Pumped Storage Hydropower International Forum

Policy and Market Frameworks Working Group

Portugal - Europe

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Overview of the country's/region's electricity market

The generation capacity in Portugal, at the end of 2020, was above 20 GW distributed by the following technologies:

Table 1 Portugal's generation capacity by different technologies, 2020

Installed Capacity at the end of 2020	Capacity in GW
Hydropower	7.2
Wind	5.2
Biomass	0.7
Cogeneration	0.3
Solar	0.9
Coal	1.8
Gas	4.6
Cogeneration	0.8

Source: REN[1]

In 2020, hydroelectricity provided 25% of the electricity generation, and renewables supplied about 60% of the consumption.

Considering hydropower specifically, its present share was made possible, to great extent, due to a National Programme for Large Dams launched by the Portuguese Government in 2008.

Under this context, the Portuguese power utility company EDP, Energias de Portugal S.A., has developed a project pipeline of 8 hydropower schemes, 3 greenfield and 5 repowering, adding 2,225 MW of installed capacity.

Portugal aims to close its remaining coal units by the end of 2021, after closing the Sines Power plant (1,200 MW) in the beginning of 2021.

Wind and solar will make up the bulk of future supply additions, alongside with the Alto Tâmega hydro scheme, currently under construction, with an installed capacity of 1,154 MW, and that will start operation between 2022 and 2023.

Policies:

In December 2019, the Portuguese Government issued the National Energy and Climate Plan 2021-2030 (PNEC 2030). According to this plan, the contribution of renewable generation will reach 80% in 2030.

[1] Redes Energéticas Nacionais – "Dados Técnicos 20" - Technical Data, page 14

Also, in 2019, the Portuguese Government published the Roadmap for Carbon Neutrality 2050 (RNC2050) aimed at promoting the actions that are needed to meet the carbon neutrality goal for 2050 set out in the Paris Agreement.

One of RNC2050's targets is the total decarbonisation of the power generation sector by 2050 and, for this to happen, batteries and hydro pumped storage, by 2050, will account for 7.5 GW, about 14% of total installed capacity, offering storage and facilitating efficient management of the electric supply/demand equilibrium.

The Roadmap assumes that batteries will become a cost-effective technology, necessary for stability of the system, as early as 2025 (187 MW), coupled with a renewable capacity, sun and wind, that will exceed 16 GW. However, it is from the 2030s onwards that the weight of this technology becomes more significant, reaching values between 0.6 and 1.0 GW in 2030 and growing to 4 GW up to 2050.

Current status of pumped storage & development potential

The total pumping installed capacity in Portugal is 2.5 GW, which will be increased in the next years to 3.4 GW (mainly from the Alto Tâmega scheme).

From the present-day pumping capacity, a significant portion (approximately 1.5 GW) was added, as mentioned before, by EDP in 5 powerplants from which the Frades II PSH (2 x 390 MW) is equipped with the largest hydro units in Portugal and, also, for adopting variable speed technology, providing the possibility of power variation in pumping mode which, in turn, makes them the largest of their kind in Europe.

Currently, PSH plants participate in the Iberian electricity market, operating either in turbine or pumping mode, attaining revenues from the price differentials (arbitrage) between the off-peak and peak hours, along with the provision of ancillary services, mainly secondary and tertiary reserves.

Although there are no public studies regarding the economic feasibility of new PSH in Portugal, there is the consensual idea that the current market and regulatory arrangement are not sufficient to provide adequate remuneration to promoters, although there are sites revealing potential, with technical and economic indicators comparable with those of other projects under development (or soon to be developed) across Europe.

Challenges, barriers and emerging opportunities for pumped storage development

The environment licensing for PSH is particularly challenging and complex, depending on public, social and governmental entities' willingness to provide a swift and predictable process approval for each project.

No visible funding has, so far, been made actionable for PSH investments which means that the promoters of recent (and undergoing) projects performed their economical evaluation based on their market outlook as it is currently defined and, possibly in some cases, the strategic interest in growing share in this particular geography. Nevertheless, from 2012 to 2020 some new PSH received a capacity payment ranging from 11.000€/MW to 23.000€/MW.

The major opportunity for pumped storage development lies in the foreseen massive entrance of non-dispatchable renewable energy sources (RES) which, as mentioned, may require 7.5 GW of installed storage capacity by 2050.

Being clear that the largest portion of added storage capacity is anticipated to be provided by batteries, there is, so far, no idea regarding the mechanisms which need to be deployed to promote such investments. Being clear that battery cost will significantly decrease in the coming years it is, however, quite likely that a feasibility gap will remain which will have to be covered (directly or indirectly) by other remuneration mechanisms that reflect the benefit provided by batteries to the system.

In any case, pumped storage should meet no entrance barrier, as long as it remains competitive in respect to batteries in a "levelized cost of energy" perspective.

Price arbitrage will increase in the future, as the share of renewables increases, implying a more significant price variation during the hours of the day and more hours of cheap prices, resulting in higher price spreads. Also, price caps that currently exist in the Iberian Market will soon be eliminated, and storage equipment will also benefit from negative prices. This evolution in the electricity market will create more opportunities for pump storage power plants.

One other relevant opportunity refers to the "long duration" storage, that will never be provided by batteries (above 4 hours). This storage will be necessary to partially replace the backup function that presently is assumed by thermal power plants that will work less and less hours and risk being decommissioned as we approach a fully decarbonized electricity generation target.

Capacity remuneration mechanisms will need to be implemented and ancillary services markets improved to create a framework for investment in storage equipment.

Regarding ancillary services in Portugal, currently:

- Frequency Containment Reserve (FCR) services are mandatory for conventional generation and this service is not remunerated.
- There are capacity tenders for automatic Frequency Restoration Reserve (aFRR) services, with obligation to offer the available capacity, which is remunerated at marginal price (Portuguese price indexed to the Spanish). Energy remunerated at the price of manual Frequency Restoration Reserve (mFRR).
- mFRR capacity must be mandatorily offered but is not remunerated. Energy is remunerated at marginal price.
- The framework disposition on standard Replacement Reserve (RR) products and market rules for the LIBRA platform were implemented. But capacity is not procured, yet big thermal and hydro plants have obligation to bid in LIBRA.
- Black Start services are not remunerated on a market basis.
- There are no other non-frequency system services, such as Inertia and Fast Frequency Response, Voltage Control and System Restoration.

As with "short duration" storage, the System must create the adequate mechanisms to transfer part of the benefits provided by storage to the generators. What will differ from the "long duration" storage is the number and diversity of players as well as the frequency with which the service is provided. These differences may determine specific revenue solutions: specific markets, long term capacity markets, bilateral agreements, etc.

In any case, hydro storage players should be proactive in finding and suggesting the definition of the most suitable market and regulatory environment to promote storage, having in mind that the longer "time to market" of such solutions recommends an enhanced foresight and readiness to execute.

Recommendations

1. The regulatory and market framework needs to evolve in order to stimulate investment in storage that will further facilitate the RES entrance, and to allow the emergence of an economic model (or models) that will ensure the profitability of investments.

   If such evolution does not occur in advance, there will come a time when the System will be forced to create the needed storage in an inefficient way, meaning, higher cost and higher stability risk.

2. The flexibility needs, imposed by RES penetration (storage and ancillary services), should be remunerated according to the benefit they provide.

   The value stream could be arranged by charging a fee to "non dispatchable" players (which could, alternatively, invest in technology to became "dispatchable") or to contract storage to other promoters operating as virtual power plants.

3. PSH should be able to participate in a "long duration" storage market/competition frame which should have a long-term perspective (around 15 years) considering the heavy capital investments as well as the long paybacks.

4. To ensure fair competition in cross-border participation of flexible plants, and particularly of PSH, a harmonization of grid tariffs/costs should be established and enforced. In other words, it should be highlighted that the ambitious decarbonization depends on mitigating differences (market arrangement, regulatory, fiscal, etc.) between countries.

5. Creation of new commercial products. PSH can be used as back-up (short or long duration), bundled with renewables: RES power purchase agreement (PPA) integration, full renewable supply, real time renewable supply, virtual storage for industrial and households PV, etc.

6. Implementation of capacity remuneration mechanisms in the framework of the Clean Energy Package.

7. Development of market-based ancillary services provisions, which will become more valuable in the future to the system: all ancillary services should be provided on a market basis and be technology agnostic. Furthermore, ensure non-frequency ancillary services procured through transparent, non-discriminatory, market-based procedures: Inertia and Fast Frequency Response, Voltage Control and System Restoration.

8. To find a solution to the expiring (or close to) hydroelectric concessions with a European common standard.