

IX CONGRESO INTERNACIONAL

Almacenamiento
DE ENERGÍA ⚡
una **nueva era** de alta Confiabilidad



**Market and circular economy of
battery energy storage systems: A
holistic roadmap for the BESS
market in Latin America - inspired
by the European model.**



Experiences from Germany

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Deutsche Gesellschaft für Sonnenenergie (DGS) German Solar Energy Society

Non-profit organisation
founded in 1975

3800 members
(600 companies, these without
voting rights → independent
association)

Germany-wide federal
association and 35
sections and 8 state
associations

National representation of
the Solar Energy Society



Solar energy magazine &
newsletter



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DGS Berlin Brandenburg Regional Association

SolarAkademie

Training courses (1 - 5 days)

Presence, online, in-house

Technology and economy



SolarAkademie
aktuell, fundiert und umfassend

SolarServices

Technical project inspections/consulting

System inspections, measurements

Yield-, damage- and glare- reports, ...



SolarServices
unabhängig und weltweit anerkannt

SolarProjekte

Recognised as a research institution

Education, standardisation and research projects

Plug-in solar, storage, BIPV, etc...



SolarProjekte
mitgestalten und vorausgehen

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Independent knowledge transfer

Photovoltaic systems guide

Autor: Ralf Haselhuhn

5. edition, Berlin 2013

6. edition, Berlin 2021 (Kapitel 5)

Internet portal with updated
content

www.pv-wissen.de



Translations in English and Spanish only of earlier versions of the guide

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Ecology and sustainability

- EU-Battery Directive
- Recycling

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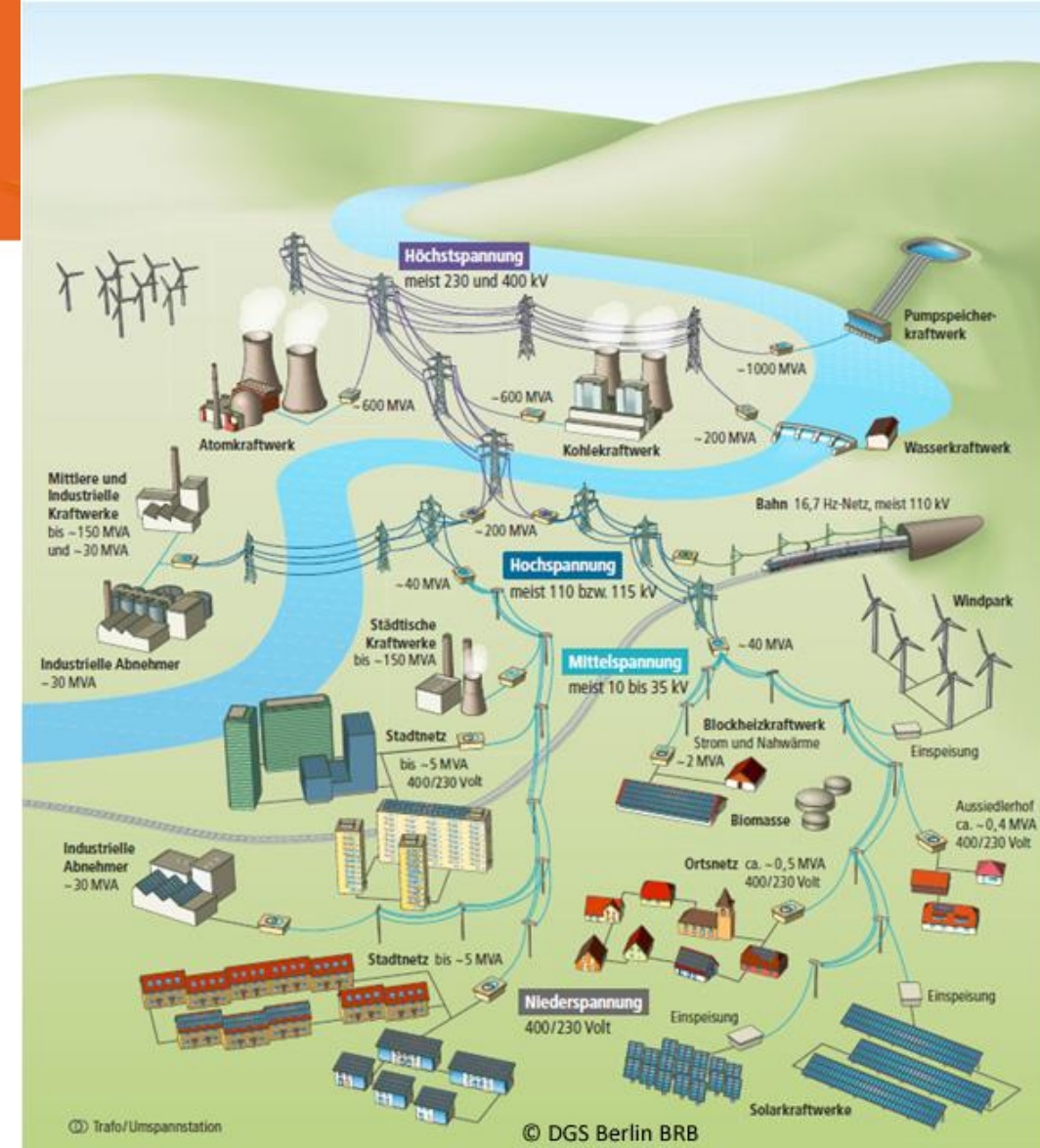


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Energy supply networks in transition

- Until now, generation, grid control and grid management have been almost exclusively centralised in the high and extra-high voltage grid
- The millions of decentralised feeders (CHP, WTC, PV...) are increasingly shifting these tasks to the medium-voltage grid and, in the case of PV, also to the low-voltage grid
- If existing power plants are shut down in the future, storage facilities will become necessary



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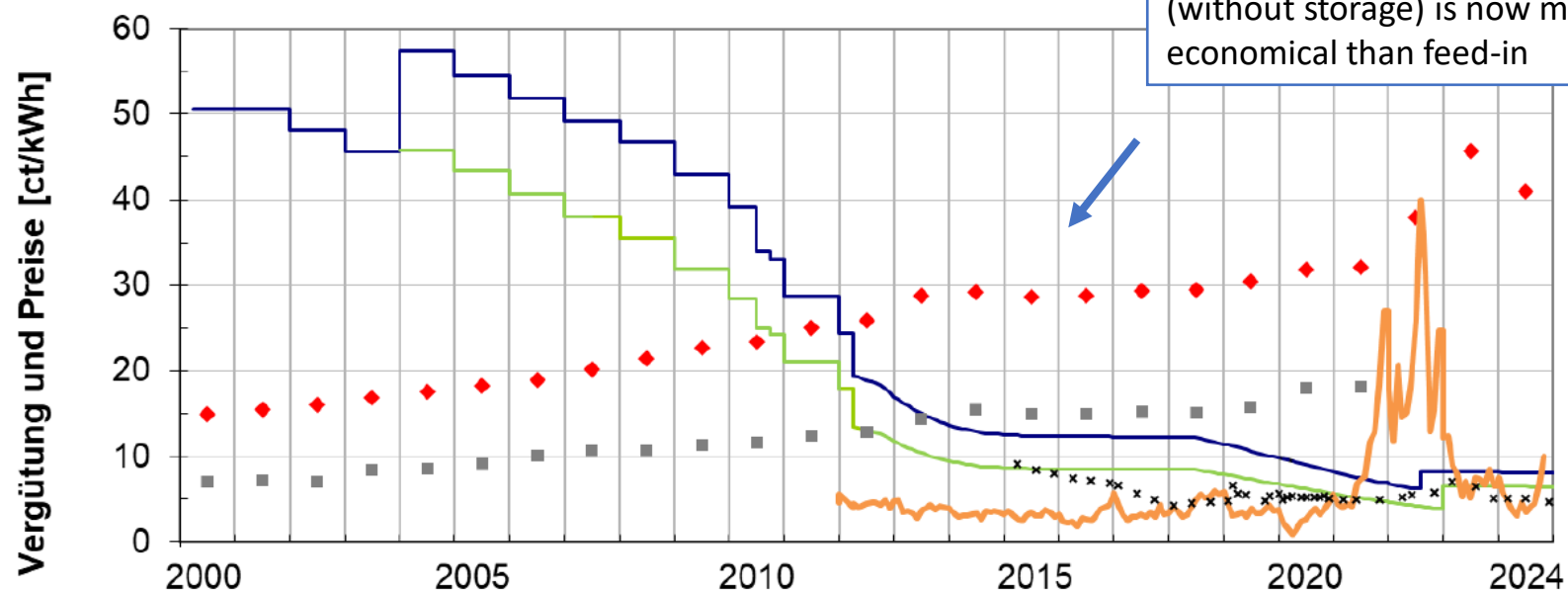
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Feed-in tariffs and electricity prices in Germany



Feed-in tariff falls below purchase electricity price - Own consumption (without storage) is now more economical than feed-in

Cost-saving potential compared to grid feed-in

— PV Gebäude, klein — PV Gebäude/Sonstige x PV Ausschreibung
♦ Strompreis Haushalte, brutto ■ Strompreis Industrie klein — Marktwert Solar

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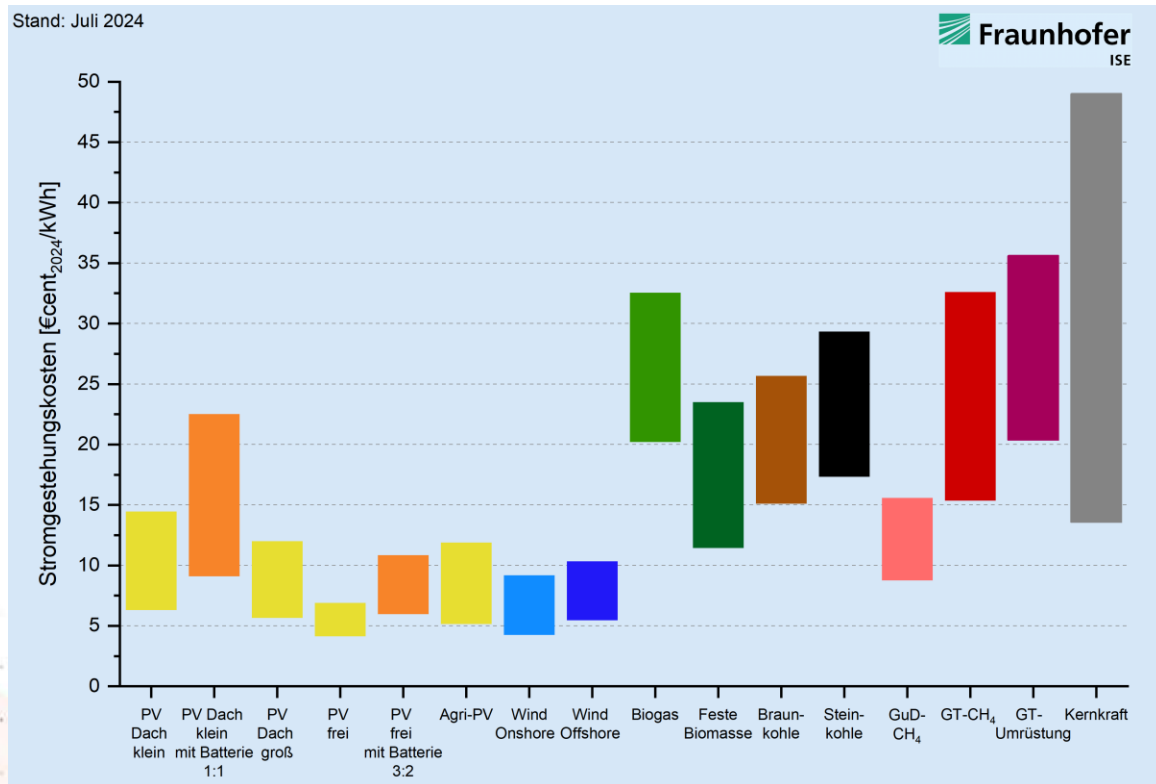
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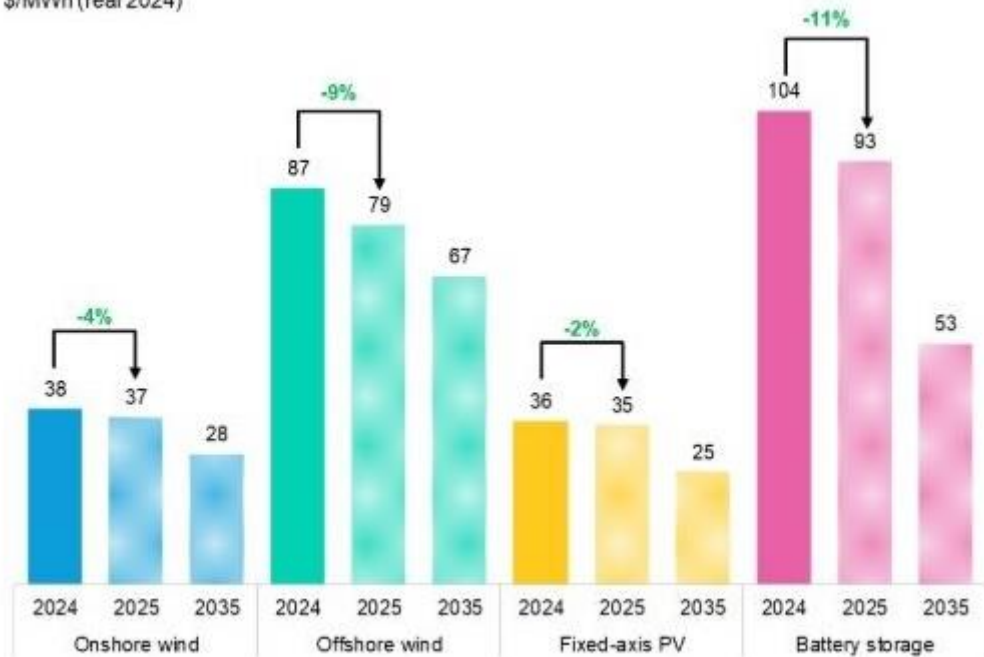
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LCOE in Germany (in €) and worldwide (in \$)



\$/MWh (real 2024)



Bloomberg NEF

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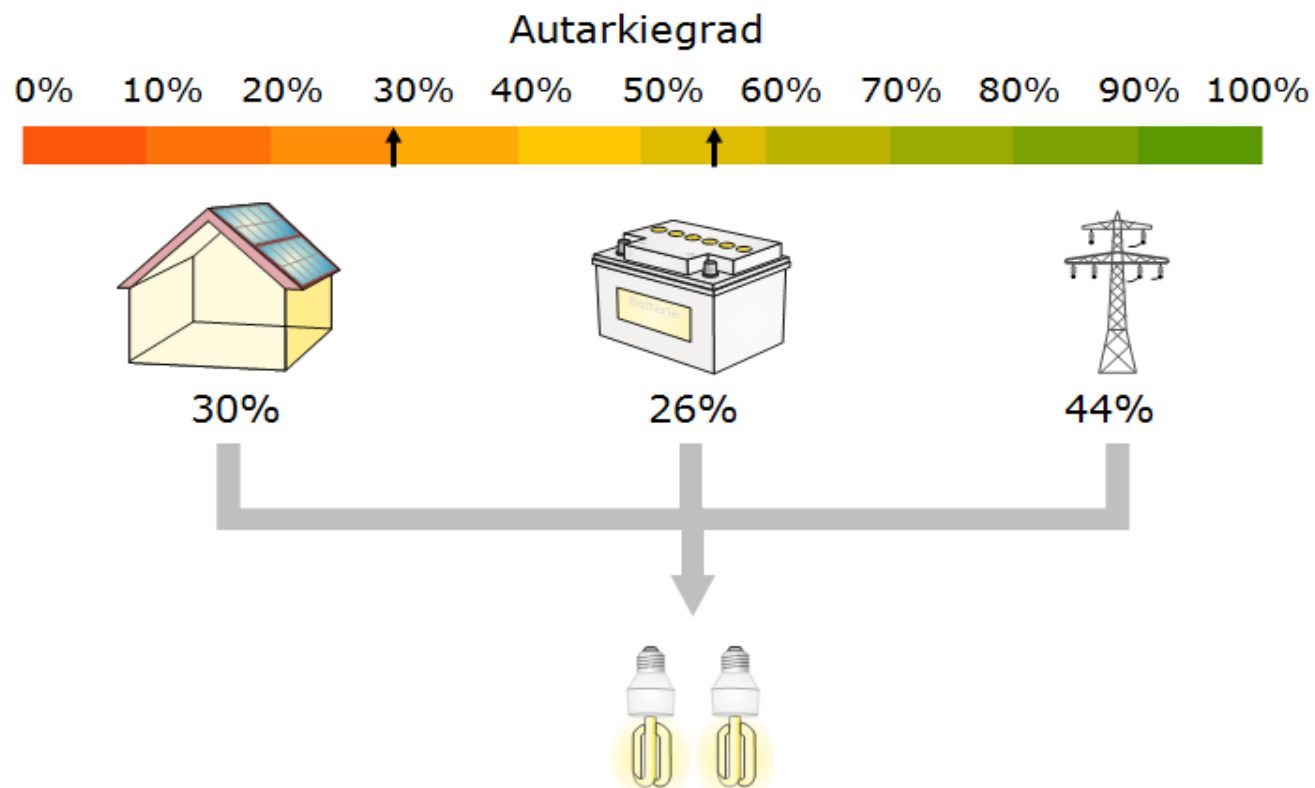
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Self-consumption as a driving force for storage

With a PV system, you can partly cover your own energy consumption.

In order to utilise self-generated electricity during periods of low irradiation and especially at night, most new small systems in Germany are installed with storage units



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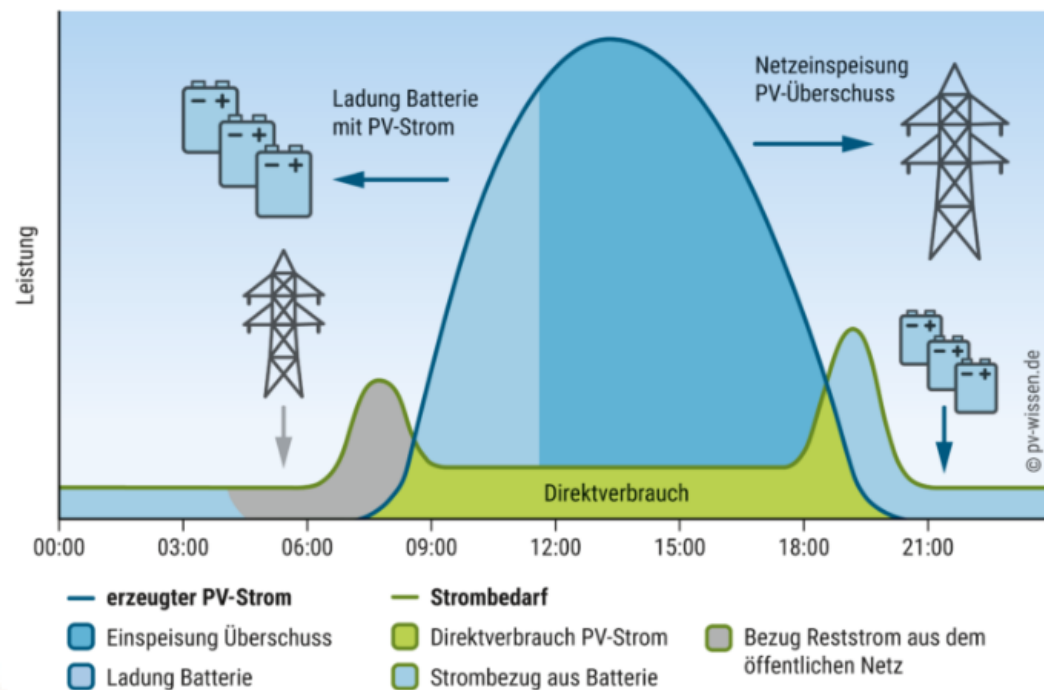
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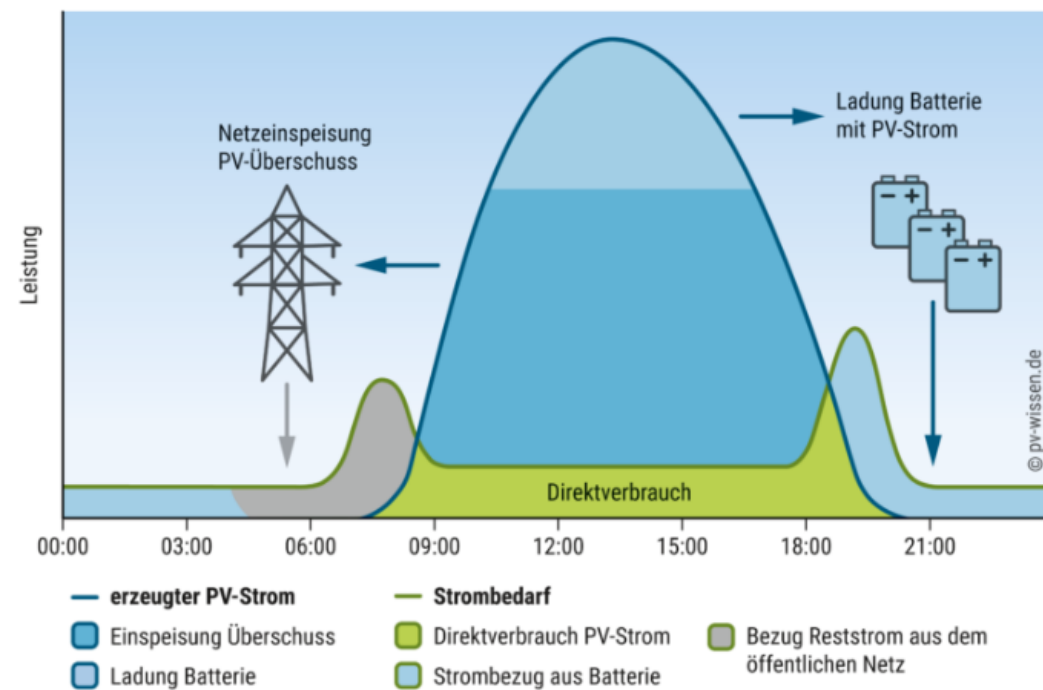
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Storage with and without grid support



Nicht netzdienlicher Speicherbetrieb



Netzdienlicher Speicherbetrieb

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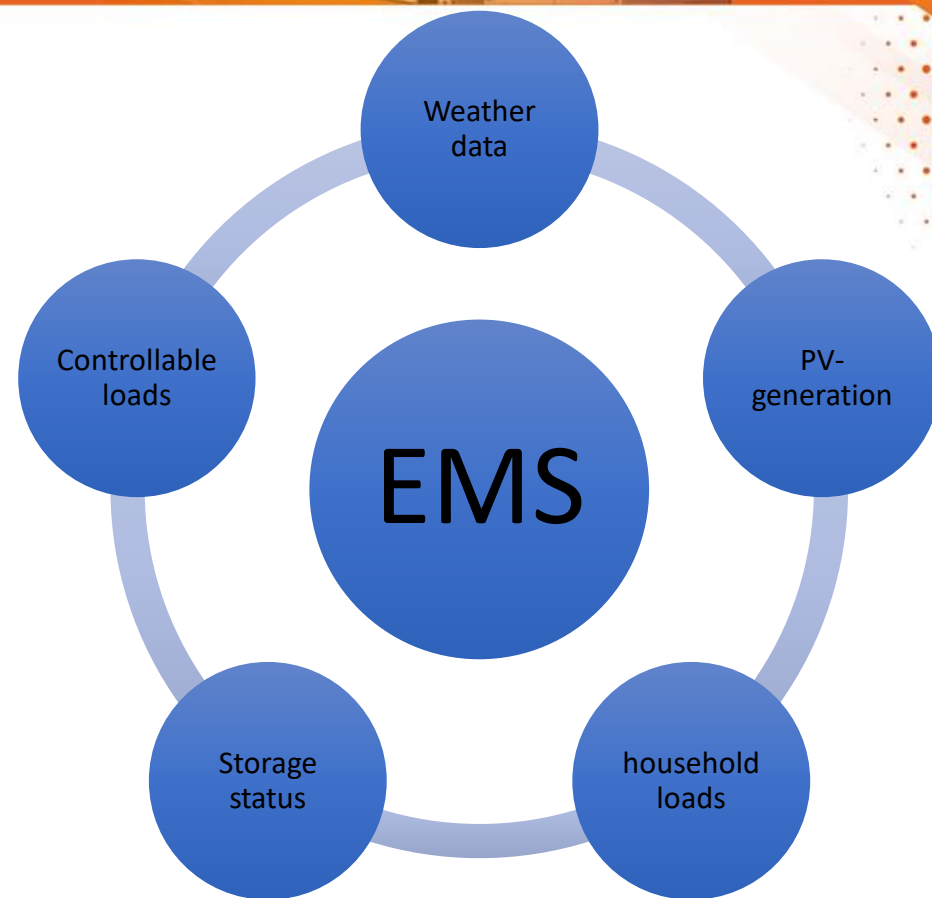


Decentralised feed-in with grid support

Limiting the maximum permissible feed-in power to the grid supports the grids, but leads to less generation from PV systems overall

If the storage system is not charged in the morning, but rather at times of energy surplus in the grid (in grids with a lot of PV at midday), the load on the grids is reduced.

An energy management system can be used to optimise direct consumption and the storage of surpluses



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peak load clipping

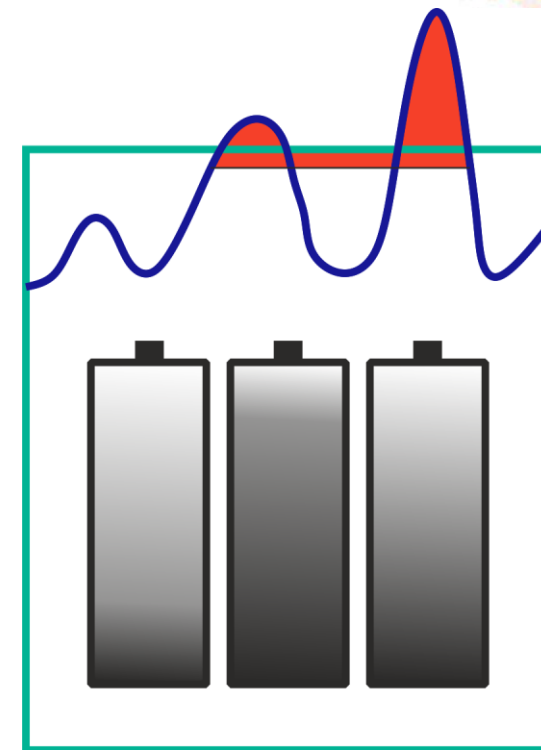
Power grids must be designed for peak loads, even if they only occur briefly

For large consumers (>100,000kWh grid consumption/a), the grid fees also depend on the maximum power consumption

The supply from the grid can be limited by limiting the load, but also with a storage system that takes over the peak load

The economic efficiency of a storage system depends on the respective load profile and the tariffs

In many cases, storage systems result in very short amortisation times



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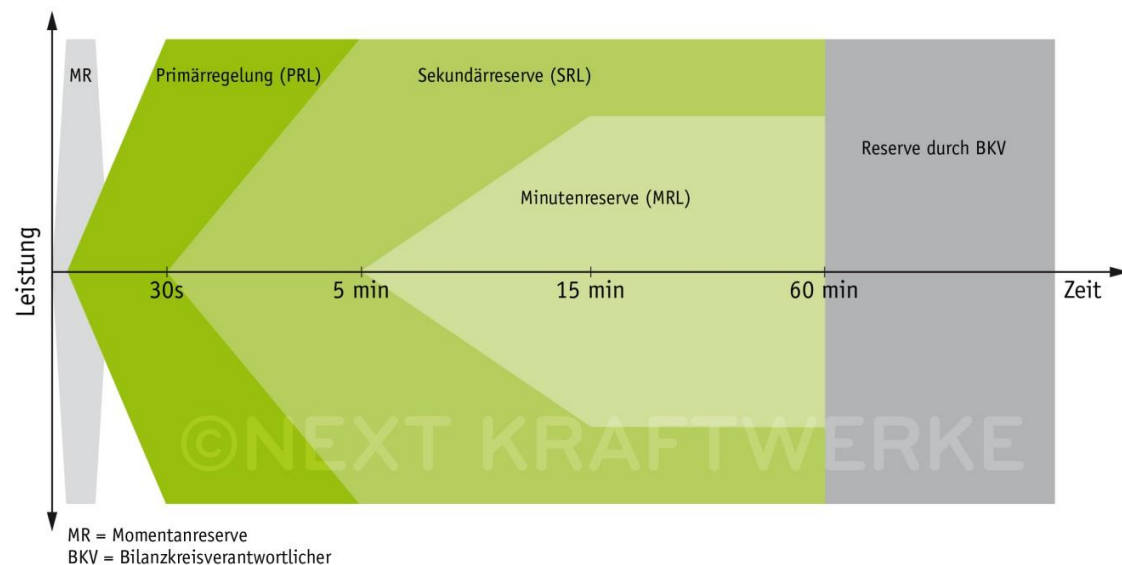
Balancing power

Compensates for fluctuations in the power grid as a reserve.

From 1 MW (single system/storage or "swarm") you can participate in the balancing energy market through "pre-qualification":

supply power for a fee if it is required in the public grid.

Draw power when there is a surplus in the public grid.



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Balancing power market

	(FCR Frequency Containment Reserves)	(aFRR automatic Frequency Restoration Reserves)	(mFRR manual Frequency Restoration Reserves)
minimum delivery time	15min (positiv/negativ)	4h (positiv and/or negativ)	4h (positiv and/or negativ)
minimum supply size	1MW	1MW (since 12.07.2018)	1MW (since 12.07.2018)
Minimum technical availability	100% of the total time	95% of the total time	100% des of the total time
Retrieval time	1-30Sek.	30Sek.-5min	15min
Activation	Frequency-controlled	Remote controlled	Remote controlled
time slices	6 four-hour blocks per day	Main (8-20Uhr) and Secondary time (0-8Uhr&20-24Uhr)	6 four-hour blocks per day
Tender period	Calendar daily	Calendar daily	Calendar daily
Compensation	Service price	Service and energy price	Service and energy price

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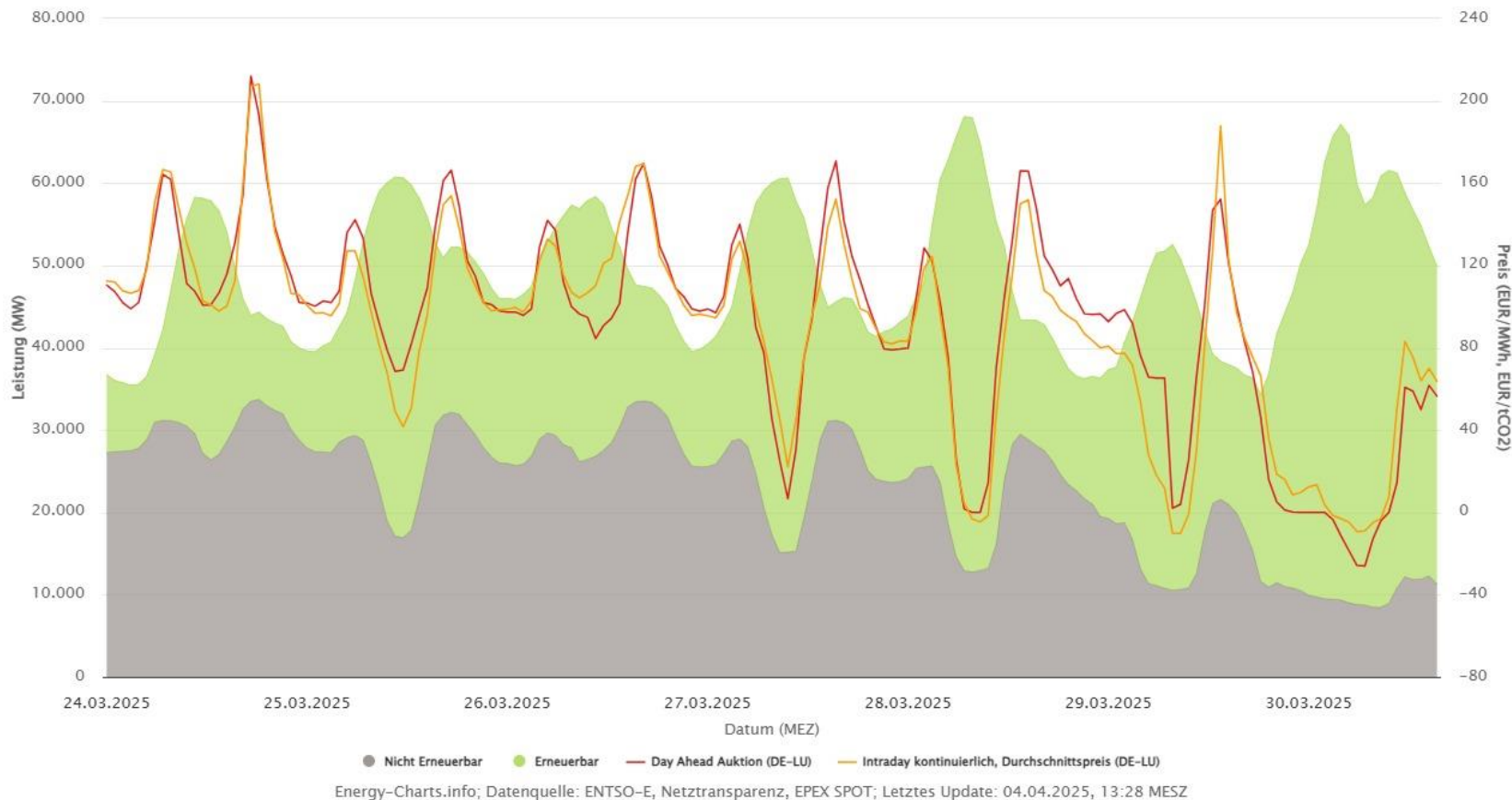
Arbitrage trading

General: the utilisation of price differences of a good in different marketplaces

The markets can be separated from each other in terms of time, space or subject matter

In the electricity market, storage facilities can be used to sell the electricity generated at a later date and achieve higher returns.

Stromproduktion und Börsenstrompreise in Deutschland in Woche 13 2025



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Innovation tender

Fostering the combination of PV+storage (or wind turbine+storage)

Investors state the required guaranteed tariff (Ct/kWh) in the bidding process

If the subsidised value is not reached when the electricity is sold, the difference is paid out

More security for investors thanks to fixed subsidy amount over 20 years

If the storage system can also be charged from the grid, better economic efficiency can be achieved than if only the self-generated PV electricity is remunerated

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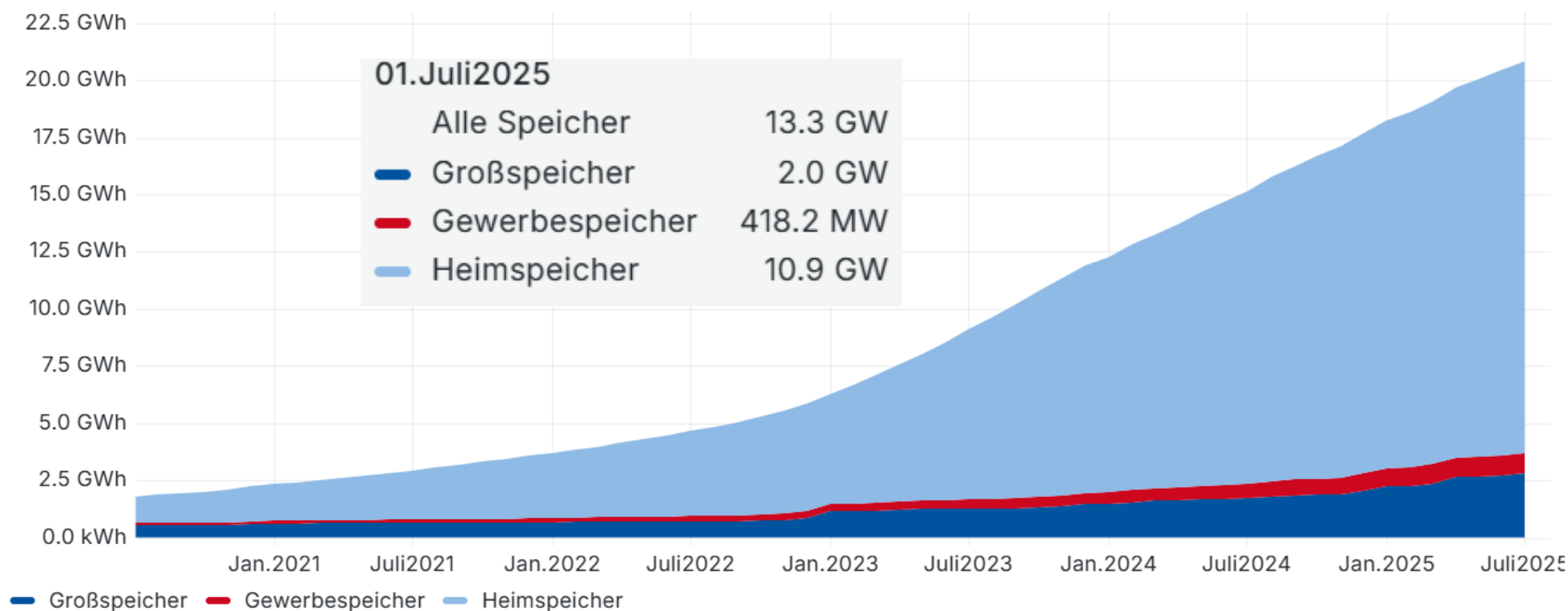


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Market development in Germany



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Grid connection of large storage systems

For a long time, only renewable energy and CHP plants had grid connection priority. This led to:

- Delays in storage expansion
- Increased costs and risks for investors due to planning uncertainty
- Cutting back on excess renewable energy instead of storing it
- Grid bottlenecks and, in some cases, grid instability

With the introduction of Section 17 (2a) EnWG, storage facilities have been treated equally with RE and CHP systems since 1 January 2024 and are no longer subordinate

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Flexible grid connection agreements

Previously: Output from PV + storage < grid connection point connection capacity

However, there is hardly any simultaneous feed-in, as electricity prices are low when renewable energy generation is high and the storage facility is being charged, while electricity is being discharged when electricity prices are high.

The grid connection point is more highly utilised with PV + storage. This reduces the required grid expansion and accelerates the transformation

§Section 8a of the EEG now allows for a flexible grid connection agreement, whereby the output of PV + storage can be above the grid connection capacity.

The system operator must ensure active power limitation, which can also vary over time after consultation with the grid operator

Rejection still possible, but network operator is now obliged to check and should only reject if this is necessary for technical reasons

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Construction cost share for grid connections

The grid operator requires the connecting customer to contribute to the costs of connecting to the grid and any necessary expansion of the grid.

The requested payments can be very high and have a major impact on the economic viability of storage projects.

The storage facility is only seen as a load; its potential grid serviceability is not taken into account.

However, grid serviceability reduces other costs for the grid operator. This gives them a double advantage at the expense of the investor.

Without construction cost share, or at least with a limit in the case of grid serviceability, this will provide investors with greater planning security. This will lead to more investment in storage systems.

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Grid stability through power regulation(EEG)

New PV systems may feed in a maximum of 60% of the generator's rated output (e.g. 6kW for 10kWp). The energy fed into the grid is remunerated. The feed-in tariff is specified in the EEG and applies for 20 years + the year of commissioning.

Once an intelligent metering system (iMSys) has been installed, only necessary power regulations are carried out. No remuneration is paid when electricity prices on the exchange are negative, but the remuneration period is extended. Reductions for other reasons receive substitute remuneration.

Instead of power regulation, feed-in power can be reduced by charging a storage unit. This encourages the installation of systems with grid serviceability through the installation of storage units, even in open spaces.

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Grid fees

Grid fees are part of the electricity price and cover the costs of the electricity grids. Due to the necessary grid expansion and modernisation, grid fees are rising

In order to encourage the installation of PV systems, no grid fee is charged for own-consumption, although a grid connection is still required.

Energy that is stored but later fed back into the grid is also excluded from grid fees.

If generation and storage are without grid serviceability, this increases the grid fees.

New rules are to be drawn up and implemented from 2029 onwards. Dynamic grid fees based on the current local grid situation could encourage serviceability.

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Grid stabilisation through load control

Section 14a of the Energy Industry Act (EnWG) calls for regulatory options for larger consumers

Since 1 January 2024, newly installed loads with a power consumption of 4.2kW or more must be controllable by the grid operator in critical grid situations (heat pumps, electric car charging systems, air conditioning systems, battery storage systems)

There is compensation in the form of reduced grid fees for mandatory participation

Existing plants can participate voluntarily to get the compensation as well

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Grid fee reduction for load control

Module 1: the customer receives a flat-rate, annual reduction in the grid charges, which ranges from around €110 to €190 depending on the grid operator/grid area. No separate metering technology is required for this.

Module 2: the labour price of the grid charge is reduced as a percentage, typically by around 60 %. This applies to every kWh drawn from the controlled load, which requires a separate meter for the load.

Module 3: can be selected in addition to Module 1 and enables the use of time-variable grid fees. A smart metering system is required. The high, standard and low load times vary depending on the grid operator.

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EU Battery Directive

regulates requirements in relation to

- regulations for the CO2 footprint
- Minimum percentage of recycled materials
- Performance and durability criteria (exclude bad cells from the market)
- Conformity assessment procedures
- Collection targets for spent batteries and recycling efficiency targets
- Removability and replaceability of batteries
- Safety and labelling
 - Handling and reuse of waste batteries
 - Due diligence obligations for the procurement of raw materials
 - Battery passport

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battery passport

Mandatory for batteries > 2kWh

Can be called up via QR code (also for smaller batteries, but less extensive information than in the battery passport)

Different information can be viewed depending on the user

Is deleted when the battery is recycled



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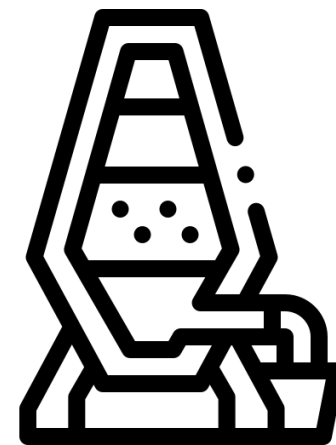
Pyrometallurgical Recycling

Up to now, mainly recovery of the metals contained (nickel, cobalt, copper) in pyrometallurgical processes (blast furnace)

Electrolytes and plastics are primarily used as fuel to generate process energy

Lithium remains bound in the slag and is used in the construction industry, for example

According to supplier Umicore, the blast furnace process is virtually energy self-sufficient



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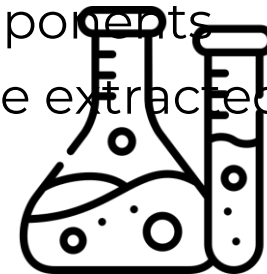
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Hydrometallurgical Recycling

Wet chemical process. More complex, but with higher recovery rates

- Manual dismantling of the housing
- Complete discharge of the modules and utilisation of the residual energy in the process
- Shredding of the modules in the shredder under a nitrogen atmosphere
- Electrolyte is vaporised from the shredded mass and recovered
- Residual granulate is sorted through sieves, magnets and eddy current filters
- Copper, aluminium and separator foil and grey powder remain as separate components
- in the hydrometallurgical process (acid bath), the components of the powder are extracted and separated
- Graphite, manganese, nickel, cobalt and lithium are recovered in high purity



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Summary

In the private (small-scale) storage sector, profitability is often not the main focus – nevertheless, subsidies create an additional incentive for acquisition and grid-friendly behavior.

Large-scale storage projects must be profitable for investors, which must be considered in regulations.

Grid connection costs should not make storage projects unprofitable and can help ensure that storage systems are installed where they can be well integrated.

The design of grid fees and feed-in tariffs should create financial incentives for the use of storage systems, allowing both grid and storage operators to benefit and reducing the need for grid expansion.

Combined PV + storage projects reduce the need for grid expansion and related costs.

The EU Battery Regulation conserves resources and reduces dependence on raw materials.

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¡Muchas gracias por su atención!

Udo Siegfriedt

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