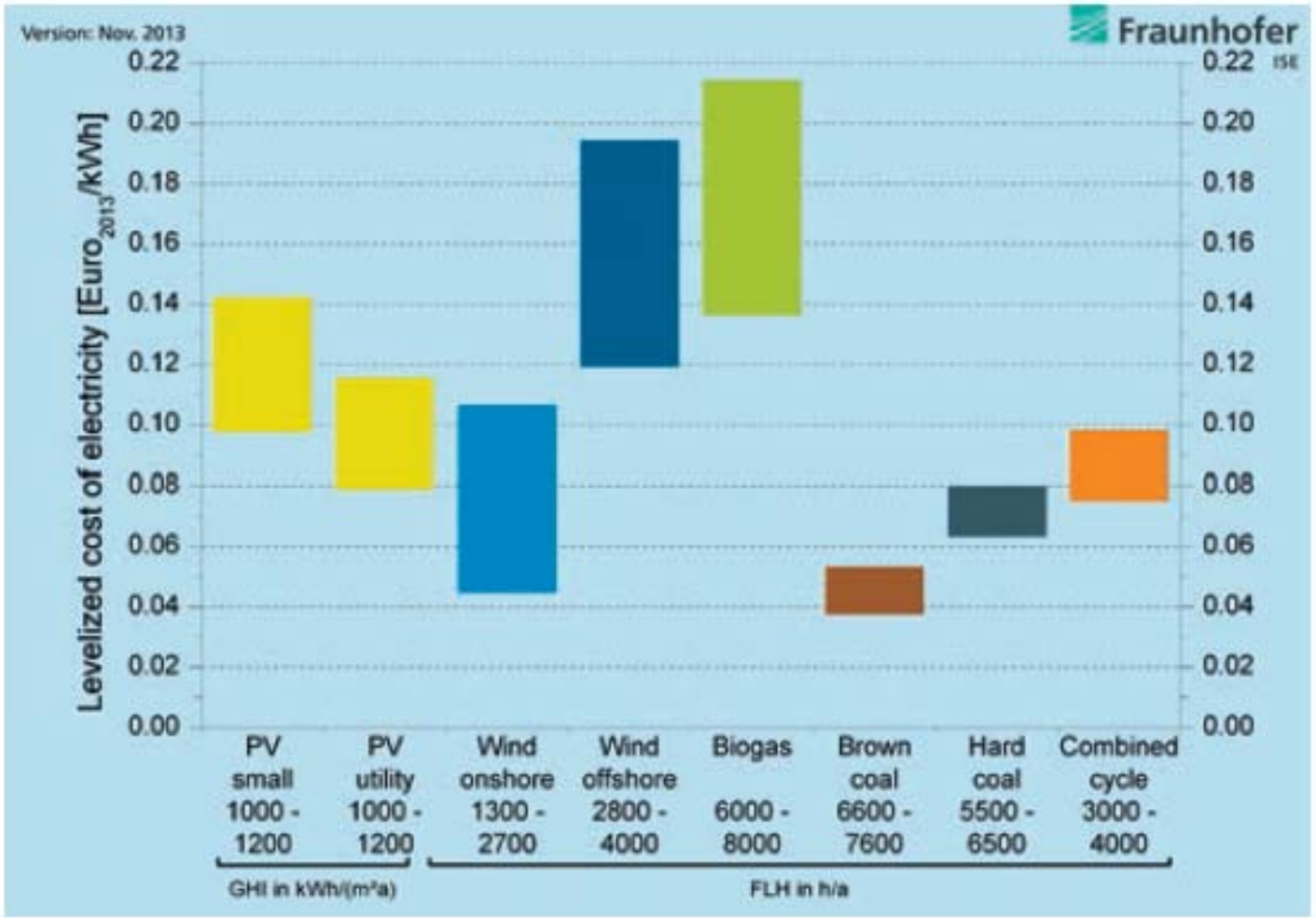
How to gain stable and economic advantageous PV-Hybrid Mini Grids

impacts of technical features on LCOE

Actual Situation

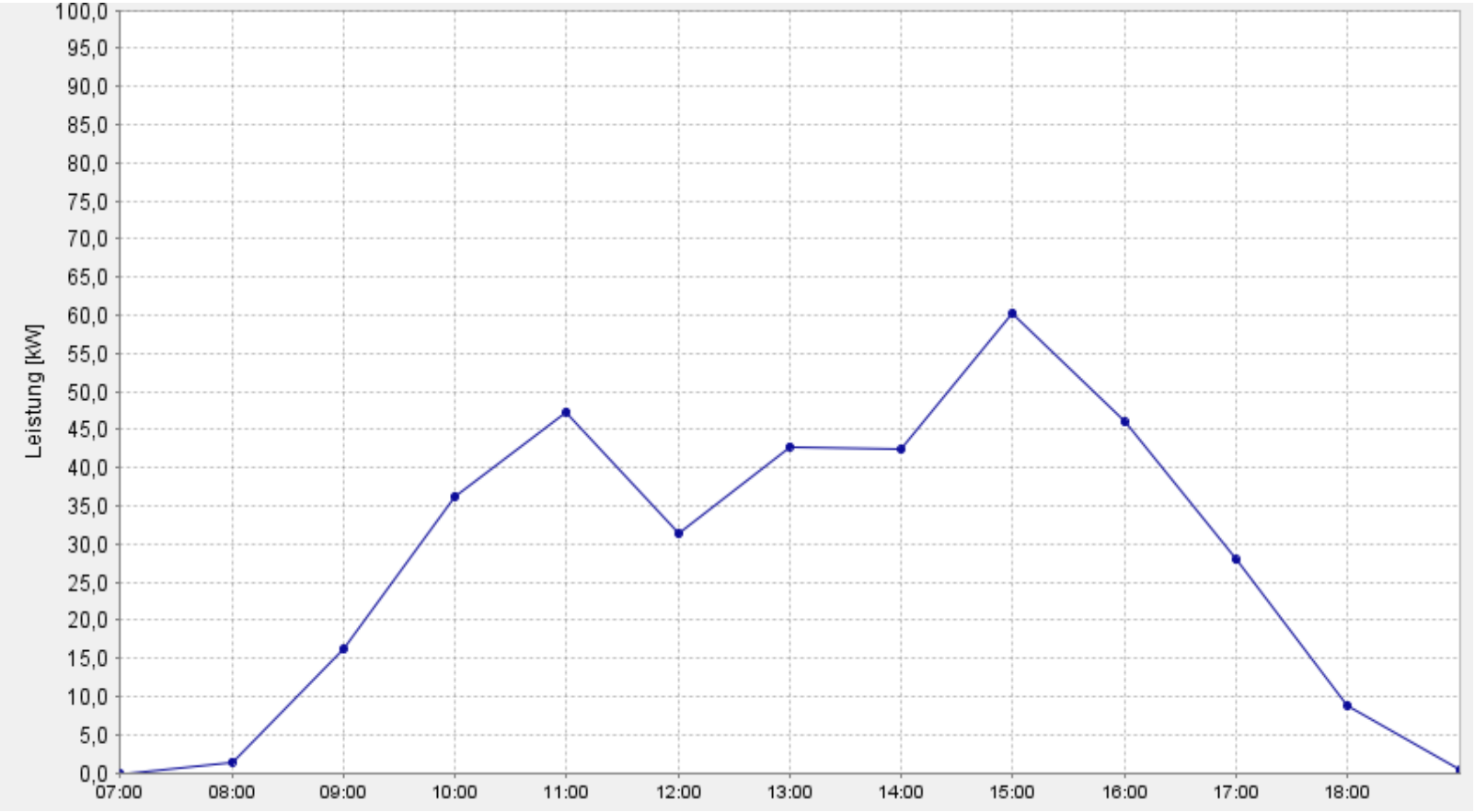
Energy generating technologies

overview of levelized costs of electricity dependent on technology



Levelized cost of electricity (LCOE)of renewable and conventional power plants in Germany 2013. The value under the technology refers in the case of PV to the insolation global horizontal irradiation (GHI) in kWh/m²/a. For the other technologies refers it to the full load hours (FLH) per power plant per year. Specific investments are taken into account with a minimum and maximum value.

Fluctuations of a medium sized photovoltaic system (100 kWp) during a scattered cloudy day



Data interval 1 Hour

Thanks to my former colleagues at syktron-energy for kindly sharing these pictures

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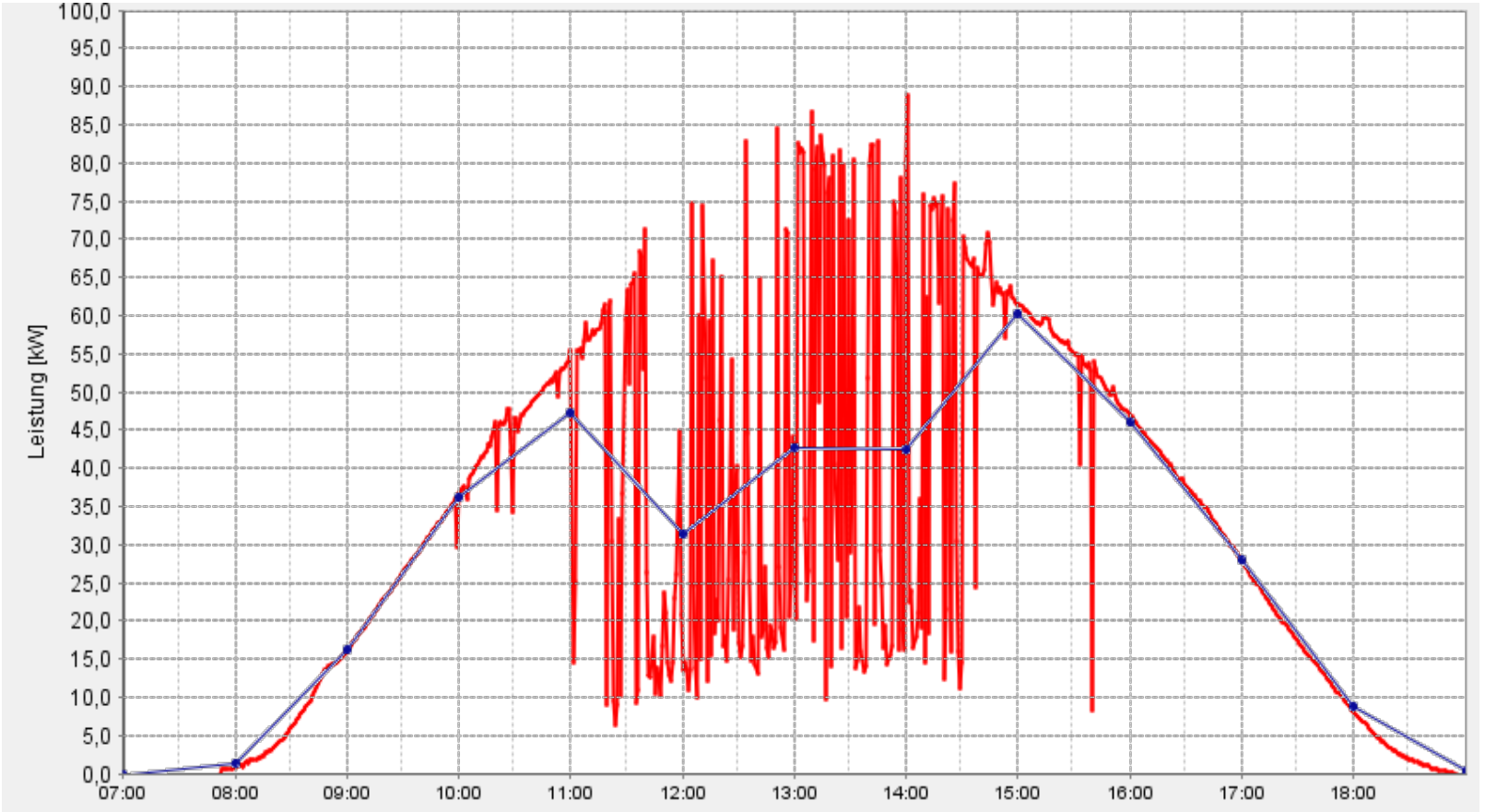

Strategies to solve this behavior:

1. Limit PV-power to an acceptable amount of fluctuations and keep enough genset capacity running

2. Install a storage unit which is able to capture all fluctuations

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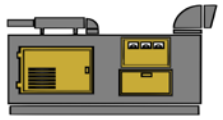
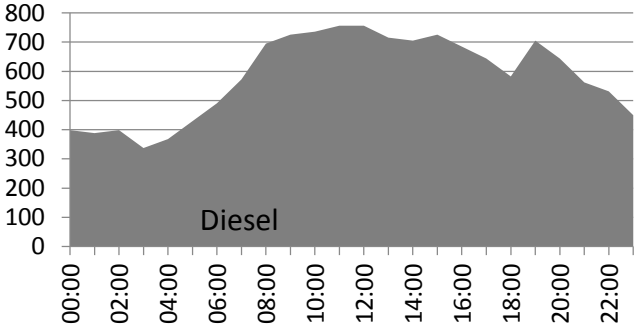
Possible energy generation systems in rural Kenya

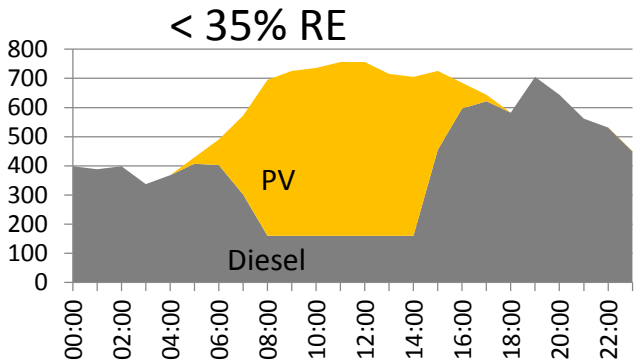


Diesel Genset only



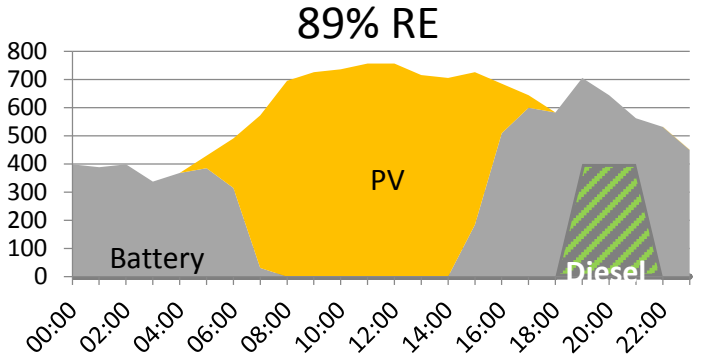
LCOE ≈ 44 $ct/kWh

PV + Diesel (Fuel Saver)



LCOE ≈ 37 $ct/kWh

Battery Hybrid System



LCOE ≈ 27 $ct/kWh

Gensets [kVA]	500 kVA / 500 kVA / 300 kVA	500 kVA / 500 kVA / 300 kVA	500 kVA / 500 kVA / 300 kVA
Online hours/genset/year	8760 h / 4758 h / 5023 h	8760 h / 2376 h / 5856 h	1109 h / 95 h / 1102 h
Fuel consumption [l/a]	1,392,130 L/a	956,365 L/a	153,508 L/a
PV-plant size [kWp]	-	2,000 kWp	3,500 kWp
Battery size [kWh]	-	-	8,500 kWh

How to get high renewable generation share

Shut down the Diesel gensets as often as possible !

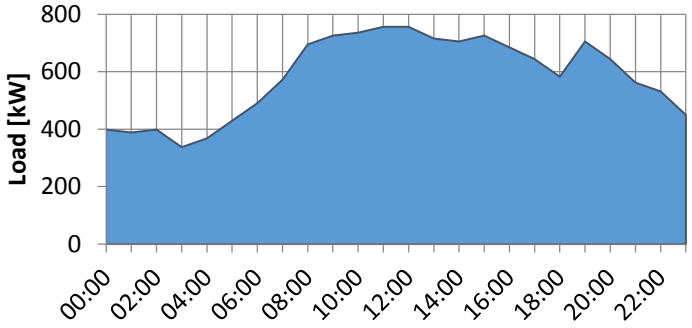
- **Battery-system (ESS) need to be sized to capture the full load demand**
- **ESS has to provide voltage source functionality**
- **ESS adjusts voltage and frequency in the grid**
- **ESS has to balance active and reactive power in the grid**
- **ESS has to provide enough short circuit current to shut down faults**
- **Use Diesel genset only in high efficient operating point.**

Technical requirements to achieve high renewable share in combination with low LCOE

Requirement		Effect
Long lasting system design	• Project life >20 Years	• Low O&M / replacement costs
Optimal and stable ambient for battery and electronics	• Protection against high temperature, dust, salty air and humidity	• Maintains warranty conditions for battery, inverter and control electronic
High round trip efficiency	• > 90%	• Lowers investment in renewable generation, improve of diesel efficiency
Modular battery and inverter system		• Flexible for up/down scaling • Increased redundancy • Efficient spare part management
Minimum component number on site	• Less connections -> lower failure rate	• Reduce project risk • Increase reliability
High quality components	• Design life > 10 Years	• Increase reliability, reduce maintenance effort
Containerized design	• System mobility	• Improve risk mitigation

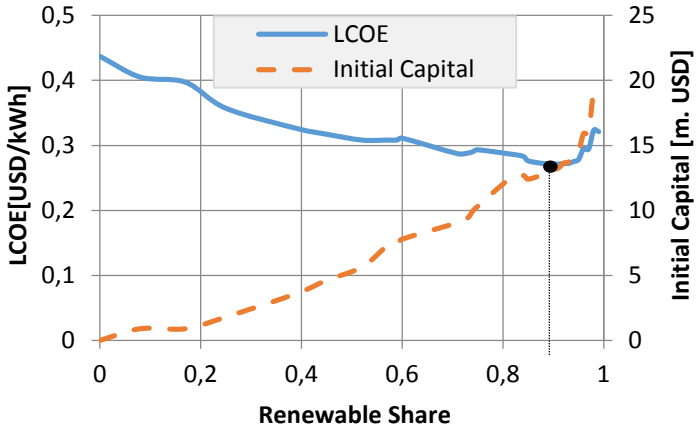
Examples of different applications for PV-energy-storage solutions in East Africa

Town (≈ 20,000 resident)

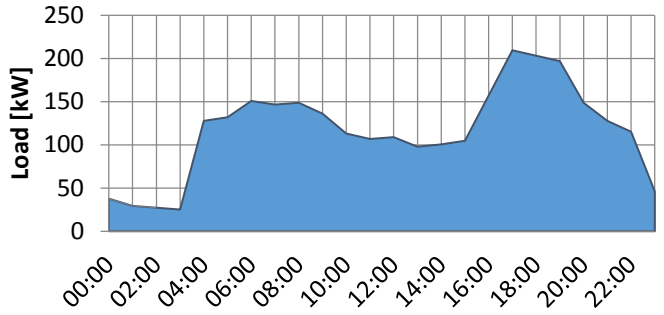


- Daily consumption 14 MWh
- RE 89%
- PV: 3.5 MW
- Battery: 8.5 MWh

- LCOE Diesel only: 44 ct
- LCOE Hybrid: 27 ct

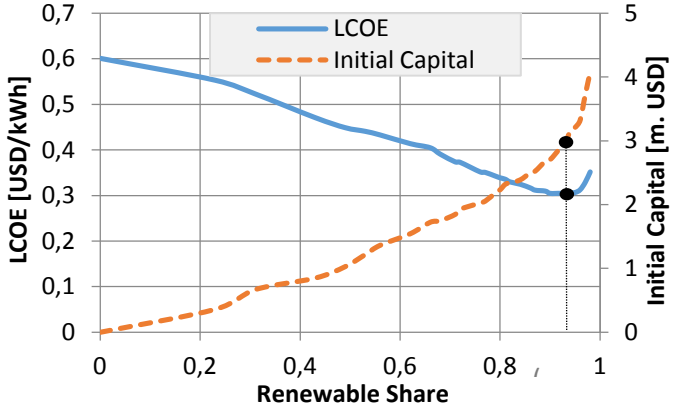


Lodge

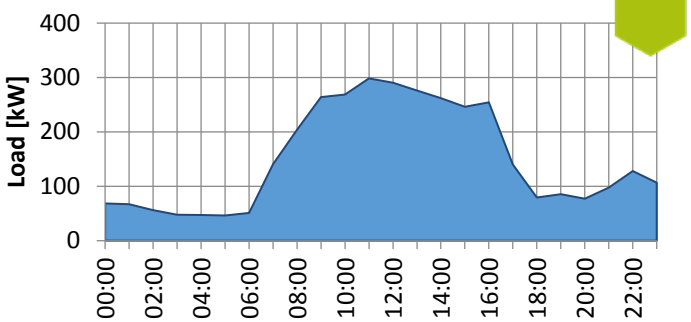


- Daily consumption 2.8 MWh
- RE 93%
- PV: 0.8 MW
- Battery: 1.9 MWh

- LCOE Diesel only: 60 ct
- LCOE Hybrid: 30 ct

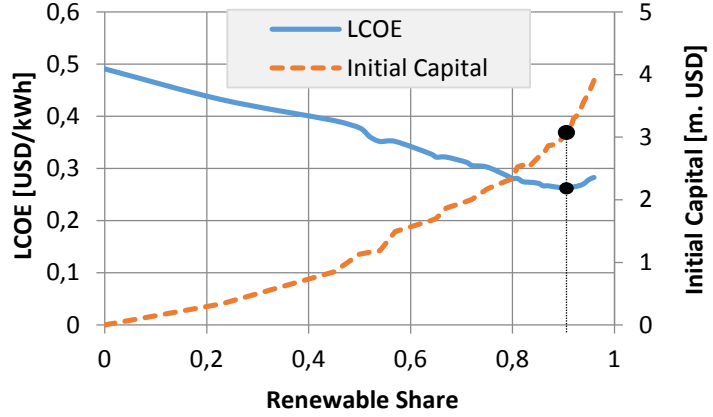


Farm



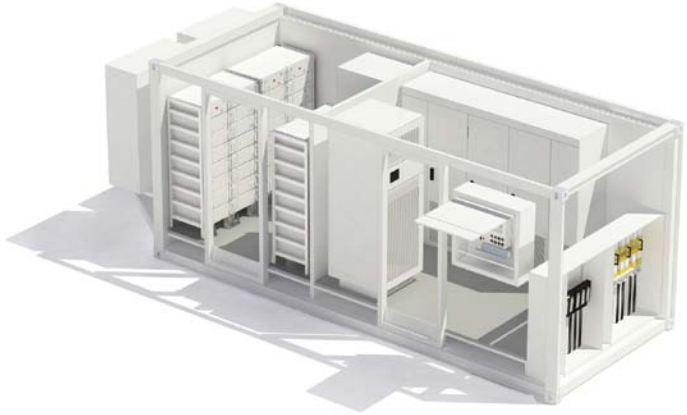
- Daily consumption 3.6 MWh
- RE 88%
- PV: 1 MW
- Battery: 1.9 MWh

- LCOE Diesel only: 46 ct
- LCOE Hybrid: 28 ct

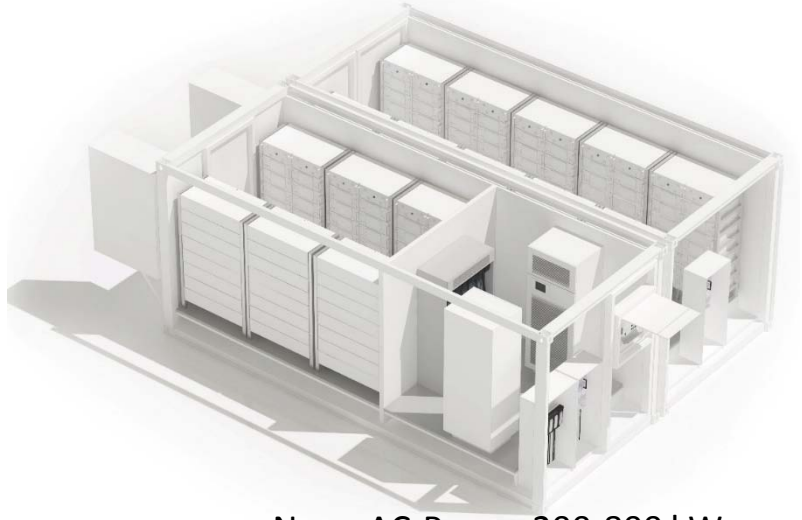


A modular system to fulfill the demand

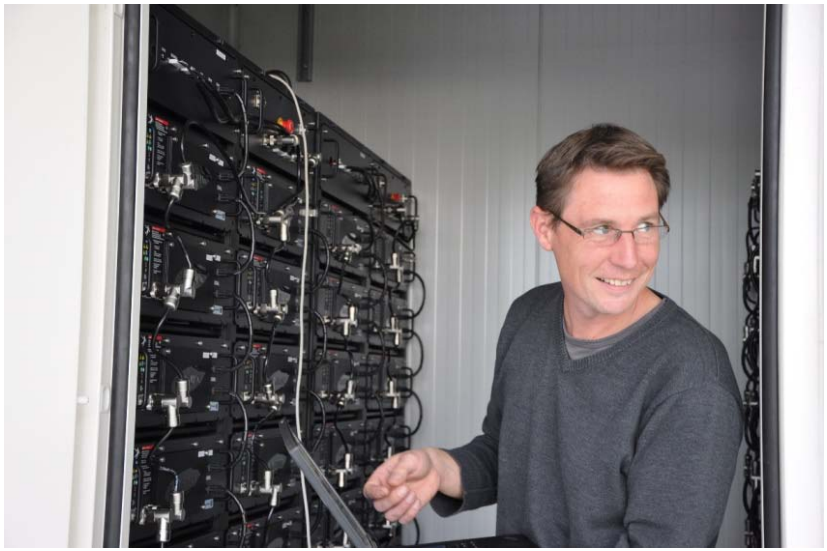
Nom. AC-Power 50-100 kW
AC-Capacity 50 – 100 kWh



Nom. AC-Power 150-200 kW
AC-Capacity 150 – 200 kWh



Nom. AC-Power 200-800 kW
AC-Capacity 300 – 2 MWh



Thank you

Questions can be submitted now

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