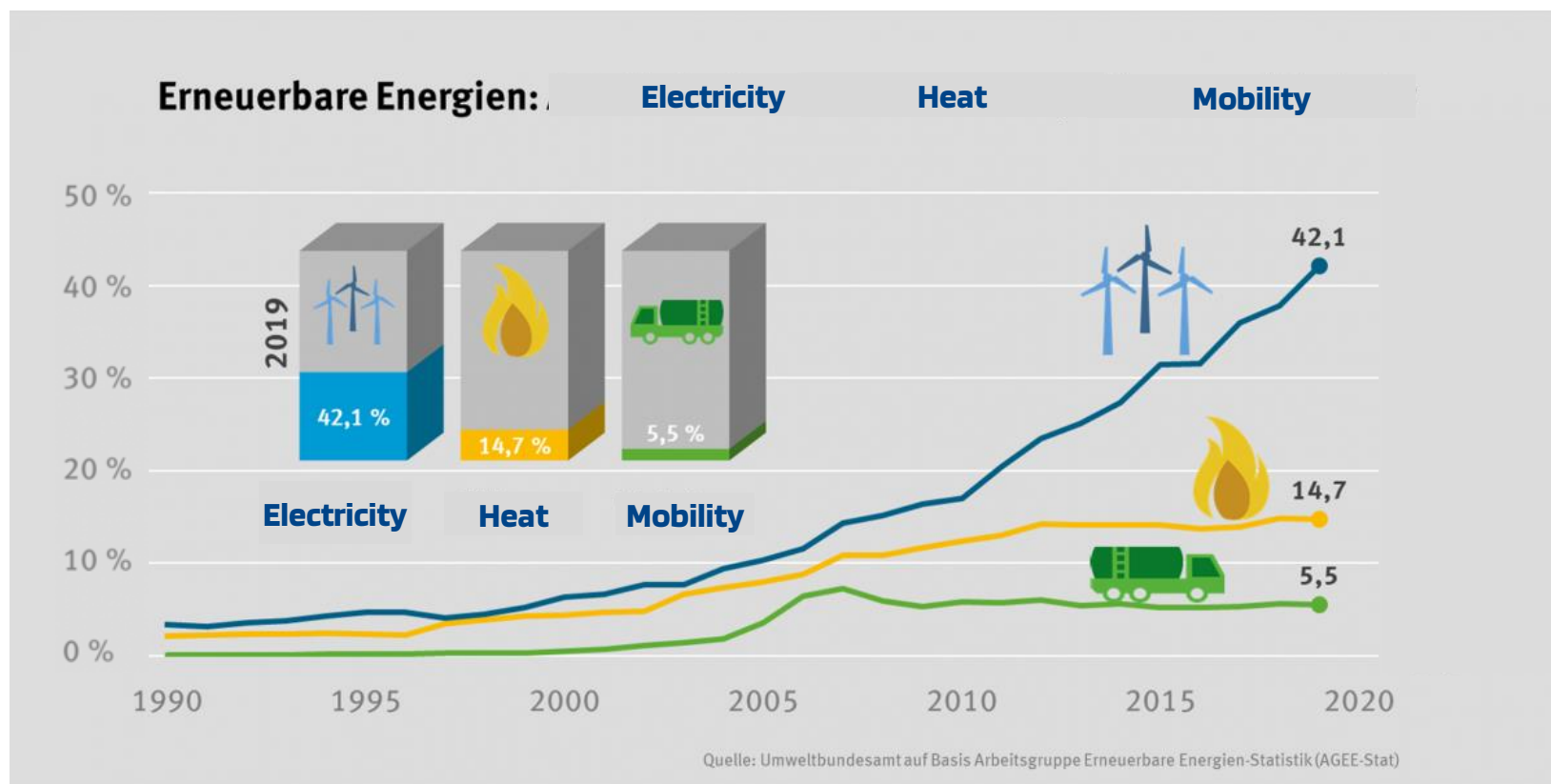


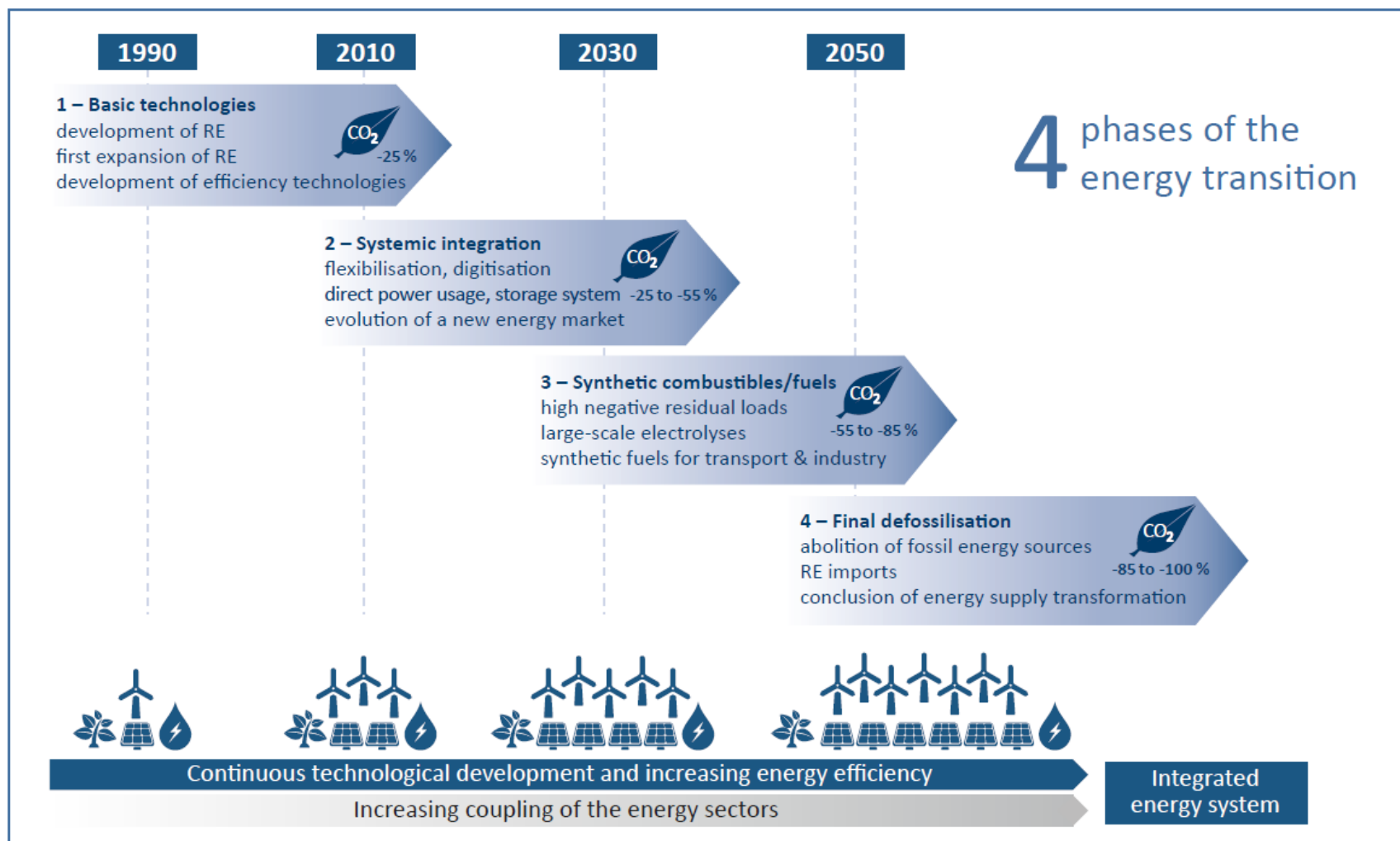
Energy storage systems as the key to the electricity, heat and mobility transition

Energy Storage System Solutions

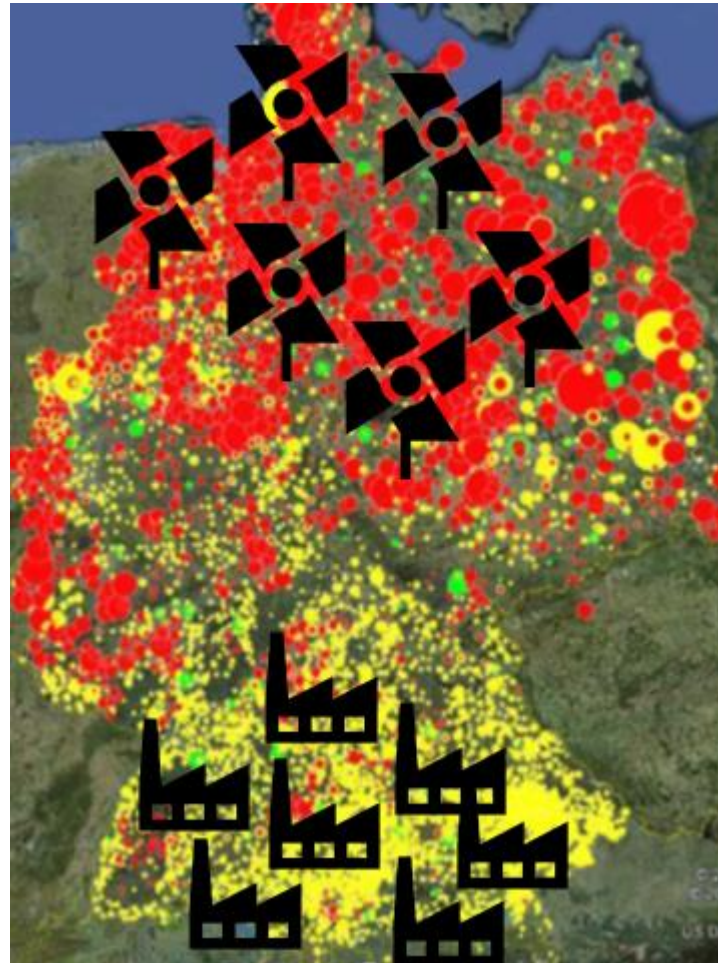
On the way to 100% renewables.



Energiewende: STEP BY STEP

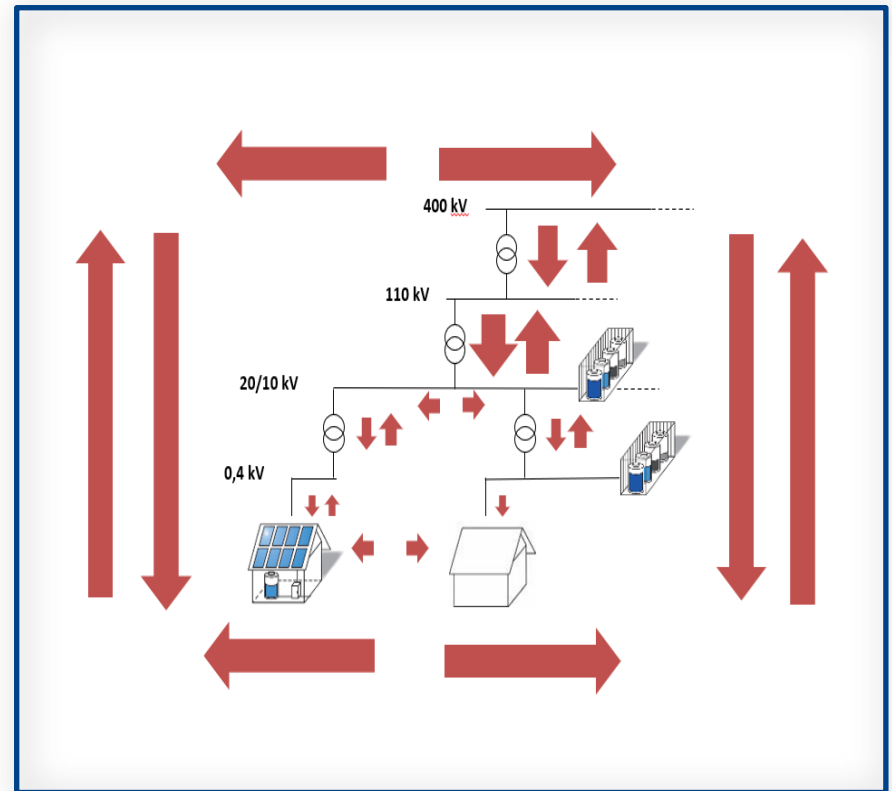
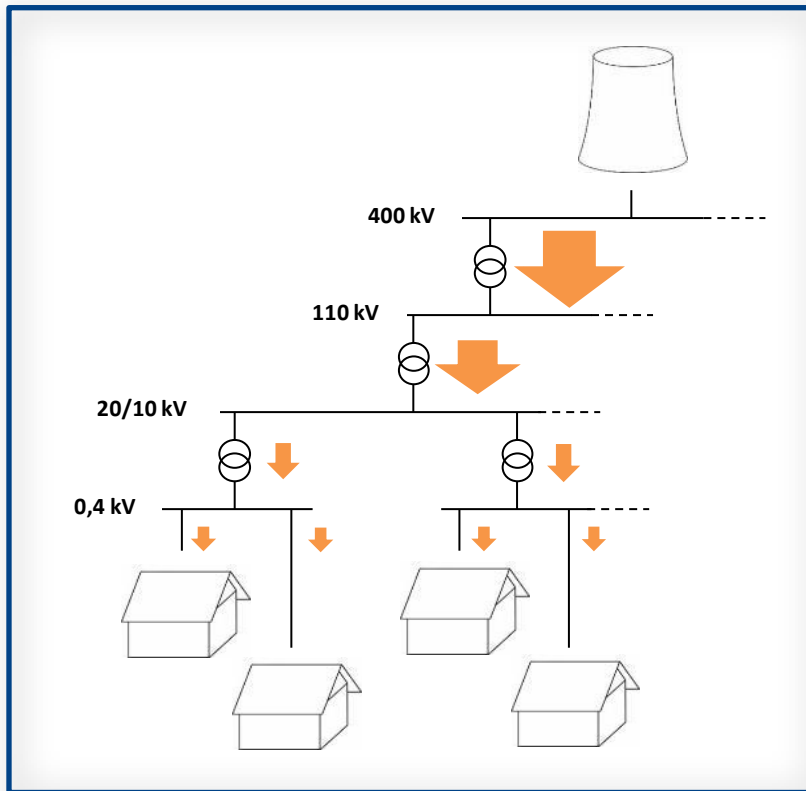


Energy Transition: Effect No. 01 = Decentralization



Energy Transition: Effect No. 02

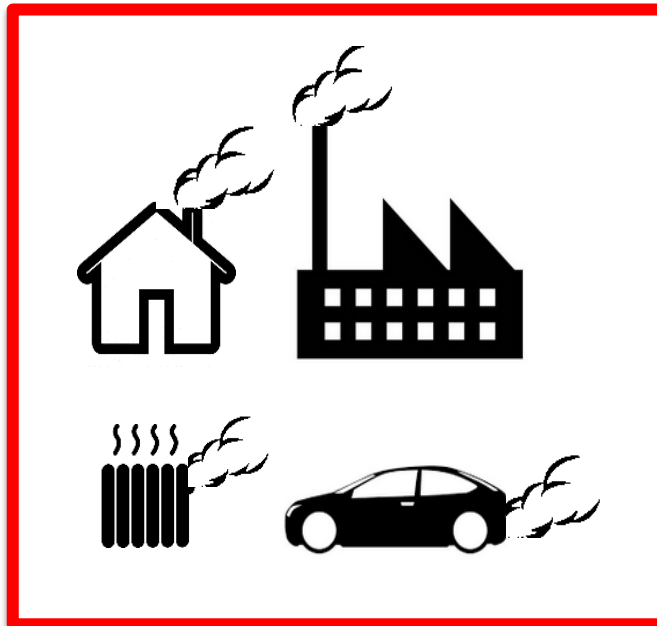
= New structure, new tasks, new issues



Energy Transition: Effect No. 03

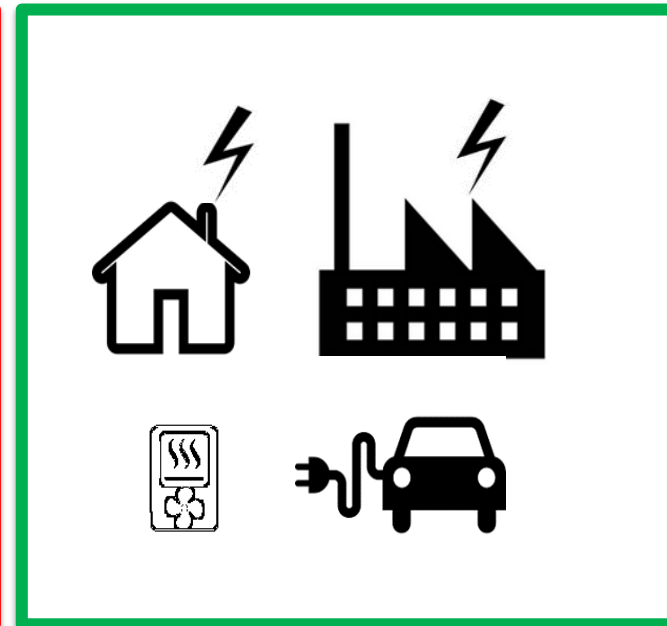
= Power is the new currency

FOSSIL AGE



Energy is always available
and it is sufficient.

ELECTRIFICATION WAVE



Power is needed.



SCHNELLE
SPEICHER
STATT LANGER
LEITUNG.

„The 3 D's“ =

- **Decarbonization**
- **Decentralization**
- **Digitalization**

Local availability



Temporary availability

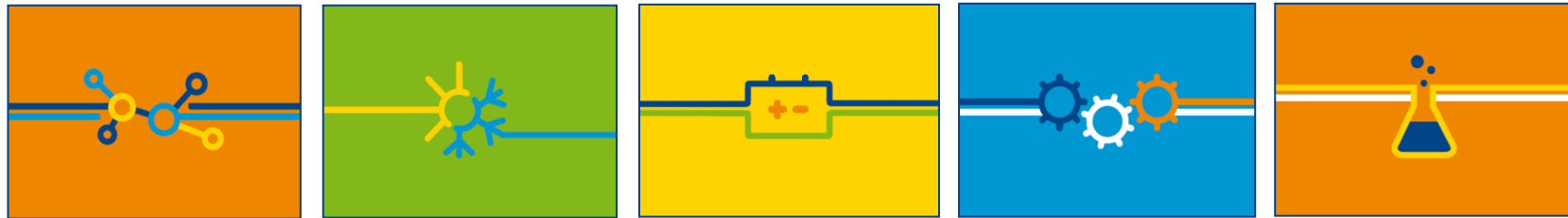
- Renewable Energies can be generated ANYWHERE.
- But not ANYTIME.
- ANYTIME Availability: ONLY with storage.

No electricity, no power, no heat during night



STORAGE TECHNOLOGIES AND APPLICATIONS

A basket full of technologies...



WÄRME/KÄLTE ZU WÄRME/KÄLTE
(THERMISCHE ENERGIESPEICHER)

Sensibel

Wasser (FactSheet»)
Salzschmelze und andere Flüssigkeiten (FactSheet»)
Feststoffe (FactSheet in Arbeit)

Latent

fest-flüssig Niedertemperatur (FactSheet»)
fest-flüssig Hochtemperatur (FactSheet»)

Thermochemisch

Sorption (FactSheet»)
Chemische Reaktion (FactSheet»)



SPEICHERTECHNOLOGIEN STECKBRIEF
Li-Ionen Stromspeicher

ALLGEMEINE BESCHREIBUNG:
Form der Energieaufnahme und -abgabe: Strom zu Strom
Kurzbeschreibung des Speicherprozesses: Stromspeicher dienen zur Speicherung von Strom zu einem späteren Zeitpunkt zu nutzen.



Abb. 1: Schematischer Aufbau einer Lithium-Ionen-Zelle¹

Die Kathode besteht überwiegend aus Aluminiumträger, häufige Mangan- oder Nickel-Lithium-Kobalt-oxiden (NMC) oder Nickel-Mangan-Kobalt-oxiden (NMC) aber auch LFP (Eisenphosphat) oder NCA (Nickel-Cadmium-Äquivalent) Kupferträger (alternativ: Aluminiumträger) sind z.B. Graphit. Die Kathode sind durch einen Separator mit der Anode verbunden. Der Separator hat einen wesentlichen Einfluss auf die Lebensdauer und die Kapazität der Zelle wie Spannung (V), Kapazität (Ah) und Temperaturabhängigkeiten.

Beim Laden gibt die Kathode (Pluspol) eingelagerte Lithium-Ionen in den Elektrolyten ab. Die Lithium-Ionen (Li+) wandern zur Anode (Minuspole), werden dort eingelagert und auf der Anode (Minuspol) wieder in den Elektrolyten abgegeben. Dieser Einlagerungs- und Entladungsvorgang (Interkalation/Deinterkalation) (Konversion, z.B. bei Blei-Säure, NiCd), der den hohen Wirkungsgrad des Stromspeichers ermöglicht.

Der Anschluss des Stromspeichers im Wechselstromkreis, also nach dem Wechselrichter, ist in diesem Fall und der Solarstrom an die Verbraucher abgebet und ein eventueller Überschuss in den Speicher und/oder das öffentliche Stromnetz eingespeist. Die entsprechende Leitung der Ströme erfolgt über eine Steuerungseinheit. Stromspeicher können an eine Vielzahl von Generatoren angeschlossen werden: Wind, Diesel, BHKW, PV, Wasser oder auch zur Sicherung der Netzstabilität in das öffentliche Netz eingebunden werden.

¹ Quelle: Fraunhofer IZT Technologie ² Erklärung Anode und Kathode siehe Glossar.

BVES | Januar 2016

STROM ZU STROM
(STROMSPEICHER)

Elektrochemisch

Vanadium Redox Flow Batterie (FactSheet»)
Hochtemperatur Batterie (FactSheet»)
Hochtemperatur Batterie (FactSheet»)

STROM ZU GAS/FLÜSSIGKEIT
(CHEMISCHER ENERGIESPEICHER)

Wasserstoff

Power to Gas (FactSheet»)

Synthetisches Methan/ Methanol

Power to Gas (FactSheet»)

Chemische Energiespeicher

Kondensatoren

www.bves.de

Storage of Electricity

- Storage of electrical energy



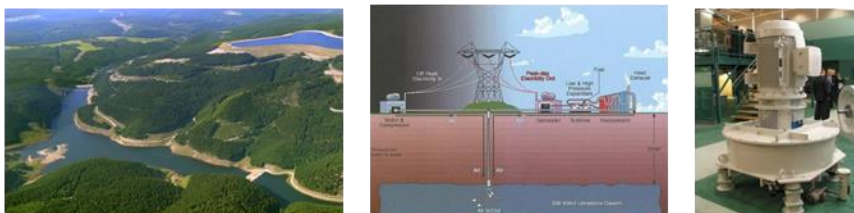
- Super-conducting Magnetic Energy Storage (SMES)
- Super-capacitor

- Electrochemical storage of electricity



- Sodium-Sulphur batteries (NaS-Cells)
- Lead acid batteries
- Redox-Flow batteries

- Mechanical storage of electricity



- Hydro pump storage
- Compressed-air storage (CAES)
- Fly wheel

Thermal Energy Storage

- Storage of sensible heat



- Hot-water accumulator
- Underground Thermal Energy Storage (UTES)

- Storage of latent heat



- Phase change material (PCM) PCM-device
- Slurries

- Thermochemical storage



- Adsorption-(zeolite) and Absorption-storage (LiCl)
- Thermochemical materials (TCM)

Three horizontal bars in yellow, green, and blue.

Chemical Energy Storage

Production of hydrogen and storing of hydrogen.

- Hydrogen is the energy-richest power fuel (in relation to its inertia)
- Lossless long-time storage
- Production of electricity with fuel cell / H₂-turbine

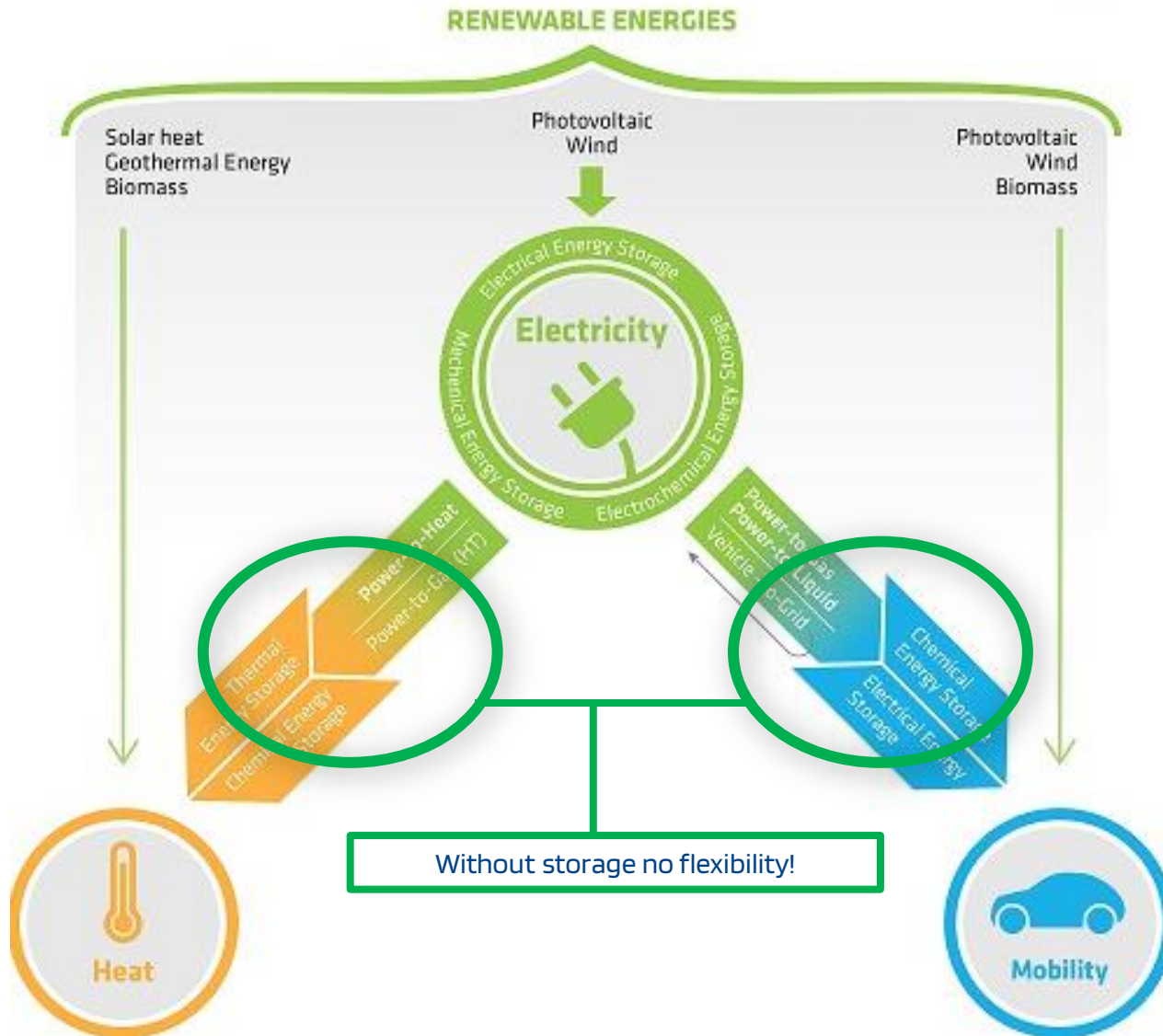


[illegible]

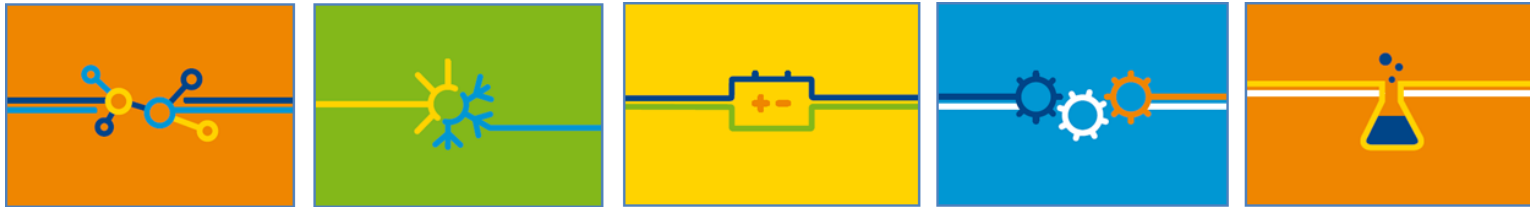
Multi Tool Energy Storage



Flexibel Sector Coupling



THE APPLICATION DETERMINES THE STORAGE



- The technical and economic requirements for a storage device are determined by the exact use of the storage in the supply system.
- The application specifies technical requirements (form of energy, power, storage capacity, response time).
- The application also defines the economic environment (e.g. which energy prices can be set, depth of use, etc.).

What is the value of storage?

From Benefit to Business Case

What is the benefit of energy storage?
What is the value of energy storage?
Who would pay for it?

Benefit



Value



Business Case

Availability of
energy
and power (in many
applications by
many technologies)

How much would
somebody pay for
the benefit?

Who would pay for
the benefit?

Diversity of Benefits

**From availability of energy and power
we can derive the following services:**

- **Flexibility – grid services, integration of renewables, ...**
- **Reliability / Security – uninterruptable power supply, ...**
- **Mobility – electric vehicles, mobile phones, ...**
- **Autarky – island solutions, self sufficiency, ...**
- **...**

**What is the value of storage?
What are you willing to pay?**

What is the value of storage?



Examples:



≈ 10.000 €/kWh

Mobile Phones

to have no free time at all!

Hot Water Tank

to fill up your bath tub fast!



≈ 1 €/kWh

E-Mobility

for the possibility of a CO₂-free transportation



© Leipzig



≈ 500 €/kWh

What is the value of storage?

Examples:

Grid Services

for fast and exact response on fluctuations!



Competitive Production by improving energy efficiency in industry!



→ ≈ 100 €/kWh

Integration of Renewable Energies

by increasing self consumption !



→ ≈ 250 €/kWh

Main Message:

Always think **Energy Storage** within real applications!

...only then we can quantify the value of **Energy Storage**

Overview – Energy Storage in the Energy Transition (Part 2)

Basics:

Current Markets for Storage

**Use Cases – Trends – New Business Models – New
Players**

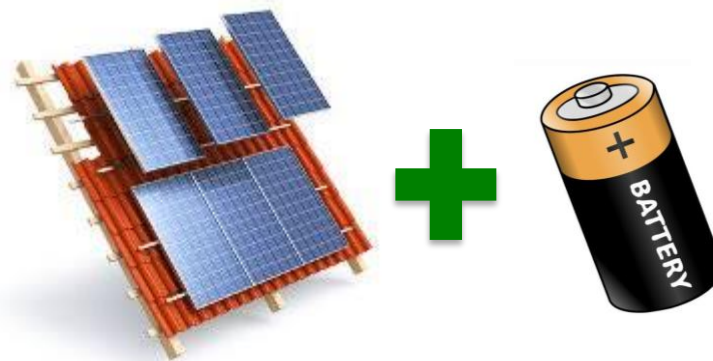
Regulatory Framework



Residential Storage Market



Self consumption ~ 35 %

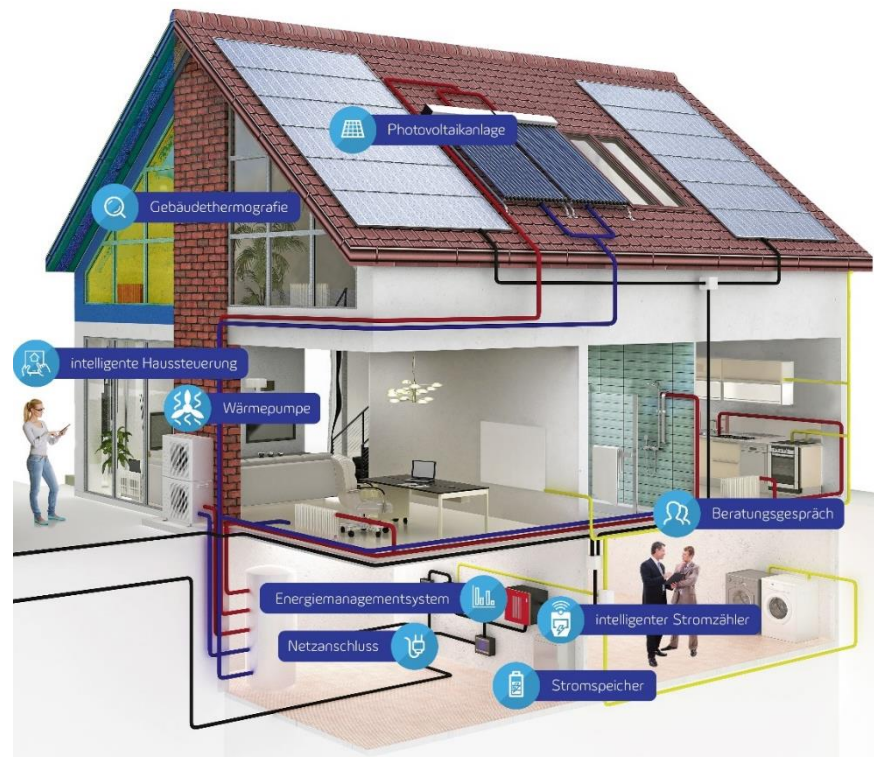


Self consumption ~ 70 %

Own generation and consumption Electricity (+ Heat)

Decentralized:

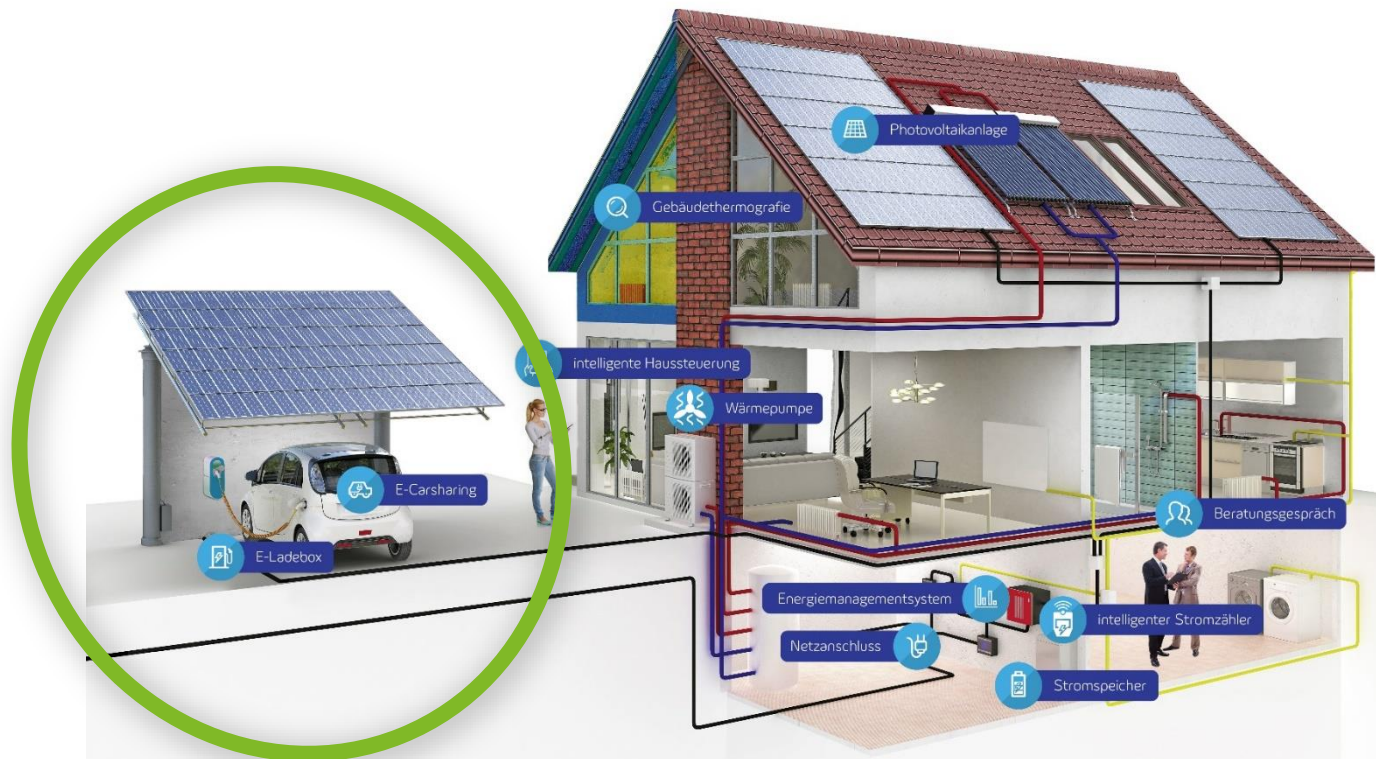
- Ca. 350.000 Storage Systems installed.
- Ca. 2.000.000 Rooftop-PV.
- New installations mostly incl. Heatpump
- Huge retrofit potential



Quelle: enviam

Trend: Electricity + Heat + Mobility

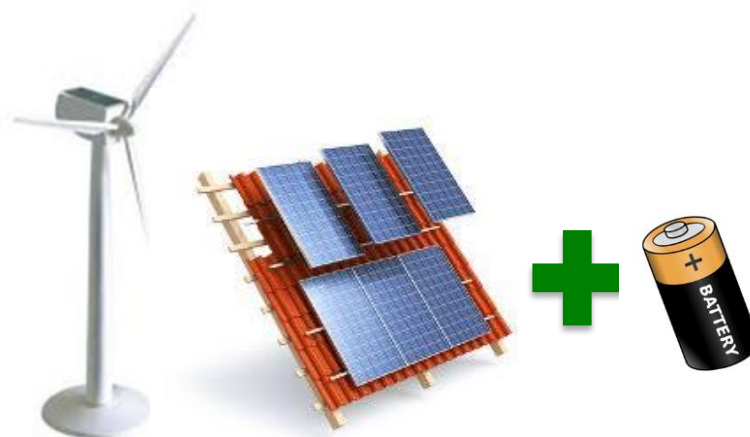
Carefree package for all enery needs.



Industrial Storage Market



Self consumption



Self consumption

+ UPS + PLS + Backup Power + no Diesel

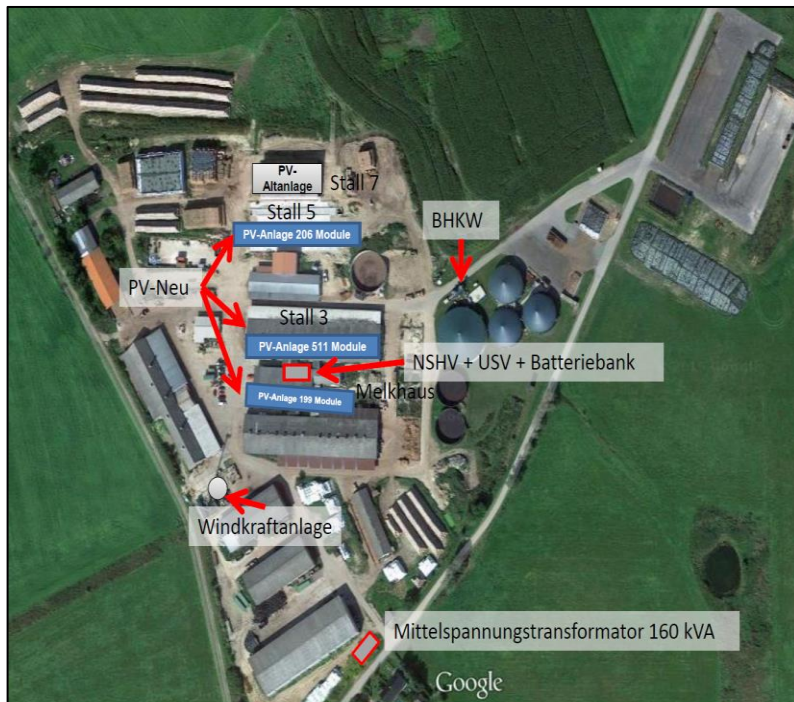
Electricity, Power, Heating, Cooling + Mobility

Industry: ca. 1600 Projects in Germany



Multi-Use in Agriculture:

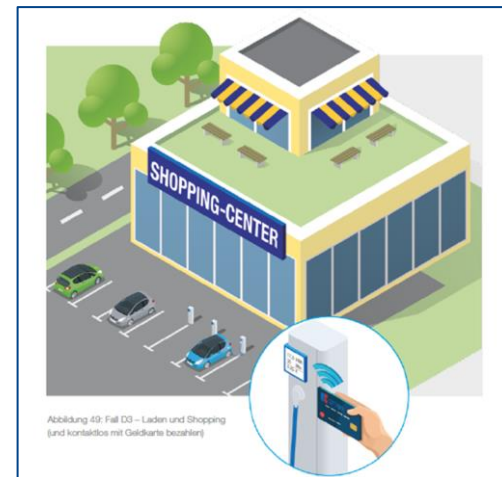
PV + wind + biogas plant + Li-ion battery + heat storage = 100 % autarchy



Reduction of energy costs: 0,3 € cent/liter

Game Changer: E-Mobility

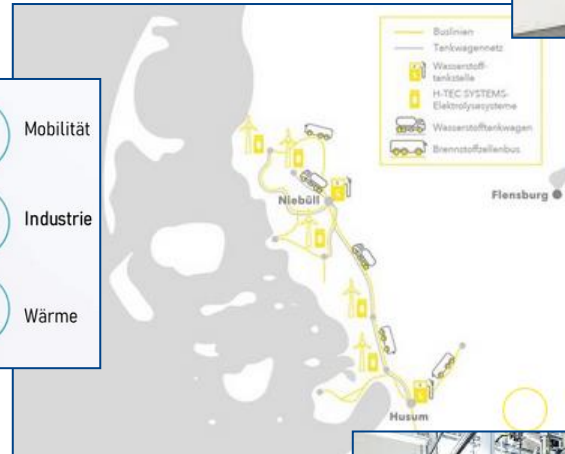
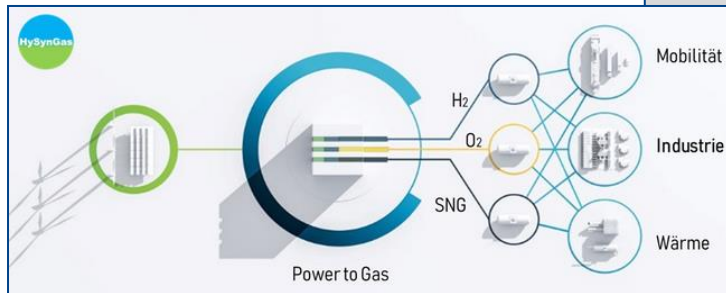
NEW + Additional application: FAST CHARGING INFRASTRUCTURE



Battery Storage Systems for Mobility Infrastructure

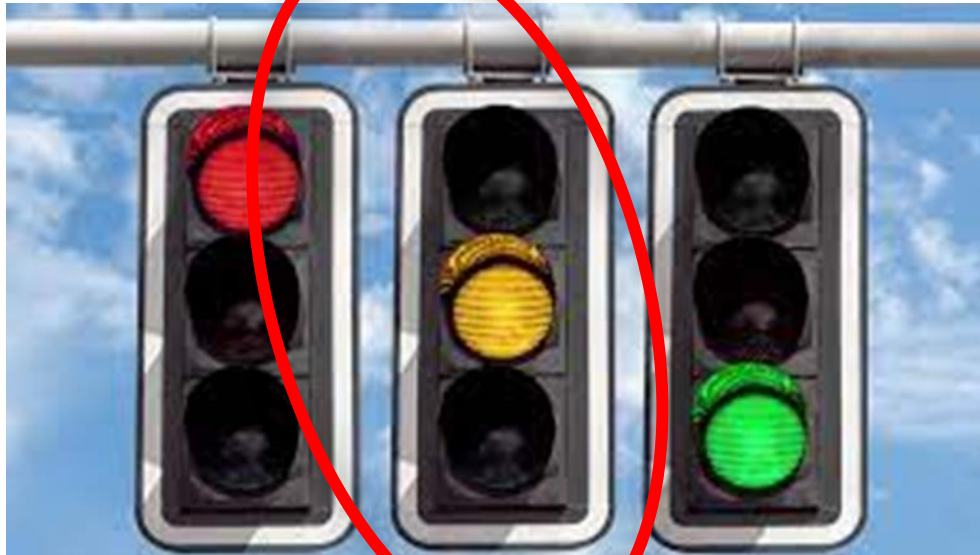


Hydrogen - how much is available ? A way to go within the EU

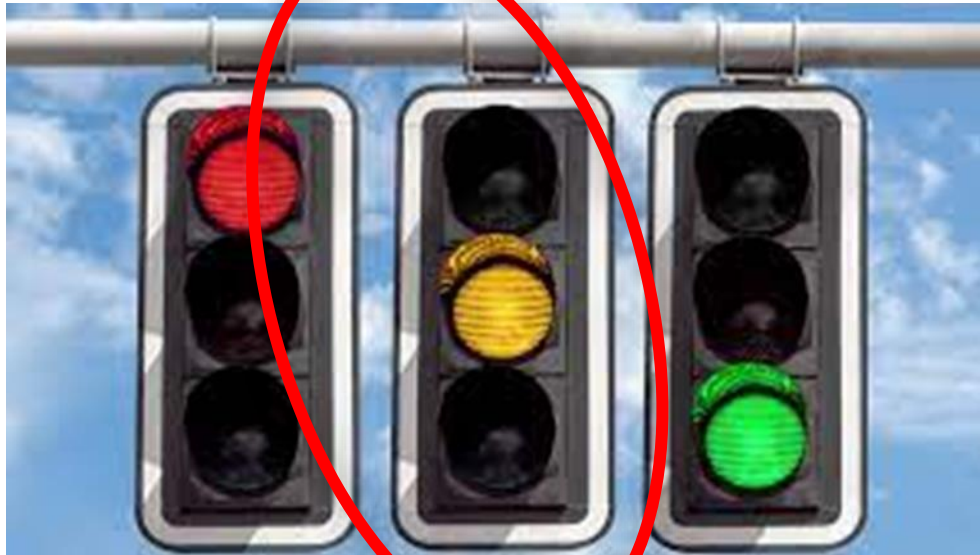



Legal Framework

Technologies are Ready, but...



Technologies are Ready, but...



Three horizontal bars in yellow, green, and blue on the left side of the slide.

Technologies are Ready, but the German energy law defines storage as generation of energy as well as last use of energy.

This means additional political costs in terms of fees and levies

“energy storage” means, in the electricity system, deferring the final use of electricity to a moment later than when it was generated, or the conversion of electrical energy into a form of energy which can be stored, the storing of such energy, and the subsequent reconversion of such energy into electrical energy or use as another energy carrier

Article 2 (59), Electricity Market Design Directive, 2019/944

A row of light bulbs is shown against a dark grey background. One bulb in the center is illuminated, while the others are dark. The bulbs are arranged in a slightly curved line, receding into the distance.

RED II & Storage Systems

Article 20a Facilitating system integration of renewable electricity

(...)

4. Member States shall ensure that the **national regulatory framework** does **not discriminate against participation in the electricity markets, including congestion management and the provision of flexibility and balancing services, of small or mobile systems such as domestic batteries and electric vehicles**, both directly and through **aggregation**. (Page 36)

Three horizontal bars in yellow, green, and blue, stacked vertically.

The EU is moving forward!

EU Market Design Directive (EBM-RL)

- Energy storage as an essential element for flexibility and stability in the energy system.
- Suitable Definition of energy storage: Storage as a **time shift of energy**.
- Opening up the energy markets for the active customer (Prosumer).

Three horizontal bars in yellow, green, and blue.

Contact:

Markus Rosenthal

Head of Policy

T: +49 – 30 – 54610632

E: m.rosenthal@bves.de

Follow us:

@BVESeV:



www.bves.de