity, the analysis also looks at the benefits from the utility perspective. This means assessing the benefit values if loss reduction leads to reduced electricity generation. In the Myanmar power system this reduction would come from combined-cycle gas turbines. Their cost of production is MK130/kWh ($0.133/kWh).

17. Two other extreme cases were examined: (i) a flat benefit applying the lowest value to all consumer categories, and (ii) a 30% increase in project costs. Based on current project implementation, cost overruns may occur. But cost overruns have always been below 30%. Reducing the benefit values reduces the EIRR to 22% (NPV = $75.5 million). The project can withstand the worst-case scenario, combining a 30% increase of estimated costs and lowest estimated benefits, which results in an EIRR of 19% (Table 2).

Table 2: Estimates of Economic Costs and Benefits
($ million)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036		
Electricity saved, GWh				184.5	202.9	223.2	245.5	270.1	297.1	326.8	359.5	395.4	435.0	478.5	512.0	547.8	586.1	627.2	671.1	718.0	768.3	822.1	879.6		
Industry				66.4	73.0	80.4	88.4	97.2	107.0	117.6	129.4	142.4	156.6	172.2	184.3	197.2	211.0	225.8	241.6	258.5	276.6	296.0	316.7		
Business				40.6	44.6	49.1	54.0	59.4	65.4	71.9	79.1	87.0	95.7	105.3	112.6	120.5	129.0	138.0	147.6	158.0	169.0	180.9	193.5		
Households				77.5	85.2	93.7	103.1	113.4	124.8	137.3	151.0	166.1	182.7	201.0	215.0	230.1	246.2	263.4	281.9	301.6	322.7	345.3	369.4		
Economic benefits																									
HH, MK35, 2x premium				5.5	6.1	6.7	7.4	8.1	8.9	9.8	10.8	11.9	13.0	14.4	15.4	16.4	17.6	18.8	20.1	21.5	23.0	24.7	26.4		
Business, MK75, 2x premium				6.2	6.8	7.5	8.3	9.1	10.0	11.0	12.1	13.3	14.6	16.1	17.2	18.4	19.7	21.1	22.6	24.2	25.9	27.7	29.6		
Industry, MK75, 3x premium				15.2	16.8	18.4	20.3	22.3	24.6	27.0	29.7	32.7	36.0	39.5	42.3	45.3	48.4	51.8	55.5	59.3	63.5	67.9	72.7	**EIRR**	**NPV**
Cash flow	(23.0)	(41.3)	(8.1)	27.0	29.7	32.7	35.9	39.5	43.5	47.8	52.6	57.9	63.6	70.0	74.9	80.2	85.8	91.8	98.2	105.1	112.4	120.3	128.7	35%	216.8
Utility perspective																									
Savings at 0.133 $/kWh	(23.0)	(41.3)	(8.1)	24.5	27.0	29.7	32.7	35.9	39.5	43.5	47.8	52.6	57.9	63.6	68.1	72.9	78.0	83.4	89.3	95.5	102.2	109.3	117.0	33%	191.7
Savings at 0.2 $/kWh	(23.0)	(41.3)	(8.1)	36.9	40.6	44.6	49.1	54.0	59.4	65.4	71.9	79.1	87.0	95.7	102.4	109.6	117.2	125.4	134.2	143.6	153.7	164.4	175.9	42%	318.1
Savings at 0.3 $/kWh	(23.0)	(41.3)	(8.1)	55.3	60.9	67.0	73.7	81.0	89.1	98.0	107.8	118.6	130.5	143.5	153.6	164.3	175.8	188.2	201.3	215.4	230.5	246.6	263.9	54%	506.7
Savings at 0.4 $/kWh	(23.0)	(41.3)	(8.1)	73.8	81.2	89.3	98.2	108.0	118.8	130.7	143.8	158.2	174.0	191.4	204.8	219.1	234.5	250.9	268.4	287.2	307.3	328.8	351.9	64%	695.4
Sensitivity																									
Life-line rate, 2x premium	(23.0)	(41.3)	(8.1)	13.2	14.5	15.9	17.5	19.3	21.2	23.3	25.7	28.2	31.1	34.2	36.6	39.1	41.9	44.8	47.9	51.3	54.9	58.7	62.8	22%	75.5
and 30% cost overrun	(29.9)	(53.7)	(10.5)	13.2	14.5	15.9	17.5	19.3	21.2	23.3	25.7	28.2	31.1	34.2	36.6	39.1	41.9	44.8	47.9	51.3	54.9	58.7	62.8	19%	57.8

EIRR = economic internal rate of return, HH = household, GWh = gigawatt-hour, kWh = kilowatt-hour, NPV = net present value.
Source: Asian Development Bank estimates.