TC Document

I. Basic Information for TC

Country/Region:	REGIONAL
TC Name:	Regional Hydropower Modernization Program
TC Number:	RG-T4006
Team Leader/Members:	Alarcon, Arturo (INE/ENE) Team Leader; Baldivieso, Hector (INE/ENE) Alternate Team Leader; Acevedo Calle, Daniela (LEG/SGO); Ballon Lopez, Sergio Enrique (INE/ENE); Baltodano Carrasquilla, Fabiola (INE/ENE); Grunwaldt, Alfred Hans (CSD/CCS); Jacome Montenegro, Carlos Alberto (INE/ENE); Langstroth, Robert Peter (VPS/ESG); Malagon Orjuela, Edwin Antonio (INE/ENE); Marquez Barroeta, Fidel (INE/ENE); Nakagawa, Yumi (INE/ENE); Porta Garcia, Raimon (VPS/ESG); Ricardo Espino (INE/ENE); Snyder, Virginia Maria (INE/ENE); Suber, Stephanie Anne (INE/ENE); Urteaga Dufour, Jose Antonio (INE/ENE)
Taxonomy:	Client Support
Operation Supported by the TC:	N/A
Date of TC Abstract authorization:	27 Sep 2021.
Beneficiary:	Empresa Nacional de Electricidad (Bolivia), Comisión Federal de Electricidad (Mexico), Comisión Ejecutiva Hidroeléctrica del Río Lempa (El Salvador), Staatsolie (Suriname).
Executing Agency and contact name:	Inter-American Development Bank
Donors providing funding:	Japan Special Fund(JSF)
IDB Funding Requested:	US$1,500,000.00
Local counterpart funding, if any:	US$0
Disbursement period (which includes Execution period):	36 months
Required start date:	April 2022
Types of consultants:	Firm and individual consultants
Prepared by Unit:	INE/ENE-Energy
Unit of Disbursement Responsibility:	INE/ENE-Energy
TC included in Country Strategy (y/n):	Yes
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. Objective and Justification of the TC

2.1 **Objective.** The main objective of this non-reimbursable Technical Cooperation (TC) is to support the modernization of hydropower plants in Latin America and the Caribbean (LAC).[1] Its specific objectives are to support: (i) studies to develop hydropower modernization projects in four LAC countries; and (ii) technical local capacity for hydropower modernization in the region.

[1] The term "modernization" includes all types of rehabilitation, renovation, modernization, updating, automation, or digitalization, which is carried out in a hydroelectric power plant to extend its useful life, increase its efficiency and/or production. This includes providing higher generation performance and increasing the resilience and adaptation to climate change of plants. Source: Modernización de centrales hidroeléctricas en América Latina y el Caribe: priorización e identificación de necesidades de inversión / María Ubierna, Juan Alberti, Arturo D. Alarcón.

2.2 **Background. Hydropower Modernization in LAC.** Nearly half of the electricity in Latin America and the Caribbean (LAC) relies on hydropower, that with more than 200 GW installed remains as the largest source of renewable energy (RE) in the region.[2] This hydro-energy capacity has allowed LAC to be the region with the cleanest electricity matrix in the world, with access to low-cost RE, and to be in an excellent position to accelerate the penetration of Variable Renewable Energies (VRE) sources, such as wind and solar energy.

2.3 Countries in the region are developing transition plans towards a low carbon economy, based in the increased participation of VRE and a higher electrification of other sectors of the economy (such as transport, heating, and industry). Electricity demand is expected to continue growing in the next decades (2.8 to 3.5% per year), almost doubling by 2040.[3] In this context, hydropower is essential as the largest source of RE with the capacity to provide storage and flexibility to the power systems. The storage and grid services provided by hydropower are critical to guarantee energy security and to support further insertion of VRE sources without increasing emissions.

2.4 Digitalization as part of modernization has proven to be essential in the hydropower industry to improve operational efficiency, maintenance downtime, infrastructure security – with cybersecurity applied to critical infrastructure as it is the case of dams– and to effectively coordinate dispatch with other energy sources, while at the same time securing ecological flows and other water uses (irrigation, flood control, etc.).[4]

2.5 More than half of the installed hydroelectric capacity in the region has reached a stage of its useful life that requires some level of modernization. Consequently, assessing the state of the assets and implementing improvements to extend the life of existing hydropower infrastructure is one of the fundamental issues to enable LAC's energy transition in the next decades. According to the conclusions of the studies and analysis carried out by the Energy Division (INE/ENE) of the IDB, the region needs to mobilize at least US$5 billion of investments in the short term-, and US$30 billion in the medium-term, for the modernization of hydropower plants. These investments are estimated to allow the modernization and rehabilitation of around 127 GW of hydropower capacity.[5]

2.6 Modernization of existing hydropower in LAC is essential to reach net zero emissions by 2050. This task requires a multidimensional approach, including the development of technical, economic, and environmental assessments, the financial structuring of projects, and the development of regulatory incentives that promote these investments. As the largest source of development finance for the LAC region, the IDB Group plays a key role in promoting hydropower modernization and paves the road for the region's energy transition. The IDB maintains a dialogue regarding hydropower modernization with several counterparts in the region. Four countries have been included in this TC, as they expressed interest in conducting studies for hydropower modernization with support of the IDB: Bolivia, El Salvador, Mexico, and Suriname. All these

[2] According to the IADB Energy Hub 45% of the total installed capacity is hydropower.
[3] Source: The energy path of Latin America and the Caribbean. Rigoberto Ariel Yépez-García, Yi Ji, Michelle Hallack, David López Soto.
[4] Source: The Digital Revolution of Hydropower in Latin American Countries.
[5] Source: Modernización de centrales hidroeléctricas en América Latina y el Caribe: priorización e identificación de necesidades de inversión / María Ubierna, Juan Alberti, Arturo D. Alarcón.

countries have old hydropower plants with high or medium priority for modernization.

2.7 **Bolivia.** In 2021, the Bolivian electricity matrix relied on 32.4% of hydropower energy generation. In terms of installed capacity, from a total of 3590 MW, Bolivia has 735 megawatts (MW) of hydropower. According to the IDB study, the country has 9 hydropower plants with over 30 years in operation, with a consequent potential for modernization, with a total capacity of 284 MW. The Corani hydropower plant, built in 1965 with a capacity of 54 MW, has been identified as the one with the highest need for modernization. This power plant is key for the operation of the whole power system, as it administers the largest reservoir in the system and is located at the top of a cascade of four major power plants. The IDB supported a study in 2021 to identify the key elements for a modernization program, which included fields visit, meetings with counterparts, and the identification of key studies to move forward with modernization. The studies identified have been considered in this TC.

2.8 **El Salvador.** El Salvador has an electricity matrix currently relying on 29% in hydropower for power generation. From a total of 2,403.9 MW, it has 552 MW of hydropower capacity. Hydropower represents a low-cost source of RE, that complements the expansion of other renewable sources such as wind and solar. According to the beforementioned IDB study, the country has 4 hydropower plants with more than 30 years old and with potential for refurbishment, 552 MW in total, all of them in the Lempa River. Since 2020, the IDB has supported a study to identify the key elements for a modernization program for two of these power plants, which included the review of maintenance reports, the review of the status of equipment, and meetings with the operation and maintenance personnel in both power plants. The diagnostic of the power plants identified studies that need to be completed to move forward with a modernization program, which have been included in this technical cooperation. The *15 de Septiembre* power plant has an installed capacity of 180MW and it was built in 1983. The *5 de Noviembre* power plant has also an installed capacity of 180 MW, and it was built in 1954.

2.9 **Mexico.** The country has 83.2 gigawatts (GW) of installed generation capacity. The largest amounts of installed capacity consisted of fossil fuel at 66% and hydroelectricity at 15.2%. Most of the Mexican hydropower fleet has been installed – and functioning – for over 30 years. The IDB modernization study identified 18 power plants, with an installed capacity of 6.7 GW that have a medium and high potential for modernization. The federal government is already advancing in the modernization of 14 of its hydropower plants. Through dialogue with the *Commisión Federal de Electricidad* (CFE), a state-owned power company, two power plants were included in the scope of this TC: (i) Colimilla, located in the state of Jalisco, which began operations in 1951 with a capacity of 51.2 MW, has 4 units and operates with a plant factor of 10%, generating 44 GWh/year; and (ii) Texolo, located in the state of Veracruz, which began operations in 1951 with a capacity of 1.6 MW, has two units and operates with a plant factor of 81%, generating 10 GWh/year.

2.10 **Suriname.** Has a single hydropower power plant, which is a critical facility for the national power system, as it provides 48% of electricity generation in the country. The Afobaka Hydroelectric Project is owned and operated by a governmental company, Staatsolie Power Company Suriname (SPCS). The facility is an embankment dam with a main gravity dam section on the Suriname River, in the Brokopondo District, with an installed capacity of 189 MW. The plant started production in 1964, and with almost 60 years in operation, there are opportunities to improve its efficiency, resiliency, and security, given technological developments in the past five decades. In 2021, the IDB supported an initial

diagnosis for the plant, which included information of maintenance reports, production reports, and extensive meetings with the power plant personnel. The study identified key actions that need to be conducted for its modernization, which have been included in this TC. Moreover, the IDB is supporting the Government of Suriname in analyzing the feasibility of implementing a solar floating plant in the reservoir (ATN/JF-18695-SU), which would be integrated to the hydroelectric facility, and the SPCS personnel identified that a dam safety study is required to comply with dam safety regulations.

2.11 **IDB experience and lessons learned.** In the last ten years, the IDB has financed the modernization of close to 5 GW in LAC accumulating extensive experience supporting the development and implementation of this type of project through technical cooperation and overall project financing. Additionally, INE/ENE, through its Hydropower Group, has developed regional diagnostic studies and training for hydropower modernization and digitalization. This experience positions the IDB as a natural leader in this area in the region. Currently, the Bank is implementing three loans for hydropower modernization (US$262,000,000) and is involved in dialogue for four potential projects across the region.

2.12 Most recently, the 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 three modernization projects in execution, the Rehabilitation and Modernization Program for the Acaray Hydroelectric Power Plant (4690/OC-PR) in Paraguay, the Salto Grande Binational Hydropower Complex (4694/OC-RG, 4695/OC-RG) in Uruguay and Argentina, and Cañaveral-Río Lindo Hydropower Complex Rehabilitation and Uprating Project (3435/BL-HO) in Honduras. The latter is co-financed with the Japan International Cooperation Agency (JICA) through the Framework Agreement for Cooperation for Economic Recovery and Social Inclusion (CORE).

2.13 Moreover, the Bank has extensive experience in supporting the development of studies regarding hydropower in the region. Through the TC “Support for the development, rehabilitation and expansion of Sustainable Hydroelectric Projects in LAC” (ATN/OC-16441-RG), 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). Also, in 2020, the IDB conducted a study to assess the potential for hydropower modernization in the region and organized a regional seminar on the modernization of hydropower. In the World Hydropower Congress of 2021, the Bank organized a session specifically focused on hydropower modernization, as well as a ministerial meeting regarding the role of hydropower in the energy transition.

2.14 **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 Non-Conventional Renewable Energies (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 RE sources and contributing to

the reduction of greenhouse gas emissions through the operational life extension of existing hydropower infrastructure.

2.15 The TC is also aligned with (i) the IDB Country Strategy with Suriname 2021-2025 (GN-3065), as it will contribute to increase the share of RE in the energy matrix and to reduce the cost of generation thus reducing the subsidies to the electricity sector; (ii) the IDB Country Strategy with Mexico 2019-2024 (GN-2982) as it will contribute with the objectives to encourage the dynamism of investment and contribute to a more balanced and sustainable territorial development; (iii) the IDB Country Strategy with El Salvador 2021-2024 (GN-3046-1) in the dialogue area of energy, as it will be supporting the development of modernization projects that improve the efficiency of the energy matrix; and (iv) the IDB country Strategy with Bolivia 2016-2020 (GN-2843) by supporting productivity and diversification in the economy.

2.16 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. Lastly, this TC is also aligned with the G20 principles for Quality Infrastructure considering its first principle: Maximizing the positive impact of infrastructure to achieve sustainable growth and development.

III. Description of Activities/Components and Budget.

3.1 The technical cooperation will be structured in two components:

3.2 **Component I: Prefeasibility and feasibility studies (US$1,350,000).** The resources will finance the development prefeasibility and feasibility of studies for specific hydropower modernization projects. This component aims to create a pipeline of at least four investment projects to be implemented in the coming decade, that could eventually be co-financed through CORE between IDB and JICA. The studies that have been identified as part of the modernization project are described in the next paragraphs. In each of the power plants, an assessment of the possibility of including digitalization will be conducted. All of these studies will include an initial evaluation of the environmental and social impacts of the potential modernization project.

Bolivia (US$350.000). Inspection of the hydromechanical equipment, turbines, generators, and auxiliary equipment. Analysis of the operation of the power plant, based on the information collected in the field and compiled from previous studies. Development of the technical specifications for the rehabilitation and modernization of the Corani Power Plant in terms of hydromechanical equipment, turbines, generators, and auxiliary equipment. Development of an operation plan that optimizes the use of water resources and the versatility of the plant in the face of forced and scheduled shutdowns.

El Salvador (US$400.000). Assessment for the replacement of stator core and windings of turbo generator unit of the *15 de Septiembre* and *5 de Noviembre* hydroelectric power plants to increase efficiency and prolong the lifetime which will allow the participation of clean and reliable RE source. Prepare the Terms of

Reference (ToR) for procurement and installation of dam instrumentation to modernize the monitoring though data acquisition, automation in data collection, and process. Prepare the scope of work, estimate the budget, elaborate the manufacturing and commissioning schedule, and prepare the procurement documents including technical specifications to replace generators of Unit No.1 and 4 of the *5 de Noviembre* plant.

Suriname (US$350.000). Conduct: (i) a dam safety analysis, including a Gap assessment to meet Federal Energy Regulatory Commission (FERC) compliance and dam failure impact study; (ii) studies to increase the efficiency of the hydroelectric turbines, including the development of technical specifications; and (iii) reservoir management optimization study to increase operational efficiency and electricity supplied to the network, as well as to provide additional flexibility to the grid to allow the integration of future VRE sources.

Mexico (US$250.000). Considering the availability of the hydraulic resource of the Santiago River in the case of Colimilla, and the hydraulic resources of Texolillo and Atoyac rivers in the case of Texolo, is possible to increase the installed capacity and annual generation of both plants (without increasing the reservoirs), since it currently has old and inefficient turbines, in addition, the waste of the hydraulic resource that is spilled by the spillway of the regulating dam, which represents significant energy losses. Therefore, it is necessary to carry out hydrological and hydro energy studies in the area of influence of this power plant, in order to determine the additional capacity that can be installed, without increasing the dam.

3.3 **Component II: Capacity building and coordination (US$150,000).** This component will finance one workshop on hydropower modernization in each beneficiary country (4 workshops in total), the workshops will be delivered to the personnel of the power companies, and decision makers related to hydropower in the beneficiary countries. The component will also finance the engagement of a project manager with hydropower expertise to support the studies' technical review and facilitate coordination at a regional level.

3.4 The total cost of this TC is US$1,500,000, to be financed with resources of the Japan Special Fund JSF (JSF), as indicated in the following table. Given the nature of the TC, no counterpart is considered.

Indicative Budget (US$)

Activity/ Component	Description	BID/JSF	Total Funding
Component I	Prefeasibility and feasibility studies	1,350,000	1,350,000
Component II	Capacity building and coordination	150,000	150,000
Total		**1,500,000**	**1,500,000**

IV. Executing agency and execution structure.

4.1 At the request of the beneficiaries, and in line with the Procedures for the Processing of Technical Cooperation Operations and Related Matters (OP-619-4), the Bank will act as the executing agency for this TC. Given the nature of the TC, which is regional, it will be executed by the Energy Division (INE/ENE) to facilitate the coordination among different stakeholders. 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. The project will be implemented in close coordination with the CSD departments, particularly with RND and CCS Divisions, and ESG, who have been actively working in the areas of dam safety

and sediment management. Likewise, all the activities of the TC will be coordinated with the beneficiary entity in each country: Empresa Nacional de Electricidad (Bolivia), CFE (Mexico), Comisión Ejecutiva Hidroeléctrica del Río Lempa (El Salvador), and Staatsolie (Suriname).

4.2 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. 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.

4.3 As a result of this TC, the Energy Division expects to create a pipeline of at least four investment projects that could eventually be co-financed through CORE between IDB and JICA. In this context, through the implementation of this TC, the Bank will coordinate closely with JICA and receive operational and technical inputs for this TC activities and outputs based on their operational experience in each country and their knowledge. JICA will join key meetings including progress meetings of this TC at least twice a year for an overall assessment of the program's progress and results and for necessary inputs to this program.

4.4 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. This TC is classified as Client Support.

V. Major issues

5.1 One of the main risks associated to this TC is the number of studies to be conducted in parallel, and the amount of coordination needed with different stakeholders related to the studies. The Energy Division has active and productive dialogue with each of the counterparts of this TC (see paragraph 4.3), as well as the authorities in the energy sector of Mexico, El Salvador, Suriname, and Bolivia, nonetheless, the size of the studies to be conducted in parallel will require a high degree of coordination. As such it is contemplated to hire a project manager with hydropower expertise, who will be supported by the Hydropower Group in the energy division. Also, the energy specialists based in each country will support the coordination and follow up with the counterparts. A second risk is to get all the information required to produce the studies in a timely manner. To mitigate this risk, the project coordinator will establish frequent coordination meetings with each of the country stakeholders, this work and coordination will be supported by the energy specialists in each country. The studies will be conducted in countries which expressed interest in being part of this TC, and where the Bank has already been supporting the development of studies regarding hydropower modernization. A final identified risk is the difficulty to predict biosecurity measures related to the Covid-19 pandemic that may be implemented in the beneficiary countries. If travel is not possible, the hiring process will consider a provision to include local consultants in the consultancy teams.

VI. Exceptions to Bank Policy

6.1 No exceptions to the Bank’s policies are requested.

VII. Environmental and Social Strategy

7.1 In coordination with VPS/ESG, it was assessed that the TC has a Substantial Environmental and Social Risk (ESRR), due to contextual risks of supporting

hydropower operations in LAC and levels of performance of the borrowers. An ESG specialist has been assigned to support the execution of the TC, especially in reviewing the ToR following requirements of the Bank's Environmental and Social Policy Framework (MPAS). For details, see the ESRR report.

Required Annexes:

Request from the Client - RG-T4006

Results Matrix - RG-T4006

Terms of Reference - RG-T4006

Procurement Plan - RG-T4006