ECONOMIC ANALYSIS

A. Introduction

1. The economic analysis was undertaken in accordance with ADB Guidelines for the Economic Analysis of Projects, updated earlier in 2017. The objective of the proposed project is to support the development of the Majuro Island distribution network and reduction of electricity losses, through installation of advanced metering infrastructure (AMI), which will collect near-real-time data on the network and identify sections for improvement. The project is expected to be implemented over a period of 1 year, with completion by December 2018.

B. Macroeconomic and sector context

2. The Republic of Marshall Islands (RMI) is heavily dependent on external assistance with annual grants averaging about 60% of gross domestic product (GDP), mostly through the Compact of Free Association (COFA) with the United States. When grant flows declined during 1995–2001, per-capita GDP dropped by nearly 35%. A new 20-year COFA (2003-2023) provides an opportunity for the RMI to shift toward economic self-reliance. In FY2016 (ended 30 September), economic growth improved to 1.5% from 0.6% in the previous year due to stronger fisheries output and the resumption of infrastructure projects connected with COFA. ADB projects growth of 4.0% and 2.5% in FY2017 and FY2018, respectively.[1] The average GDP growth of 1.7% is expected through 2025.[2] Unemployment is high and human development indicators are generally low, with income distribution being quite uneven and considerable poverty on the outer atolls.

3. Majuro is the capital island of the RMI and has a population of about 27,800 that is slightly over a half of the total population of the country. Marshalls Energy Company (MEC) is a fully state-owned electricity utility, which generates, distributes, and retails electricity on Majuro and a number of smaller islands. Total annual energy demand in Majuro is about 54 gigawatt-hours (GWh), which requires about 3.8 million US gallons (14.4 million liters (L)) of diesel fuel. MEC is heavily dependent on imported diesel fuel for generation, so that the 2008 fuel price spike nearly bankrupted the country. At the macroeconomic level, high fuel costs can pose significant challenges to policymakers through their effects on growth, inflation, foreign reserves, and government resources. This feeds directly and indirectly into production and household well-being through transport, electricity, and cooking fuel costs.

C. Least-Cost Option

4. The project aims to support the reduction of Majuro's dependence on imported diesel fuel by reducing its distribution network losses (both non-technical and technical), which constituted 14%–42% of total annual generated energy in Majuro over the past 5 years. The proposed option is to install: (i) advanced metering infrastructure on all distribution transformers (about 500) on the island, which will provide fine-grained measurement data to MEC and precisely determine network areas suffering high technical or non-technical losses; and (ii) a centralized control and metering distribution network center, which will automatically collect and compile metered data from all distribution transformers. The technical analysis found that this option is best as: (i) it is simple to implement; and (ii) it has strategic value relating to revenue and cost management, which MEC needs to improve.

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[1] Asian Development Outlook 2017.

[2] RMI Economic Review. US Graduate School, Oct. 2016.

5. It should be noted that some losses couldn't be reduced by the metering project, e.g., streetlights that remain un-metered and therefore show up as technical losses. Also, free electricity that is provided to landowners whose land is used for power lines is fully compensated by a special subsidy from the government; these consumptions are metered and not part of the losses.

D. Economic Costs

6. Project capital costs were assessed at mid-2017 constant prices and include: (i) the initial costs of the hardware and electrical works needed for the installation; (ii) software and training costs; and (iii) consulting services for design, tendering, overall training, and project supervision as required.

7. Economic costs were estimated based on cost adjustments to reflect the economic resource cost of project inputs and summarized in Table 1.

Table 1. Economic costs of the Project (in US$ millions)

Item	Financial cost items	Economic costs *
A. Base Cost	2.100	1.528
1. AMI and AMIC project costs	1.600	1.528
Advanced Metering Infrastructure (AMI)	0.710	0.654
Advanced Metering Infrastructure Center (AMIC)	0.416	0.400
Training and commissioning services	0.240	0.240
Supervision consulting services	0.234	0.234
2. Capacity building for overall MEC	0.500	0.000
B. Contingencies	0.147	0.076
Physical, 7%	0.147	0.076
Total (A+B+C)	**2.247**	**1.604**

Note: * At Border price numeraire.

8. Capacity building for overall MEC (Cost item A.2. in the above table) is not part of the metering project and included in the cost table only for the sake of consistency with the financial tables provided in other project documents.[3] Incremental annual and periodic O&M expenditures, including parts replacements required for the components through useful life, were assessed at annual base of 1.0% of the total capital cost.

9. *Border price numeraire* was used for convenience, as most of the costs (capital and O&M costs) and the benefits (fuel saving and carbon values) are internationally traded. Thus, only local costs (i.e., MEC labor that is expected to be used for installation of the meters) will be adjusted to border price.

10. The capital costs were calculated to consist of traded goods (equipment/meters) and services (international consultants), non-traded services (MEC labor, i.e., scarce labor assumed 80% and surplus labor 20%), and physical contingency. Traded goods and services are assumed to reflect the economic prices, thus no conversion is applied. Non-traded goods and services are multiplied by standard conversion factor of 0.93 and surplus labor costs are multiplied by the shadow wage rate factor of 0.83, estimated for the RMI.

[3] Please also refer to para 11 of RRP.

11. Price contingency was excluded from the economic costs. The economic costs also exclude transfers, such as customs duties and taxes.

E. Economic Benefits

12. Fuel saving and reduced greenhouse gas emissions were estimated and included as major benefits in this economic analysis.

13. Estimated immediate project impact is reduction of losses up to total of 4% of the total generated energy in one year after the project is finalized, metering data collected and analyzed, and loss reduction measures implemented. This is based on the technical analysis that suggested that there will be reduction of about 3% of technical losses and 1% of non-technical loses without any notable additional investments in the distribution system; by measuring power generated and power delivered to its customers via distribution transformers, MEC will be able to determine distribution network losses, and distribution sections that have unbilled connections to the grid. Economic benefits include only technical loss reduction.

14. The economic benefit of annual fuel saving due to technical loss reduction was calculated based on related reduced generation of 1,592 MWh due to loss reduction (i.e. 3% of gross generation of 53,070 MWh in 2016) and was valued using the cost of fuel in thermal generation, which is a function of the average fuel consumption and the cost of fuel. The average fuel consumption from 2012-2016 was 0.2502 L/kWh and the cost of fuel was $0.43/L in 2016. It is assumed that the average fuel consumption will remain unchanged. The World Bank projects crude oil prices to increase from $45.7 per barrel (bbl) to $62.2/bbl by 2020, $64.2/bbl by 2025 and $66.0/bbl by 2030,[4] it is assumed that prices will remain at this level after 2030. Based on these assumptions and an annual loss reduction of 1,592 MWh, annual fuel savings valued at over $230,000 are expected as a benefit to MEC.

15. The economic benefit of annual greenhouse gas emission reductions was calculated based on the annual fuel saving, as estimated above, multiplied by the carbon dioxide emission per unit of diesel burned (i.e. 2.7 kg/L or 22.4 pound/gallon)[5] and valued using the cost of carbon. Cost of carbon per each ton of reduced emissions was applied and it was obtained based on the carbon value of $36.3/ton in 2016, and adjusted to 2017 prices by inflation of 1.4%. This was further adjusted by 2% of annual real increase to allow for the potential of increasing marginal damage of climate warming over time, in accordance with the 2017 ADB Guidelines.[6] Thus, carbon value increases from of $40.6 per ton in 2021 to $52.6 by end of project life in 2034, and the related carbon benefit increases from around $43,000 to around $56,000, accordingly.

16. The project will also have additional non-quantified benefits that are not included in the cost-benefit analysis. Metering data will assist MEC to address further reduction of technical losses with additional investments. Also, knowing load patterns could help MEC try to shift load usage from peak to off-peak periods by applying different charge rates according to the time of the day, or the day of the week, in which the energy is used. The large customer loads could be shifted to a lower peak time if they are metered for their peak kVA power demand. Also if buildings have HVAC systems, then it is possible to move the cooling to a non-peak period with standard energy

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[4] World Bank Commodity Price Forecast, April 2017

[5] United States EIA, 2015. http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11

[6] Guidelines for the Economic Analysis of Projects, ADB, 2017. It states that Carbon value is "$36.3/ton in 2016 and to be increased by 2% annually in real terms to allow for the potential of increasing marginal damage of global warming over time".

management software. This shift from peak periods to off-peak periods would reduce expensive peak generation capacity.

F. Cost-Benefit Analysis

17. The project lifespan is 15 years, based on life expectancy of the major project equipment (meters), following expected full commissioning by December 2019. Benefits are expected to start in 2021, in one year after completion. All benefits and costs are expressed in constant mid-2017 prices.

18. The economic internal rate of return (EIRR) and the economic net present value (ENPV) were calculated for the proposed metering project, with the details of the cost and benefit streams and calculated EIRR and ENPV presented in Table 2.

Table 2. Details of calculations of EIRR and ENPV (in US$ millions).

Year	Capital costs	O&M costs	Fuel saving due to Loss reduction	Carbon value	Net benefit
2017	0.000	0.000	0.000	0.000	0.000
2018	-1.283	0.000	0.000	0.000	-1.283
2019	-0.321	0.000	0.000	0.000	-0.321
2020		-0.016	0.000	0.000	-0.016
2021		-0.016	0.234	0.043	0.262
2022		-0.016	0.236	0.044	0.264
2023		-0.016	0.237	0.045	0.266
2024		-0.016	0.239	0.046	0.269
2025		-0.016	0.241	0.047	0.272
2026		-0.016	0.242	0.048	0.274
2027		-0.016	0.243	0.049	0.276
2028		-0.016	0.245	0.050	0.279
2029		-0.016	0.246	0.051	0.281
2030		-0.016	0.247	0.052	0.283
2031		-0.016	0.247	0.053	0.284
2032		-0.016	0.247	0.054	0.285
2033		-0.016	0.247	0.055	0.286
2034		-0.016	0.247	0.056	0.287
				EIRR	**10.6%**
				ENPV, $m	**$0.169**

EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance.

19. In the base case scenario, the EIRR is estimated at 10.6% (including greenhouse gas emission reduction benefits), exceeding the economic hurdle rate of 9.0%. ENPV is positive at $0.169 million. As a result, the project is considered economically viable.

20. Sensitivity of EIRR and ENPV to the key risk parameters was conducted under the following scenarios: (i) increase in capital costs by 10%, (ii) increase in O&M costs by 10%, and (iii) reduce benefits (fuel saving and carbon values) by 10%. The EIRR and ENPV of the project under the base case and the scenarios defined for the sensitivity analysis are presented in Table 3.

Table 3: Results of sensitivity analysis

Base case and Sensitivity cases	EIRR	ENPV, $m	SV
Base Case	10.6%	0.169	
Capital costs up by 10%	9.3%	0.036	12.7%
O&M cost up by 10%	10.5%	0.159	169.1%
Benefits down by 10%	9.1%	0.009	10.6%

EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance, SV = switching value.
Source: Consultant estimates.

The results of the sensitivity analysis indicate that the project is resilient to adverse impacts of the key risk parameters. The project is most sensitive to changes in loss reduction and is least sensitive to changes in O&M costs.