SIW17-041

Overcoming grid connection limitations of PV plants in distribution networks with battery storage systems

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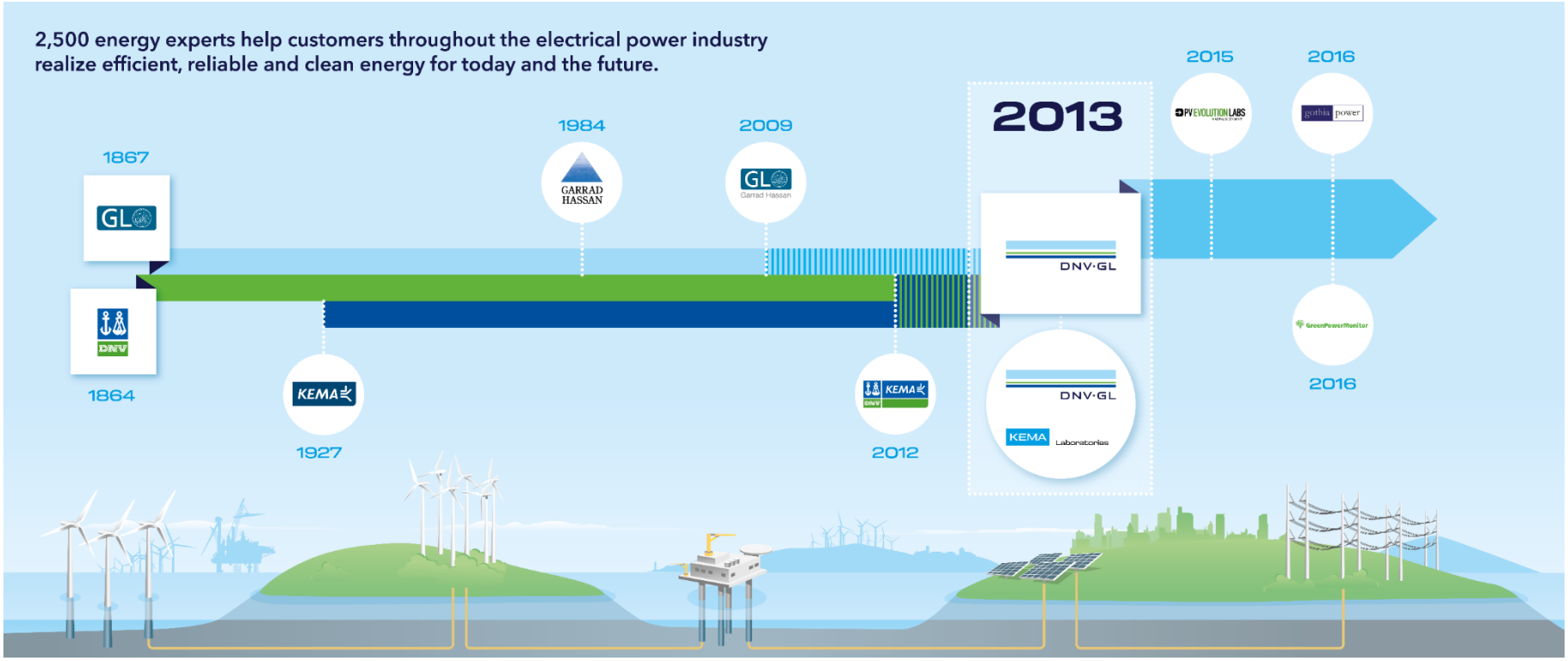
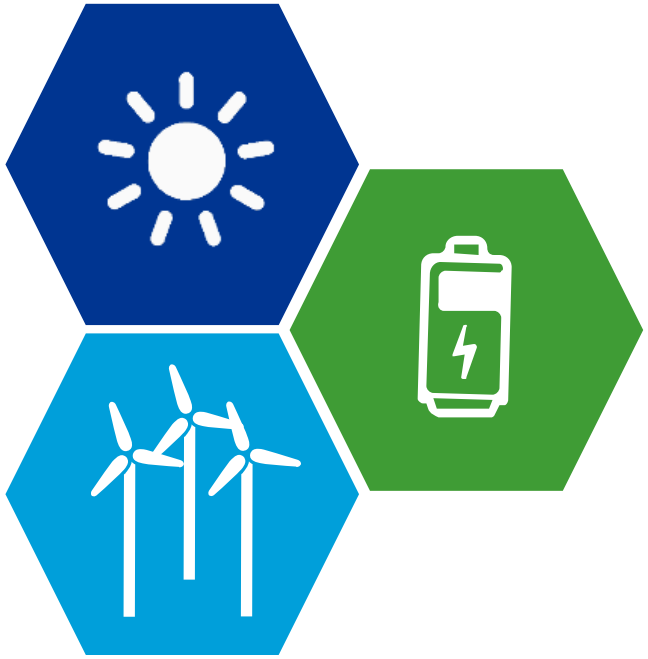


Background

- Decreasing cost of both solar and storage
- Storage still relatively novel
- Competitive LCOE for PV, commoditization
- Increasing share of PV on installed capacity -> adequacy, stability and power quality challenges
- Power quality – special interest in distribution

- Overcoming network limitations with BESS
- Storing part of the curtailed energy



Investigated case

- 5 MWp DC, single-axis tracker
- Wheeling scheme for private company
- Plant limited to 4200 kW (reactive power capability)

- 33 kV feeder, 28km with loads,
- Total feeder load 4-8 MW, p.f. 0.89
- Radial branches
- OHL only, no cables
- SC capacity 120 MVA at PCC

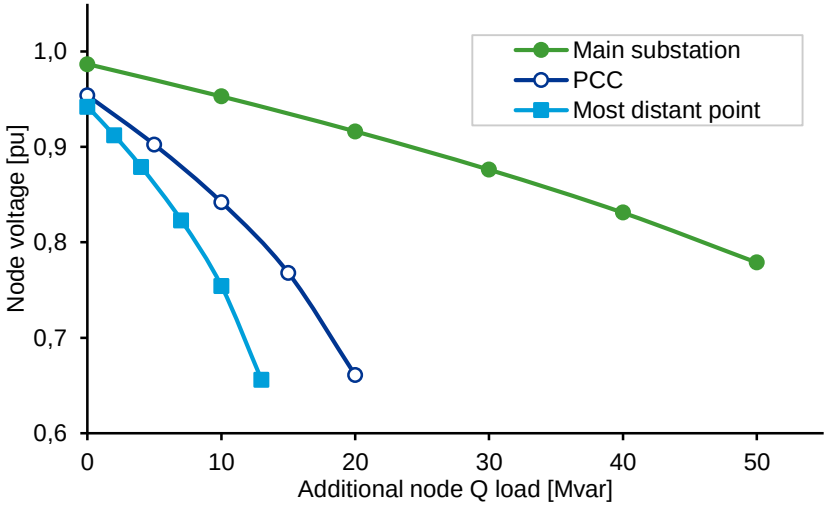
Compliance check

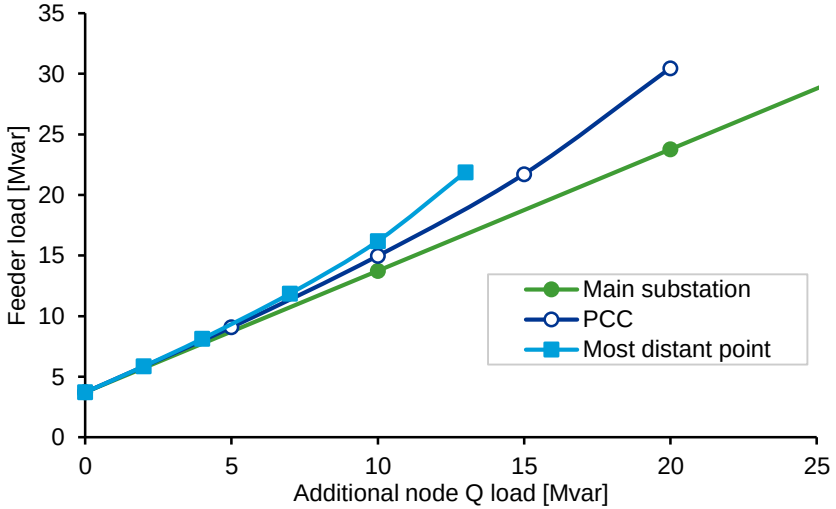
- Network studies & GCC have low priority -> risk of re-design
- Rules of thumb good in meshed grid, but not in long radial feeders
- Relative steady-state voltage change (IEC 61000-3-3) often a problem

Voltage step assessment

1. equivalent impedance (2.3%)
2. X, R & P, Q (3.5%)
3. **Risk-based approach with loaded network (4.0%)**

-> non-compliance, problems

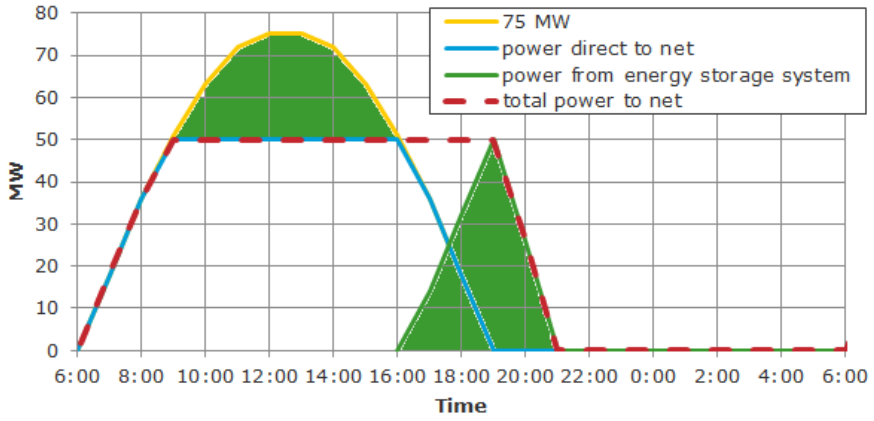


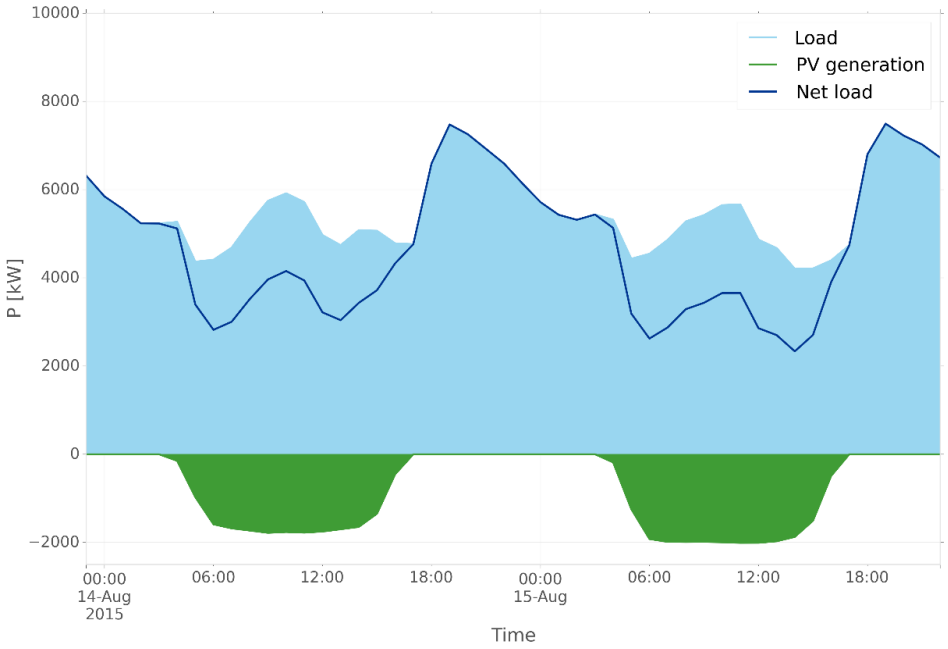


Why storage?

- Store the curtailed energy
- Better utilization of wheeling scheme and connection agreement
- Possibility to further expand the plant
- Reduction of ramp-down in the evening
- Additional revenue streams from ancillary services
- Early adopters

However, increase of LCOE and risk





Financial feasibility

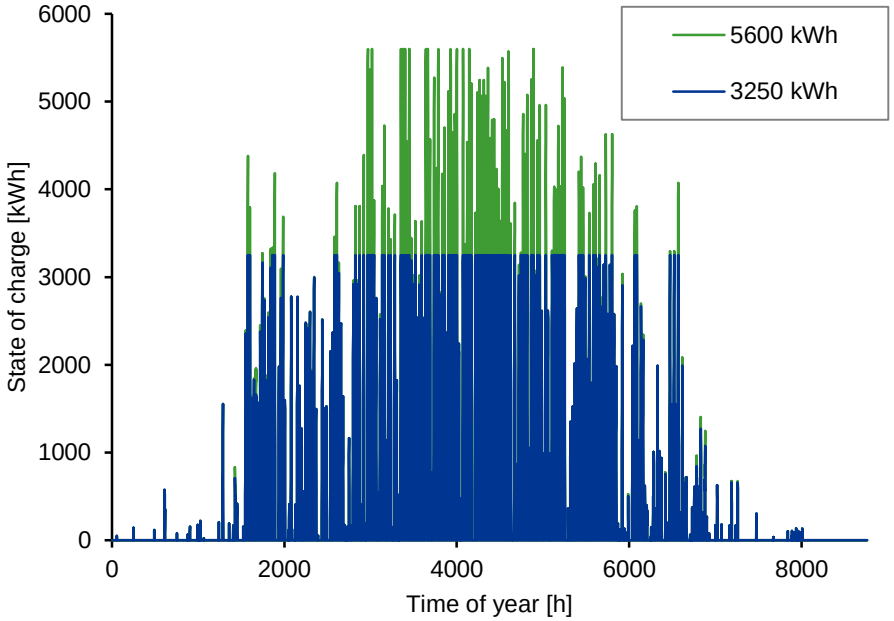
- Conservative assumptions (prices, efficiency, refurbishment)
- 3300 kW network connection limitation
- 30 years, 10% interest

1% energy lost (year 1)

- 5600 kWh / 800 kW BESS
- LCOE 120 EUR/MWh

2% energy lost (year 1)

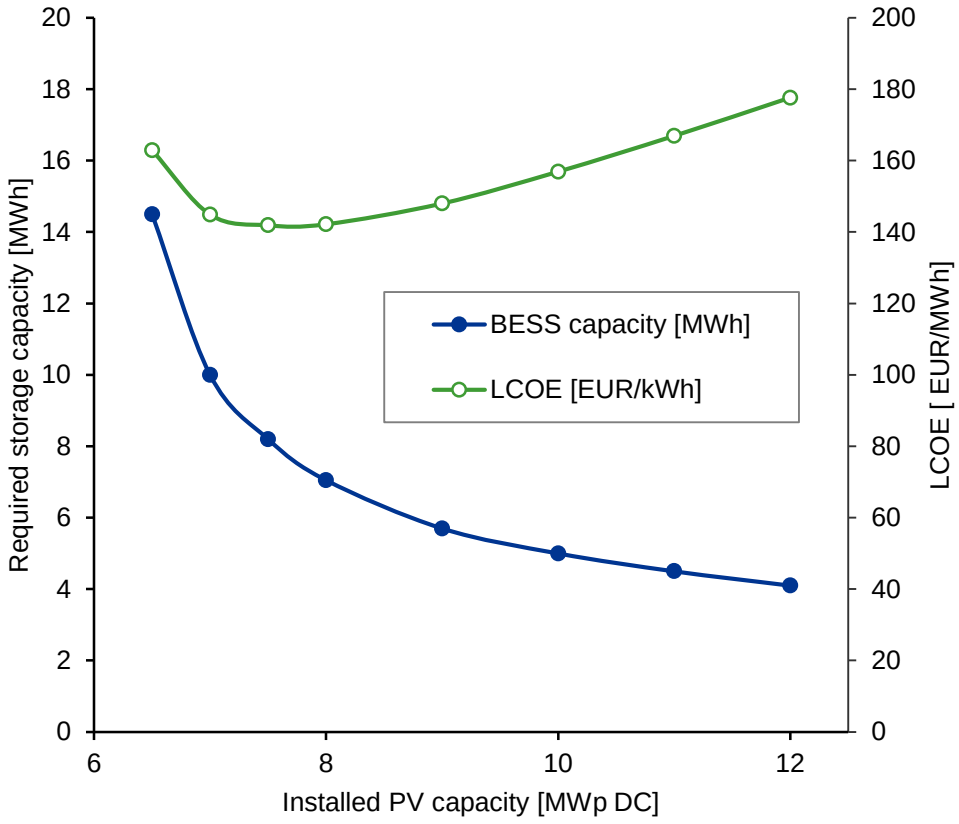
- 3250 kWh / 500 kW BESS
- LCOE 105 EUR/MWh



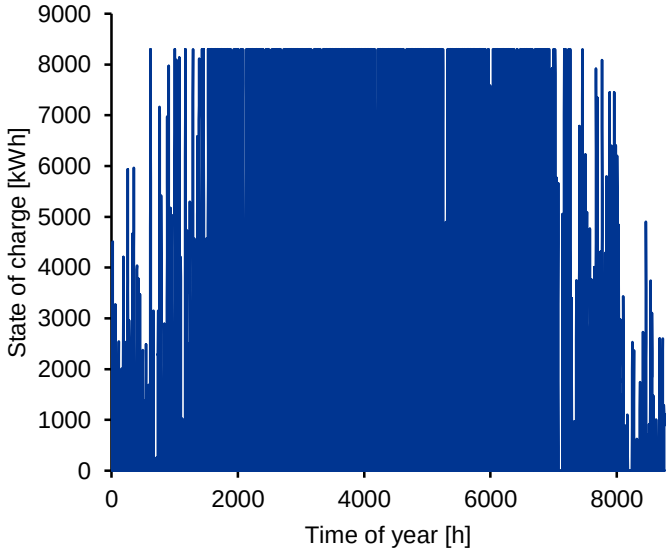
Curtailment still better option (low ratio installed PV / connection capacity)

Increased energy output

- Energy output +25%, network connection same



- 7.5 MWp PV
- 8.3 MWh / 1.2 MW BESS
- LCOE 142 EUR/MWh
- **Storage is efficient solution**



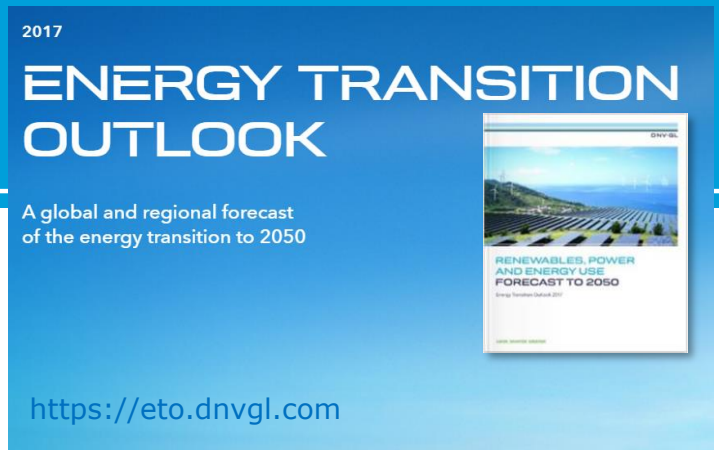
Key implications

1. LCOE for PV + storage > PV only (normal circumstances)
2. PV + storage competitive with tariffs and peak generation (not only Jordan)
3. Storage useful for overcoming network limitations, especially in case of wheeling and net-metering schemes.
4. Growing PV / connection capacity ration -> better case for storage
5. Feasibility highly dependent on electricity prices
6. Possibility for additional revenue with ancillary services

Recommendations for more detailed studies:

1. Degradation of BESS depends on application and needs to be modelled in more detail.
2. More accurate data on pricing and available P/E ratio is needed.
3. Economic performance can be improved with overall optimization of combined PV + storage system.

Thank you



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