HS'BI

Hochschule Bielefeld
University of Applied Sciences and Arts

Research-Atelier:
Battery Storage Systems in Distribution Grids

15.05.2024

In Kooperation mit dem
VDE OSTWESTFALEN-LIPPE

AGNES

ites
Institut der HSBI

AGENDA

13:00 – 13:20	**Welcome Address** Prof. Jens Haubrock, HSBI
13:20 – 13:40	**AI4DG – Project Results** Katrin Schulte, HSBI
13:40 – 14:00	**Battery storage as an alternative for grid expansion** Julius Dresselhaus, WWN/HSBI
14:00 – 14:30	**Refreshments**
14:30 – 14:50	**Storage optimization in fractal networks of tomorrow** Hélène Schricke, Atos
14:50 – 15:10	**Research potential within the framework of §13k EnWG** Prof. Jens Haubrock, HSBI
15:15	**Networking Reception**

PROF. DR.-ING. JENS HAUBROCK

- 2007 Doctorate (Dr.-Ing.) at the Otto-von-Guericke University Magdeburg, topic: fuel cells
- Experience in the industry in the field of simulation and training of power failure scenarios
- 2010 Appointment as **Professor for Renewable Energy Systems and Electrical Engineering** at HSBI
- Deputy Head of the Institute for Technical Energy Systems (ITES)
- Head of the Working Group Grids and Energy Systems (AGNES)
- Professorial member of the **NRW doctoral college (PK-NRW)**
- Member of the Board: **IEEE PES**
- Member of **CIGRE, VDE and IEEE**

PROMOTIONS-KOLLEG NRW

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INSTITUTE FOR TECHNICAL ENERGY SYSTEMS (ITES)

- **7** professors and **21** researchers
- An institute within the Faculty of Engineering and Mathematics
- Areas of focus: **Intelligent and sustainable energy systems for the future**
- **29** successfully completed projects
- **1.16** million euros in external funding in 2021

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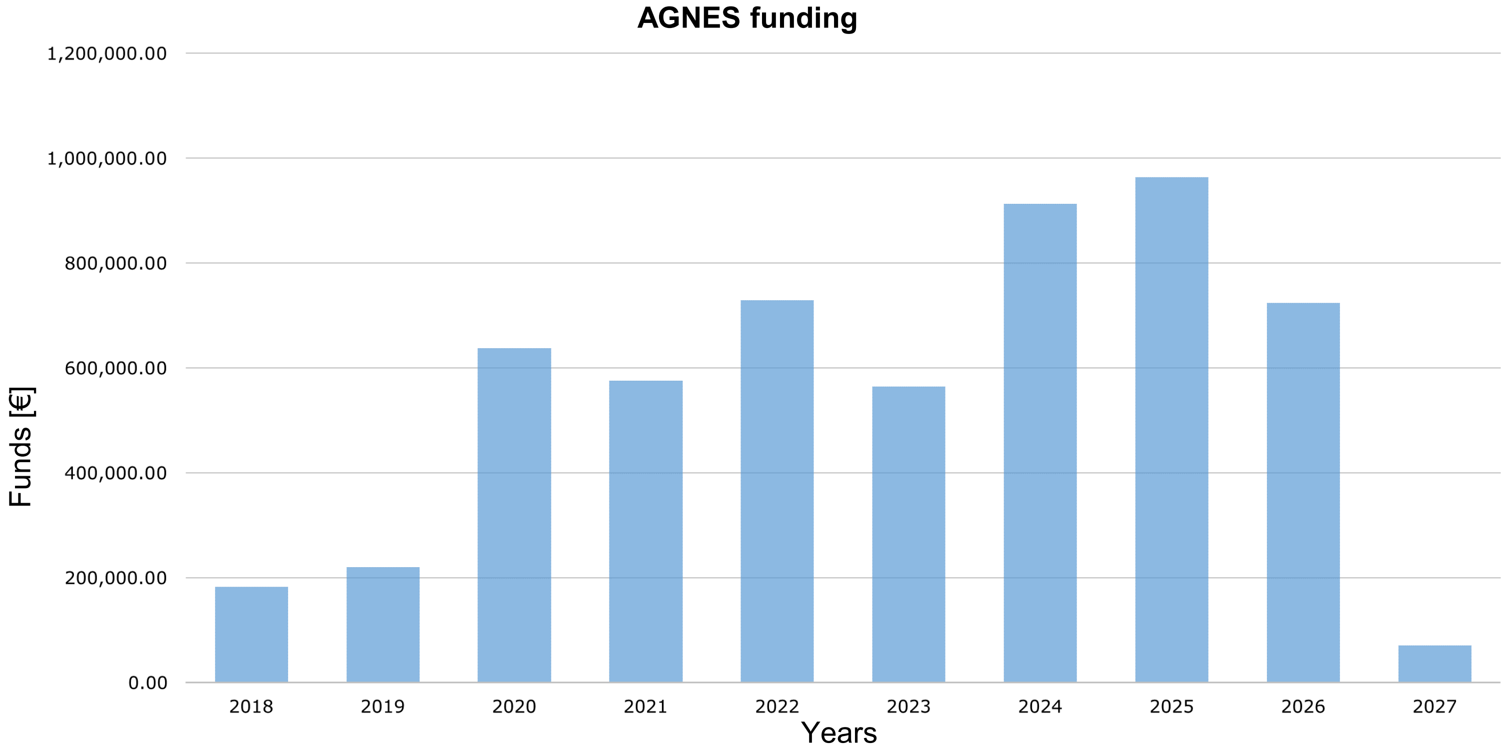
GRIDS AND ENERGY SYSTEMS WORKING GROUP (AGNES)

- Working group within ITES
- 2 professors
- 12 research associates
- Research topics:
  - Integration of **electric vehicles and renewable energy systems** into the electrical grid
  - Integration of intelligent grid and measurement technology
  - Use of **AI-based systems** for grid operation

FACTS, FIGURES AND DATA

- **7** successfully completed research projects
- **7** current projects
  - 4 national
  - 3 international
  - 3 Research networks/ transfer
- **5.58 Mio. €** External funding (2018-2027, as of Nov. 2023)



SMART ENERGY APPLICATIONS LABORATORY (SEAp)

- **Hardware-in-the-loop** (HiL) test bench with hardware components for simulating PV, electric vehicles, loads, battery storage + real-time grid simulator (OPAL-RT)
- Development and validation of **intelligent algorithms** and methods for the control and monitoring of electrical grids to provide **flexibility through sector coupling**

https://www.eranet-smartenergysystems.eu/ll/133/SEAp---Smart-Energy-Applications.html

AI4DG

- AI4DG: AI on the edge for a secure and autonomous Distribution Grid control with a high share of renewable energies
  - **Partners:**
    - Bielefeld University, Westfalen Weser Netz GmbH (GER)
    - Université Grenoble Alpes, ATOS Worldgrid (FRA)
  - **Project duration:** 10/2021 – 09/2024
  - **Funding institution:** Federal Ministry of Education and Research Germany (*Bundesministerium für Bildung und Forschung BMBF*)
  - **Project volume:** € 1,1 million (HSBI 209 T€)

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

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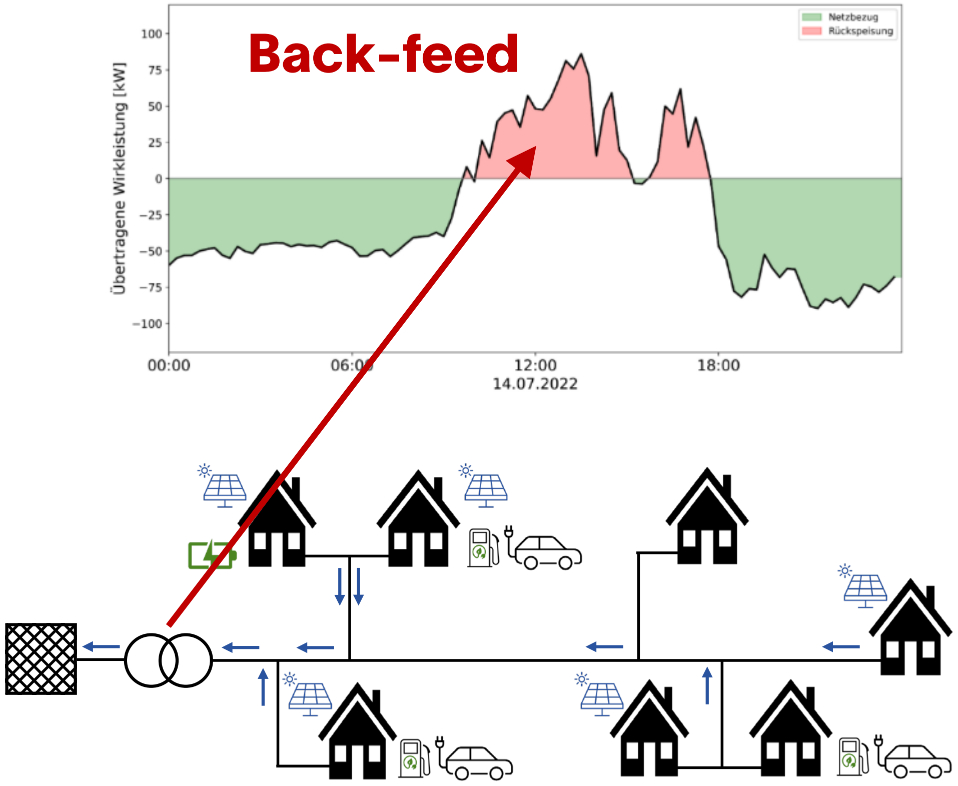
AI4DG

gefördert vom Bundesministerium für Bildung und Forschung

AI4DG

- Objectives:
  - To **minimise the backfeed** power in a low-voltage (LV) grid with a high proportion of photovoltaic (PV) systems.
  - Increase the share of local PV generation through **grid-optimised, controlled solar battery storage systems.**
  - **Optimise transformer utilisation** by controlling distributed battery storage systems.
    - Minimise power feedback at transformers



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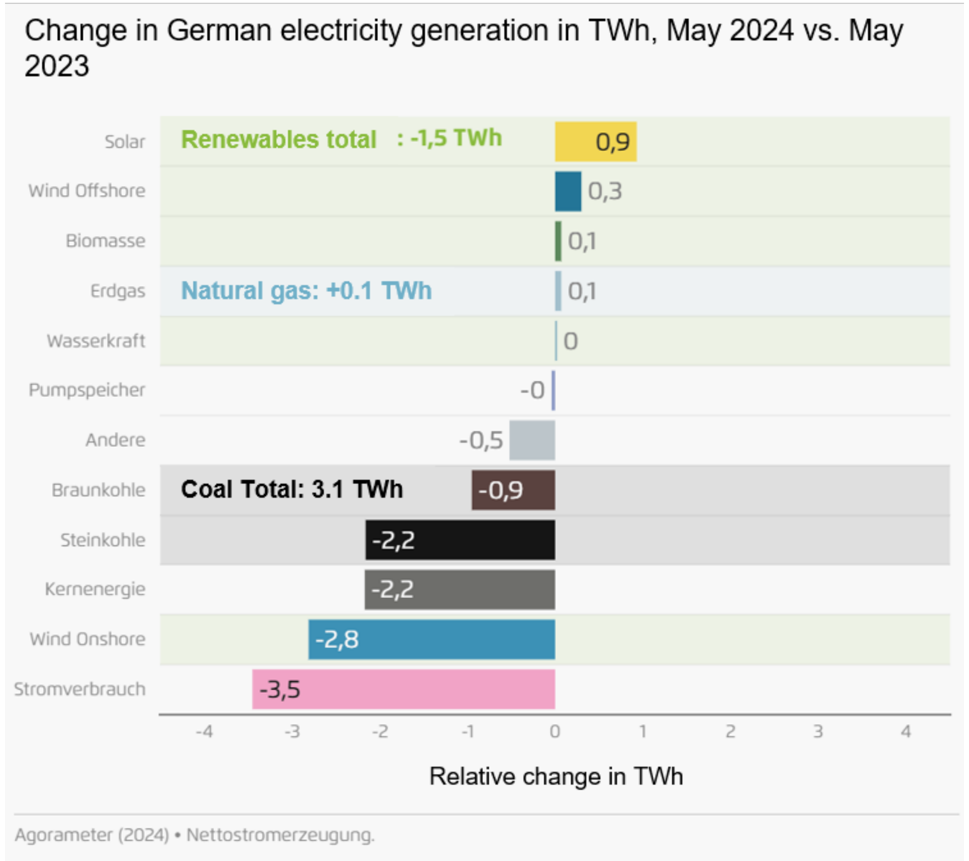
Why AI4DG?

CURRENT STATUS OF THE ENERGY TRANSITION

- Renewable energies (RE) covered 52.0% of electricity consumption in 2023 [Source: Statistisches Bundesamt]
- Climate Protection Act - greenhouse gas neutrality by 2045
- **EEG targets: 80%** of electricity consumption (600 TWh) from RE by **2030** [Source: EEG 2023 § 4 Ausbaupfad]
  - **Wind:**
    - **115 GW** by 2030 **(onshore)**
    - **30 GW** by 2030 **(offshore)**
  - **Solar**:
    - **215 GW** by 2030
    - Status at the end of 2023: 82,2 GW

! Renewable electricity generation is highly volatile, depending on weather conditions.



CHALLENGES

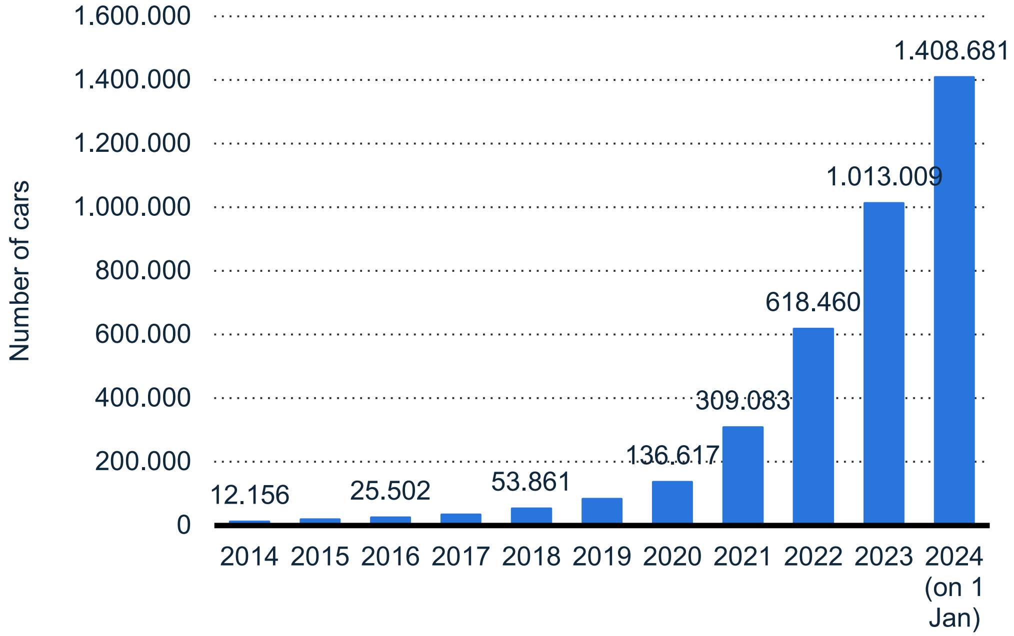
- Decarbonisation of the energy sectors needed to meet climate targets.
  - **Electrification of the sectors ➔ Increase in electricity consumption!**
  - Expected electricity consumption of 1,000 TWh in 2045 (current electricity consumption at 517 TWh)

[Source: Netzentwicklungsplan Strom 2023]

- **Electromobility** - Around **1.4 million** registered EVs (as of 1 January, 2024)
  - Around 2.3 million charging points/stations planned by 2030

! Uncontrolled charging of electric vehicles could cause voltage issues.

Registered EVs in Germany up to 2024



Source(s): KBA; ID 265995

Note(s): Germany, as of January 1; BEV

CHALLENGES

- More than 90 % of electricity generated from renewable energy sources is connected to the distribution grid.
- In addition, new loads (electric cars, heat pumps, etc.) deviate from the standard load profiles of households.
  - Higher performance & higher simultaneity
  - Less predictability

  ➔ Need for more detailed load flow analysis!
- Capacity limits may be reached
  - The distribution grid will have to provide a high charging capacity if a large number of electric vehicles are connected at the same time.

  ➔ Threat of grid congestion!

[Source: Agora Verkehrswende, Agora Energiewende, Regulatory Assistance Project (RAP) (2019): Verteilnetzausbau für die Energiewende – Elektromobilität im Fokus]

What can be done?

SOLUTION 1 : DISTRIBUTION GRID EXPANSION

- **Reinforcement and expansion of the grid.**
- **92,642 km** of lines to be reinforced, optimised, rebuilt or replaced (with increased transmission capacity).
- Lengthy planning and approval processes
  - Implementation time for 110 kV lines could take up to 10 years.

[Source: https://www.eon.com/de/energienetze/bedeutung-des-verteilnetzes.html]

- 82 largest DSOs estimate grid development needs until 2032 at **EUR 42.27 billion.**
  - Capital intensive!

Estimated investment requirements for distribution grid expansion with increased transmission capacity

	Gesamt erwarteter Verteilernetzausbaubedarf bis 2032	Davon durch Maßnahmenplan gemeldet	Davon durch aggregierte 10-Jahresplanung der unteren Netzebenen gemeldet
HS	10,66 Mrd. Euro	10,66 Mrd. Euro	--
HS/MS	3,10 Mrd. Euro	3,10 Mrd. Euro	--
MS	13,01 Mrd. Euro	2,02 Mrd. Euro	10,99 Mrd. Euro
MS/NS	5,43 Mrd. Euro	0,07 Mrd. Euro	5,36 Mrd. Euro
NS	9,93 Mrd. Euro	0,44 Mrd. Euro	9,49 Mrd. Euro
Sonstige	0,14 Mrd. Euro	0,14 Mrd. Euro	--
Gesamt:	**42,27 Mrd. Euro**	**16,42 Mrd. Euro**	**25,84 Mrd. Euro**

Quelle Bundesnetzagentur

[Source : Bundesnetzagentur (BNetzA): Bericht zum Zustand und Ausbau der Verteilernetze 2022. Available at: https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/NetzentwicklungUndSmartGrid/ZustandAusbauVerteilernetze2022. pdf?__blob=publicationFile&v=2]

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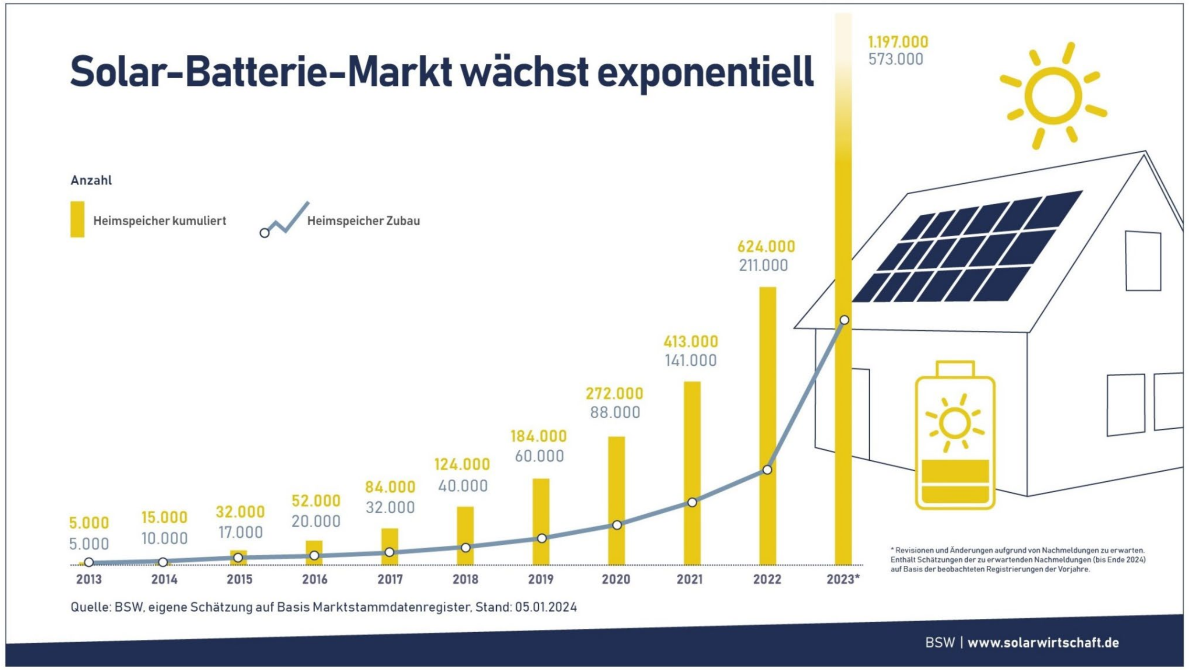
SOLUTION 2: FLEXIBILITY IN THE DISTRIBUTION GRID

- Flexible loads (such as electric cars, home storage, etc.) can make 100 TWh of electricity demand more flexible per year in 2035 and save €4.8 billion.

  [Source: Agora Energiewende und Forschungsstelle für Energiewirtschaft e. V. (2023): Haushaltsnahe Flexibilitäten nutzen.]

- The storage capacity of home, large and commercial storage is 11.2 GWh (end of 2023).
- Corresponds to 1/5 of the average hourly electricity demand. [Source: ISEA RWTH Aachen 2023]
  - Demand for battery storage is also growing exponentially, making it an important flexibility option in the low-voltage grid.



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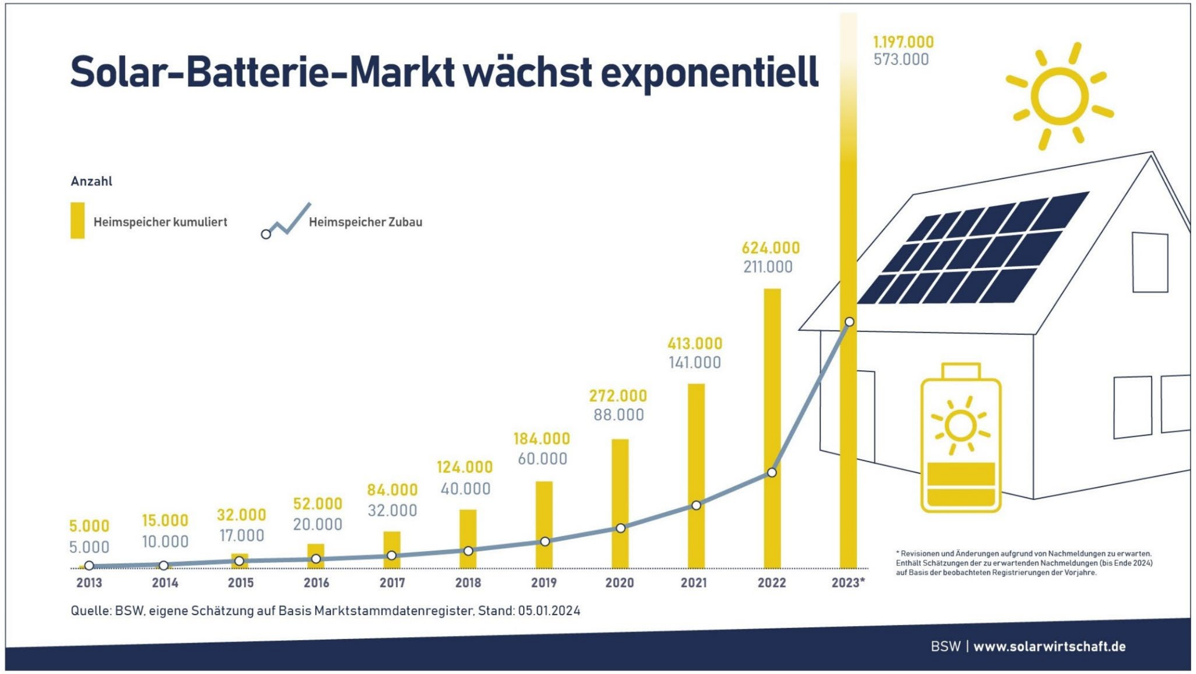
gefördert vom Bundesministerium für Bildung und Forschung

SOLUTION 2: FLEXIBILITY IN THE DISTRIBUTION GRID

- Through **intelligent charge control**, **battery storage systems** can help optimise grid load and facilitate the integration of renewable energy.
- Controlling flexible loads can reduce the need for investment.
  - Up to 57% of distribution grid expansion can be saved.

    [Source: Wirtschaftlicher Vorteil der netzdienlichen Nutzung von Flexibilität im Verteilnetz. Kurzstudie im Auftrag von innogy SE, EWE NETZ GmbH, Stadtwerke München Infrastruktur GmbH, 2019.]
  - The need for new transformers is reduced by 53%.
  - And 56% fewer new lines.

[Source: Agora Energiewende und Forschungsstelle für Energiewirtschaft e. V. (2023): Haushaltsnahe Flexibilitäten nutzen.]



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CONCLUSION

- Ambitious targets for transforming the energy system lie ahead.
- In the future, the limits of today's grid capacity may be reached by a high share of renewable energy and an increasing number of energy-intensive loads.

- There are 2 possible solutions
  1) **Expansion and reinforcement** of the electricity grid.
     - Capital and time intensive
  2) Exploiting **flexibility** in the grid.
     - Load peaks could be better distributed, e.g. through intelligent control of home storage systems.
     - Faster and technically easier to implement
     - Could be a short-term solution to ensure grid security and stability in parallel with grid expansion.

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Thank you for your attention!

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Grid-controlled distributed battery storages to increase the local share of renewable energy sources and avoid grid congestions

Katrin Schulte, M. Eng.

AI4DG

20.06.2023

RESEARCH PROJECT AI4DG

- **AI4DG: AI** on the edge for a secure and autonomous **D**istribution **G**rid control with a high share of renewable energies

- Objective :
  - **Minimization of back-feed power** in a low-voltage (LV) grid with a high share of photovoltaic (PV) systems
  - Increase **share of local PV** feed-in
  - By **grid-optimized** controlled solar **battery storage** systems

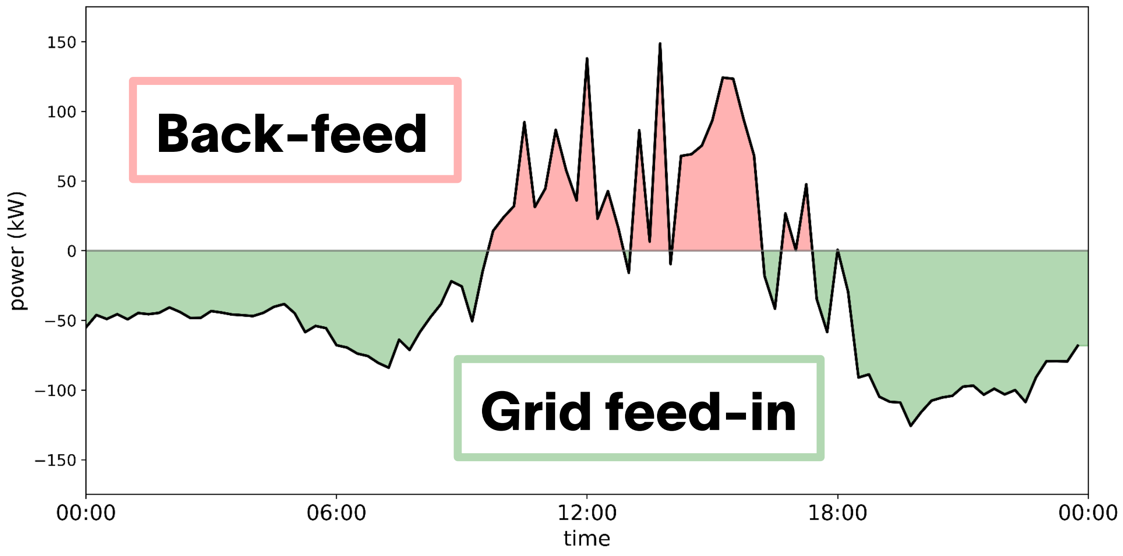
- Duration: 10/2021 – 09/2024

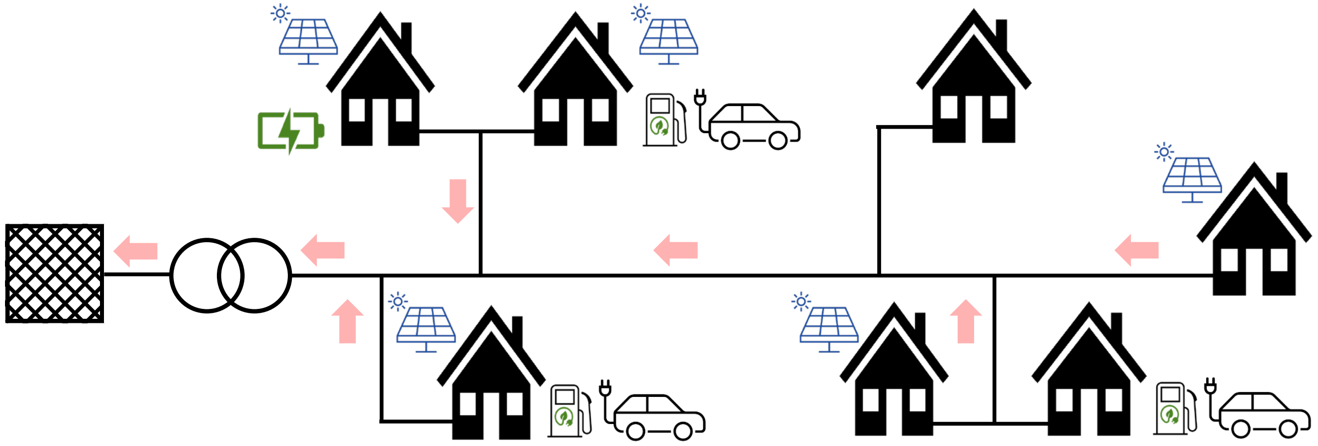
- Project partner:

Hochschule Bielefeld
University of Applied Sciences and Arts

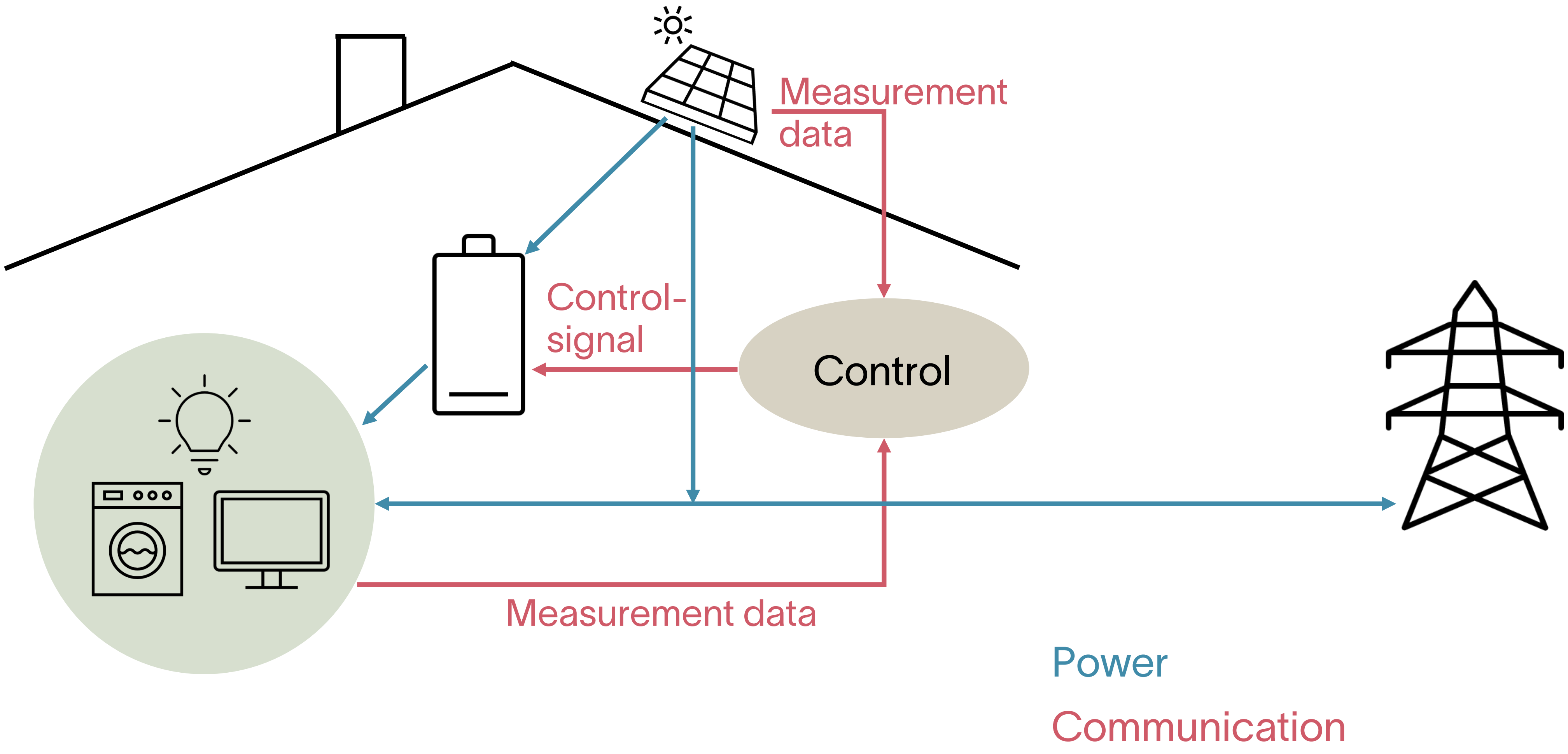
BACKGROUND

Transformer load on 16/05/2023

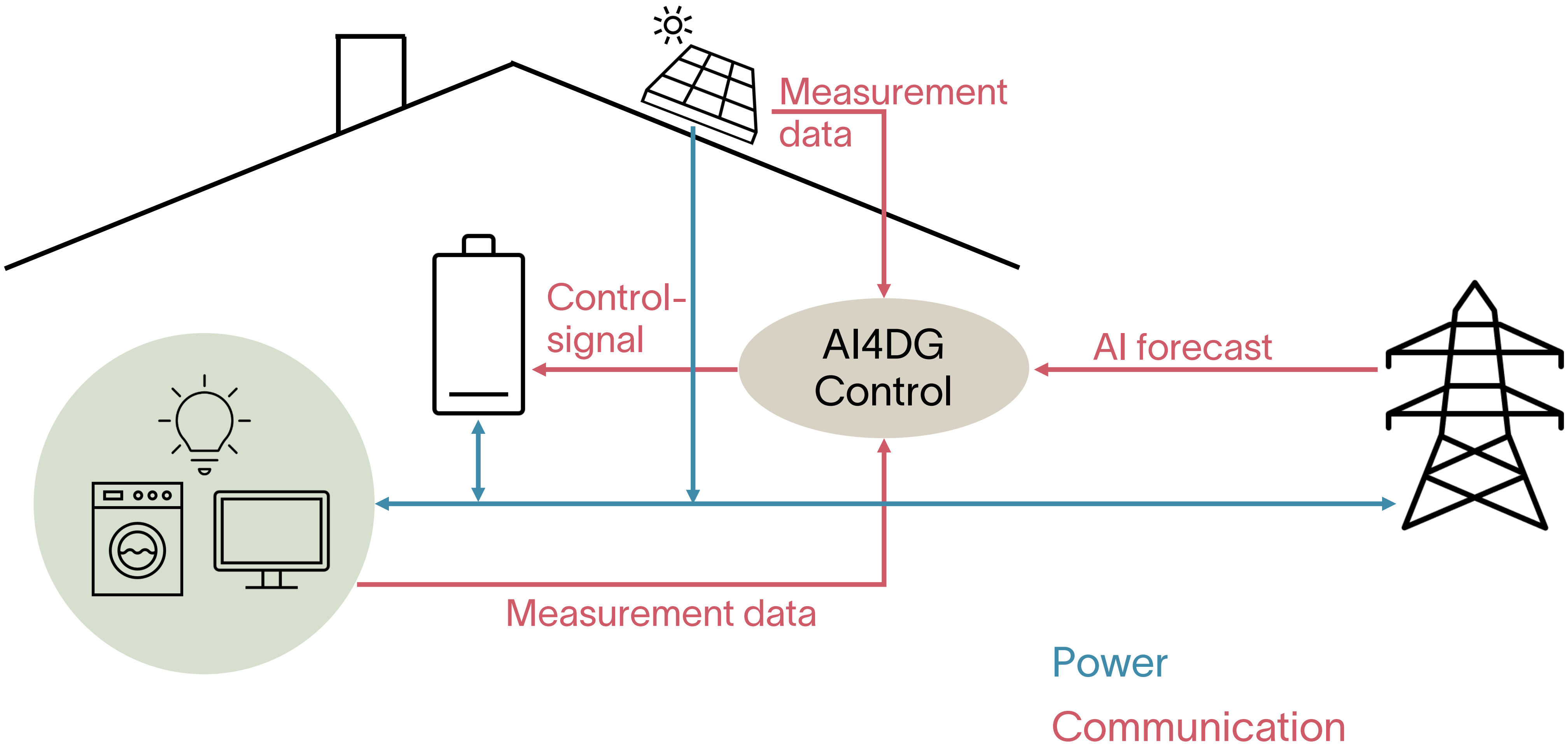




BASIC BATTERY CONTROL IN THE HOUSEHOLD

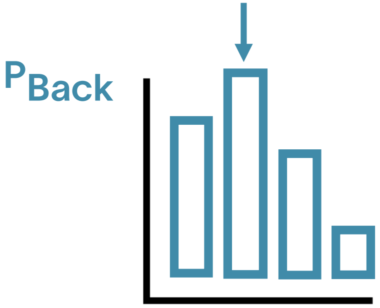


AI4DG BATTERY CONTROL IN THE HOUSEHOLD

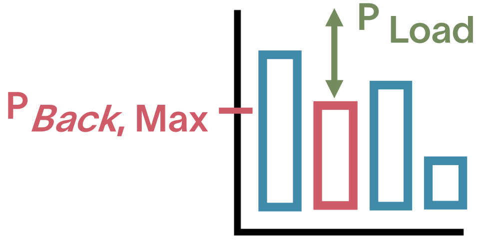


GRID-OPTIMISED AI4DG BATTERY CONTROLLER

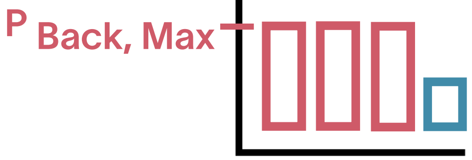
Model Predictive Control (MPC):
Forecasting the load on the transformer for the following day and controlling the batteries by means of optimisation with the target function of minimising regenerative braking



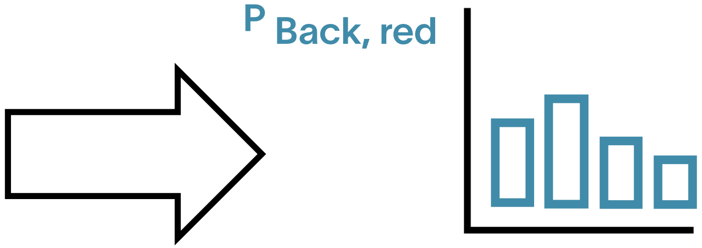
Identification of the maximum Back-feed peak



Definition of the upper limit for Back-feed peaks



Minimisation of all Back-feed peaks



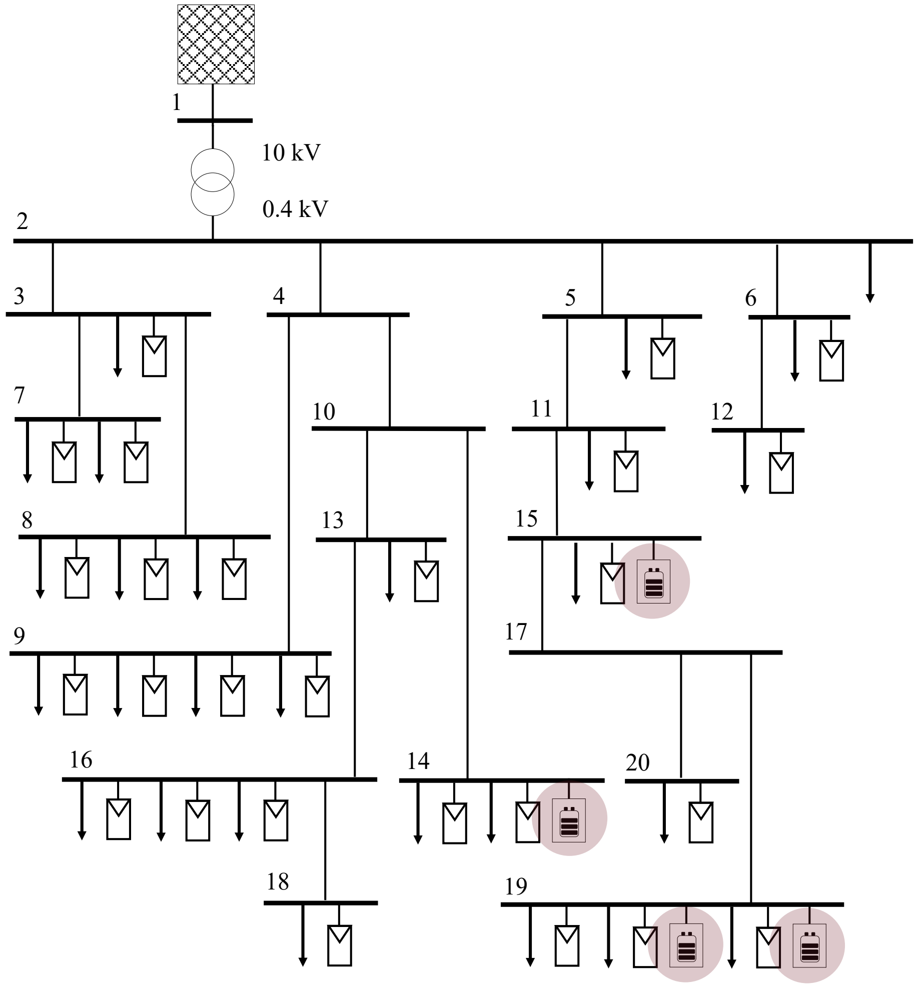
Result: Minimisation of all Back-feed peaks

FIELDTEST

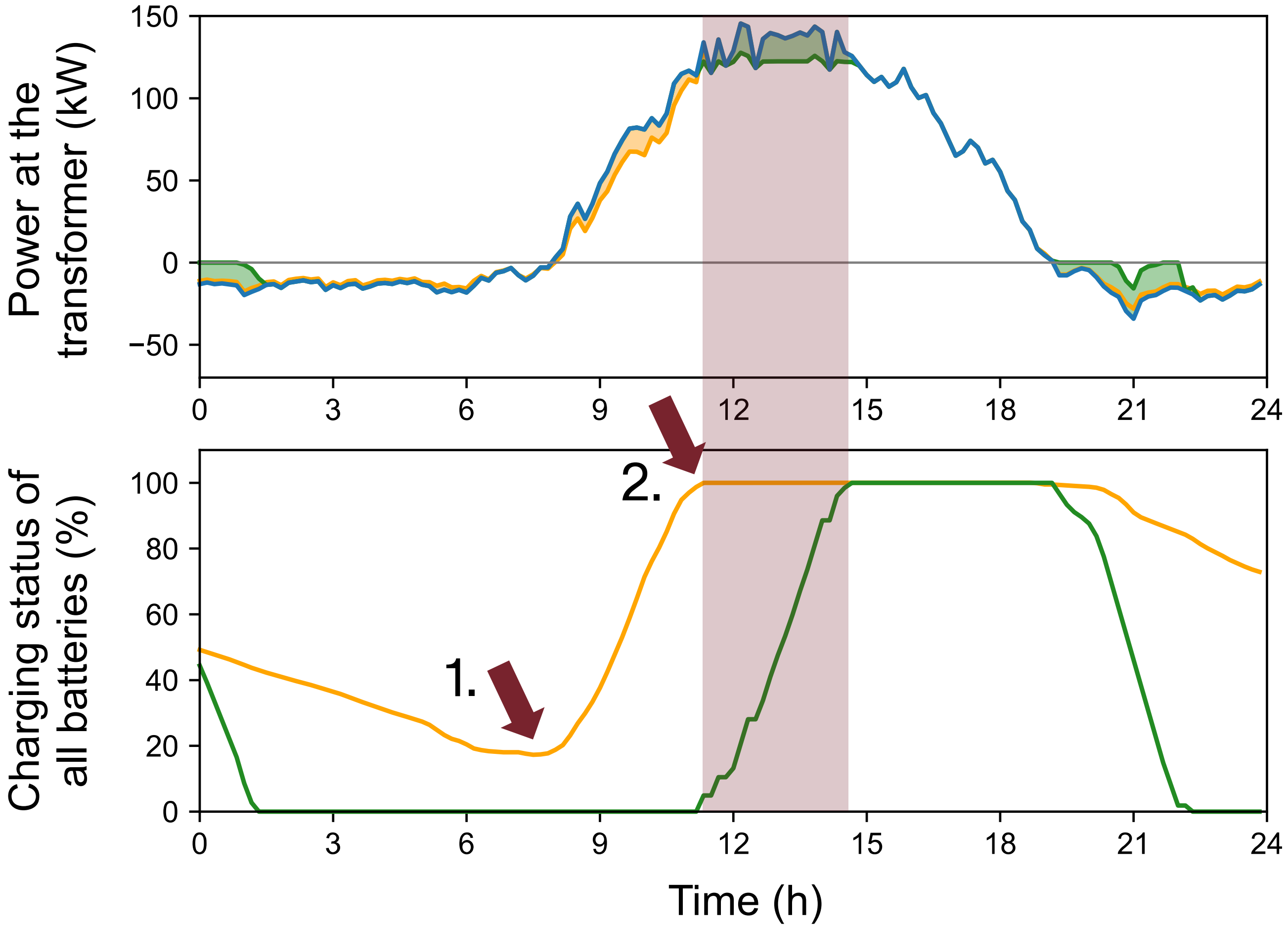
- Real suburban LV grid of German DSO WWN
  - 250 kVA transformer
  - 160 households
  - 26 PV systems (total 207.6 kWp)

- 4 households equipped with battery storage systems

- Predictive control of the batteries based on optimisation and AI prediction of the load on the transformer



RESULTS BATTERY CONTROL



1. Battery capacity is not completely used
2. Batteries full before back-feed power peaks occur

➡ Peaks are reduced (overloads) & battery capacity is completely used

FIELD TEST HOUSEHOLD SETUP

Edge Controller

PV inverter

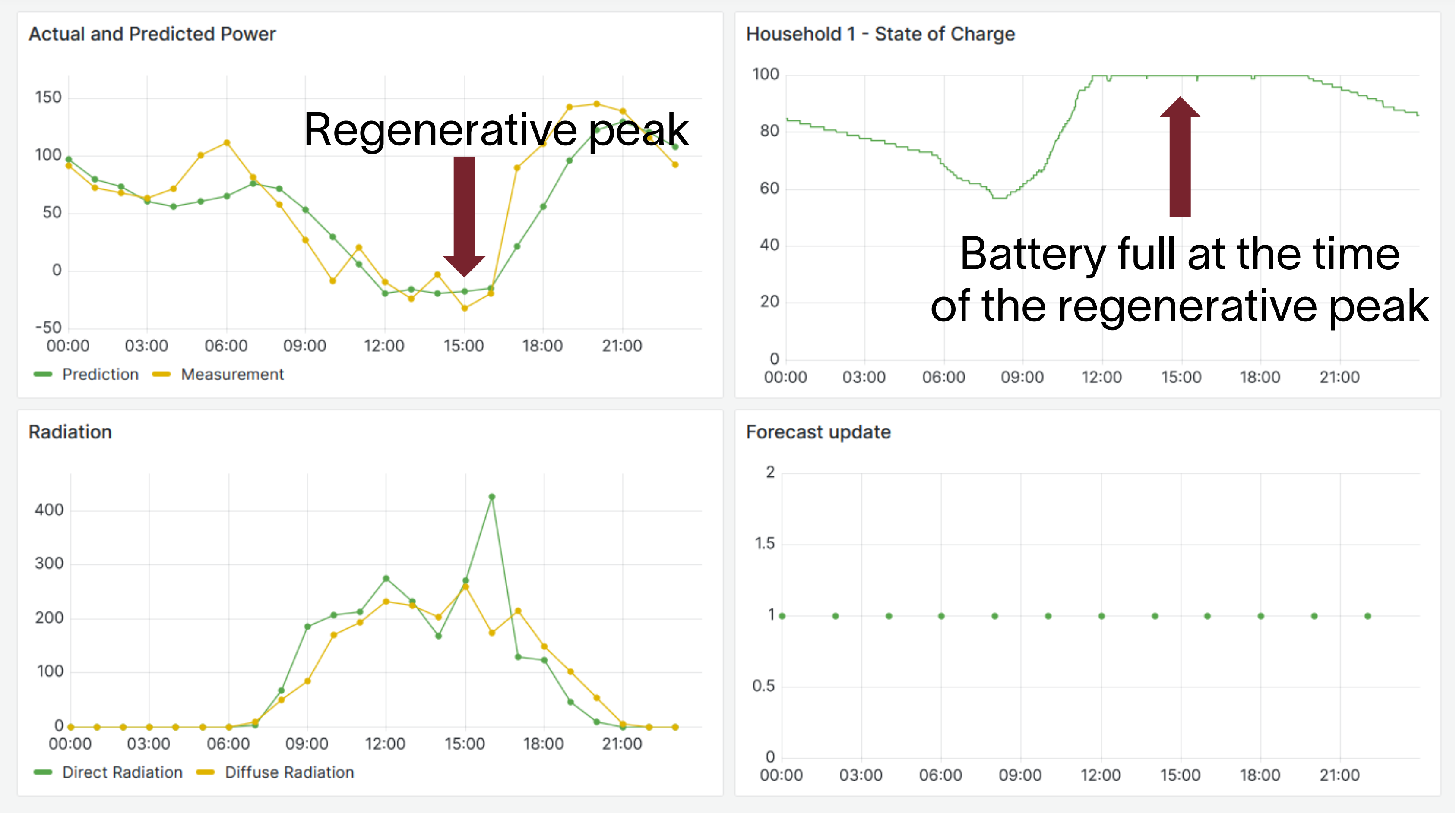
Battery storage

LTE router for communication

Battery inverter

FIELD TEST

- Load on transformer and battery charge level in household 1 on 18/04/2024
- Link



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Potential of battery storage to avoid grid expansion

Results from the bachelor's thesis entitled: Comparative analysis between grid expansion and grid-friendly control of PV battery storage systems

Author: Julius Dresselhaus

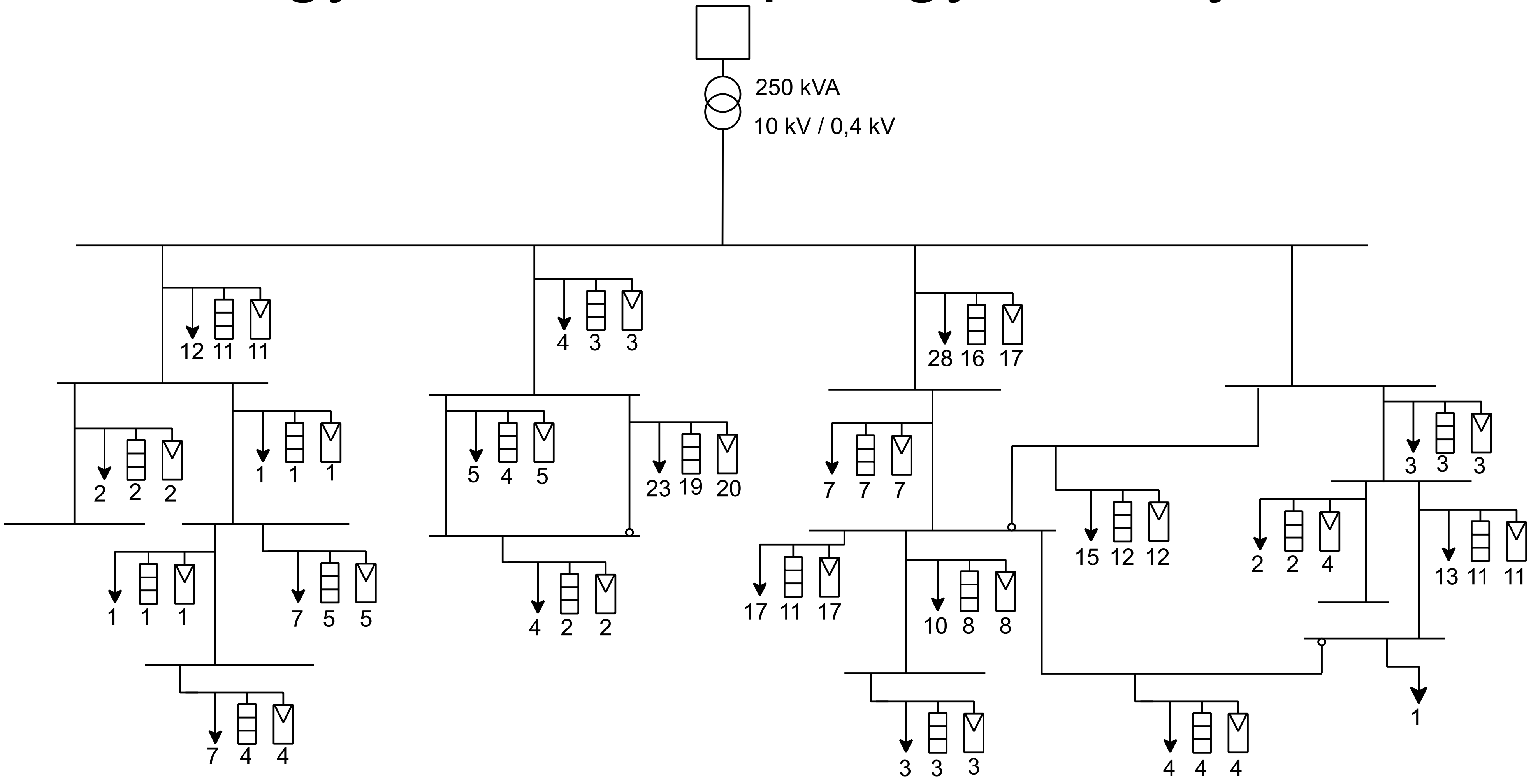
Date: 15.05.2024

Contents

Introduction

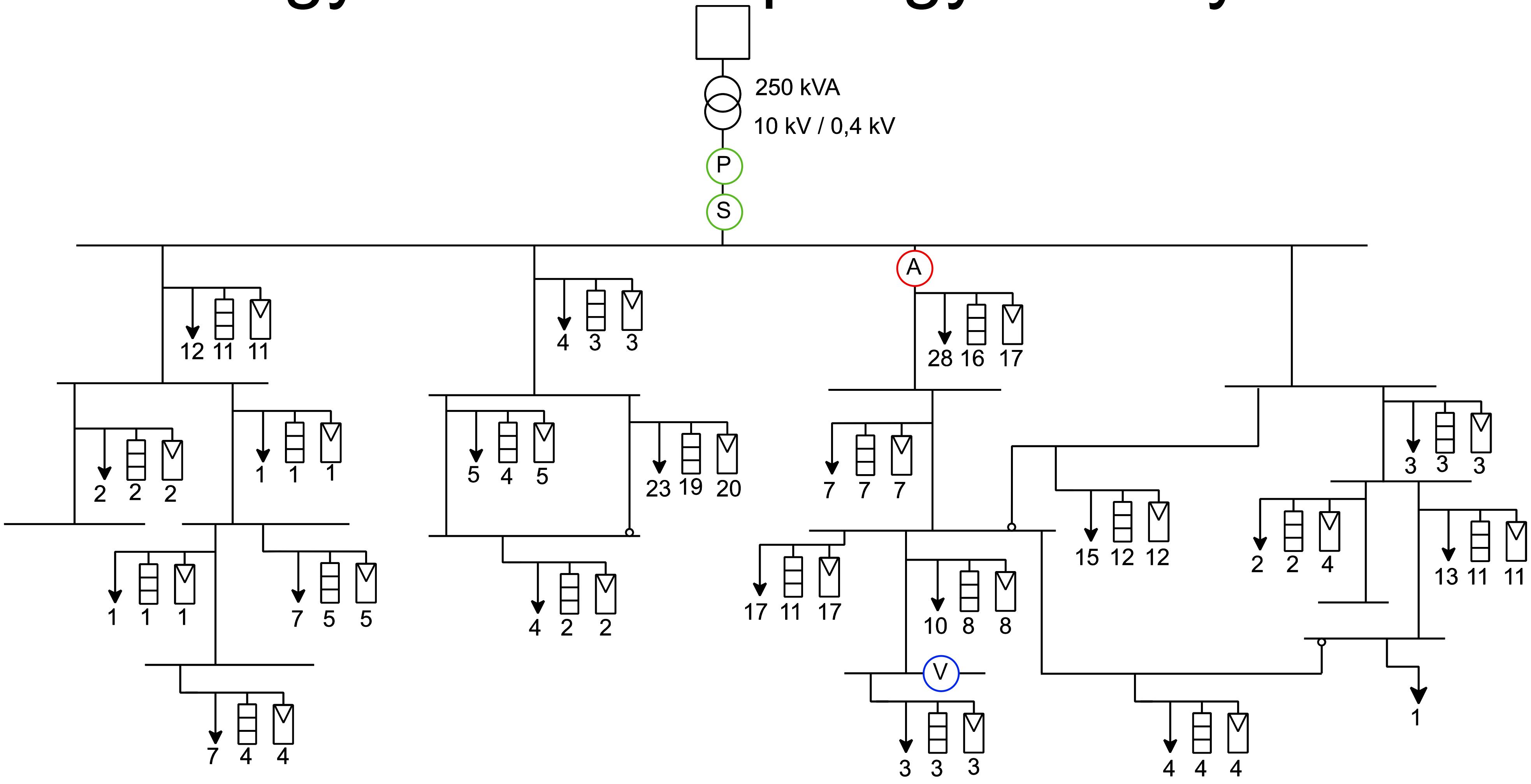
- High integration of PV systems in LV grids
  - Problem: Massive need for grid expansion in low-voltage grids
  - Solution approach: Grid optimisation through grid-serving controlled BESS
- Question:
  - What potential do grid-orientated BESS offer for avoiding or postponing grid expansion?
- Analysing the technical potential based on simulation results
- Consideration of the investment costs
- Legal regulation not clear

Methodology: Network topology in the year 2037



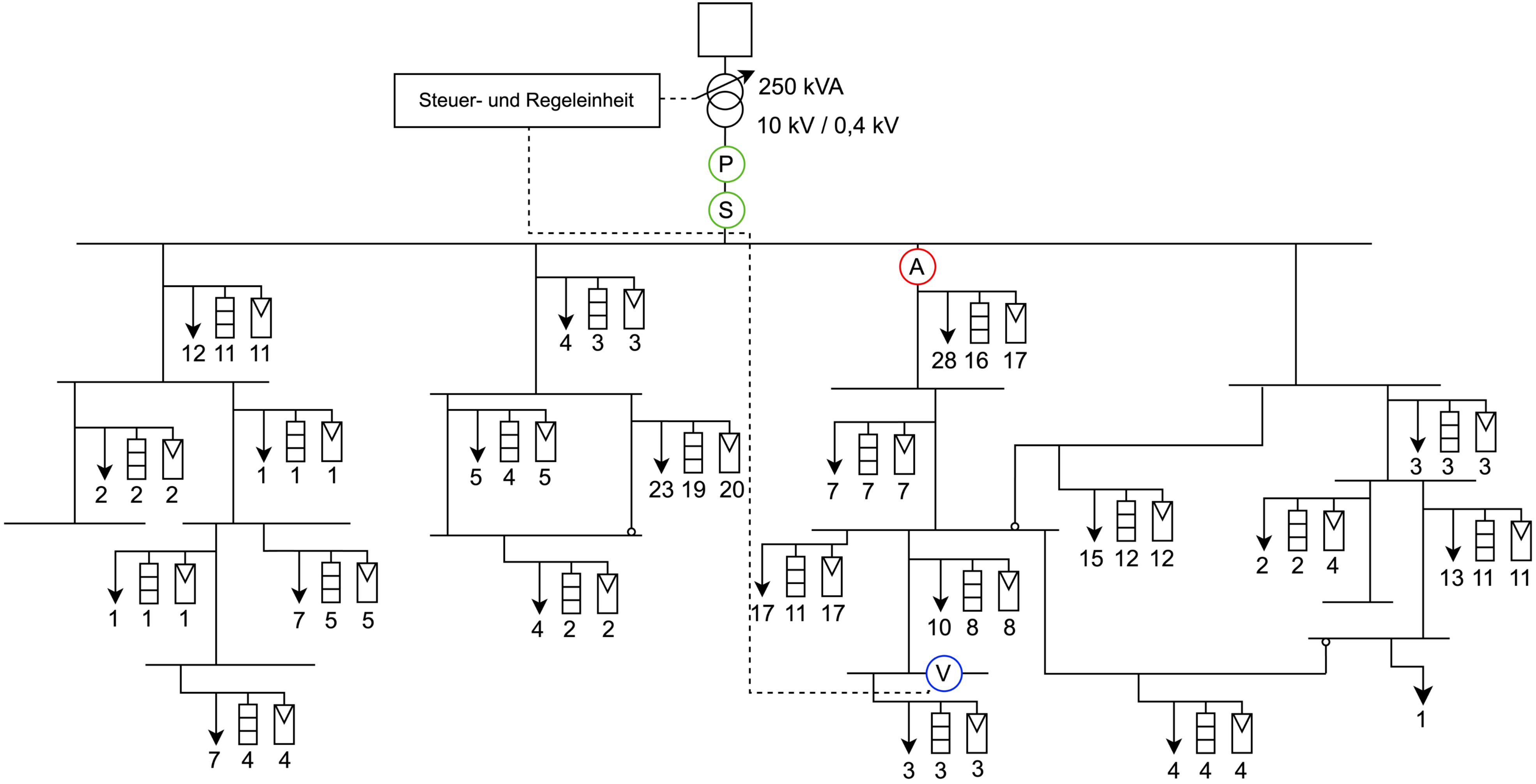
- Power distribution of PV systems between 5 kWp and 13 kWp [1]
- BESS dimensioned with 10 kWh as average value [2]

Methodology: Network topology in the year 2037



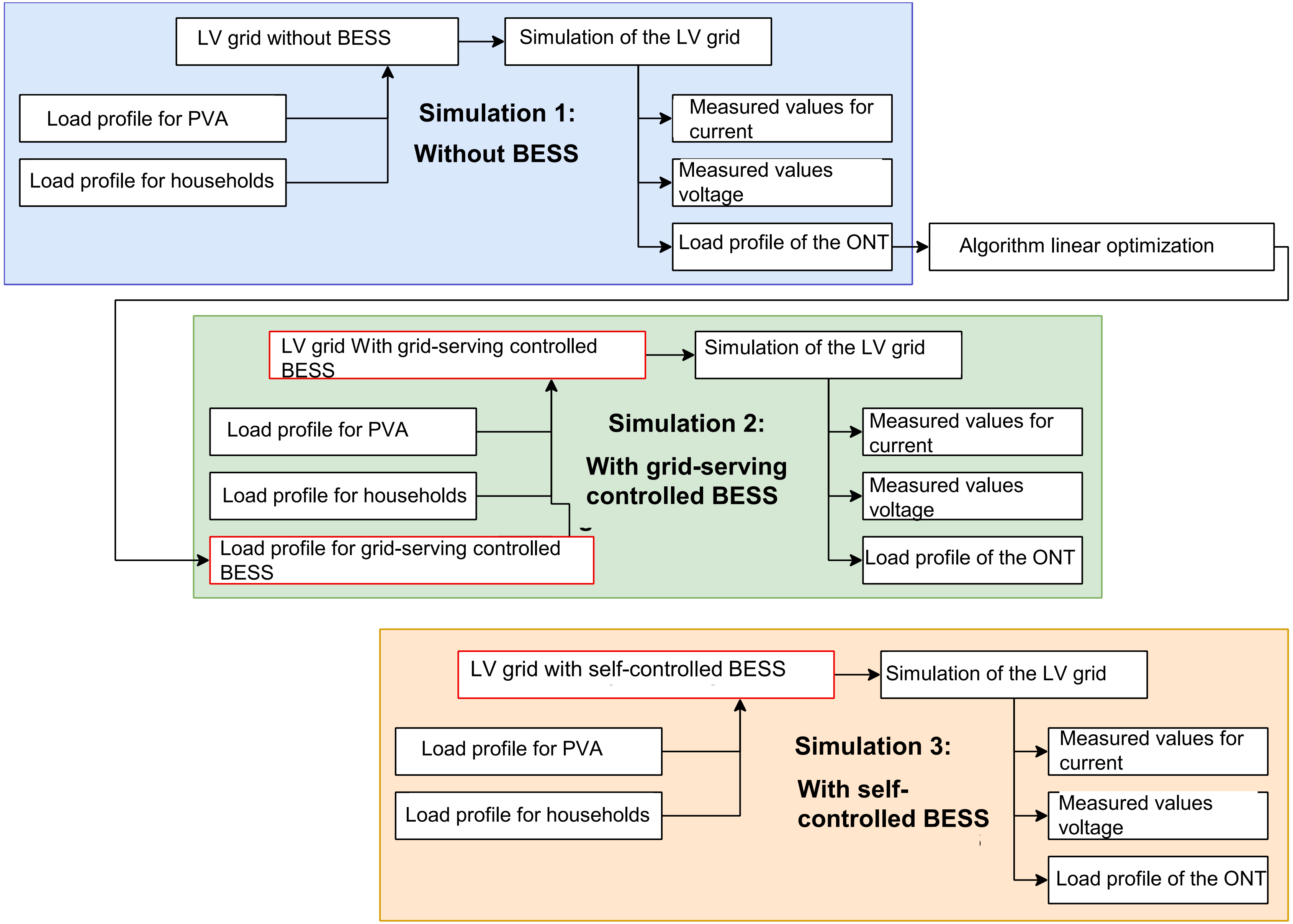
- Power distribution of PV systems between 5 kWp and 13 kWp [3]
- BESS dimensioned with 10 kWh as an average value [4]

Methodology: Network topology in the year 2037

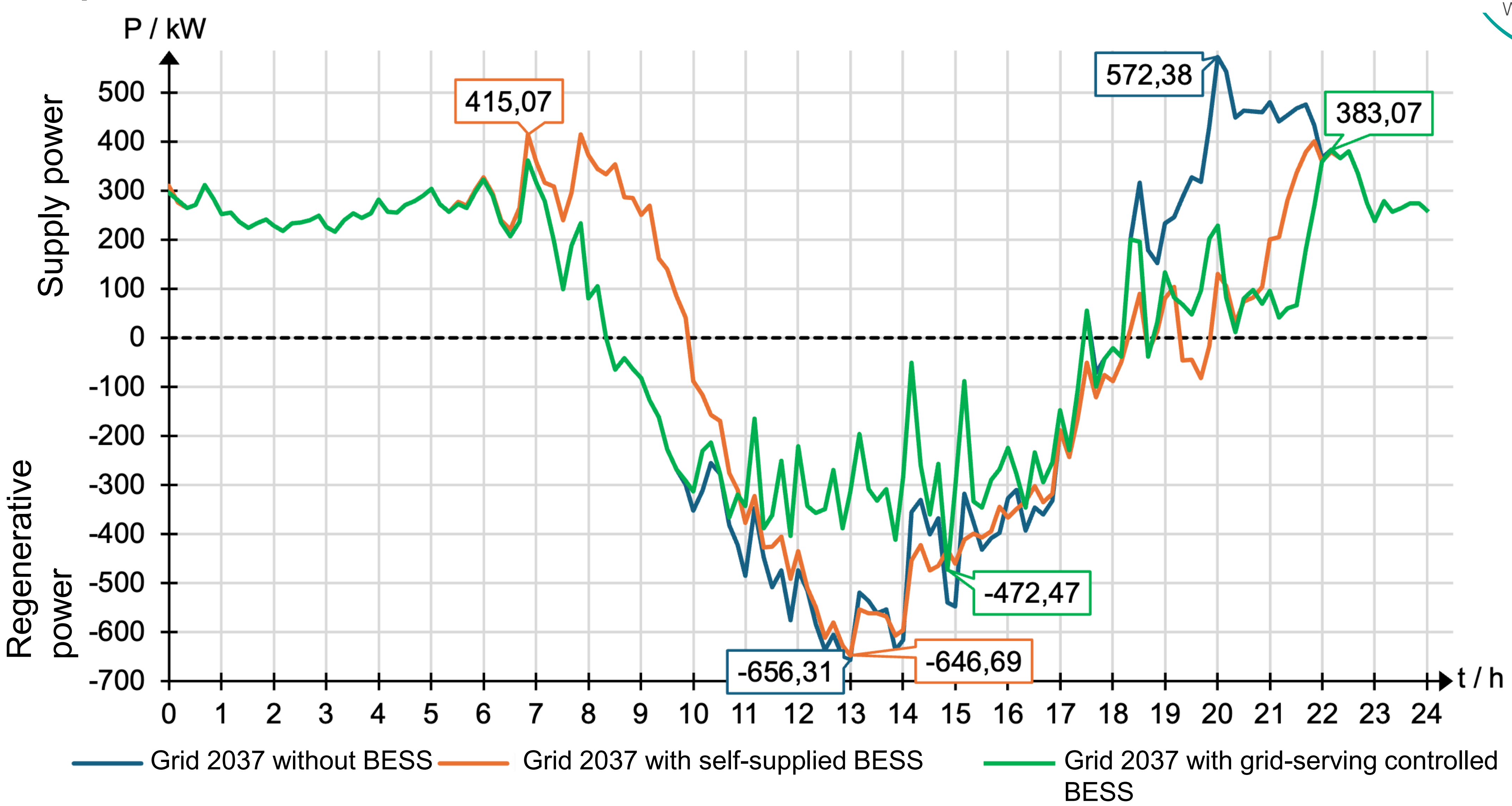


- Power distribution of PV systems between 5 kWp and 13 kWp [3]
- BESS dimensioned with 10 kWh as an average value [4]

Methodology: Procedure of the simulations



Measurement results of the active power at the ONT (2037)



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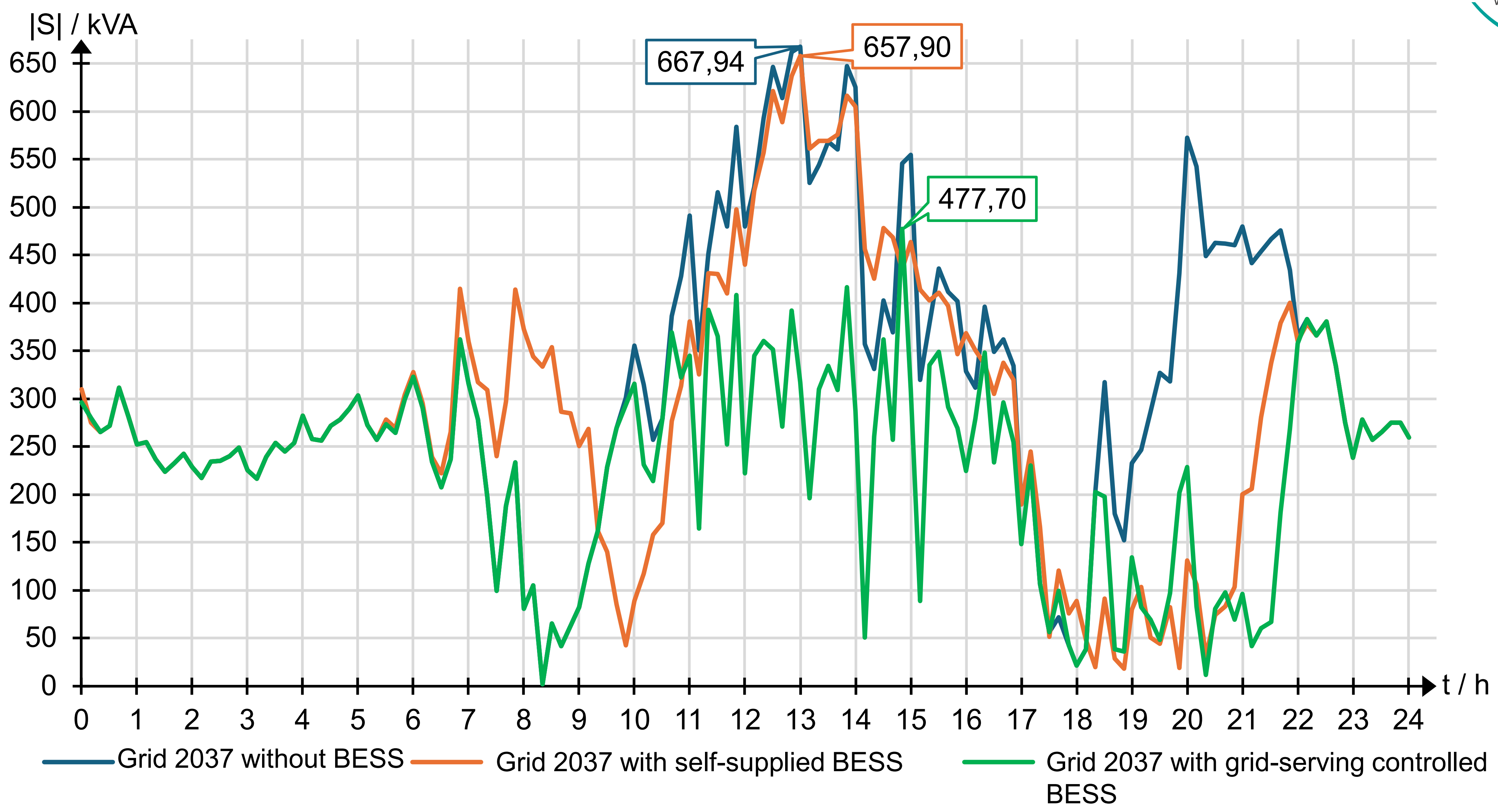
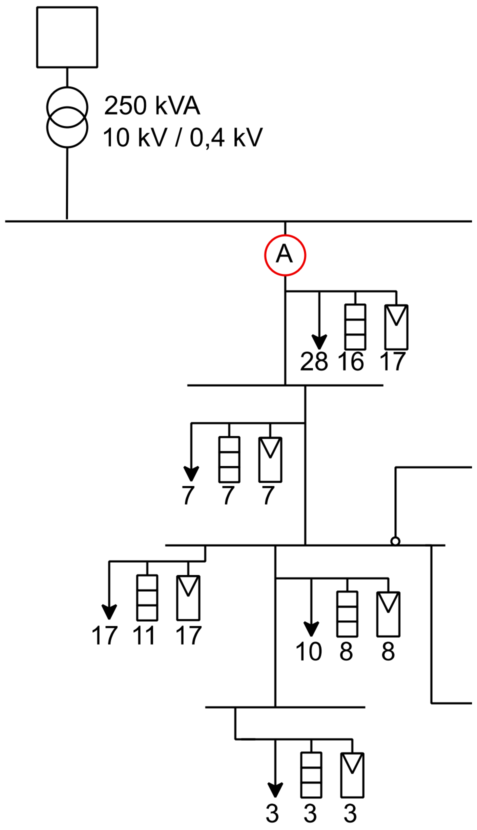
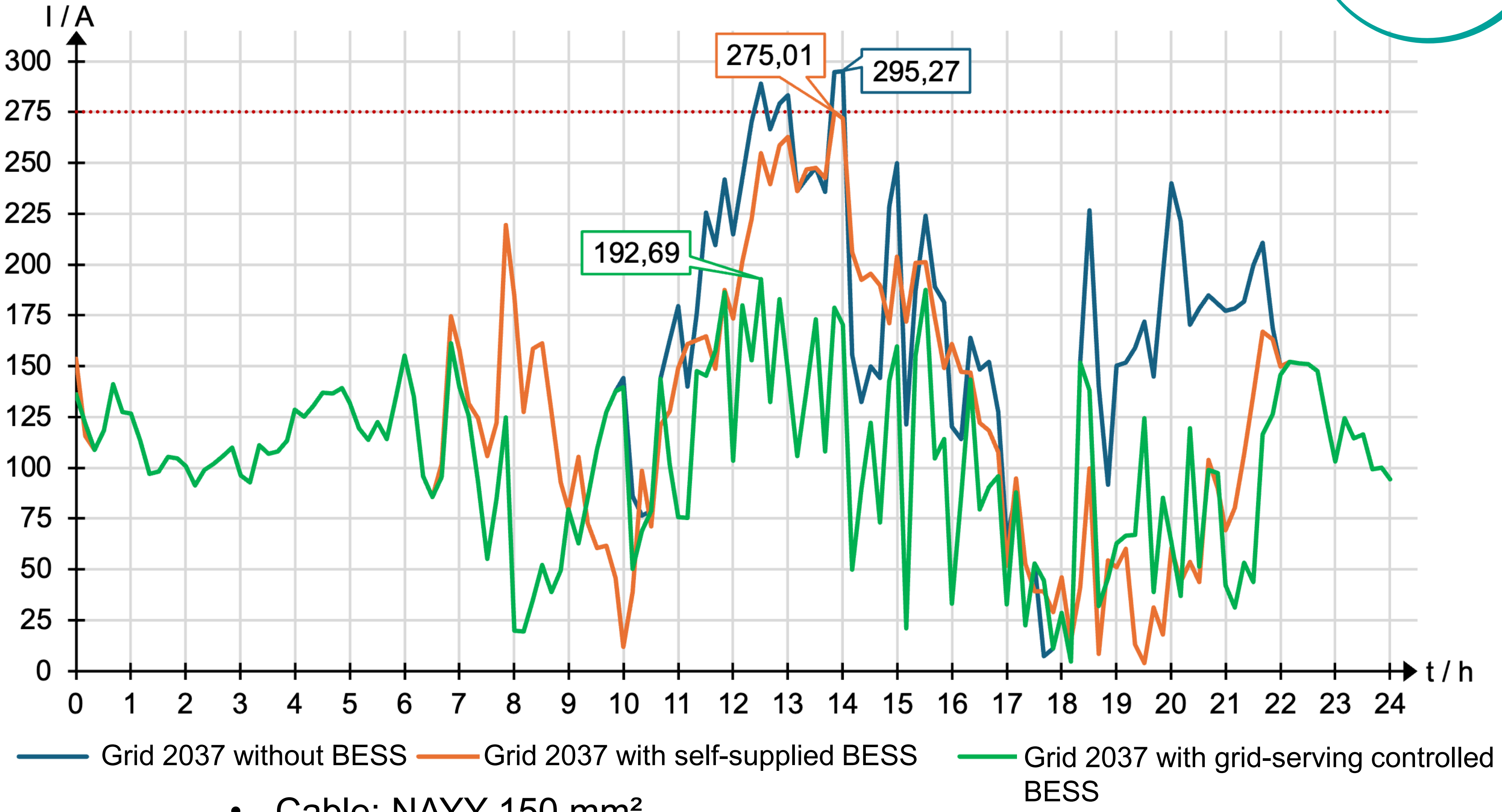


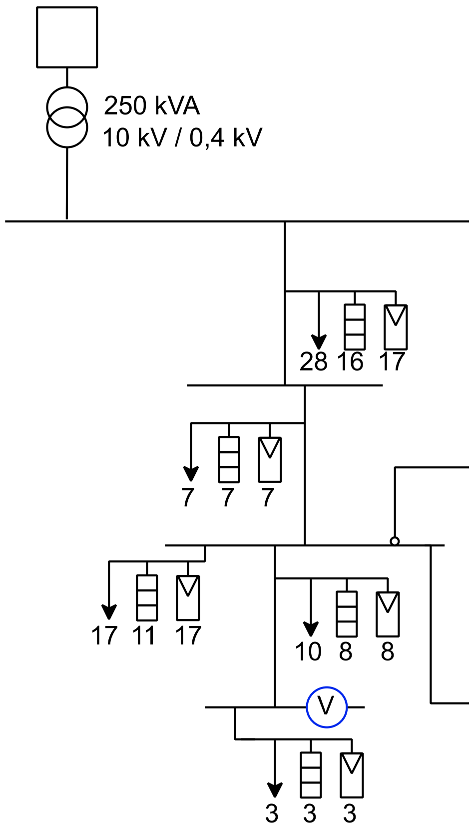
Measurement results of the current in the LV cable (2037)

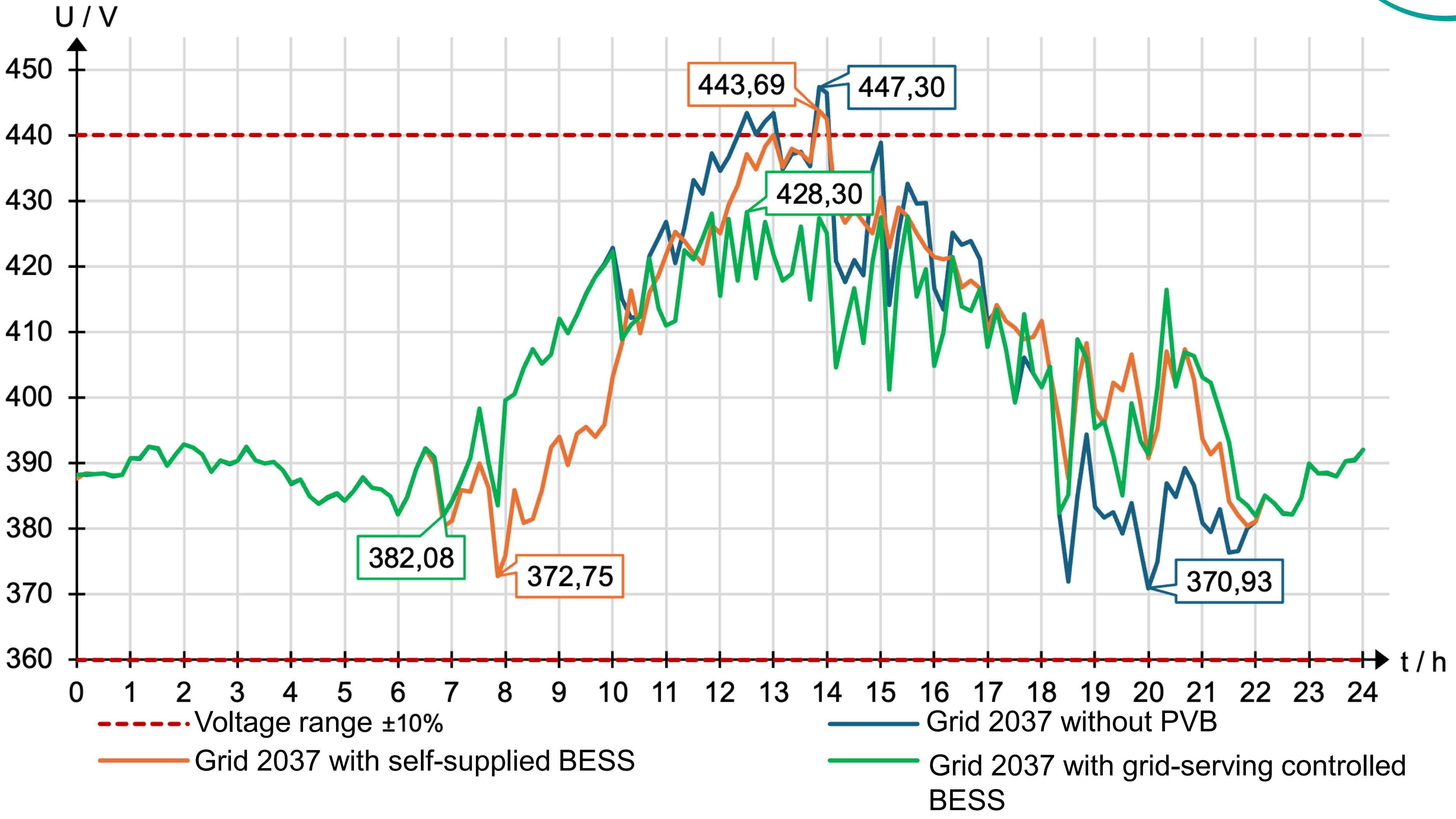




- Cable: NAYY 150 mm²
- Permissible maximum current according to DIN VDE 0298-4 [3]: 275 A

Measurement results of the voltage band (2037)





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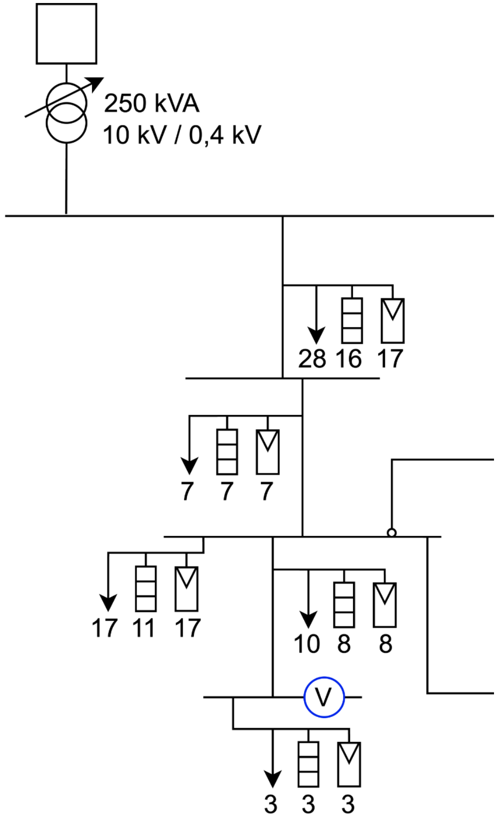
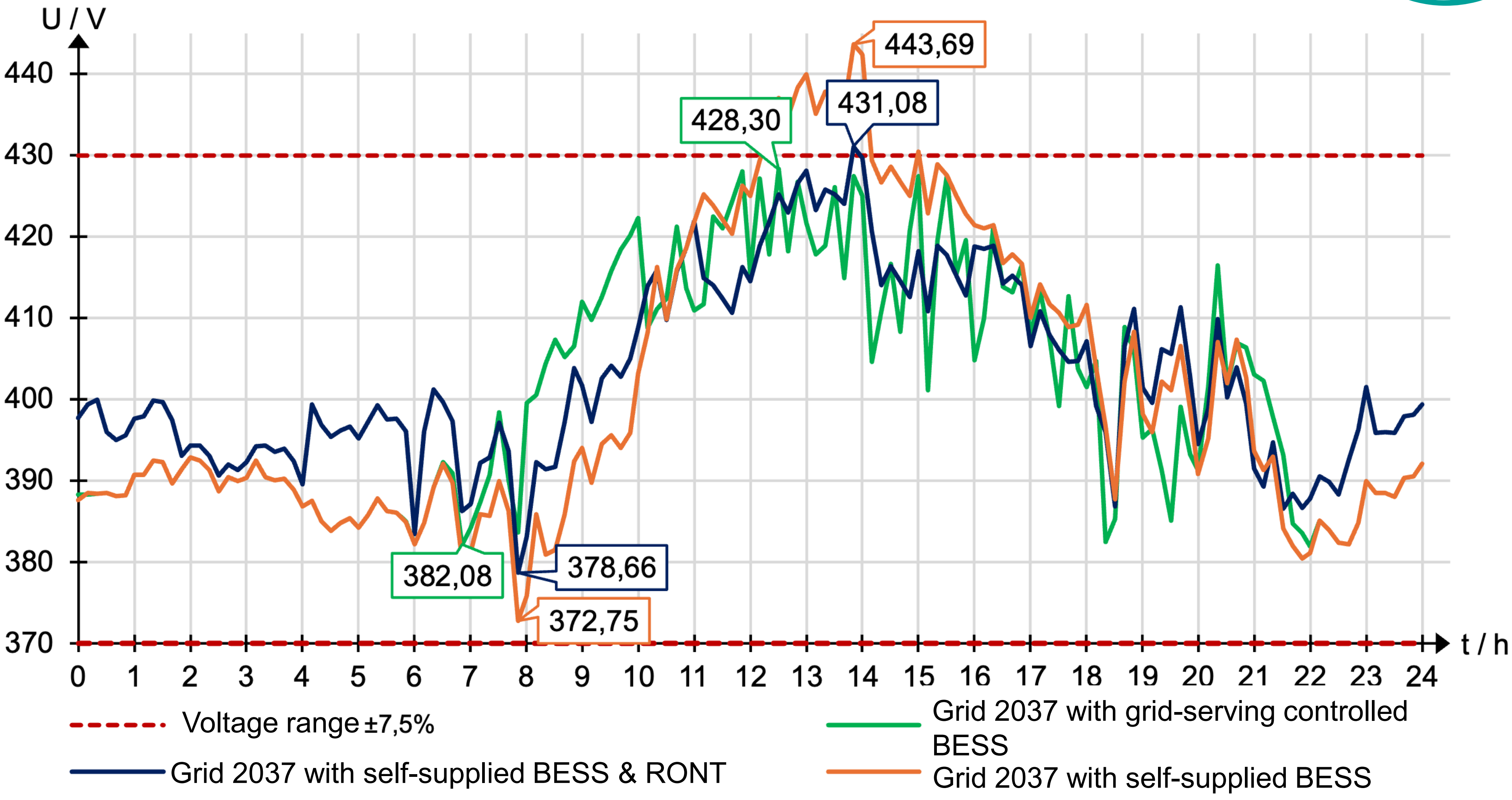
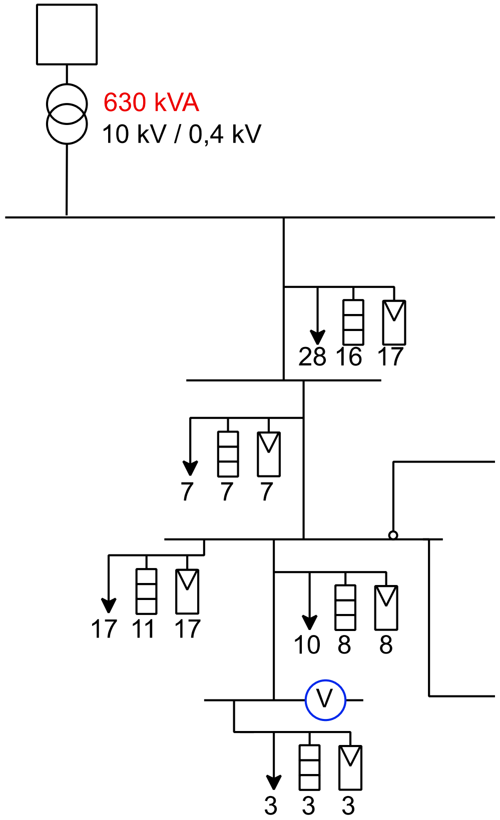
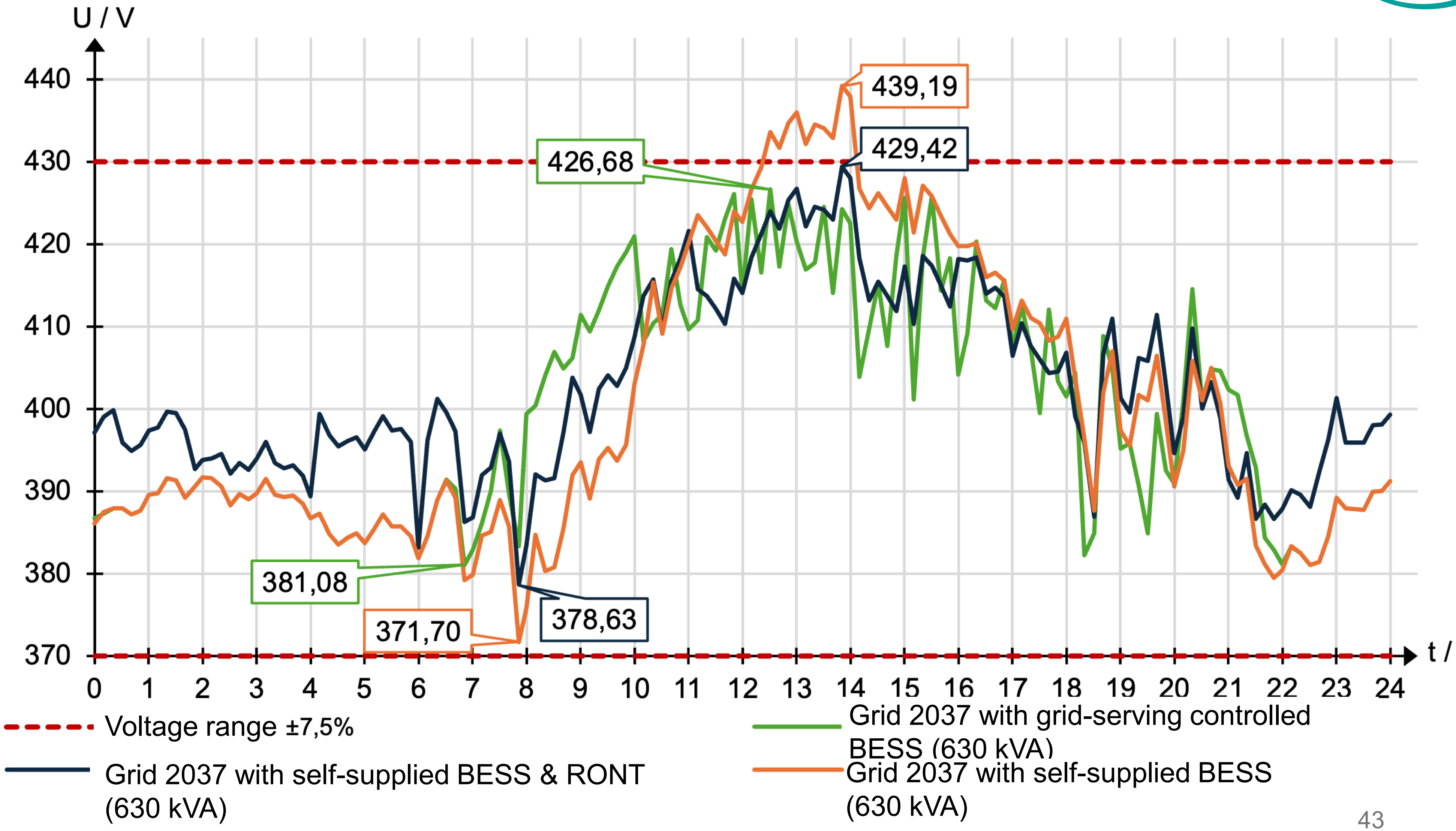




Measurement results of the voltage band with 630 kVA ONT

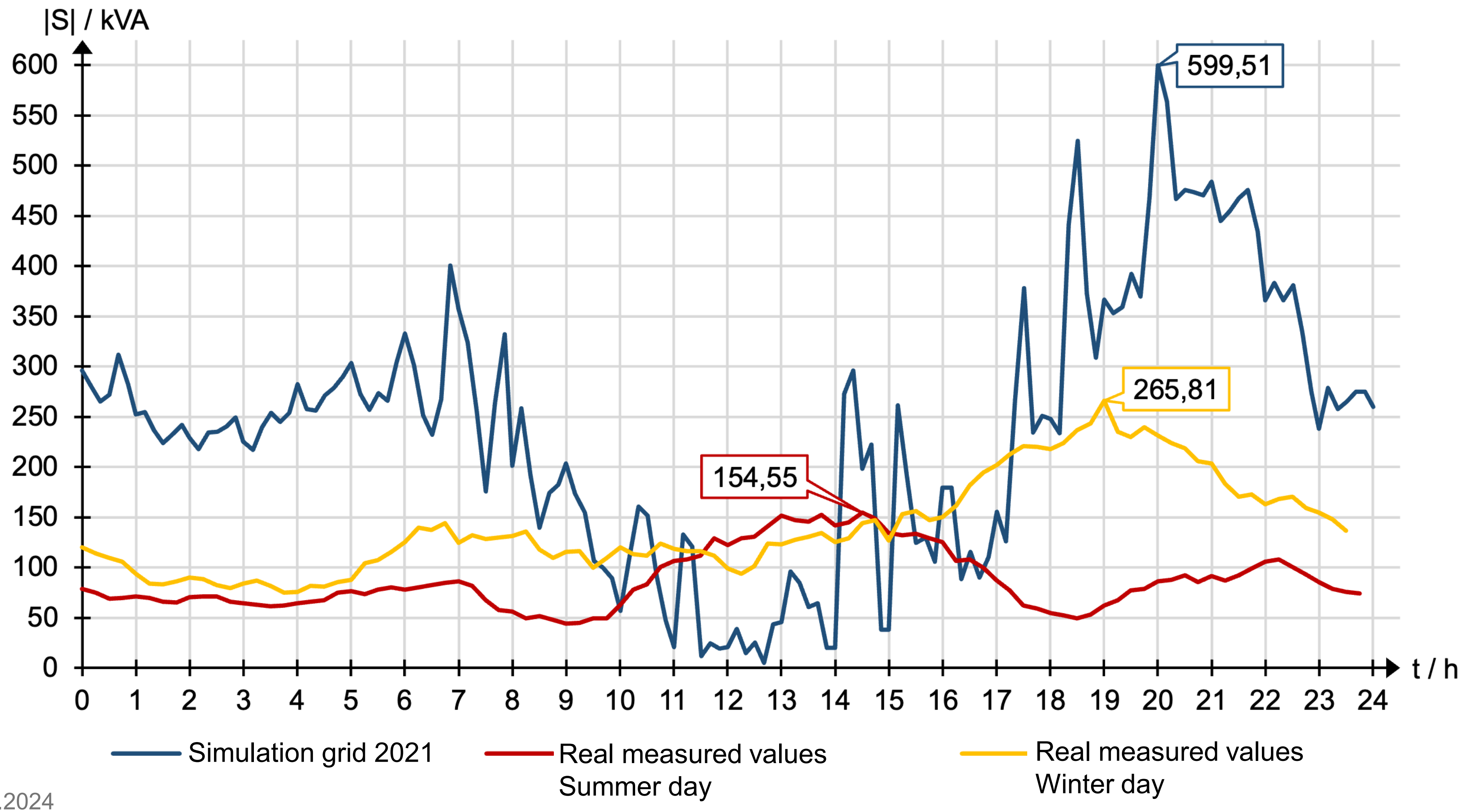




Comparison of investment costs

Grid expansion measure in the 2037 grid topology	Investment costs without grid optimisation	Investment costs with grid optimisation
Local grid transformer 630 kVA [4]	24.560 €	24.560 €
Additional costs RONT [4]	15.200 €	15.200 €
New LV cable construction of 0.5 km [4]	65.000 €	/
Industrial PC for the LV network	/	800 €
Total investment costs	**104.760 €**	**40.560 €**

Summary of the methodology
Comparison of the load profiles (2021)



Summary and outlook

- Grid-orientated controlled BESS can ...
  ... avoid the removal of LV cables
  ... partially postpone the expansion of the local grid transformer
  ... positively influence the tension band
  ... reduce the investment costs of grid expansion

Outlook

- Simulation can be improved with more realistic household load profiles
- Further research and development work required for implementation
- Development of a business model with a suitable remuneration structure required

Sources

[1]: Nexiga on behalf of Westfalen Weser Netz GmbH, „Diffusionsmodul Nexiga“, 10 November 2022

[2]: C. Kost, S. Längle, M. Muhr and T. Reuther, „Photovoltaik- und Batteriespeicherzubau in Deutschland in Zahlen,“ 2022

[3]: DIN VDE 0298-4, „9 Strombelastbarkeit von Kabeln und Leitungen“, 06.2013

[4]: Westfalen Weser Netz GmbH, „Budgetplanung Netzbetriebsmittel“, 2024

Agenda

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14:30 – 14:50	**Storage optimization in fractal networks of tomorrow** Hélène Schricke, Atos
14:50 – 15:10	**Research potential within the framework of §13k EnWG** Prof. Jens Haubrock, HSBI
15:15	**Networking Reception**

Worldgrid
an Eviden business

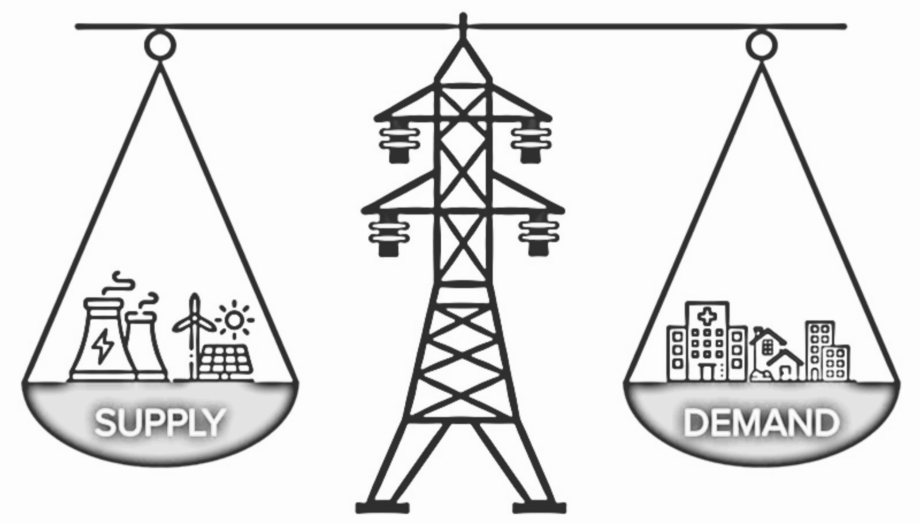
Storage optimization in fractal networks of tomorrow

A challenge for Network flexibility and Renewable expansion

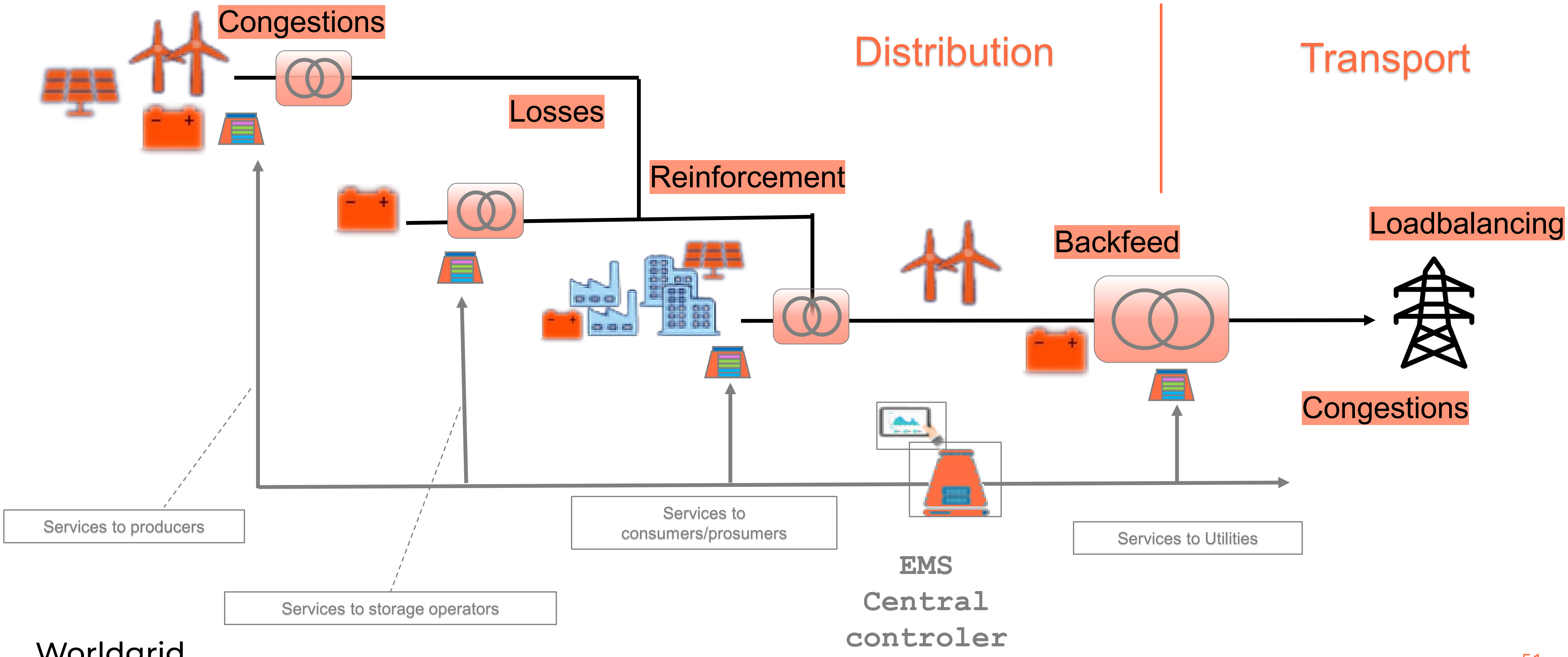
Hélène Schricke

an atos business

Network flexibility: a challenge for the expansion of renewables

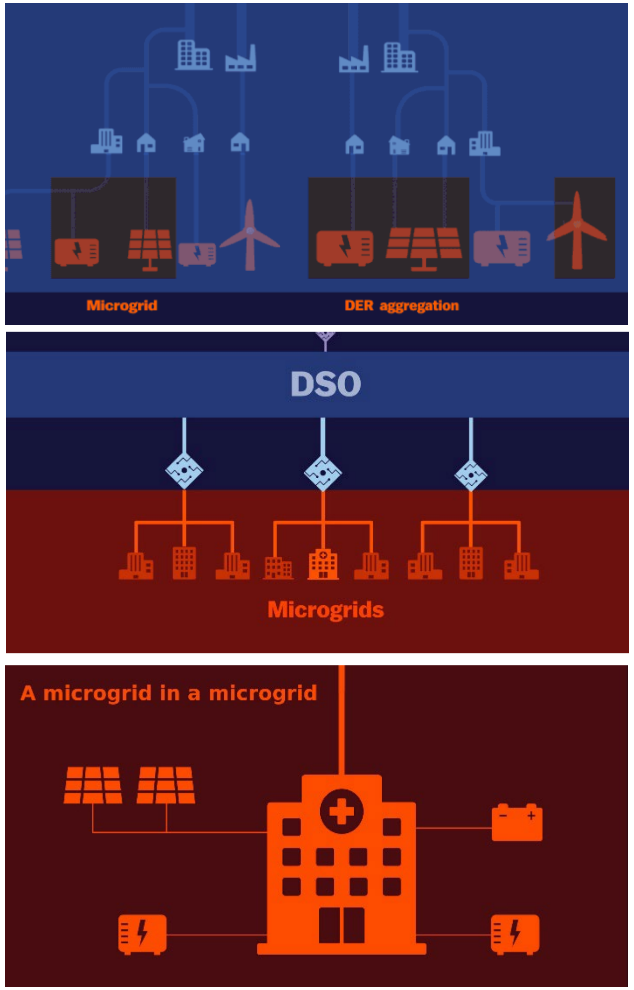


Issues related to the integration of renewable energies into the network



Fractal network management to deliver flexibility

Next-generation of smart grids



Animation © Javier Zarracina for Vox

- Distributed storage (stationnary or not)
- New paradigms:
  - Positive Energy Neighborhoods
  - Microgrids, mini-grids
  - Multi-energy systems
- REN Aggregation / Virtual Power Plant :
  - Decentralized network management
  - System of systems approach

=> Fractal architecture

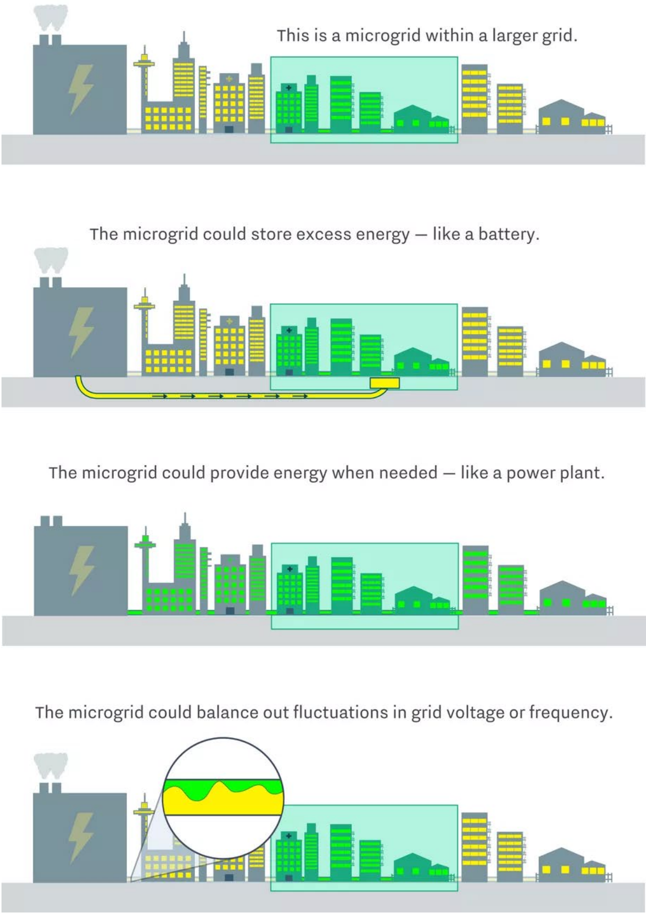
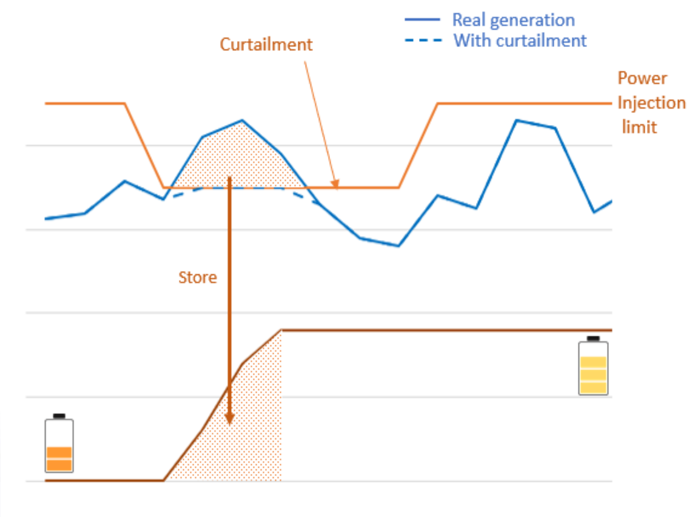
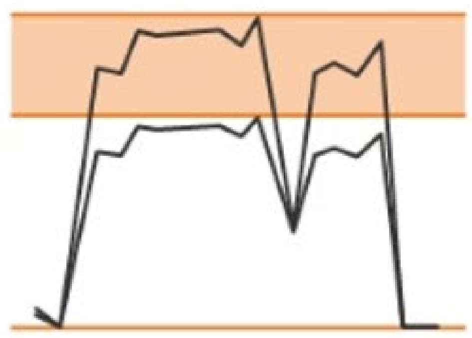


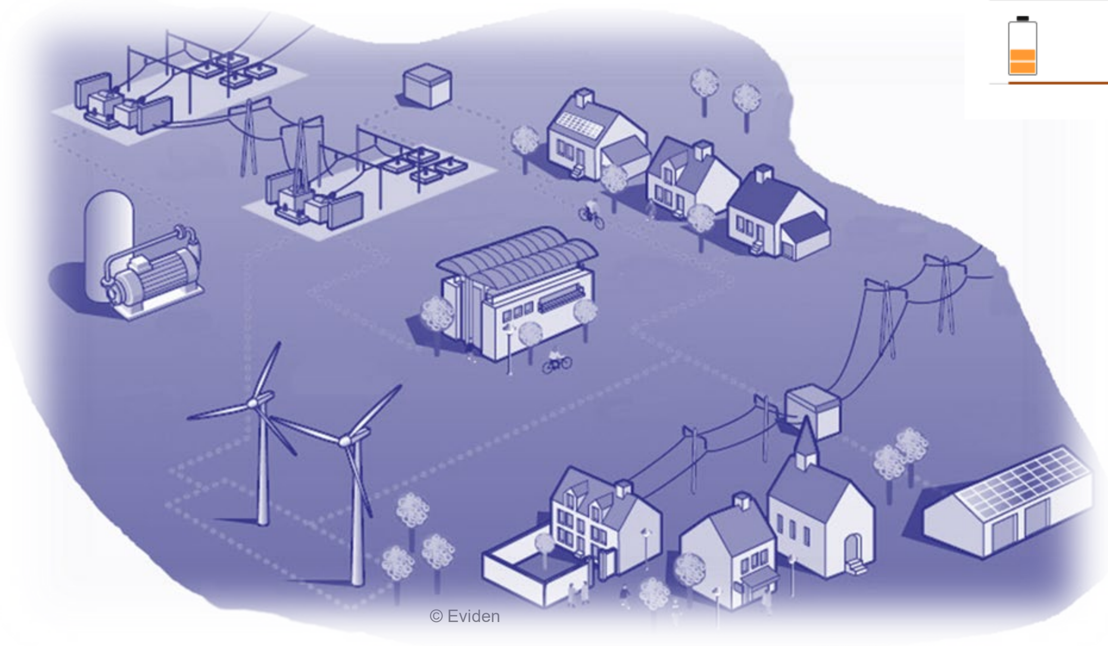
Image © David Roberts for Vox

Maximizing the potential of batteries at microgrid level

- Maximize the consumption of local production and optimize flows
  => backfeed limitation
  => Reduction of technical losses
- Reduce production and consumption peaks
- Reduce power levels at injection points
  ⇒reduction of congestion
  ⇒postponement of reinforcement investments

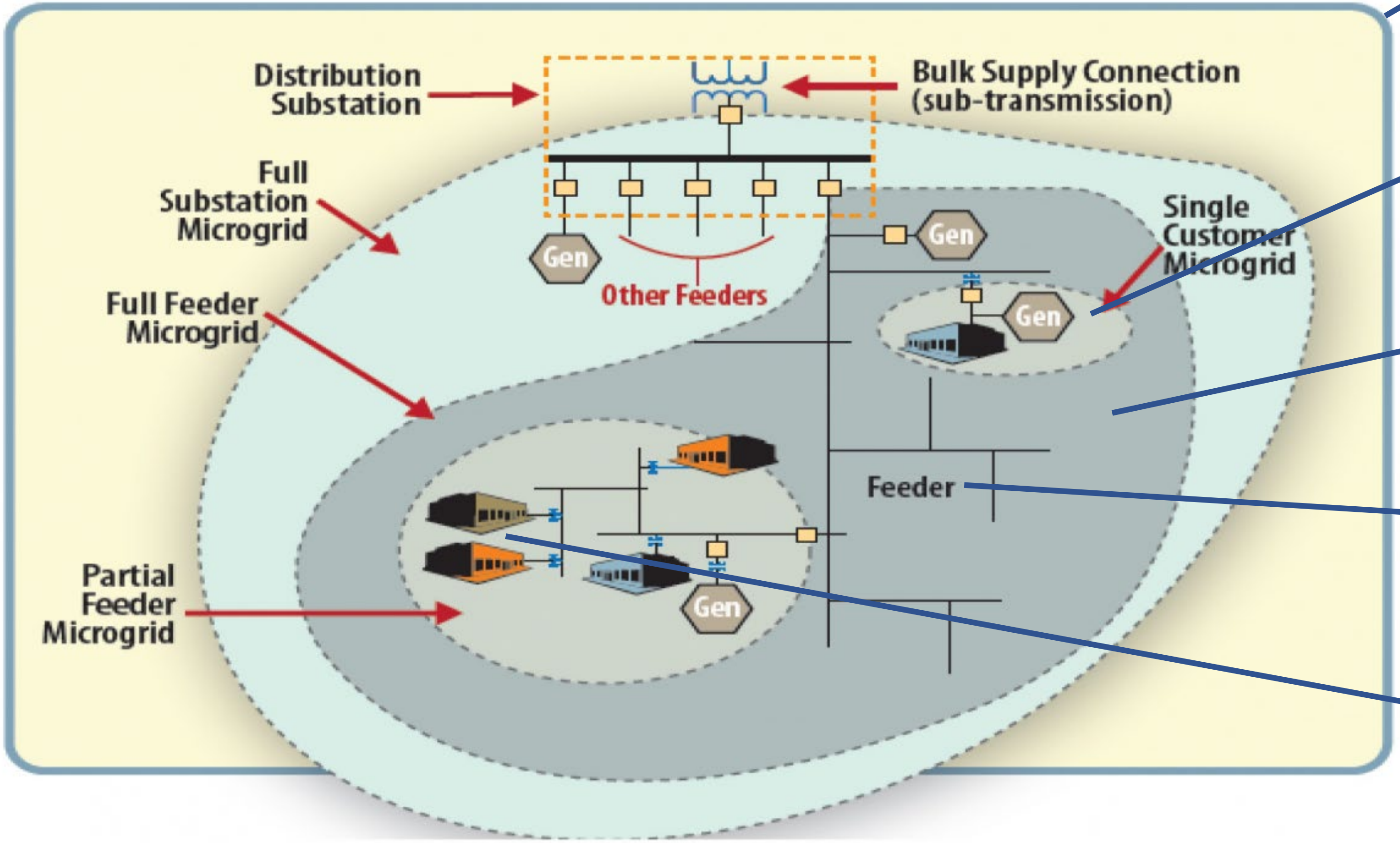






Fractal network

Connected renewable : 209MW
Peak load : 70MW
2022



Monitoring : ADMS

SG CAPITOLE

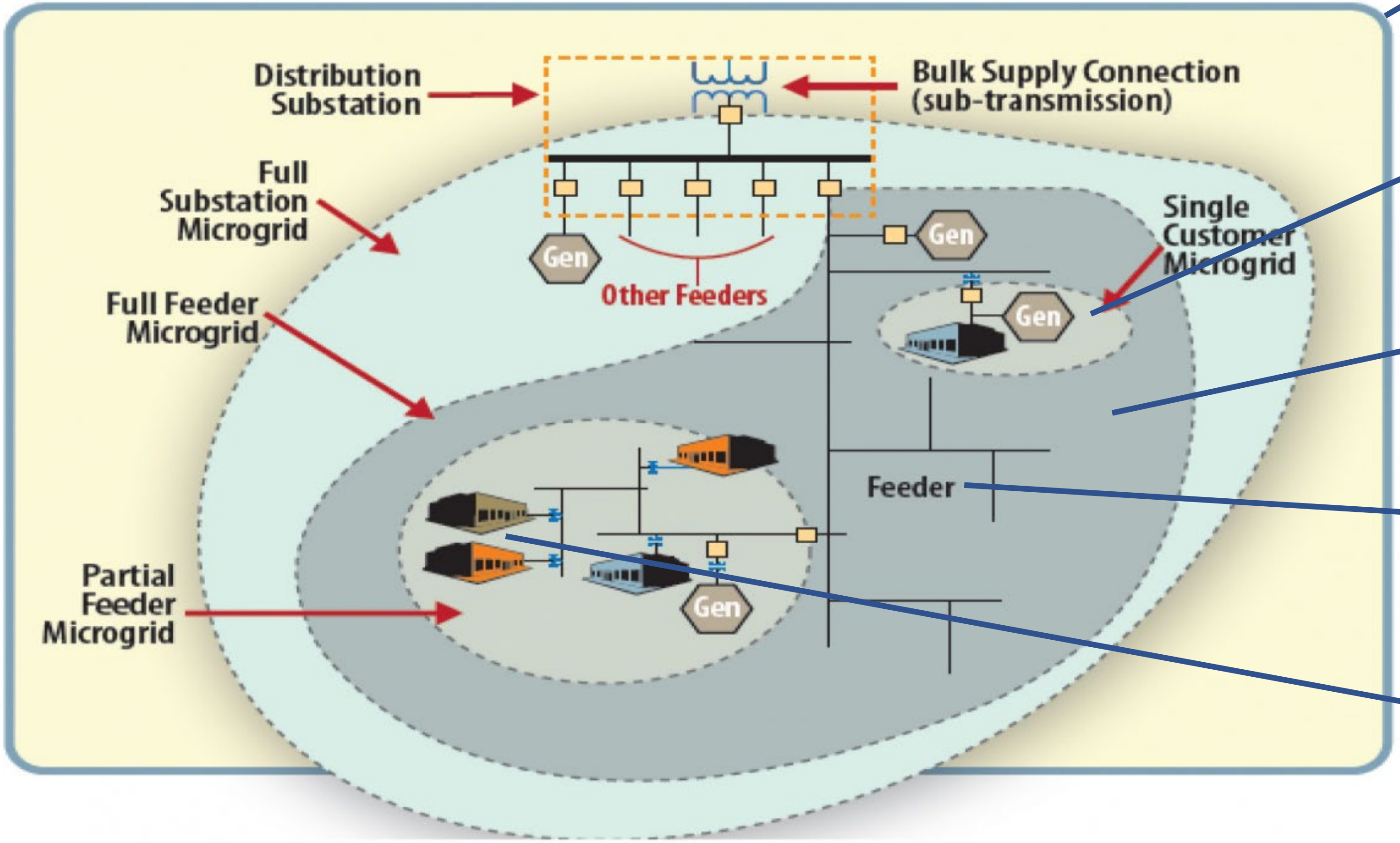
Grid Optimisation (storage)

Grid Efficiency

Smart Meters

Fractal network

Connected renewable : 209MW
Peak load : 70MW
2022



Monitoring : ADMS

SG CAPITOLE

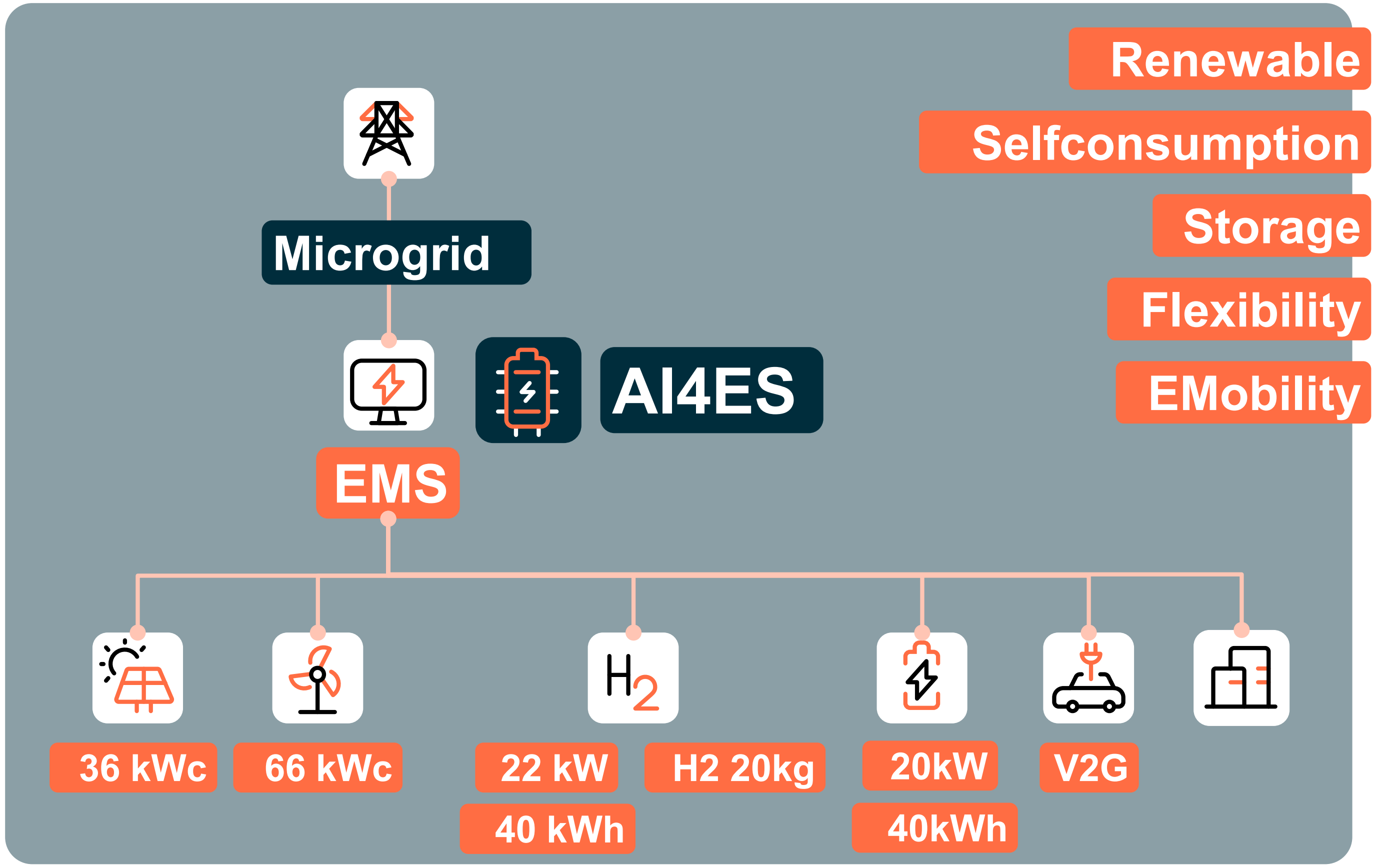
Grid Optimisation (storage)

Grid Efficiency

Smart Meters

AI for energy storage: Capitole project

Testing the building blocks of future networks



Manage flexibility to maximize self-consumption
Islanded capacity tests
AI4ES to optimize energy management (EMS) based on:

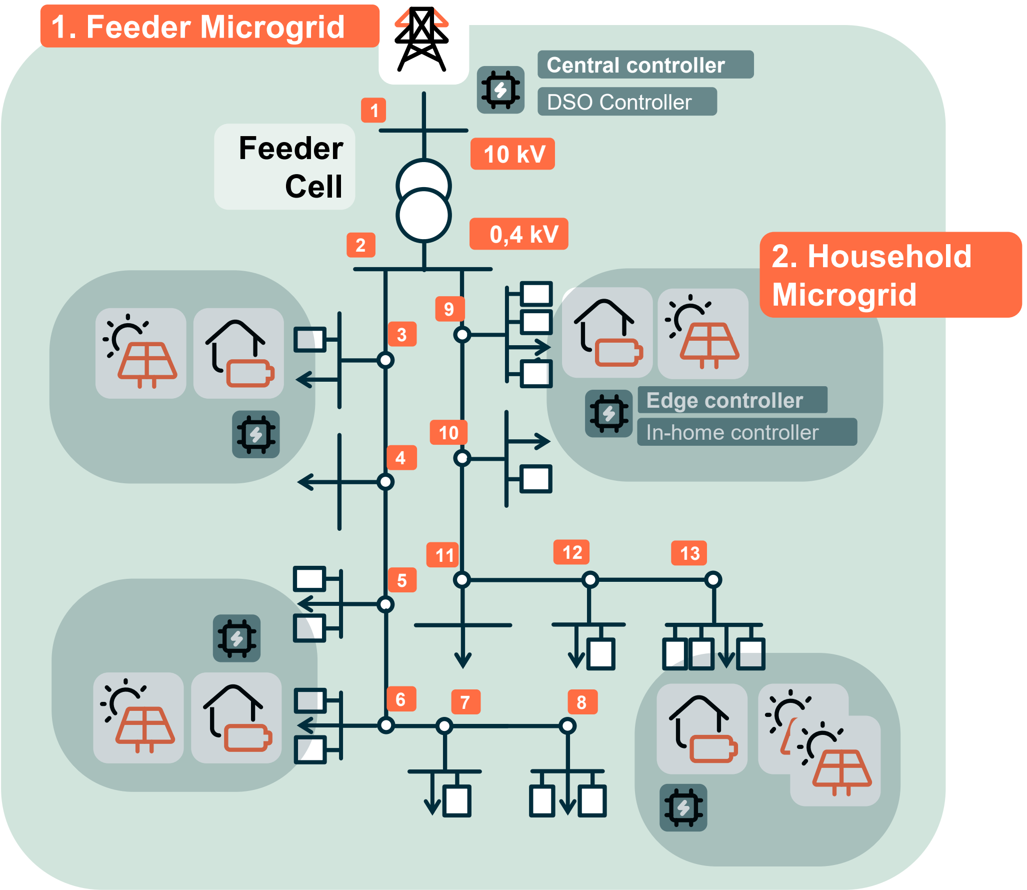
- **Production,**
- **consumption and storage forecast**
- **Energy optimization plan**
- **Real time management**

Financement dans le cadre de la réponse de l'Union à la pandémie de COVID-19

Production and self consumption of the site

AI for Energy Storage : Microgrid project in Germany

Optimization-based control of distributed BSS to reduce backfeedback power in WWN network area



AI for Energy Storage : Microgrid project in Germany

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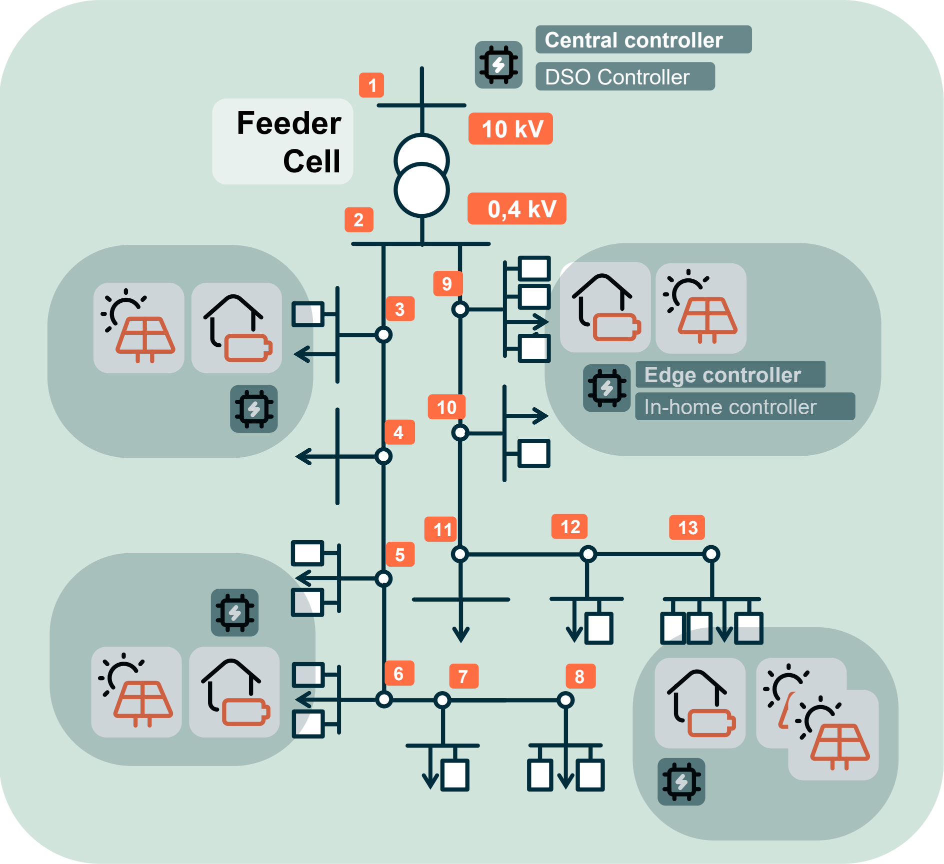
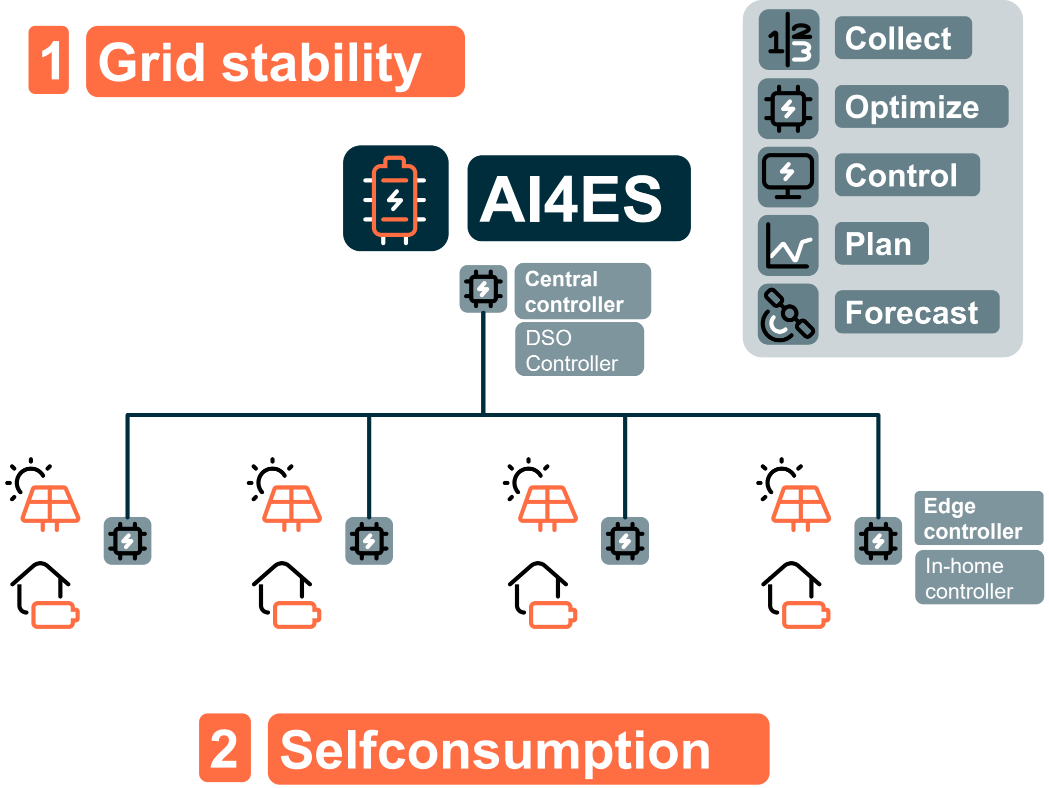
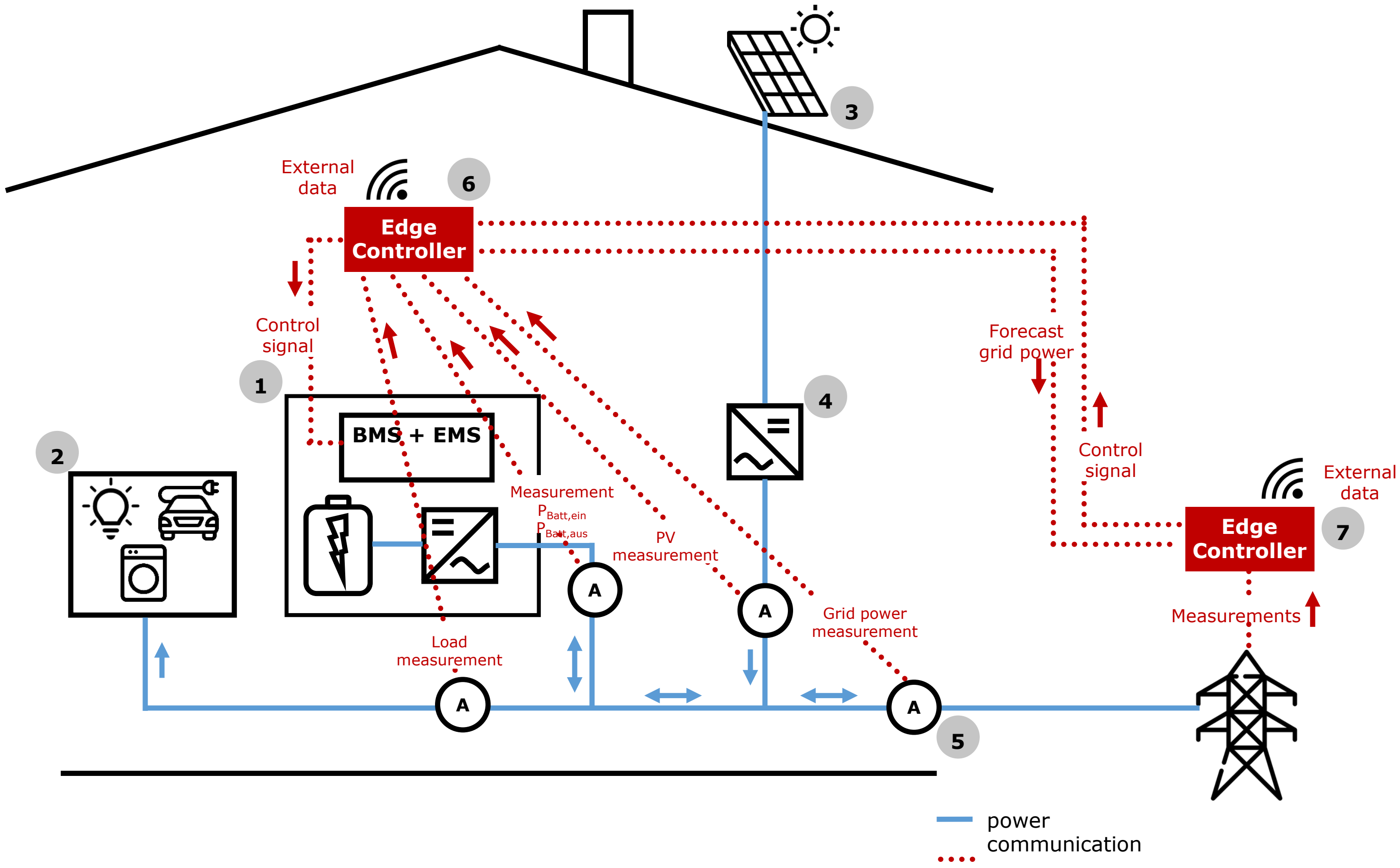




Zoom inside the house



Household self consumption Energy management

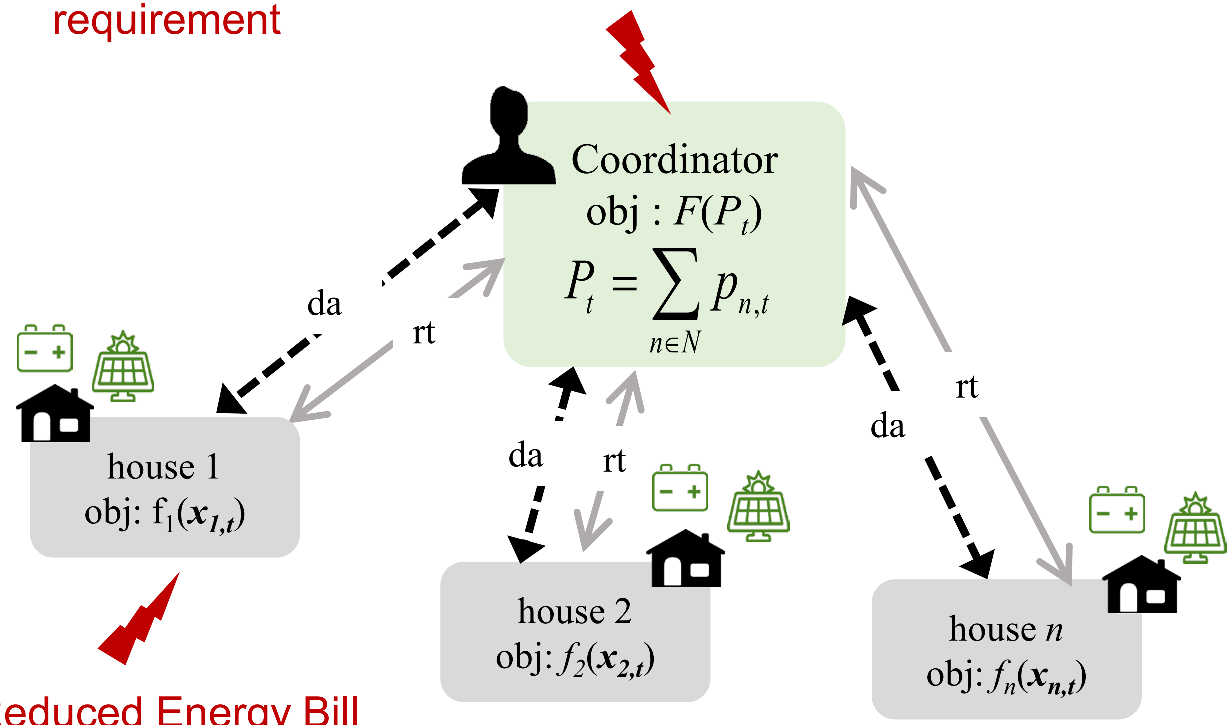
Battery :

- 10 kWh / 10,6 kW

Fractal Management Strategy

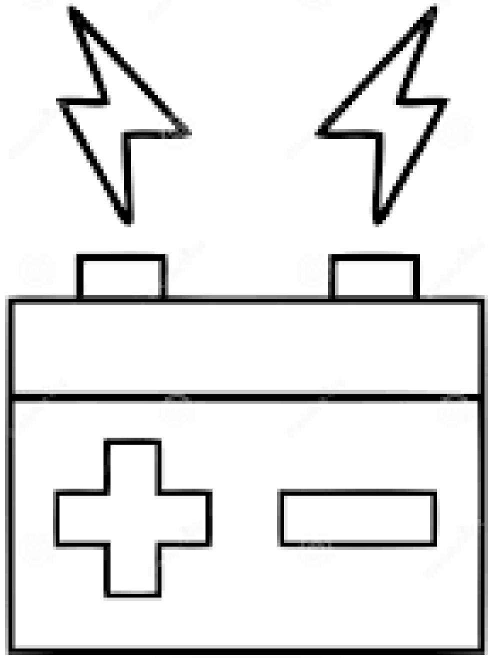
- Controls of resources « behind the meter» :
  - Privacy by design – third party assets.
  - Need for coordination strategy.
  - Account for global and local objectives.
- Look-Ahead Phase :
  - Every 2 hours : schedule of the controls – 30 min resolution.
  - Smooth the overall power profile at the coordination level.
  - Algorithm with successive optimizations at the coordinator and users' levels until convergence.
  - Contribution of every users within their capabilities.

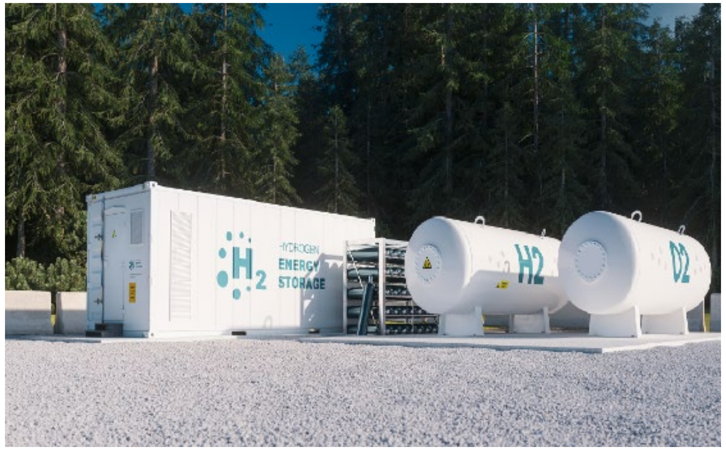
- Peak shaving to reduce backfeed
- Smooth aggregated power → less losses, and equipment ageing
- Minimum deviation with schedules → less reserve requirement



- Reduced Energy Bill

Storage for the sustainable development of electrical systems





Worldgrid
an Eviden business

?

HS'BI

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AGNES

Research potential within the framework of Section 13k EnWG

Prof. Dr.-Ing. Jens Haubrock

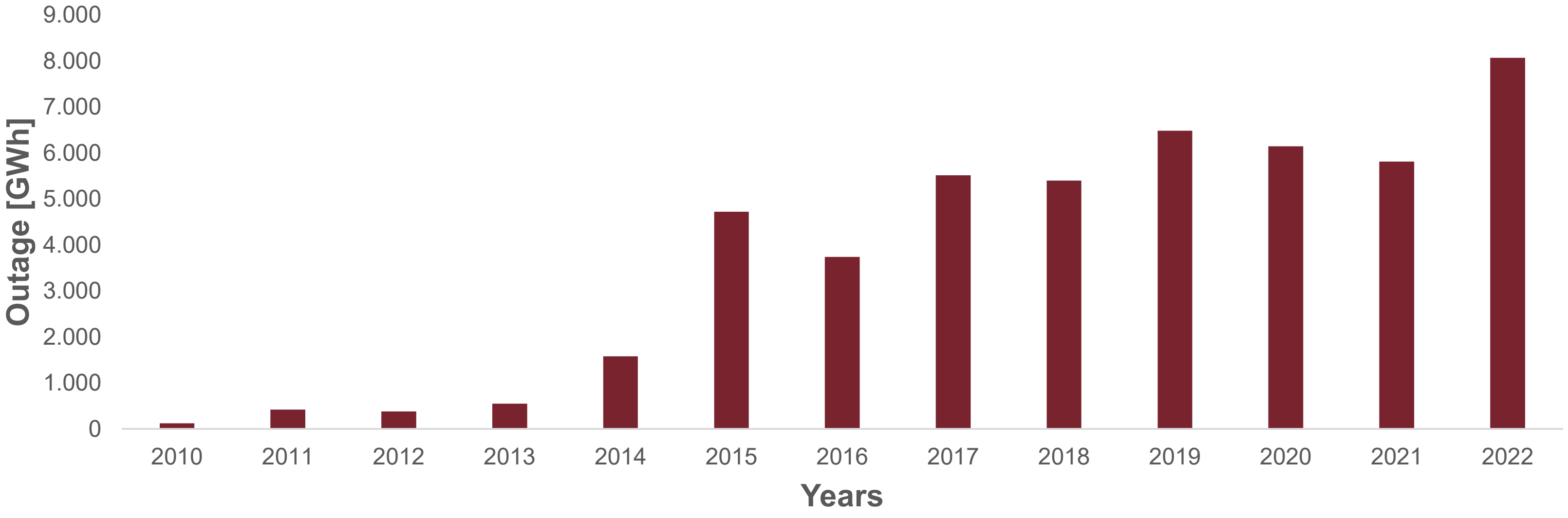
ites

Institut der HSBI

GRID CONGESTION

- RES (Renewable Energy Sources) curtailment due to congestion increases
- In 2022, **70% (5,682 GWh)** of the curtailment of RE resources was attributed to bottlenecks in the **transmission grid**.
  - The remaining **30% (2,389 GWh)** of the curtailments were caused in the **distribution grids.** [Bt23]

Development of outage work due to curtailment of renewable electricity feed-in in Germany in the years 2010 to 2022 [St23]



[St23]

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GRID CONGESTION

- Strategies against grid congestion:
  - At transmission and 110kV distribution grid levels:

    EnWG §13k

  - At distribution grid levels:

    EnWG §14a

[St23]

§ 13K

> (1) In order to mitigate a reduction in the active power generation of installations in accordance with section 3(1) of the Renewable Energy Sources Act due to electricity-related congestion, operators of transmission networks with control area responsibility shall, from 1 October 2024, enable authorised participants **to use electricity quantities in additional controllable loads** in accordance with subsections (2) to (7).

- The hourly amount of electricity that may have to be curtailed due to possible bottlenecks are determined by the TSOs for the following day.
- From 1 October 2024, the amount of electricity to be curtailed can be determined using a simplified flat-rate allocation procedure for a two-year trial phase

[BJ22]

REQUIREMENTS FOR CONTROLLABLE LOADS

- Power consumption must:
  - be **flexible** in the way it is used
  - contribute to the transition to a **greenhouse gas-neutral, reliable, secure and affordable** energy system.

- Ensuring the additional electricity consumption of controllable loads
  - Three segments where additional electricity consumption can be reasonably assumed
  1. Substitution of fossil heat generation with **electric heat generation** (E-heating, also aggregated from low-voltage systems)
  2. Deployment of **grid-connected storage** (BES installed solely for control purposes)
  3. Newly installed **electrolyzers** and **large heat pumps** with a **minimum electrical capacity of 100 kW**

[BNA24]

FORECAST OF THE AMOUNT OF CURTAILED ELECTRICITY

- Use of **grid status forecasts** based on power plant utilisation, grid load and renewable energy generation.
- Consideration of grid utilisation in the Continental European interconnected grid.

- Determination of the **amount of curtailment flow**:
  - Simulation of German redispatch utilisation including relief facilities and grid status forecasts.
  - Prioritisation of load relief systems over the curtailment of renewable energies.
- **Safety discount**:
  - Introduction of a safety margin due to forecast uncertainties.
  - Application depending on the relief region with expected discounts of 30-50%.
  - Planned analysis of uncertainties during the trial phase to determine transparent discounting methods.

[Nt24]

IMPLEMENTATION CONCEPT OF THE TRANSMISSION SYSTEM OPERATORS

- Each installation to be registered for participation in the 13k instrument must be defined as a relief system. For this, the system must
  - have already completed a successful installation at the time of application for registration,
  - be geographically located in a relief region,
  - have a connection to the general supply grid,
  - be flexible in its mode of operation (controllable and not load profile-bound)
  - have an installed rated electrical output of >= 100 kW
  - and not be the subject of a contractual agreement between the operator and the TSO in accordance with section 13(6a) EnWG.

[Nt24]

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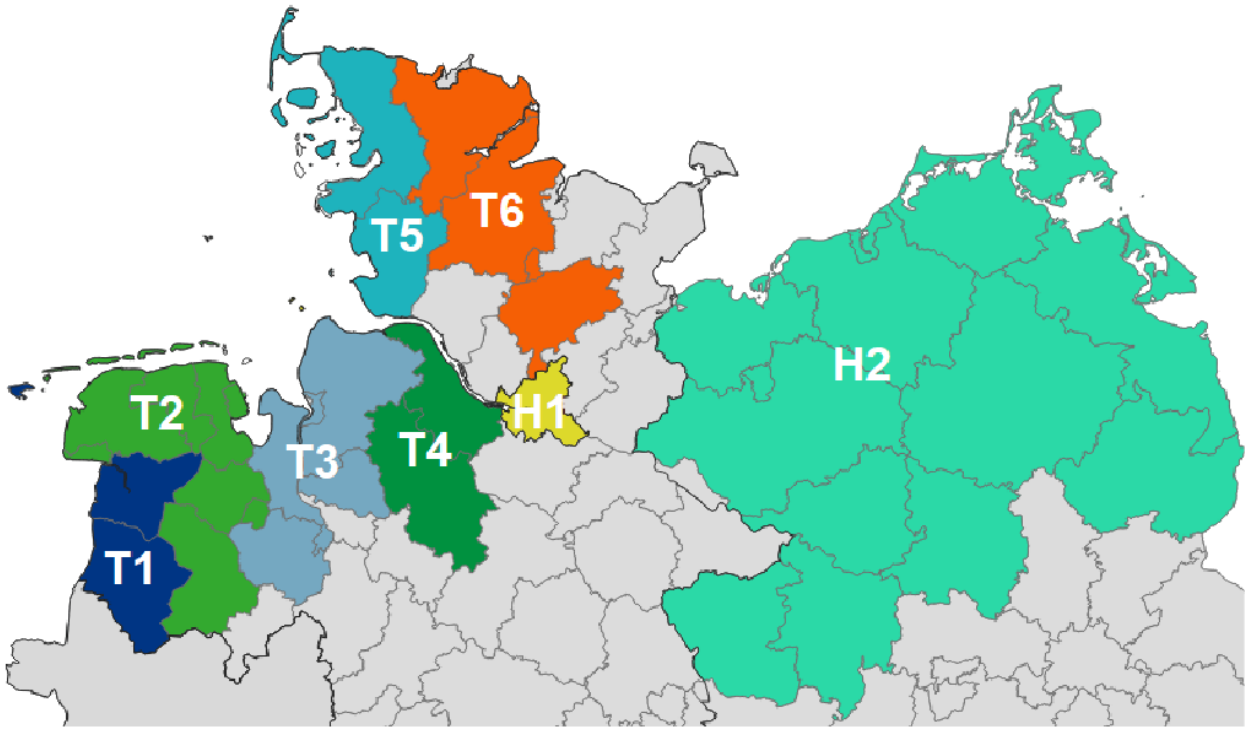
GEOGRAPHICAL DESIGNATION OF THE RELIEF REGIONS



[Nt24]

Figure 3: Illustration of TSO relief regions for the trial phase

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SMALL RELIEF SYSTEMS

- Relief systems with an installed rated electrical output of less than 100 kW

- Must be summarised as a relief group within the same relief region
  - The sum of the installed nominal power of all participants in a relief group must be greater than 100 kW

[Nt24]

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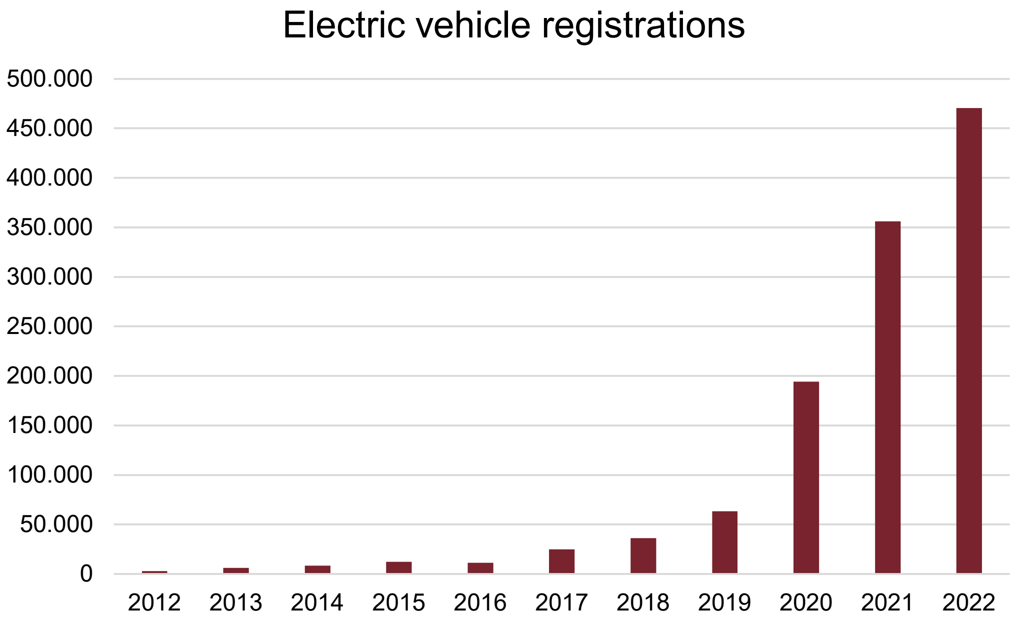
§ 14A

> Grid-orientated control of controllable consumption devices and controllable grid connections

- Controllable consumption devices within the meaning of paragraphs 1 and 2 include **heat pumps, charging points for electric vehicles** that are not accessible to the public, systems for generating cooling or storing electrical energy and night storage heaters.

[BJ22]

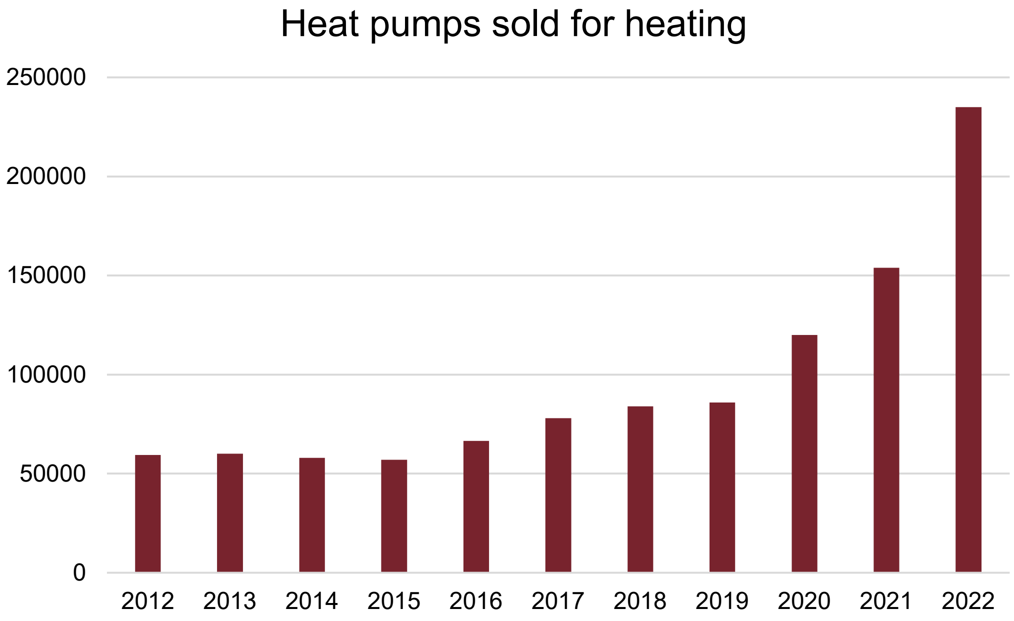
PROBLEMS OF SECTORAL COUPLING FOR DSO



Quelle: Kraftfahrtbundesamt

- Federal government forecast: 15 million electric vehicles by 2030

Quelle: Koalitionsvertrag aktueller Bundesregierung



Quelle: Bundesverband Wärmepumpe

Erneuerbare Energien

Habeck will 500.000 Wärmepumpen jährlich

Stand: 29.06.2022 16:27 Uhr

Quelle: Title Tagesschau.de

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CONTROLLABLE LOADS

- Controllable load equipment in LV (control equipment) with more than 4.2 kW includes:
  - Electric vehicle charging systems
  - Heat pumps
  - Air conditioning systems
  - Battery storage systems (connected to the grid)
- Excluded from control:
  - All other types of household appliances
  - Critical infrastructure (e.g. hospitals)

OVERLOAD IN THE LOW VOLTAGE GRID

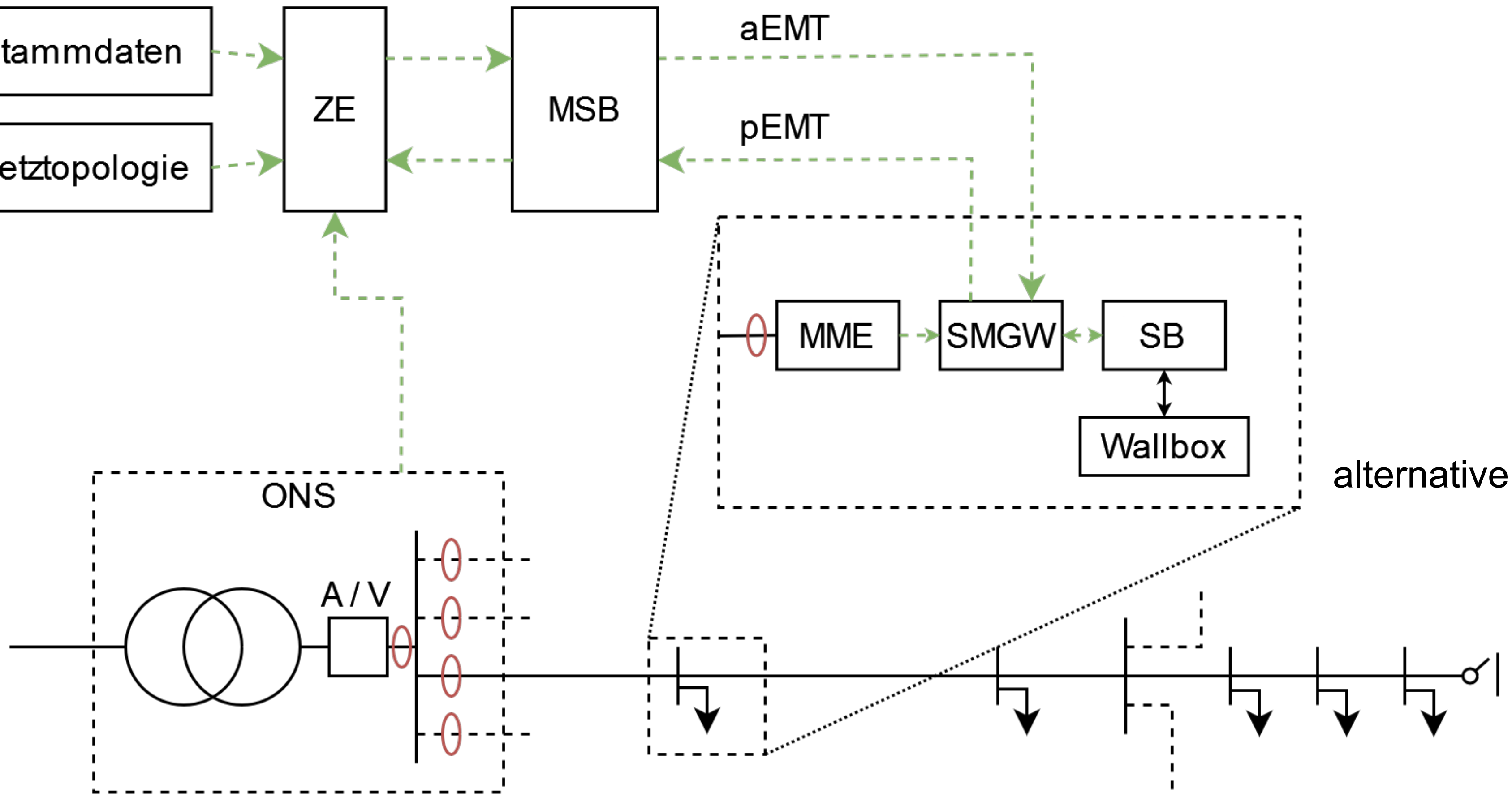
- Overload detection allows only curative control

- Low voltage overloads are:
  - Use of devices above rated current (FNN 80%)
  - Voltage limit violations

- How does a distribution system operator detect an overload?
  - Based on a status assessment (different from a TSO's status assessment)
  - Prerequisite for a 'sufficiently' accurate state determination (BNetzA):
    - local substation + Outlets recorded by measurement + 7% of households via SMGW to TAF10
    - 15 % of households via SMGW to TAF10

  - The state determination must be performed every minute

FUTURE STRUCTURE OF LOW-VOLTAGE GRIDS



alternatively via EMS

DETERMINATION OF THE CONTROL COMMAND SIZE

- Check whether direct control of the controllable consumption device or via EMS

- Transmit the target value for power to EMS or controllable consumption device
- It may only be reduced to avoid overloading!
- There is no prioritisation of different control devices. (In winter, a heat pump is no more valuable than an EV)

- Prior determination of the min power:
  - for a controllable consumption device = 4,2 kW

  - for several controllable consumption devices :
  - Flextime factor (GZF): $P_{min,\ 14a} = Max(0{,}4 \times P_{Summe\ WP};\ 0{,}4 \times P_{Summe\ Klima}) + (n_{steuVE} - 1) \times GZF \times 4{,}2\ kW$

n_{steuVE}	2	3	4	5	6	7	8	>= 9
GZF	0,8	0,75	0,7	0,65	0,6	0,55	0,5	0,45

OBLIGATIONS OF THE END CONSUMER

- Connection of controllable loads must not be rejected by the DSO (Distribution Syst em Operator).

- Consumer must install MME + SMGW and control box. For this they may:
  - Hire an external company
  - Appoint a Metering Service Provider (MSB)
  - Appoint the DSO

- Customer receives reduced grid fees.

PREVENTIVE CONTROL (INTERIM SOLUTION)

- Determination of Overload using Static Network Calculation
- Time-series-based simulation to determine time windows for control commands
  - Max. 2 hours per day
  - Directly based on potential minimum load
- Transmission of control command with interim solution (e.g., timer)
- Once preventive control is initiated for the first time -> 2 years to implement network-oriented control in the grid area

RESEARCH - DISSEMINATION - INNOVATION

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SOURCES

[Nt24] https://www.netztransparenz.de/xspproxy/api/staticfiles/ntp-relaunch/dokumente/systemdienstleistungen/betriebsf%C3%BChrung/nutzen-statt-abregeln/%C3%BCnb-umsetzungskonzept-gem%C3%A4%C3%9F-13k-abs-6-enwg/2024-04-01_%C3%BCnb-umsetzungskonzept%20%C2%A713k%20enwg.pdf

[Bt23] https://www.bundestag.de/presse/hib/kurzmeldungen-975420

[St23] https://de.statista.com/statistik/daten/studie/617949/umfrage/einspeisemanagement-in-deutschland/

[bdew23] https://www.bdew.de/presse/presseinformationen/gruenstrommengen-praxistaugliche-regelungen/

[BJ22] https://www.gesetze-im-internet.de/enwg_2005/__13.html

[UB23] https://www.umweltbundesamt.de/themen/erstmals-ueber-die-haelfte-des-stroms-in

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[SB24]	https://www.destatis.de/DE/Presse/Pressemitteilungen/2024/03/PD24_087_43312.html
[BMWK24]	https://www.bmwk.de/Redaktion/DE/Dossier/erneuerbare-energien.html
[BNA17]	https://www.bundesnetzagentur.de/DE/Fachthemen/ElektrizitaetundGas/Ausschreibungen/Wind_Onshore/Netzausbaugebiete/NetzausbauGV_node.html
[BNA24]	https://www.bundesnetzagentur.de/DE/Fachthemen/ElektrizitaetundGas/Versorgungssicherheit/NSA/Festlegungsentwurf.pdf?__blob=publicationFile&v=2

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