Acknowledgement

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Overview of Austria’s electricity market

Austria’s annual electricity demand is at approximately 74 TWh, where 90% of the annual balance is supplied by domestic generation and the rest by net imports from the EU. Electricity generation from domestic renewables counts for appr. 74% of the domestic generation. Regarding renewable generation, Austria has a top ranking within the EU. Since the very beginning of electricity supply Austria has focussed on electricity generation from renewables, with hydropower as the most relevant technology. In 2019, with 38 TWh, hydropower forms the renewable generation backbone followed by wind power (6 TWh), solar PV (1.4 TWh), biomass (4.9 TWh) and other minor renewable generation sources (RESE).

Due to the favourable topographic and hydrological conditions, many forms of storage hydropower represent one third of the power plant capacity in Austria, the installed capacity of run-of-river and storage hydropower equal approximately two thirds. The natural inflow of hydro storage and pumped hydro storage plants flexibly generate some 8-10% of Austria’s electricity from renewables (cycling not included). For industrial purposes and additional generation of public heat and power supply, several gas-fired plants are in operation. Most of them highly efficient combined heat and power units (CHPs).

On 8th of January 2021 a close-to-a-blackout-event occurred. Huge hydropower assets significantly contributed to system stabilisation, as well as providing inertia, and the major hydro storage and pumped hydro storage facilities, in case of a blackout, would have been the first on the scene for black start, islanding operation and grid restoration as they are an integrated part of the national emergency management of power supply. Meanwhile, the interim report of the European Network of Transmission System Operators (ENTSOE) on the event gives evidence of the substantial role that hydro storage and pumped hydro storage played to avoid any further damage.

According to the EU’s Green Deal, Austria’s climate and energy strategy is ambitious. By 2030 100% (annual energy balance) of the electricity generation should be consumed from national renewable generation sources. This means approximately 27 TWh of additional generation installations consisting of 5 - 8 TWh hydropower, 10 – 12 TWh wind power, 10 – 12 TWh solar PV and some additional generation from biomass. All in all, Austria has a techno-economic hydropower residual potential of approximately 12 TWh. Regarding hydro and wind power this additional generation will be achieved preferably by efficiency improvements and extension of existing facilities, but also by new installations. In a first estimation, the efficiency improvement potential of existing hydropower plants in Austria will be significantly used to compensate renewable generation losses caused by measures to be taken in order to implement the Water Framework Directive (WFD).

Following the general decarbonisation policies, Austria aims to become climate neutral by 2040 – 10 years before the EU. This means enormous efforts to decarbonise the industry and transport sectors as well as heating and cooling. Sector coupling and sector integration will be the key drivers, which implies an even further need for new RES generation going beyond the 27 TWh target. To avoid conflicts with other sustainability criteria, these investments will be accompanied by an ambitious environmental impacts assessment framework.

Austria’s electricity market is fully liberalized for ancillary services products such as frequency reserves, while others (e.g., black start capability, islanding ability, voltage stabilisation, reactive power compensation, etc.) are not remunerated. Being situated within the heart of Europe, Austria’s electricity companies are also engaged in the European power market. Austrian hydro storage and pumped hydro storage power plants significantly contribute to Central Europe’s needs of system stability, security of supply, and big scale renewables integration. In particular one of the major concerns of the strategic European electricity infrastructure planning is to make the Alpine hydropower potential available for the future Central European flexibility demand (ENTSOE TYNDP 2020) being the most affordable, efficient, scalable and reliable emission free technology for that purpose.

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1 Integrated National Energy and Climate Plan for Austria 2021-2030
The main challenge to PSH development is comparably disproportionate funding policies. These disproportionate funding policies may cause market distortions in future, when new flexibility technologies amount a significant market share, such as Power-to-X (P2X) solutions. For market entrants based on new technologies, permitting procedures may be reduced to foster their development.

While – depending on their location – wind power plants and PV installations may already be commercially fit today, further need for incentive funding is argued to attract private investors for further installations. On an international level, there are discussions that power to gas (e.g., electrolysers), and storage facilities including pipeline buffer storage, should be owned and operated by unbundled gas infrastructure enterprises to speed up sector coupling engagement. These solutions in fact could significantly influence the power (flexibility) market as they would then be part of the regulated grid operators’ portfolio with a significantly different financing regime. Moreover, effects of regulatory sandboxes proposed for sector coupling solutions should be observed in order to avoid distortions to/in the electricity markets.

The energy transition process is intended to progress rapidly. Long-lasting permitting procedures including spatial planning issues, etc. are only one example that may become an essential criterium for any kind of large-scale renewable energy technology engagement. This is relevant for large-scale hydropower, wind farms and solar PV-farms as well.

From a technical perspective, the intermittent generation characteristics of PV and wind power, together with the given seasonality of all renewables, will disproportionately drive the flexibility demand in a yet unknown manner, in any timeframe from short-term to seasonal. Thus, safeguarding system stability and redispatch issues are the focus of ENTSOE’s system needs studies and the European energy regulation framework (e.g., the regulation on guidelines for the trans-European energy infrastructure, TEN-E regulation).

Current status of pumped storage & development potential

There are approximately 20 pumped hydro storage sites with an installed turbine capacity of approximately 5.1 GW and a pump capacity of approximately 4.2 GW located in Austria. Additionally, there are approximately 35 larger hydro storage sites with an installed turbine capacity of approximately 3.4 GW. A few of them are of system relevance.

It is typical for the Alpine region that system relevant flexibility facilities are designed as integrated functional units consisting of one or more pumped hydro and hydro storage sites with a succeeding cascade. Following the lower reservoir, this cascade consists of at least one power station (Figure 1). As a rule, the use of natural water bodies expands the flexibility potential in all timeframes, from short-term to seasonal. Concepts include seasonal storage also for pumped hydro. From a general flexibility needs perspective, and under the precondition of an efficient use of natural resources, it would be restrictive if system relevant flexibility from hydropower would only be focussed on pumped hydro storage designs.
These hydropower flexibility facilities are the backbone of Austria’s system stability and security of supply. All assets are in private ownership and operate as part of the energy markets, providing all given products. Remuneration of storage assets is mainly given by the energy market (intraday, day ahead, forward) while the reserve market also includes a capacity component.

Flexibility from Austrian storage and pumped storage assets is also provided cross-border on the European markets. Regulatory issues essentially concern ancillary services (frequency containment reserves) provision and grid fees. In general, PSH is charged with double grid fees for pumping and generation, while this is not the case in any other neighbouring country, and results in market distortions. In Austria and Germany – the main market spots for this purpose – ancillary services provision underlies regulated, transparent auction mechanisms. Ancillary services market access for reserves is available for prequalified facilities (Figure 2). As other ancillary services like voltage stabilization, reactive power compensation, blackstart capability, etc. are not remunerated today, an EU-wide market for these products could foster the Internal Market.

To speed up the implementation of sector coupling, and to make it commercially more attractive, at the national and EU level, it could be considered implementing special grid tariff solutions for this purpose. To avoid market distortions, it would be more reasonable to have a technology neutral playing-field on grid tariffs from the very beginning of this development: on a national level and within the EU.

Depending on the future regulatory framework and the expected market conditions, another approximately 800 MW pumped hydro storage capacity is expected to be installed by 2030. The vast majority will be an extension of existing flexibility facilities. In 2021, TIWAG will start the construction of a 130MW-pumped hydro unit complementing the Sellrain-Silz-Group located in Tyrol.
Challenges, barriers and emerging opportunities for pumped storage development

As hydropower in general and storage – as well as pumped hydro storage facilities in particular – have been the backbone of Austria’s security of electricity supply and a substantial precondition of socio-economic welfare, this technology has a very good standing in the public opinion. Furthermore, it is and will be a basic precondition for the big scale integration of variable RES. From 2019 on, there have been several studies on Austria’s future flexibility demand resulting from the latest national climate and energy action plan targets. They outlined, that already by 2030 Austria would have an excessive demand growth for flexibility needs (both GW and TWh); this applies to both energy directions, being characterised by an enormous increase of ramp rates and thus requires highly efficient, reliable and powerful flexibility facilities, preferably given by hydropower but also by other technologies. The existing flexible capacities will not be sufficient for these expected challenges.

From an industrial perspective, the investment volume for Austria’s further hydropower development may be roughly estimated at a similar level as is expected for solar PV and wind power.

As mentioned above, Austrian hydropower flexibility facilities use natural water bodies and generate electricity from a domestic renewable resource to meet the demand at any time. Compared to other European regions, this integrated concept combined with huge storage volumes and heads is an economic advantage for these facilities in the Alpine region. A true challenge is the long duration of permitting procedures caused by the increasing complexity and the dynamics of changing legal frameworks that may also lead to inconsistencies.

From a technical perspective, ENTSOE’s strategic electricity infrastructure planning offers in a technology neutral manner a good orientation for the quantified dynamic growth of future system needs, that are also relevant for the future demand of flexible hydropower facilities. At EU level, EURELECTRIC and VGB PowerTech/Hydro combine technical questions and market relevant issues to clear policy statements as an input for regulatory framework also regarding hydropower. Oesterreichs Energie, the Austrian association of electricity suppliers, represents hydropower concerns at national level. Furthermore, there are several international institutions of interest that give good support relevant to hydropower (e.g., Arbeitsgemeinschaft Alpine Wasserkraft, AGAW, IEA Working Group Hydro/Annex IX, etc.).
While the given Austrian National Energy and Climate Plan (NECP) clearly recognises flexible hydropower facilities as a backbone for system stability, security of supply, and intermittent renewables integration, for the time being there is no significant regulatory or legal engagement evident, that would specifically support the further development of this highly efficient, scalable, reliant and emission-free technology. On the EU-level, the regulation on Trans European Energy Infrastructure, TEN-E, is the legal basis to identify infrastructure projects of common interest (PCI). Meanwhile, the 4th PCI-list is published and pumped hydro storage projects have the major share of all eligible projects to improve system flexibility and security of supply. This would also be expected for the 5th PCI-List being published end of 2021.

Since 2015, in Austria there have been several pumped hydro storage investments with system relevance: Obervermunt II, Reilswerk, Reisseck II being already commissioned, and last but not least the Sellrain-Silz-Extension (construction start in spring 2021) underline the ongoing engagement of Austria's leading hydropower companies. As far as is known all these investments were done without any public investment support.

Recommendations

1. **To policymakers:**
   Since decarbonisation is the primary target of the energy and climate strategy, we recommend giving hydropower clear political support as that given to solar PV, wind power, sector coupling technologies and batteries, as PSH projects are already an integrated part of the TSOs’ Ten Year Network Development Plans.

2. **To policymakers:**
   Since efficiency is the leading principle for policymaking, we recommend giving hydropower clear public support as it is technically and economically a well-developed and proven technology.

3. **To policymakers:**
   In order to guarantee the large-scale integration of wind power and solar PV, hydro storage and pumped hydro storage should be positioned as the most efficient, reliable and scalable technology to safeguard system stability and security of supply.

4. **To policymakers and authorities:**
   In order to continue the energy transition successfully with the given and even accelerated high speed performance, we must avoid any two-speed development of energy infrastructure improvement and renewables integration. Otherwise, a blackout will be unavoidable. We suggest an acceleration and streamlining of approval processes without lacking quality as a key factor.

5. **To policymakers and authorities:**
   In order to avoid any market distortions, we need to create and keep a technology neutral regulatory level playing field including unbundling options for sector coupling issues.

6. **To policymakers:**
   In order to make the Internal Market work effectively, a clear commitment to it and its decent implementation are needed. A clear regulation for storage and flexibility at EU-level is desirable. The strategic goal should be a market-driven remuneration scheme for flexibility. This implies a reduction/cancellation of all market-distorting support schemes for flexibility and storage options (unless in the stage of research and innovation). All system services have to be remunerated. This is not the case in all member states and requires EU-wide streamlining to reach a level playing field.

7. **To national policy makers:**
   To reach 2030 targets, member states have to speed up permitting procedures.