EU – Philippines

Access to Sustainable Energy Programme

Solar hybridization of diesel power plants: A programmatic approach

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Philippines Mini-Grid B2B Forum

Session II: Hybridisation of existing island diesel mini-grids and power plants

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Hybridization as key for Philippines to move towards a sustainable future!

Pictures by NPC

Hybridization to reduce fuel consumption and costs

- Hybridization should **reduce** the generation **costs** and **extend reliability and service** hours.
- It should also represent a **viable business case** for the private sector to take over NPC SPUG plants and hybridize them or to extend with **PV** or other **renewable energy technologies**.
- ASEP supports with hybridization **prefeasibility study**, hybridization **pilot study** (Cuyo island), and the development of a **simplified planning tool** for hybridization.

Motivation of different stakeholders for hybridization

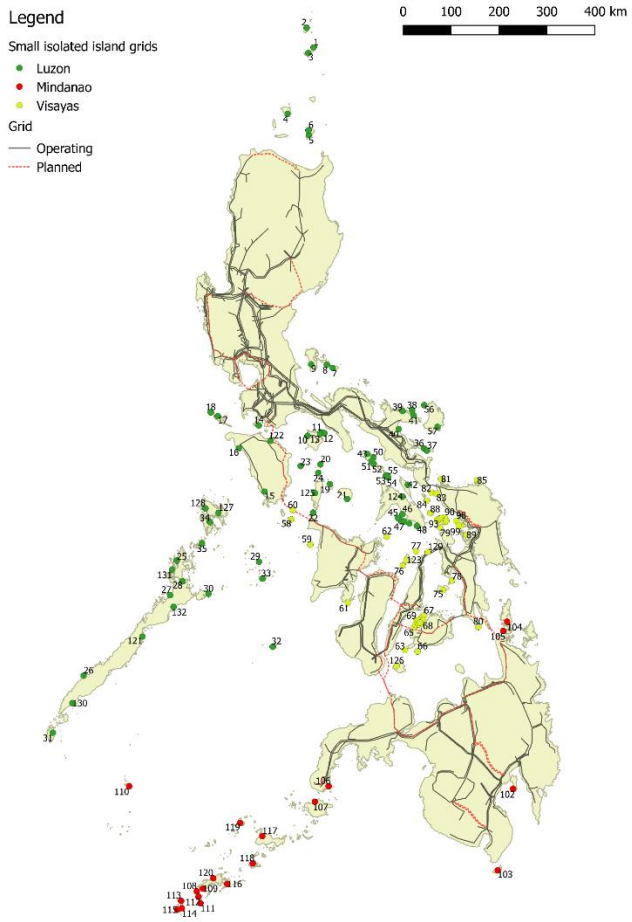
Overall: Increase resilience, improve reliability of supply, reduce fuel consumption and emissions.

- **NPC SPUG**: Lower fuel and operational costs
- **DOE**: Reduce UCME subsidies
- **Private sector**: Create attractive investment options
- **ECs**: Offer sustainable and affordable electricity to customers in isolated areas. JV opportunities. Prepare for a future without subsidies.
- **Customers**: Longer service hours, fewer outages

Hybridization prefeasibility study

- Island Grid (IG) is an isolated grid which can consist of one or many power plants
- A total of 132 IGs have been initially identified excluding the very small IGs in Masbate (PRES)
- Extensive data collection was conducted focusing on energy demand, load profiles, diesel fuel costs, diesel generator efficiencies
- Detailed information are available on grid name, region, operating hours, demand, installed capacity, distribution utility and operator of power plants

Prefeasibility study - Island grid overview



Key information of identified small isolated island grids per region.

Region	No. of grids	No. power plants	Operating hours	Rated capacity	Diesel fuel price	Peak demand	Demand
	[#]	[#]	[hours]	[MW]	[USD/ liter]	[MW]	[GWh/a]
	sum	sum	avg.	sum	avg.	sum	sum
Luzon	67	99	16.5	356.2	0.55	190.7	1022.6
Visayas	46	48	12.8	26.6	0.51	13.1	59.7
Mindanao	19	22	16.2	67.1	0.63	29.8	177.5
National	**132**	**169**	**15.2**	**449.9**	**0.56**	**233.6**	**1259.8**

Prefeasibility study - approach

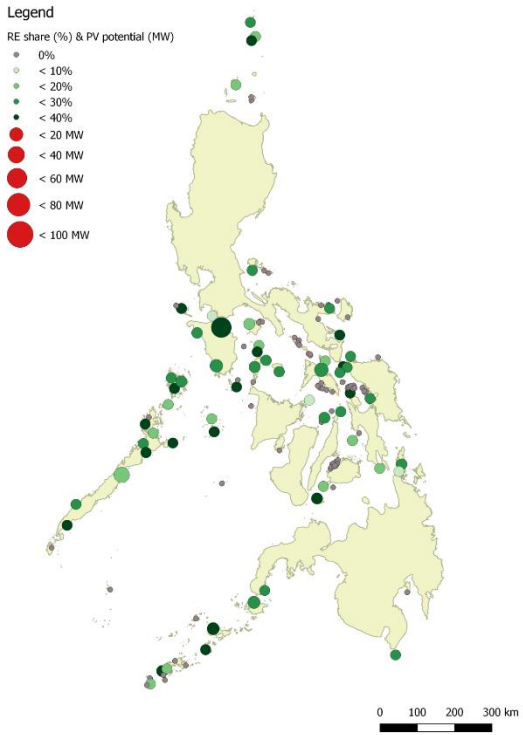
- Modelling of cost optimized system for each IG
- Solar PV and Li-Ion Batteries have been considered along other techno-economic parameters
- Scenario 1 : Status Quo
- Scenario 2: Load Growth

Overview on technical and economic input values for energy system simulation tool.

Category	Parameter	Unit	Value
PV	CAPEX	USD/kW	1500
	OPEX	USD/kW/year	30
	lifetime	years	20
Battery	CAPEX (Capacity & Power)	USD/kWh	700
	OPEX	USD/kWh/year	10.5
	lifetime	years	10
	maximum C-rate	kW/kWh	1
	maximum depth of discharge	%	80
	charging efficiency	%	90
	discharging efficiency	%	90
	initial state of charge	%	50
Diesel	CAPEX	USD/kW	0
	OPEX (fix)	USD/kW/year	10
	OPEX (var)	USD/kWh	0.02
	Lifetime	years	20
	Rotating mass	%	40
	Efficiency	l/kWh	Individual for each SIIG
	Fuel price	USD/liter	Individual for each SIIG
Economic	Project lifetime	years	20
	Annual Fuel Changings	%	3
	WACC	%	10

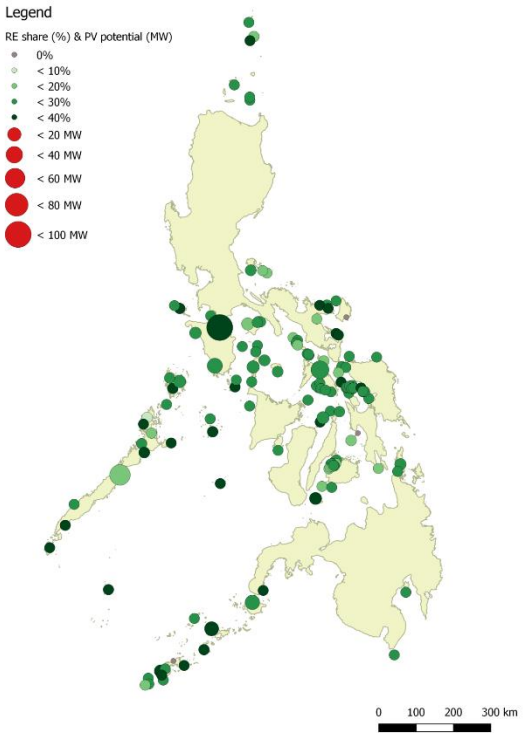
Prefeasibility study - results

Status quo



PV potential:	**226 MW**
Battery potential:	**50 MWh**
LCOE redution:	**0.2 USD/kWh**
RE share:	**24.4**

Load growth

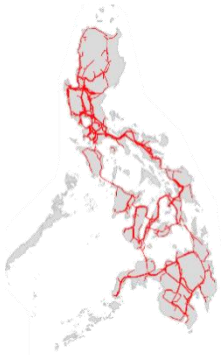


PV potential:	**492 MW**
Battery potential:	**111 MWh**
LCOE redution:	**0.2 USD/kWh**
RE share:	**24.8**

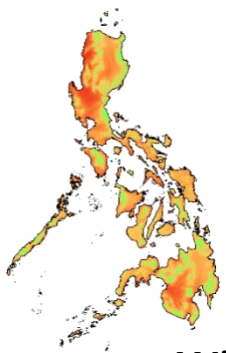
What else is out there?

Off-grid & On-grid Islands

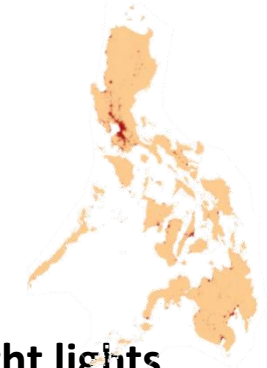
Power grid



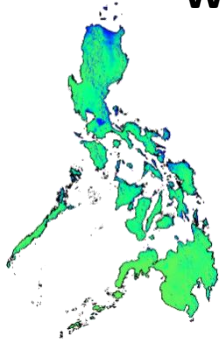
Solar Potential



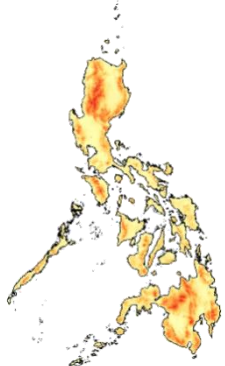
GIS analysis



Night lights



Wind Speed



Altitude

What else is out there? Small island landscape

Pop. Class	Island	Population	GDP	Area	Altitude	GHI	Wind Speed	Distance to Grid
	#	Sum	Sum	Sum	Mean	Mean	Mean	Mean
			Mill. USD	km^2	m	kWh/m2/year	m/s	km
< 100	1,457	31,400	2.6	310	11	1,839	1.15	120
< 500	398	92,500	33	512	19	1,840	2.01	95
< 1,000	91	64,000	38	315	22	1,849	3.34	85
< 5,000	138	289,600	45	1,400	28	1,851	3.89	110
< 25,000	35	413,100	340	1,550	45	1,848	4.59	110
< 100,000	10	603,500	93	1,730	390	1,799	5.22	55

- Overall 2,129 islands with 1.5 million people without grid connection or island grid (official)
- Island classes > 500 and <5,000 interesting, as similarity of conditions may allow for project clustering

Hybridisation of existing island diesel mini-grids and power plants

Opportunities

- Large market potential with project opportunities in many size classes (few kW to MW)
- High impact for local development
- Role model for RE deployment in the region

Bottlenecks

- Coordination between actors (IPP, EC, NPC)
- Concern about grid stability after RE integration from grid operators (ECs)
- Long approval procedures for both investors and ECs

Thank you very much for your attention!
Maraming Salamat Po!

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