Workshop for replicant partners: Energy grid and infrastructures”
Mai 06.2021

Business Models for energy storage integration

PROSPECT2030 | HSMD | Prof. P. Komarnicki, Dr. P. Lombardi

AGENDA

RES

Status quo in EU and in Germany

Integrating volatile RES:

Problems and solutions

Business models for energy storage integration

Conclusions

EUROPEAN GREEN DEAL STRATEGY

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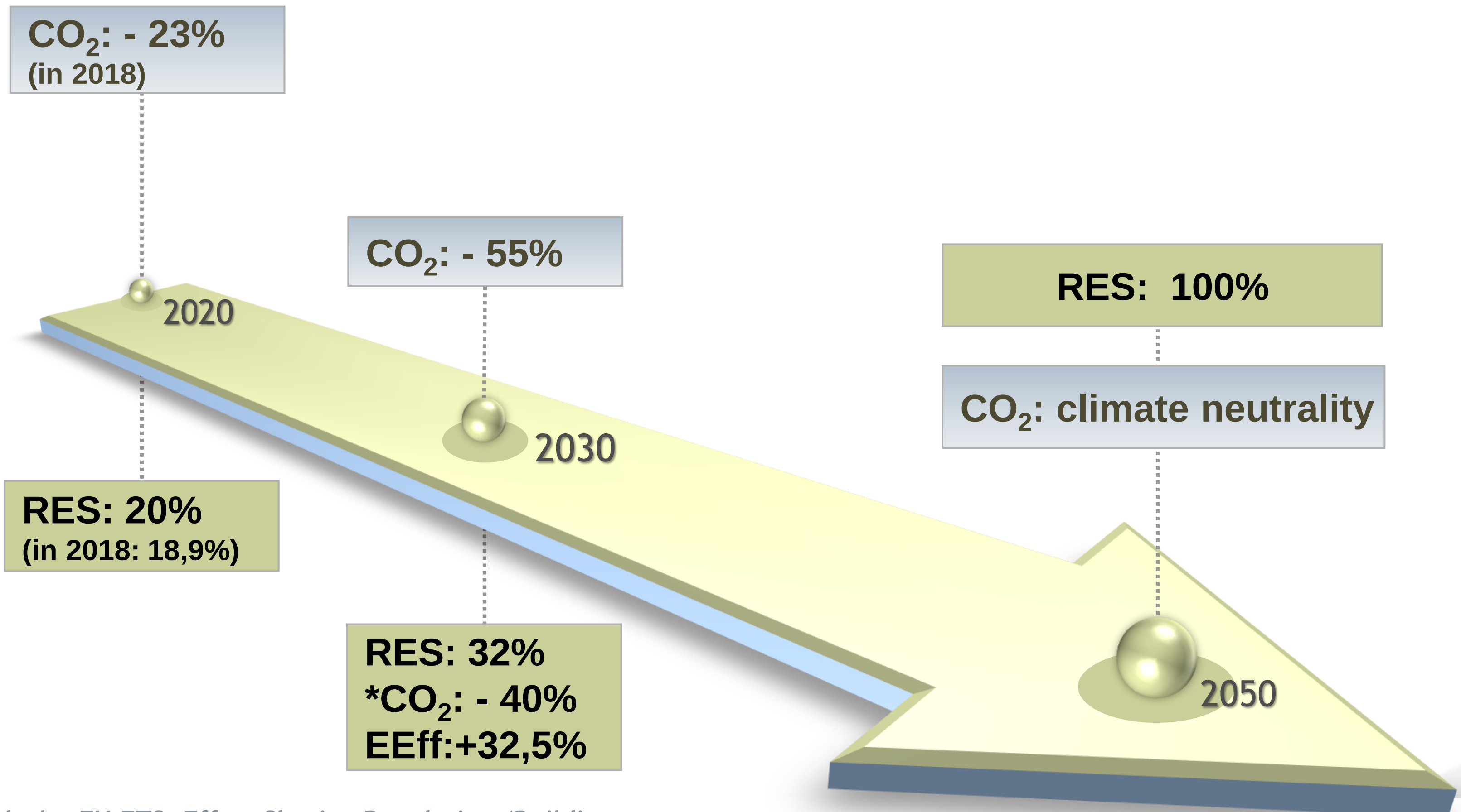
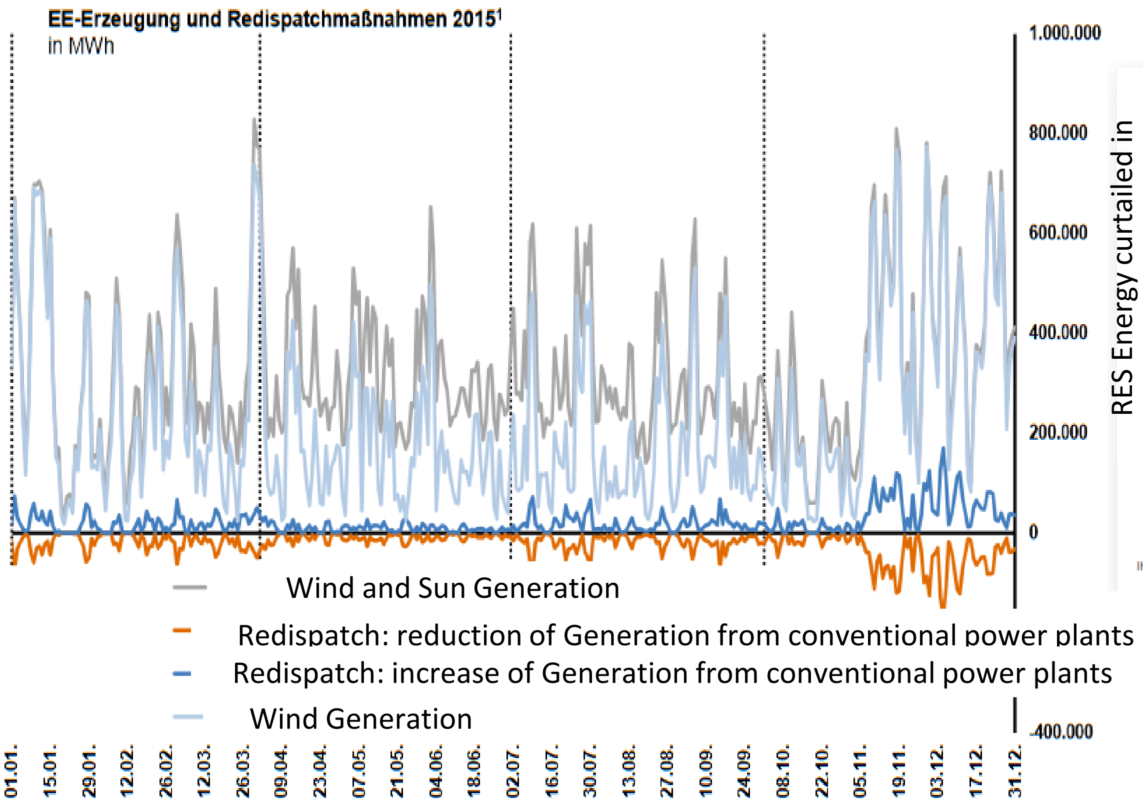


* Through the EU ETS, Effort Sharing Regulation (Building, transport, agriculture and waste) and Land use, forestry regulation

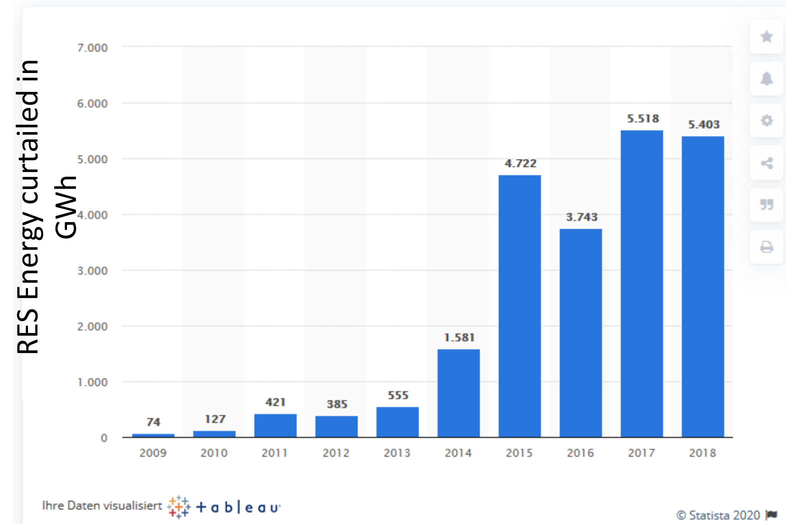
DECARBONIZATION. PROBLEMATIC TO GENERATE ELECTRICITY THROUGH RES: GERMAN EXAMPLE

RES-Generation and Redispatch actions in Germany (2015) - MWh



Quelle: Monitoringreferat der Bundesnetzagentur
[1]In dieser Abbildung wird die Korrelation zwischen der Einspeisung Erneuerbarer Energien und Redispatchmaßnahmen dargestellt. Es gibt weitere Ursachen für Redispatchentwicklungen, die unter 3.1.1 genannt sind.

RES-curtail in Germany 2009-2018



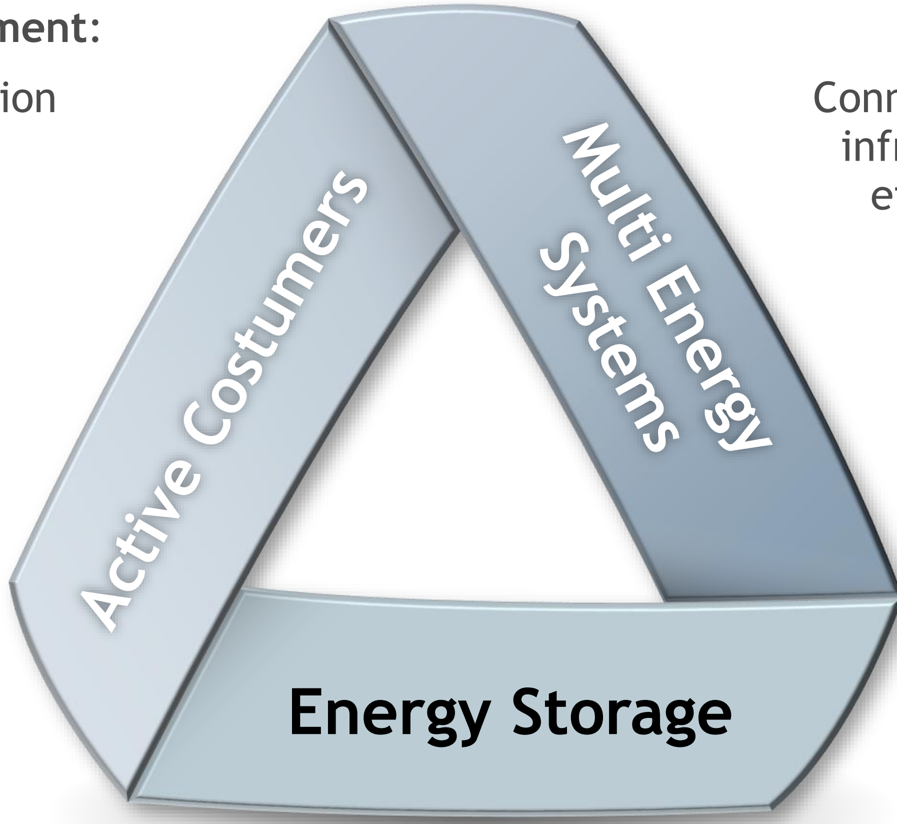
SOLUTION FOR INTEGRATING RES INTO THE ENERGY SYSTEMS: MORE FLEXIBILITY

Demand Side Management:

Align energy consumption with volatile Energy generation

Energy Hubs:

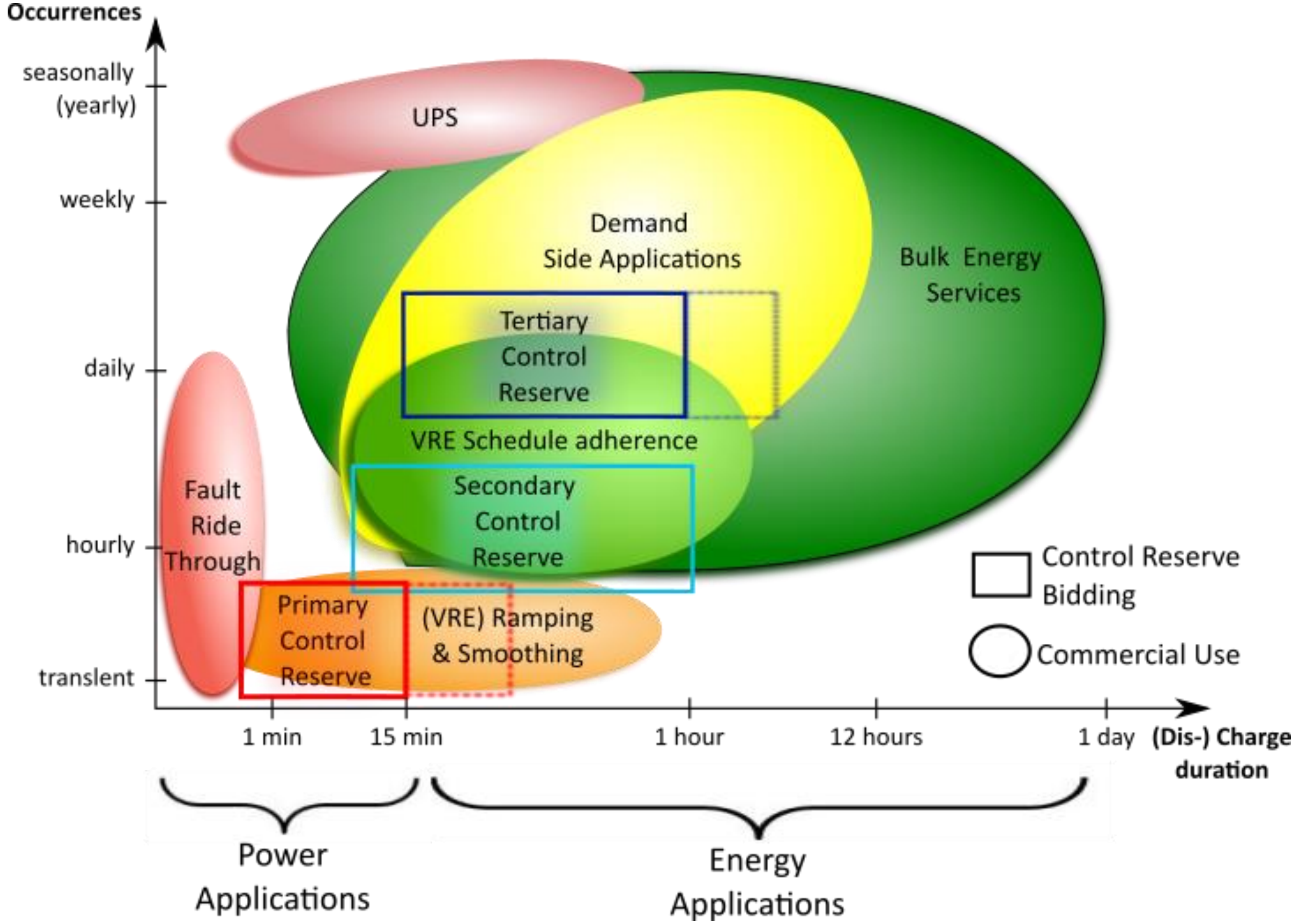
Connect the existing energy infrastructures to increase efficiency, flexibility and synergies



Energy Buffering:

Store surplus energy for times with high demand

ENERGY STORAGE SYSTEM APPLICATIONS



ENERGY STORAGE SYSTEMS

Technology		Main Issues
Pumped Hydro Storage (PHS)		- Geographically limited
Compressed Air Energy Storage (CAES)		- Geographically limited - Expensive
Batteries		- mature but still expensive - Limited natural resources - No capacity for long term storage
Power to Gas		- Expensive - Low efficiency

Also: Thermal Energy Storage, Flywheels, Capacitors

ENERGY STORAGE SYSTEMS: PRATICAL EXPERIENCES

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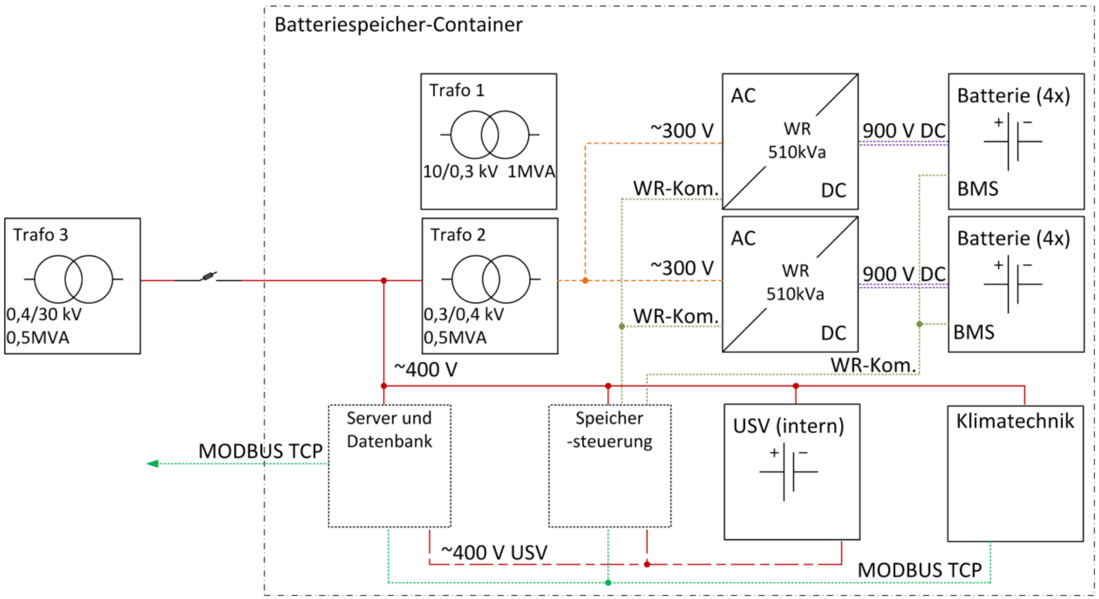

Specification

- power: 1 MW
- capacity: 0,5 MWh
- Fed-in: 0,4kV or 10kV
- size: 40ft container
- mass: 26t
- technical features:
  - reactive power capability
  - black start capability (grid restauration)
  - island grid capability (can be synchronized and reconnected)

➢ *e.g. up to 4h supply of VDTC building*

MOBILE USAGE

1ST BUSINESS CASE. STORAGE USAGE IN PV PARK NEUHARDENBERG (GERMANY)

- <u>SGESS</u>
  - development and implementation of control algorithm and usage strategies
  - multi purpose use cases to minimize PV-own consumption, active and reactive power supply, energy market, etc.

- <u>5MW battery storage for primary reserve</u>
  - scientific valuation of usage concept and operation
  - life-time and operation data analyses

1ST BUSINESS CASE. STORAGE USAGE IN PV PARK NEUHARDENBERG (GERMANY)

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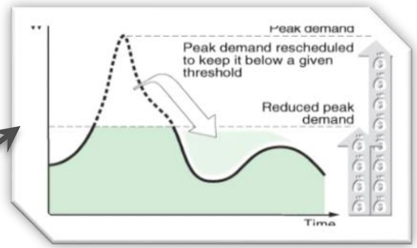
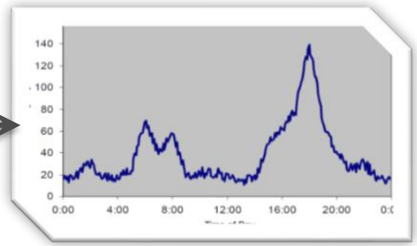


supply during night hours



limited energy production, limited power gradient

energy market, intraday

Optimal combination

- ✓ life-time
- ✓ profit
- ✓ grid serving use

1ST BUSINESS CASE. STORAGE USAGE IN PV PARK NEUHARDENBERG (GERMANY)

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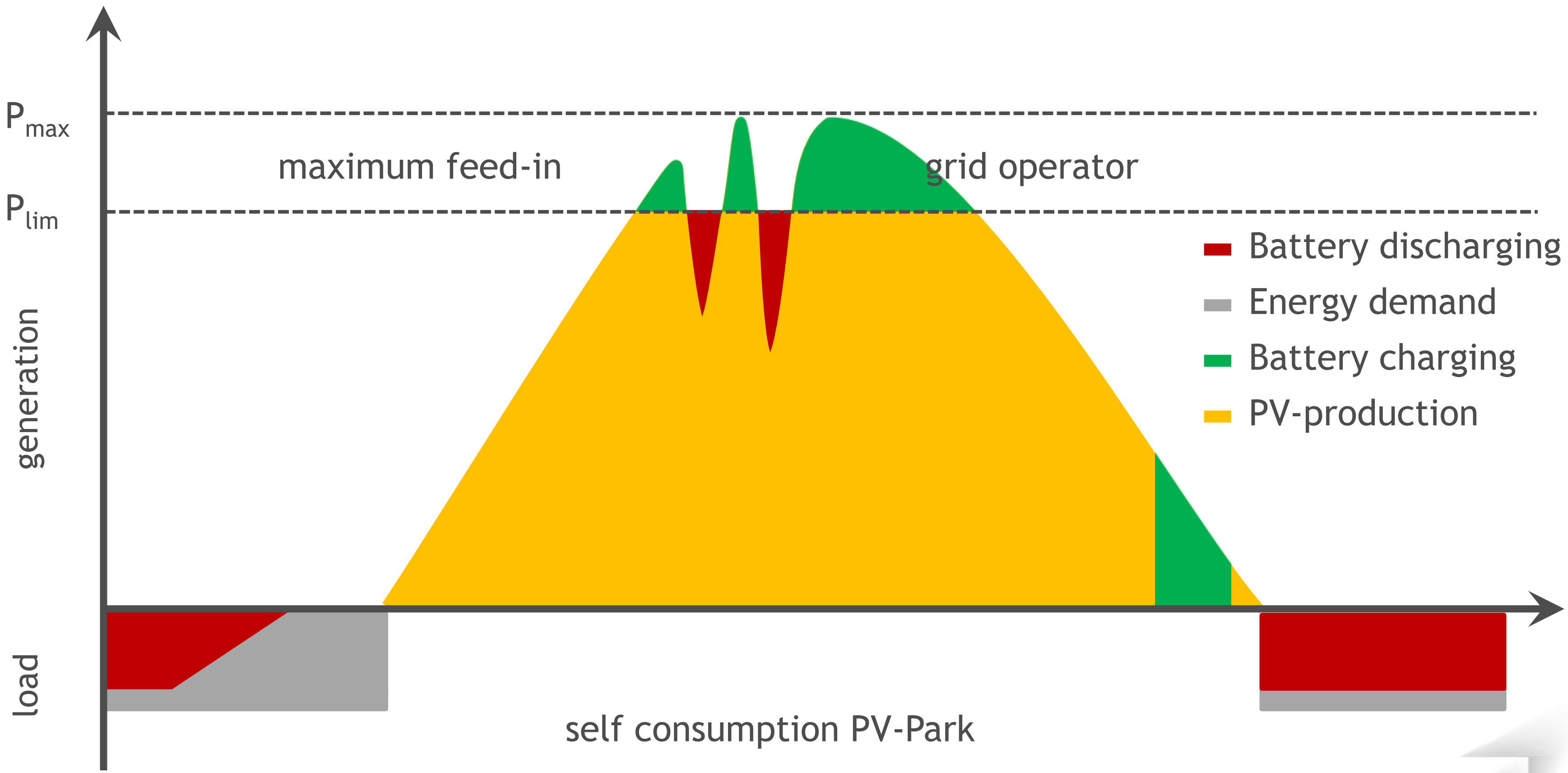
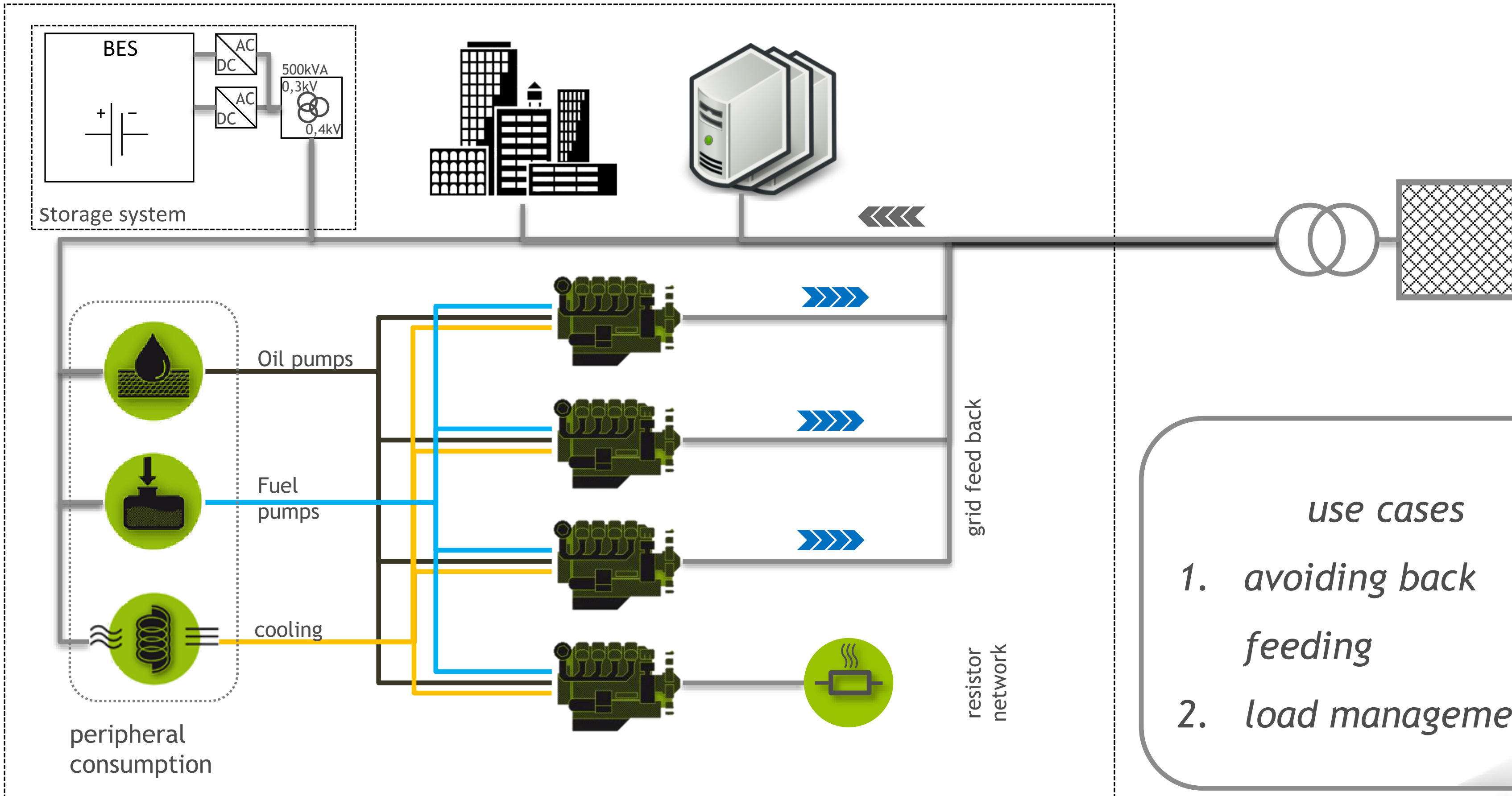


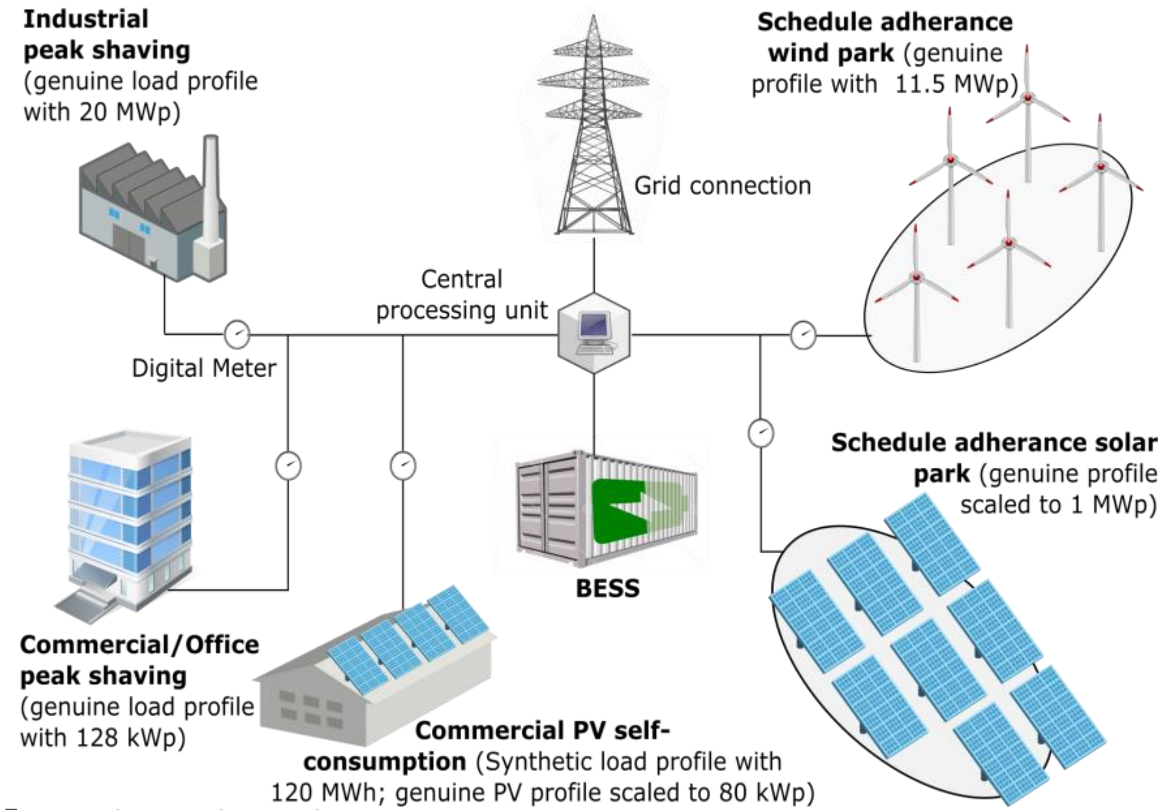
2ND BUSINESS CASE. STORAGE USAGE IN MECHANICAL INDUSTRY



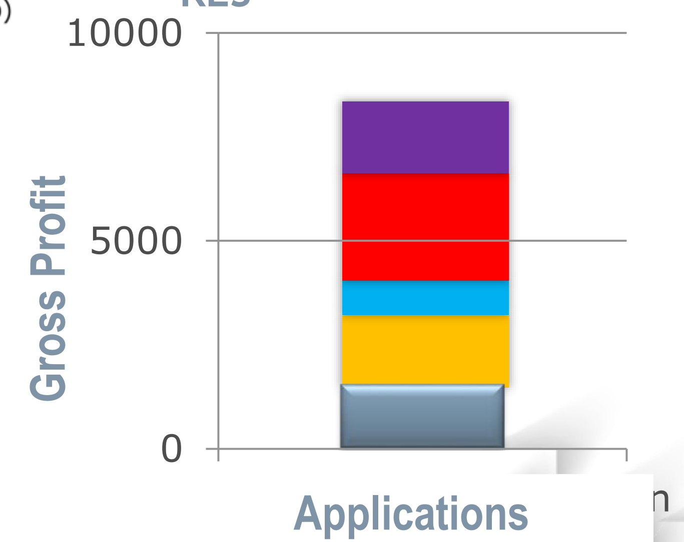
use cases

1. *avoiding back feeding*
2. *load management*

3RD BUSINESS CASE. SHARING ECONOMY



- Time Horizon 10 years
- Three different technologies: Li-ion, NaS and Vanadium Redox Flow
- Three different applications:
  - Peak shaving
  - Increase of self consumption
  - Schedule Adherence for RES



Investment costs

$$c_{inv} \leftrightarrow \pi_1 + \pi_2 + \pi_3 + \pi_4 + \pi_5$$

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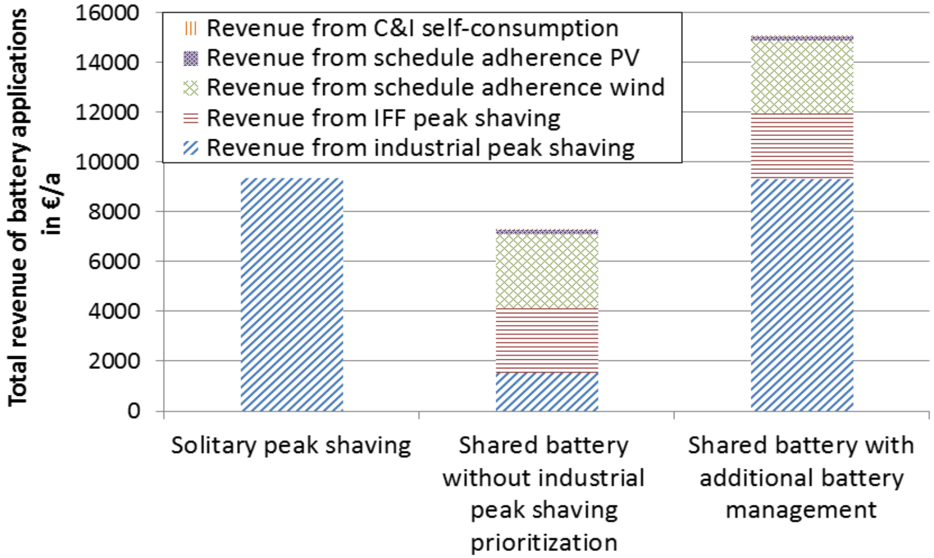
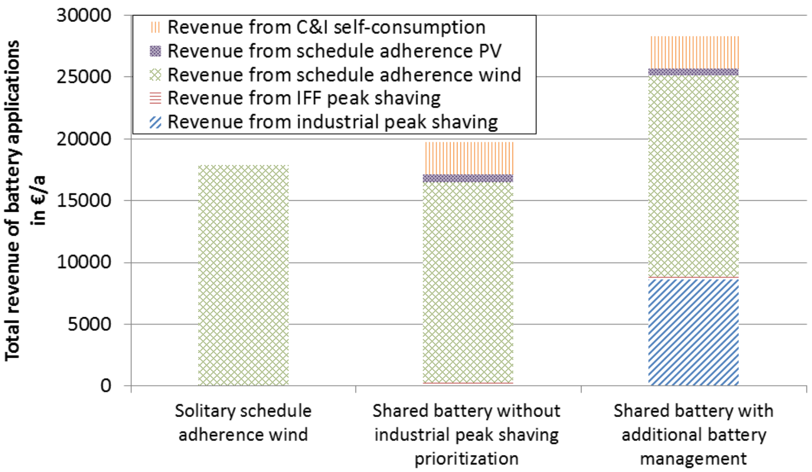


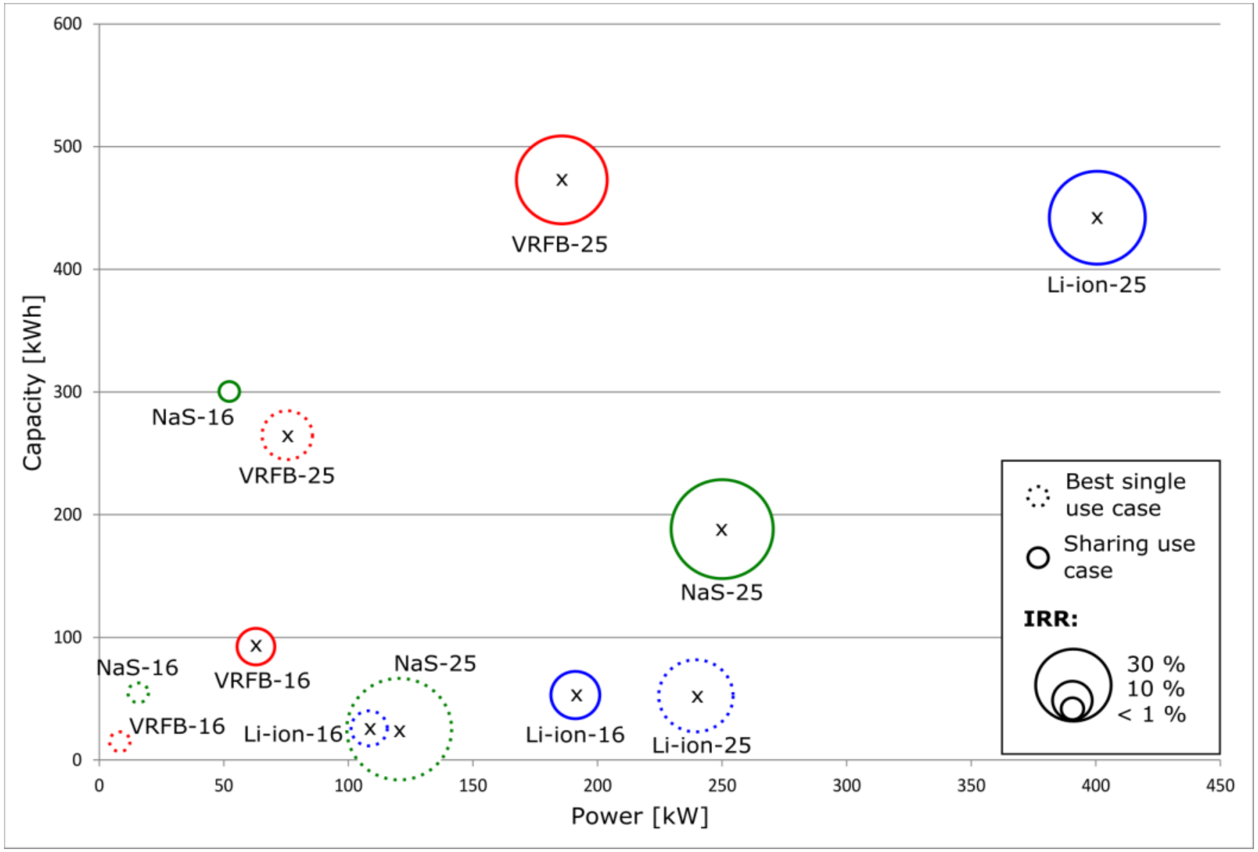


Battery size: 110 kW, 37 kWh. Li-ion Technology
Battery parameter regarding the year 2016

Battery size: 75 kW, 270 kWh. Vanadium RF Technology
Battery parameters regarding the year 2025

Parameter	Li-ion		NaS		VRF	
	2016	2025	2016	2025	2016	2025
Specific energy storage investment costs [€/kWh]	450	250	300	225	250	100
Specific power conversion investment costs [€/kW]	175	100	175	100	400	300
Overhead investment costs [% of total investment costs]	20	20	20	20	30	30
Annual operational and maintenance costs [% of total investment costs]	1	1.5	2	2.5	2	2.5
Battery system roundtrip efficiency AC to AC [%]	85	90	80	85	75	80
Depth of discharge [%]	80	85	90	90	100	100
Average cycle life [number of full cycles]	5500	10000	4500	6000	12000	25000
Calendar life [years]	12	20	15	20	20	20
Self-discharge of battery cells [%/day]	0.1	0.04	0	0	0	0
Degradation [%/year]	1.5	1	1.3	1	0	0

3RD BUSINESS CASE. SHARING ECONOMY



CONCLUSIONS

- Energy storage systems as key element for the decarbonisation process
- Battery technologies able to cover both power as well as energy applications
- For single use applications, it is difficult to find attractive business models
- Sharing economy business models result to be economically more attractive than single use application

THANK YOU FOR YOUR ATTENTION