ECONOMIC ANALYSIS

1. The Cook Islands is a Pacific island country with a population of 18,600 spread across seven low-lying coral atolls in the north, and eight fertile volcanic islands in the south. Economic and social development is hindered by the country's limited size, isolation and distance from markets, a lack of natural resources, periodic devastation from natural disasters, and inadequate infrastructure. The country also suffers from a shortage of labor, exacerbated by emigration, and its high reliance on its tourism sector makes it vulnerable to global economic shocks.

2. Growth in the Cook Islands economy accelerated to 3.3% in 2012, from 1.0% the previous year. Growth was driven by public spending on infrastructure projects, and continued strong performance in the tourism sector. Tourist arrivals in the Cook Islands increased by an average of 8.0% in 2011 and 2012. Growth is expected to track about 3.0% over 2013 and 2014 due to improving economic conditions in Australia and New Zealand. Inflation in the Cook Islands rose to 2.8% in 2012 (from 0.6% in 2011) due to higher transport and utility costs, and is expected to remain at about 3.0% through 2013 and 2014.

3. The total fuel import bill of the Cook Islands significantly increased from NZ$20.3 million in 2008 to NZ$34.6 million in 2012. This was primarily due to the increase in international oil prices. Fuel imports account for 25% of the total import bill and for 9% of the country's gross domestic product. Diesel fuel for power generation accounted for 56% of total fuel imports in 2012. Long-term price forecasts for world oil products indicate that diesel oil prices could increase by an average 2.9% per annum until 2040.

4. Electricity costs in the Cook Islands are among the highest in the Pacific. Volatile diesel fuel prices and heavy reliance on imported diesel fuel for power generation significantly affects the economy and the living standards of the population. It is estimated that high electricity tariffs account for 3%−4% of household expenditure and 7%−15% of business expenditure.

5. Replacing conventional diesel-based power generation with generation based on renewable energy sources will reduce the production cost of electricity and the import bill of diesel, and will contribute to sustainable social and economic development. The Cook Islands is endowed with potential renewable energy sources, especially solar energy thanks to global horizontal irradiation of around 1,900 kilowatt-hours per square meter per year.

6. The proposed Renewable Energy Sector Project will support the implementation of the Cook Islands Renewable Energy Chart[1] (CIREC), which sets a target of supplying 50% of inhabited islands with power from renewable sources by 2015, and 100% of the inhabited islands by 2020. It will construct up to six solar photovoltaic power plants with a total installed capacity of about 3 megawatt peak coupled with advanced battery storage, and rehabilitate the existing distribution network for core and noncore subprojects. A least-cost analysis showed that solar photovoltaic generation with battery storage is the optimal option over other renewable energy systems such as wind and biomass. The project will include three core subprojects on Mangaia, Mauke, and Mitiaro, and up to three noncore subprojects on Aitutaki, Atiu, and Rarotonga, all in the Southern group of islands.

7. This economic analysis evaluates the three core solar photovoltaic power plants, coupled with advanced battery storage, and rehabilitated distribution networks in Mangaia, Mauke, and Mitiaro. It was carried out in accordance with the Asian Development Bank (ADB) Guidelines for

[1] Ministry of Finance and Economic Management. 2011. *Cook Islands Renewable Energy Chart*. Rarotonga.

the Economic Analysis of Projects.[2] Similar analysis and due diligence will be prepared for noncore subprojects in Atiu, Aitutaki, and Rarotonga during project implementation.

8. **Economic costs.** The economic analysis was conducted for a project life of 25 years plus the project implementation period of 3 years. The residual value at the end of the project life is assumed to be zero. All prices and costs are expressed in 2014 prices. Traded goods and services are multiplied by a shadow exchange rate factor (SERF) of 1.15. Nontraded goods and services are assumed to reflect economic prices. Unskilled labor costs are multiplied by a shadow wage rate factor (SWRF) of 0.95. A discount rate of 12% per annum is assumed. The financial capital costs were converted to economic costs after deducting taxes, subsidies, and price contingencies, then applying the SERF and SWRF. The capital costs of the project include costs related to civil works, solar photovoltaic system, advanced battery storage, grid refurbishments, other associated costs, and physical contingency. These costs occur primarily during the construction period in the first 3 years of the project. The operation and maintenance (O&M) costs, assumed to remain constant in real terms, comprise costs for maintenance, salaries, overheads, and administration expenses. The O&M costs occur throughout the operational life of the project, which is 25 years, and also include replacement costs for batteries (every 15 years) and inverters (every 10 years).

9. **Economic benefits.** The economic benefits of each subproject were estimated on the assumption that solar photovoltaic power generation will substitute current diesel generation, and any increase in demand will be met by diesel generation.[3] Economic benefits include (i) avoided system losses due to rehabilitated transmission lines, and (ii) reduction in diesel fuel consumption due to displacement by solar photovoltaic generation. The assumptions used are in Table 1.

Table 1: Assumptions for Economic Analysis

	Mangaia	Mauke	Mitiaro
Net generation (GWh/year)	0.46	0.23	0.20
Tariff net of VAT (NZ$/kWh)	0.47	0.58	0.49
Transmission losses with project (%)	8	8	8
Transmission losses without project (%)	20	20	20
Diesel consumption (liter/kWh)	0.26	0.26	0.26
Initial diesel power displacement (kWh)	0.42	0.21	0.18
Diesel price (NZ$/liter)	3.50	3.50	3.50
Government subsidy (NZ$/kWh)	0.65	0.88	0.40

GWh = gigawatt hour, kWh = kilowatt hour, NZ = New Zealand, VAT = value-added tax.

Source: Asian Development Bank estimates.

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

[3] The CIREC implementation plan estimates an increase in annual load demand of about 3% by 2020. However, electricity demand on Mangaia, Mauke, and Mitiaro is dominated by households, and because the population on these islands has been constant for 5 years, an increase in demand is expected to be negligible.

10. Grid refurbishment is assumed to reduce transmission losses by 12%, which is a net benefit. Benefits are also derived from the volume of diesel required to generate the equivalent amount of electricity displaced by solar photovoltaic generation, which is multiplied by the diesel price. Solar photovoltaic generation is assumed to decrease by 0.8% annually.

11. **Rate of return, net present value, and sensitivity analysis.** The economic internal rate of return (EIRR) is the rate of return for which the present value of the net benefit stream is zero, or at which the present value of the benefit stream is equal to the present value of the cost stream. The economic net present value (ENPV) is the difference between the total social benefits and costs discounted at the economic cost of capital (ECC), which is assumed to be 12%. The three core subprojects on Mangaia, Mauke, and Mitiaro achieve an EIRR at or above the ECC. Their aggregated EIRR is 13.7% and the ENPV is NZ$1.89 million (Table 2).

Table 2: Economic Costs and Benefits of the Core Subprojects
(NZ$ million)

Year	Capital Costs	O&M Costs	Total Cost	Total Benefit	Net Benefit
2015	0.86	-	0.86	-	(0.86)
2016	5.65	-	5.53	-	(5.53)
2017	2.94	-	2.81	1.07	(1.74)
2018	-	0.15	0.14	1.71	1.56
2019	-	0.15	0.14	1.66	1.52
2020	-	0.15	0.14	1.62	1.48
2021	-	0.15	0.13	1.57	1.44
2022	-	0.15	0.13	1.53	1.40
2023	-	0.15	0.13	1.49	1.36
2024	-	0.15	0.13	1.45	1.33
2025	-	0.15	0.12	1.42	1.29
2026	-	0.32	0.25	1.38	1.13
2027	-	0.15	0.12	1.35	1.23
2028	-	0.15	0.12	1.32	1.20
2029	-	0.15	0.11	1.29	1.17
2030	-	0.15	0.11	1.26	1.14
2031	-	1.89	1.33	1.23	(0.10)
2032	-	0.15	0.11	1.20	1.09
2033	-	0.15	0.10	1.17	1.07
2034	-	0.15	0.10	1.15	1.04
2035	-	0.15	0.10	1.12	1.02
2036	-	0.32	0.20	1.10	0.89
2037	-	0.15	0.10	1.07	0.98
2038	-	0.15	0.09	1.05	0.96
2039	-	0.15	0.09	1.03	0.94
2040	-	0.15	0.09	1.01	0.92
2041	-	0.15	0.09	0.99	0.90
2042	-	0.15	0.09	1.01	0.92
		ENPV	**0.76**	**EIRR** (%)	**13.7**

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

12. Sensitivity analysis of the EIRR and ENPV was conducted under the following scenarios: (i) construction delay of 1 year; (ii) increase in transmission losses by 3% after refurbishment; (iii) estimated solar generation reduced by 10%; (iv) increase in O&M costs by 10%; and (v) reduction in diesel cost by 10%. The EIRR and ENPV for all the subprojects are most

sensitive to a construction delay of 1 year. The EIRR and ENPV results under the base case and scenarios defined for the sensitivity analysis are shown in Table 3.

Table 3: Sensitivity Test of Economic Internal Rate of Return (%) **and Economic Net Present Value** (NZ$ million)

	Aggregate		**Mangaia**		**Mauke**		**Mitiaro**	
	EIRR	ENPV	EIRR	ENPV	EIRR	ENPV	EIRR	ENPV
Base scenario	13.7	0.76	13.3	0.25	13.8	0.29	14.4	0.23
Construction delay of 1 year	11.5	(0.25)	11.1	(0.19)	11.6	(0.06)	12.0	0.00
Increase in line losses by 3% after refurbishment	13.6	0.71	13.1	0.22	13.7	0.27	14.3	0.22
Solar generation reduced by 10%	12.4	0.16	11.8	(0.05)	12.7	0.10	13.1	0.11
Increase in O&M cost by 10%	13.7	0.75	13.2	0.24	13.8	0.28	14.4	0.23
Reduction in diesel cost by 10%	12.5	0.22	12.1	0.02	12.7	0.11	13.0	0.10

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value.
Source: Asian Development Bank estimates.

13. Other benefits also contribute to the overall economic viability of the project. The use of solar photovoltaic power generation will reduce about 2,930 tons of carbon dioxide equivalent (tCO_2e) emissions per year, or about 75,000 tCO_2e emissions over the 25-year operational life of the project. The lower exposure of energy tariffs to international fuel price fluctuations will also benefit households and business entities.