



Paris, March 3, 2023

Subject: Consultation on the form of public support for the development of pumped storage hydropower (PSH)

— This consultation focuses on the appropriateness of public support for the development of pumped storage hydropower (PSH) stations, the different forms and modalities that such support could take and, more generally, the interest of interested parties in the development of such facilities. It contains nine questions (see end of document).

Interested parties include operators and developers of hydroelectric or storage projects, professional organizations related to the development of renewable energy and storage and renewable energy aggregators.

This consultation is open for 1 month. You can send your contributions within this period to the following address:

concertation-hydro@developpement-durable.gouv.fr

1. Pumped storage hydropower stations in France

A pumped storage hydropower (PSH) station is a hydroelectric facility that stores electricity by pumping water from a lower basin to an upper basin. The energy is then recovered by conventionally turbinizing the water from the upper basin to the lower basin.



Figure 1 Operating principle of a PSH plant - Source EDF

France has about 5 GW of PSH capacity. In 2021, French PSH plants generated 4.1 TWh of electricity, for a total hydroelectric production of 62.5 TWh. The French Multiyear Energy Plan (*Programmation pluriannuelle de l'énergie – PPE*) 2019-2028 foresees that during the first five-year period of the PPE, steps will be taken to allow the development of PSH plants for a potential of an additional 1.5 GW, with a view to the commissioning of installations between 2030 and 2035. The realization of large-scale PSH projects will require significant changes to

the current concession contracts. It is therefore conditional on the renewal of these contracts. Other projects, such as the *Lacs Blanc et Noir* project in the department of Haut-Rhin, for which a consultation process on the balanced and sustainable management of water resources was conducted from 28 June to 16 September 2022, could be launched in the near future.

The essential current and future role of PSH is also highlighted by the French Transmission System Operator (RTE) in its study "Energy Futures 2050". Whatever the electricity mix choices, a development of flexibilities for the electricity network is necessary by 2050. In all the scenarios studied by RTE, it is assumed that PSH capacities will increase to 8 GW installed by 2050.

PSH plants differ from other hydroelectric installations in that they operate according to pumping-turbining cycles of varying duration depending on their size, ranging from a few hours (so-called daily PSH) to several days (so-called weekly PSH).

Legal framework

The vast majority of PSH plants are subject to the legal regime of a concession because their administrative capacity is greater than 4.5 MW. Under this regime, the facilities are owned by the State. Responsibility for the investment, construction and operation of a hydropower facility is transferred to a concessionaire who is remunerated by the profit from the operation of the facility for the duration of the concession. In return, the concessionaire pays a fee and must, at the end of the concession, return the assets necessary for the operation of the concession to the State free of charge and in good condition, which may then decide to renew the concession. Various obligations are included in the concession specifications, which bind the concessionaire to the State.

The procedure for granting and renewing concessions is carried out in accordance with the provisions of Part III of the *Code de la commande publique* and Title II of Book V of the *Code de l'énergie*. For new projects that would be subject to a call for competition, the award procedure begins with the publication of a concession notice. Pursuant to Article R. 521-8 of the *Code de l'énergie*, several criteria are used to select the best offer. These criteria include at least the energy optimization of the waterfall, the respect of the balanced and sustainable management of the water resource as well as the economic and financial conditions for the State and the local authorities.

Public support could also be awarded to the winner of the competitive procedure. In this case, one criterion for the selection of candidates would be the amount of this support. In accordance with the European Commission's guidelines on State aid for climate, environmental protection and energy, the weighting of this criterion will then be at least 70%.

For the granting of hydroelectric concessions for PSH projects on identified sites, it is not planned at this stage to use the tender procedure defined in Article L. 352-1-1 of the *Code de l'énergie*.

2. Public support may be needed to develop PSH projects

a. Economic context

However, the economic development of new PSH projects would face two major obstacles:

- High investment costs that the revenues from the electricity market would not allow to be written off over the duration of the concession. PSH plants are indeed installations requiring very high investment costs, due to the scale of the civil engineering work to be

carried out.

- There is great uncertainty about the evolution of their remuneration in the market. By remunerating themselves on electricity price differentials and not on electricity prices like other renewable electricity generation, PSH projects are subject to significant market uncertainty, especially as they have a very long operating life (over 60 years). While it is already very difficult to make multi-year projections of electricity prices, PSH business plans require projections of both peak and base electricity prices.

Public support may be necessary for the development of some of these facilities. In this context, the General Directorate for Energy and Climate Change (GDECC) of the ministry of Energy Transition has initiated a reflection on the form that public support for the development of PSH projects could take.

The considered support mechanism would be in line with the new European Commission guidelines on state aid for climate, environmental protection or energy published in early 2022. It would be notified to the European Commission.

b. Several forms of public support are possible

The considered support mechanism would cover pure PSH projects, i.e. PSH projects for which natural water inputs are negligible in the lower and upper basins. This public support would be granted through a competitive procedure between several operators, candidates for the operation of a PSH concession on a given site.

First option: additional remuneration

The first type of public support that could be mobilized is a power and energy premium, which is a specific additional remuneration for installations that derive their income from energy placement and capacity remuneration mechanisms. The objective of this first type of support is to compensate for the significant uncertainties detailed above for operators by guaranteeing a certain level of annual income, irrespective of conditions on the electricity and capacity markets. Taking into account price differences in the electricity markets in its parameters, this premium seems appropriate for pumped storage hydropower stations and consists of supplementing the revenues from the sale of energy and the sale of capacity guarantees, which constitute the majority of the PSH projects turnover. However, this first type of aid does not fully cover the production volume risk of the PSH projects, could affect the operation of the facilities (including its participation in system services), would not cover all revenues, and would necessarily be for a limited period, much shorter than the lifetime of the facilities. This type of aid also raises the question of the replicability of the reference market price formula (M_0) by a market player, i.e. the ability for the player valuing the electricity on the market (e.g. an aggregator) to guarantee a remuneration at the level of M_0 to the operator, with an acceptable risk premium.

The calculation of this additional remuneration could be as follows:

$$CR_{PSH} = \sum_{i=Week\ 1}^{Week\ 52/53} E_{turbinee_i} * (P_{Réf\ candidat} - M_{0_i}) + Nb_{Capa} * (P_{Réf\ État} - K_0)$$

With :

- CR_{PSH} : the annual amount of the additional remuneration in € ;
- $E_{turbinee, i}$: the weekly electricity production of the PSH plant in MWh;
- $P_{Réf\ candidat}$: the reference price in €/MWh proposed by the candidates in the tendering procedure and indexed;
- $M_{0, i}$: the reference market price defined as :

- $M_{0i} = P_{Vente_i} - \frac{P_{Achat_i}}{Efficiency}$ si $P_{Vente_i} > \frac{P_{Achat_i}}{Efficiency}$
 - o P_{Vente_i} : the arithmetic average of the highest hourly spot prices in €/MWh on the EPEX exchange for delivery the following day, over a number of weekly hours to be determined;
 - o P_{Achat_i} : the arithmetic average of the lowest hourly spot prices in €/MWh on the EPEX exchange for delivery the following day, over a number of weekly hours to be determined;
 - o Efficiency: The efficiency of the PSH project determined by the administrative authority in the tender is close to 75%;
 - o For all weeks in which the M_0 value is negative, the additional remuneration for the energy produced corresponds to a fixed premium independent of production.
- Nb_{Capa} : the number of certified capacity guarantees on the concession in MW ;
- $PRéf_{État}$: a reference price for capacity set by the administrative authority in the competitive bidding process;
- K_0 : the reference market price for capacity, expressed in €/MW and published by the Commission de régulation de l'énergie.

If the spread or prices of the capacity mechanism were to exceed the target tariffs, the additional remuneration would be negative - i.e. the concessionaire would have to pay a premium to the administrative authority.

The $P_{Réf_{candidate}}$ and $PRéf_{État}$ prices would be indexed for the duration of the contract. The indexation would be carried out annually on the 1st of January with an indexation coefficient taking into account the evolution of the hourly labor cost and the production price index for industry and business services for the whole of industry.

The duration of the additional remuneration would be 20 years.

With regard to the price criterion of the tender, the various candidates would be ranked solely on their $P_{Refecture}$ proposal.

Second option: investment aid

Public support could be granted only in the form of investment aid, the amount of which would possibly be smoothed over time. The total amount of support would thus be fully known to the successful applicant and would compensate for a major constraint to the development of PSH projects, which is their high capital requirement. The public support would then depend on assumptions agreed before the project (such as production volume and price) and might not cover the risk of inflation.

The different candidates would then be ranked on the price criterion according to the aid requested, either in euros or in euros per megawatt depending on the specifications of each site.

Third option: a combination of investment aid and annual support

An intermediate solution would be to grant investment aid when the concession is granted and then annual operating support during the first years of operation.

This annual operating support could take the form of the additional remuneration described in the first option. In this case, the investment support would be lump-sum and the candidates would be ranked according to the target tariff of the proposed additional remuneration.

Annual operating support could also take the form of a guarantee to cover a base of OPEX based on market revenues. *A posteriori*, on the basis of the actual market revenues recorded, if the latter do not make it possible to cover an OPEX base determined by the conceding authority during the procedure for granting the concession (identical for all candidates or depending on the power of the project), the difference between this OPEX base and the actual revenues would be paid back to the concessionaire. In this case, the candidates would be ranked according to the amount of investment aid requested.

Whatever the support measures implemented, an overcompensation clause would be included in the concession specifications. If the profitability of the project were higher than initially foreseen in the business plan provided by the applicant, the operator would pay back a share of this excess profitability to the conceding authority.

3. Issues for consultation

To feed its reflections on the design of a public support mode for the development of PSH projects under the concession regime, the GDECC wishes to collect contributions from interested parties on the following questions:

- 1) To what extent do you consider public support for the development of PSH projects in France to be indispensable?
- 2) What form of support do you consider most appropriate for the development of PSH projects (including forms of support not detailed above)? Why or why not?
- 3) More specifically on the additional remuneration if you consider it relevant:
 - a. Is the weekly period of the M_0 suitable for you?
 - b. How many hours should be selected for the calculation of the variables P_{Vente} and P_{Achat} ?
 - c. What value should be assigned to the fixed premium if the M_0 is negative?
 - d. What efficiency value should be chosen for the installations, depending on the length of the penstock and the head?
 - e. What level of $P_{Ref\acute{e}tat}$ would be relevant?
- 4) More specifically on investment aid, if you consider it relevant:
 - a. What would be the order of magnitude of the investment support needed for the development of such projects (if any, depending on various key characteristics including the ratio $\frac{\text{Height of the waterfall}}{\text{Length of the penstock}}$)?
- 5) More specifically on investment aid combined with operating aid, if you consider it relevant:
 - a. What level of flat-rate investment aid would be optimal if the investment aid were combined with an additional remuneration (provide associated assessment and justification)?
 - b. What elements should be included in the OPEX base that would be covered by market revenues and operating aid?
- 6) Which mechanism would you consider most relevant to prevent possible over-returns?

- 7) What forms of participation by local and regional authorities in the investment in the PSH project and up to what level of the total investment would this participation be preferable?
- 8) For developers, would you be interested in launching procedures for new greenfield PSH concessions, such as the one envisaged for a new concession on the *Lacs Blanc et Noir* site in the department of Haut-Rhin, with or without public support?
- 9) If the future Multiyear Energy Plan highlights a development potential for small installations, which support scheme would you consider the most suitable to be extended to possible low power PSH project (under the authorization regime)?