The Relevance of Short and Long-Term Electrical Storage in Austria and the Czech Republic

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Content

Abstract

Electrical energy storage technologies are an essential bridge between electricity generation from fossil fuels and energy supply from renewables. These technologies help fight fluctuations of energy supply from renewable resources and provide grid security. Energy supply stability is becoming increasingly important with increased electricity production from renewables. Hence, more energy storage solutions must be implemented.

Both Austria and the Czech Republic have targets of increasing renewable energy in their portfolio. With already quite a high share of renewables, Austria developed specific targets for energy storage implementation, supporting both small-scale commercial storage technologies like integrated PV modules with battery storage and large-scale seasonal projects, for example, underground hydrogen storage. On the other hand, the Czech Republic puts as a primary goal a decrease of fossil fuel energy in their energy mix and has not yet developed a clear picture for the future of energy storage possibilities. Nevertheless, Czechs also implement support programs for small-scale storage.

Motivation

The alert of the community on the topic of global warming forces society to discover different pathways of fossil fuel substitution with more environmentally friendly sources of energy. The target of reduction of greenhouse gas emissions provides a push for energy generation using renewables such as wind, solar, biomass, geothermal energy, etc.

There is an annual increase in renewable energy share in the EU energy portfolio. However, a total switch of an energy supply towards renewable energy sources brings significant technical, organizational and economic challenges. Future cost and energy-effective smart grid solutions must provide stability to a power grid. This stability requires a balance of electricity and heat generation and consumption. Unfortunately, most renewable energy sources do not have stable output and cannot effectively react to changes in demand even during the day. Therefore, energy storage solutions are essential to compensate for discrepancies between supply and demand. Those discrepancies are caused by seasonal changes, day-night cycles, weather changes, and fluctuations in electricity prices.

The main idea of energy storage is to accumulate electricity or heat in a certain way in times of excess supply of energy, e.g. daytime or warm seasons, and further reuse this stored energy in times of its shortage. Electricity itself cannot really be stored in its own form. Hence, electrical energy storage mainly implies a conversion of electrical energy to other forms, such as mechanical, chemical, and thermal energy. In times of need, a backward conversion to electricity takes place.

As a result, of increasing demand, the decentralization of electricity production is being promoted. In this way, consumers become producers. While the main advantages of central energy are reliability and security of supply, decentralized energy is built primarily on the use of renewable resources and has the advantage of environmental friendliness and a constant supply price from own production. Energy storage is highly vital to district energy systems.

Problem Statement

Most of the energy storage technologies are still quite expensive, e.g. hydrogen storage, and most of the technologies are in the stage of development. Nevertheless, there is a high demand for more efficient and larger both electricity and heat storage technologies that must be implemented in the near future to achieve the goals of the EU for net zero emissions with a stable energy supply during the year.

This paper aims to give a comprehensive overview of short-term and long-term electrical energy storage technologies currently in use, being developed, and being considered for future possibilities in Austria and the Czech Republic. The differences and similarities of market trends in Austria and the Czech Republic regarding energy storage are outlined. The overview of targets of the countries is also discussed in the paper.

Approach

An extensive review of review papers and official reports such as EU publications and IEA and IPCC reports is performed while writing this paper. The local data sources are used for the literature review and data gathering for the research of the Austrian and Czech Republic markets.

The energy storage targets of the countries and governmental reports provide information for both electricity and heat storage possibilities. However, the paper focuses only on electrical storage solutions and does not provide information about heat storage technologies.

Results

1 Relevance of Energy Storage in AT and CZ

1.1 Relevance of energy storage in Austria

According to the European Green Deal (European Commission), the goal of carbon neutrality is set to be 2050. Unlike European Union, the Austrian government put the target of zero carbon emissions to be 2040 (IEA, 2020). In 2018, a strategy Mission2030 was released as a basis of the Austrian National Energy and Climate Plan (NECP) (Federal Ministry Republic of Austria, 2019). Some of the targets of this climate and energy strategy plan include the reduction of greenhouse gas emissions by 36% in comparison to 2005, the installation of 1 million PV systems by 2030, an increase in the share of renewable energy in electricity consumption to 100%, a decrease of primary energy intensity by 25-30%, etc. Some of the objectives and measures related to renewable energy are listed in Table 1.

Table 1 – Some of the main objectives and measures of the NECP related to renewable energy and energy storage (Federal Ministry Republic of Austria, 2019)

Objective	Sector	Measure
Reduction of GHG emissions by 36% compared to 2005	General	-
Increase the share of renewable energy in gross final energy consumption of energy to 46-50%, and source 100% of electricity consumption from renewables	General	- Expansion of renewable energy - Create a '100 000 rooftops solar panel and small-scale storage programme' - Basic conditions for feeding biogas and renewable hydrogen into the existing natural gas infrastructure - Develop a hydrogen strategy - Tax advantage for biogas and hydrogen
	Transport	- Increase the share of renewable energy in transport in 2030 to at least 14% by using biofuels and increasing the share of e-mobility
	Buildings	- Phase out the use of fossil fuels by replacing them with renewable energy sources for heating, hot water and cooling
Improve primary energy intensity by 25-30% compared to 2015	General	- Invest in electricity, gas and district heating grid infrastructure - Invest in storage, including heat accumulators - Accelerate demand response
	Buildings	- Increase the share of efficient renewable energy sources - Increase the share of district heating/cooling systems for heating, - active use of hot water storage and buildings as storage for load balancing and load flexibility

According to (Eurostat), the total share of renewable energy in Austria in 2020 was 36.5%, which is 1.5% higher than the target for 2020 as shown in Figure 1. In order to achieve 100% renewable electricity supply by 2030, a net increase of around 27 TWh in all sectors is required (IEA, 2020). In 2020 78.2% of electricity generated in Austria was coming from renewable energy (Oesterreichsenergie).

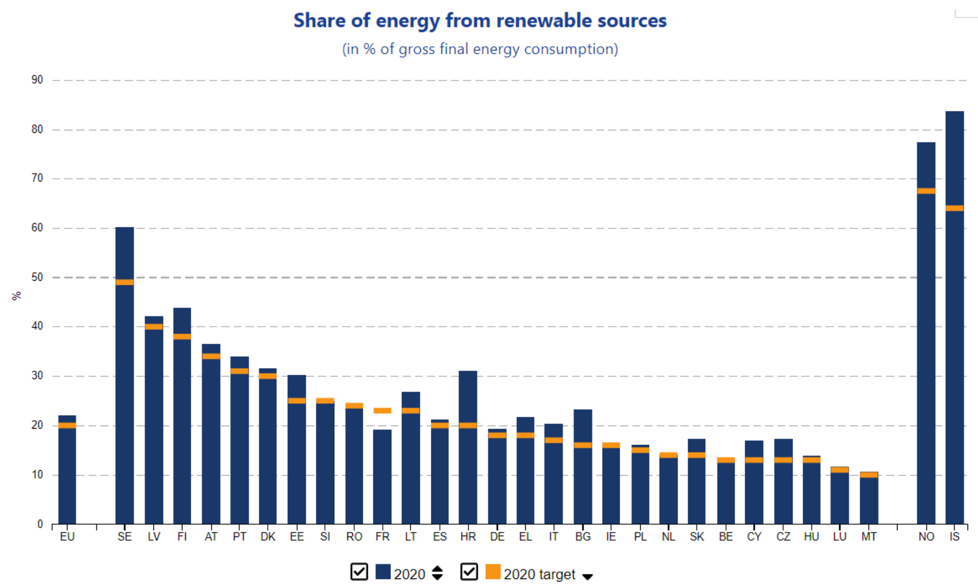

Figure 1 – Total share of renewable energy in Europe by country in 2020 (Eurostat)

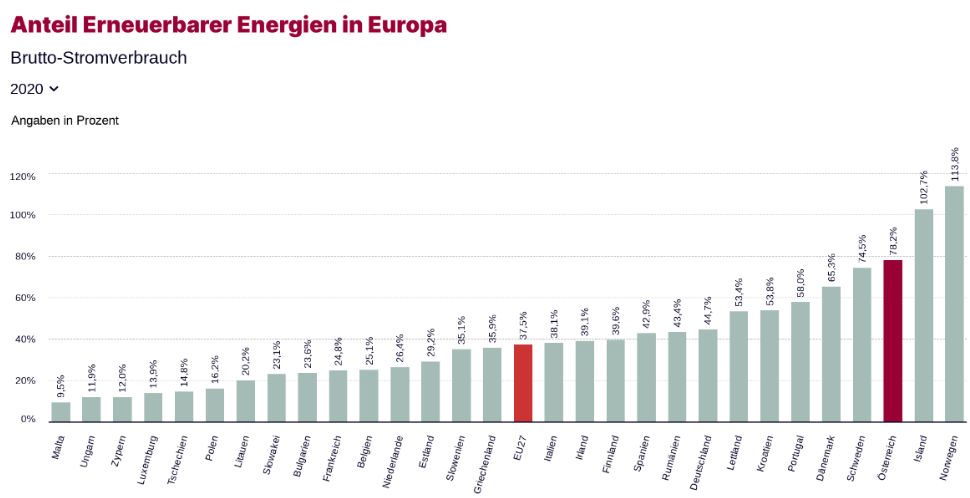

Figure 2 – Share of renewable energy in electricity generation in Europe in 2020 (Oesterreichsenergie)

In order to achieve a 100%-balanced power supply from renewables in 2030, good control and flexibility of the power system are required. This is achievable by high-efficiency combined heat and power plants and an increase in the energy storage facilities ranging from short-term to seasonal storage (Federal Ministry Republic of Austria, 2019).

1.2 Future aims for the energy storage of Austria

Energy storage systems are a key component in achieving the integrity of energy systems to come to climate neutrality in 2040 in Austria (Federal Ministry Republic of Austria, 2021). Energy storage provides flexibility for the grids by leveling energy generation and consumption, and as a result create stability and quality of supply. The importance of innovative storage technologies increases with time. It is proposed that energy storage will become a key component for connection between mobility and industry sectors. In general, sector coupling is one of the solutions to achieve carbon neutrality in Austria – surplus of electricity in one sector could be stored and used further in another sector (Oesterreichsenergie).

Ten target areas of the energy storage systems were developed as a part of phase two of the storage initiative 2019/2021 by Climate and Energy Funds of Austria (Federal Ministry Republic of Austria, 2021). The targets are shown in Table 2 in descending order according to potential. Some of the projects proposed in the report for the targets related to electricity storage in different fields of application are described further in the paper.

Table 2 – Ten targets for energy storage by Climate and Energy Funds Austria (Ettwein, et al., 2022)

Target	Field of action
1. Direct and indirect use of electricity and heat storage by energy suppliers to optimize the overall system	Energy industry
2. Power storage for peak load reduction	Industry and commerce
3. Seasonal electricity storage	Energy industry
4. Seasonal heat storage	New players
5. Network and system-friendly use of private electricity and heat storage (power-to-heat)	Households
6. Sharing of (central) electricity storage in energy communities	Households
7. Heat storage for waste heat utilization	Industry and commerce
8. Electric mobility for local grid stabilization	New players
9. Local electricity storage as grid and system-friendly equipment for the network operator	Energy industry
10. The energy community as a virtual power plant or virtual storage facility	New players

Many Austrian companies and research institutions are working on different energy storage solutions to decrease investment costs, improve the safety efficiency of the systems and provide compact designs of facilities (Federal Ministry Republic of Austria, 2021).

1.3 Relevance of energy storage in the Czech Republic

The biggest challenge for the Czech energy sector is the preparation for eliminating fossil fuels that account for one-third of the total energy supply and 46% of electricity generation (IEA, 2021). The energy production by years in the country is presented in Figure 3. In the EU countries, there is growing pressure to reduce energy production from coal and nuclear sources, and renewables are increasingly coming to the energy market. In the Czech Republic, renewable sources account for only 17% of energy production in 2020 according to (Eurostat) which is higher than the targeted 13% for 2020. A share of 37.5% of total electricity generated is coming from renewables (Figure 2). In order to phase out coal from the country's energy mix, nuclear capacity is planned to be the largest generation source in 2038 according to the National Energy and Climate Plan (NCEP) (IEA, 2021).

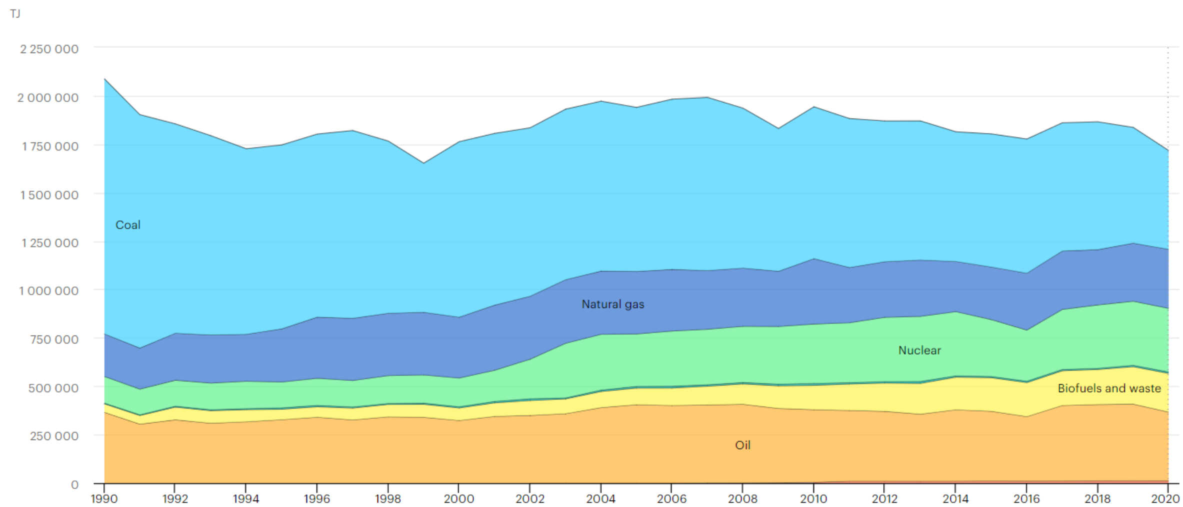

Figure 3 – Energy supply in the Czech Republic by source in 2000-2020 (IEA, 2021)

At present, biogas plants are the most widely used for the production of electricity from renewable sources, accounting for 13.62%, photovoltaic power plants for 4.15%, hydroelectric power plants for 3.9% of electricity and 0.97% for wind farms (the numbers account nuclear energy as a renewable source of energy) (Sitek, 2020).

In 2020, 10.3TWh of electricity was generated using renewable energy sources. NCEP projections target an increase to 17% of renewables in the electricity sector by 2030 that corresponds to 12.7 TWh. However, IEA considers this number as rather low target, for example only 4 GW of solar PV and just under 1 GW of wind power are planned to be achieved in 2030 (IEA, 2021). In 2018, 92 % of renewable energy in total final energy consumption was produced from bioenergy. The future of renewables also mainly relies on biomass in the country.

The government also initiated measures for the efficient use of geothermal energy in the electricity and heating/cooling sectors. Currently, geothermal electricity is not being used, but several projects are ongoing (IEA, 2021)

1.4 Future aims for the energy storage of the Czech Republic

The relatively low share of renewables in the energy market of the Czech Republic shows not much of a need for a particular strategy plan for electricity storage in the country. The government encourages renewable installations through investment support, for example, rooftop small-scale solar modules combined with battery storage, so-called hybrid systems.

Electricity and storage technologies are accounted for 12% of the total budget of the research, development and demonstration (RD&D) funds, mainly for electric power conversion and electricity transmission. The Czech Republic is also funding hydrogen by allocating 8% of the total energy-related RD&D budget (IEA, 2021).

Energy storage is also included in the plan of the Coal Commission, which proposed four scenarios for the coal phase-out from the energy market of the country (IEA, 2021):

1. reference: business-as-usual; maintaining the share of renewable energy sources as set in the SEP
2. conceptual: coal phase-out in the electricity sector by 2038 and identifying options for the further decarbonisation of the heating industry
3. progressive: coal phase-out by 2033, enhanced development of renewable energy sources and accelerated development of battery storage options
4. ambitious: builds on the progressive scenario and maximizes the development of photovoltaic power and even more accelerated storage options, including a significant development of seasonal storage.

2 Electrical Energy Storage in Austria

2.1 Current Operating Energy Storage Systems

2.1.1 Pumped Hydroelectricity Storage

The highest share of electricity generation among renewables is coming from hydropower – around 60%. The plan of the government is to increase hydropower generation by 5 TWh until 2030, making it accountable for 85% of total electricity generation in 2030 in Austria (IEA, 2020), as shown in Figure 4. Hence, the importance of pumped hydroelectricity storage will increase further to provide an even better integration in the European market by flexible dispatch of variable renewable generation.

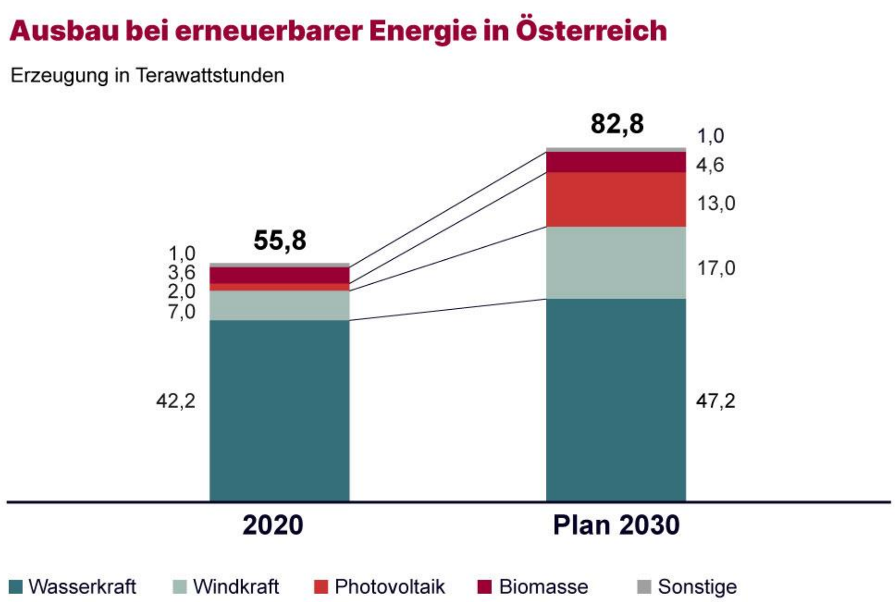

Figure 4 – Expansion of electricity from renewable energy by 2030 in Austria (Oesterreichsenergie)

Historically, the most popular type of energy storage in Austria are hydraulic storage and pumped storage power plants. The first commercial hydroelectric generation was performed in 1884, while theoldest pumped storage power plants appear a century ago in the 1920s (Pranz, 2020). The gross maximum capacity of a hydraulic storage power plant was 8.8 GW with a gross electricity production of 14.7 TWh (Federal Ministry Republic of Austria, 2021; Bundesministerium Klimaschutz, 2020). Among them, pumped power plants provide more than 4.5 GW of storage capacity in 2018 (Strobl, 2018).

The pumped storage hydropower plant is a modification of a conventional hydropower plant. In general, power plants include two tanks laid at different heights. These can be either natural characters or constructed artificially. Energy is stored in the form of potential water energy (Huggins, 2010). The water is pumped from the lower tank to the higher, this activity consumes energy. The pumping is done by low-cost off-peak electric power. To release the energy the water flows downwards through the turbines converting potential energy into electricity. In many cases, a reversible turbine can be used as a turbine and as a pump during pumping (Barnes & Levine, 2011).

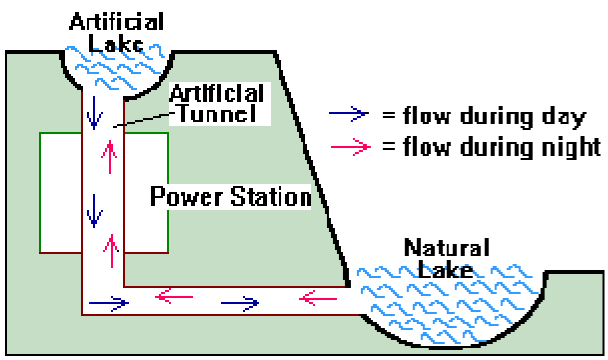

Figure 5 – Pump storage plant diagram

Unfortunately, the process of pumping water and subsequent discharge is not 100% efficient. Part of the electricity consumed to pump the water will result in losses. With regard to all losses, the efficiency is 70-80% depending on a specific design of the power plant (Barnes & Levine, 2011).

The biggest pumped storage in Austria is Mthe alta pumped storage power plant with a power capacity of 730.7 MW. It is located about 1933 m above sea level in the mountains of Carinthia, Austria (Obermann, 2019). The ten biggest pumped hydroelectricity storage systems of Austria are shown in Figure 6.

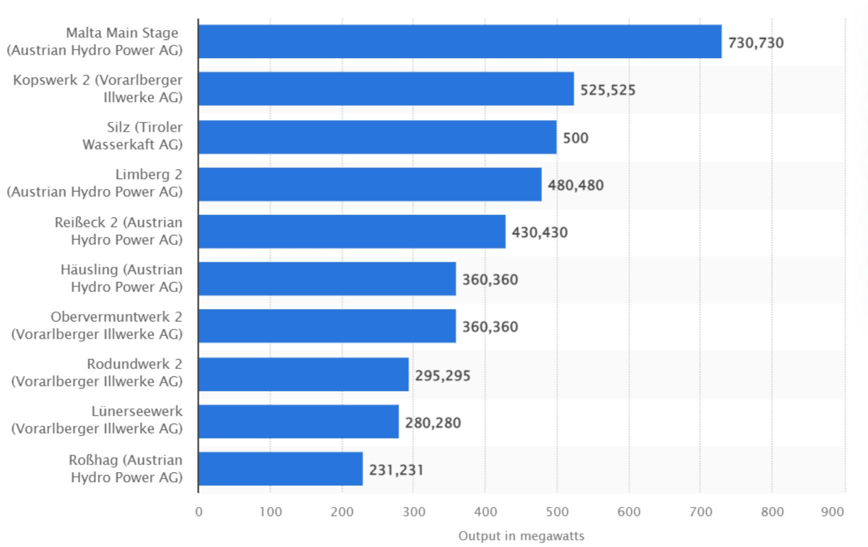

Figure 6 – Ten biggest pumped storage power plants in Austria in 2022 (Statista, 2022).

According to the Power plant map provided by Österreichsenergie, there are 20 pumped hydro storage plants in Austria (Oesterreichsenergie, 2022).

2.1.2 Battery Electricity Storage

A large battery storage system is located in Prottes, Lower Austria and connected to the Prottes-Ollersdorf wind farm with a 36.6MW active capacity. The storage system consists of 14,112 lithium-ion battery cells that offer a partial solution for grid stabilization (Figure 7). The output is 2.5 MW, which is enough for 600 households on average, and the capacity of the storage is 2.2 MWh. The system was developed as a part of the "BatterieSTABIL" research project and was commissioned in 2017 (EVN).

Figure 7 – Battery storage integrated to EVN wind farm in Prottes, Austria (noeORF.at, 2019)

2.1.3 Commerciale Scale of Energy Storage for Households and Individual Usage

The drop in price led to a substantial increase in sales of photovoltaic batteries (PV). Contribution to a rise in the number of sold PV batteries was also from public subsidies and increased motivation of private and commercial investors. In 2020 only 4385 photovoltaic battery storage systems were installed in Austria with a total capacity of 57 MWh. Overall, there were 11908 PV storage systems in Austria with a cumulative capacity of 121 MWh (Federal Ministry Republic of Austria, 2021).

A governmental program “100,000 rooftops” targets panels panel and small-scale storage and intends to encourage private individuals and businesses to use the rooftop areas for PV modules. Self-produced electricity is abolished from taxthe es by NCEP plan: currently, the first 25,000 kWh of self-produced electricity is exempt from tax (Federal Ministry Republic of Austria, 2019).

2.2 Electricity Storage Projects

A special interest is put onto sector coupling technologies that realize long-term energy storage possibilities. These technologies provide a link between different energy sectors such as the electricity sector with gas and heat sector, e.g chemical storage through conversion (power-to-heat, power-to-gas (PtG), etc) (Federal Ministry Republic of Austria, 2021).

Innovative energy storage technologies such as hydrogen storage systems, PtG, stationary electrical storage, latent heat storage systems and thermochemical storage systems are in active research and innovation or early marketing stages. Overall, 36 Austrian companies and research institutions are involved in the development of these new energy storage technologies. Among 36, 17 stakeholders already offer innovative energy storage solutions to the Austrian market (Federal Ministry Republic of Austria, 2021).

2.2.1 Hydrogen and Power-to-Gas Storage

One of the most promising current projects is “Underground Sun Storage 2030”. In this project, underground hydrogen storage is developed on a large scale for seasonal storage of energy (USS-2030). The project targets renewable sources of energy such as wind and solar power. The energy is harvested during summer for hydrogen production by water electrolysis. Produced pure hydrogen is pumped into the depleted natural gas reservoir and stored in the subsurface. In the wintertime or at the time of need, the hydrogen is pumped back to the surface and used as an energy source (Figure 8). The concept of the project is tested at a small former natural gas reservoir in the municipality of Gampern in Upper Austria.

The facility has an enormous storage capacity – more than 8 billion m^3, equivalent to 92,000 GWh (Underground Sun Storage).

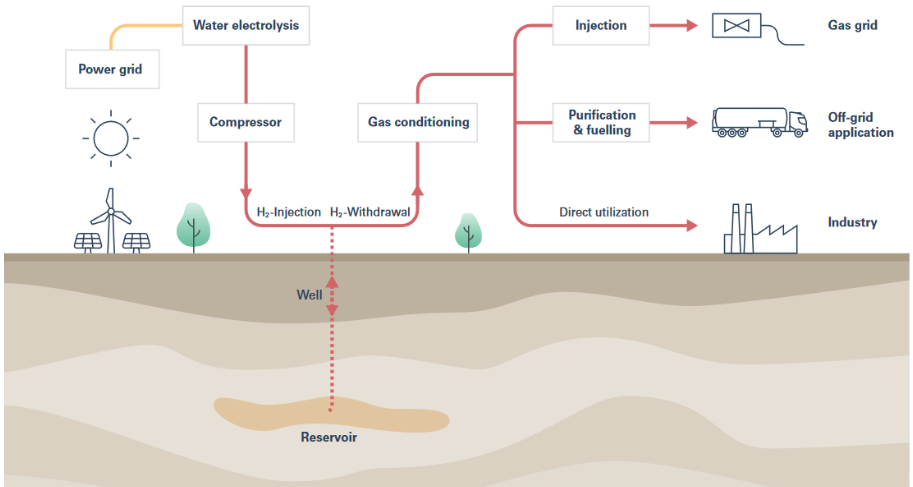

Figure 8 - Sketch of storage concept for the project Underground Sun Storage - 2030 (USS-2030)

The project is based on the previous "Underground Sun Conversion" and "Underground Sun Storage" projects. In "Underground Sun Conversion", the mixture of hydrogen and carbon dioxide from biomass combustion is pumped into the porous rock at 1000 m depth. The microorganisms that exist in the reservoir convert hydrogen and carbon dioxide into methane in a short time as shown in Figure 9.

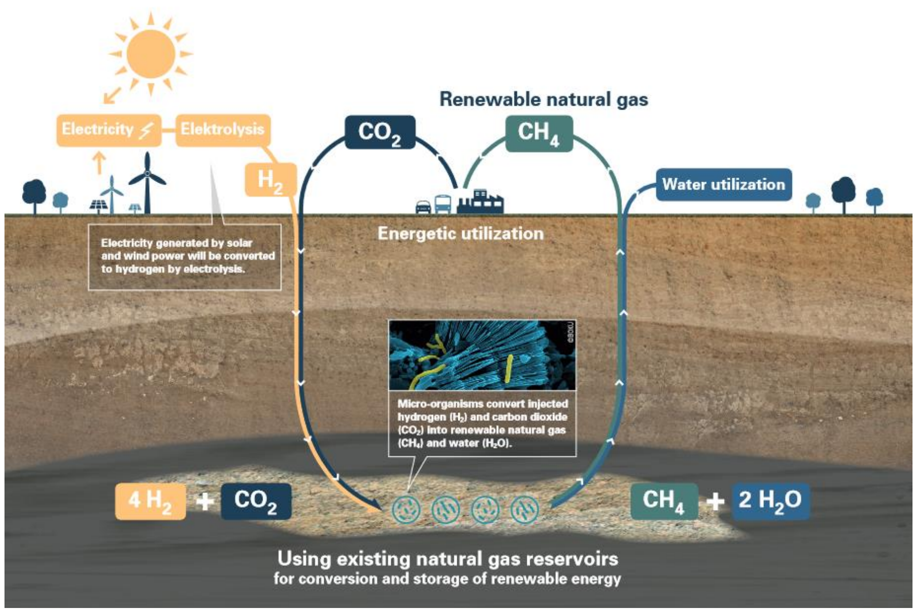

Figure 9 – Power-to-gas storage concept in the project Underground Sun Conversion (Underground Sun Conversion)

The process simulates a geological accumulation of natural gas in the rock performed in a much shorter timeframe (Underground Sun Conversion).

The second project, “Underground Sun Storage” aimed to demonstrate that gas reservoirs could tolerate hydrogen content of up to 10 % (Underground Sun Storage). This goal was achieved and it was proved that even 20% of hydrogen content might be stored in the underground reservoir.

2.2.2 Battery Storage

The second promising project “Car2flex” targets short-term electricity storage. Electrical vehicles make a big contribution to CO2 reduction in the transportation sector. Additionally, the batteries of electric cars can be used as an intermediate electricity storage option for a surplus of energy generated during the day from wind and solar power (Federal Ministry Republic of Austria, 2021). Stored energy is then discharged during the peak loads. Such a solution safeguards the stability of the entire energy system. Flexible charging and discharging may help to balance out the fluctuation of energy.

The focus of the project is on the private users of electric cars, company e-vehicle fleets and electric car-sharing. In order to assure the effectiveness of the concept, those three electric mobility user groups were defined (Figure 10). For each application the concepts of charging and discharging processes are developed and tested based on the data about the maximum average charge required, frequency of car usage and the average distances travelled.

Interaction of an electric vehicle and power grid is done through bidirectional direct-current charging, which assures a direct transfer of PV electricity without conversion into an alternating current. The bidirectional function allows the delivery of the energy back to the grid by drawing power from the car battery to the charging pillar (Car2Flex).

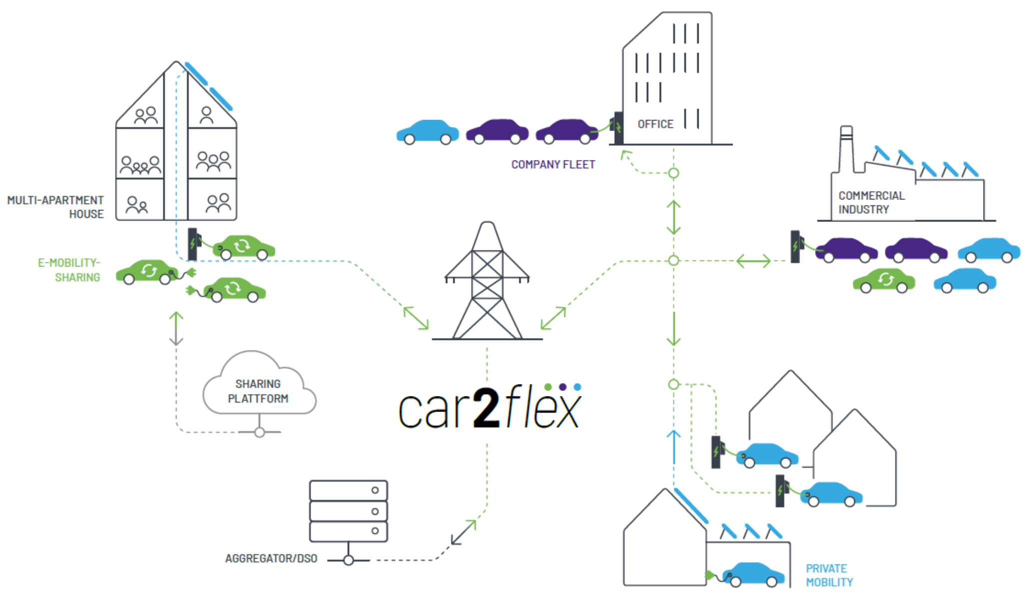

Figure 10 – Battery storage concept in Car2Flex project (Car2Flex)

There are also several other projects related to battery storage systems as a solution for peak load reduction in commercial buildings. One of such projects is “SPIN.OFF”. The idea implies the integration of zinc-bromine redox flow batteries within the office building Tech2Base in Vienna.

Additionally, a self-learning energy management system is implemented to increase self-consumption (SPIN.OFF, 2016).

3 Electrical Energy Storage in the Czech Republic

3.1 Current Operating Storage Systems

Currently, there are only two main storage technologies being used on the industrial scale in the Czech Republic. The main technology is pumped storage and another an emerging widely spreading technology is battery storage centers. Other technologies such are hydrogen storage are still under testing and development. Hydrogen storage has not been implemented on an industrial scale in the Czech Republic yet.

3.1.1 Pumped Hydroelectricity Storage

The most widely used electricity storage technology in the scale of grid electricity systems in the country are pumped storage plants. Over 90% of the installed capacity of large storage facilities in Europe so far is a pumped storage. There are four pump storage plants in to Czech Republic and their total installed power output is 1175 MW (Voboril, 2016). The most powerful of which is Dlouhé stráně in the Jeseníky Mountains (Figure 11). The construction of the plant started in May 1978. In the early 1980s, however, it was transferred to the decommissioning program by decision of the central authorities. In 1985 the project was modernised and after 1989 it was decided to complete the construction. The plant was commissioned in 1996. The technological process is provided by two reverse turbomachines, each with an output of 325 MW. The reverse turbine output is 312 MW in pump mode and up to 325 MW in turbine mode (Cez Group, 2022).

Figure 11 – Dlouhé Stráně pump storage plant.

3.1.2 Battery Storage Systems

The Czech Republic now has only four battery electricity storage sites. The battery storage facility at C-Energy Planá, which uses Siemens Siestorage technology, has a capacity of 4 MW and a guaranteed capacity of 2.5 MWh for 10 years, making it the largest battery storage facility in the Czech Republic. The project won the Czech Energy and Environmental Project, Construction, Innovation of the Year 2018 competition (Hybrid.cz, 2021). The total installed capacity of the connected power plant is over 105 MW (C-Energy).

Figure 12 – C-Energy battery storage and the Plana power plant (C-Energy)

3.2 Commerciale Scale of Energy Storage for Households and Individual Usage

Today, more than 2,000 buildings in the Czech Republic use battery storage facilities, which are used to store electricity obtained from photovoltaics. Thanks to subsidies and a gradual reduction in the prices of domestic battery storage, it can be expected that the demand for energy storage systems in our country will continue to grow (Sdeleni, 2020). The capacity of battery storage is around 4.8 - 16 kWh. With the strengthening tendency to "behave sustainably", interest in these technologies is growing not only among companies but also in ordinary households. This is also helped by the support programs of the ministries, especially the Ministry of the Environment with the New Green Savings Program, which is intended for homeowners. The path to self-sufficiency thus opens up for Czech households as well.

4 Comparison to the EU Energy Storage Targets

According to the latest EU strategy REPowerEU, power production from renewable sources of energy is set to increase from 1.028 TWh to 2.447 TWh in 2030, corresponding to 45% of the energy supply in 2030 (European Commission, 2022). The share of renewable energy in the European electricity market is set to increase to 50% in 2030 (European Commission, 2017). EU Solar Strategy targets a doubling of solar PV capacity by 2025 (European Commission, 2022).

Hence, cost-efficient integration of the renewables is required. The EU sees energy storage as one of the key solutions for the successful energy transition (European Commission, 2017).

The global energy capacity was estimated as 171 GW, which is approximately 2% of energy capacity. The main energy storage technology globally still remains pumped hydroelectricity storage, which accounts for 97 % of global electricity storage capacity (European Commission, 2017). In 2015, 50 GW of net pumped hydro storage capacity was in operation in the EU which corresponded to 12% of the total electricity capacity in the EU (EASE & EERA, 2017). The biggest pumped hydro storage players in the European market are shown in Figure 13.

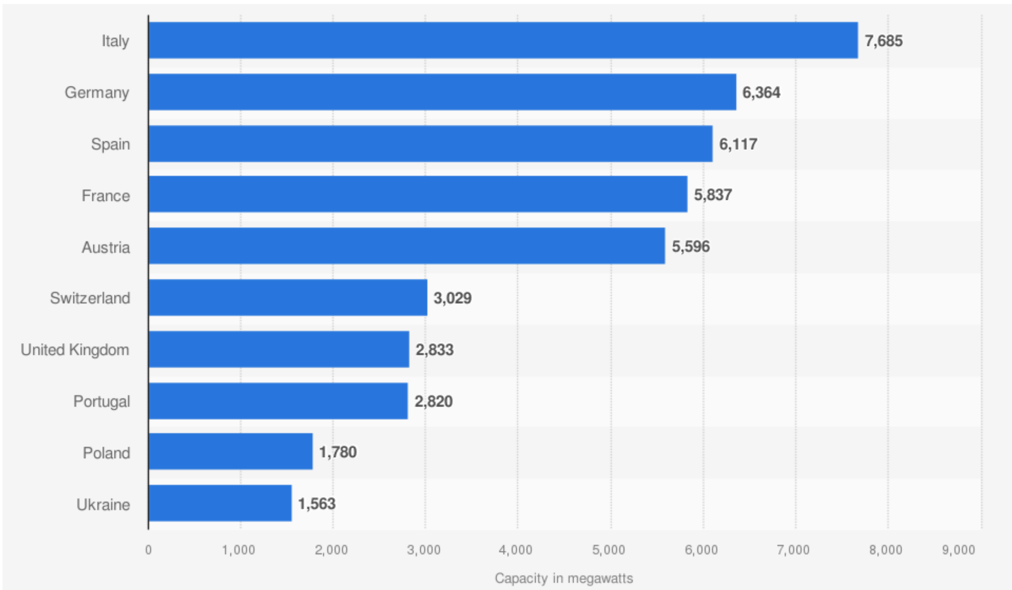

Figure 13 – Cumulative installed pumped hydropower storage capacity in Europe by country (Statista, 2022)

The goal of the EU is to have 10 million tons of hydrogen production and 35 billion m³ of biomethane by (European Commission, 2022). These two technologies are long-term large energy storage solutions called power-to-X (-gas, -liquid, -heat). With the new strategy, they will become a big player in sector-coupling solutions, proving a bridge between the electricity sector and the gas and oil sectors. These storage solutions, for example, synthetic methane production and hydrogen storage are seen to use in the future in the existing infrastructure from the gas sector (EASE & EERA, 2017). This correlates to the Austrian vision of “Underground Sun Storage”, where the test of ready pipeline and infrastructure of natural gas industry was done for different hydrogen gas contents in storage and transportation.

A Solar Rooftop Initiative is directed towards to future obligation on the solar panels installation on the new residential and commercial buildings (European Commission, 2022). Both, Austria and Czech Republic have already implemented some strategies to attract individuals and businesses for a private PV module usage.

Among EU countries, Germany is the strongest in the development of battery storage facilities, while in the Czech Republic this is hindered by legislation and mainly pumped storage plants operate as storage facilities. However, by 2050, batteries are set to surpass hydrogen in importance (Hybrid.cz, 2021). Among EU member states, Germany is the top performer with 115 facilities or projects. A study commissioned by the European Commission summarizes the state of storage facilities. According to it, the Germans also lead in the number of facilities already in operation and in the installed capacity of operating storage facilities. This amounts to 7.5 GW, which corresponds to about a third of the installed capacity of all power plants in the Czech Republic.

Conclusion

The EU Green Deal strategy and the additions made by REPowerEU target a huge increase of the share of energy generated by renewables source b 2030 and 2050, which is a part of the plan for carbon neutrality in 2050. Austria and the Czech Republic both aim in this direction, however, big differences in the type of energy sources in the energy portfolios show dissimilarities in the energy strategies of the two countries.

The main target of the Czech Republic for the next decades is the elimination of fossil fuels primary coal from the energy mixture by 2050. In order to accelerate the process, the Czech government is willing to increase nuclear share and biomass. As overall electricity produced from renewables is not high in the country, there are no specific strategies for energy particularly electricity storage defined so far. Nevertheless, the country continues the growth of number of pumped hydro storage power plants and the battery storage facilities in PV power plants. Future projects and developments on energy storage need to create a smooth transition towards less-fossil energy market.

In contrast to the Czech Republic, Austria has already a big share of renewables in electricity production. Therefore, the importance of the electricity storage is extremely high for achievement of flexible energy system of the country and providing energy sector coupling. The largest energy storage type similar to the neighbors is pumped hydroelectricity storage. Additionally, the power-to-gas projects related to hydrogen and the battery storage are implemented in the country and so many more projects in different types of energy storage is developed.

On the private and commercial are, the both countries implement measures to stimulate an increase of hybrid PV batteries.

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