**Invitation for international cooperation on pumped storage hydro - R&D project**

Dear Sirs,

PSR – a Brazilian analytics firm - is currently undertaking a R&D project with the utility of Rio de Janeiro and the Brazilian subsidiaries of EDF, ELERA, China Three Gorges and Brazilian utility Light. Collectively, the four companies act as R&D sponsors and the project was authorized by ANEEL, the Brazilian electricity regulatory authority, under the following code: PD-00678-0120/2020.

The objective of the project is to develop a methodology to identify interesting sites for pumped-storage hydro plants (PSH) with a computational model. The model also develops automatic engineering designs and estimates project costs. Finally, an integrated resource planning model is used to assess the value of PSH projects of different sizes and locations to the Brazilian national power grid which is currently experiencing a strong growth of variable renewable generation, mostly wind power and solar PV.

This R&D project is a follow up of a previous one between PSR and EDF from 2015 to 2019 that developed computational model HERA[[1]](#footnote-1) for conventional hydropower development planning1. The level of detail being targeted for the coding of PSH in HERA is equivalent to hydropower pre-feasibility planning studies executed by corporations and the energy planning agency.

Since the end of the 1970s, Brazil has developed a *Hydropower Inventory Studies Manual* that it is largely used to study possible alternatives of cascaded hydropower projects in several river basins considering the technical, economic, and environmental dimensions (ELETROBRAS, 20102). This Manual includes worksheets for every component of a conventional hydropower plant a guideline for its design (dimensions of each structure) and, based on a large database of built projects, tables and charts that are used to estimate equipment costs. These worksheets would be a natural model for the engineering solutions for PSH in this R&D project. However, once Brazil does not have an equivalent experience with the development of PSH projects, this option is not available. Furthermore, documentary research related to specific components of these plants, especially on equipment and powerhouse design, is limited because, understandably, they are not usually uncovered by the developing companies. Therefore, external references from the sponsors becomes critically important for the success of the R&D project.

PSR highlights the importance of establishing a technical cooperation with international specialists from the sponsors regarding the state-of-the-art of PSH, considering their experiences as developers and operators of PSH projects. This research is listed as one of the initial activities of the project schedule. We invite the technical teams of the sponsors to get involved in this project and collaborate with its technical developments. For this matter we request access to any relevant information related to engineering design solutions and technological development of electromechanical equipment. It is worth mentioning Brazil has no PSH projects but ranks 2nd globally regarding conventional hydropower installed capacity.

These references will help us development the guidelines for the coding of the engineering module of the project which designs PSH components such as turbines, pump-turbines, motor-generators, and the hydraulic structures (dams, tunnels, channels, etc.). Cost estimates will also benefit greatly from the experience of sponsors in undertaking projects and their own, as well as their research of the state of the art of existing technologies.

PSR now requests cooperation from sponsors to prepare standard engineering solutions for PSH projects, including schematic drawings. References may come from the archives of each sponsor, but also from governmental agencies of their countries, technical reports produced from various stages of PSH project developments, general descriptions, calculation memories, engineering drawings of civil works and equipment, as well as "as built" drawings, drawings of plans, sections and details of the embankments, conveyance system and the powerhouse, design guidelines and general criteria from government agencies. Videoconferences with specialists involved in engineering and feasibility analysis of PSH projects from the sponsor companies would also be extremely valuable to this research.

From these documents, it would be extremely useful to obtain the following information:

* General description and drawings of the engineering arrangements.
* Civil engineering drawings of powerhouses with different turbines.
* Budgets for early stages of project (identification, prefeasibility or feasibility studies).
* Civil engineering design criteria.

In the specific case of electromechanical equipment, a contact with manufacturers is greatly appreciated. If available, the following information is also of interest:

* Manufacturers catalogs.
* Turbines and pumps design schemes.
* Tables, graphs, or abacus for equipment selection (turbines and pumps).
* References of unit prices per ton for each equipment.
* Data plates or datasheet of existing PSH, including main characteristics and weight.

In the regulatory scenario, some aspects are greatly appreciated to be reported, if available. These aspects would be the following:

* State-of-the-art of the regulatory scenarios about the PSH in China, France, Canada and some other countries whose information is available. These scenarios are related with the type of policies adopted by these countries.
* Market design of the PSH in these mentioned countries: constrains, subsidies, etc.
* Legal aspects related to the business models and operation models of the PSH in these countries.

Following the regulatory questions addressed to regulatory team of project sponsor country in China, France, Canada or other countries where the sponsors have developed PSH projects:

1. What is the current construction stage of pumped-storage hydroelectric (PSH) in your country?
2. How are PSH operated in your country?
3. How will the decarbonizing target of your country (e.g., France wants to achieve 40% renewable energy in the energy matrix by 2030) impact the construction of new PSH?
4. In a scenario of great expansion of renewables in electricity market, especially photovoltaic and wind, what are the chances that hybrid ventures will be installed in your country? Do these hybrid developments consider PHS? Is there a regulatory agenda to make it possible?
5. Are there any specific legal instruments for PSH in your country?
6. Is there a R&D on PSH in your country? If so, what are the objectives of research?
7. Regarding the tariff model, what is the current discussion or trend to remunerate PSH in your country? Is feed-in-tariff being considered? If so, for how long?
8. What other revenue streams for PSH exist or being proposed in your country? (e.g.: energy arbitration; ancillary services; avoided cost model - virtual plant; green energy market integrated with wind and solar plants)
9. Does the current business model of PSH depend on monopoly? Is there a trend towards opening PSH development to independent producers?

Following the R&D project timeline; in blue the planned activities, in dark green the activities performed, and in light green the rescheduled activities.



We thank you, in advance, for your attention and cooperation.

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EDF NORTE FLUMINENSE

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CHINA THREE GORGES

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BROOKFIELD

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LIGHT

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1. https://www.psr-inc.com/softwares-en/?current=p7067 [↑](#footnote-ref-1)