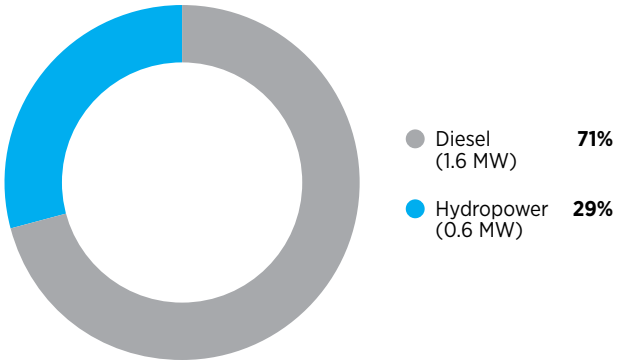
Grid integration assessment:
Espiritu Santo, Vanuatu

IRENA
International Renewable Energy Agency

DISPATCH AT PEAK DEMAND (2016)



- Higher share of diesel generation and thus higher costs.

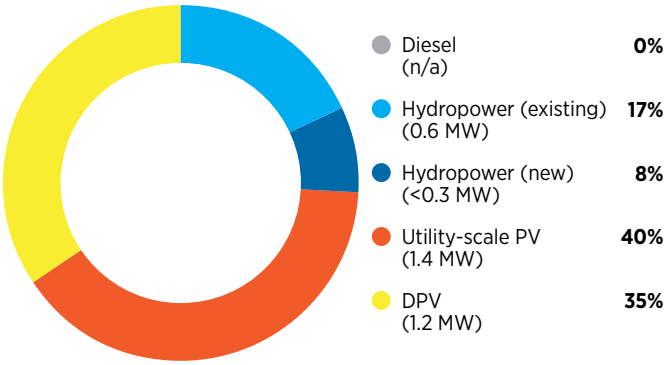
GRID INTEGRATION ASSESSMENT

IRENA's grid study, aimed at assisting the country and local communities, analysed:

- Extension of the power system to Port Olry;
- Options to increase the **use of renewables** such as through:
  - **Hydropower and solar power expansion**
  - **Lowest-cost power mix without major enablers**
  - **Biofuels and modern bioenergy development**
  - **Highest achievable shares of renewable power**

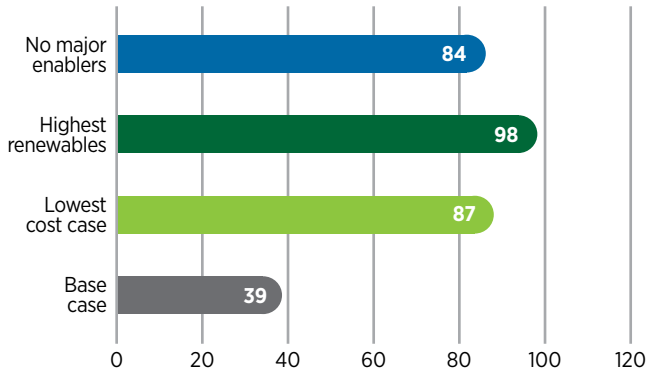
IMPACT

2030 dispatch at peak demand with 100% renewable generation



- No generation with diesel
- Increased share of hydropower and solar

RENEWABLE SHARES (%) ACHIEVABLE BY 2030



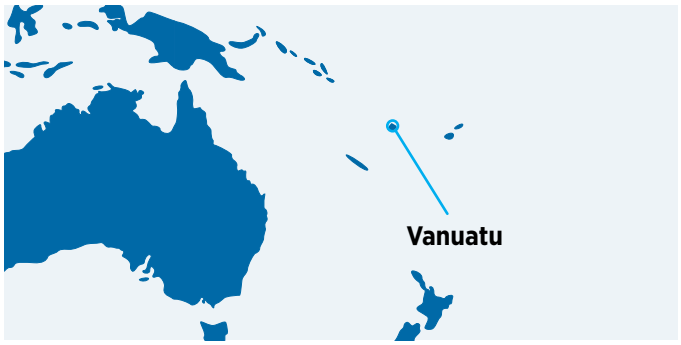
The best renewable option for Espiritu Santo involves **800 kW** + **300 kW** (both new) for hydropower, combined with, **2 MW** of solar PV, a **1 MW/2 MWh** battery, **0.5 MW** of diesel UPS and a comprehensive hybrid control system at current equipment costs, achieving **84%** renewable energy contribution in 2030.

RECOMMENDED GRID UPGRADES

- Installation of batteries/storage
- Diesel UPS
- Solar PV
- Hybrid control system

Summary of findings

from IRENA's Grid Integration Assessment for **Espiritu Santo, Vanuatu**



POWER SYSTEM CONDITIONS (2016)

The power system of the Luganville grid on Espiritu Santo comprises one 600 kW and two 300 kW hydropower plants. Vanuatu Utilities and Infrastructure (VUI) has indicated that 40 kW of solar PV has been in place within the power system as of 2016. The remaining demand is supplied by five diesel generators. The total demand of Luganville and Port Olry is expected to grow to 15.13 GWh in 2030. The voltage levels in the system vary between 20 kV and 5.5 kV at feeder level.

THE STUDY

The techno-economic study was undertaken for Vanuatu upon the request of the Department of Energy (DoE) of the Republic of Vanuatu. This grid integration study presents a high-level assessment of the potential to expand the proportion of renewable energy in the Luganville grid on Espiritu Santo to 100%. It is intended to provide guidance to the Vanuatu DoE and VUI on setting objectives and refining options for renewable energy investment.

POWER SYSTEM MODELLING AND SIMULATION STUDIES

Specialists at the International Renewable Energy Agency (IRENA) did the power system modelling in (PSS/E)® and later converted to Digsilent PowerFactory®. To model the power system, 16 scenarios were developed, following discussions between IRENA, the DoE and VUI, to present the combination of maximum and minimum power demand and supply scenarios.

HOMER Pro® was used to make energy balance calculations and sensitivity analyses, as well as to analyse least-cost options. The studies included steady state load flow analysis, along with voltage stability, frequency stability and transient stability studies.

kW = kilowatt
kV = kilovolt
MW = megawatt
GW = gigawatt
GWh = gigawatt hours
PV = photovoltaic

RECOMMENDATIONS

The following recommendations were made to improve the share of renewable power generation on the Luganville grid:

- Use of **improved control systems** and upgraded transmission assets.
- Improve the control capabilities of **existing hydropower** stations.
- Develop a **detailed grid code** and interconnection requirements for new generators.
- Review **frequency constraints**.
- Upgrade **existing network** and assets to accommodate more renewables and higher load.
- Review **entire power system**, including generation, feeders and protection systems.
- Use of batteries and where necessary diesel to maintain **uninterrupted power supply (UPS)** at specific locations.
- Install **flow monitoring** equipment.

GRID DEVELOPMENT OPPORTUNITIES

- The best renewable option is **Lowest cost Case 1**, with new hydropower installations of **800 kW + 300 kW (both grant-funded)**, supplemented with **2 MW** of solar PV, a **1 MW/2 MWh** battery, **0.5 MW** of diesel UPS and a comprehensive hybrid control system at current equipment costs, achieving an **87%** renewable energy contribution in 2030.
- The second-best renewable option is **Lowest cost Case 2**, obtained from new hydropower installations of **800 kW (grant-funded) + 300 kW (non-grant-funded)**, supplemented with, **2 MW** of solar PV, a **1 MW/2 MWh** battery, **0.5 MW** of diesel UPS and a comprehensive hybrid control system at current equipment costs, achieving an **87%** renewable energy contribution in 2030.