Grid congestion management through demand-side flexibility and storage

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AGENDA

01 Energy transition and its effect on a Southern German TSO

02 Techno-economic potential of distributed flexibilities for congestion management

03 Redispatch in Germany today and in future: legal framework and market-based elements

04 Learnings from research project PV-Shift

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01 Energy transition and its effect on a Southern German TSO

NEW INSTRUMENTS NEEDED FOR SECURE SYSTEM OPERATION

Grid congestion in Germany

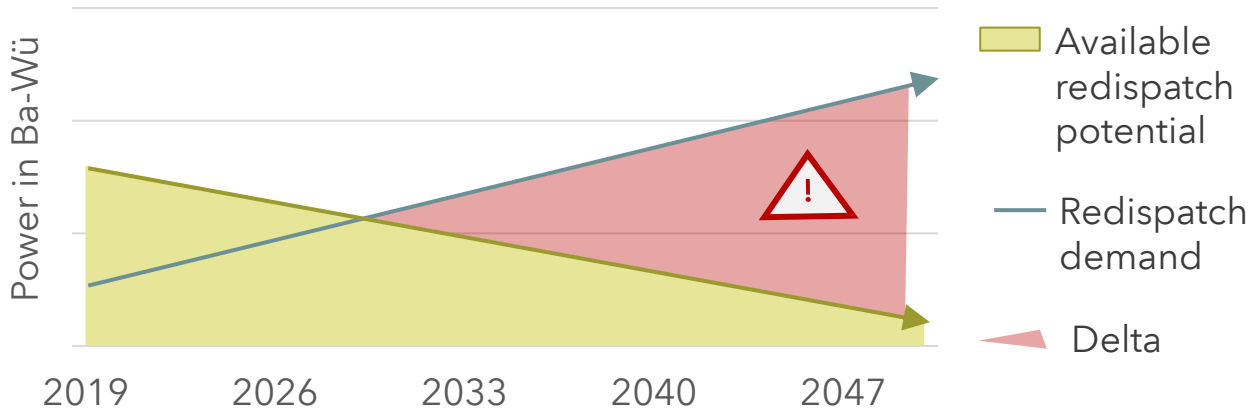
- Limited transmission power capacity, RES generation predominating in Northern Germany, demand centers in Southern Germany
- Congestion management required: Mainly curtailing RES (renewable energy systems) in the North, whilst ramping up generation in the South

Main issue: Lack of secured generation capacity

- In Southern Germany, a reduction of 7.7 GW coal-based and nuclear capacity is expected until 2030 [1]
- Grid reserve reaching end of technical lifetime [1]
- Lacking investments into new generation capacities

Positive Redispatch in Baden-Württemberg

Schematic illustration for a possible future scenario (2021)



- **"Redispatch gap"**: In a worst case scenario, the demand for positive redispatch might not be met from ~2028 onwards.
- Need for **new instruments** for secure system operation: Grid extension, system reserve, sector coupling, and distributed flexibility.

[1] Power plant list of the German Federal Network Agency, as of May 31, 2022. Own calculations based on the assumption that nuclear and coal phase-out will be completed by 2030.

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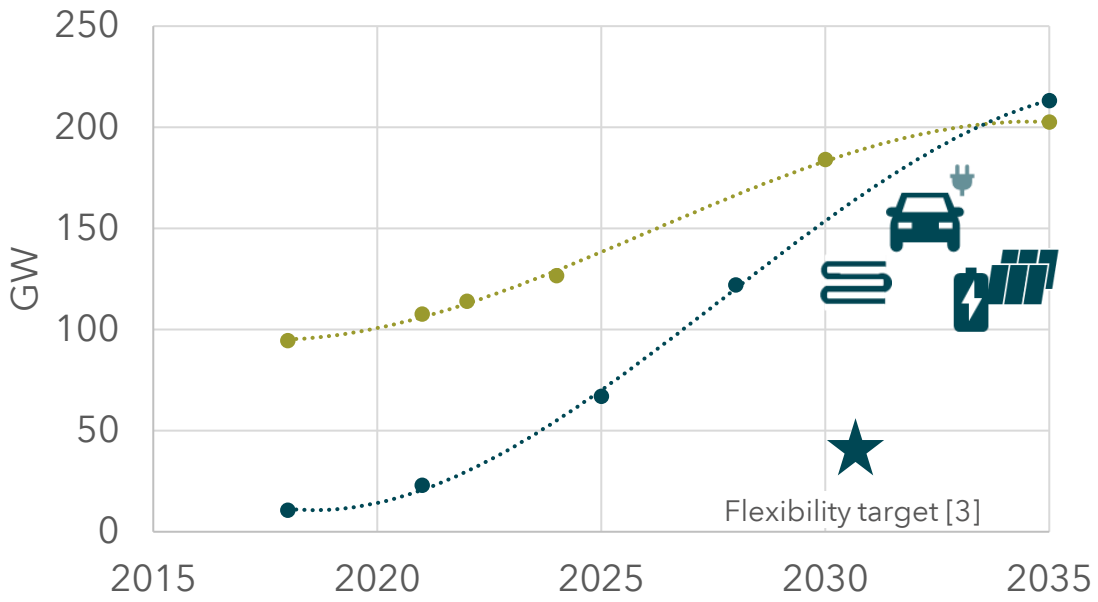
02 Techno-economic potential of distributed flexibilities for congestion management

STEEP RAMP-UP OF BOTH FLUCTUATING RES GENERATION AND DEMAND SIDE FLEXIBILITY

Development of installed power in Germany



- Wind onshore & PV [1]
- Distributed flexibility („installed capacity“) [2]

  Battery electric vehicles, heat pumps, residential PV-battery systems, heating-ventilation-air-conditioning systems [2]

Simultaneous development:

/ Installation of volatile RES

/ Ramp-up of distributed demand-side flexibilities

➢ **Driving energy transition by grid-supporting operation of distributed flexibilities**

[1] smard.de, System analyses of German TSOs, Langfristszenarien 3, Netzentwicklungsplan 2021
[2] Klempp et al. (2021): Potenziale dezentraler Flexibilität: Welchen Beitrag können E-Autos und Wärmepumpen zu einem kosteneffizienten Redispatch leisten? University Stuttgart, 2021. https://www.transnetbw.de/de/presse/presseinformationen/presseinformation/mit-e-autos-und-waermepumpen-die-energiewende-voranbringen
[3] Bericht Versorgungssicherheit Strom 2023

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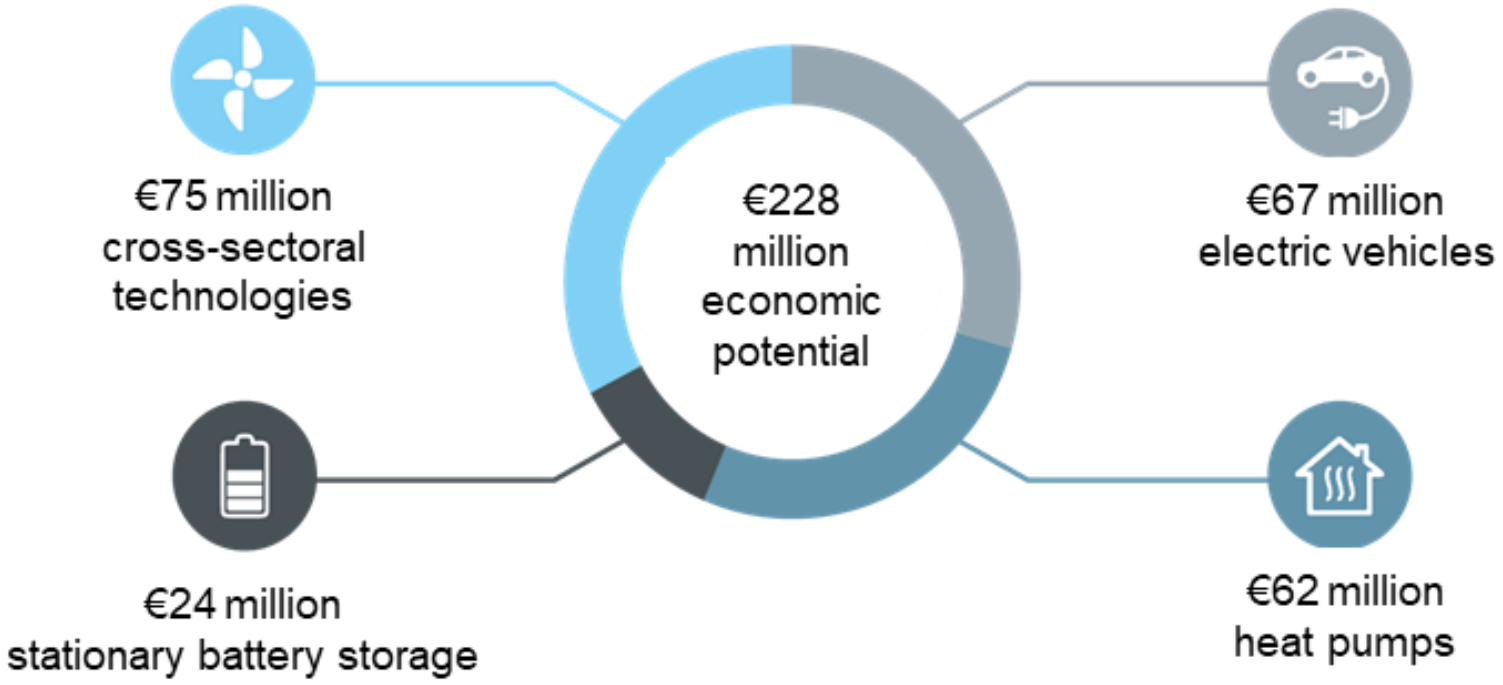
DISTRIBUTED FLEXIBILITY FOR REDISPATCH: ECONOMIC POTENTIAL ALREADY TODAY



Cost-saving potential
up to 228 Mio. €
in 2022-2028 in
Baden-Württemberg only

(Study published 2021)

Klempp et al. (2021): Potenziale dezentraler Flexibilität: Welchen Beitrag können E-Autos und Wärmepumpen zu einem kosteneffizienten Redispatch leisten? University Stuttgart, 2021.
https://www.transnetbw.de/de/presse/presseinformationen/presseinformation/mit-e-autos-und-waermepumpen-die-energiewende-voranbringen

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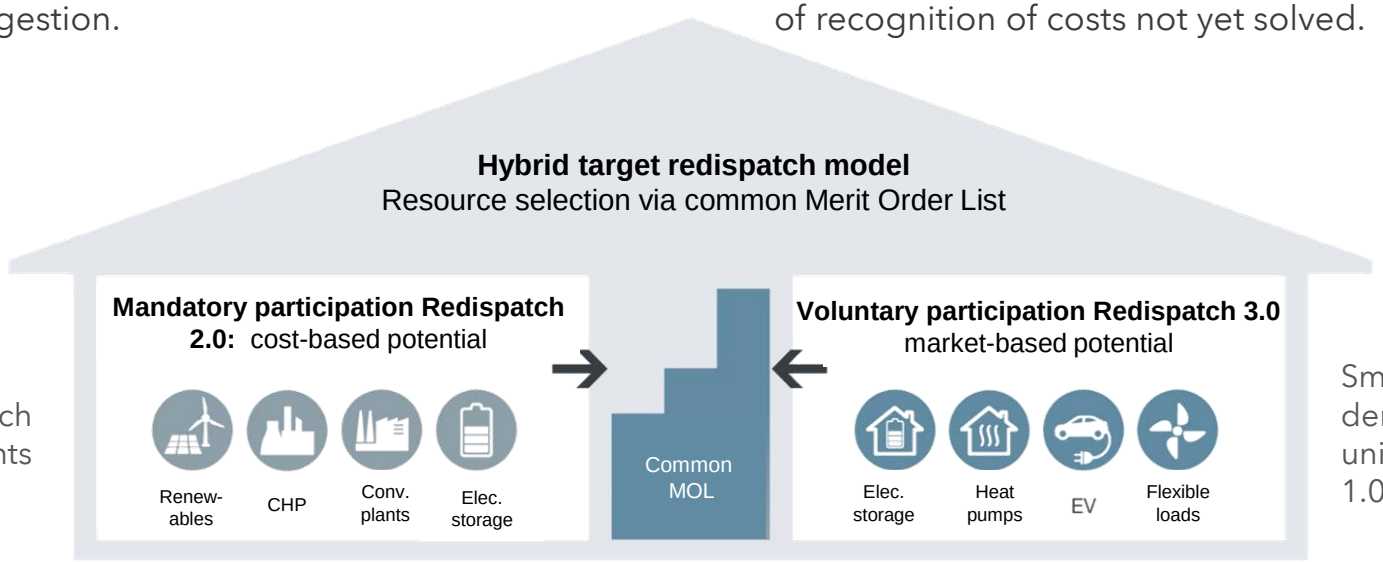
03 Redispatch in Germany today and in future: legal framework and market-based elements

HYBRID REDISPATCH MECHANISM SUGGESTED BY THE TSOS TRANSNETBW AND TENNET

- **„Redispatch 2.0"** covers generation and storages >100 kW
- **Suggested market-based "Redispatch 3.0"** as additional module: voluntary participation for demand-side flexibility
- A common **Merit Order List (MOL)** and **pay-as-bid auction process** is used to select the units most suitable for avoiding grid congestion.
- Both **long-term capacity offers** and **short-term energy offers** tap into the potential of different technologies.
- Market monitoring limits **Inc-Dec incentives** in the case of short-term energy price offers.
- **Regulatory analysis** shows: target model is EU-compliant, issue of recognition of costs not yet solved.



Larger Redispatch 1.0 and 2.0 plants

Smaller distributed and demand-side Redispatch 3.0 units that are not included in 1.0 / 2.0

TRANSNET BW tennet E-Bridge Kompetenz in Energie Study available online

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OUR RECOMMENDATION: A "COMBINED HYBRID MODEL"

➢ All bidders can submit long-term "capacity" offers, some can also submit short-term energy offers.

Cost-based redispatch (Redispatch 1.0/2.0)

Flexibility potential of a technology

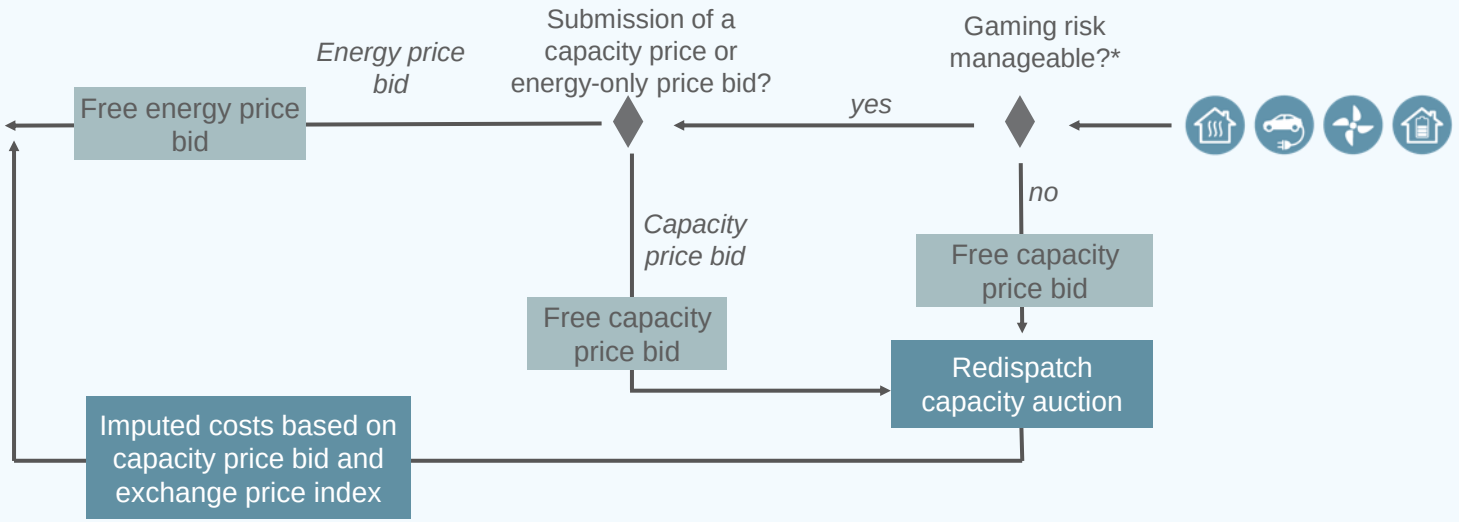
(imputed) costs

Common Merit Order List

Remuneration in cost-based redispatch:

- Regulated compensation in case of activation according to Redispatch 2.0 specifications

Complementary market-based redispatch (Redispatch 3.0)



Remuneration in market-based redispatch:

- Short-term energy offers, when used: in accordance with free energy price bid (pay-as-bid)
- Long-term capacity offers: capacity price bid if capacity available (pay-as-bid), regulated when used

* Gaming incentives can be limited using instruments like baseline monitoring

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AGILE APPROACH REQUIRED. REGULATORY FRAMEWORK NEEDED.

EnWG: Energiewirtschaftsgesetz
FSV: Freiwillige Selbstverpflichtung

Short-term solutions for scaled pilot projects:

- **Step by step, agile approach**: Complex processes and short-cycle developments require an „innovate before you regulate“ approach
- **Flexible regulatory framework** for developing new processes within pilot projects („Reallabore“, including exceptions to charges, fees and levies)
- **Cost recognition** especially for Redispatch 3.0 activations

Long term solutions:

Adjustments of **EnWG para 13a**:

- Extend scope of redispatch to include deman side (< 100 kW).
- Introduce supplementary market-based redispatch (envisaged under EU directive on common rules for the internal market for electricity).

Adjustments of the Incentive Regulation Ordinance (**ARegV**):

- Equal cost recognition for demand-side Redispatch ("FSV Redispatch“)
- Incentive regulation acknowledging future (IT-focussed) development

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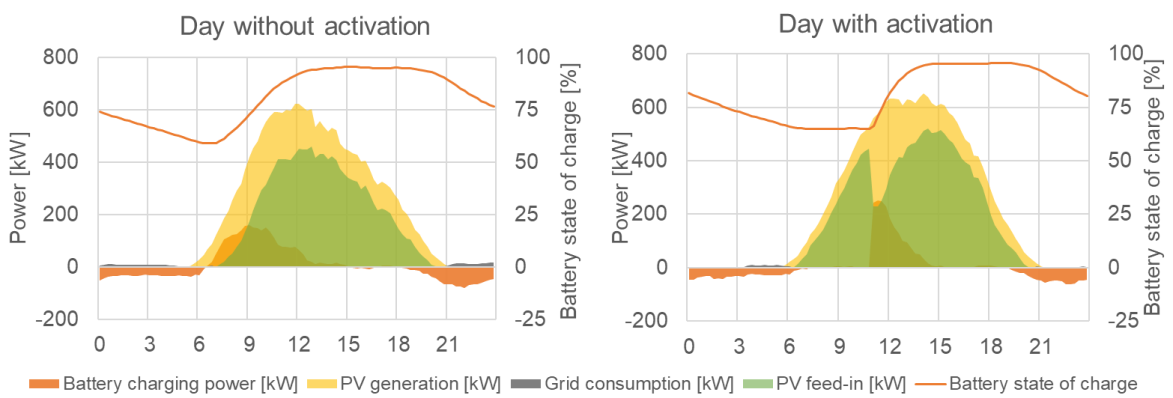
04 Learnings from research project PV-Shift

PV-SHIFT PROJECT: PV-BATTERY-SYSTEMS FOR REDISPATCH

- Pilot project of TransnetBW and Tesla with over **100 Tesla Powerwalls** in TransnetBW control area (May to Oct. 22)
- Battery maximizes PV self-consumption, yet a flexibility potential between spring and fall remains.
- By **shifting the battery charging** from morning to afternoon, PV feed-in to the public grid can be brought forward.
- When activated, "**positive Redispatch**" (residual load reduction) takes place in the morning, followed by an opposite catch-up effect ("**negative Redispatch**"). Energy quantities balance each other out.

Systems' behaviour with and without PV-Shift activation
aggregated measurement data of participating Powerwalls



Main findings:

1. Distributed flexibility requires new products
2. Proof-of-concept of operational use of ~ 100 Powerwalls
3. Activations every other day confirm demand
4. Functional process for pilot scale implemented
5. Demand-side flexibility requires methods for validating delivery
6. High level of buy-in from pilot participants

Ried, S.; Brenneke, M.; Bammert, J.; Schlipf, D. (2023). PV-Shift: Redispatch aus PV-Heimspeichern. *Energiewirtschaftliche Tagesfragen, 73(3)*, 59-63.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THANK YOU FOR YOUR ATTENTION.
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