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Highlights of Energy Research 2021

"Energy storage - key element to energy transition"

Event report

November 23, 2021 Online

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Photo left: Research facility "Underground Sun Storage", Photo: RAG; right: High-pressure heat storage

Highlights of Energy Research 2021 "Energy storage - key element to energy transition"

On November 23, 2021, the event "Highlights of Energy Research" took place at the invitation of the Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) in cooperation with the Austrian Climate and Energy Fund, AEE Intec and the Austrian Society for Environment and Technology (ÖGUT).

The focus was on energy storage technologies. Activities of the IEA Energy Storage TCP, the market analysis of energy storages in Austria as well as various research projects were presented. The lectures covered a wide range of topics from battery development to large-scale heat storage and sector coupling.



Screenshots from the Livestream: Henriette Spyra, BMK (left) & Theresia Vogel, Austrian Climate and Energy Fund (right)



Photo: Sabine Mitter, BMK

After the inspiring opening words by Henriette Spyra (BMK) and Theresia Vogel (Austrian Climate and Energy Fund), Teun Bokhoven, Chairman of the IEA Energy Storage TCP, provided insights regarding the activities of the Energy Storage TCP and addressed the importance of energy storage in the transformed global energy system.

His presentation was followed by the market analysis of energy storages in Austria as well as many other exciting research projects, which covered a wide range of topics from battery development to large-scale heat storage and sector coupling.

A panel discussion on the relevance of different energy storage technologies in decarbonisation strategies of three European countries completed the programme.

Opening Poll

At the beginning of the event, participants were invited to take part in a survey about their geographical and professional background. The results show that most of the more than 220 participants came from Vienna, followed by Upper Austria, Lower Austria, international participants and people from Styria.

Which region are you from	?	
Vienna		25%
Upper Austria	17%	33%
Lower Austria	17%	
International	17%	
Styria	11%	
Carinthia 2%		
Salzburg		

In terms of their institutional background, the participants mostly came from the field of "Research", followed by "Economy" and "Public Administration".

Which institutional background do you have?		
Research 34%		
Economy 27%		
Public Administration 18%		
Other 12%		
Representation of Interest 9%		

Screenshot from the Livestream: Result of the poll – Institutional background

Screenshot from the Livestream: Result of the poll – Region

Session 1

Moderated by Elvira Lutter, Austrian Climate and Energy Fund

Importance of energy storage in the transformed global energy system – Activities of the IEA Energy Storage TCP

Teun Bokhoven, Chairman IEA Energy Storage TCP



Screenshot from the Livestream: Teun Bokhoven, Chairman IEA Energy Storage TCP

Teun Bokhoven, Chairman IEA Energy Storage TCP gave insights in the various activities of the IEA Energy Storage Technology Collaboration Programme (TCP) as well as an overview of the future and strategic considerations and challenges for energy storage in contributing to global decarbonization targets. He highlighted the necessity to create flexibility in our energy system through energy storage as key enabler for the energy transformation. Research priorities are on system transformation to decarbonized energy by using storage technologies and storage solutions that are safe, affordable, compact, and cost effective. Here, electrical, thermal, and also hybrid options such as Power2Heat (P2H) have to be considered.

Current activities of the Energy Storage TCP include research in the fields of Energy Storage in Energy Systems (4 tasks), Technology Improvements (3 tasks) and Material and Components (1 task), with Austrian participation in three of eight tasks. New tasks are planned on the topics of Economics of Energy Storage and Large-Scale Medium Duration ES.

IEA Energy Storage (ES TCP) at NachhaltigWirtschaften.at

Energy Storage Technology Collaboration Programme (IEA)

Energy storage in Austria – target images, market development and recommendations for action

Heinz Buschmann, Austrian Climate and Energy Fund & Kurt Leonhartsberger, University of Applied Sciences Vienna



Screenshot from the Livestream: Heinz Buschmann, Austrian Climate and Energy Fund (left) & Kurt Leonhartsberger, University of Applied Sciences Vienna (right)

Heinz Buschmann from the Austrian Climate and Energy Fund started with an overview of the "Storage Initiative" which aims to highlight relevant topics for the further development of different storage technologies and their effective integration into the energy system.

Kurt Leonhartsberger, researcher at the University of Applied Sciences Vienna, then presented the results of the study "Innovative Energy Storage Technologies in Austria: Market Development 2020". The findings focus on PV storage systems up to 50 kWh, large-scale heat storage in local and district heating networks, thermal activated building parts and innovative storage systems and aim to build the basis for a future continuous storage monitoring in Austria.

The results show that PV storage systems have a very high annual growth rate (about 220% from 2019 to 2020), with almost 12.000 PV storage systems installed, reaching a total net capacity of 120 MWh. Due to the market report, large-scale heat storages in local and district heating systems include 840 water storage systems with a total heat storage capacity of about 7.8 GWh and a volume of more than 190,150 m³ installed in 569 heating networks in Austria. Borehole storages with a total length of more than 50 km are implemented in three "cold" heating networks. Considering the thermally activated building parts, the results show that almost all of them are linked to the use of heat pumps, representing a theoretical maximum load transfer potential of about 0.43 GW_{el}, with a growth rate of around 20%. The analysis shows that currently 36 Austrian companies and research institutions are active in the field of innovative storage technologies - 17 of them already on the Austrian market and 19 on the research level.

Download of the presentation (Heinz Buschmann)

Download of the presentation (Kurt Leonhartsberger)

Storage Initiative of the Austrian Climate and Energy Fund

Energiespeicher in Österreich: Marktentwicklung 2020 (German)

Research results on underground storage of hydrogen and conversion to methane

Stephan Bauer, RAG Austria AG



Screenshot from the Livestream: Stephan Bauer, RAG Austria AG

In his presentation, Stephan Bauer, Head of Green Gas Technology at RAG Austria AG, focused on concepts for seasonal energy storage and Power2X-Technologies for underground storage and gave an overview on various projects of RAG Austria in this field. Via the transformation to hydrogen (H2) or methane (CH4) the underground storage (UGS) of PV-power is possible, which enables net stabilization and sector coupling.

Stephan Bauer's key messages were that an increase of intermittent renewable energy generation will generate additional demand in seasonal and high capacity large-scale storage options. Underground Sun Storage as well as Underground Sun Conversion technologies can solve the problem of inter-seasonal energy storage. Concluding, he noted that state of the art underground gas storage facilities play an essential role for Europe's security of energy supply.

Download of the presentation

Session 2

Moderated by Karin Granzer-Sudra, Austrian Society for Environment and Technology (ÖGUT)

Solar power, even if the sun is not shining

Hannes Heigl, Fronius International GmbH



Screenshot from the Livestream: Hannes Heigl, Fronius International GmbH

Hannes Heigl, responsible for the development area System Engineering at Fronius International GmbH, presented several research projects on storage technologies for PV systems, ranging from storage management to energy conversion and business models. The ongoing project "Flex+", for

example, develops concepts and large-scale real-world tests to enable flexibility of prosumer components such as heat pumps, boilers, PV storage systems and e-mobility for selected services supporting the energy system. In the project "HySnow" the decarbonisation of the winter tourism is in focus, realized by the development of hydrogen onsite production and fuelling applications for alpine areas while the project "Car2Flex" has the aim to develop, implement and operate user-centric solutions for bidirectional DC-Charging of electric cars in different use cases (sharing, Fleet, individual). The development of user-centred energy services at city district level as well as optimization algorithms and system simulations are the core research area of the project "USER GRIDs".

By combining intelligent generation, storage, distribution and consumption it is possible to achieve a 100% supply from renewable energies. Here, the different storage options and their characteristics play a very important role. A combination of different storage systems and the systematic use of these technologies is a key factor for reaching a decarbonized energy system.

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Large-scale heat storage – technological developments in Austria and internationally

Wim van Helden, AEE INTEC and Manager of IEA Energy Storage Task 39 & Josef-Dieter Deix, CEO Porr Construction



Screenshot from the Livestream: Wim van Helden, AEE INTEC and Manager of IEA Energy Storage Task 39 (left) & Josef-Dieter Deix, CEO Porr Construction (right)

Wim van Helden, Leader of the department Technology Development at AEE Intec and Manager of IEA Energy Storage Task 39, stated that large thermal energy storages (LTES) play a pivotal role in reaching 100% renewable energy supply in the heating sector, especially for district heating.

Together with Josef-Dieter Deix, CEO of Porr Construction, he presented the 3-year flagship project giga_TES, which aimed to use numerical simulation techniques to develop methods, materials and construction concepts for very large thermal energy storages with volumes of more than 100 000 cubic metres. The results cover, among other things, material innovations, system improvements and simulation techniques for optimising the LTES. The project also delivered a cost tool to determine the total cost of storage for a given configuration, which can be used to optimise storage in a district heating environment.

On international level, work on LTES is being performed in the framework of the Energy Storage TCP Task 39, where experts from 11 countries collaborate to improve the knowledge base in the design, planning, building and operation of large thermal energy storages for district heating. The

aim of the work is to create a knowledge base that is useful for decision makers and other stakeholders and helps to accelerate the realisation of LTES for district heating.

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Battery storage for the urban distribution network

Roland Zoll, Wiener Netze & Christian Messner, Austrian Institute of Technology



Screenshot from the Livestream: Roland Zoll, Wiener Netze (left) & Christian Messner, Austrian Institute of Technology (right)

Roland Zoll from the department "network planning electricity and telecommunication" at Wiener Netze and Christian Messner, research engineer at the Austrian Institute of Technology spoke about their experiences and lessons learned from battery storage for the urban distribution network during the procurement phase, acceptance testing, and field operation.

The advantages of Battery Energy Storage Systems (BESS) are an increase in available grid capacity due to a balanced load on the lines, and the ability to connect more customers and producers to a common interconnection point, as well as quick and convenient implementation on site, with possibilities for relocation. BESS also represent new active assets for distribution system operators (DSO) in terms of ICT (e.g., security, ICT data connection) and enable new forms of maintenance and troubleshooting.

The research results show that the maximum performance of BESS cannot be always achieved but depends on different parameters such as the State of Charge (SoC) and the battery temperature. Based on the measurements carried out, there is no ideal configuration for BESS in low-voltage networks.

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Session 3

Moderated by Bianca Pfefferer, Austrian Society for Environment and Technology (ÖGUT)

Carnot Batteries – Power storage for the MW range

Dan Bauer, German Aerospace Center



Screenshot from the Livestream: Dan Bauer, German Aerospace Center

Carnot batteries were the topic of Dan Bauer, head of the department "Thermal Process Technology" as well as manager of the research area "Thermal Systems with Phase Change" at the German Aerospace Center (DLR). In his presentation, Dan Bauer gave an overview of the technology and showed current research aspects. On the one hand, the advantages of the technology lie in the free choice of site, the small environmental footprint, life expectancies of 20-30 years and the function as optional low-cost backup capacity. Moreover, the components of a fossil fuelled power plant can be partially reused to build a Carnot Battery. On the other hand, the efficiency of the power-to-power transformation of about 40-70 % needs to be considered.

The IEA Energy Storage TCP Task 36 is a working group on Carnot Batteries with more than 100 participants from 55 institutions and 16 countries which collects, discusses, and provides information for all stakeholders. Austria is represented by AEE Intec.

Dan Bauer concluded that Carnot Batteries are an emerging technology for the inexpensive and site-independent storage of electric energy at medium to large scale. In addition, Carnot batteries offer numerous opportunities for coupling the power sector with the heat sector and are key elements in the expansion of fluctuating renewable energies as well as in the electrification of other sectors.

Integrated Multi-Energy Storages coupling the power network to the transportation sector

Marie-Gabrielle Macherhammer & Wolfgang Siegl, HyCentA Research GmbH



Screenshots from the Livestream: Marie-Gabrielle Macherhammer (left) & Wolfgang Siegl (right), HyCentA Research GmbH

Marie-Gabrielle Macherhammer, responsible for the area "Electrochemical Technologies" at the Hydrogen Center Austria (HyCentA) presented the key data and activities of Austria's Research Centre for Hydrogen Technologies and outlined the role of hydrogen in our future energy system based on 100% renewable energy.

Wolfgang Siegl, research manager at the Hydrogen Center Austria, went on with giving insights in the project "CrossChargePoint", which develops solutions for communities and other stakeholders to be able to align supply and demand in electricity and hydrogen-based energy systems. The project scope comprises a virtual power plant linking the energy generation, conversion, storage and charging of vehicles, where surplus energy is stored or used for e-mobility and considers different regions and local characteristics. A modelling of demand and production of energy is conducted based on simulations and a regional energy management system for controlling and monitoring of the project's infrastructure is to be developed. In addition, the integration of energy conversion (power-to-gas) is addressed in the project.

The two speakers stated that hydrogen is essential to move our energy system towards zero-emission power generation and that investments in hydrogen technologies and infrastructure need to start now to make hydrogen available for all sectors in time. Furthermore, activities for hydrogen implementation must be combined to increase the impact and resources must be bundled. Energy communities can support this transformation. To ensure smooth and fast market introduction research and development need to be strengthened.

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Flexible Sector Coupling

Andreas Hauer, CEO Bavarian Center for Applied Energy Research (ZAE Bayern) and Manager of IEA Energy Storage Task 35



Photo: Screenshot from the Livestream: Andreas Hauer, CEO ZAE and Manager of IEA Energy Storage Task 35

Andreas Hauer, CEO of ZAE Bayern and responsible for R&D activities in his role as Vice-President at BVES, German Energy Storage Systems Association, spoke about the necessity of sector coupling for the integration of high shares of renewable energy into the energy system. Additionally, storage capacities are needed to close the mismatch between renewable supply and demand. Flexible Sector Coupling (FSC = sector coupling + storage capacities) allows higher shares of renewables by installing energy storage technologies adapted to the final demand. The main goal of IEA Energy Storage Task 35 is to clarify possibilities and impact of energy storage implementation in Flexible Sector Coupling. In his presentation, Andreas Hauer outlined the variety of possible storage solutions for Flexible Sector Coupling including concepts with battery storage for power-to-mobility, heat and cold storage for power-to-cold, heat and electricity storage for power-to-heat as well as a living lab that comprises heat, battery and gas storage to enable power-to-heat and -mobility.

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Panel Discussion: Energy storage in the transformed energy system – Are there different paths?

Moderated by Sabine Mitter, Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)

The event was concluded with a panel discussion on the relevance of different energy storage technologies in decarbonisation strategies of three European countries.

The panellists Georgina Morris (Department for Business, Energy & Industrial Strategy, UK), Per Alex Sörensen (CEO Plan Energi, DK), Christiane Brunner (Verbund, AT) and Ernst Höckner (Wien Energie, AT) started with an **opening round on decarbonisation strategies** of their countries and an overview of the specific measures on which the countries are focusing.



Photo: Moderation by Sabine Mitter, BMK



Screenshots from the Livestream: Christiane Brunner, Verbund, AT (top, left), Per Alex Sörensen, CEO Plan Energi, DK, (top, right), Georgina Morris, Department for Business, Energy & Industrial Strategy, UK (bottom, left) and Ernst Höckner, Wien Energie, AT (bottom, right) Georgina Morris started and explained that in the UK there were a number of different strategies for decarbonisation published recently - for example, the Ten Point Plan for a Green industrial revolution, the Smart systems and flexibility plan for a transition to a net zero energy system or the UK hydrogen strategy. She emphasized three areas in the context of energy storage where important measures should be taken: innovation, hydrogen and markets.

Denmark has the very ambitious goal to cut GHG emissions by 70 % by 2030, stated Per Alex Sörensen. Besides plans to accelerate the transition to renewables towards at least 55 % renewables energy in gross final consumption in 2030 and measures regarding energy efficiency and building renovation, the latest step was on agriculture and food production. Furthermore, CCS/CCUS plays an important role in the net zero strategy of Denmark. The next step is to foster power-to-heat (P2H) using heat pumps for flexibility measures and power-to-mobility to include the e-mobility sector.

Christiane Brunner explained the position of Verbund regarding the Austrian climate targets. The Austrian power supply company is facing an increasing electricity demand due to the broad electrification of the mobility, heat and industry sectors. From their perspective a price on CO₂ for all sectors as well as fundings for energy efficiency measures and the heat sector are needed. Cooperation between all bodies (federal government, provinces etc.) and a supportive legal framework are crucial to put Austria on the path to the zero-emissions target. Action needs to be taken quickly and long-term infrastructure decisions need to be made now.

Ernst Höckner from the Viennese energy supply company Wien Energie added his point of view from a city's perspective. Wien Energie sets mostly on geothermal energy combined with heat pumps and waste heat to decarbonize the district heating system of Vienna. In the electricity sector, an increase in electricity demand of about 60 % is projected for the city of Vienna due to the electrification of the mobility sector and increasing cooling demand. The company calculates 21 billion Euro for the transition of the energy system in Vienna.

The second round deepened the opening topic in terms of the specific role of storage technologies in the presented decarbonisation strategies. The panellists were invited to give their assessment of what developments will be necessary in the future.

The UK is planning to build 3 GW of storage capacity to meet rising peak electricity demand. In doing so, the country will rely on different storage technologies at all scales, which will be realised at the most optimal locations in terms of infrastructure, energy supply and demand. As already mentioned, hydrogen will play a crucial role in the energy storage and decarbonisation strategy. Georgina Morris stated that funding schemes are needed to foster the commercialization of storage technologies. Electric, thermal and power-to-X technologies should be considered at all TRL levels.

In Denmark, storage systems are already under development. The next step will be the implementation of power-to-X technologies. The country does not have a high demand for large storage capacities for electricity, as its neighbouring countries in the north have numerous hydropower plants that can provide electricity when needed. The need to build large and expensive storage capacities is therefore not present. On the community level, district heating systems have already been implemented to a large extend, but they still need to be optimised in the future. Wien Energie is considering using hydrogen for electricity storage in the future. Ernst Höckner pointed out that cities must always be understood as net energy importers due to their spatial limitations for installing renewable energy and the high energy demand caused by high population density. Thermal energy can be stored via seasonal heat storage and aquifer storage. Solar thermal energy is not a focus for Wien Energie, as it only achieves high energy yields in summer when heat is not needed to this extent.

Austria has a long tradition of pumped-storage power plants and therefore large storage capacities already implemented, as Christiane Brunner explained. Verbund will focus on battery storage and the realisation of the flexibilization of energy demand. From Christiane Brunner's point of view, market signals and the right framework conditions are needed. For the broad implementation of storage technologies as crucial elements of the energy transition worldwide, international cooperation is important as well as cross-sector cooperation between R&D and industry to accelerate development and realisation.

Finally, Sabine Mitter thanked all the speakers and panellists of the day for their contributions to make it an interesting event and referred to the subsequent ExCo Meeting of the IEA Energy Storage TCP on 24 and 25 November.

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