
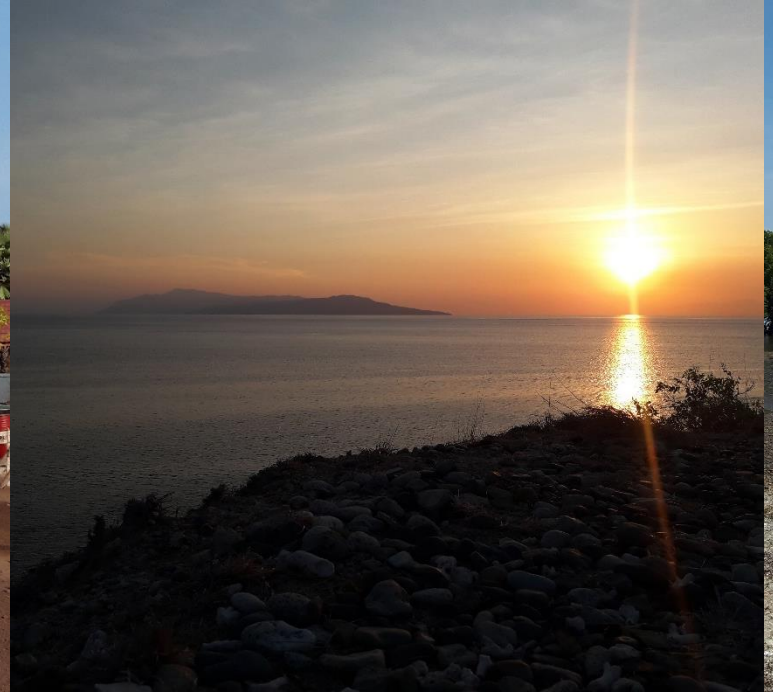


From gensets to renewable hybrid microgrids in Maluku

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NZMATES

Outline

Introduction

Context and projects

PV-Diesel Hybrid Microgrids

Summary and lessons

NZMATES Introduction

NZMATES (New Zealand – Maluku Access to Renewable Energy Support) main goal is to support the uptake of affordable, reliable, and renewable energy in Maluku Province

- 5-year technical assistance programme to support renewable energy
- Funded by New Zealand's Ministry of Foreign Affairs and Trade (NZ MFAT)
- Partnership Arrangement with Indonesia's Ministry of Energy and Mineral Resources and PLN (utility company) at national level
- Delivered by Infratec, with Yayasan Mercy Corps Indonesia (YMCI)
  - Infratec: NZ-based company EPC and Consultancy
  - MCI: 20 years experience in Maluku

NEW ZEALAND FOREIGN AFFAIRS & TRADE Aid Programme

INFRATEC

Mercy Corps Indonesia

Context highlights

Maluku Province

- 1.7 million people, 1340 islands
- 120 inhabited islands with 1241 villages
- Electrification ratio reached 93.7% in August 2020
- There are over 300 diesel gensets installed in almost 100 grids, consuming >120 Million litres of diesel annually
- Grids range from 5 kW to 60 MW peak demand
- The cost of generation goes from **0.20 – 1.1 USD/kWh**

Project Information

PLN aims to hybridize existing diesel generators in Maluku Province to reduce fuel use and levelized cost of electricity

Location: 18 diesel-powered locations grouped in 3 geographic areas

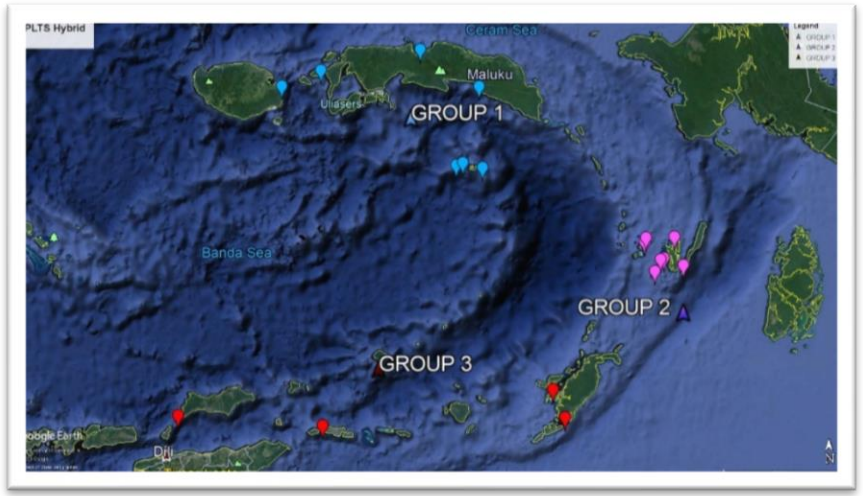
Currrent LCOE: 0.4-0.96 USD/kWh

Estimated Fuel Consumption: 5.4 Million L/yr

Solar Irradiance: 4.45-5.44 kWh/m^2/day*

Project Scope: four technical options assessed per site

- PV grid-connected (no storage)
- Small PV Hybrid microgrid (<30% RE Fraction)
- Medium PV Hybrid microgrid (>50% RE Fraction)
- Large PV Hybrid microgrid (>80% RE Fraction)



*) source: Meteonorm 7.2 and SolarGIS

Simplified Workflow

STAGE 1

Data cleaning and analysing

Load Profile Assumption

Solar System Potential

Economic Data:
- Cost Curves (PV, BESS, O&M)
- Diesel fuel price per group location

STAGE 2

Initial HOMER Modelling and recommendation for all sites in group

Group feasibility study:

Recommended systems, Economic parameters

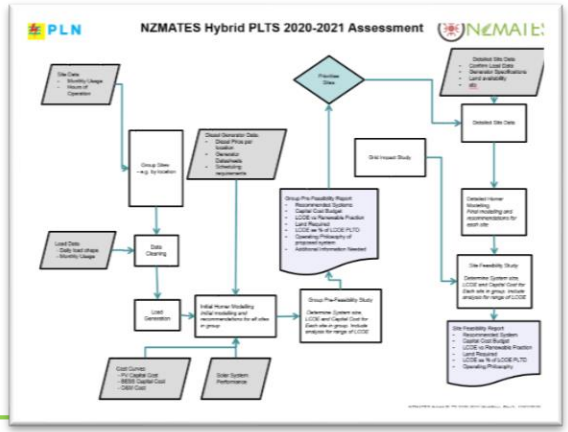
Prioritise Site

STAGE 3

Detailed sites data

Detailed HOMER Modelling

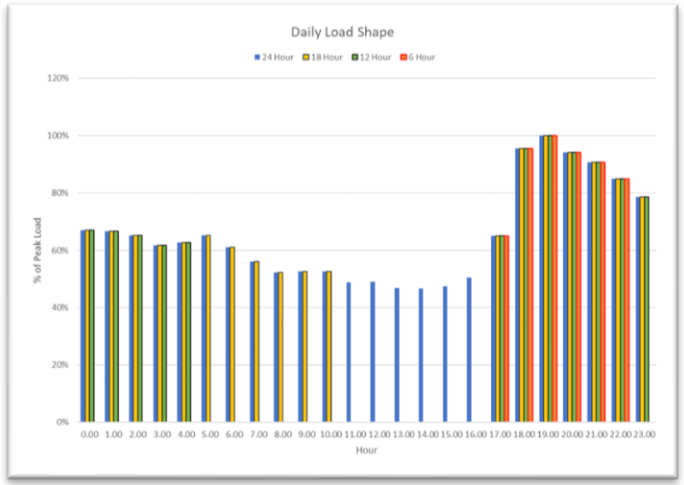
Detailed Feasibility Study



System design considerations

Load assumption builder

- Historical load data available for hundreds of diesel gensets
- Load converter to 24 hours operation (in some cases)
- Immediate and future load growth



Cost curves developed

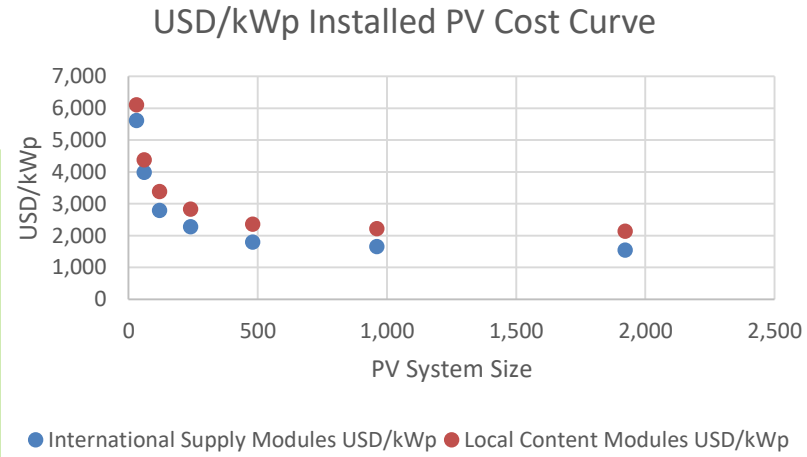
- Costs based on built projects and local costs

Diesel fuel cost

- Fuel cost based on group location

Inputs are used to drive a PVSyst and HOMER study

- Several options are modelled – different configurations and RE fraction



HOMER Modelling

Group modelling result example

Sensitivity		Architecture												Cost				
PVsyst Derating (%)	Community Load Scaled Average (kWh/d)	⚠						PVsyst	Generator (kW)	Generator (1) (kW)	100kWh - 4Hr	BESS Inverter (kW)	Dispatch	NPC ($)	COE ($)	Operating cost ($/yr)	Initial capital ($)	Ren Fr (%)
100	320								20.0	50.0			LF	$1.11M	$0.748	$95,337	$88,675	0
86.2	2,202							21.0	200	20.0	15	999,999	LF	$4.24M	$0.414	$200,934	$2.08M	65.5
94.6	562							8.00		50.0	6	999,999	LF	$1.55M	$0.593	$53,085	$978,973	88.8
96.0	876							11.0		100	9	999,999	LF	$2.08M	$0.509	$72,834	$1.29M	85.5
96.2	365								20.0	50.0			LF	$1.21M	$0.709	$103,760	$88,675	0
97.8	1,410							16.0	100	50.0	12	999,999	LF	$2.86M	$0.436	$107,892	$1.70M	78.9
98.0	1,404							16.0	100	50.0	12	999,999	LF	$2.85M	$0.436	$106,961	$1.70M	79.1

Represent total specific energy yield in each location

Total demand (kWh/day) in each location

Decision Criteria

Renewable energy fraction

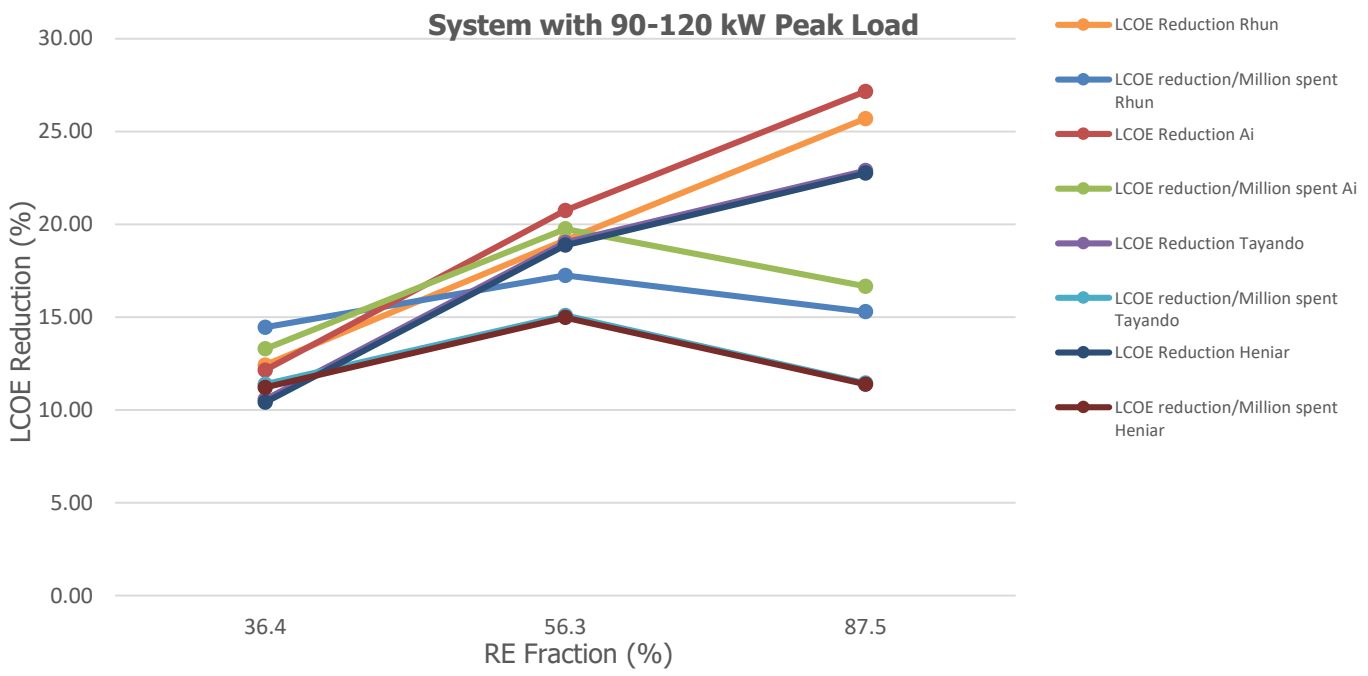
- Achieve 23% of RE penetration by 2025

LCOE and fuel consumption

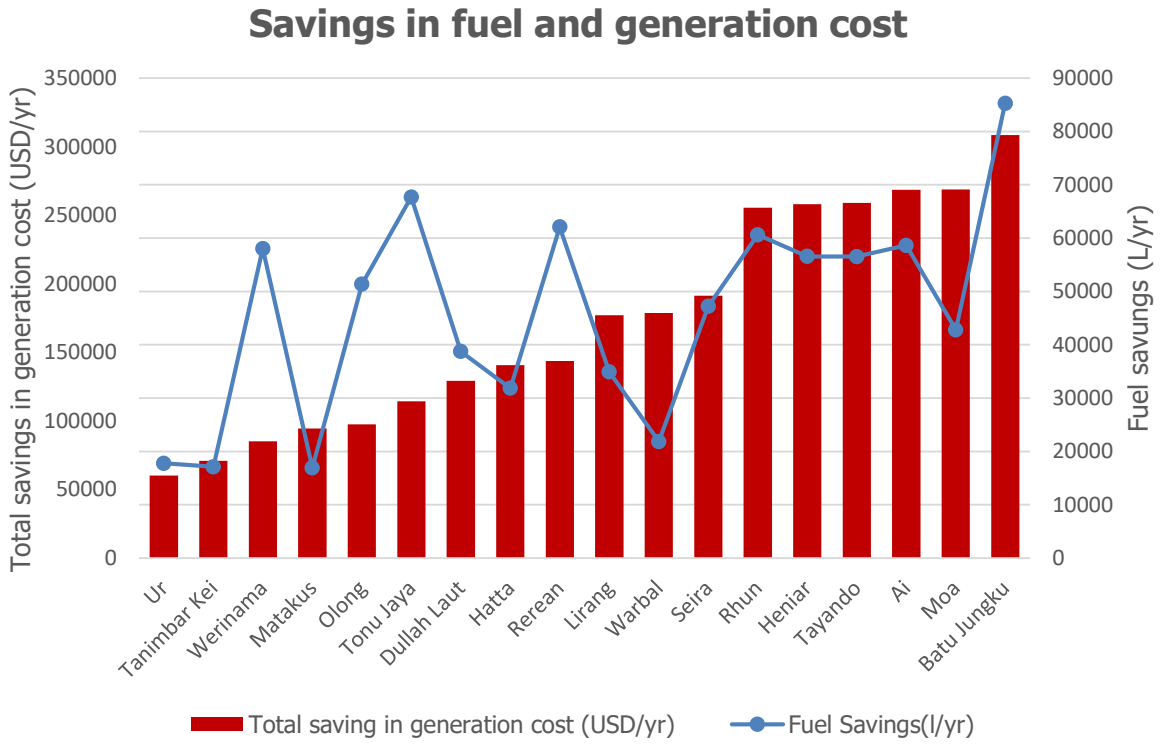
- Lower LCOE and fuel consumption is obtained

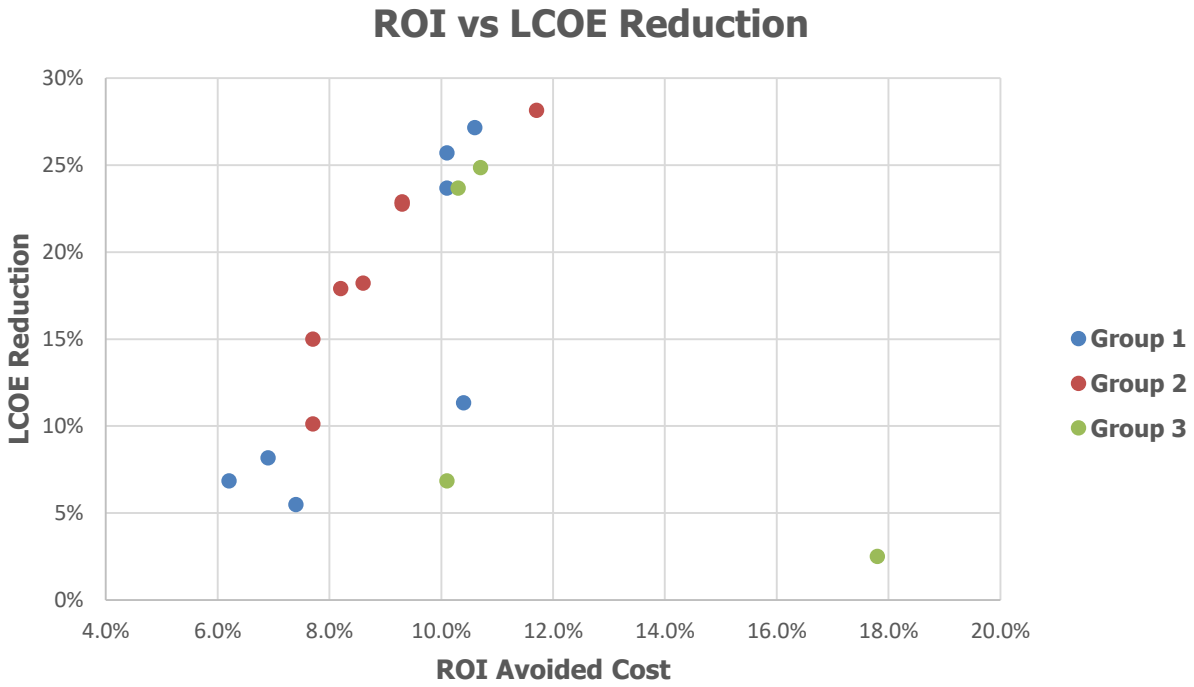
Return on Investment

- Prioritize by the most significant value for money between projects due to capital limitation



Site Priority





Site Priority

Site	Peak Load(kW)	PV Size (kWp)	BESS Size (kWh)	Diesel generators (kW)	Total saving in generation cost (USD/Year)	ROI with Avoided Cost (%)	CAPEX (USD)	Recommended System LCOG (per kWh)	LCOE reduction (%)
Moa	1487	360	-	2x1000	$ 69,127.35	17.8%	$ 1,480,000	0.39	3%
Warbal	45	210	600	100	$ 45,949.12	11.7%	$ 948,410	0.572	28.1%
Lirang	60	210	800	100	$ 45,530.10	10.7%	$ 1,090,000	0.49	25%
Ai	92.00	450	1300	200	$ 69,048.88	10.6%	$ 1,630,000	0.432	27%

Key Result Summary

Parameter	Value
PV Size	160 – 600 kWp
RE Fraction	6 (grid connected)-91%

Parameter	Value
NPC	1-34 Million USD
ROI	6-18%
LCOE	0.36 – 0.73 USD/kWh
LCOE Reduction	3-28%
Payback	5.6-8.7 years

Summary and lessons

Technical

- For most sites, high RE fraction over 80% gives higher savings, although medium RE fraction is recommended for some systems >250 kW and on-grid for the largest system
- Larger demand with high RE fraction reduce significant fuel consumption
- Total PV capacity: 6.5 MWp from 18 locations
- CO2 avoided: 9,528 tonnes/year

Economic

- Fuel consumption reduction: 3,212,168 L/year
- Savings in generation cost: 797,667 USD/year
- LCOE of recommended system: 0.36-0.73 USD/kWh

Next Steps

Desk-Study and Planning

- Detailed feasibility study for next year project implementation
- Incorporate hybrid solution into national electricity master plan as a strategy to achieve 23% Renewable Energy share

Project Implementation

- Developed typical technical specification for Hybrid Power Plants
- Next year project implementation will be dependent on COVID 19 situation.
- Build and start to construct Hybrid Power Plant in Pulau Tiga

Capacity Development

- A Microgrid Lab is being built in University of Pattimura to support training of new generation
- NZMATES has been working with PLN to form a renewable energy unit at the provincial level

Thank you

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