# ECONOMIC ANALYSIS

## A. Introduction

1. The project will assist the Government of Vanuatu (GOV) to expand renewable energy generation, connect currently un-served customers and significantly improve access to grid connected electricity supply. The project consists of the construction of a 400kW hydropower plant (HPP) in Malekula, as well as grid extensions in Espiritu Santo and Malekula.

2. **Macro-Economic Context**. Following a decade of uninterrupted economic growth, Vanuatu's gross domestic product (GDP) contracted by 1.0% in 2015 with tourism and agriculture affected by a series of adverse shocks, including Tropical Cyclone Pam in March. Growth rebounded to an estimated 3.8% in 2016, as reconstruction following the cyclone and the initiation of several large infrastructure projects supported economic Over the near-term, growth is projected to accelerate to 4.3% in 2017 with continuing recovery in agriculture and tourism, and with the implementation of major reconstruction and infrastructure projects ramping up. It is seen to slow slightly to 3.8% in 2018 as construction activity peaks, and the recovery in agriculture and tourism plays out. Government plans for a significant infrastructure push are expected to drive medium-term growth prospects, with the total investment pipeline during 2016–2020 amounting to almost half of annual GDP. Inflation is expected remain within the government target range of 2.0%–3.0% through to 2018. Construction, tourism, and services are the main drivers of growth, which is underpinned by improved economic policy and effective fiscal management. The other main sectors are tourism, trade, transport and telecommunications. Vanuatu's natural resources support tourism, agriculture, fisheries, and some forestry. Subsistence agriculture is critically important as this is the main economic activity of 50% of the heads of households (HH) in rural areas.

3. Vanuatu's monetary and exchange rate policy framework pursues external balance and price stability (with occasional policy inconsistencies or slippages), and is mostly able to mitigate the effects of internal and external shocks. The country's current account deficit stood at the equivalent of about 14% of GDP in 2016. Latest estimates suggest that the fuel import bill is equivalent to about 63% of the value of total exports, and the costs of petroleum product imports exceed 8% of the value of total imports.[1]

4. Over the past years, GOV has consistently taken adequate account of debt sustainability considerations when considering new loans. However, reconstruction and new infrastructure projects have pushed external debt to the equivalent of 52% of GDP in 2016 from under 20% in 2014. As a result of previous prudence, Vanuatu's ratio of external debt service to exports of goods and non-factor services ratio remains one of the lowest (at around 1.8% as of 2015) among ADB's developing member countries. The International Monetary Fund (IMF) debt sustainability analysis shows that Vanuatu is at a moderate risk of debt distress. Although debt levels are projected to continue to rise slightly over the next few years, they are expected to remain manageable given the availability of concessional financing terms, and provided that the current surge in financing needs is only temporary.

5. **Sector Context.** Electric power supply in Vanuatu is provided through an estimated 30.7 MW of installed generation capacity, composed of approximately 27.1 MW of diesel generation (86%), 3.1 MW wind generation (9.8%), 1.2 MW in hydroelectric power (3.8%), 0.04

[1]National Statistics Office: Quarterly Statistics Indicators March 2017: In 2016, the imported cost of mineral oils was VUV3,405 million, against gross export revenues VUV5,446 million and gross imports of VUV41,408 million.

MW coconut oil generation and <100 kW of grid connected solar generation (<1%).[2] Of these, approximately 27.4 MW are managed by UNELCO, the private concessionaire for Efate, Malekula and Tanna, and 4.1 MW are managed by Vanuatu Utilities and Infrastructure Limited (VUI), the private concessionaire for Luganville.

6. The Utilities Regulatory Authority (URA) monitors the concession contracts and sets tariffs under the Luganville concession, while tariffs are set contractually for other concessions. Vanuatu's power tariffs are high with a base tariff of VUV46.76/kWh ($0.44/kWh) in UNELCO concession areas. In Santo, residential tariff rates include cross-subsidy from high consumption to low consumption customers. Customers consuming less than 60 kWh/month are covered by a lifeline tariff of $0.13/kWh while high consumption users above 120 kWh/month are charged $0.36/kWh. The weighted average electricity tariff in Santo is estimated at $0.23/kWh.

7. **Least-cost analysis.** The technical assistance project *Promotion of Renewable Energy in the Pacific* assessed alternative renewable energy generation options for the provinces in Vanuatu[3]. The assessment concluded that hydropower generation was least cost for power generation (levelized cost of energy basis) compared to diesel generation and other forms of renewable energy such as solar, wind and biomass. The project preparation technical assistance[4] assessed various catchments to supply the Malekula grid and concluded that the Brenwe River was the optimum site. Various technical options were then assessed to ensure the design of the Brenwe River Hydropower plant was least cost, including (i) generator sizing and configuration, (ii) alternative plant configurations, and (iii) optimizing use of existing earthworks. For example, plant sizes of 600kW plant and 400kW were analysed and the 400kW plant was selected as least cost on a levelized cost of energy basis.

## B. Economic Analysis Methodology and Approach

8. Economic analysis has been carried out in accordance with ADB Guidelines.[5] The result of the economic analysis is an Economic Rate of Return (EIRR), which is based on incremental economic cashflows, i.e., the difference between "with project" and "without project" cashflows. In addition, the project generates non-quantifiable benefits which have been identified. In projecting cashflows, the financial costs and benefits need to be converted to economic costs and benefits by way of economic or shadow prices. Under the "with project" scenario for new infrastructure interventions, consumer surplus is gained through the supply of a cheaper source of power to the population. "Without project" scenario assumes the continuation of the present mode of high cost of electricity service delivery.

## C. Costs

9. The assumptions used in the analysis of costs and benefits including (i) a 30-year project economic life; (ii) no residual value assumed at the end of the 30 year period; (iii) all costs based on 2017 constant prices that include physical contingencies but exclude price contingencies, taxes and duties; and (iv) fuel prices have been converted to economic prices by eliminating all taxes and duties.

10. **Labor Costs**. The economic price of labor is measured through its supply price. The Shadow Wage Rate Factor (SWRF) is assumed to be 0.8 and it is applied 60% of the labor cost

[2]Concessionaire Annual Technical reports 2012
[3] ADB. 2009. *Technical Assistance for the Promotion of Renewable Energy in the Pacific.* Manila.
[4] ADB. 2012. *Technical Assistance to Vanuatu for Preparation of the Energy Access Project.* Manila
[5] ADB, 1997. *Economic Analysis of Projects*. Manila

and the balance is assumed to be skilled, where the SWRF is not applied. It is assumed that 15% of the overall project costs will be the cost of labour. A Standard Conversion Factor of 0.9 has been assumed to convert financial prices to Border Price Equivalent Values (BPEV), equivalent with similar recent projects in the Pacific. Certain financial costs such as taxes and interest have been eliminated as they are transfer payments and do not have an effect on the economy. Other financial costs have been adjusted to their BPEV to reflect impact on the national economy. The economic analysis uses the World Price Numeraire to adjust to BPEV.

## D. Benefits

11. Economic benefits consist of incremental benefits arising from the extension of the distribution grid and non-incremental benefits arising from resource cost savings, mainly fuel savings. Incremental benefits are valued using the consumer surplus.

12. **Consumer Surplus (CS).** Evaluation of the impacts of electrification is accomplished by quantifying the energy services that electricity makes possible and relating this to consumers' willingness to pay (WTP) for this serves as shown by their actual use. CS is based on what the consumer will be willing to pay without the project (currently) as compared to what they will pay with the project. CS represents an increase in the economic welfare.

13. Analysis of the cost of generating power for lighting using the various sources (such as solar lanterns, solar home systems, communal diesel generators and kerosene lamps) conducted in 2014 shows that, including both capital and recurrent costs, the average cost of solar lanterns has been estimated at VUV 377 kWh, solar home systems at VUV 228/kWh, communal diesel generators at VUV 74/kWh and Kerosene lamps at VUV 636/kWh. Excluding diesel generators for communities, these sources of lighting have typically short economic lives and low wattage resulting in a high cost per kWh. The weighted average cost for non-electrified HHs—brought forward to 2017 prices using observed movements in the household utilities component of the consumer price index—is VUV 396/kWh ($3.76/kWh) in Malekula and VUV 379/kWh ($3.60/kWh) in Santo. The total number of HHs in Malekula is 4,928. The total electrified customers are 526 (with HHs being the major customers). In Santo, the total number of HHs is 7,864 of which 2,307 are electrified.[6] Using the WTP for non-electrified HHs and the prevailing electricity tariff for electrified HHs it is possible to estimate a weighted average economic price of electricity without the project which is VUV 355/kWh for Malekula and VUV 273/kWh for Santo.

14. Since the number of HHs to be connected under the project have been estimated and also the demand with and without project has been identified it is possible to calculate the quantity of electricity with and without the project and thereby estimate the demand function and the weighted average economic price of electricity with the project. The weighted average economic price of electricity with the project is VUV 240/kWh for Malekula and VUV 204/kWh for Santo The economic benefit is in the form of a consumer surplus with increased quantity being supplied along the demand curve which results in the reduction of the economic price by 33% in Malekula and 25% in Santo. This results in an undiscounted consumer surplus of $71 million over the economic lifetime of the project.

15. **Non-incremental benefits from fuel cost savings** as a result of reduced importation of fossil fuels. Displaced fuel price is calculated at unit economic price multiplied by displaced volumes. The fuel savings are estimated at $9.4 million over the economic lifetime of the project. Resource cost savings from equipment and labor are not considered significant.

[6] Includes non-grid connected electrified households

16. **Non Quantified Benefits.** The following economic benefits have been identified but have not been factored into the economic analysis:

(i) **Induced production**. For most of the rural population, agriculture production is near subsistence level and does not approach the maximum potential use of available labor and natural resources since grid power (if available) is costly and own generation requires capital. With access to cheaper hydropower, residents of rural communities will find it in their economic interest to produce more for exchange.

(i) **Tourism development**. Few subproject locations (Champagne Beach, Port Olry and Turtle Bay in Santo) showed potential for further tourism development if better facilities and services were available. There are several small resorts, the largest of which has its own 15 kVA generator located <100m off the main road near Turtle Bay. Anecdotally there is considerable potential for economic development in the region.

(ii) **Climate change mitigation**. Hydropower generation produces considerably less carbon dioxide emissions than diesel power generation. Reductions in greenhouse gas emissions by converting diesel generation to hydropower can assist in addressing climate change. However, the emission reductions attributable to this project are negligible and are not considered adequate to pursue carbon financing.

## E. Results of the Economic Evaluation

17. The project's incremental EIRR is 14.9% and the Economic Net Present Value (ENPV) is $5.9 million. This indicates that the project is economically viable since it exceeds the Economic Opportunity Cost of Capital (EOCC) of 9%. The sensitivity analysis is also robust, with the EIRR exceeding the EOCC even under a worst-case scenario where a 20% increase in costs is combined with 20% decrease in revenues

**Table 1. Detailed EIRR and ENPV Computation (Constant 2017 VUV million)**

| | Capital costs | O&M costs | Consumer surplus | Fuel cost savings | Net benefits |
|---|---|---|---|---|---|
| 2019 | (152.9) | - | - | - | (152.9) |
| 2020 | (502.4) | - | - | - | (502.4) |
| 2021 | (425.1) | - | - | - | (425.1) |
| 2022 | (47.7) | (0.2) | 14.5 | 1.6 | (31.9) |
| 2023 | - | (25.9) | 187.3 | 24.9 | 186.3 |
| 2024 | - | (26.0) | 190.9 | 25.5 | 190.4 |
| 2025 | - | (26.1) | 194.5 | 26.1 | 194.5 |
| 2026 | - | (26.2) | 198.2 | 26.7 | 198.7 |
| 2027 | - | (26.2) | 201.9 | 27.4 | 203.0 |
| 2028 | - | (26.3) | 205.7 | 28.0 | 207.4 |
| 2029 | - | (26.4) | 209.6 | 28.6 | 211.8 |
| 2030 | - | (26.5) | 213.6 | 29.2 | 216.3 |
| 2031 | - | (26.6) | 217.7 | 29.8 | 220.8 |
| 2032 | - | (26.7) | 221.8 | 30.3 | 225.4 |
| 2033 | 24.0 | (26.8) | 226.0 | 30.9 | 254.2 |
| 2034 | - | (26.9) | 230.3 | 31.5 | 234.9 |
| 2035 | - | (27.0) | 234.6 | 32.1 | 239.8 |
| 2036 | - | (27.1) | 239.1 | 32.7 | 244.7 |
| 2037 | - | (27.2) | 243.6 | 33.2 | 249.7 |
| 2038 | - | (27.3) | 248.3 | 33.7 | 254.7 |
| 2039 | - | (27.4) | 253.0 | 34.3 | 259.9 |

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|---|---|---|---|---|---|
| 2040 | - | (27.5) | 257.8 | 34.7 | 265.0 |
| 2041 | - | (27.6) | 262.7 | 35.2 | 270.3 |
| 2042 | - | (27.7) | 267.7 | 35.6 | 275.6 |
| 2043 | - | (27.8) | 272.8 | 36.1 | 281.0 |
| 2044 | - | (27.9) | 278.0 | 36.5 | 286.5 |
| 2045 | - | (28.1) | 283.3 | 36.8 | 292.0 |
| 2046 | - | (28.2) | 288.7 | 37.2 | 297.6 |
| 2047 | - | (28.3) | 294.2 | 37.5 | 303.3 |
| 2048 | - | (28.4) | 299.8 | 37.8 | 309.1 |
| 2049 | - | (28.6) | 305.5 | 38.0 | 314.9 |
| 2050 | - | (28.7) | 311.3 | 38.2 | 320.8 |
| 2051 | - | (28.8) | 317.2 | 37.7 | 326.1 |
| 2052 | - | (29.0) | 322.9 | 37.1 | 331.1 |
| | | | | **ENPV ($ million)** | **5.9** |
| | | | | **EIRR** | **14.9%** |

EIRR = Economic Internal Rate of Return, ENPV = Economic Net Present Value, O&M = Operations and Maintenance.

Source: ADB estimates

**Table 2. Economic Sensitivity Analysis**

| Indicators | |
|---|---|
| Total Cost | $10.7 m. |
| EIRR | 14.9% |
| ENPV | $5.9m. |
| 20% increase in costs – EIRR | 12.6% |
| 20% increase in costs – ENPV | $4.1m. |
| 20% reduction in revenues – EIRR | 12.2% |
| 20% reduction in revenues – ENPV | $2.9m. |
| 20% increase in costs and 20% decrease in revenues – EIRR | 10.1% |
| 20% increase in costs and 20% reduction in revenues – ENPV | $1.1m. |

EIRR = Economic Internal Rate of Return, ENPV = Economic Net Present Value, O&M = Operations and Maintenance, m. = million.

Source: PPTA Consultants' estimates.