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energy innovation austria

Current developments and examples of sustainable energy technologies

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Federal Ministry
Republic of Austria
Climate Action, Environment, Energy, Mobility, Innovation and Technology

Energy storage systems

Key technologies for the energy transition

Efficient and reliable energy storage systems are central building blocks for an integrated energy system based 100% on renewable energy sources. Innovative storage technologies and new fields of application for the use of energy storage systems are being researched and demonstrated in practical operations as part of national and international research and development activities.

ABS4TSO battery storage unit interior, project "ABS for the power grid", Photo: APG/Gerhard Wasserbauer

Photo: stock.adobe.com

Innovative storage technologies

Building blocks for the energy system of the future

The switch to an energy supply with 100% renewable energy sources poses major technical and organisational challenges to our energy system. To be able to guarantee the safe and efficient provision of electricity and heat in the future, new approaches in energy distribution and storage with greater flexibility in energy requirements are needed.

Electrical, thermal and chemical storage systems are key technologies for an energy system based on decentralised energy supplies from fluctuating sources, such as wind and solar power. In order to achieve the ambitious goal of "climate neutrality by 2040" in Austria, an integrated energy system must be created in which energy storage systems take on central functions. Storage systems can compensate for fluctuations between energy generation and consumption, provide flexibility for the grids and therefore contribute to system stability, security and quality of supply. Innovative storage technologies will play an increasingly important role for the electricity and heating markets as well as in mobility and industry in the future and also represent a central building block for interconnection between these sectors.

Numerous new storage technologies and their fields of application are being researched, further developed and demonstrated in practice at national and international levels. There is both a technical and an economic need for innovations. Amongst other aspects, research and development is geared towards reducing investment costs, extending service lives, increasing efficiency and improving safety for storage systems as well as giving these a compact design. In addition, suitable business models and legal frameworks must be developed. In this issue, we present some national research projects as well as the international research cooperation within the framework of the technology programmes of the International Energy Agency (IEA), which cover a broad range of topics from battery development to large-scale heat accumulators and sector coupling.

High-pressure heat storage facility, district heating Vienna, Photo; Wien Energie/Ian Ehm

STORING ELECTRICITY AND HEAT OVER THE SHORT OR LONG TERM

A distinction in energy storage is made between the storage principle as well as short-term and long-term storage. Electrical energy can be stored mechanically (e.g. pumped storage, compressed air storage), electrochemically (classic battery), chemically (e.g. conversion of electricity into hydrogen/methane), electrically (magnetic storage) and also thermally. Heat/cold storage systems can be differentiated by storage process and storage media (e.g. sensitive heat accumulators, latent heat accumulators, thermochemical accumulators). Sector coupling technologies are of particular interest for long-term energy storage aimed at balancing out energy generation and consumption. This integration involves the linking of different energy sectors, such as the electricity sector with the gas and heat sector through the conversion and storage of energy (e.g. power-to-heat, power-to-gas). This increases flexibility in the energy system and enables the integration of renewable energy sources.

POTENTIALS AND MEASURES FOR THE INTEGRATION OF ENERGY STORAGE SYSTEMS

The Climate and Energy Fund launched the "Storage System Initiative" as early as 2015, aimed at collecting substantial information on storage technologies and their potential areas of application in the energy system and making these available to potential market participants. Following discussions with numerous national and international experts, the project team looked at the entire innovation chain from research to market. Austria has already gained major technological expertise in the field of electricity and heat storage. Numerous Austrian companies (including mechanical engineering, assembling and engineering as well as research and development) are already working on solutions for energy storage. The further development and practical testing of storage technologies should be accelerated in the next few years in order to open up new areas of application, such as high-temperature, seasonal storage, modular pumped storage and hydrogen/methane.

In the second phase of the storage system initiative, 10 specific targets for the use of energy storage systems in Austria for the year 2030 were developed together with national experts and stakeholders before being evaluated within the framework of an international resonance group and in close consultation with representatives of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). Finally, as part of an online consultation, the targets developed were evaluated, among other things, with regard to potential and the need for support, and implementation measures were derived to reduce any hurdles.

These include improving the legal framework, ensuring data availability and interoperability, developing new business models, implementing pilot and demonstration projects, suitable planning tools and appropriate education and training programmes. ●

www.speicherinitiative.at

TARGET SCENARIOS FOR THE USE OF ENERGY STORAGE SYSTEMS IN AUSTRIA 2030

(ranked by potential in descending order)

- Direct and indirect use of electricity and heat accumulators by energy suppliers in order to optimise the overall system
- Use of battery storage systems for peak load reduction in industries
- Seasonal electricity storage through power-to-gas plants
- Seasonal heat accumulators with underground storage systems, geothermal probe fields (often in combination with heat pumps) or alternative concepts (e.g. thermochemical storage)
- Use of private electricity and heat accumulators that are useful for the grid and the system (power-to-heat)
- Joint use of (central) electricity storage systems in energy communities
- Heat accumulators for waste heat utilisation in industrial and commercial enterprises
- Use of electric vehicle batteries for local grid stabilisation
- Local electricity storage systems as resources useful to the grid and system for grid operators
- Electricity storage systems in energy communities as a virtual power plant or virtual storage system






Photos above: RAG/Steve Haider, stock.adobe.com
Photos centre: Energie Steiermark/Symbol, stock.adobe.com
Photos below: Climate and Energy Fund/Astrid Bartl

ENERGY STORAGE

Technology Programme of the International Energy Agency IEA

The issue of energy storage systems also plays an important role in research and technology development at the international level. The Energy Storage Technology Programme (ES TCP) of the International Energy Agency (IEA), in which Austrian experts are actively involved, aims to promote international networking. The technology programme supports the research, development, implementation and integration of new energy storage technologies. These are intended to help optimise the energy efficiency of energy systems and accelerate the expansion of renewable energy technologies. As energy storage is an interdisciplinary topic, expertise from all areas of energy supply (energy production, final consumption and distribution) must be pooled centrally.

Research into the development, prevalence and market launch of storage systems is being conducted and numerous coordination activities are being organised as part of the ES TCP. The focus is on innovations from a technical, economic and legal aspect. The research topics include the reduction of investment costs, ensuring a longer service life and higher efficiency, a compact design and the safety of energy storage systems. Regulatory framework conditions and suitable business models are also covered in the programme.

nachhaltigwirtschaften.at/de/iea/technologieprogramme/eces/

MATERIAL AND COMPONENT DEVELOPMENT FOR THERMAL ENERGY STORAGE SYSTEMS

In this project, which was completed in 2020, experts from the fields of materials development, component development and system integration worked together on the efficient development of materials and components for new compact thermal energy storage systems. These storage systems play an important role in integrating renewable heat sources into the energy system – from building applications to district heating and industrial applications as well as for sector coupling. The focus was on phase change materials (PCM energy storage systems) and thermochemical heat accumulators (TCM). The project included material development, characterisation and testing under various application conditions.

nachhaltigwirtschaften.at/de/iea/technologieprogramme/shc/iea-shc-task-58.php

LARGE THERMAL ENERGY ACCUMULATORS FOR DISTRICT HEATING

This project is led by Austrian experts (AEE INTEC) and deals with the integration of large-scale heat accumulators into district heating systems. All of the important aspects for the planning, design and implementation of these types of projects are dealt with, taking into account the different locations and system configurations. Among other aspects, representative application scenarios are defined, techno-economic evaluations of already implemented best practice examples are carried out and new material test procedures are developed.

nachhaltigwirtschaften.at/de/iea/technologieprogramme/eces/iea-eces-annex-39.php

FLEXIBLE SECTOR COUPLING THROUGH THE USE OF ENERGY STORAGE SYSTEMS

The potential of different storage technologies and configurations for the application for sector coupling of the areas of electricity, heat and mobility is being investigated within the framework of Task 35. Existing and future storage technologies are being analysed and evaluated under this aspect. The results of the analyses are processed for politics, research and industry. ●

nachhaltigwirtschaften.at/de/iea/technologieprogramme/eces/iea-eces-annex-35.php

Energy storage systems in Austria

Market development 2020

A study[1] carried out by the University of Applied Sciences Technikum Wien, AEE INTEC, BEST and ENFOS presents the market development of energy storage technologies in Austria for the first time. This study focuses on photovoltaic battery storage, heat accumulators in local and district heating networks, thermally activated building systems and innovative storage concepts.

In 2020, Austria had a hystorically grown inventory of hydraulic storage power plants with a gross maximum capacity of 8.8 GW and gross electricity generation of 14.7 TWh. This storage capacity has already played a central role in the past in optimising power plant deployment and grid regulation. Additional storage capacities will also be required in both the electricity and heat sectors as part of the energy transition. The increasing linkage between sectors also gives rise to innovative approaches to the conversion and storage of energy.

PHOTOVOLTAIC BATTERY STORAGE

Falling prices for battery storage systems, public subsidies and increased motivation on the part of private or commercial investors led to a strong increase in sales of photovoltaic battery storage systems in Austria in 2020. In 2020 for instance, 4,385 photovoltaic battery storage systems with a cumulative usable storage capacity of approximately 57 MWh were newly installed in the Austrian domestic market. Of these, approx. 94% were built with public funding and 6% without. The total inventory of photovoltaic battery storage systems in Austria therefore rose to 11,908 storage systems with a cumulative usable storage capacity of approx. 121 MWh. For 2020, a price of around € 914 per kWh of usable storage capacity excl. VAT was charged for PV storage systems installed as turnkey solutions. This means a price reduction of approx. 9.6% on the previous year 2019.

HEAT ACCUMULATORS IN LOCAL AND DISTRICT HEATING SYSTEMS

Of the total of 875 local and district heating networks surveyed, heat accumulators have been installed as an element of flexibility in 572 heating networks over the last 20 years. Tank water storage systems were used almost exclusively in terms of heat storage technology. However, the first anergy networks (cold district heating networks) have also been built over the last five years, using geothermal probe fields as seasonal storage for heat pump systems. The installation of new heat accumulators is usually directly related to the construction or expansion of heating networks. A total of 840 tank water storage systems in primary and secondary networks with a total storage volume of 191,150 m^3 were surveyed in Austria. The five largest individual tank water storage systems have volumes of 50,000 m^3 (Theiss), 34,500 m^3 (Linz), 30,000 m^3 (Salzburg), 20,000 m^3 (Timelkam) and twice 5,500 m^3 (Vienna). Assuming a temperature difference of 35 Kelvin, the storage inventory corresponds to a capacity of 7.8 GWh.

THERMALLY ACTIVATED BUILDING SYSTEMS

Heat and cold can be stored in buildings and sections of buildings. If buildings have a large mass and good thermal insulation, this results in thermal inertia that can be used for load shifting. Plastic hoses through which a heat transfer medium flows are installed in solid sections of the building. Load shifting is useful for the higher-level energy system if, for example, a grid operator is able to control the load to a certain extent via an interface. Activated components and buildings are usually heated and/or cooled with heat pump systems. As of 2015, heat pumps in Austria have been equipped with a corresponding smart grid interface. In total, this amounted to approx. 121,200 buildings at the end of 2020 with a maximum load shift potential of approx. 0.43 GWh_{el} per hour of shifting time. The increase in this potential from 2019 to 2020 was approximately 20%.

INNOVATIVE ENERGY STORAGE SYSTEMS

The examination covered hydrogen storage & power-to-gas, innovative stationary electrical storage systems, latent heat-accumulators and thermochemical storage. A total of 36 Austrian companies and research institutions were identified that research innovative storage technologies within these technology groups or offer these on the Austrian market. Most companies and research institutions are working on hydrogen storage, followed by innovative stationary electrical storage systems. A total of 17 stakeholders already offer storage on the Austrian market, with 19 actively involved in researching this. The sales figures for innovative storage systems are currently still low, but an increase is expected in the next few years. ●

nachhaltigwirtschaften.at/schriftenreihe/2021-35

[1] The documentation and analysis of the market development of selected storage technologies is based on research of the literature, expert interviews, evaluations of available statistics and empirical data collection.

Underground Sun Storage 2030 research facility, photo: RAG Austria AG

Underground Sun Storage 2030

Storing wind and solar energy in natural-gas storage facilities

Long-term storage of renewable energy sources will play a central role in the future energy system. Underground gas storage facilities are long-established large-volume energy storage facilities with high storage capacities. By converting electrical energy into hydrogen, the existing natural gas infrastructure – consisting of pipelines and natural gas storage facilities – could be used as buffer storage for surplus energy from renewable sources.

This pioneering concept for energy storage will be further researched and tested in practice over the next few years in the Austrian flagship project "Underground Sun Storage 2030". Under the leadership of RAG Austria AG, safe, seasonal and large-volume storage of renewable energy sources in the form of hydrogen in underground gas storage facilities will be developed by 2025 in cooperation with numerous corporate and research partners[1]. The aim is also to gain valuable technical and economic knowledge for the development of a secure hydrogen supply in Austria.

[1] **PROJECT PARTNERS:** RAG Austria AG (project management), Axiom Angewandte Prozesstechnik GmbH, Energie AG, Energy Institute at the Johannes Kepler University Linz, EVN AG, HyCentha Research GmbH, K1-MET GmbH, TU Wien/Institute of Chemical, Environmental and Bioscience Engineering, University of Natural Resources and Applied Life Sciences/Interuniversity Department of Agricultural Biotechnology, IFA-Tulln, VERBUND, voestalpine Stahl GmbH

A project within the framework of the WIVA P&G – Austria Power & Gas Flagship Region hydrogen initiative, www.wiva.at

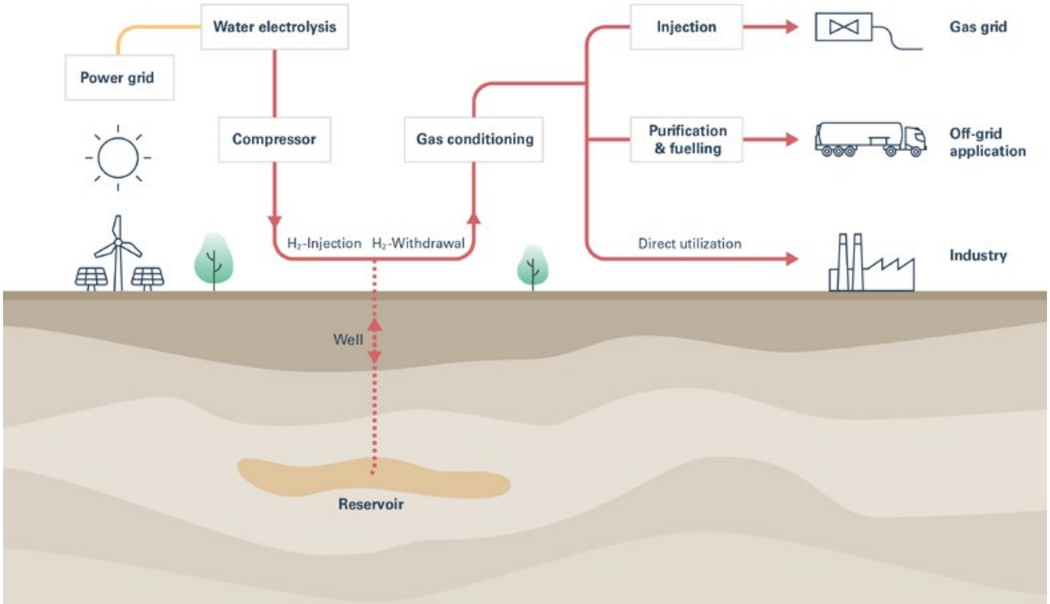
STORING HYDROGEN UNDERGROUND

The hydrogen compatibility of underground pore storage systems had already been investigated in the previous projects "Underground SUN.STORAGE" and "Underground.SUN.Conversion". It was possible to prove that a hydrogen content of up to 20% can be stored in natural-gas storage facilities with good levels of compatibility. A new process was researched within the framework of "Underground.SUN.Conversion" to produce renewable natural gas directly in a gas storage facility through a microbiological process that was initiated specifically.

For this purpose, hydrogen produced from wind and solar energy is pumped with CO_2 (e.g. from biomass combustion) into an existing gas storage facility over 1,000 metres below ground. A methanation process subsequently takes place naturally in the underground rock layers, i.e. hydrogen and CO_2 are converted into methane in a relatively short time. The renewable natural gas can then be stored directly in the storage facility and withdrawn and used flexibly in accordance with requirements.

INTERDISCIPLINARY RESEARCH AND ROAD TESTS

Further laboratory tests showed that a hydrogen content of up to 100% would also be possible in the underground storage facilities. Building on the previous projects and the findings to date, the "Underground Sun Storage 2030" project is now moving to



Charts and photo: RAG Austria AG

real benchmarks and investigating the storage of pure hydrogen in underground gas storage facilities as part of a road test. Together, the project partners will carry out interdisciplinary technical-scientific investigations under real conditions at a small underground gas storage facility in the municipality of Gampern in Upper Austria. A customised research facility is being built for this purpose. The investigations are supplemented by the development of suitable processing technologies, the modelling of future energy scenarios and economic analyses.

The partners also want to work on various other aspects related to stored hydrogen. These include:

> the use of hydrogen as a substitute for fossil natural gas
> the direct use of hydrogen in the energy-intensive industry
> the preparation and utilization of hydrogen with high purity

KEY TECHNOLOGY IN THE SUSTAINABLE ENERGY SYSTEM

Storable gaseous energy carriers, such as hydrogen, have major potential in playing a central role in the future energy system. The conversion of surplus solar and wind power into large-volume and seasonally storable gaseous energy carriers is a key technology in implementing a secure energy supply based on renewable energy sources. The globally unique project "Underground Sun Storage 2030" will provide important insights into the seasonal storage of renewable energy sources in the form of hydrogen. ●

- www.underground-sun-storage.at/en/project/project-description.html
- www.underground-sun-conversion.at/en
- www.uss-2030.at/en

“ RAG's strength lies in its strong innovative power and responsible forward-looking actions. What we do is always supported by a long-term perspective, with investments for generations. The main problem with renewable energy sources is their volatility and the fact that they are not available all year round. The necessary reduction of CO_2 emissions in the energy systems will only succeed if part of the summer energy harvested from solar and wind can be carried over into the winter.”

MARKUS MITTEREGGER
CEO RAG AUSTRIA AG

Photo: RAG/Karin Lohberger Photography

GIGATES

Giga-scale storage systems for the sustainable heat supply of urban quarters

District heating networks that are supplied entirely with renewable energy sources require very large storage systems so that they can store the large quantities of renewable heat and waste heat needed for the winter during the summer, thereby enabling a high degree of flexibility. The volume of these giga-storage facilities must be up to ten times that of the storage systems used today (with 200,000 m^3). In urban areas, these types of large-scale heat accumulators can only be built underground. This places high demands on the technology, materials and construction of these giga-storage systems.

LARGE-SCALE FLAGSHIP PROJECT

The GigaTES project was aimed at developing giga-scale storage system concepts for urban quarters that are supplied exclusively or to a high degree with renewable energy sources. A total of 18 international partners from research and industry[1] worked together under the leadership of AEE INTEC. These included material and component manufacturers, contractors and engineers, energy supply companies as well as national and international research institutes.

All important aspects that are relevant in the planning, construction and operational phases of large-scale thermal energy storage systems were covered as part of the project. Solutions were sought that could be implemented in Austria.

Research priorities included:

- new materials for watervapour-tight films, with a focus on long service life and high storage temperatures
- new building constructions for walls, floors and covers of the heat accumulators
- tools for cost optimisation of different building concepts

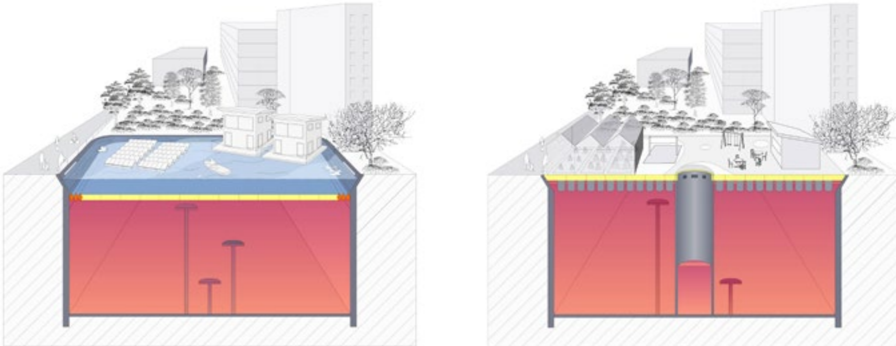
Furthermore, calculation methods were developed for integrating the storage systems into district heating networks and for estimating the economic efficiency at material, component and system level. Moreover, simulations were carried out for designing and evaluating the thermal energy storage systems. These take into account specific boundary conditions such as size, system, location and hydrogeology.

CASE STUDIES FOR TWO HEATING NETWORKS

Two representative case studies show that the integration of a large-scale heat accumulator can improve the overall performance of the system by significantly increasing the share of renewable energy sources in the district heating networks. The analysis involved a smaller heating network, in which a 100,000 m^3 long-term storage tank is to be integrated, as well as a medium-sized heating network with a storage volume of 1,200,000 m^3. The primary goal is to reduce the running times of the fossil peak load boilers in the winter months significantly

> **"For a successful energy transition, it is not only important to increase the share of renewable energy sources but it also requires an expansion of storage capacities. Therefore, innovative storage technologies are an essential building block for the functioning of the energy system of the future. As a Green Tech Company, we have already been working on the development of storage technologies for several years. In Salzburg's district heating system, larger heat accumulators will play a key role in the future. That is why we have been actively involved in research projects on the technical feasibility of large-scale heat accumulators in urban areas for a long time."**
>
> BRIGITTE BACH
> MEMBER OF THE BOARD SALZBURG AG

Photo: Salzburg AG



Two variants for coverage of the storage basin, source: AEE INTEC

by storing surplus solar thermal and geothermal heat from the summer. Two variants were defined for each system to represent high-temperature systems (90°C/60°C) and future low-temperature systems (60°C/30°C). The newly developed cost tool is used to determine the most favourable storage concept for each application and boundary condition.

INNOVATIVE CONSTRUCTION

The innovative construction concepts can provide significantly larger volumes than previous construction variants. Suitable design variants were developed for different volume sizes, surface area availability and geotechnical ground models. One important issue is cost-effective thermal insulation, which should reduce heat loss and protect the groundwater from overheating. A special requirement involves the storage of water at high temperatures over longer periods of time. Significant heat loss can occur here. The "insulating bored pile wall" was developed and patented for this application, a solution with potentially low installation costs and very good thermal material properties.

[1] **PROJECT PARTNERS**: AEE INTEC (project management), SOLID Solar Energy Systems, JKU Linz/Institute of Polymeric Materials and Testing, University of Innsbruck, Ingenieurbüro ste.p, AGRU Kunststofftechnik GmbH, Metawell, Bilfinger VAM Anlagentechnik GmbH, Geologie und Grundwasser GmbH, PORR Bau GmbH Tiefbau, Lenzing Plastics GmbH, PlanEnergi, Gebriel-Chemie Gesellschaft m.b.H., Smart Minerals, Wien Energie, Solites, Salzburg AG, GVT

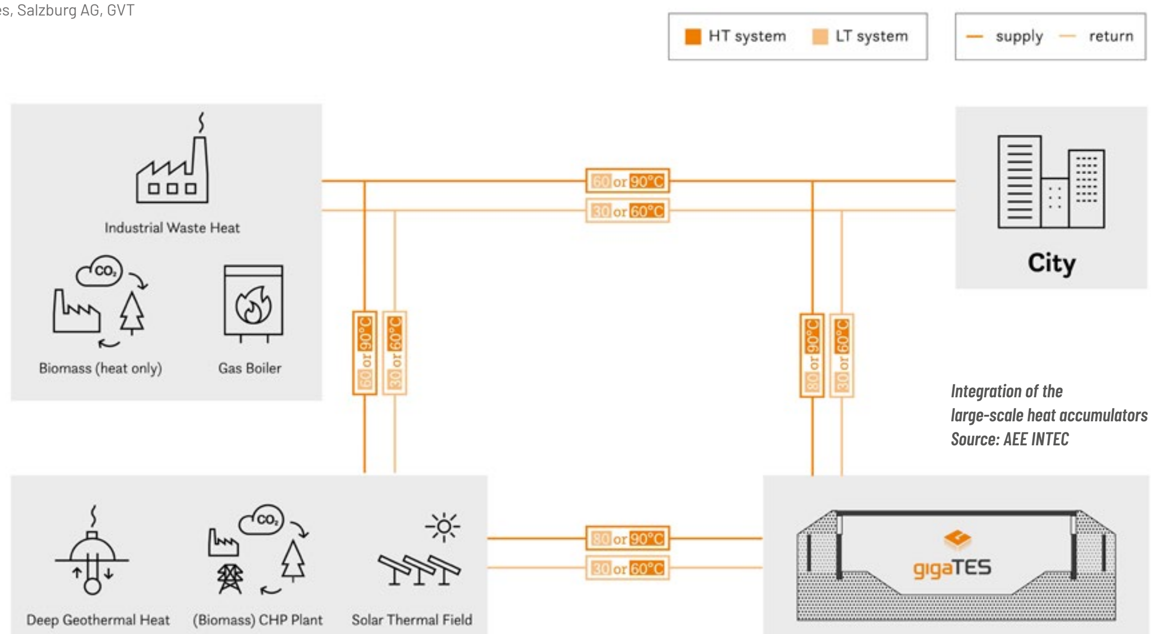
INNOVATIVE COVER

The cover for the storage tank is a key component and is crucial in terms of cost-effective operation of the heat accumulator. Two innovative cover concepts, a submerged and a floating variant, were also developed and patented as part of the project. These covers can be used as recreational space, for greenhouses or for the installation of solar thermal and PV systems.

DURABLE MATERIALS

Various new polymeric materials were tested as liner for the storage and their service life was estimated using experimental ageing data. For the best-performing polypropylene type, average service life values are in the range of 31 to 35 years. Periods of well over 50 years were determined for low-temperature giga-scale storage systems with operating temperatures in the range of 35 to 80°C. The new material therefore has a service life that is more than a factor of 2 longer than that of conventional polyethylene liner materials. ●

www.gigates.at/index.php/en/



Integration of the large-scale heat accumulators Source: AEE INTEC

Photo: voestalpine & AIT/Kiedl & Drexler-Schmid

HyStEPs

Hybrid storage concept for efficient industrial processes

In industry, storage technologies are used to decouple heat generation and heat consumption over time, thereby increasing the efficiency and flexibility of industrial processes. Steam storage systems are a proven and widespread technology that is e.g. used in the food, luxury food, paper and metal industries. By storing and subsequently using surplus heat or waste heat, the total heat generation requirement in the production process is reduced and CO_2 emissions are lowered. The flexibility of the processes is also necessary to be able to integrate a high proportion of renewable energy sources. Thermal energy storage systems with much larger capacities than before are needed for decarbonisation and the switch to renewable energy sources in industry.

INNOVATIVE CONCEPT

With HyStEPs, an innovative hybrid storage concept was developed and tested in order to increase the storage capacity of "Ruth's steam accumulators" by up to 40% in the medium term. For this purpose, a storage tank was encased with latent heat storage elements as a laboratory sample. These special storage elements contain phase change material (PCM), in this case technical salt mixtures, which have a high storage density. The PCM sheathing makes it possible to store significantly larger amounts of energy using almost the same design size. The loading and discharge behaviour of the steam accumulator should remain unchanged wherever possible, including with the increased storage capacity. The innovative solutions were developed by a consortium of research and corporate partners led by the AIT Austrian Institute of Technology[1].

The following aspects were at the centre of the project:

- thermal connection of the latent heat storage elements to the steam accumulator
- increasing thermal conductivity of the phase change material through heat conduction structures
- corrosion behaviour of the material combinations
- strength calculations
- new methods for mathematical modelling and simulation of the behaviour of hybrid storage systems

COST-EFFECTIVENESS

Detailed needs analyses were prepared and initial techno-economic assessments were carried out based on five industrial processes from different sectors. According to the concept, the investment costs for retrofitting an existing storage tank to a hybrid storage tank are only half of an equivalent Ruth's steam accumulator. Since Ruth's steam accumulators require a lot of space, increasing the storage capacity with PCM sheathing would present an innovative alternative.

TEST OPERATION AT VOESTALPINE

The experimental storage system was set up in the laboratory environment of voestalpine Donawitz and is being tested at this location. For this purpose, steam is branched off from the existing steam network and fed into the storage tank under laboratory conditions. Both the steam accumulator and the PCM elements are connected to a variety of measuring devices in order to be able to record the thermodynamic condition of the storage tank at any time and to determine its dynamic behaviour. The plan is to develop the concept further and transfer it to other storage systems based on the knowledge gained here. ●

www.nefi.at/en/hysteps/

[1] **PROJECT PARTNERS:** AIT – Austrian Institute of Technology GmbH (project management), Edtmayer Systemtechnik GmbH, TU Wien/Institute of Engineering Design and Product Development/Institute for Energy Systems and Thermodynamics/Institute of Mechanics and Mechatronics, voestalpine Stahl Donawitz GmbH

A project within the framework of the Energy Flagship Region NEFI – New Energy for Industry, www.nefi.at/en

GMUNDEN HIGH TEMPERATURE HEAT LINK R&D

Using industrial waste heat

The Gmunden cement plant has a waste heat potential of approx. 10 MWth at 400°C. In this project, a project team of research and industry partners[1] developed concepts and technologies to utilise this potential and thereby achieve the greatest possible reduction in CO_2. The aim of the concepts is to extract waste heat from the industrial plant, store and transport it at a high temperature level via a 1.5 kilometre-long heat transport pipeline to large industrial consumers in the urban area of Gmunden.

HEAT EXTRACTION

The comparison between the approaches "dust-loaded smooth pipe heat exchanger" and "ceramic hot gas filter + ribbed pipe heat exchanger" has shown financial advantages for the ribbed pipe option. Nevertheless, the smooth pipe variant was chosen for the techno-economic project concept, as the technical risk is lower and the internal material flows can be organised more effectively.

OVERALL CONCEPT

Almost 30 interconnections of the subsystems heat extraction fluid, storage system and district heating system were analysed thermodynamically and with regard to the technical-economic optimum. From these, four concepts were technically designed and compared economically.

HEAT-LINK

Contrary to the original assessment at the start of the project, a district heating system based on steam clearly emerged as the most techno-economically advantageous solution. The project team was able to work out a technically feasible route between the waste heat source and the potential industrial consumers.

HEAT ACCUMULATORS

The aim of a heat accumulator is, on the one hand to optimise operation, and on the other to maximise waste heat utilisation and, therefore avoid CO_2 emissions by decoupling generation and consumption over time. The load profiles of waste heat and heat demand vary greatly and are not in sync. A storage system allows supply and demand to be balanced out. The project made a distinction between operational storage (6 MWh), daily storage (330 MWh) and long-term storage (>4 GWh). The number of storage cycles and, therefore the cost-effectiveness increases with decreasing storage size. For the operating storage variant, Ruth's steam accumulators and pressurised water accumulators were evaluated from a techno-economic point of view. For daily storage or larger high-temperature storage systems, a gravel storage system was developed, simulated, tested in the laboratory of the TU Wien and evaluated from a techno-economic point of view. For long-term storage with use up to seasonal storage, gravel storage and earth basin water storage systems were evaluated.

Test facility in the TU Wien laboratory, photo: TU Wien/IET

CO_2 SAVINGS AND COST-EFFECTIVENESS

The available waste heat of 70 to 90 GWh (depending on the concept) would have a theoretical CO_2 emission avoidance potential of up to 22,000 tonnes (22 kT) of CO_2 each year. The variants analysed with operational storage, with daily storage, and without storage systems allow waste heat utilisation in the range of 42 GWh per year to 65 GWh per year (47 to 72% of the maximum potential) at different investment levels. The following key data are the most important input variables for the economic viability of the project: Investment costs, running costs (operating costs), economic observation period (life cycle), interest rate, specific fuel costs, substituted primary energy quantity, subsidies (especially investment subsidies) and the avoidance of other costs (e.g. taxes per kWh or per tonne of CO_2) according to the primary energy quantity and emissions avoided. On the basis of the key data currently applicable to the project, it was unfortunately not possible to demonstrate economic feasibility for any of the concepts examined. For even larger heat accumulators, the economic efficiency was worse under the present framework conditions. The project worked out which changes in the framework conditions would make implementation possible.

The macroeconomic simulation results in an increase in the gross regional product of an average of EUR 6.2 million per year and an increase in employment of about 80 employees if the project is implemented. ●

www.nefi.at/en/gmunden/

[1] **PROJECT PARTNERS**: TU Wien/Institute for Energy Systems and Thermodynamics, Energy Institute at JKU Linz, ste.p ZT GmbH, Rohrdorfer Zement, Energie AG Oberösterreich Erzeugung GmbH, Energie AG Oberösterreich Vertrieb GmbH, Porr Bau GmbH, Kremsmüller Industrieanlagenbau KG

A project within the framework of the Energy Flagship Region
NEFI – New Energy for Industry, www.nefi.at/en

CAR2FLEX

E-car batteries as power storage systems

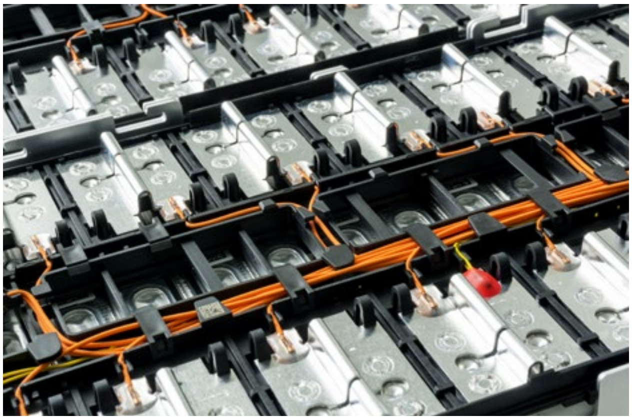


Photo: stock.adobe.com

Photo: fahrvergnügen.at

Electric mobility can make a significant contribution to reducing the high environmental impact in the transport sector. However, sustainable concepts are needed to integrate the increasing number of e-vehicles into our energy system. One innovative approach is to use the batteries of electric vehicles as a storage option in the future and thereby ensure stabilisation for the entire energy system. Technologies for controlled, flexible charging and discharging of vehicles could help to integrate as many renewable energy sources as possible and balance out fluctuations between power generation and consumption. The batteries are charged when there is a surplus of wind and solar energy. The energy stored in the vehicle battery is then released back into the power grid to compensate for peak loads.

CONCEPTS FOR DIFFERENT MOBILITY NEEDS

In the Car2flex lead project, concepts, suitable technologies and business models are being developed for various electric mobility user groups. Under the leadership of the TU Wien, this project involves cooperation between 19 partners[1] from the fields of energy supply, research and technology development. The focus is on private users of electric vehicles, e-vehicle fleets (e.g. in companies) and e-car sharing in apartment buildings.

The question is how the increasing share of e-mobility can be optimally integrated into the energy system while taking different mobility needs into account. An important basis for this is information about when e-cars are charged, how much charge is needed on average and how often and for how long the vehicles are travelling. These data are generated for the three user groups. Building on this, new technologies and concepts for making charging and discharging processes more flexible are to be tested in practice in the three application areas. A participatory process with users (private individuals and companies) and relevant stakeholders (e.g. housing developers, charging station operators, etc.) is supporting the developments.

SMART OPTIMISATION OF ELECTRIC MOBILITY

The central technology for the interaction between the electric vehicle and the power grid is bidirectional charging of the electric cars. This enables communication and interoperability between charging pillars, cars and building services. Among other things, the Car2Flex project uses bidirectional DC charging points (direct current), with which the locally generated PV electricity can be used directly as direct current and no longer has to be converted into alternating current. The bidirectional function also allows the charging pillar to draw power from the car battery and makes it possible to deliver power back to the grid. Specially developed algorithms are used for optimised charging and discharging, e.g. to reduce peak loads and for integration between aggregator and booking platforms.

[1] **PROJECT PARTNERS**: TU Wien/Institute of Energy Systems and Electrical Drives/Energy Economics Group (EEG) (project management), AED Systems KG, AIT Austrian Institute of Technology GmbH, ecoplus. Niederösterreichs Wirtschaftsagentur GmbH, Energie Burgenland AG, Energie Steiermark AG, EVN AG, University of Applied Sciences Technikum Wien, Forschung Burgenland GmbH, Fronius International GmbH, Grazer Energieagentur Ges.m.b.H., im-plan-tat Raumplanungs GmbH & Co KG, JOANNEUM RESEARCH Forschungsgesellschaft mbH, The University of Leoben - EVT, NÖ Energie- und Umweltagentur GmbH (eNu), Salzburg Netz GmbH, Schrack Technik Energie GmbH, Spectra Today GmbH, Stromnetz Graz GmbH & Co KG

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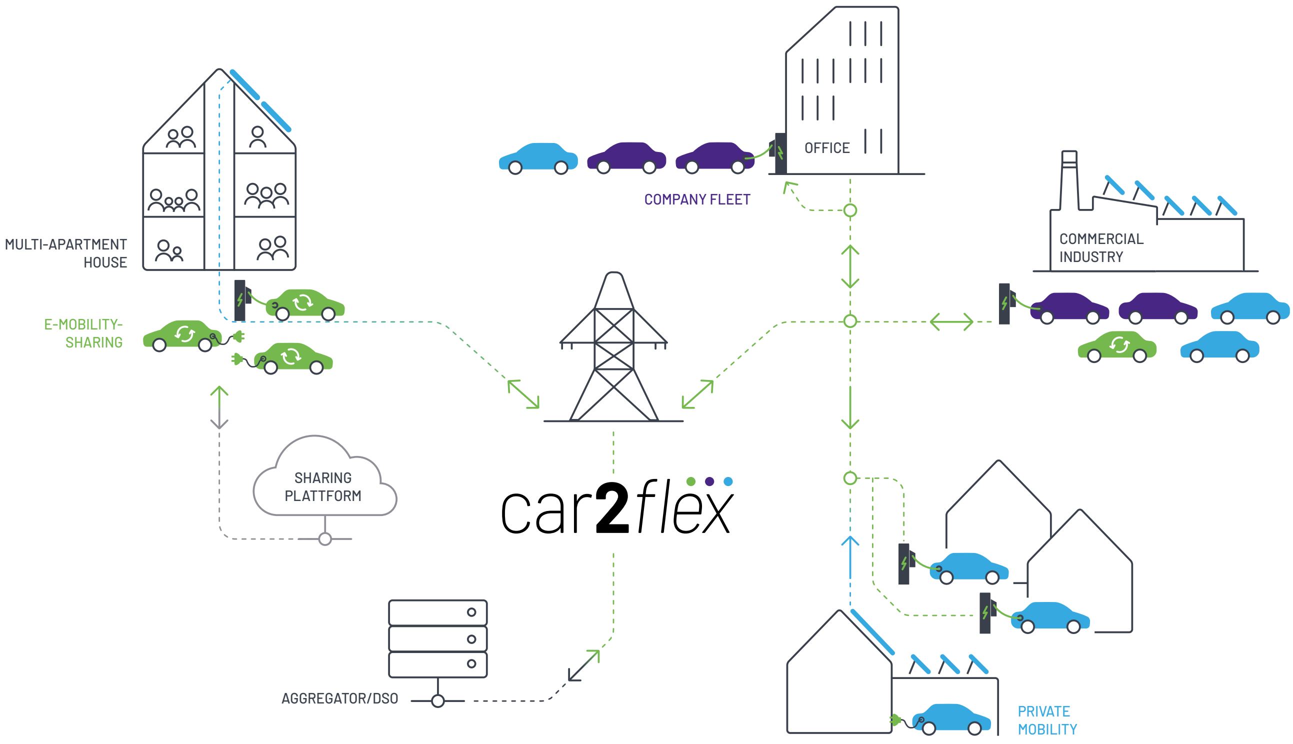

ECONOMIC INCENTIVES

The innovative Car2Flex concepts are intended to create new economic incentives, e.g. with solutions that increase the internal consumption of PV electricity through intermediate storage in the battery of a vehicle. This optimised flexible battery use can increase the share of renewable energy generation and use and also save costs.

TESTING E-CAR SHARING

One focus of the project is on concepts for e-car sharing providers. An e-car sharing service is to be established and tested in a multi-storey residential building. The operators can use a booking system (app) to track where each e-car is located at which charging pillar and its charging status around the clock. The batteries of the vehicles offer potential for additional flexibility, as they can be charged in a controlled manner when there is a surplus of electricity and discharged when there is a demand for electricity. The concept is also interesting for aggregators who combine (aggregate) individual flexibilities and market these further. ●

greenenergylab.at/en/projects/car2flex/

Photo: unsplash

Photo: unsplash

SecondLifeBatteries4Storage

New life for used batteries from e-mobility

When batteries from electric vehicles only provide 80% of their power, they are disposed of because they are no longer suitable for demanding mobility applications once their total capacity has dropped. The core idea behind the "SecondLifeBatteries4Storage" project is to continue using used batteries from e-mobility and thereby extend their life cycle. After use in electric vehicles, the condition of lithium-ion rechargeable batteries (known as their "state of health") is often still sufficient in order to integrate them as electric storage into stationary applications. This can save valuable resources and improve the carbon footprint. Due to the growing market for electric vehicles, more and more used battery systems will be available in the future.

SECOND-LIFE RECHARGEABLE BATTERIES IN STATIONARY STORAGE SYSTEMS

Under the leadership of the Graz Energy Agency, the use of second-life batteries in stationary storage systems is currently being researched and tested in cooperation with partners from industry, energy supply and research[1]. The systems are intended to support the integration of renewable energy sources in the energy system in the future. They can e.g. be used to cover peak loads ("peak shaving") as well as to optimise own electricity in the industrial sector or in residential complexes and used to stabilise the grid or as a blackout reserve.

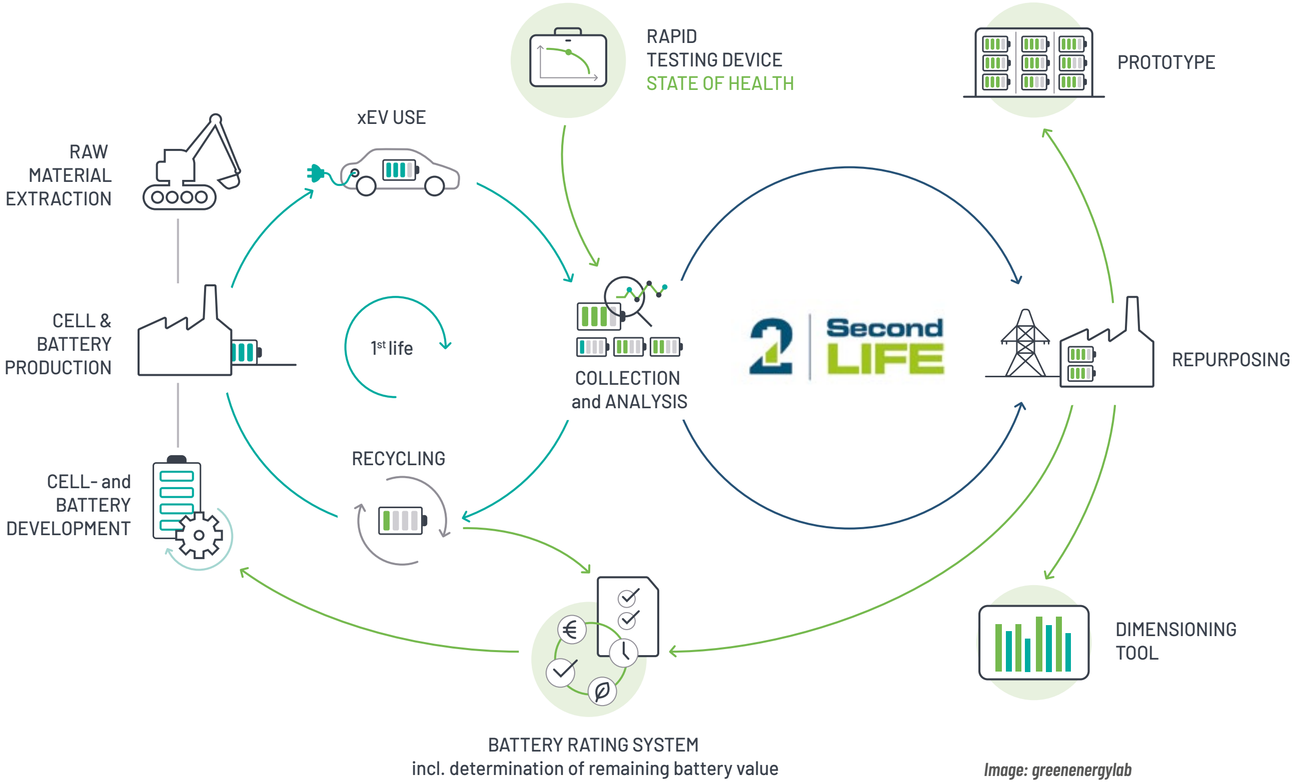

Image: greenenergylab

[1] **PROJECT PARTNERS**: Grazer Energieagentur Ges.m.b.H. (project management), AVL DiTest GmbH, AVL List GmbH, Energie Steiermark AG, Saubermacher Dienstleistungs AG, Smart Power GmbH

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> **“The project is particularly important for Saubermacher. In line with our Zero Waste vision, the use of used electric car batteries in stationary storage systems is a leading example of re-use and resource conservation in action. There are still many challenges to be solved in relation to broader use – keyword: economic efficiency and liability issues. At the same time, the initiative also shows how important cross-industry cooperation is for sustainable product life cycles.”**

RALF MITTERMAYR,
CHAIRMAN OF THE EXECUTIVE BOARD SAUBERMACHER DIENSTLEISTUNGS AG

Photo: Michael Königshofer for moodley brand identity

Both photos: Saubermacher Dienstleistungs AG

QUICK ANALYSIS DEVICE AND PLANNING TOOL

A mobile rapid analysis device was developed by the project partner AVL DiTest in order to be able to survey the condition of used batteries quickly and cost-effectively. The special feature of this product is its cross-brand functionality, meaning that different battery systems can be measured regardless of the manufacturer. If the batteries have a sufficiently high state of health, they are installed in stationary accumulator packs.

A new software tool was also developed for the overall economic and ecological evaluation of a battery system. The benchmarking is intended to determine the suitability for reuse at different life cycle stages, as well as to derive recommendations for improving recyclability. With the help of another planning tool, the storage system can be optimally dimensioned for the different areas of application (e.g. for peak load coverage, PV own power optimisation, etc.).

FIRST PILOT PLANT IN STYRIA

A first functioning prototype of the SecondLife storage unit has been installed at the premises of the Austrian waste management company Saubermacher Dienstleistungs AG in Premstätten near Graz, which is used to support the start-up of a recycling plant.

It is possible to expand the energy (of the storage system) from 100 kWh to up to 100 MWh in order to be able to use the system for different areas. The modules used to achieve the prototype come from a Vito test fleet and were provided by Daimler. The commissioning of the storage facility proved that the concept works. During the pilot operation, the project team wants to test and evaluate various other use cases in order to demonstrate the transferability of the concept.

Potential target groups for storage systems from used battery systems include the electricity-intensive industry, installers of PV systems on residential buildings or operators of large e-car fleets, electric buses and e-mobility service providers. The project lays the foundation for creating a free market for second-life batteries from electric mobility and optimally utilising the potential of used battery systems for storage applications. Private individuals also have the option of using the battery from their electric vehicle as a home storage system after its useful life has expired, or of making it available to other users. ●

greenenergylab.at/en/projects/secondlife-batteries/

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INFORMATION

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Cover – ABS4TSO battery storage system:
In the ABS4TSO (Advanced Balancing Services for Transmission System Operators) project, intelligent battery storage systems and other rapidly controllable technologies are used to demonstrate ways of stabilizing the domestic and European electricity transmission network of the future. Project Partners: Austrian Power Grid (project coordination), Austrian Institute of Technology (AIT), TU Wien, VERBUND.
(see energy innovation austria Issue 1/2021)
www.energy-innovation-austria.at/wp-content/uploads/2021/02/eia_01_21_fin_english.pdf

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