Simulation of the measured operational behavior of the existing microgrid in Cerros de Vera, Uruguay, as a basis for its future evolution

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In collaboration with:

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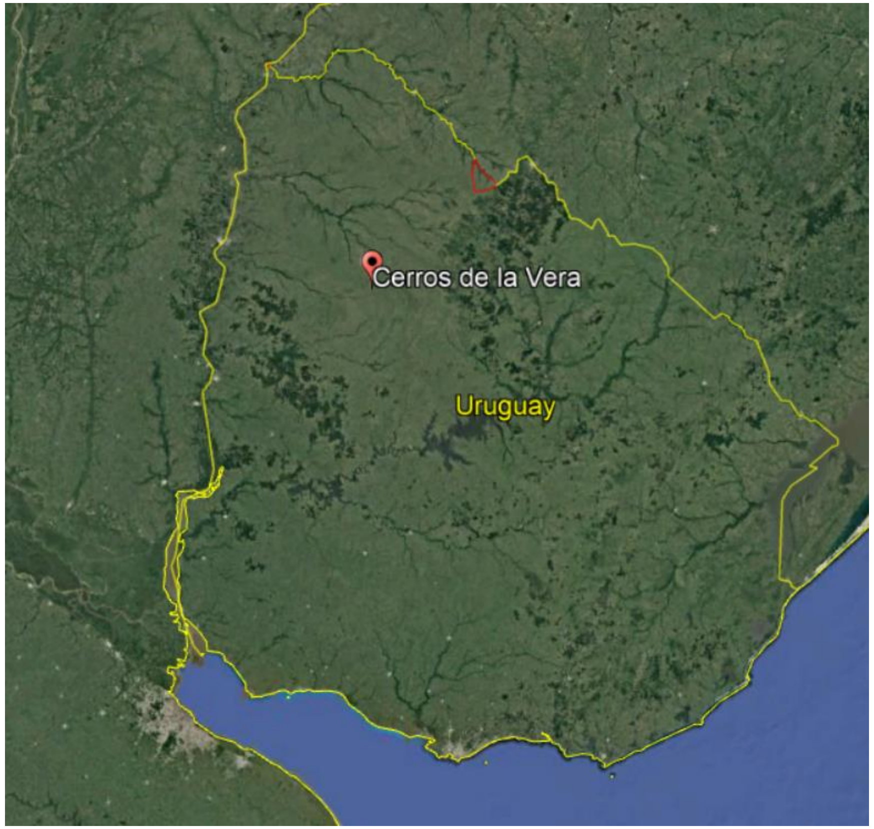
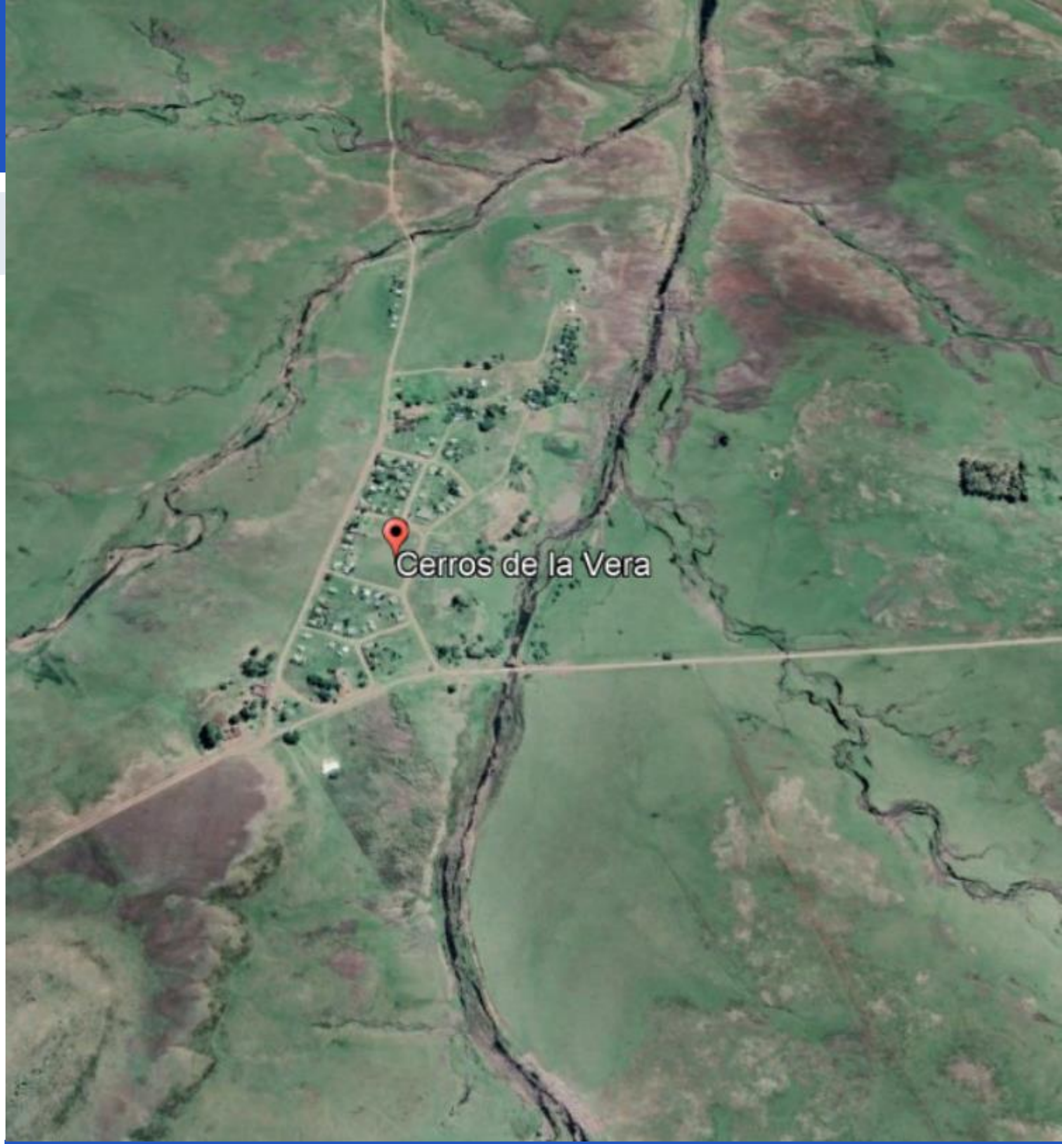
BACKGROUND

Cerros de vera





BACKGROUND

Cerros de vera

- 70 electricity home services.
- First isolated rural village in Uruguay to be supplied autonomously with renewable energy (2016).
- PV Plant + battery storage + diesel generators.

- STUDY TRIGGER: Increase in the village loads and fuel consumption has been detected.

- OBJECTIVE: Analyze the actual operation system and evaluate the inclusion of wind energy in it.

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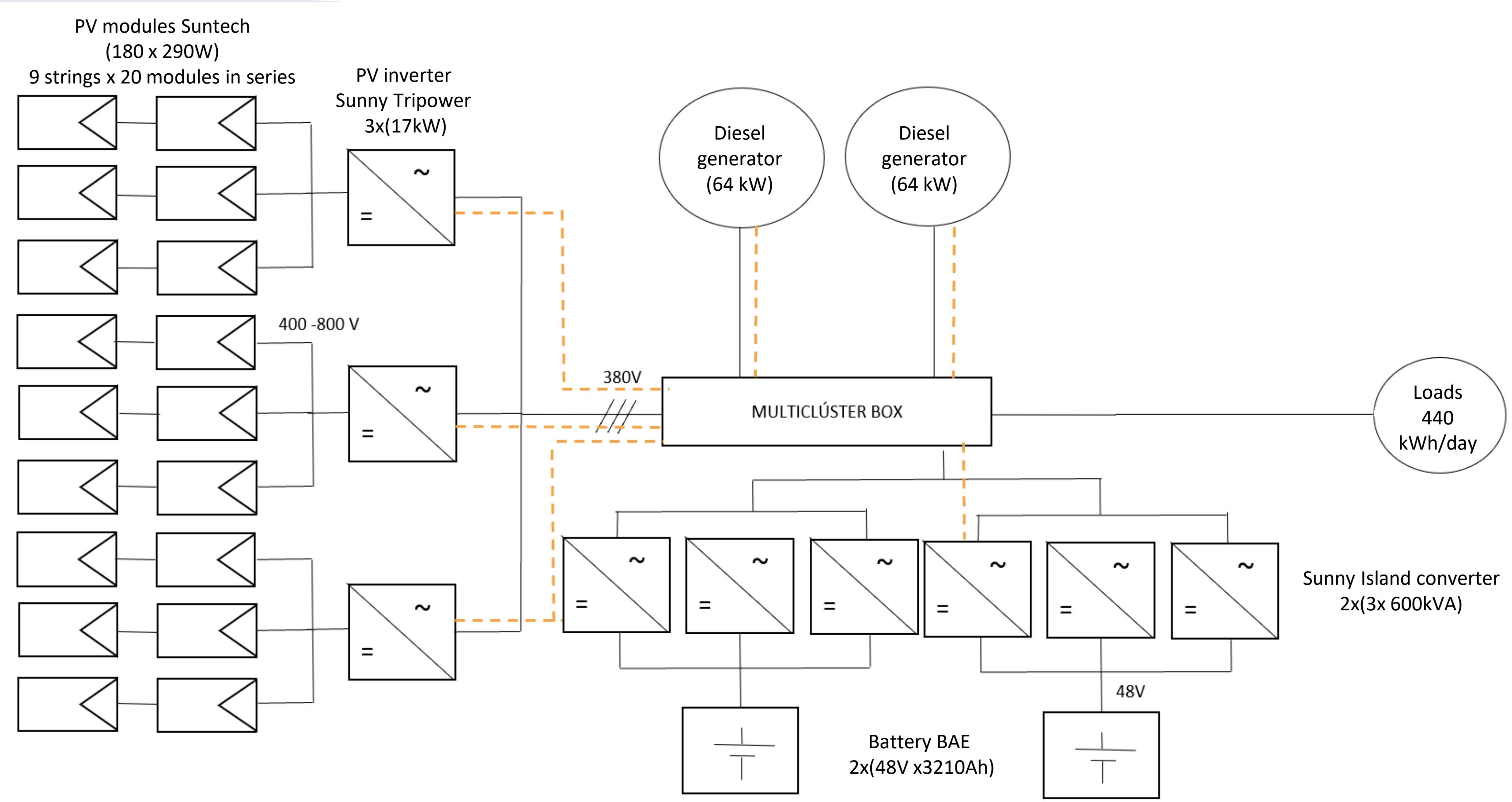
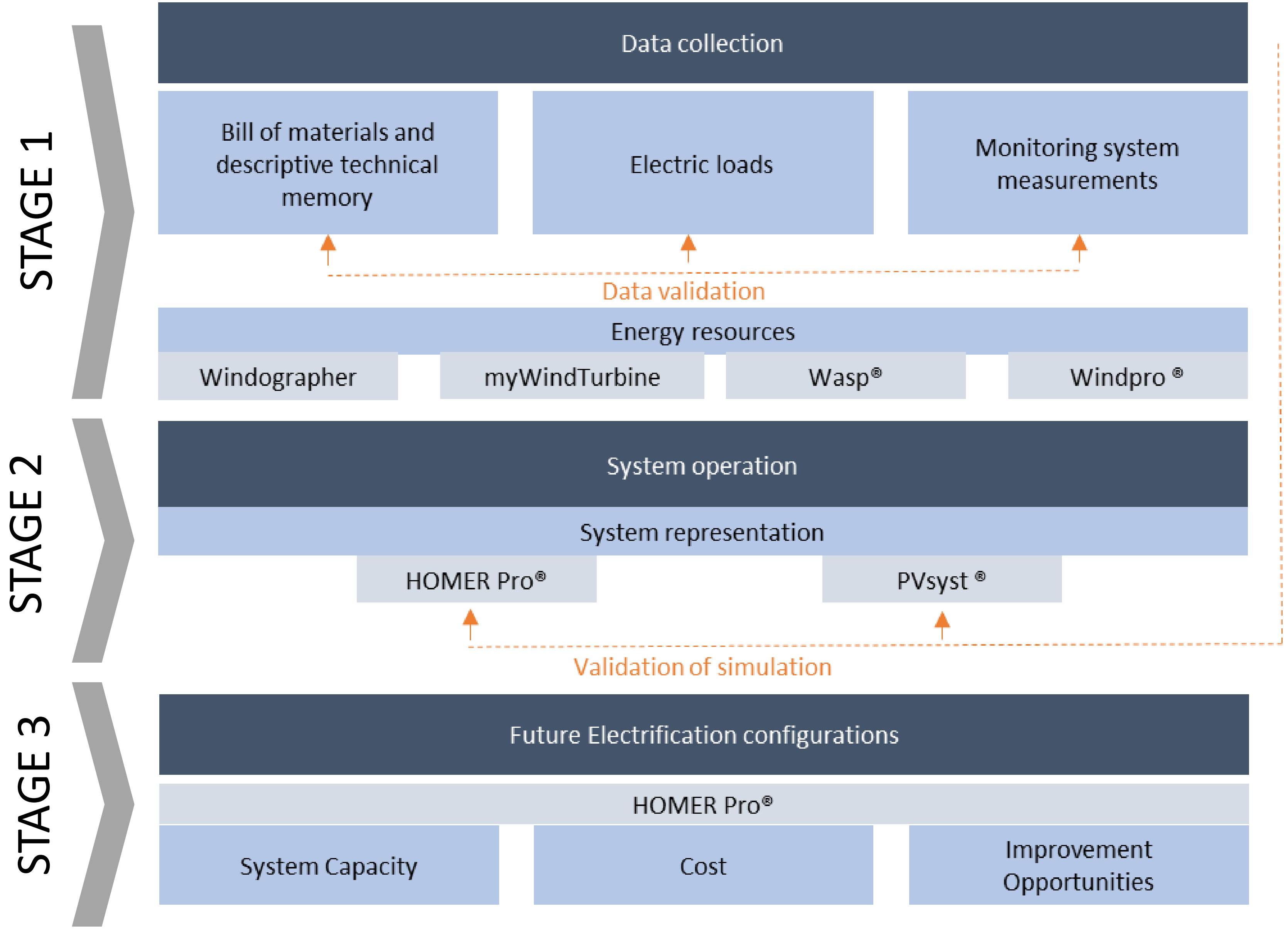
CURRENT SYSTEM

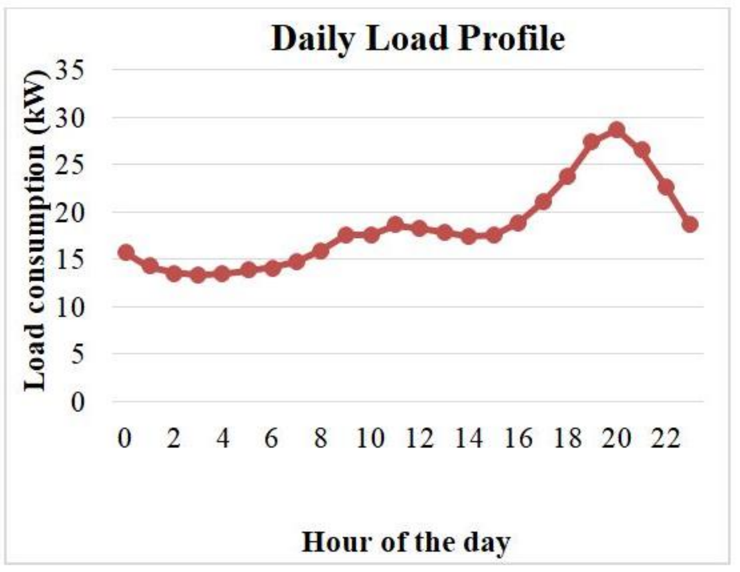


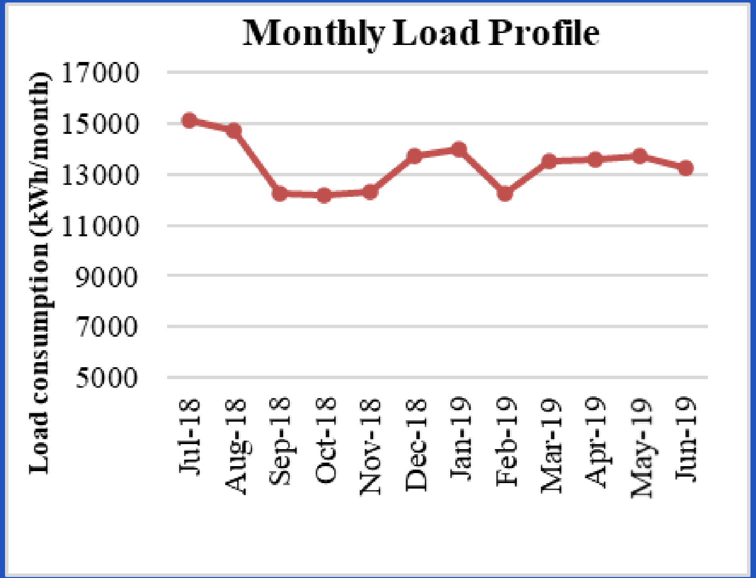
METHODOLOGY



1. DATA COLLECTION

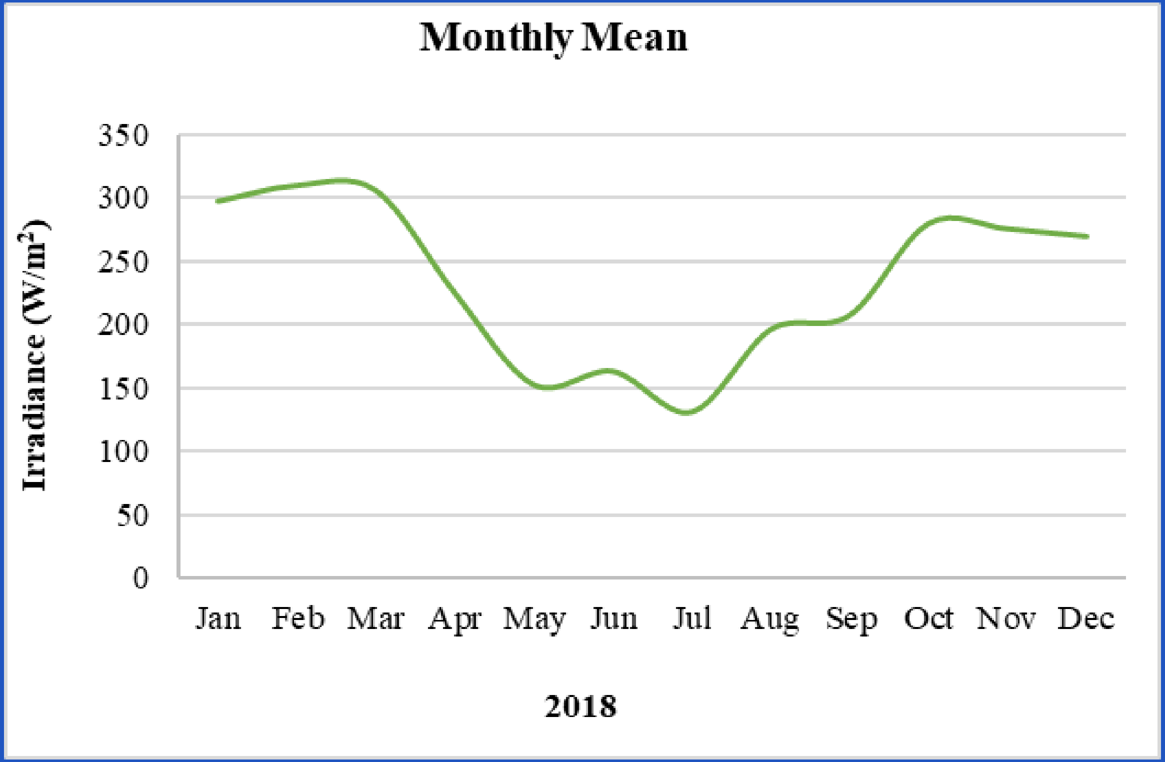
1. DATA COLLECTION – Load Profile





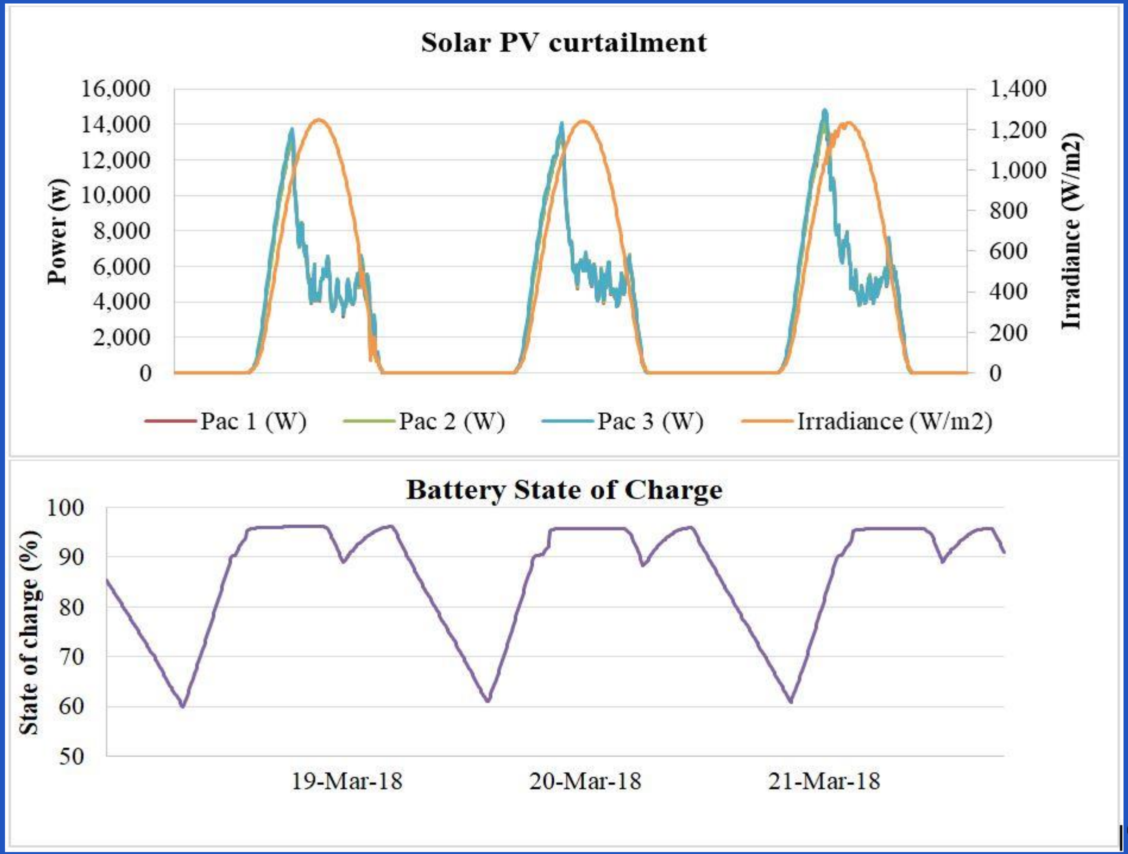
- Quite flat monthly profile
- Average hourly profile with a nighttime peak

1. DATA COLLECTION – Solar resource



- Solar resource obtained from the system's weather station

1. DATA COLLECTION – System operation



- The measured performance ratio is 77.2%
- Regulation of solar PV generation when the batteries are fully charged

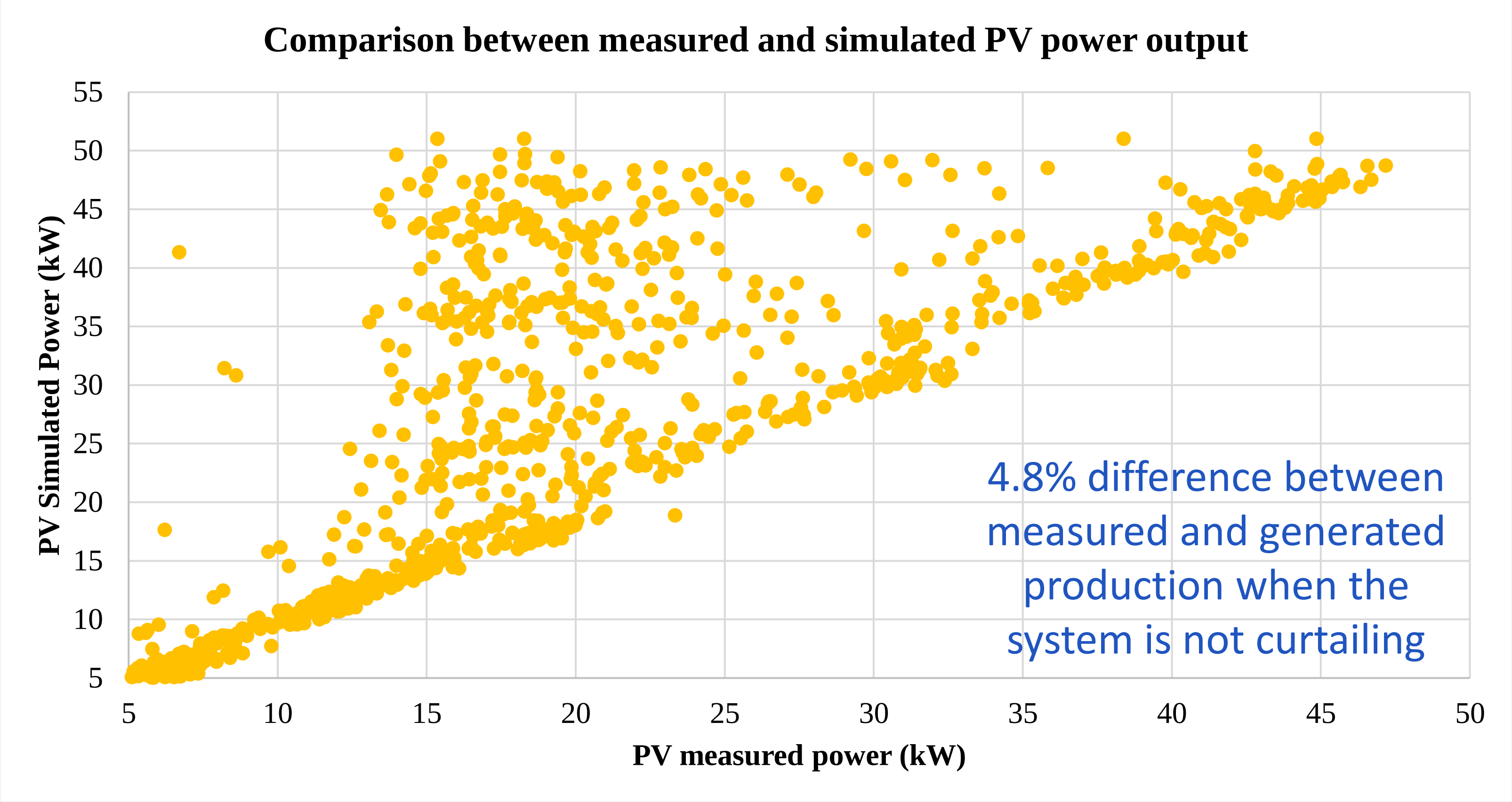
2. SIMULATION OF THE OPERATION OF THE CURRENT ELECTRIFICATION SYSTEM

Photovoltaic generator

PVsyst simulation: to obtain the photovoltaic production capacity without the influence of curtailment

PVsyst simulated production
84,912 kWh/year

Measured PV production
64,403 kWh/year

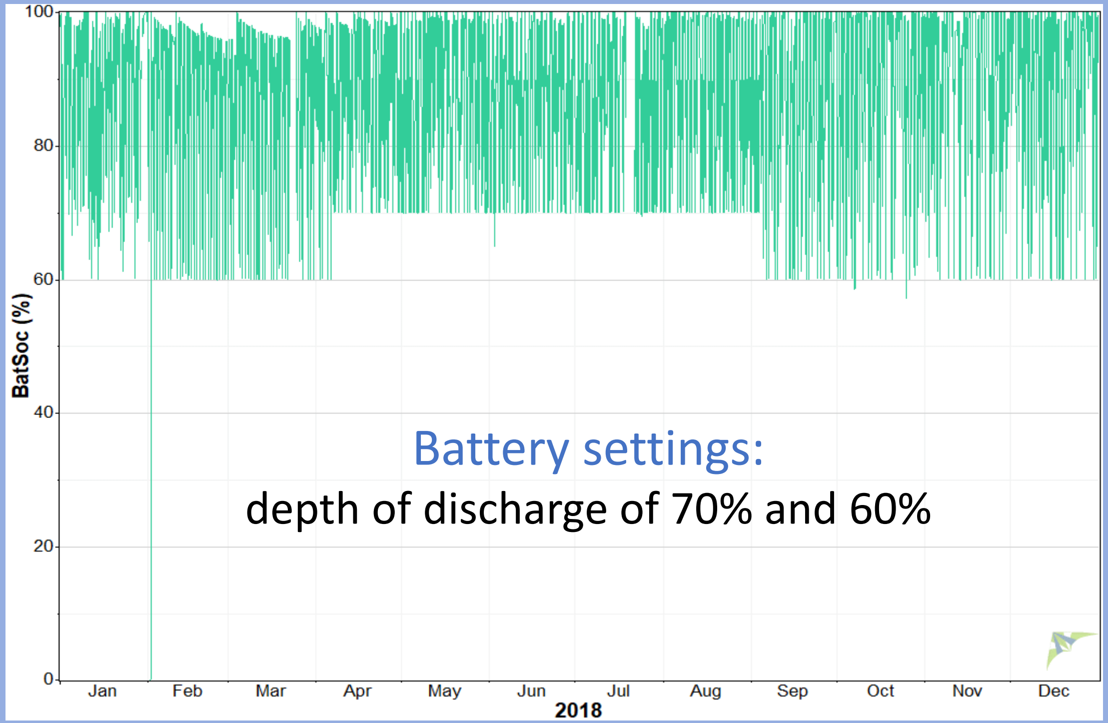


Battery and converters

Inverter and rectifier average efficiencies:
92.33% and 89.71%, respectively

Battery efficiency:
77.1%

Difference between measured and simulated efficiency:
1.96% in charge (battery + rectifier) and
2.94% in discharge (battery + inverter)



Diesel Generators

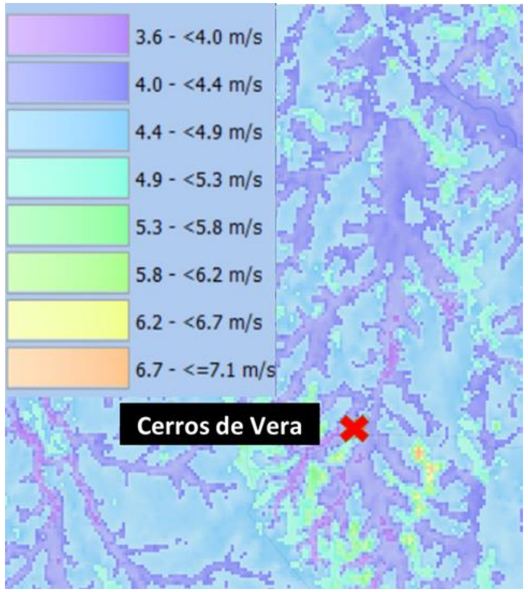
Operation mode:
"Cycle Charging"

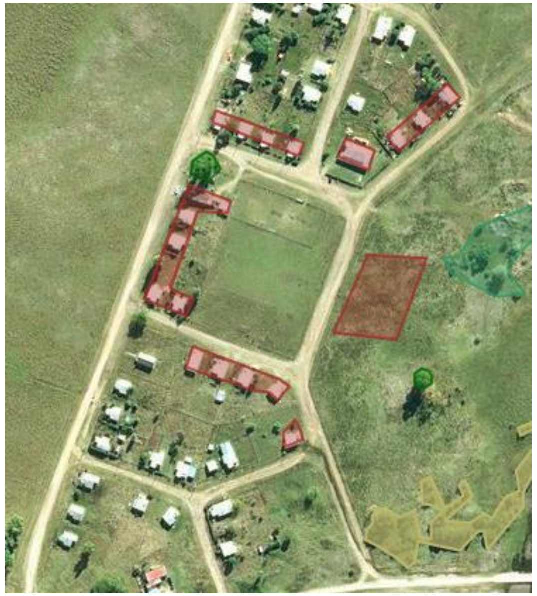
Measured energy: 22,329 kWh
Simulated energy: 23,761 kWh
Difference: 6.41%.

Validation summary

Component - variable	Difference between measured and simulated
PV generator - Energy	4.8%
Battery and converters - Efficiency	1.96% in charge (battery + rectifier) 2.94% in discharge (battery + inverter)
Diesel generators - Energy	6.41%

3. ANALYSIS OF THE INCLUSION OF WIND ENERGY





Wind Turbine Site

- Considerations:
  - Wind resource
  - Proximity to the point of consumption and connections
  - Influence of obstacles

Wind Turbine selection

- Cost criteria:
  - Initial capital→5000 €/kW for 10kW turbines and of 4000 €/kW for 30 kW turbines, and for the remaining sizes, the costs are interpolated.
  - Replacement cost → defined as 85% of the initial capital value.
  - Annual Operation and Maintenance cost → a value of 45.5 €/kW has been assumed for 10kW turbines and a value of 35.6 €/kW for 30 kW turbines.

Wind Turbine	Power (kW)	Hh (m)	Initial Capital (€)	Replacement Cost (€)	O&M (€/year)	System LCOE (€/kWh)
Bergey Excel 10	10	30	50,000	42,500	445.00	0.373
Gaia Wind 15	15	30	67,500	57,375	600.75	0.353
Eocycle E20	20	23	80,000	68,000	712.00	0.322
Ecocycle 25	25	23	87,500	74,375	823.25	0.320
PitchWind	30	30	90,000	76,500	801.00	0.332

Simulation results

Simulation inputs:

- Selected wind turbine
- Wind speed data
- The components of the current system and their references values
- Load consumption of the village
- PV generation without curtailment
- Diesel fuel (0.58 €/L)

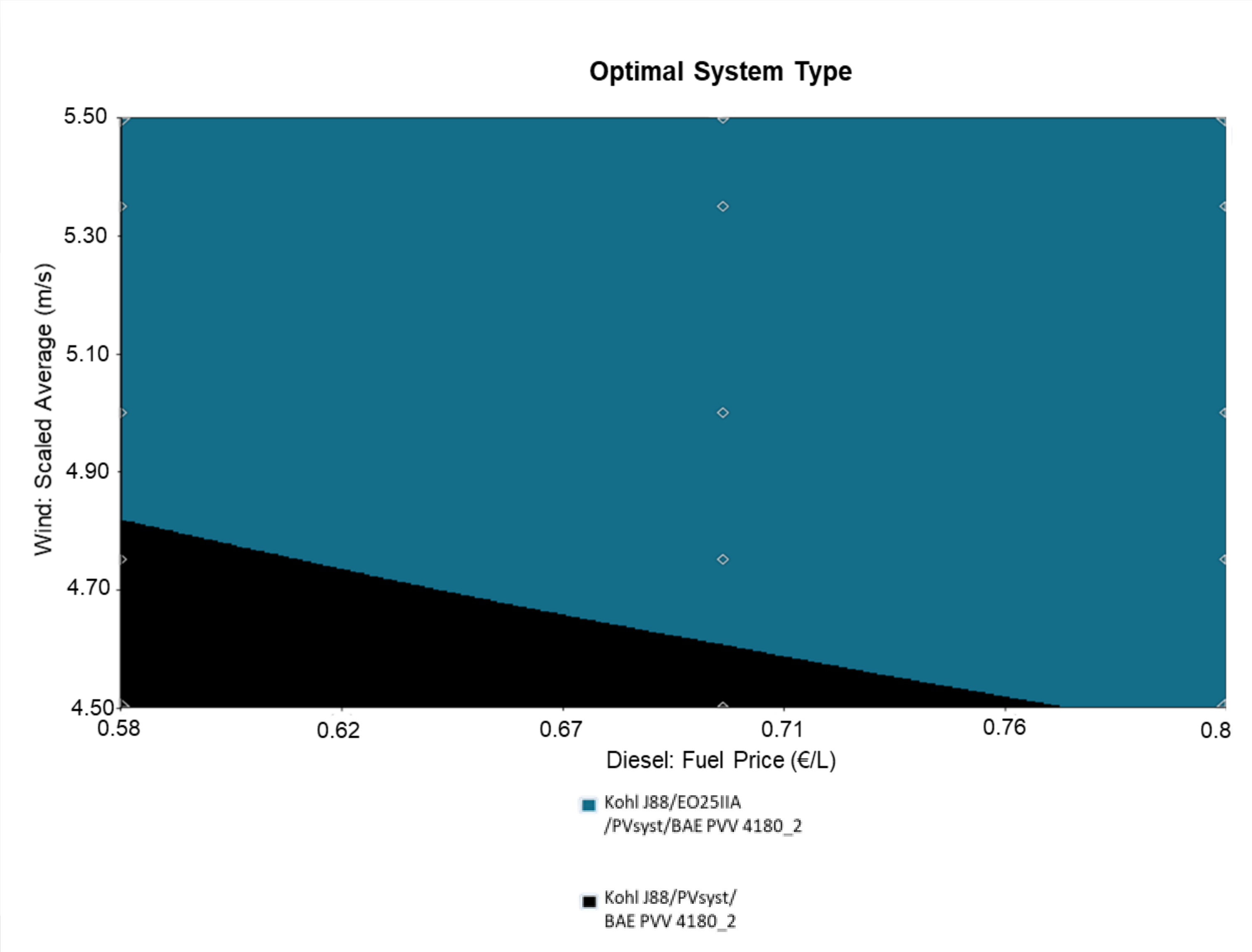
Export... | **Optimization Results** | Left Double Click on a particular system to see its detailed Simulation Results. | Categorized | Overall

Architecture					Cost				System		Kohl J88					PVsyst	
EO25III	PVsyst	Kohl J88 (kW)	BAE PVV 4180_2	SMA8 (kW)	NPC (€)	COE (€)	Operating cost (€/yr)	Initial capital (€)	Ren Frac (%)	Total Fuel (L/yr)	Hours	Production (kWh)	Fuel (L)	O&M Cost (€/yr)	Fuel Cost (€/yr)	Capital Cost (€)	Productio (kWh/yr)
1	1.00	64.0	48	36.0	€665,304	€0.320	€23,924	€356,023	64.2	16,717	1,098	57,645	16,717	2,745	9,696	109,724	84,912
	1.00	64.0	48	36.0	€769,740	€0.370	€38,771	€268,523	27.6	33,812	2,695	116,558	33,812	6,738	19,611	109,724	84,912

Case	NPC (%)	LCOE (€/kWh)	Fuel consumption (L/year)	Renewable Fraction (%)
Existing	100%	0.370	33,812	27.6
With wind	94.9%	0.320	16,717	64.2

Sensibility analysis

- 3 parameters
  - Average wind speed: from 4.5 to 5.5 m/s (estimated value was 5.35 m/s)
  - Village consumption: increase of 5 and 15%
  - Price of fuel: from 0.58 (present value) to 0.8 €/L



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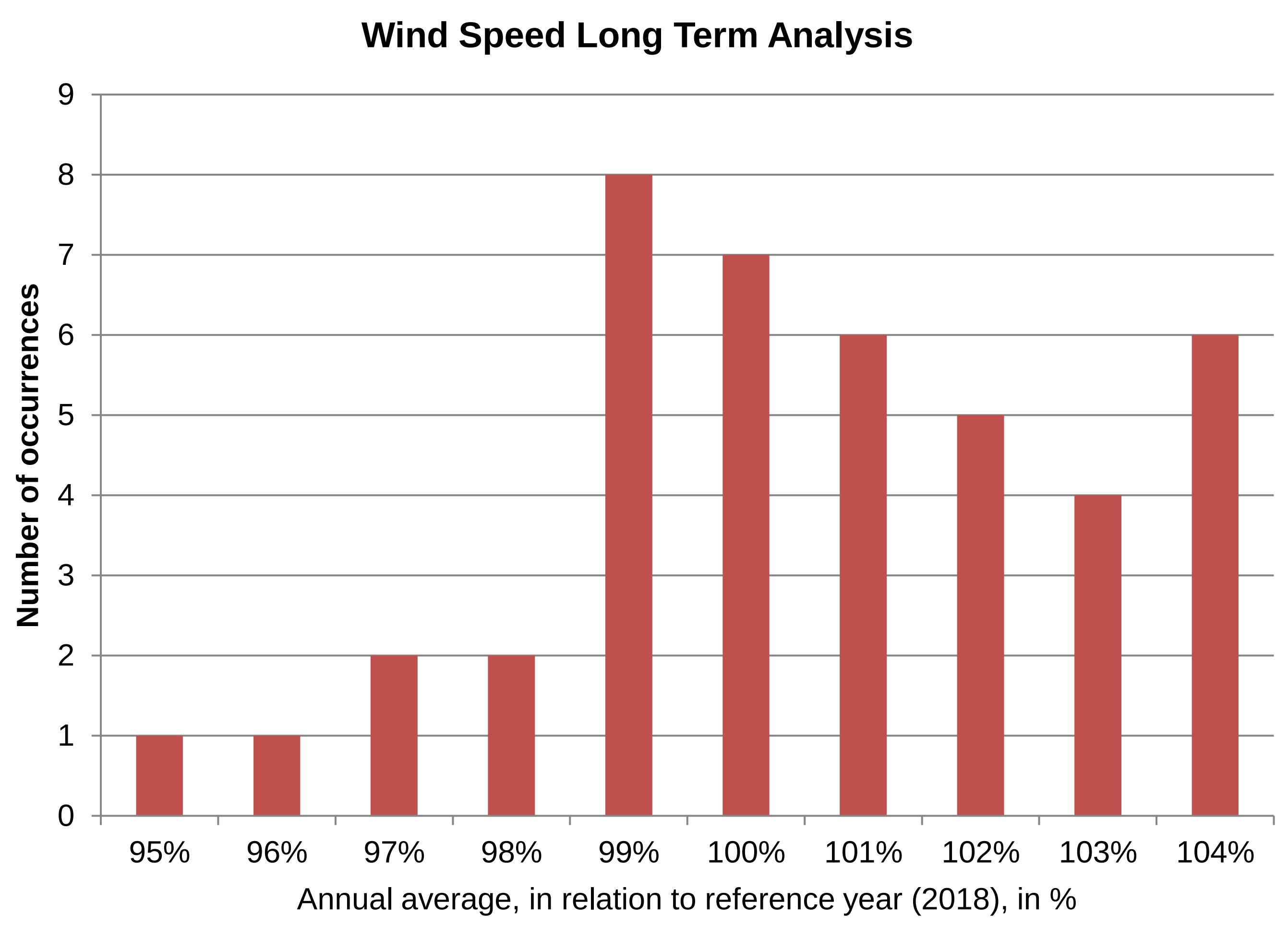
Long Term analysis

- Comparison of the annual average wind speed values to the one used for the analysis (2018's = 5.35 m/s, 100% in the Figure)

- Range is approximately ± 5% in relation to 2018
- 2018 wind data may be considered as representative and conservative



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CONCLUSION

- This analysis seeks to raise a discussion about the different scenarios and provide information for decision-making.

- As shown before, there is a wide area in the search space of the main parameters (diesel fuel cost, average wind speed and load consumption) where the installation of a 25 kW SWT seems recommendable.

Find Out More

Thanks for listening!

Visit to read:

“Taking into Consideration the Inclusion of Wind Generation in Hybrid Microgrids: A Methodology and a Case Study”

Energies 2021, 14, 4082.

https://doi.org/10.3390/en14144082

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