Successful microgrid deployment

EPS experience in Somalia & the Maldives

Manila, 5 June 2018

endless energy. everywhere.

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Our Mission

EPS is part of the **Engie group.**

The Group’s mission is to **unlock the energy transition** by mastering the intermittency of renewable energy sources.

To be a pioneer in **hybrid storage solutions,** transforming **intermittent renewable** sources into a **stable power source.**

And **to enable renewables to power the societies of the future** reliably, affordably and sustainably.

How we power islands and off-grid areas

COMMODITIES

Renewable Sources

Generators and Power Plants

Battery Pack

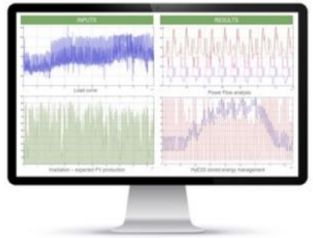
HyESS®

HYBRID ENERGY STORAGE SYSTEM

24/7 stable power supply

HYDROGEN MODULE
Power2Power for long term storage without fossil fuels

SMART INVERTER
Instant RPPT/MPPT for unique microgrid performance



ENERGY MANAGEMENT SYSTEM (EMS)
Pool Algorithms & Black Start

BATTERY MANAGEMENT SYSTEM (BMS)
For all battery chemistries

POWER CONVERSION SYSTEM (PCS)
Synthetic Inertia
DROOP Control and Statism

SCADA and AI
Cloud based DERs, Cybersecurity and Predictive Maintenance

Spinning reserve: the game changer for storage economics

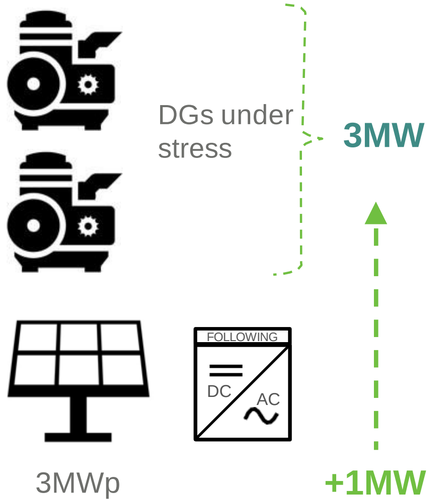
220-500€/MWh
depending on fuel price

Rotating Inertia

Peak load 2.5MW
max load insertion 2MW
Genset ramp 1.5MW (60%).
2 gensets installed running at partial load, with high inefficiency and high fuel consumption.

190-440€/MWh
depending on PV size and WACC

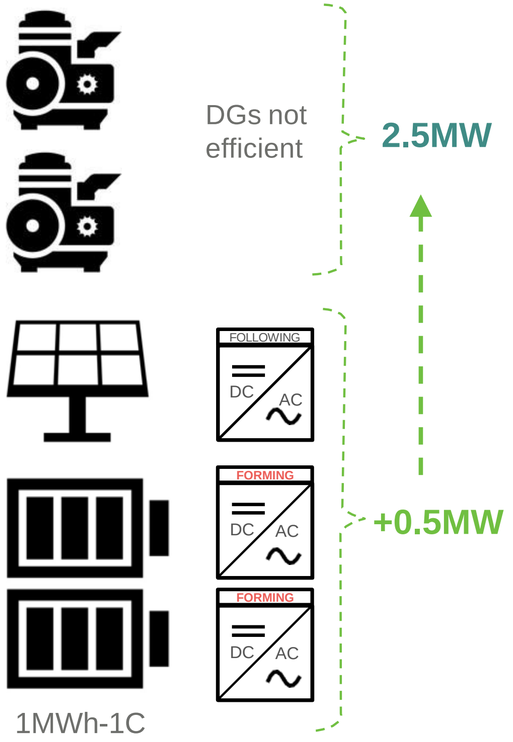
(+) Rotating Inertia



Intermittent solar requires **additional spinning reserve** which increases genset inefficiency, keeps fuel consumption high, and **offsets the low-cost solar power.**

180-420€/MWh
depending on PV/ESS size and WACC

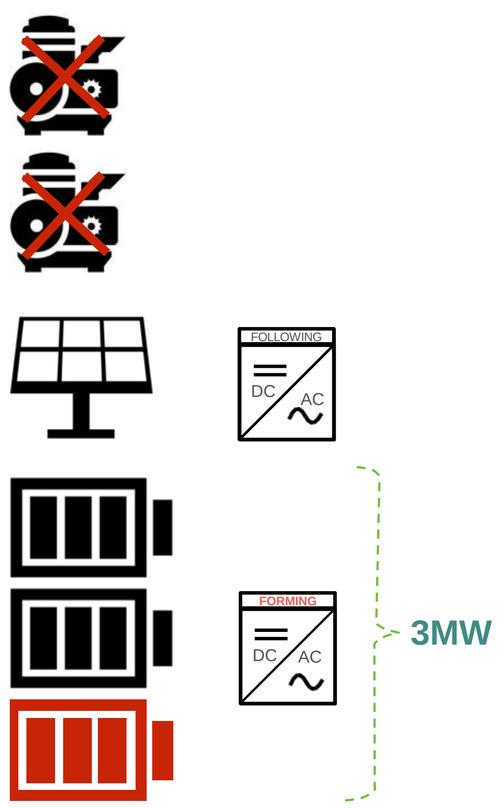
(–) Rotating Inertia



Storage with “Following” inverters just **minimize** the PV **intermittency** but **do not manage the spinning reserve**. Gensets are on at full speed despite the PV installed.

200-460€/MWh
depending on PV/ESS size and WACC

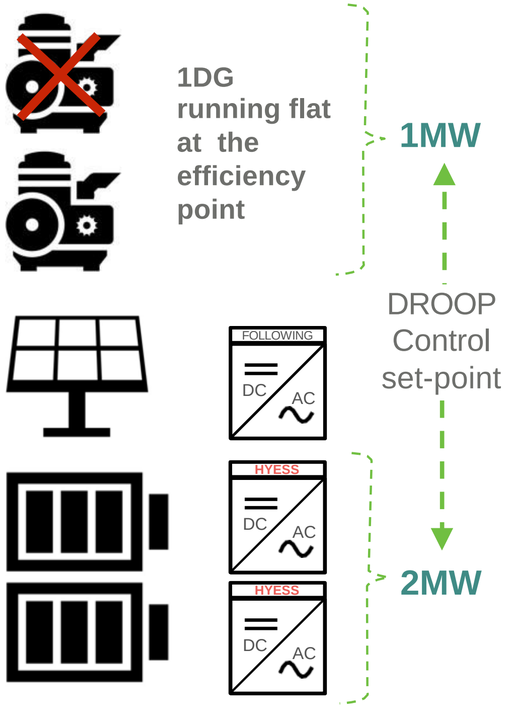
Synthetic Inertia



Storage with “Forming” inverters allow gensets to turn off, **full spinning reserve** managed by an **oversized storage capacity**.

90-300€/MWh
depending on PV/ESS size and WACC

Full Virtual Inertia



HyESS enable **spinning reserve sharing between the gensets and storage**, limiting the former to a base-load **flat running at the efficiency point**, and following load peaks with storage.

Our global footprint: 40MW of microgrids worldwide

Diesel Generator	Solar *(no storage)*	Hybrid Power *(solar + hybrid storage)*
220-500 €/MWh depending on fuel price	**40-100 €/MWh** depending on scale and WACC	**90-300 €/MWh** depending on scale and WACC
Base-load 24/7 power	Intermittent 6-8 hours/day	24/7 primary clean power source

HyESS: 0.5MW/0.6MWh

PV : 1.8MWp

DG: 8MVA

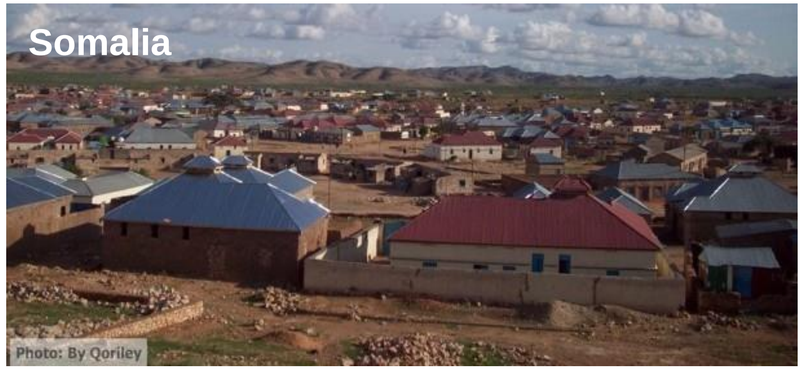
10.2MW
installed power

HyESS: 0.2MW/1.1MWh

PV : 125kWp

Diesel free (back-up)

1MWh
hydrogen module



HyESS: 1MW/1.8MWh

PV : 1MWp

Wind: 0.8MW

DG: 3.2MVA

5.9MW
installed power

HyESS: 1MW/ 0.5MWh

PV : 3MWp

Wind: 2MW

DG: 6MVA

12MW
installed power

HyESS: 0.5MW/0.3MWh

PV : 0.5MWp

DG: 2MW

3MW
installed power

Powering a town in Somalia

Somalia has no national grid, hence every town is a de facto microgrid

Initially only lead acid batteries were installed due to client preferences and lithium-ion technology was added in a second phase

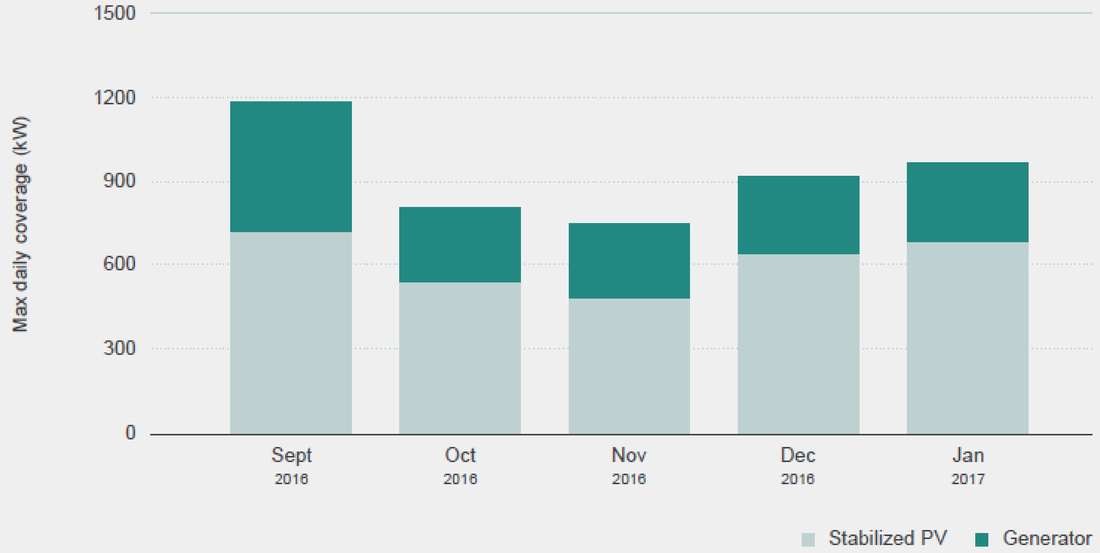
A third microgrid extension is being discussed, as a significant increase in load has been recorded since the introduction of stable and reliable power

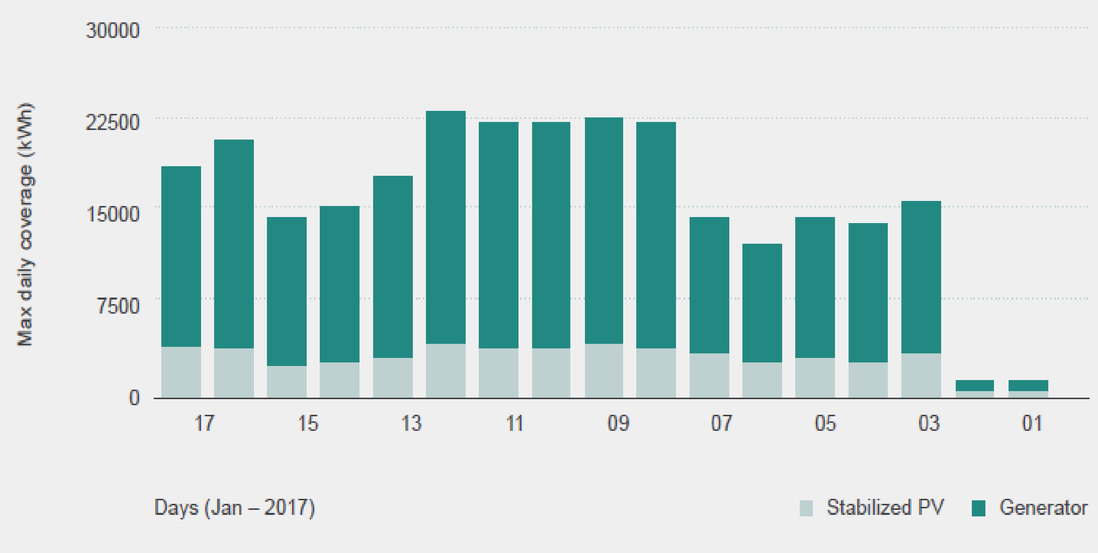
Microgrid features

- **PV:** 1MWp
- **Wind:** 750kW
- **Storage:** 1MW/1.8MWh
  ALA + Li-ion chemistry
- **DG:** 3.2MVA
- **Power Conversion System:** 1MW
  Full Virtual Inertia DROOP Control Technology
- **Master Controller**
  Pool Algorithms & Black Start Function
- **Connected Users:** 50,000+ people
- **CO_2 Reduction:** 600 tons/year
- **Electricity Bill reduction:** 17%

Powering a town in Somalia

Load coverage & diesel savings





90%	MAX INSTANT LOAD COVER WITH RES	50%	LOAD COVER IN ENERGY DURING WIND SEASON	1.1mln	LITERS DIESEL FUEL SAVED PER YEAR
20%	DUE TO PV + WIND DIESEL REPLACEMENT	+ 31%	DUE TO INCREASED DG EFFICIENCY	= 51%	FUEL SAVINGS

Somalia: main challenges & lessons learnt

Accurate load estimates

- Due to EPS' **system modularity**, we were able to easily add capacity on top of the previously installed system to cater to the **skyrocketing load** once better-quality affordable power was available in the town

Information asymmetry

- The client was initially **wary of using lithium-ion** battery technology due to its cost & perceived maintenance specifics: we opted for lead-acid to get the project off the ground. Lithium ion was added in the second stage, with **significant training** provided by EPS

CAPEX optimization

- We used **refurbished wind turbines** to deliver the system respecting the total investment that the client could allocate to the project

Diesel replacement

- We installed two types of renewables – wind and solar – to have significant portion of the load covered by clean power **instead of resorting to heavy time-shifting** via oversized batteries

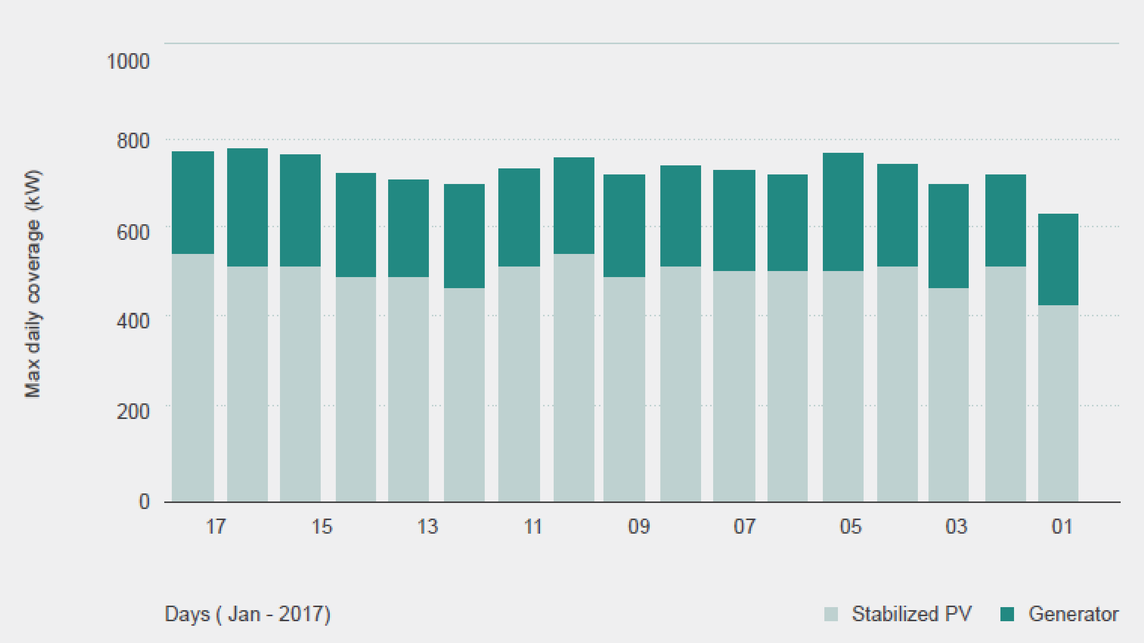
Powering two resorts in the Maldives

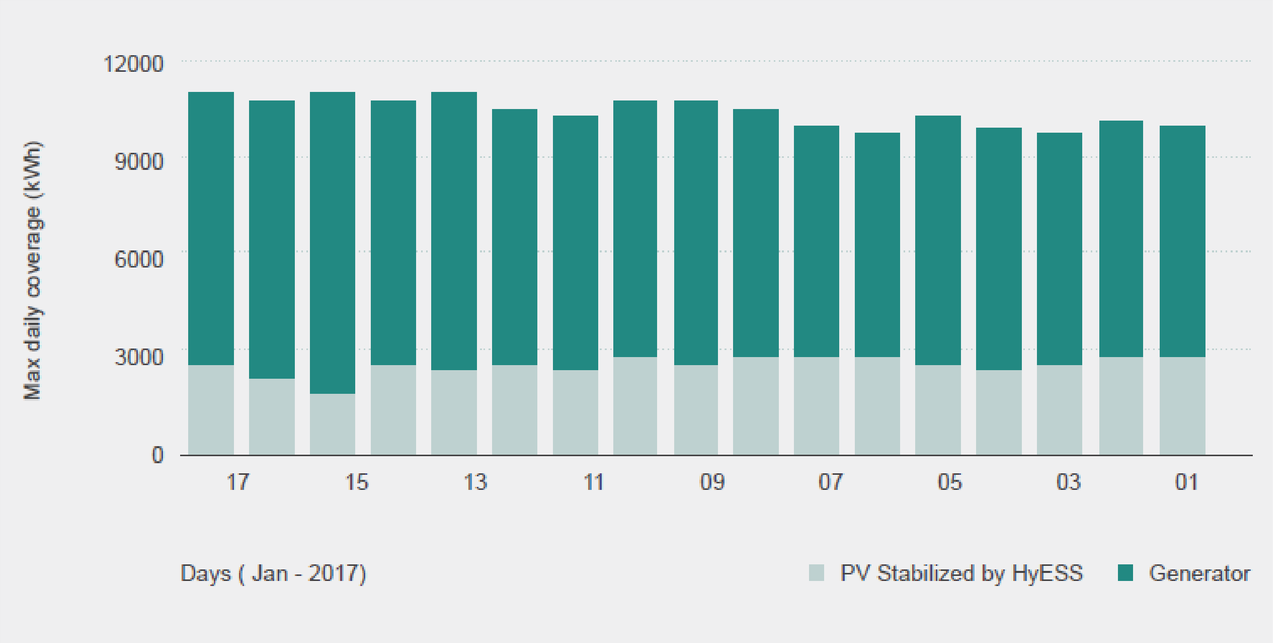
Main challenge: space constraints for PV installation
EPS solution: exploiting the footpaths that lead to resort villas

Microgrids features

- **PV:** 1.8MWp
- **Storage:** 0.5MW/0.6MWh
  Sodium Nickel chemistry
- **DG:** 8MVA
- **Power Conversion System:** 2.4MW
  Full Virtual Inertia DROOP Control Technology
- **Master Controller**
  Pool Algorithms & Black Start Function
- **Connected Users:** 2,000+ people
- **CO_2 Reduction:** 460 tons/year
- **Diesel reduction:**
  423,000 liters/year

Load coverage & diesel savings





63%	MAX INSTANT LOAD COVER WITH RES	26%	LOAD COVER IN ENERGY	423,000	LITERS DIESEL FUEL SAVED PER YEAR
26%	DUE TO PV DISPATCHABILITY	+ 30%	DUE TO INCREASED DG EFFICIENCY	= 56%	FUEL SAVINGS

An Energy Company with a clear Vision

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