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Industrial Hybrid Systems with High PV Penetration

Performance Analysis and Key Success Factors

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Challenges and Opportunities

- Industrial PV-Diesel Hybrids have shown competitivenes and attractiveness to investors and operators
- Investment barriers are mainly due to unmitigated risks and maturity of technology
- Technology (without energy storage) is nowadays mature
- With decreasing energy storage prices, storage becomes the key for highly efficient and profitable systems

System description

Largest industrial PV-Diesel Hybrid System with storage in south america

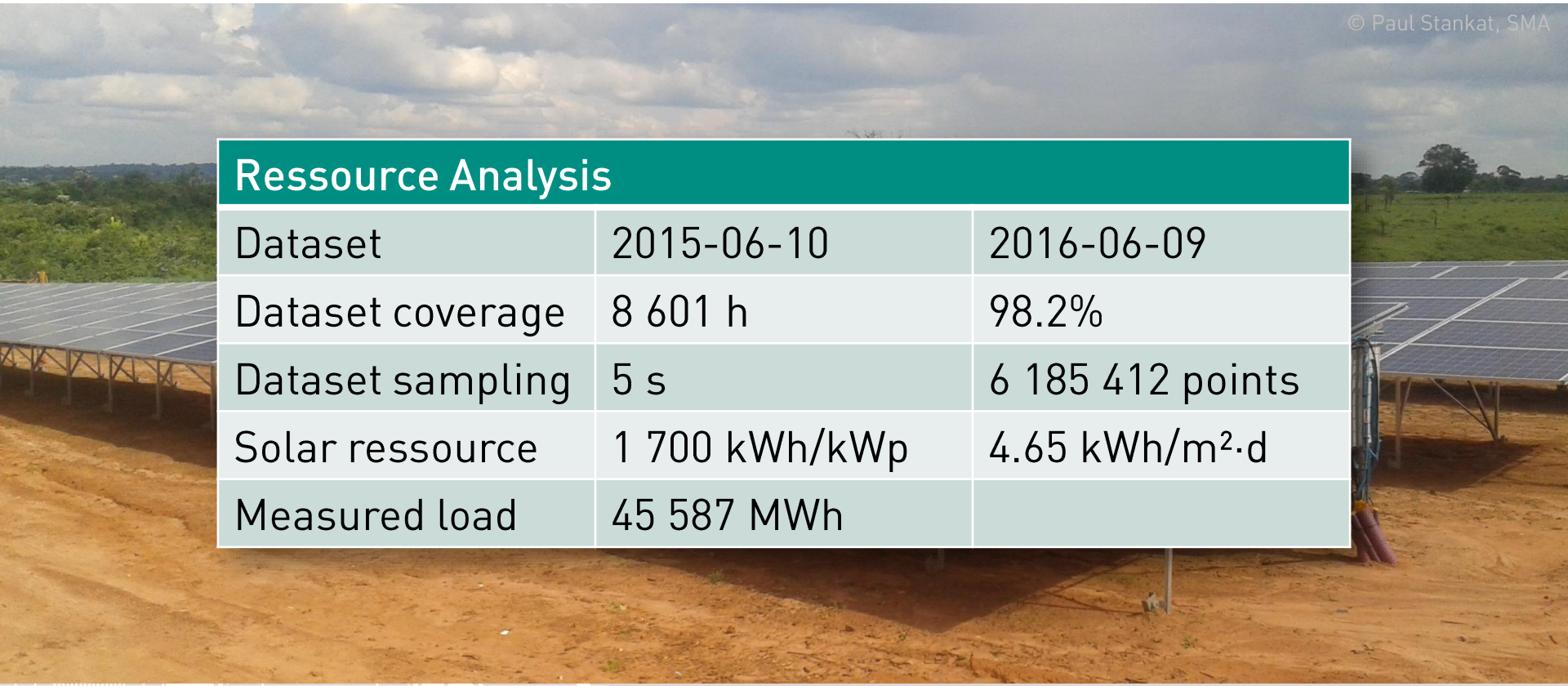
5 MWp Photovoltaics with 6 central inverters

14 MW installed Genset power in 10 Units

2,5 MW (1 MWh) Li-Ion Battery system

Dataset

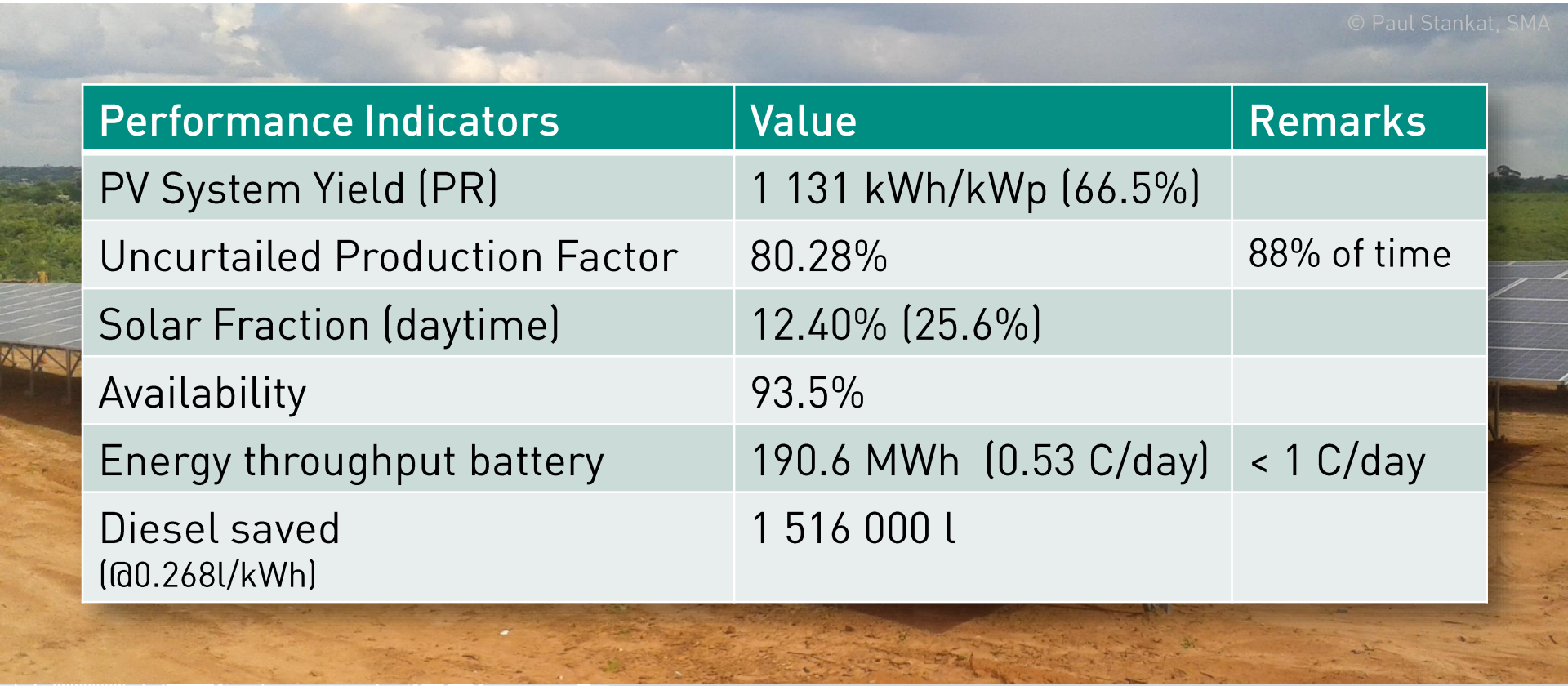
High resolution data for performance analysis shows several important operational effects such as effect of Ramp Rate Control functions



Ressource Analysis		
Dataset	2015-06-10	2016-06-09
Dataset coverage	8 601 h	98.2%
Dataset sampling	5 s	6 185 412 points
Solar ressource	1 700 kWh/kWp	4.65 kWh/m²·d
Measured load	45 587 MWh	

Traditional Perfomance Analysis

Performance Ratio is on the range of typical off-grid systems. The system‘s performance can be improved if availability is improved



Performance Indicators	Value	Remarks
PV System Yield (PR)	1 131 kWh/kWp (66.5%)	
Uncurtailed Production Factor	80.28%	88% of time
Solar Fraction (daytime)	12.40% (25.6%)	
Availability	93.5%	
Energy throughput battery	190.6 MWh (0.53 C/day)	< 1 C/day
Diesel saved (@0.268l/kWh)	1 516 000 l	

Diesel Gensets

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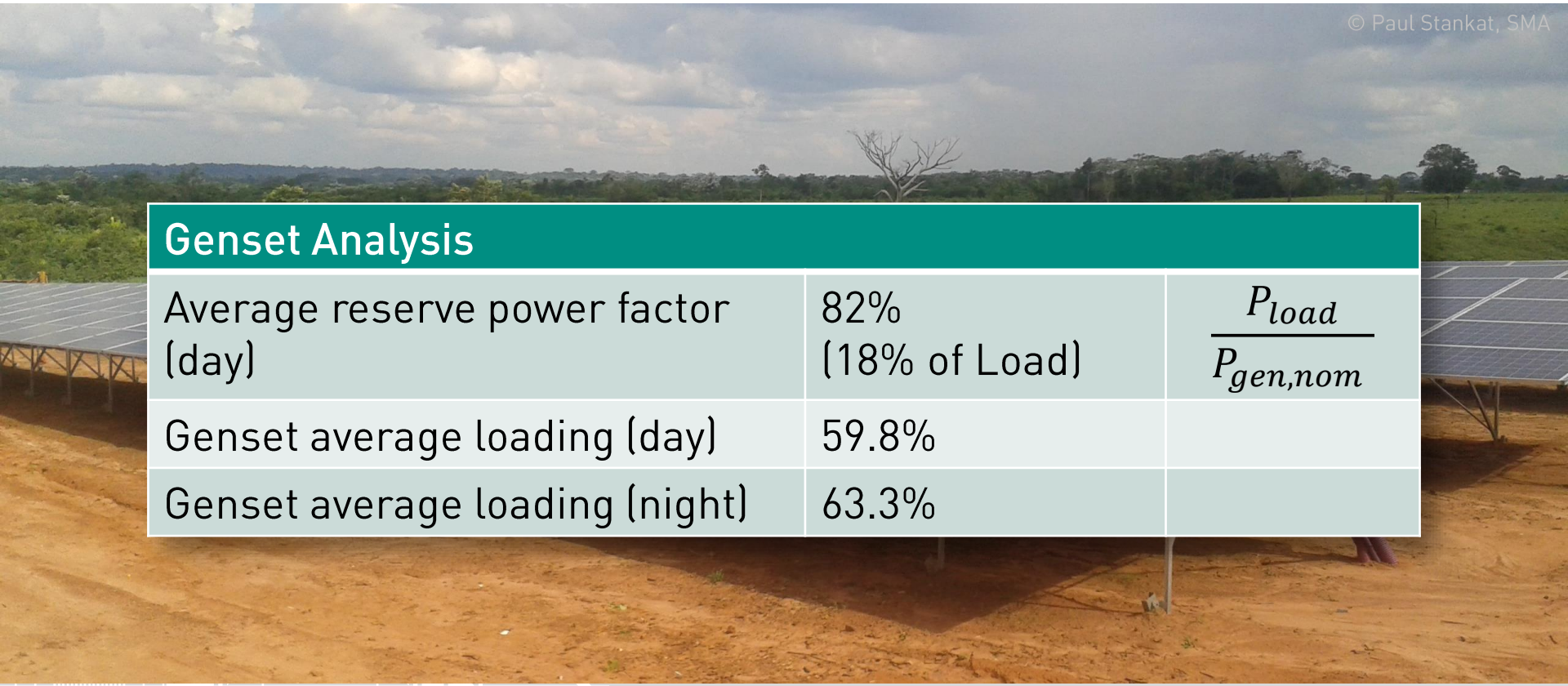
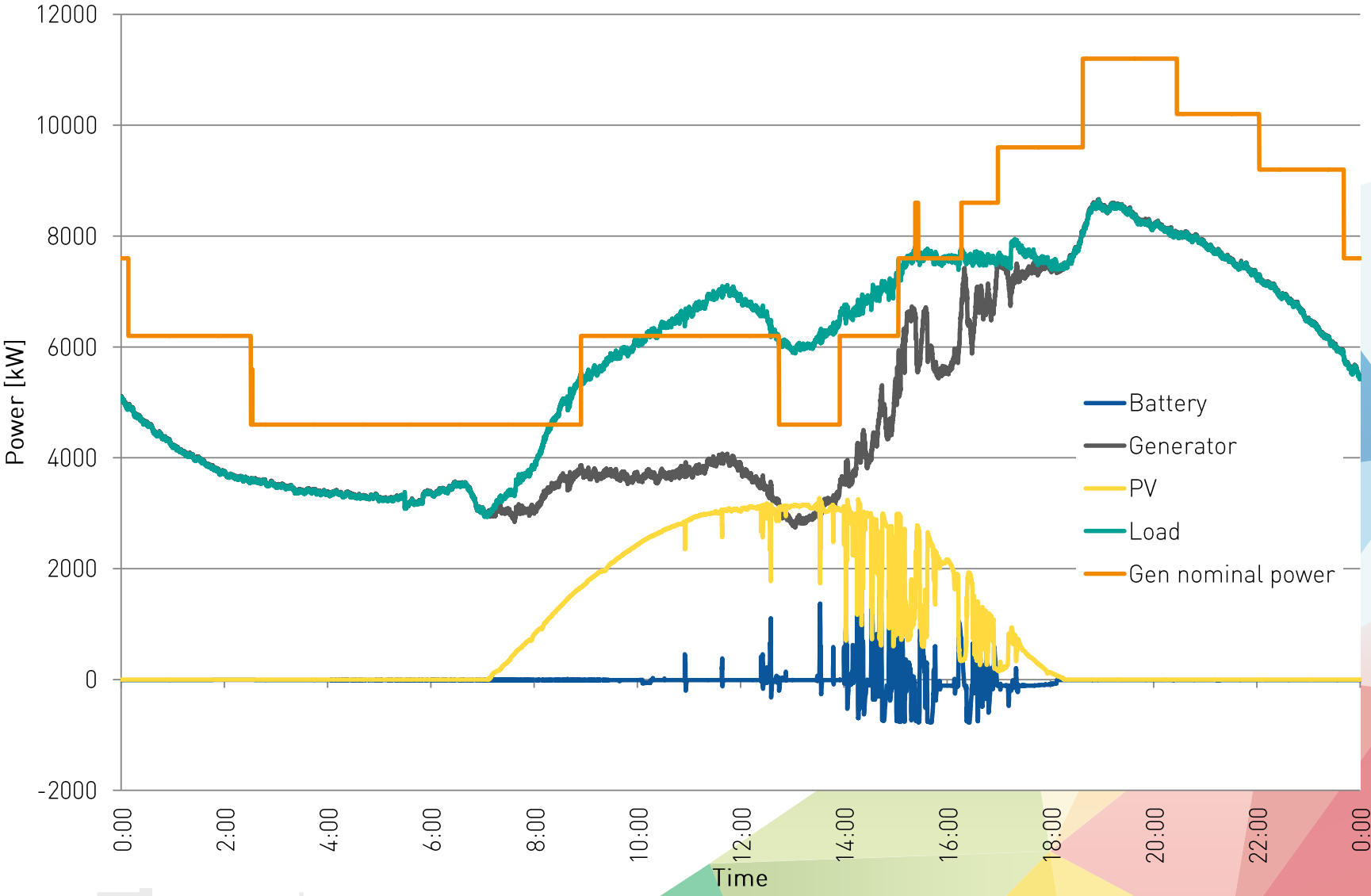
Since energy storage is covering reserve power requirements of PV most of the time, there is almost no negative impact in the amount of spinning reserve compared to a traditional system

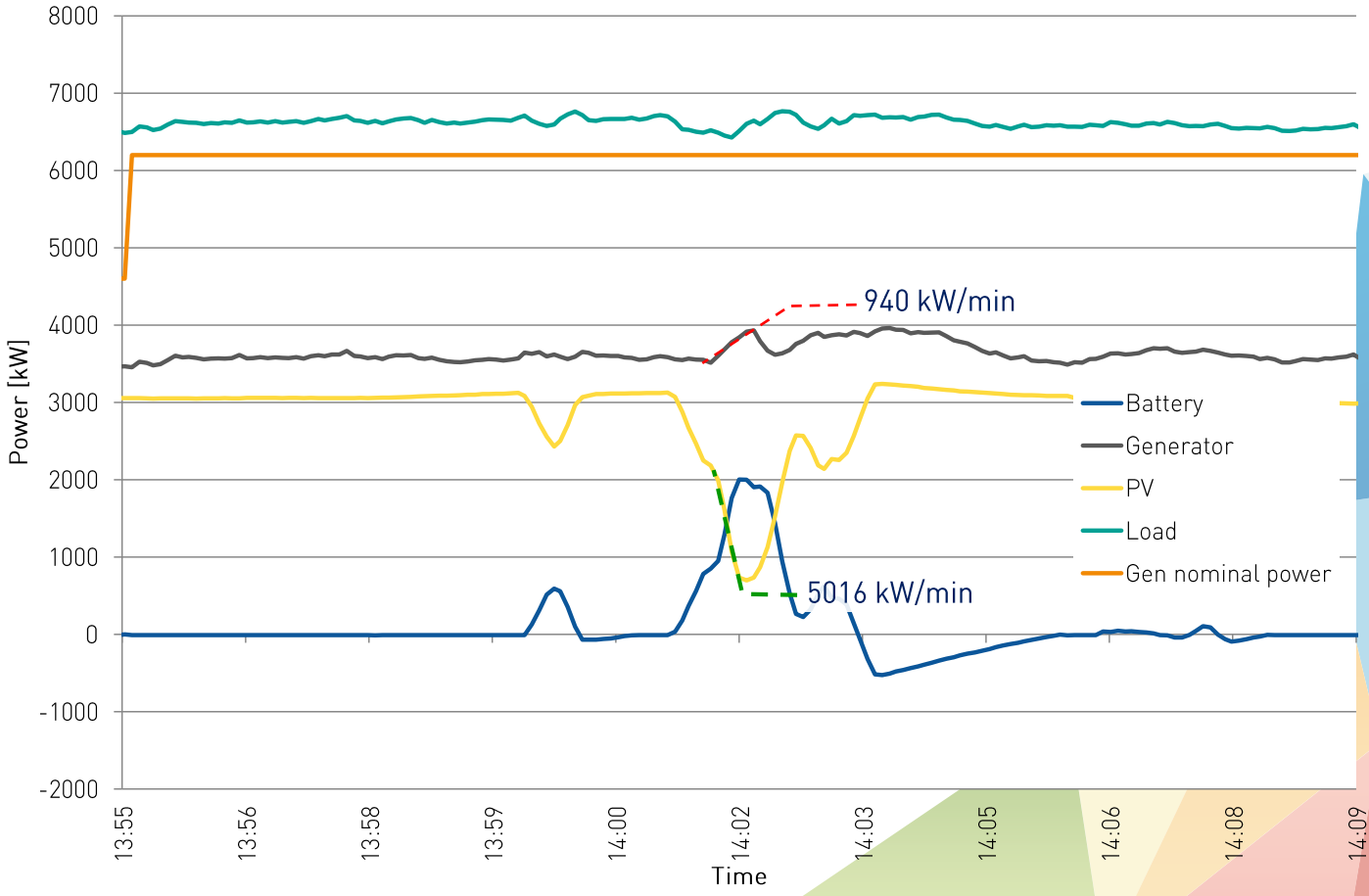


Genset Analysis		
Average reserve power factor (day)	82% (18% of Load)	$\frac{P_{load}}{P_{gen,nom}}$
Genset average loading (day)	59.8%	
Genset average loading (night)	63.3%	

A typical day



Closeup on Ramp-Rate Control



Lessons learned

- Storage allows for better genset loading and more stability in system operation
- Storage is not only a commodity for PV, it also helps during contingencies like genset breakdown
- Centralized inverter approach for remote areas impacts availability and requires a spare part warehose on site
- Online visualization of operational data (spinning reserve, available MPP power, minimum running gnset power) helps the operator take better decisions

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