EASY-RES

SUMMER SCHOOL "ENABLING DRES TO OFFER ANCILLARY SERVICES" 20TH – 24TH SEPTEMBER 2021

BATTERY ESS IN DISTRIBUTION GRIDS AND THEIR POTENTIAL ROLE IN THE AS PROVISION (BESS)

Sagar Bandi Venu // 23.09.2021

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Agenda

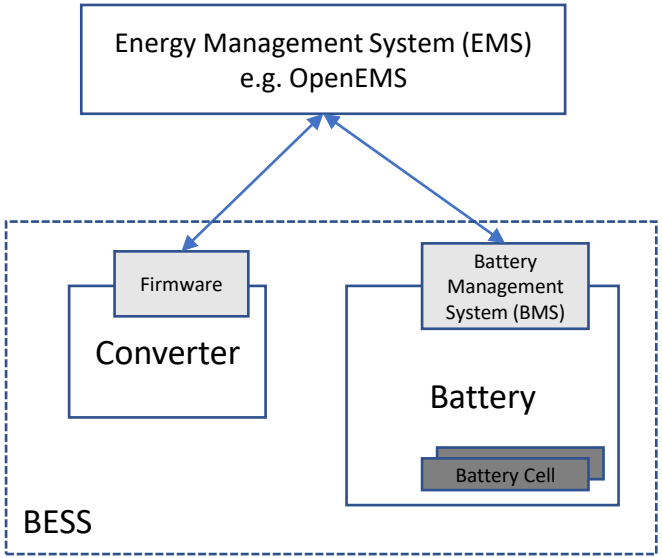
- The need for Energy Management System (EMS) of Battery Energy Storage Systems (BESS).
- EASY-RES vision for Battery ESS.
- Battery ESS Market Integration and Economical value for the AS provision.

Battery Energy Storage Systems

Combination of:

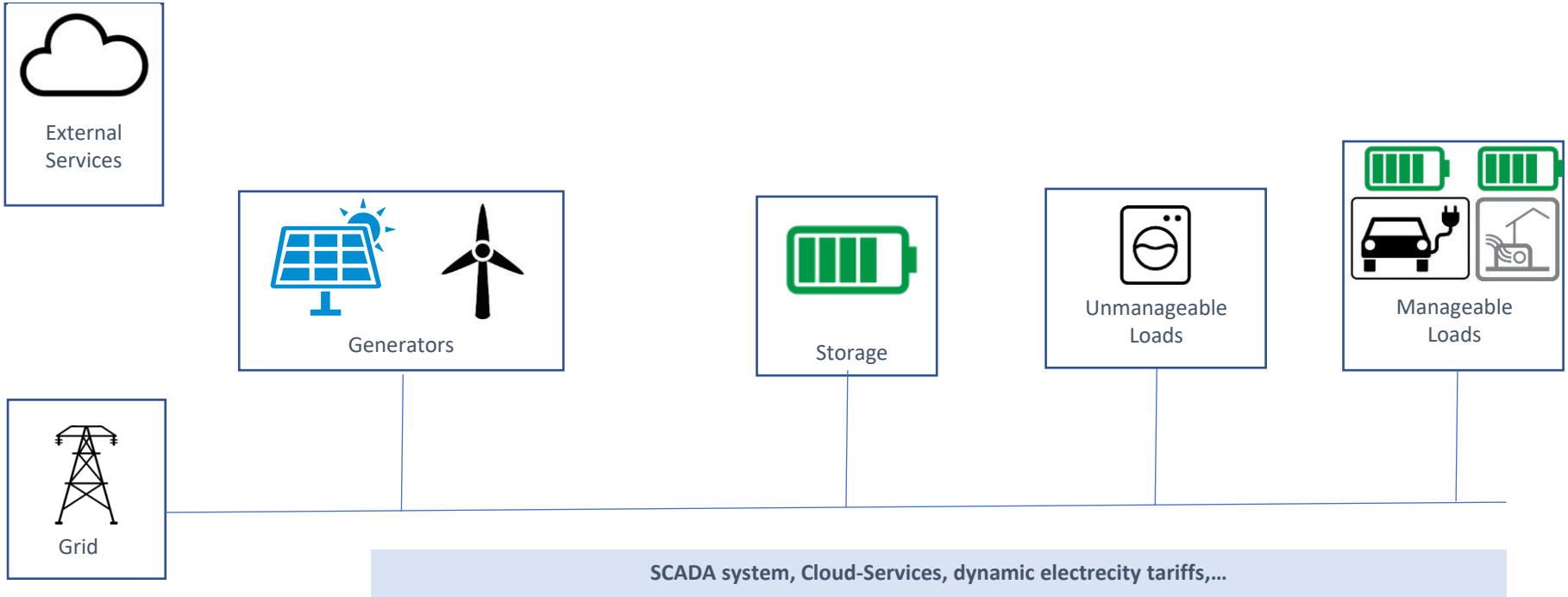
- Batteries
- Converters
- Meters

- ❑ Each device within BESS run device-specific embedded software.
- ❑ All these devices are managed by Energy management System (EMS).



The need for Energy Management System (EMS) of Battery ESS.

What is Energy Management?



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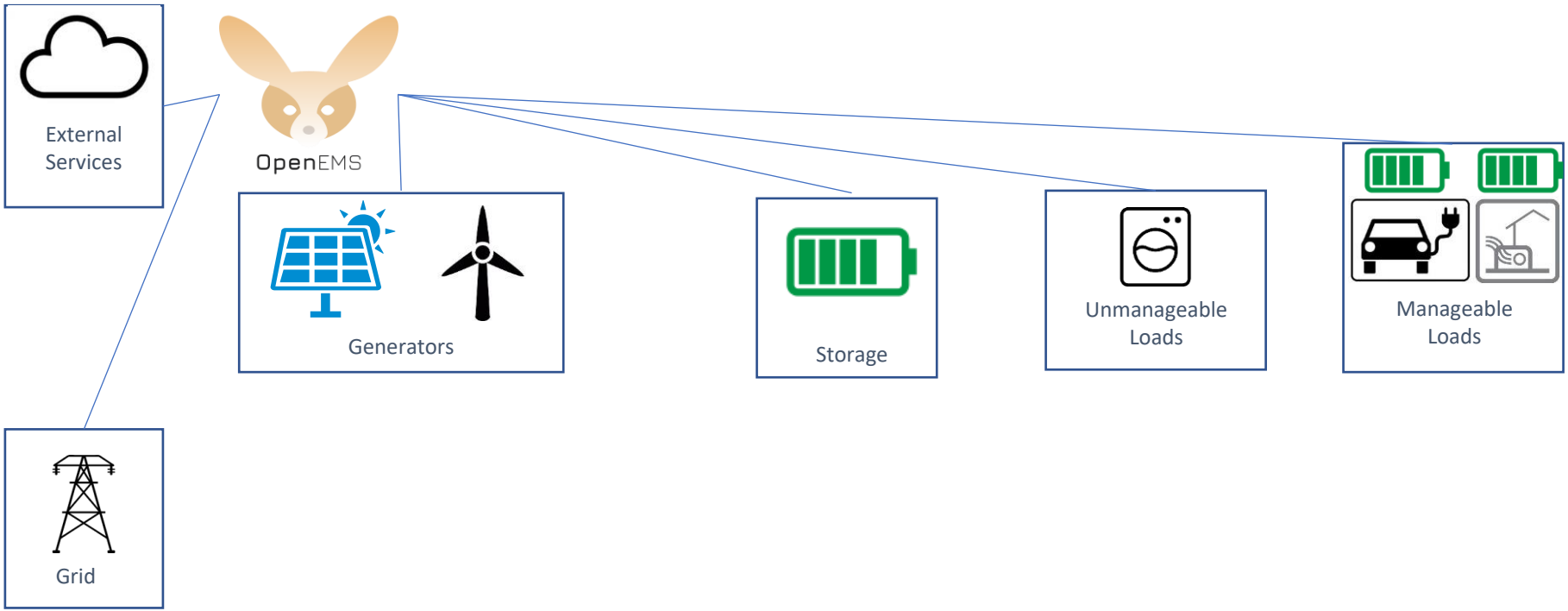

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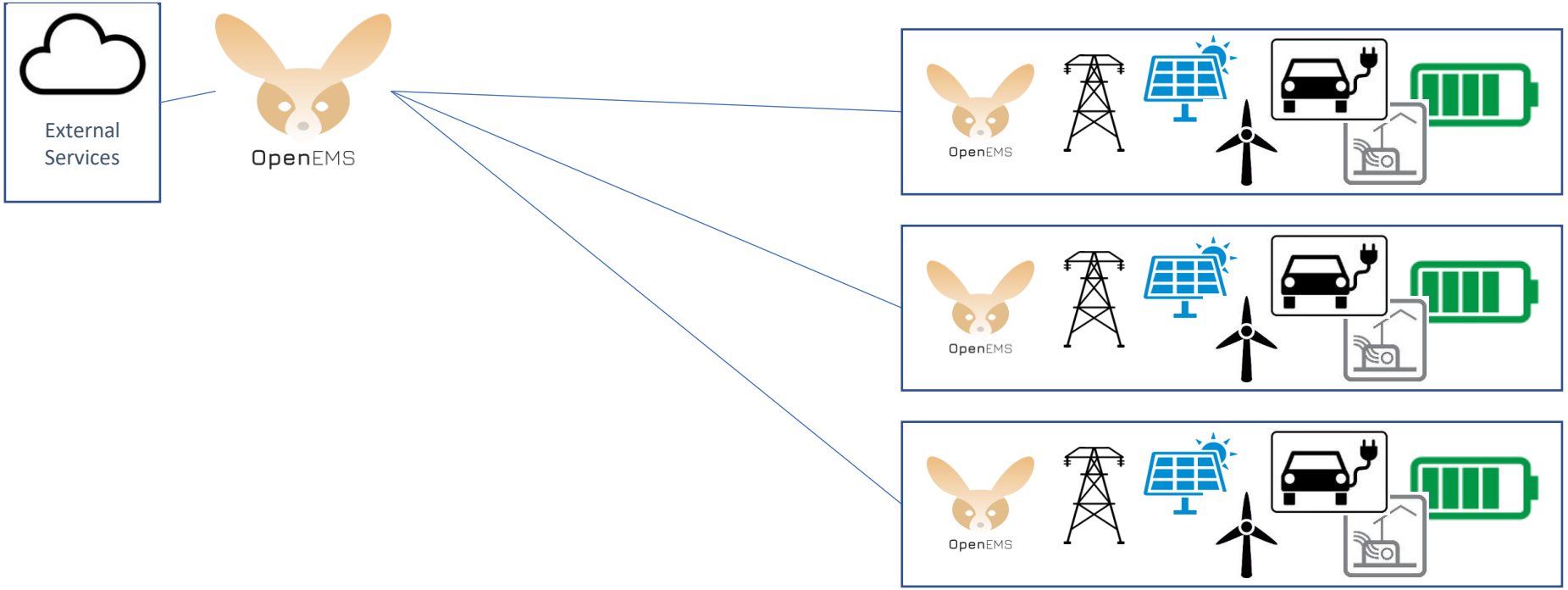


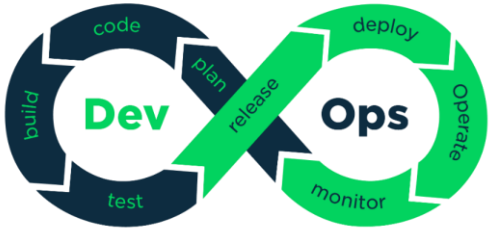
Types of EMS

- Central
  - Virtual power plants (e. g. for Primary control reserve)
  - Customer-„Cloud“/-“Community“
- Decentralized
  - Home / Industrial automation.
  - Load and generator management.
- Mix of both
  - Market flexibility
  - Dynamic electricity prices.

The need for Energy Management System (EMS) of Battery ESS.

Development

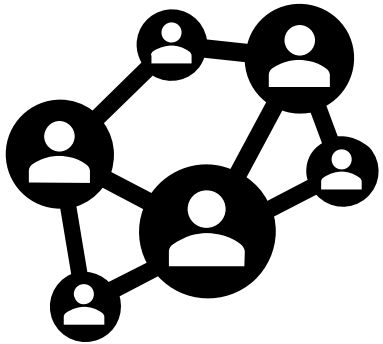
- ❑ Evaluate hardware
- ❑ Design and implement suitable, flexible software architecture
- ❑ Program interface connections and protocols
- ❑ Implement control and regulation algorithms
- ❑ Define and implement authentication and access restrictions
- ❑ Create a monitoring and configuration interface
- ❑ Develop cloud service & secure connection



The need for Energy Management System (EMS) of Battery ESS.

Integration

- Hardware manufacturers
  to be able to sell inverters, charging stations, energy storage systems,…
- Planning offices/ integrators
  to create an integrated energy solution with different hardware
- Commercial and private end customers
  to solve individual challenges and secure long-term investments
- Grid operators/ energy suppliers
  to use the flexibility in the grid
- Labs and Universities
  for education purposes, to test new algorithms, evaluate hardware,…



The need for Energy Management System (EMS) of Battery ESS.

Optimization

- Optimization of self-consumption rate / autarchy
- Cutting peak loads
- Grid services (frequency, reactive power, phase symmetry,…)
- Smart sector coupling with e-mobility and heating/cooling
- Behaviour on grid outages
- Dynamic electricity prices

- **Reasonable combination of applications**

The need for Energy Management System (EMS) of Battery ESS.

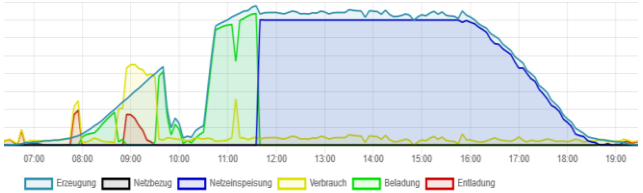
Combination with smart algorithms

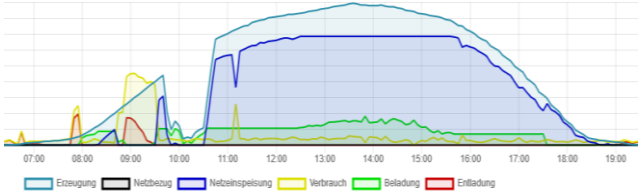
- „Grid-friendly“ self-consumption optimization
  based on forecasting of production and consumption
  avoids regulatory cutting at 70 %

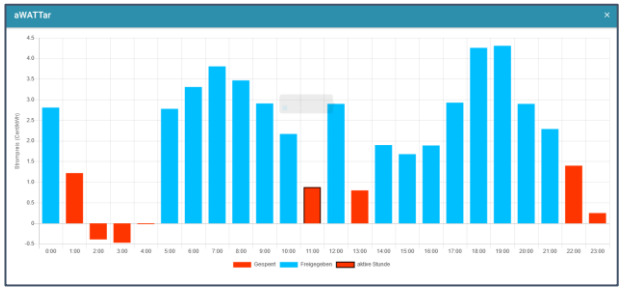
- Dynamic electricity price
  Forecast-based charging/discharging schedule for the battery

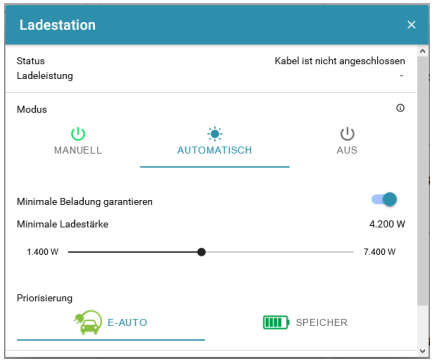
- Optimized charging of electric vehicles & multi-charging point management
  Excess-charging of PV production
  Fast-charging on demand

and many more…







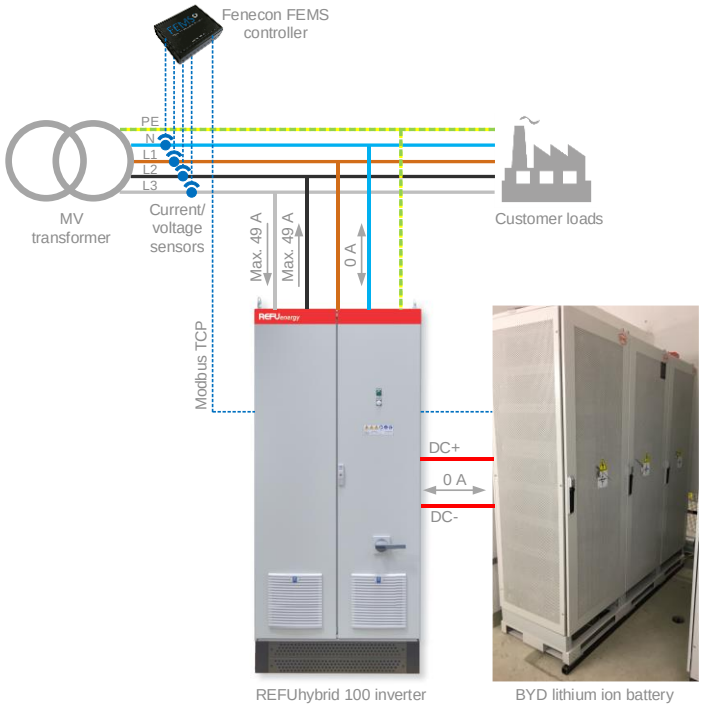


The need for Energy Management System (EMS) of Battery ESS.

References:
Grid services for Wien Energie

Provide grid services at transformator station in Vienna

- Peak-Shaving
- Phase symmetry
- Active and Reactive Power control



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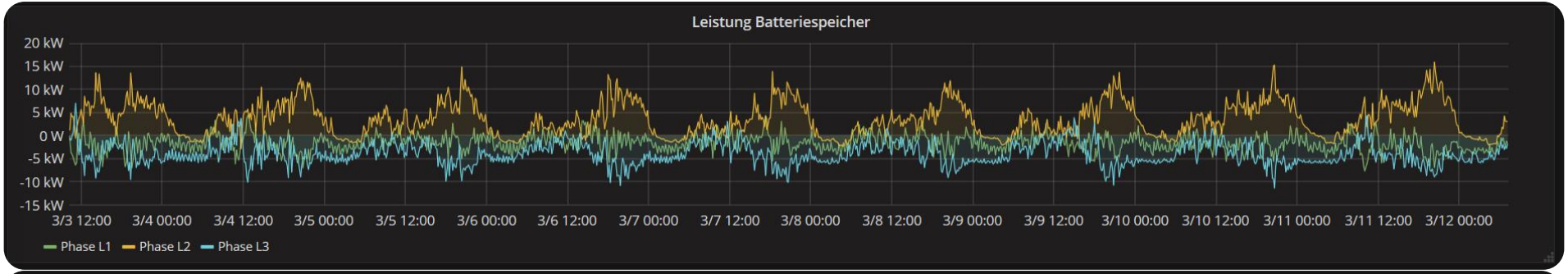
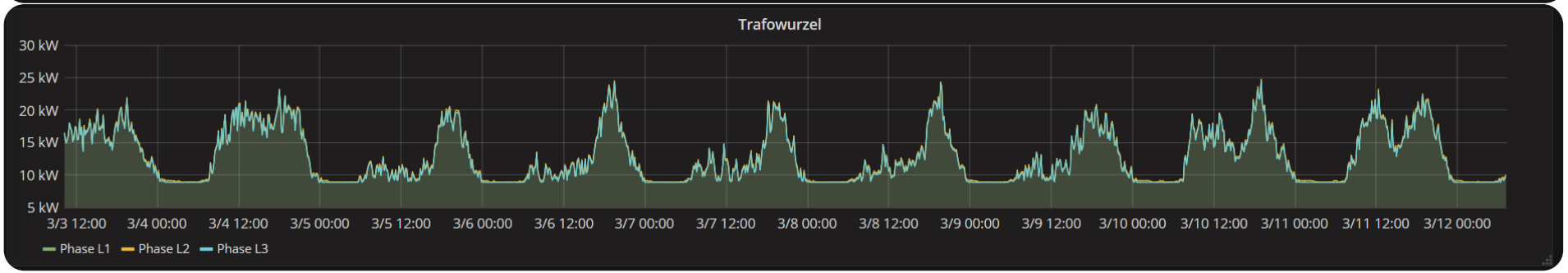


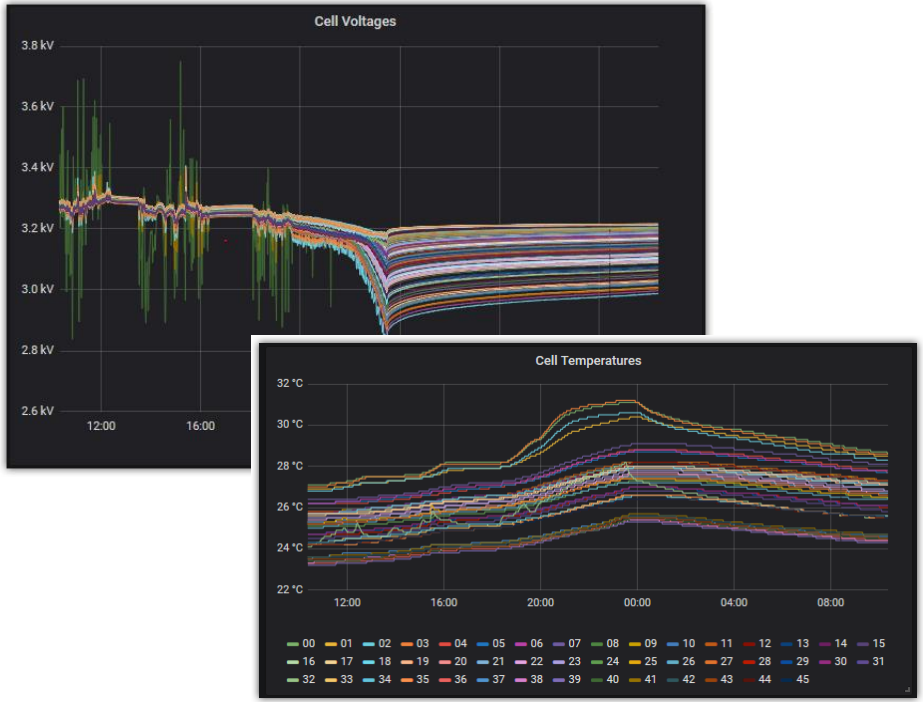


Charts show phase symmetry algorithm in action.

Above: Asymmetric active power output of the battery inverter; Below: Phases at the grid connection point

The need for Energy Management System (EMS) of Battery ESS.

References:
Big Data – recording and analysis

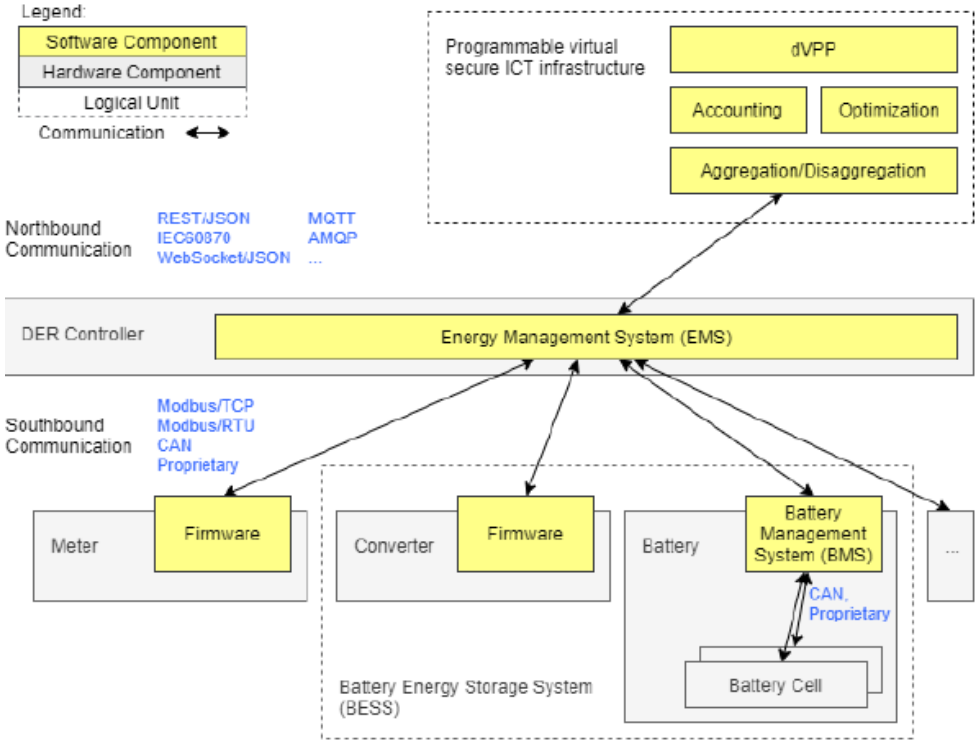


> 100 data points per Edge

average resolution of 10 seconds

The need for Energy Management System (EMS) of Battery ESS.

Overview of EMS in EASY-RES



- Gateway between individual DRES and higher level control system (ICT infrastructure).
- Collects the data from DRES or BESS and send it to ICT infrastructure.
- Takes schedule from ICT as input for local control algorithm.
- Enables the devices such as battery, converter etc, to provide AS.

EASY-RES vision for Battery ESS.

What are the goals?

- In EASY-RES, BESS is used to mitigate the power oscillations, which lie in the low frequency range.
- BESS is primarily intended to provide Low Frequency Power Smoothing (LFPS) as Ancillary service.

How can it be made real?

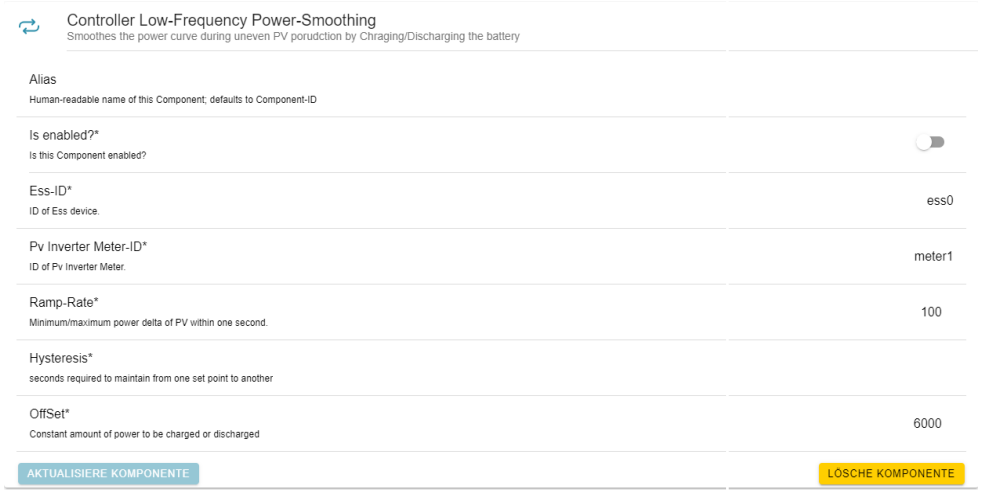
- Appropriate BESS is placed at point of common coupling of the renewable source.
- Set points for the BESS is given through ICT infrastructure.
- Actual control of BESS is done through EMS where the controller algorithms are installed/deployed.
- BESS is tested with the algorithm with scaled down PV profile from one of the DSO sites.
- BESS is also tested for dynamic reactive power capability.

EASY-RES vision for Battery ESS.

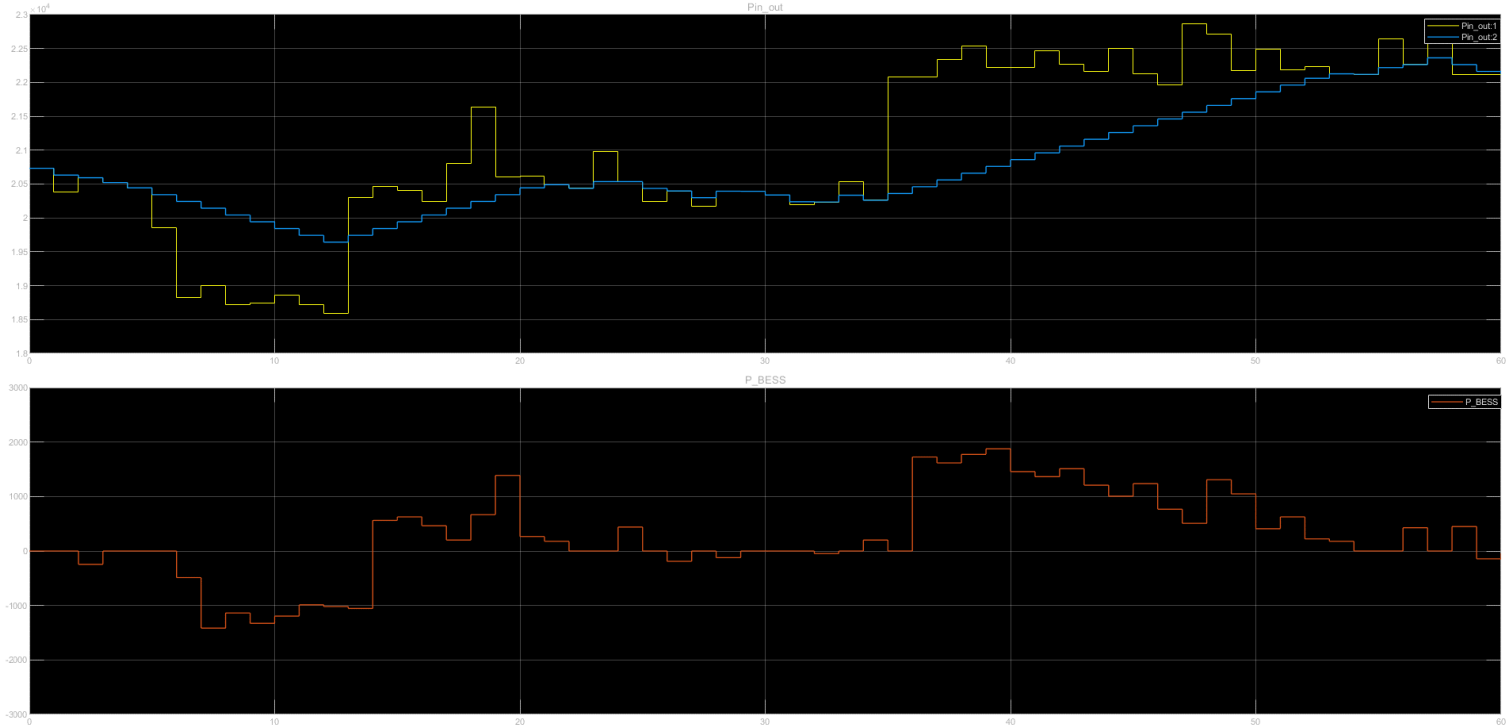
Low Frequency power Smoothing (LFPS) experiment.

What is done?

- ❑ Received battery requirements for testing and also the algorithm for LFPS.
- ❑ We provided a Battery according to requirements and implemented the algorithm as a controller in EMS (OpenEMS).
- ❑ Generated user friendly Interface for controller to test with different ramp rates.
- ❑ Deployed at the test system at TU Delft.



Low Frequency power Smoothing (LFPS).



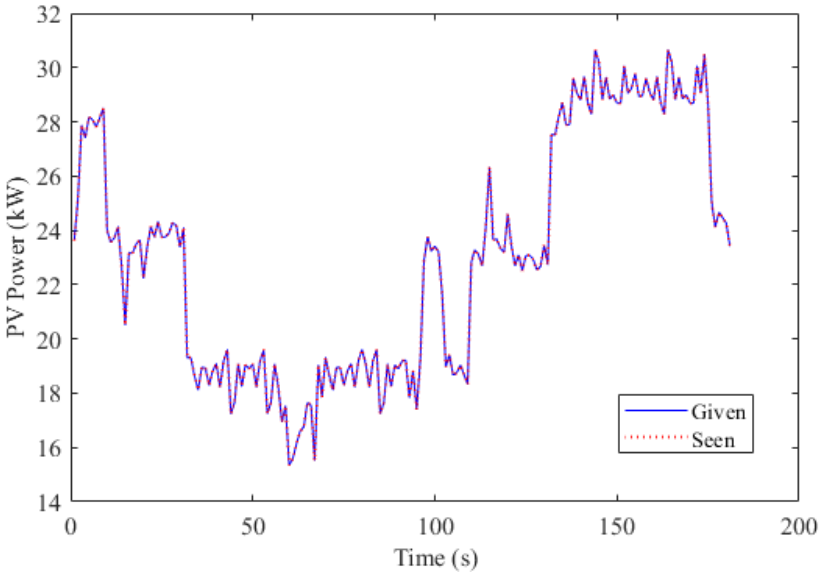
Charts show the simulation result of LFPS in action for 100 watts/sec RRL for a time step 1 sec.

Above: yellow line is P_in (PV), Blue line is P_out (Grid feed in);

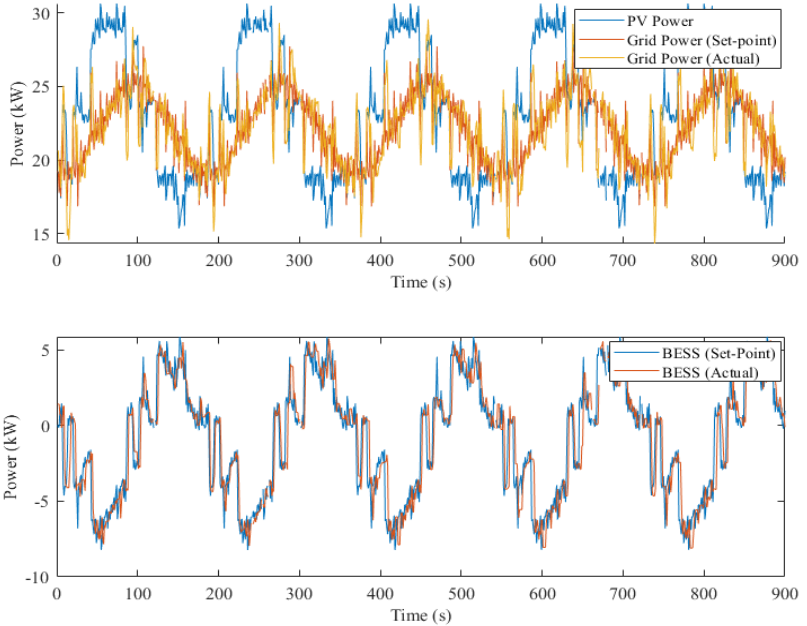
Below: Orange line is P_Bess (Battery power)

EASY-RES vision for Battery ESS.

Low Frequency power Smoothing (LFPS).



Above chart shows the PV profile taken for testing.



Above chart show the test result performed by the battery.

Battery ESS Market Integration and Economical value for the AS provision.

- Usage of BESS in power systems:
  - Load shifting
  - Frequency control
  - Voltage control
  - System restoration
  - System control
- The Usage of BESS to provide Ancillary services is growing rapidly.
- This is due to reduction in costs of BESS every year and modern battery inverters are technically similar to wind and PV inverters.

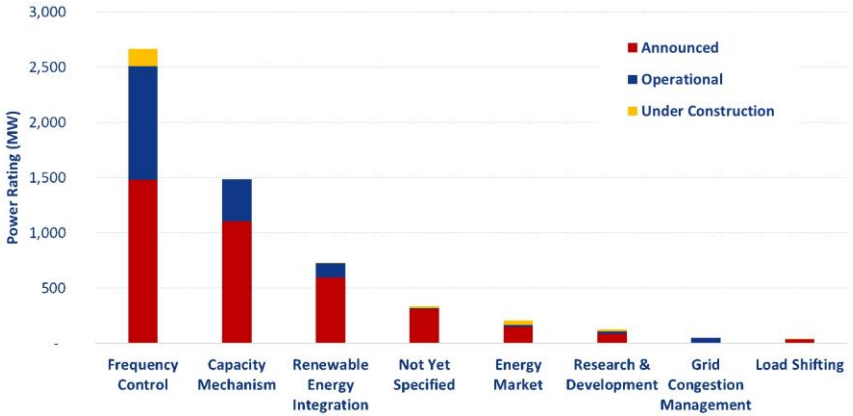


Figure showing most common applications for European large-scale energy storage systems.
Image: Clean Horizon

Battery ESS Market Integration and Economical value for the AS provision.

Advantages

- High Accuracy
- Fast reaction times
- Bidirectional operation
- High efficiency
- Faster process for implementation
- Mobility of BESS

Challenges

- Lack of grants from govts for BESS operation.
- Battery costs needs to reduce further.
- Lack of awareness of technology benefits.
- Dedicated BESS for dedicated AS results in more amortization time.

Instead:
Multi purpose usage of BESS should be considered.

- Reactive power provision as AS
- Atypical grid usage which is often used in winter
- E-point peak shaving, which reduces the effort to not upgrade the grid.
- Power reserve.

Suggestions for future market?

- Multi purpose usage should be less restricted in Europe.
- Grants should be provided for inclusion of BESS in the network.
- Second life batteries should be considered as an option for certain networks with appropriate pricing schemes.
- Incentives for better performance like higher speed and accuracy.

Item 4: The EASY-RES Consortium

The Consortium

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Thank you!

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