TC Document

I. Basic Information for TC

▪ Country/Region:	REGIONAL
▪ TC Name:	Support Hydro Pumped Storage Development in Latin America
▪ TC Number:	RG-T4126
▪ Team Leader/Members:	Alarcon, Arturo (INE/ENE) Team Leader; Malagon Orjuela, Edwin Antonio (INE/ENE) Alternate Team Leader; Baldivieso, Hector (INE/ENE); Echevarria Barbero, Carlos Jose (INE/ENE); Goldenberg Lopez, Federico (INE/ENE); Gomez, Jose Ramon (INE/ENE); Juarez Olvera, Mariel (CSD/CCS); Marquez Barroeta, Fidel (INE/ENE); Planas Marti, Maria Alexandra (INE/ENE); Snyder, Virginia Maria (INE/ENE); Vila Saint-Etienne, Sara (LEG/SGO)
▪ Taxonomy:	Research and Dissemination
▪ Operation Supported by the TC:	N/A
▪ Date of TC Abstract authorization:	31 March 2022
▪ Beneficiary:	Countries with potential for hydro pumped storage (Brasil, Bolivia, Panamá, Colombia, Perú, Ecuador, Argentina, Chile, Uruguay)
▪ Executing Agency and contact name:	Inter-American Development Bank
▪ Donors providing funding:	Clean Technology Fund(CTF)
▪ IDB Funding Requested:	US$250,000.00
▪ Local counterpart funding, if any:	US$0
▪ Disbursement period (which includes Execution period):	36 months
▪ Required start date:	May 2022
▪ Types of consultants:	Firms
▪ Prepared by Unit:	INE/ENE-Energy
▪ Unit of Disbursement Responsibility:	INE/ENE-Energy
▪ TC included in Country Strategy (y/n):	No
▪ TC included in CPD (y/n):	No
▪ Alignment to the Update to the Institutional Strategy 2010-2020:	Environmental sustainability; Institutional capacity and rule of law; Productivity and innovation

II. Objectives and Justification of the TC

2.1 **Reversible hydropower plants, or hydro pumped storage (HPS)** are hydropower plants that allow energy storage, by pumping water from a lower reservoir in hours of excess energy generation (or low demand), to a higher reservoir, for later use in hours of the need of energy. HPS is used not only to provide power and energy but also as an asset for the grid in terms of providing ancillary services, such as frequency control, voltage regulation, black-start capability, and reactive power. They are a valuable resource to support the integration of non-conventional renewable energy (NCRE) resources such as wind and solar.

2.2 HPS is a mature technology, with worldwide deployed, in different schemes including turbine, pumps and turbine-pumps. The challenges in terms of pre-investment and construction are like hydropower plants, as these plants include two reservoirs, one or two dams, a powerhouse, and civil works for water conduction. Nonetheless, these schemes work with smaller reservoirs than normal hydropower plants, as they can

pump water to the upper reservoir daily. Currently, there are over 500 HPS totaling around 161 GW of power[1]- worldwide. In the last 5 years, almost 10 GW of HPS capacity were installed. HPS currently accounts for over 94 per cent of installed global energy storage capacity, and over 96 per cent of the energy stored on a grid scale. HPS enjoys several distinct advantages over other forms of energy storage due to its long asset life, low lifetime cost, and independence from rare materials. As a result, there has been a resurgence of interest in HPS around the world. It is estimated that global HPS capacity will grow by 78 GW by 2030, considerably more than other forms of energy storage technologies.

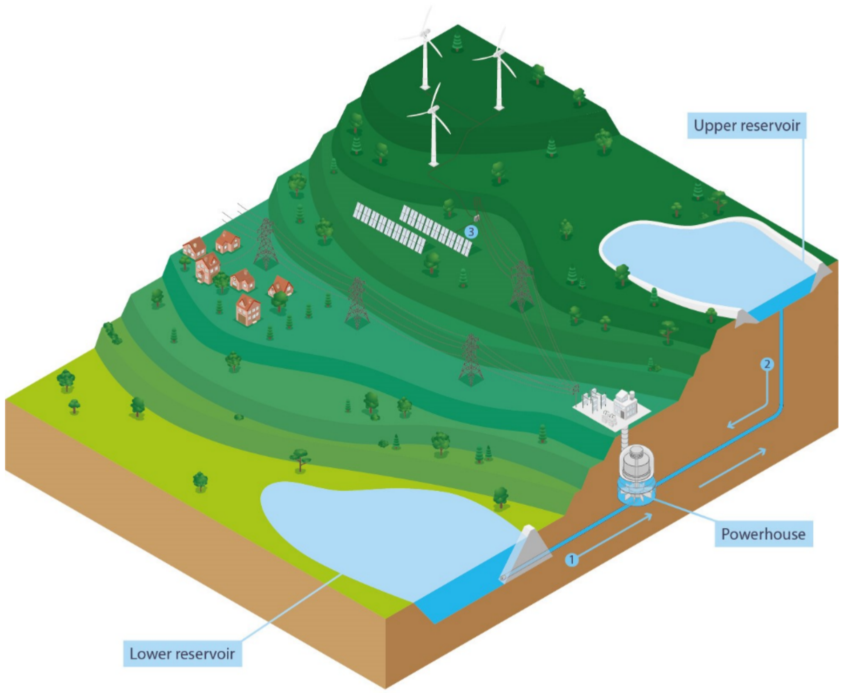

Figure 1 - Hydro-pumped Storage Scheme (Source: International Hydropower Association)

2.3 From an energy point of view, an HPS requires 1.20-1.25 MWh of pumped energy to generate 1 MWh of energy, which is an overall efficiency of 80%-85%. Moreover, HPS costs are lower than other storage technologies (106-200 US$/Kwh, compared with 400 US$/kWh for lithium batteries). As a result, HPS will be an important part of a transition towards a low carbon energy matrix, particularly as they add flexibility to the power system, and enable other forms of renewable energy to be integrated into the matrix. Thus, the condition required for being an economically feasible project is the price gap difference between the energy used for pumping (in an excess supply and low price) and the energy generated (at demand, with high market price).

2.4 LAC is the region of the world with the largest share of hydropower in the electricity matrix (50%). Nonetheless, the use of HPS technology in Latin America is marginal, from 200 GW of hydropower there is only 1 GW of installed capacity in two plants in Argentina developed in the early 80s and one plant in Brazil of 20 MW, which is not

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[1] IHA, 2018, https://www.hydropower.org/sites/default/files/publications-docs/the_worlds_water_battery__pumped_storage_and_the_clean_energy_transition_2.pdf.

operative. The main reasons for the lack of development of HPS in LAC are: (i) lack of adequate regulation for energy storage, particularly providing price-gaps that create incentives for energy storage; (ii) the existence of large numbers of hydroelectric power plants with large reservoirs, which provide energy storage without the need of pumping; (iii) the existence of hydropower potential (untapped), which could provide further development of hydroelectric power plants that can provide storage, estimated at over 500 GW; and (iv) asymmetry of knowledge regarding HPS technologies. Regarding an adequate regulatory framework, there are few cases of energy systems in the region with regulation that creates significant differences between peak and non-peak pricing gap, or regulatory systems that offer capacity payment rewards, that will give economic feasibility to HPS development.

2.5 Power systems in Latin America are changing, with a growing interest in installing non-conventional renewable energy (NCRE), particularly wind and solar, to reduce the use of fossil fuels. The massive installation of NCRE technologies creates the need to have firm generation and/or storage to compensate for the variability of these energy sources. Currently, there are two sources that can provide firm generation on a cost-effective manner: (i) Fossil fuel-based generation (such as natural gas), or (ii) hydropower plants with large reservoirs. Fossil fuel generation requires to store fuels and has CO2 emissions. On the other hand, the social and environmental impacts associated with new hydropower developments, particularly those with large reservoirs, have resulted in new hydropower installations that are run-of-the-river, without the capacity to store energy for long periods. HPS, on the other hand, is a storage system that can provide firm energy, without the need of creating new reservoirs of large size. Thus, it is of interest system planners and regulators in the region to study if large energy storage systems, such as HPS, could provide firm energy and compensate the fluctuation in the power generation in a cost-efficient manner. Nonetheless, this scenario requires to develop adequate regulation and incentive mechanisms, that identify and value the services the HPS can provide to the system, to incentivize its development[2].

2.6 In LAC, the recent increase in participation of NCRE in the electric systems and the required necessity of having enough storage associated to match the demand, has increase the interest to study the development of HPS. The IDB recently finished an analysis of the regulatory framework in 6 countries (Argentina, Brazil, Chile, Colombia, Panamá and Perú), which identified the opportunities and barriers for the development of HPS in these countries. The study: (i) evaluated the state of the art of HPS technology among other energy storage alternatives, and its potential for use in LAC; (ii) analyzed the regulatory framework to promote HPS deployment in these countries; and (iii) analyzed and evaluated areas for improvement in the regulatory framework for the promotion of investment in the technology. This study will provide inputs for the further development of the activities of this TC to generate an overall assessment of the technology in the region and develop specific case studies.

2.7 Other studies have been developed in the Region, for instance in Brazil the electric utility of Sao Paulo (CESP) in 2014 identified an overall potential of 200 GW for HPS, the main barrier identified was regulatory and commercial not technical. Also, in Brazil, the planning entity (EPE) has conducted a study on the overall potential in the country.

[2] For further reference of the development of HPS in LAC see: Analysis of the Policy and Market Framework for Hydro Pumped Storage in Latin America and the Caribbean

In Uruguay, the public utility identified 3 sites for feasibility studies for the development of a 200 MW and 12-hour storage HPS, the site with the lowest investment to energy stored ratio was identified at 123 US$ per kWh and required investment of US$470 million. In Mexico, the isolated electric system of Baja California Sur presents an opportunity fora higher NCRE due to the solar resources available. A study concluded in 2017 determined the economic prefeasibility of 4 possible HPS plants. In Chile, the *Espejo de Taparaca* project of a 300 MW HPS was proposed in 2014 to pump seawater using electricity from solar resources. This project compromises a US$600 million project finalizing financial structure and is expected to start construction in 2020.[3]

2.8 There is a global interest in HPS, which has translated in the creation of an International Forum for Hydro Pumped Storage[4], a government-led multi-stakeholder platform to shape and enhance the role of pumped storage hydropower in future power systems. The Forum brings together governments, industry, financial institutions, academia and NGOs to develop guidelines and recommendations on how sustainable pumped storage hydropower can best support the energy transition. IDB joined the Forum since its inception, publishing a technical note regarding the state of the market for HPS in LAC and policy recommendations for its development. While the Forum will serve as a learning opportunity for the Bank and the region, results of this TC will also support the Forum, providing knowledge on how to develop HPS in the LAC region.

2.9 **Objective.** The main objective of this TC is to evaluate and support the development of HPS in the region to enable higher penetration of NCRE in Latin America and the Caribbean by increasing energy storage, and other grid services.

2.10 **IBD experience and lessons learned.** The Bank has experience providing technical support and financing several hydroelectric power plants. Most recently, IDB provided funds to rehabilitate hydroelectric power plants in the region, notably the Furnas and Luiz Carlos Barreto (2549/OC-BR) and Passo Real and Itaúba (2813/OC-BR) plants in Brazil; the Simón Bolívar Guri plant (2429/OC-VE) in Venezuela, the Péligre plant (1296/OP-HA) in Haiti, the Carlos Fonseca and Centroamérica plants (1933/BL-NI) in Nicaragua. Currently, there are two modernization projects in execution, the Rehabilitation and Modernization Program for the Acaray Hydroelectric Power Plant (4690/OC-PR) in Paraguay, and the Salto Grande Binational Hydropower Complex (4694/OC-RG, 4695/OC-RG) in Uruguay and Argentina.

2.11 Moreover, the Bank has extensive experience in supporting the development of studies regarding hydropower in the region. Through the technical cooperation ATN/OC-16441-RG,"Support for the development, rehabilitation and expansion of Sustainable Hydroelectric Projects in LAC", the IDB has conducted studies to analyze the state of the art of digitalization of hydropower in the region, and organized a session regarding hydropower digitalization in the World Hydropower Congress (2019). As well, in 2020 IDB conducted a study to assess the potential for hydropower modernization in the region and has organized a regional seminar on the modernization of hydropower. As a result, IDB approved in March 2022 a US$1,5 million technical cooperation, to support the modernization of hydropower plants in the region (ATN/JF-19202-RG).

[3] http://valhalla.cl/es/espejo-de-tarapaca/

[4] https://pumped-storage-forum.hydropower.org/

2.12 **Strategic Alignment.** The TC is consistent with the Bank's Second Update to the Institutional Strategy (UIS) (AB-3190-2) and is aligned with the development challenge of Productivity and Innovation by promoting the use of a new technology in the region to foster the penetration of NCRE. The TC is also aligned with the cross-cutting themes of: (i) Institutional Capacity and the Rule of Law by providing support to create technical capacity in the power companies and decision makers related to hydropower of the beneficiary countries, to enable investment and development of sustainable infrastructure; and (ii) Climate Change and Environmental Sustainability, by promoting the development of NCRE sources and contributing to the reduction of greenhouse gas emissions through the operational life extension of existing hydropower infrastructure.

2.13 The TC is also consistent with the Sustainable Infrastructure Strategy for Competitiveness and Inclusive Growth (GN-2710-5), through the promotion of ongoing improvements in infrastructure governance, particularly, the regulatory framework to determine performance, quality, and sustainability. The TC is also consistent with the Energy SFD (GN-2830-8), specifically with the priority areas of: (i) Energy Sustainability, with the development of energy storage project; and (ii) Energy Governance, through the promotion of innovation and updates in regulation; and with the Climate Change SFD (GN-2835-9), specifically with the goal of innovation for climate-resilient and low-carbon development for the promotion of technologies and new business models to advance RE integration. The TC is aligned with the IDB's Vision 2025 in three key areas: Climate Change, Digital Economy, and Local Value Chains.

2.14 The TC is also aligned with the IDB Country Strategy with Brasil 2019-2022 (GN-2973), the IDB Country Strategy with Panamá 2021-2025 (GN-3055), the IDB country Strategy with Bolivia 2022-2025 (GN-3088), the IDB country Strategy with Colombia 2019-2022 (GN-2792), the IDB Group Country Strategy with Chile 2019-2022 (GN-2946), the IDB Group Country Strategy with Perú 2017-2021 (GN-2889), the IDB Group Country Strategy with Ecuador 2018-2021 (GN-2924), the IDB Group Country Strategy with Uruguay 2021-2025 (GN-3056), the IDB Group Country Strategy with Argentina 2021-2023 (GN-3035) by increase the knowledge regarding solutions for climate change adaptation and mitigation, trough energy storage and renewable energy, and promoting the innovation in the regulatory frameworks, to improve the quality and sustainability for the electricity service.

2.15 Finally, this TC is aligned with the objectives of the Clean Technology Fund (CTF), which is one of the two multi-donor trust funds within the wider Climate Investment Funds (CIFs). The CTF aims to provide positive incentives, through public and private sector investments, for the demonstration of low carbon development and mitigation of greenhouse gas emissions. The CTF was established in 2008 to provide emerging economies with scaled-up financing for the demonstration, deployment, and transfer of low-carbon technologies with a significant potential for long-term greenhouse gas (GHG) emission savings. The CTF received 5.5 billion in commitments, to be deployed through six partner multilateral development banks (MDBs). The TC is also aligned with the new CIF's Global Energy Storage Program (GESP) which will help deliver breakthrough energy storage solutions at scale in developing countries.

III. Description of activities/components and budget

3.1 Activities will be organized under the following components:

3.2 **Component I: Support of the regulatory framework analysis**: This component will finance consulting services to revise the current regulatory framework and institutional frameworks to propose adjustments in regulation and market schemes to promote the investment of HPS. This component is expected to focus on two of the six countries where already the Bank studied initially the potential for HPS (paragraph 2.6). The criteria to select the two countries for this component will be: (i) previous experience with HPS or explicit interest in the development of the technology; (ii) potential reservoirs for the development of HPS plants; and (iii) incorporated or plan to incorporate NCRE for power generation. This study is expected to enhance the level of knowledge of the actual regulatory framework for energy storage in the region, and specifically HPS, by: (i) a review and evaluation of the existing regulatory framework on energy storage and HPS, (ii) identification of barriers, incentives and gaps that affect the development of the technology; (iii) recommendations on existing regulation and new regulation to promote investment in HPS; and (iv) understanding the potential impacts of these changes.

3.3 **Component II: Support the identification of case studies**. This component aims to strengthen the knowledge available on potential sites and projects for HPS studied in the region through consulting services.

3.4 **Activity II.1. Case study compilation and comparative analysis**. This activity will finance consulting services to gather existing information on projects and sites already studied in the region for HPS projects, including new or conversion of traditional hydroelectric power plants. This revision will be focused on ten (10) countries with hydroelectric plants and an ongoing or expected growth of NCRE in their electric matrix. This activity will build a database of the individual efforts completed or started by the countries in the region. This activity will improve the level of information available through the standardization of information, update of relevant data, and comparison of case studies. As a result of this study, a database of potential HPS projects in the region will be compiled.

3.5 **Activity II.2 Support an initial study of a pilot**. This activity will finance consulting services to evaluate at least one project for HSP. The pilot project will be selected from the list gather in Activity II.1 considering, initially: (i) interest of the country; (ii) adequate, or at least potentially adequate, regulatory framework; (iii) existing level of information to conduct an assessment; (iv) low or medium level of social and environmental impacts initially identified. Other criteria could be proposed by the consultant. This activity will contribute to understanding the economic feasibility of a specific HSP project, including the investment required for the construction of the project, the costs associated with the operation and maintenance, and the streams of revenue based on the services provided to the electric grid. The study shall also include and evaluation of the impacts both economic and technical on the electric grid and analyze the implications on the NCRE integration on the electric system. Moreover, a preliminary assessment of environmental and social impacts will also be included. The pilot project will be identified based on the results of activity II.1.

3.6 **Component III: Communication and Dissemination**. This component will finance a regional workshop with main stakeholders to disseminate the main findings of the activities and products obtained in components I and II, and to facilitate the knowledge transfer, the workshop will be virtual. This component will also support the publishing of a technical note that shall include a detailed description of the knowledge obtained

through the studies and an overview of the state of HPS in Latin America[5]. The dissemination campaign will be coordinated with the energy country specialists.

Indicative Budget

Activity/Component	Description	Clean Technology Funding	Total Funding
Component I	Consultancies for regulatory framework analysis	**50,000.00**	**50,000.00**
Component II. Activity 1	Consultancies for Case study compilation and comparative analysis	**20,000.00**	**20,000.00**
Component II. Activity 2	Consultancies for pilot study for HPS	**160,000.00**	**160,000.00**
Component III. Communication and Dissemination	Communication and Dissemination	**20,000.00**	**20,000.00**
Total		250,000.00	250,000.00

3.7 The focal point designated and responsible for the execution of the TC is Team Leader Arturo Alarcon (INE/ENE), supported by specialists of the energy division.

IV. Executing agency and execution structure

4.1 Given the strategic objective of the TC of providing a deep overview and analysis of the regulatory framework as answer the challenges associated with energy storage, and HSP development of the energy sector in LAC, the Bank will act as the executing agency for the administration of the project taking advantage of its expertise and relationship with different stakeholders related to the energy sector and the electricity sector. The Bank is expected to serve as a catalyzer of knowledge, innovation, and impact policy on multiple scales within the region, making the regional coordination of the IDB a necessary condition of this TC. The Bank will lead implementation, programmatic oversight of the different activities, and coordinate annual meetings with the donor to provide an overall assessment of the program's progress and results. Active engagement with and awareness of the work of other organizations operating in the field will also help avoid any potential overlaps with ongoing efforts.

4.2 The Bank will be responsible for the selection and contracting of consulting firms and individual consultants. All activities to be executed under this TC have been included in the Procurement Plan (Annex IV) and will be contracted in accordance with Bank policies as follows: (a) AM-650 for Individual consultants; (b) GN-2765-4 and Guidelines OP-1155-4 for Consulting Firms for services of an intellectual nature; and (c) GN-2303-28 for logistics and other related services.

4.3 This TC is classified as Research and Dissemination. Prior to the initiation of specific in-country activities in the beneficiary countries, the Bank will obtain the letter of non-objection from the corresponding liaison office.

V. Major issues (estimated length: 1 page)

5.1 The main implementation risk is level of coordination required with power companies, sectorial ministers and agencies from different countries to access to the information in a timely manner, to mitigate this risk the team will have meetings with the different stakeholders to discuss the value added of the project, requirements and key outcomes to enhance interaction and collaboration. Another concern is that the planned analytical products may not be produced at the desired level of quality. To

[5] All knowledge products derived from this Technical Cooperation will be the Bank's intellectual property.

address that issue, the team is simultaneously pursuing several different avenues of research and will implement several layers of peer-reviewing throughout the process to ensure quality and relevance.

5.2 The dramatic spread of COVID-19 has disrupted lives and communities and generated important disruptions in economic activities across Latin America and the Caribbean. This means that projects may face implementation challenges, including logistical issues and communication delays. To mitigate these issues, project implementation will firstly focus on remote data collection and sensing applications, desktop research, online communications, and remote interactions with willing partners.

VI. Exceptions to Bank policy

6.1 None apply.

VII. Environmental and Social Strategy

7.1 Given the nature of the expected activities to be financed for this TC, it is unlikely to have negative either direct or indirect social or environmental effects. Following ESG's project classification process. No environmental assessment studies or consultations are required.

Required Annexes:

Results Matrix - RG-T4126

Terms of Reference - RG-T4126

Procurement Plan - RG-T4126