Monitoring of Storage Unit in the Grid Structure

SITE :	$-SiteId
OPERATOR :	$-SiteOperator
MONITORING PERIOD :	$- MoniPeriod
EVALUATION DATE :	$-EvaDate

Introduction

This report provides analysis and presentation of measured data for the storage system
$-SiteId
SiteDescription
The storage unit is located at
It enables installation and operation of an enlarged PV-Generator with 2.5 times higher peak power by means of buffering PV generation, ensuring the line power to stay within the limits allowed.
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The report is conforming with the EC Guidelines for unified monitoring and performance assessment of storage-units in the grid structure.
Thus, it reveals energy balancing in a subgrid, characterized by both energy surplus and autonomy ratio. Further it quantifies and details contribution of the storage unit to grid control and balancing, and thus relief of the utility interface, resp. power line.
In the form of directed power-flows, monitoring data is suitable for spatial aggregation with results from other storage units in a common grid area.
Further to reporting for storage and distribution system operators, guideline conformant data and monitoring evaluation qualify for sharing performance experience, e.g. in the JRC's storage observatory.

General Data

Storage Unit	Nominal Power/[MW]: $-NomStoPow	Nominal Capacity/[MWh]: $-NomStoCap
Utility Interface	Nominal Power/[MW]: $-NomUIPPow	Site : $-SiteId

Energetic Balances

In line with recording format from independent metering, the total energies in the monitoring period sum up to :

	Input		Output	
Subgrid	17.5	MWh	19.5	MWh
Utility	30.0	MWh	30.0	MWh
Storage	28.0	MWh	25.0	MWh

with the total difference between in- and outputs covering the storage losses.
In accumulation of directed powerflows, the energy exchanges of the storage unit with subgrid surpluses(net generation) and deficits(net-load), and with the utility can be distinguished from the direct flows between subgrid and utility.

net-generation to utility	19.58	MWh
storage from net-generation	25.00	MWh
storage from utility	3.21	MWh
storage to utility	2.73	MWh
storage to net-load	25.07	MWh
net-load from utility	30.84	MWh

Exchange Yields

Normalizing the directed powerflows, to the nominal power of the storage unit, is resulting in yields, comparable for units of different sizes. Chart 1 shows the exchange yields in their daily averages .

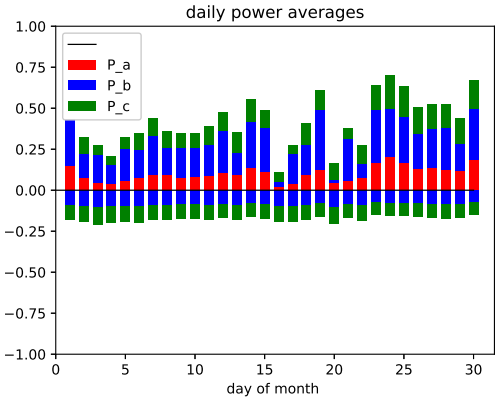

chart 1 : Average DailyYields

Accordingly chart 2 shows the hourly averages of the exchange yields, reflecting average operation in the daily course.

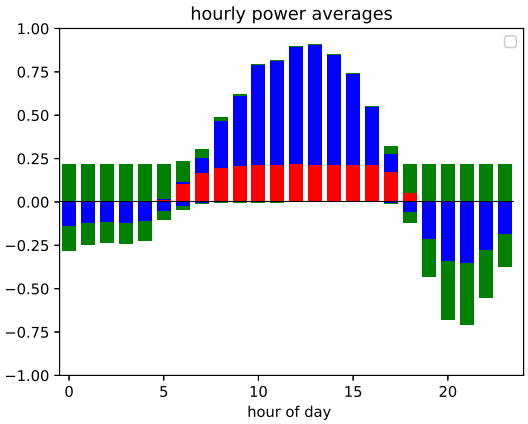

chart 2 : Average HourlyYields

Storage Performance in the Grid

Performance is resulting from average yields in the monitoring period, indicating the contribution of the storage unit to balancing. control. This compares to the total balancing need of the subgrid and the remaining balancing control, required from the utility interface.

Subgrid Yields				
Input :	___	Output :	___	Balance Depth : 10.5 hrs
Utility Yields				
Input :	___	Output :	___	Balance Depth : 17.0 hrs
Storage Yields				
Input :	___	Throughput :	___	Balance Depth : 23.0 hrs
Subgrid Balancing			___	20.5 hrs
Shifted Generation			___	2.0 hrs
Shifted Load Coverage				0.5 hrs

Operation of the storage unit in time-shift of generation surplus, resp. of load deficit, is separated from operation in balancing the subgrid generation surplus with its load deficit. Time-shift operation reflects operation control performance and includes all exchanges with the utility interface, as well as planned services as unplanned. The storage usage and the longterm energetic losses are characterized by

Recharge Ratio :	112 %	Equivalent Full-Cycles :	120

Utility Interface Relief

Further resolving the balancing needs over increasing timespans, resp. balancing periods, results in the Balance Duration Curve of throughput, and the corresponding capacity as integral over the periods, visible as area under the curves.

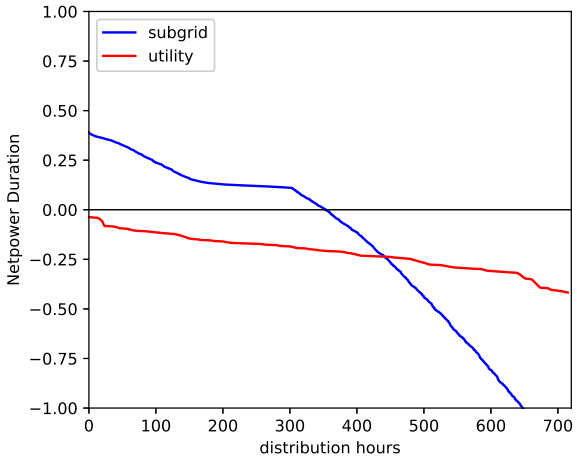

figure 1 : Yields vs Balance-Durations before and behind Storage

With the balancing yields of the subgrid in red, storage is balancing net-power yields over the red area for the balancing capacity employed, the normalized balance depth in [hrs]. The residual utility balance duration curve in blue remains to be compensated by the outer grid infrastructure., with the blue area for the total balancing depth required. Complementary to the energetic balancing, the effect of storage unit operation on releasing the grid interface from power amplitude is quantified. This graph reveals how storage operation is modifying the characteristics of normalized power yields. For the subgrid yields in red, allocated storage is releasing the utility interface, which then covers the blue part only.

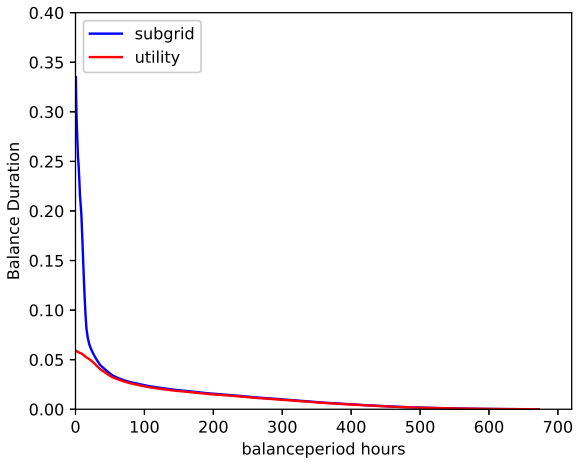

figure 2 : Yields vs Power-Durations before and behind Storage

Subgrid Coverage Performance Ratios

In relation to the average net load yield $\bar{Y}_{NL}$ in the monitoring period, subgrid coverage is characterized by performance ratios. Storage and utility are covering the total net load of the subgrid

	Net-Surplus Ratio	Throughput Ratio	Net-Load Coverage
Subgrid	120 %	100 %	21 hrs
Utility	50 %	30 %	14.5 hrs
Storage	70 %	70 %	6.5 hrs

Annuities

Based on storage unit power cost of :- PowCost -: Euro per MW-: , and capacity_cost of :- CapCost -: Euro per MWh on a financing term of :- FinTerm -: years and :- OpEx -:% operation costs, the annuities are resulting as:

Total expenditure annuity	power	capacity	operation
23 Euro/MWh	32%	60%	8%