Helmholtz platform for the design of robust energy systems and their supply chains – RESUR

The energy system of the future will be dominated by renewable energies. A faster and better transformation towards climate neutrality signifies an increased independence from fossil fuel imports.

The complexity of this transformation imposes great challenges. We provide (co-)simulations and analyses that allow energy suppliers and decision makers to examine complex interrelations in advance, such as "Re-bundling". "Re-bundling" is a combined view of energy generation and energy grids of different operators and on different network levels coupled with a view of the growing interconnection of the electricity and gas network. The focus of RESUR is placed on the short-term proactive and reactive supply of decision-making tools, mostly regarding current events. The goal is to operate RESUR for the long term and to adapt its model toolbox to new challenges by staying in constant dialog with policymakers and industry partners.

Goals

- Bottom-up models for the electricity and gas sector to evaluate the security of supply and robustness of the transport networks.
- Models and tools for a co-simulation of heat, electricity and gas.
- Supply of a meta database and toolbox for the analysis and evaluation of possible actions in economy, society, and politics in the wake of disruptive events on the energy and commodity markets.

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Involved centers: Karlsruhe Institute of Technology (KIT)
Forschungszentrum Jülich (FZJ)
German Aerospace Center (DLR) – associated

Supply security by flexibly and sustainably closing the resource cycles

German and European industries are dependent on imports for many material resources. The transition to renewable energies increases this dependence and the overall energy demand because renewable energies require considerably more resources than fossil energies. To change this, local resources need to be tapped and the energy demand for the resource supply needs to be decreased and made more flexible. This is where we present a solution with our development of new recycling methods. To recover resources needs significantly less energy than their primary production. The biggest challenge consists in the complexity and variability of the sources. Many different resources occur combined into ever-changing structures, from which they can only be recovered with adaptive processes that adjust to the different sources. An energy-efficient recovery requires an efficient mechanical pre-separation of the material flows. At the same time, partially separated material flows need to be recovered for recycling. Our goal is to develop new recycling technologies in the next 2 – 3 years that will contribute to sustainably closing the resource cycles.

Goals

- Continued development of the processing technology to improve product purity, system flow rates, and flexibility.
- Construction of two pilot-scale demonstration systems.
- Application of a multi-phase measuring technique to characterize material flows.
- Development of an active load management to increase system flexibility.

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Involved centers: Helmholtz-Zentrum Dresden-Rossendorf (HZDR)
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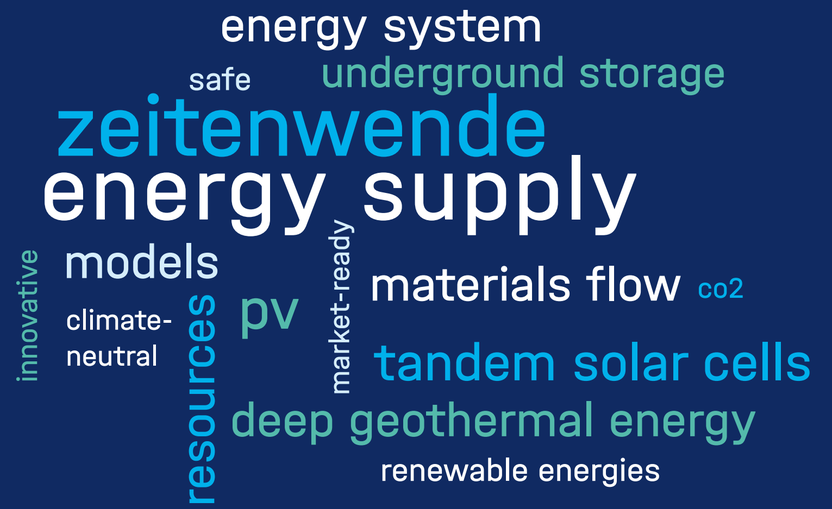
As of March 2023

HELMHOLTZ Energy

Our contribution to Zeitenwende Security of energy supply



The Research Field Energy of the Helmholtz Association

An epochal change for energy supply security

Helmholtz Energy's contribution to increased supply security

The Russian war of aggression against Ukraine exposes how Germany's energy supply strongly depends on the imports of fossil energy sources like gas, oil, and coal. The disruptive geopolitical changes are challenging society to rapidly push for more sovereignty in the fields of energy and resource supply – and to not lose sight of the goal of climate neutrality. Therefore, the German Federal Government is convinced:

> "The most important key to energy sovereignty is the expansion of renewable energies. It is a question of national and European security."
>
> – "Strengthening the security of supply – reducing dependences", BMWK

The expansion of renewable energies as the major factor for the energy transition makes us more independent from fossil fuel suppliers. This reduces an essential geopolitical threat to the energy supply in the long term. At the same time, there are technological and scientific challenges that need to be addressed to ensure supply security also during the reorganization of our energy system.

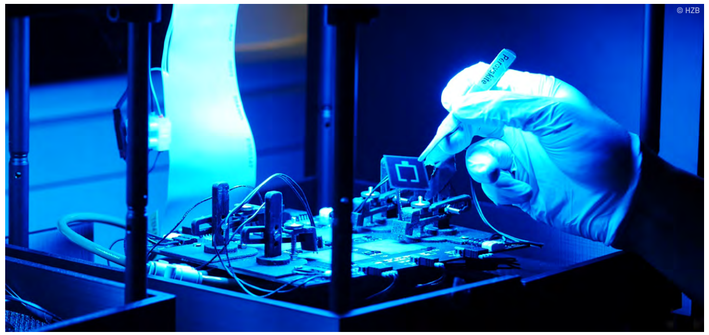
In this matter, Helmholtz Energy takes on social responsibility: Together with our partners from politics and economy, we focus on accelerating central research activities to contribute to our resource security with a quick transfer of key technologies and know-how. As a direct reaction to the Russian war of aggression, Helmholtz Energy developed four initiatives. They are financed as a contribution to the epochal change with a total of 25 million euros from unallocated pact for research and innovation funds. In the course of 3 – 5 years, the initiatives accelerate the development of technologies until their market maturity.

An overview of our four initiatives:

- Accelerated transfer of the next generation of solar cells to mass production
- Geotechnologies for an epochal change in Germany's energy supply
- Helmholtz platform for the design of robust energy systems and their supply chains
- Supply security by flexibly and sustainably closing the resource cycles

Accelerated transfer of the next generation of solar cells to mass production

Cutting-edge technology tandem solar cells



We need a massive expansion of photovoltaics and wind energy to form the basis of a climate-neutral circular economy. These two renewable energy sources have the highest potential of implementation and the lowest cost level globally as well as in Europe and Germany. The necessary expansion of solar energy can only succeed with a new generation of photovoltaics: We are counting on an innovative tandem technology that combines the new class of metal halide perovskites and the mature silicon. Featuring an efficiency of over 30 percent, high stability, and a competitive environmental and cost profile, this combination is much more efficient and cost effective than the PV technology currently dominating the market. This innovative tandem technology has to be developed with an accelerated approach to reach market maturity within the next five years.

Goals

- Adjustment of existing silicon solar cell processes for an optimal and effective tandem integration.
- Development of industrially scalable separation processes for highly efficient and large-scale perovskite-silicon tandem solar cells.
- Analysis of the stability of large-scale tandem solar cells.
- Expansion of the analytics for a better and accelerated understanding of solar cell properties.
- Development of tandem solar cells with better circular recycling properties.

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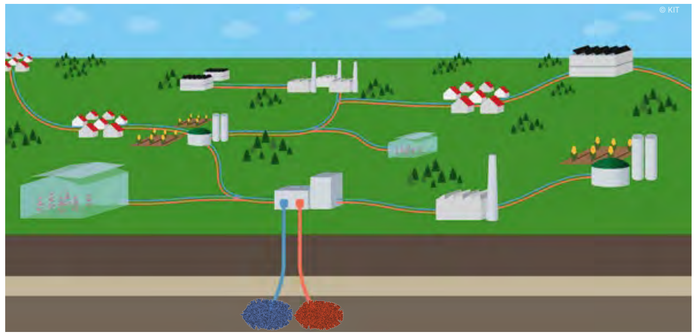
Involved centers: Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)
Forschungszentrum Jülich (FZJ)
Karlsruhe Institute of Technology (KIT)

Geotechnologies for an epochal change in Germany's energy supply – GEOZeit

Energy and material storages in the deep underground



The deep underground has enormous potential for the decarbonization of the heat supply and the increasing demand for energy storages. To use this potential, we are developing solutions for an environmentally sound utilization of deep geothermal energy as well as geo-based energy and material storage. To this end, the expansion of geological pore storages for heat and energy-related gases in the TWh range and a market penetration of geothermal technologies are necessary steps. With the help of our DeepStor heat test facility and the conversion of the Ketzin pilot site for hydrogen storage, we are developing new storage technologies to sustainably utilize depleted hydrocarbon storages. Joining environmental and energetic aspects in a new virtual Helmholtz National Laboratory for Geoenergy, we present an integrated approach for a short-term solution to the current energy storage question. In the following 2–3 years, these goals are targeted:

Goals

- Validation of technical feasibility of storage technologies in depleted hydrocarbon storages with the research infrastructure DeepStor at KIT.
- Evaluation and guarantee of stable reservoir properties in preparation of an H_2-demonstrator in a saline aquifer to enable the implementation of cyclical and safe loading and unloading operations.
- Development of geo-based solutions for hydrothermal aquifers to cover base and intermediate loads.
- Upscaling of underground storage technology to an industrial scale.
- Development of solutions in co-design and with a citizen science project.

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Involved centers: Karlsruhe Institute of Technology (KIT)
Helmholtz Centre Potsdam – German Research Centre for Geosciences (GFZ)