GCAP Sub – Committee Meeting

Brasilia, Brazil (Hybrid)

Friday, June 30, 2023

BRAZIL (REI) INVESTMENT PLAN

CLIMATE INVESTMENT FUNDS
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GCAP/SC.4/06
June 20, 2023

PROPOSED DECISION

(To be added)

MINISTÉRIO DA FAZENDA
Secretaria de Assuntos Internacionais
Subsecretaria de Financiamento ao Desenvolvimento Sustentável
Coordenação-Geral de Finanças Sustentáveis
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Carta SEI nº 100/2023/MF

To Ms. Mafalda Duarte
Chief Executive Officer
Climate Investment Funds - Administrative Unit
1818 H Street NW
Washington D.C. 20433, USA

May 25, 2023.

Dear Ms. Duarte,

It is with great pleasure that I submit Brazil's Investment Plan (IP) to support decarbonization by accelerating its clean and inclusive energy transition. The Government of Brazil appreciates all the support that the Climate Investment Funds (CIF), the Inter-American Development Bank (IADB), and the World Bank (WB) have provided to develop this IP.

This Plan was led by the Ministry of Finance as technical coordinator, with contributions from the Ministry of Mines and Energy. As a result, this IP is conceived as a tool to move towards a productive economy, accelerating the shift towards clean energy use and the democratization of electricity production.

CIF-REI concessional resources will catalyze financing from multilateral development bank partners (i.e., IADB and WB), private investment, and other co-financing in technologies/projects needed to meet the country's Nationally Determined Contribution and decarbonization commitments. The IP will be articulated and implemented through two interventions led by each of the MDB partners.

In IADB's intervention, the concessional and non-reimbursable resources of the CIF-REI will be implemented through two components led and executed by the Banco do Nordeste do Brasil (BNB), which will act as the Implementing Entity (IE) of the CIF-REI resources: the Financing Program to provide the Brazilian Electrical System with greater flexibility in the energy transition process and the Project Factory Program.

WB's intervention intends to support the development of the first Green Hydrogen (GH2) hub in Brazil, located in Pecém, State of Ceará. This investment is both in line with the CIF-REI objectives of greater integration of renewable sources in the energy matrix as well as with the climate objectives of decarbonizing the Brazilian economy and Brazil's National Hydrogen Program (PNH2). In the WB's intervention, the concessional and non-reimbursable resources of the CIF-REI will be executed by the Pecém Industrial and Port Complex (CIPP), in which the Government of the State of Ceará has a 70% participation.

The expected project portfolio will tackle the main challenges Brazil is facing in the modernization of its energy sector, such as deficient infrastructure, high costs of providing electricity to zones not connected to the National Interconnected System, and insufficient participation of energy demand in energy prices and grid operations.

The Brazilian government is grateful for the opportunity to take part in the Renewable Energy Integration Program. We look forward to working with CIF, the IADB, the World Bank, and our local partners to successfully implement the project's portfolio.

Yours sincerely,

Document signed electronically

TATIANA ROSITO

Secretary for International Affairs

Ministry of Finance of Brazil

Documento assinado eletronicamente por **Tatiana Rosito**, **Secretário(a)**, em 25/05/2023, às 16:02, conforme horário oficial de Brasília, com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

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CLIMATE INVESTMENT FUNDS
RENEWABLE ENERGY INTEGRATION PROGRAM
INVESTMENT PLAN FOR BRAZIL

May 2023

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Acronyms and Abbreviations

AAR:	Allowed Annual Revenue (Receita Anual Permitida)
ABSOLAR:	Brazilian Association of Photovoltaic Solar Energy (Associação Brasileira de Energia Solar Fotovoltaica)
AI:	Artificial Intelligence
AMI:	Advanced Metering Infrastructure
ANEEL:	National Electric Energy Agency (Agência Nacional de Energia Elétrica)
ANP:	National Agency of Petroleum, Natural Gas, and Biofuels (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis)
BaU:	Business as usual
BCB:	Central Bank of Brazil (Banco Central do Brasil)
BESS:	Battery Energy Storage System
BNB:	Bank of Northeast (Banco do Nordeste)
BNDES:	National Bank for Economic and Social Development (Banco Nacional de Desenvolvimento Econômico e Social)
BtM:	Behind the Meter
CCDR:	Country Climate and Development Reports
CCEE:	Chamber of Electric Energy Commercialization (Câmara de Comercialização de Energia Elétrica)
CIF:	Climate Investment Funds
CIPP:	Pecém Industrial and Port Complex (Complexo Industrial e Portuário do Pecém)
CMSE:	Monitoring Committee for the Electric Sector (Comitê de Monitoramento do Setor Elétrico)
CNPE:	National Energy Policy Council (Conselho Nacional de Política Energética)
COPOM:	Monetary Policy Committee (Comitê de Política Monetária)
DER:	Distributed Energy Resources
DFACTS:	Distributed Flexible AC Transmission System
DG:	Distributed Generation
DLR:	Dynamic Line Rating
DMMG:	Distributed Micro and Mini-Generation (Micro e Minigeração Distribuída)
EDA:	Energy Development Account (Conta de Desenvolvimento Energético - CDE)
EPE:	Energy Research Office (Empresa de Pesquisa Energética)
EPZ:	Export Processing Zone
FACTS:	Flexible AC Transmission System
FCA:	Fuel Consumption Account (Conta de Consumo de Combustíveis - CCC)
FEME:	Free Electricity Market Environment (Ambiente de Contratação Livre - ACL)
FIEC:	Federation of Industries of Ceará (Federação das Indústrias do Ceará)
FNMC:	National Climate Change Fund (Fundo Nacional sobre Mudança do Clima)
FtM:	Front of Meter
GoB:	Government of Brazil
GDP:	Gross Domestic Product
GHG:	Greenhouse Gases
GIZ:	German Cooperation Agency
H2:	Hydrogen
GH2:	Green Hydrogen
HPP:	Hydroelectric Power Plants
HVDC:	High Voltage Direct Current
IBGE:	Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística)
ICT:	Information and Communication Technologies
IDB:	Inter-American Development Bank
IDBG:	Inter-American Development Bank Group
IE:	Implementing Entity
IFC:	International Finance Corporation

IP:	Investment Plan
IPCA:	Extended Consumer Price Index (Índice de Preços ao Consumidor Amplo)
IPEA:	Institute for Applied Economic Research (Instituto de Pesquisa Econômica Aplicada)
IRENA:	International Renewable Energy Agency
IRF:	Integrated Resource Framework
KPI:	Key Performance Indicators
LPIT:	Low Power Instrument Transformers
MDB:	Multilateral Development Bank
MF:	Ministry of Finance (Ministério da Fazenda)
MMA:	Ministry of Environment (Ministério do Meio Ambiente)
MME:	Ministry of Mines and Energy (Ministério de Minas e Energia)
MOC:	Marginal Operating Cost (Custo Marginal de Operação)
MoU:	Memoranda of Understanding
NDC:	National Determined Contribution
NIS:	National Interconnected System (Sistema Interligado Nacional)
NM:	Net Metering
O&M:	Operation and Maintenance
OECD:	Organization for Economic Cooperation and Development
ONS:	National System Operator (Operador Nacional do Sistema)
PHS:	Pumped Storage Hydro Power Plant
PMR:	Project Monitoring Report
PNA:	National Adaptation Plan (Plano Nacional de Adaptação)
PNCV:	National Green Growth Program (Programa Nacional de Crescimento Verde)
PNMC:	National Policy on Climate Change (Política Nacional sobre Mudança do Clima)
PONTE:	National Energy Transition Policy (Política Nacional de Transição Energética)
PPA:	Power Purchase Agreements
PPP:	Public-Private Partnerships
PRODIST:	Distribution Procedures (Regras e Procedimentos de Distribuição)
PRONAMPE:	National Support Program for Micro and Small Enterprises (Programa Nacional de Apoio às Micro e Pequenas Empresas)
R&D&I:	Research & Development & Innovation
R&D:	Research and development
BN:	Basic Network (Rede Básica)
REI:	Renewable Energy Integration
REME:	Regulated Electricity Market Environment (Ambiente de Contratação Regulado - ACR)
RPB:	Reference Price Bank
RSEP:	Renewable Social Energy Program (Programa de Energia Social Renovável)
SDG:	Sustainable Development Goals
SEB:	Brazilian Electrical System (Sistema Elétrico Brasileiro)
SELIC:	Basic Interest Rate (Taxa Básica de Juros)
SHP:	Small Hydroelectric Power Plant
SISOL:	Isolated Systems
STATCOM:	Static Synchronous Compensator
STEM:	Science, Technology, Engineering, and Mathematics
STM:	Short-Term Market
SVC:	Static Var Compensators
T&D:	Transmission and Distribution
UFC:	Federal University of Ceará (Universidade Federal do Ceará)
UNFCCC:	United Nations Framework Convention on Climate Change
VRE:	Variable Renewable Energy
WB:	World Bank
WBG:	World Bank Group

I. Executive Summary

Objectives

The objective of Brazil's Investment Plan (IP) is to support the decarbonization of the country's economy by accelerating its energy transition, through (***i***) reducing barriers to the integration of Variable Renewable Energy (VRE)[1] in the Brazilian Electric System (SEB), (***ii***) expanding infrastructure financing for VRE integration, and (***iii***) building capacities related to the public and private sectors. The IP will support: i) the modernization of Hydroelectric Power Plants (HPPs) through the implementation of digital technologies, ii) the digitalization, modernization, and automation of electricity networks and the decarbonization of Isolated Systems (SISOL) through VRE-backed electrification, and the expansion of Distributed Energy Resources (RED) and iii) the expansion of energy storage technologies (Pumped Storage HydroPower Plant (PHSs), Hydrogen (H2), and batteries), to improve the integration of VRE and support a greater diversification of the country's renewable energy matrix.

Expected Results

The financing and technical assistance of the CIF Renewable Energy Integration Program (CIF-REI) will provide low-cost financing for technologies and business models that facilitate the insertion of VRE, in addition to technologies that are not yet commercially viable in Brazil, but that allows for a greater insertion of VRE, through the leverage of important additional resources from both the public and private sectors, in areas prioritized by the Government of Brazil (GoB), with the following expected results:[2]

- Modernize 4,947 MW of hydropower plants (HPP) capacity, which will result in a reduction of 57 $MtCO2_{eq}$ due to the displacement of natural gas thermoelectric plants and the implementation of 1.6 GW/year in VRE.[3]
- Increase reliable access to clean and modern energy services, by installing VREs in regions not connected to the main generation and transmission system – isolated systems (SISOL), to 3.1 million inhabitants, promoting their development and social and economic inclusion.
- Support the integration of climate risk management into electricity sector decisions to reduce the impacts caused by climate variability and climate change in the electric sector.
- Allow consumers to take a more active role in the electrical industry (prosumers) and facilitate the implementation of demand response programs, which allows for a more flexible operation of the electrical system in response to the integration of VREs.
- Accelerate reductions in the cost of the electrical system by using flexible methodologies (2.07 billion USD) in relation to government planning (4.60 billion USD).
- Reduce average operating costs by, approximately 76 million BRL/year through deploying Dynamic Line Rating (DLR) on Basic Network (BN) transmission lines with loading above 90%.
- In addition, further cost reductions in transmission, energy storage, and overall network flexibility capacity are expected to be achieved by deploying other digital technologies as network support.
- Leverage renewable energy resources to promote the country's development of clean hydrogen value chains. By supporting the Pecém Hydrogen hub with concessional financing

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1 Solar and wind technologies (onshore and/or offshore).
2 All results highlighted in the executive summary are detailed in ANNEX II.
3 In the planning studies of the EPE (PDE 2031), 51 existing plants with modernization potential were identified that contribute to increasing the firm capacity of the system.

the expectation is to have an installed capacity of 6 GW for green hydrogen (GH2) production by 2034, with a production of almost 1 million tons per year from 2034.

Program Priorities and Budget

The IP prioritizes projects included in one or more of the following categories of the CIF-REI Program, evaluated and defined by the GoB with the assistance and support of the MDBs as follows, and supported by public policies aimed at the Brazilian energy sector:

- Improvement of technologies (intelligent control-maintenance-management systems) and modernization of existing HPPs, incorporating Artificial Intelligence (AI) tools, machine learning, and energy storage development, to improve predictability, and safety, in addition to promoting greater diversification of the electrical matrix. Also, it is expected the use of prediction models that deal with the stochastic nature of VRE. In this context, it is important to consider AI and machine learning techniques to improve the predictability of both centralized and decentralized VRE generation.
- Digitalization, modernization, and automation of the transmission infrastructure to promote the country's i. Modernization of transmission infrastructure is required to support transmission energy transfer capacities, to allow the incorporation of new VRE generation capacities, decrease the energy curtailment of these sources, and expand the balancing areas.
- Digitalization, modernization, and automation of the distribution grid infrastructure to promote the expansion of Distributed Energy Resources (DER). Promote the massification of the Advanced Measurement Infrastructure (AMI), facilitating the emergence of Prosumers and/or the implementation of energy storage systems in batteries and investing in other technologies that increase the flexibility of the electrical system.
- Promoting the decarbonization of SISOL. Support innovative schemes that enable the reliable supply of energy through VREs in SISOL, involving the participation of the private sector as well as the project beneficiaries, through the implementation of new business models. Such models will promote popular-associative schemes where communities will have an active role in the development and implementation of projects, being able to benefit not only from access to energy, but also obtain or increase an income from productive uses of energy.
- Expansion of energy storage technologies (PHS, H2, and batteries) to improve the integration of VREs into the energy system. Encourage the participation of experienced companies in the development and operation of solutions that ensure access to electricity service while contributing to the security of energy supply. In addition, support projects that enable the development of new technological solutions for the Brazilian energy market, such as GH2 hubs.
- Contribute to the energy transition, as a way to support the democratization of the generation, distribution, and commercialization of electricity, as shown in ANNEX V, seeking to support communities and companies in the generation and distribution of their own energy, especially in the most remote regions, and improving the conditions of coverage, quality and price. Similarly, self-production and energy efficiency in homes and industry are expected to enable energy to be perceived as a common good. The priority is supplying vulnerable regions and communities.

The Investment Plan for Brazil's CIF-REI is composed of three Components. Components 1 and 2 are part of the intervention promoted and articulated by the Inter-American Development Bank

Group (IDBG)[4] and Component 3 by the intervention driven and coordinated by the World Bank Group (WBG)[5]. It is expected that the period of execution of the Investment Plan will be 7 years, extending between the years 2023 and 2029.

Component 1 aims to mobilize investments in technologies (see transformational activities/technologies on page 26) to provide greater flexibility to the SEB to absorb larger volumes of VRE resources to support the Brazil´s Energy Transition process. This component seeks to mobilize 412 million USD from the IDB, 33.5 million USD from CIF-REI, 325 million USD from other institutions (financing from local commercial and development banks, IDB Invest, and other international financial institutions). In addition, the budget of 286.3 million USD (2023-2029) from the Pro-Amazon Legal Program contributed annually by Eletronorte is also considered in order to implement projects that structurally reduce the costs of electricity generation from SISOL supported by the Fuel Consumption Account (FCA).[6]

Component 2, consists of a Projects and Technical Assistance Factory with a budget of 1 million USD from the IDB and 1.5 million USD CIF-REI from non-refundable resources[7], and 1.5 million USD from the IDB in reimbursable resources, with the objective of developing technical, prefeasibility/feasibility studies, and for the structuring of loan projects to be granted by the BNB (Bank of Northeast), with financial resources from the IDB loan, and the development of technical studies that contribute to overcoming the barriers identified for the development of projects that increase the flexibility of the SEB, and promote the integration of VRE.

Component 3, seeks concessional financing of 35 million USD from CIF-REI to support Pecém Industrial and Port Complex (CIPP) in Ceará, cover part of the shared infrastructure necessary for the feasibility of GH2 projects and the development of an innovation hub which will contain a research center and certification laboratories, training and capacity building center and actions aimed at Research and Development and Innovation (RD&I) for hydrogen in the Northeast region. This funding will be complementary to the 100 million USD from WBG and CIPP. The ambition of the business plan linked to the initiative foresees leveraging up to 8 billion USD of private investments in the GH2 chain in the Northeast region and the integration of 8 GW of renewable electricity.

II. Country Context

Social and Economical Context

Brazil has shown significant advances in the economic and social sphere in recent years. In 2017, the country formalized its application to become a member[8] of the Organization for Economic Cooperation and Development (OECD). However, the COVID-19 pandemic had a strong social and economic impact, decreasing energy consumption[9]. In addition, poverty[10] and extreme poverty rates[11] in 2021 increased by 22.7% and 48.2% compared to 2020.

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4 Inter-American Development Bank (IDB) and IDB Invest.
5 World Bank (WB) and International Finance Corporation (IFC).
6 Annual contributions in BRL during the period 2023-2029, at an exchange rate of 5.0486 BRL/USD from 04/21/23, without considering updating by the IPCA (https://br.investing.com/currencies/usd-brl)
7 Resource provided for technical support and cooperation activities.
8 In January 2022, the OECD Council decided to open negotiations for accession with Brazil.
9 In 2021, energy consumption in trade decreased by more than 10% compared to 2020 (EPE, 2022).
10 The World Bank considers poverty line income equivalent to 486 BRL per month per capita.
11 The World Bank considers a line of extreme poverty income equivalent to 168 BRL per month per capita.

The resumption of economic activities and the advances in the vaccination program were essential for economic recovery. Currently, 80% of the eligible population has already received both doses of COVID-19 vaccine[12]. Data from the Brazilian Institute of Geography and Statistics (IBGE) show that the Gross Domestic Product (GDP) decreased by 0.2% in the fourth quarter of 2022 compared to the previous quarter, ending the year with a cumulative growth of 2.9%. Inflation, measured by the Extended Consumer Price Index (IPCA), returned to high levels, 10.06% and 11.73%, respectively, in 2021 and 2022, having increased in the basic interest rate, Selic. The country's Investment Rate in Q3 2022 was 19.6%, an increase over the prior-year period (19.4%). The growth in inflation in 2021-22 penalized the cost of capital and negatively impacted the deployment of renewable energy investments.

In 2021, the GoB implemented a series of measures to support the mitigation of the economic impacts caused by the COVID-19 pandemic, while laying the foundation for a more resilient and sustainable long-term recovery. Regarding the electricity sector, the New Regulatory Framework for the Electric Sector (GOV.BR, 2022b) incorporated several innovations, such as the commercial model of the sector, portability of the energy bill, generation concessions, and modernization of energy tariffs. Thus, a reduction in subsidies granted to electricity companies and encouraged energy sources[13], estimated at 4.2 billion UAS and 0.7 billion USD in 2020, respectively (UPB, 2022), is expected, which is borne by consumers in the regulated market. The new framework provides for the reduction of subsidies and includes mechanisms that value the environmental benefits of ventures that use encouraged energy sources.

Current State of Energy Generation and Transmission Systems

The installed capacity of SEB[14] reached 181.6 GW in 2021. HPP and thermal plants accounted for 60.2% and 23.5% of this capacity, respectively, being complemented by wind (11.4%) and solar (2.6%) (EPE, 2022). Electricity generation in 2021 was 656.1 TWh, with 55.3% coming from hydroelectricity, followed by fossil fuels (natural gas, oil, and coal) 18.7%, wind 11%, biomass 8%, and solar 2.6% (see Figure 1).

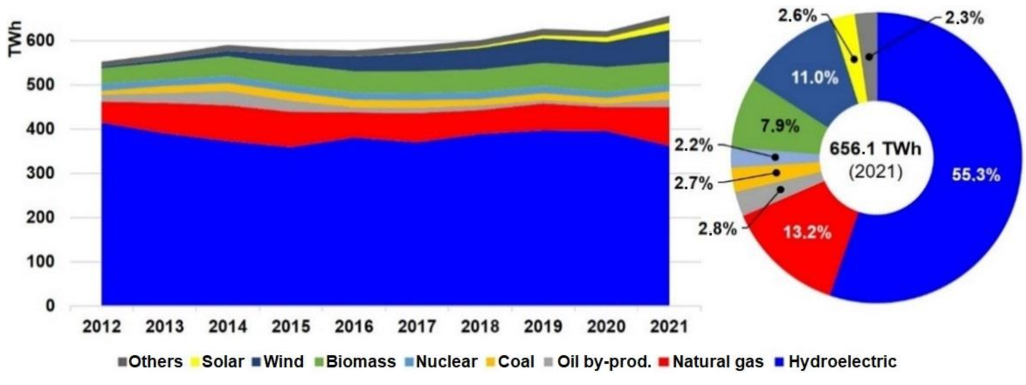

Figure 1. Generation of electricity. Source: EPE, 2022

The generation segment is divided into public companies (44%), international companies (21%), and national private companies (1%). In international companies, companies from China,

12 https://www.gov.br/pt-br/noticias/saude-e-vigilancia-sanitaria/2021/12/brasil-tem-80-da-populacao-alvo-com-duas-doses-de-vacina-contra-a-covid-19.

13 Solar, wind, biomass, and Small Hydroelectric Power Plants (SHP).

14 It involves the electrical infrastructure and the organization for its operation.

France, the United States, Portugal, Spain, Germany, and Italy stand out with 39%, 23%, 10%, 9%, 8%, 7%, and 4%, respectively (Lampis, et. al., 2022). As of 2012 (RN ANEEL No. 482/2012), the GoB adopted measures to encourage the implementation of Distributed Generation (DG), enabling consumers to produce electricity through microgeneration[15] and mini-generation[16], connected to the distribution network (legal framework of Distributed Micro and Mini-Generation (DMMG) approved by Law No. 14.300/2022). In 2015, DMMG's installed capacity was 21.8 MW, currently, this capacity is 15.3 GW, with an emphasis on photovoltaic energy (98.5%) (ANEEL, 2022).

The set of power plants, transmission lines, and electrically interconnected substations is known as the National Interconnected System (NIS). In 2021, the Basic Network (BN) extension of the transmission grid was more than 156,000 km of transmission lines at different voltage levels (see Figure 2 and Figure 3). ANEEL (Agência Nacional de Energia Elétrica, National Agency of Electric Energy) organizes auctions for the contracting of new transmission lines, in which the agent that offers the lowest discount in relation to the Allowed Annual Revenue (AAR)[17] obtains the right to build and operate the new network for a concession of thirty years. Considering the length of the transmission lines in kilometers, the four largest companies are: Eletrobras[18], CTEEP, TAESA, and CEMIG, with 55.4%, 14.4%, 9.3%, and 6.3%, respectively. Among them, 22.9% are international companies, such as Colombian CTEEP, Chinese State Grid, and Spanish Abengoa (Lampis, et. al., 2022).

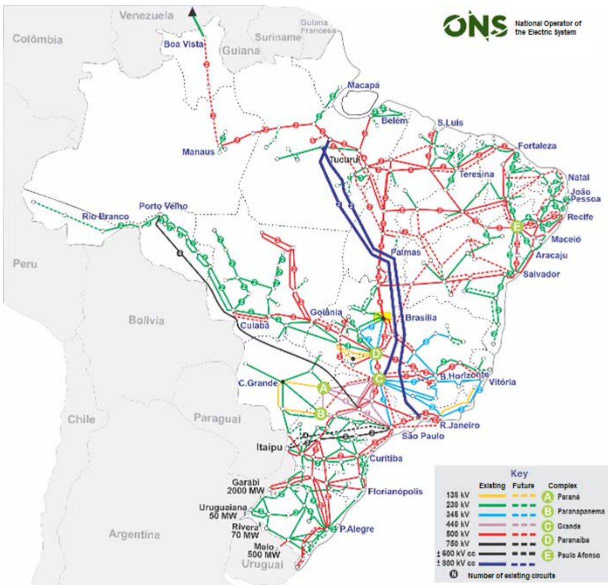

Figure 2. Basic Transmission Network - Horizonte 2024. Source: ONS, 2022

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15 Capacity less than or equal to 75 kW.

16 Capacity greater than 75 kW and less than or equal to 5 MW for dispatchable sources (hydric, including water, qualified CHP, biomass, biogas, and photovoltaic with batteries, limited to 3 MW) and less than or equal to 3 MW for non-dispatchable sources.

17 Transmission companies receive annual revenue for the electricity transmission service.[17]

18 Eletrobras was privatized in 2021.

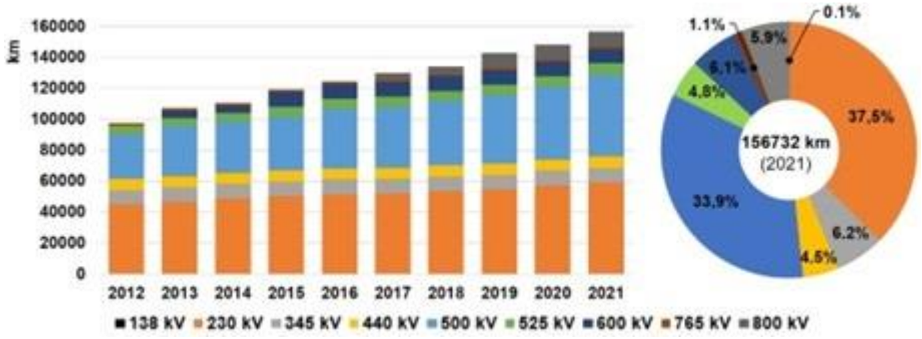

Figure 3. Voltage Transmission Network. Source: ONS, 2022

The distribution segment comprises 53 distribution companies (ABRADEE, 2022), regulated by ANEEL, based on the Distribution Procedures (PRODIST). The distribution companies' assets are remunerated based on regulated tariffs, which ensure revenues that support the financial balance of the distribution company. Considering the market served in GWh, the four largest companies are ENEL, CEMIG, CPFL, and Neoenergia, with 18.3%, 17.3%, 15.1%, and 12.8%, respectively. There are international, state-owned, and private (national) companies whose market share is 52%, 30%, and 18%, respectively (Lampis, et al., 2022).

Brazil has two energy trading environments: the Regulated Electricity Market Environment (REME) and Free Electricity Market Environment (FEME). In REME, through regulated auctions[19] promoted by ANEEL, Ministry of Mines and Energy (MME), and Electric Energy Trading Chamber (CCEE), distribution companies buy energy to serve their entire captive market. In FEME, free consumers choose their suppliers and negotiate prices freely.

Consumers at SEB are divided into: (i) captive consumers, who purchase electricity from the local distribution company at a regulated tariff, and (ii) free consumers, with a minimum demand of 500 kW and can purchase electricity on the free market. In 2021 there were approximately 87 million consumer units.

There are also regions in the SEB not connected to the NIS, called SISOL, totaling 212 systems and serving 3.1 million inhabitants[20]. SISOL are concentrated in the North region, with locations difficult to access along the rivers. These locations represent 0.6% of the NIS load, mostly served by diesel oil powerplants, with over 90% of the installed capacity[21] (EPE, 2022c, EPE, 2021a).

The hydroelectric power generation and the climate resilience initiatives

The Brazilian power system, predominantly dependent on hydroelectric power, has faced energy crises during specific periods, such as the demand rationing in 2001 and subsequent concerns of rationing in 2014, 2017and 2021.

In 2001, Brazil faced an energy crisis due to (i) the drought and low water reservoir levels, (ii) lack of diversification in the energy mix due to overdependence on hydropower, (iii) inadequate

[19] New energy auctions (15-30 years), alternative energy auctions (10-30 years), existing energy auctions (1-15 years), and adjustment auctions (up to 2 years).[19]

[20] With variations from 15 inhabitants (Maici - RO) to 436,500 inhabitants (Boa Vista - RR).

[21] There are also other sources: natural gas (173 MW), biomass (6 MW), photovoltaics (4 MW), and PCH (10 MW). The installed capacity of SISOL is approximately 442 MWaverage.

energy planning and management, (iv) rapid economic growth and increased energy demand and (v) the delayed infrastructure investments.

Over the years following the energy rationing, the Brazilian electrical system has undergone significant changes based on the lessons learned to increase resilience concerning hydroelectricity dependence that helped Brazil overcome episodes of water scarcity in 2014, 2017, and 2021.

In 2021, the heightened possibility of supply difficulties raised concerns among the government, various sectors of the economy, and society at large. The combination of low storage levels in reservoirs and the most severe drought in the historical record, spanning ninety years, posed a significant test to the resilience of the Brazilian electrical system in the face of severe shortages.

The situation in 2021 differed from that in (year of rationing). In 2021, the Brazilian generation mix (65% hydro, 20% thermal, and 15% renewable) was quite different from that of 2001 (90% hydro and 10% thermal). The first lesson was the energy mix diversification by promoting alternative sources such as wind, solar, biomass, and natural gas. The other one was that energy efficiency measures have been emphasized, along with the expansion and modernization of infrastructure for power generation and transmission. Long-term planning processes have been enhanced, considering future energy demand and integrating different energy sources.

However, the water crisis in 2021 required new measures to increase the security of the energy supply, such as the dispatch of controllable power plants, importing energy from Argentina and Uruguay, relaxing exchange limits between regions to transfer surplus wind power production from the Northeast to the Southeast/Central-West, identify additional flexibilities in the hydroelectric system to operate closer to technical limits, and relaxing constraints on multiple uses of water. These measures were implemented to mitigate the impact of water scarcity and ensure a more stable and reliable energy supply during the crisis.

Brazil is still adopting measures to mitigate these hydrological risks, like (i) improvement of reservoir management, considering different hydrological scenarios and implementing risk-based management practices to optimize water availability for energy generation over the next five years, (ii) integration of subsystems constructing transmission lines, such as the Northeast and Southeast regions, to optimize the utilization of renewable energy sources including hydro, wind, and solar power and (iii) development of energy storage technologies, like batteries and pumped storage, to overcome seasonal and daily variations in hydropower availability.

National and International Climate Strategies and Plans, Including NDC status

The goal set by the GoB as a National Determined Contribution (NDC)[22], in the Paris Agreement, aims to reduce domestic greenhouse gas (GHG) emissions by 50% by 2030, compared to 2005 levels. Brazil has a set of policies, programs, initiatives, and actions that have a direct relationship with the fight against climate change, with developments in various productive sectors, including the energy sector, among which the following stand out:

- **United Nations Framework Convention on Climate Change (UNFCCC)**; defines the obligations of all participants to combat climate change (at Rio 92 COP), to stabilize GHG concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference in the climate system. Among the commitments made by Brazil to UNFCCC is to develop and periodically update national inventories of anthropogenic emissions,

[22] Data from the International Finance Corporation (IFC) indicate that 1.3 trillion USD will be needed for Brazil to be able to meet the measures and goals of the NDC (Knoch, et. al., 2020).

by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol, in addition to providing a general description of the measures to implement the Convention. (GOV.BR, 2021).

- **Política Nacional sobre Mudança do Clima (PNMC) (National Policy on Climate Change)**; Law no. 12.187/2009. Brazil has presented a voluntary goal to limit the country's GHG emissions. For the energy sector, the measures included the expansion of hydroelectricity and other renewables, as well as energy efficiency.
- **Sustainable Development Goals (SDGs)** aim to reduce poverty, protect the environment and climate, and ensure people's peace and prosperity. SDG Number 7 (SDG7) aims to universalize access to clean energy for all Brazilians by 2030. In 2019 and 2020, the rate of electrification and share of renewables in domestic supply was 99.7% and 48.4%, respectively (SDG Brazil, 2022; WEF, 2019).
- **Plano Nacional de Adaptação (National Adaptation Plan) (PNA)**; MMA Ordinance No. 150/2016. It aims to guide initiatives to reduce national vulnerability to climate risk in the long term. It was instrumental in including the theme in the country's public policies and in encouraging the development of projects to understand climate change adaptation.
- **Fundo Nacional sobre Mudança do Clima (National Climate Change Fund) (FNMC)**; Law no. 12.114/2009. Linked to the Ministry of the Environment (MMA), it provides reimbursable (managed by BNDES) and non-refundable (operated by MMA) resources. Since its creation, it has supported 61 non-refundable projects and investments in renewable generation and distribution, such as: biomass (except sugarcane), solar, tidal, and wind (BNDES, 2022; GOV.BR, 2022).

Current Status and Expected Contribution of the Energy Sector to the NDC Goal

According to (MCTI, 2022), in 2020, the Brazilian energy sector was responsible for approximately 23.2% of total domestic GHG emissions (total 1,675.76 $MtCO_{2eq}$). Regarding the goal of the Brazilian NDC, there is no formal distribution between the different sectors, so that the country can reach the goal by different paths. Thus, the success of the NDC can occur with contributions from the various sectors of the economy, and it is up to the country to adopt the most cost-effective measures (EPE, 2020b). The Brazilian NDC presents the following indicative objectives related to the activities of production and energy use (EPE, 2016; GOV.BR, 2022a):

- Expansion of renewable sources, in addition to water, in the total energy matrix, participation of 28% to 33% by 2030.
- Expansion of domestic use of non-fossil sources, increasing renewable energy capacity (in addition to hydropower) in electricity supply to at least 23% by 2030, including by increasing wind, biomass, and solar participation.
- Achieve an estimated 45% to 50% share of renewables in the composition of the total energy matrix by 2030.
- Participation at least 66% of the water source in electricity generation in 2030, not considering self-production.
- Achieve 10% energy efficiency gains in the electricity sector by 2030.

Therefore, decarbonizing the energy matrix becomes crucial to reach the emission reduction goals of Brazil.

Gap/Barrier Analysis

Brazil currently occupies the 30th position among the 115 countries in the World Economic Forum's Energy Transition Index, surpassed in Latin America only by Uruguay, Costa Rica, and Colombia (WEF, 2021). However, there are still barriers to providing clean, safe, and reliable energy. Removing these obstacles is necessary to accelerate the transition and achieve the goals of reducing GHG emissions by 2030 and decarbonization by 2050. In this context, in 2019, the Electricity Sector Modernization Working Group (ESMWG)[23] identified three main challenges that the SEB modernization process needed to face:

- Financial viability of the expansion in REME and FEME to grow the system with reliability and sustainability. In order to ensure an adequate and timely expansion in REME and FEME it has be taken into account that the projects in the electricity sector to generate a suitable return of the investments.
- Legacy Contracts need to address the contractual relations in force, ensuring security, legal and regulatory stability. This challenge is complex due to the number of agents involved, the types of contracts, as well as the terms of these relationships, some contracts exceed 2050, while others end in the short/medium term.
- Electrical Transition, the electrical matrix has changed since the framework of current sectoral rules was designed, it became more diverse (with predominance, although relatively smaller, of hydroelectricity, and with greater participation of VRE, in addition to DG). Whatever the proposed improvements, it is important that the new framework of sectoral rules is technologically neutral, given that consumption habits and technologies are evolving with unprecedented speed, and it is not reasonable to expect that with each new configuration of the matrix a new sectoral reform will be developed.

The guiding pillars to solve these challenges are (MME, 2019): adequate allocation of payment for system security; orderly opening of the consumer market; improvement of price formation in the Short-Term Trade Market (STTM); adequacy of contracting the system expansion; preparation of the distribution segment for market opening (free market expansion) and adequacy of the regulatory framework for technological neutrality. To obtain the details of the action plan for the modernization of the electricity sector, thematic groups were defined, which are presented in Table III.1, in ANNEX III.

In addition, some technological gaps/barriers should be considered to leverage an Investment Plan to expand the integration of VREs into SEB.

Enhancing Technologies. VREs are relatively new technologies and present some challenges: lack of human capital in the field of digitalization; lack of telecommunication infrastructure; technological costs and availability; and cybersecurity. In addition, in the specific case of HPP modernization initiatives[24], they face regulatory and financial challenges that act as limiting elements for their materialization. The Plano Nacional de Energia (National Energy Plan) - PNE 2050 also highlights the need to improve rules that encourage the modernization of hydroelectric plants as an additional challenge to be overcome (EPE, 2020c). Sectoral institutions are assessing several alternatives to solve this situation, such as, the inclusion of HPP in capacity reserve auctions; clarification of the concepts of expansion and improvements used in

[23] Created by Ministerial Ordinance MME No. 187/2019.

[24] Brazil has the world`s second largest installed hydroelectric capacity, after China, with 109 GW. The installed hydroelectric capacity in the power grid exceeds 60% of the total capacity. Approximately 50% of the installed hydroelectric capacity is over 25 years old (Modernization of Hydroelectric Plants in Latin America and the Caribbean. Identification and prioritization of investment needs (IDB, 2020).

concession contracts; the possibility of extending the concession term by up to 20 years to amortize investments and obtain adequate remuneration for the provision of ancillary services.

Digitalization of the Transmission and Distribution (T&D) Infrastructure. Some of the barriers are: lack of implementation of advanced sensing and telecommunication infrastructure; lack of a regulatory framework that fosters the deployment of technologies such as batteries; lack of a market to remunerate key services (for example, ancillary services, and several batteries services could provide are not yet monetizable); lack of appropriate pricing mechanisms. Also, the expansion of implementation of Flexible AC Transmission System (FACTS) also faces barriers, as there is no scheme that encourages its implementation. In distribution networks, one of the technologies that most favors the insertion of renewable DG is intelligent measurement. However, this infrastructure still faces numerous barriers to its massification, such as the high costs of implementation in the Brazilian market, lack of telecommunication infrastructure that supports its installation, as well as cybersecurity issues.

Expansion of Energy Storage Technologies. As in the previous cases, sector institutions are analyzing several regulatory measures to be implemented so that investments in this type of technologies are recognized. At this time, for example, there is no regulatory definition on the incorporation and denomination of storage assets in T&D and the regulatory framework still does not recognize adequate revenues for some of the services provided by these technologies that could enable this type of investment. Economically, they are technologies that are still at an early stage as it relates to their consideration in the expansion of SEB, which is why they need financial support and mobilization of economic incentives. In the market, the enabling elements are still being developed to facilitate the commercialization of the products and services that these technologies can offer (for example, ancillary services market). In addition, it is necessary to develop a pricing mechanism with greater granularity that is more adherent to the operational reality and the implementation of an advanced sensing and telecommunication infrastructure that supports the deployment of these technologies, also considering the large amount of data that must be processed, managed, and stored.

III. Renewable Energy Integration Context

<u>Electric Sector Overview</u>

SEB's institutional organization and operation is based on the vertical separation of activities: Generation, Transmission, Distribution, and Commercialization. These activities are carried out by public, private and mixed economy companies (Tolmasquim, 2015).

NIS connects generators and consumers, having been designed to carry large amounts of electrical power over long distances. The connection allows synergistic gains of hydrological regimes of basins located in Brazilian geographic regions with different seasonalities, preventing the different rainfall regimes between regions from affecting energy supply at national level. This diversification brings as main benefits the reduction of the use of polluting fuels, as well as the reduction of their environmental impacts.

SEB has one of the most renewable matrices in the world. In 2019, the country was ranked 3rd in the world in installed capacity and renewable generation, with 142 GW and 515 TWh, respectively (EPE, 2022; IEA, 2021). In the same year, the country occupied the 2nd, 8th, and 25th place in installed water, wind, and photovoltaic capacity, with 109 GW; 15 GW, and 2 GW, respectively (EPE, 2022).

Institutional Structure and Capacity

SEB has its institutional framework in Laws No. 8.987/1995 and No. 9.074/1995 and comprises institutional and economic agents, and other non-sectoral agents (Tolmasquim, 2015). Institutional agents are responsible for policy, regulation, planning, and execution of sectoral activities. The institutional agents are: National Energy Policy Council (CNPE), responsible for proposing policies and guidelines; MME, responsible for formulating and implementing policies; Electricity Sector Monitoring Committee (CMSE), responsible for evaluating the security of energy supply; EPE, responsible for updating the transmission and generation expansion plan; ANEEL, responsible for regulating and supervising SEB; CCEE responsible for enabling the commercialization of energy and ONS, responsible for system coordination activities.

Economic agents are holders of concession, permission, or authorization to develop, deploy, and exploit generation, transmission, distribution, and commercialization activities. Non-sectoral agents influence political, regulatory, and business decisions, but do not have direct performance or specific skills at SEB (BNDES, National Agency of Petroleum, Natural Gas, and Biofuels (ANP), among others).

Brazil's policy and regulatory framework for the energy transition were enacted through laws and regulations that seek to diversify the energy matrix and decarbonize the energy sector:

- **Legal Framework for Distributed Micro and Mini-Generation (DMMG)**; allows the engagement of small consumers (called prosumers) in order to generate their energy through micro or mini-generation systems, allowing the entry into the network of the surplus energy produced, generating credits, through a scheme called Net Metering (NM). This scheme promotes the democratization of the electricity sector beyond corporations, reaching even actors in society, with different business models, including the low-income population, through the Renewable Social Energy Program (PERS). According to EPE, investments in DMMG were more than 740 billion BRL between 2010 and 2020.
- **Centralized photovoltaic solar energy**; centralized solar generation began participating in new energy auctions in 2014, with a contracted capacity of 889.6 MW. In September 2022, Brazil exceeded 6 GW of installed capacity in centralized photovoltaic plants. Data from the Brazilian Association of Photovoltaic Solar Energy (ABSOLAR) show that centralized photovoltaic projects totaled 34.3 GW requested granted in April 2021. According to EPE, investments in centralized solar generation were 22 billion BRL between 2010 and 2020.
- **Hourly spot market price (PLDh)**[25]; is the price used to settle the difference between resources and needs of each agent in the Short-Term Market (MCP). Since January 2021, PLD is calculated for each hour of the next day, by a statistical mathematical model called DESSEM. The model developed by CEPEL that determines the daily schedule of the operation of hydrothermal systems, including intermittent sources, giving rise to the semi-hourly price to be applied in the short-term market.
- **Decree No. 10.946/2022**; provides for the assignment of the use of physical spaces and the use of natural resources in inland waters under the domain of the Union, in the territorial sea, in the exclusive economic zone, and on the continental shelf for the generation of electricity from an offshore wind project.

In addition, the essential regulations and standards issued in recent years, which have contributed to the promotion and penetration of VREs, are described in ANNEX VIII.

[25] Previously, PLD was calculated weekly.

Analysis of the Country's Renewable Generation Portfolio

The installed capacity of the country's electricity matrix is more dependent on hydroelectric power than on thermoelectric power. However, the SEB has faced critical situations: since 2012, the hydrological conditions of the SEB are not favorable (lack of rainfall) which reduced the levels of the reservoirs. Also, the increased environmental, technical, economic, and social restrictions prevent the implementation of HPP with large reservoirs. Also, the increase in VREs is noteworthy. In these cases, thermoelectric power assumes a greater generation role, despite its higher costs and greater pollution. GHG emissions related to the 82 thermoelectric plants inventoried in Brazil increased[26] by 75% from 2020 to 2021, totaling 54.6 $MtCO_{2eq}$ last year. It is important to highlight that, regardless of the water crisis, the increase in GHG emissions must be a trend, since more and more thermoelectric plants are incorporated into SEB (EMA, 2022).

Up to 2019, seven auctions were held with the participation of solar energy for the regulated market. In June 2019, 203.7 MW of installed capacity were contracted in solar energy projects, negotiating their energy at a discount of more than 75% compared to the stipulated maximum price (ceiling price) of 70 USD/MWh, in which the resulting price was 17 USD/MWh (EPE, 2019). Table III.2 in ANNEX III shows the solar energy auctions.

SISOL mainly uses diesel fuel for generation, served by 7 distribution companies. In 2019, the total emissions of these systems were 2.94 $MtCO_{2eq}$ (EPE, 2022c). In addition to the high level of GHG emissions, these systems have high losses of between 34% and 45%. Some distribution companies are implementing actions[27] to combat losses to reduce the indices (EPE, 2021a).

In 2021, NIS and SISOL recorded a load of 69,449 MWaverage and 442 MWaverage, respectively (Table III.3 in ANEEX III shows some characteristics of SISOL in relation to NIS). NIS emissions in that year totaled 54.6 $MtCO_{2eq}$ (emission intensity indicator of 0.1170 tCO_{2eq}/MWh). In contrast, SISOL, in the same year, presented an estimated 0.5720 tCO_{2eq}/MWh indicator.

SISOL represents 0.6% of the NIS load, and although small, this number considerably impacts the sector accounts. The generation in SISOL is subsidized by the FCA and paid by all NIS users as a charge on the energy bill. According to the CCEE, the budget for FCA for 2023 is around 2.3 billion USD. This high cost, associated with the high participation of diesel oil generation, reinforces the importance of transparency and predictability in the planning of services for SISOL, also representing an opportunity to provide solutions that can reduce diesel consumption (reduction of GHG emission) and generation cost (EPE, 2021c; EPE, 2021b; EPE, 2020). Due to this issue, the GoB creates the Pro-Amazon Program[28], which aims to implement structural reduction projects of the generation costs borne by the FCA.

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26 This growth is due to a year of low hydrology in a system dominated by hydroelectric sources, which required greater use of thermal plants. This dynamic varies year by year.

27 Energy efficiency programs from Amazonas Energia, Equatorial Pará, Energisa Acre and Energisa Rondônia foresee energy savings of the order of 29 GWh/year.[27]

28 Through Law No. 14,182/2021, regulated by Decree No. 11,059/2022, the Program for Structural Reduction of Energy Generation Costs in the Legal Amazon and Navigability of the Madeira River and the Tocantins River – Pro-Amazon Legal is created with a triple objective: i) the implementation of projects that structurally reduce the costs of electricity generation supported by the Fuel Consumption Account; ii) the implementation of measures that improve the navigability of the Madeira River and the Tocantins River; and iii) the allocation of resources for the continuity of the infrastructure works of the Tucuruí Line, corresponding to the Manaus-Boa Vista interconnection. The Program will receive contributions of 295 million BRL annually, for a period of ten years from 2023.
https://www.gov.br/mme/pt-br/acesso-a-informacao/legislacao/decretos/2022/decreto-n-11-059-2022.pdf/

Promoting flexibility in NIS is currently considered a priority. In this sense, in 2021, the Energy Research Company (EPE) held the first capacity reserve auction (MME Ordinance No. 20/2021), a new mechanism designed to meet the demand for NIS capacity, identified since PDE 2026. The products offered in the auction were Energy and Power, with 4.6 GW of power being contracted, shared among natural gas (3.8 GW), fuel oil (700 MW), diesel (94 MW) and sugarcane bagasse (65 MW).

National Low or Zero-Carbon Energy Strategies

SEB has a low level of greenhouse gas emissions compared to other systems in the world. For example, in 2019, emissions from the electricity sectors of China, the United States, the European Union, and Brazil were 698 kgCO_2/MWh, 387 kgCO_2/MWh, 285 kgCO_2/MWh, and 104 kgCO_2/MWh, respectively, in 2021 these emissions in Brazil were 119 kgCO_2/MWh (EPE, 2022d; EPE, 2022e).

Brazil's commitment to the Paris Agreement under its NDC seeks to reduce GHG emissions by 37% and 50% below 2005 levels by 2025 and 2030, respectively. In addition, the GoB hopes to neutralize its emissions by 2050; everything that the country issues should be offset with forest plantations, biomass recovery, or the use of technologies (GOV.BR 2022a).

The WBG recently developed the Brazil Country Climate and Development Report (CCDR), which was published in May 2023,[29] to identify political priorities to accelerate the decarbonization and resilience of the energy sector in order to achieve the commitment of zero net emissions in the Brazilian economy.[30] According to the study, the characteristics of the electrical system offer unique conditions to zero emissions and even support the decarbonization of the economy by 2050. The increase in the transmission lines expansion and transmission investment costs required are offset by savings in operating costs. These characteristics include: (i) NIS is an efficient system, which allows the National Operator of the Electric System (ONS) to benefit from the “portfolio effect” to manage variations in
potential for VRE expansion, particularly onshore and offshore wind energy with high capacity factors (greater than 50% in some regions); and (iii) abundant existing hydroelectric resources that provide base energy and serve as a huge source of energy storage.

In addition to the energy system, a key part of meeting national mitigation objectives is the eradicating illegal deforestation, currently planned for 2028. For this, a gradual decrease in the rate of forest destruction by 15% per year in the period from 2022 to 2024 is proposed, increasing to 40% reduction in 2025 and 2026, and finally achieving the complete eradication of illegal deforestation by 2028 (BBC, 2021).

Also noteworthy is the National Green Growth Program (PNCV), created in 2021 and whose objectives are to combine the reduction of carbon emissions, forest conservation and rational use of natural resources with the generation of green employment and economic growth, thus improving the living condition of the Brazilian population (GOV.BR, 2022c).

The Federal Government currently has credit lines that exceed 48 billion USD and include projects in areas such as renewable energy, low-emission agriculture, forest conservation, and restoration, waste management, transportation and logistics, Information and Communication Technologies (ICT) and green infrastructure, among others.

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[29] https://openknowledge.worldbank.org/entities/publication/a713713d-0b47-4eb3-a162-be9a383c341b

[30] The findings of the study relate exclusively to the World Bank's prospects for Brazil and not necessarily to Brazil's official ambitions for the energy transition agenda.

Private Sector Role, Innovation, and Resource Leverage

In addition to greater capital mobilization, the energy transition requires a more active role for the private sector, with the strengthening of international financial and development institutions. These institutions are essential to catalyze investments and provide concessional financing for developing and deploying new technologies. MME data estimate that the expected investments for the physical evolution of NIS must be 19.5 billion USD in the horizon from 2022 to 2031. For the same perspective, projections show that DMMG's contribution, of 37 GW of capacity, requires investments in the order of 24 billion USD (EPE, 2022a).

The post-COVID-19 context and the slowdown in economic activity as a result of the instability associated with the international economic crisis and the geopolitical tensions resulting from the war in Ukraine make it difficult to mobilize a greater share of public investment in infrastructure. In this context, partnerships, known as PPPs (Public-Private Partnerships), are necessary to diversify capital sources for large and multiannual investments required by the energy sector.

In addition to companies, private investment can also come from individual energy consumers, interested in becoming *prosumers*, through the implementation of DMMG and batteries. Consumers are also interested in participating in demand aggregation schemes and demand response programs to reduce their carbon footprint and even market their energy to generate revenue. These initiatives also require funding to achieve scale impact.

The private sector and national authorities join efforts to conduct research and investigations through partnerships with academia and programs led by chambers of commerce and others. As an example, it is worth mentioning the GH2 Hub, CIPP, which is a Ceará's partnership between the Federation of Industries of Ceará (FIEC), Universidade Federal do Ceará (UFC), and CIPP S.A. The state of Ceará has high onshore wind (94 GW), offshore wind (117 GW) and solar (643 GW) energy potential, in addition to solar and daily wind complementarity, excellent conditions for electrolysers.

Given the volumes and needs of infrastructure financing in Brazil, these are traditionally met through, among other instruments, corporate loans, or *Project Finance*, facilitated by commercial banks, and through the issuance of securities in the domestic or international market. Although financial institutions are familiar with financing VRE projects, they are less familiar with new technologies, such as those related to digitalization and automation of grids or storage of energy or offshore wind. Moreover, some financial institutions are reluctant to financially support projects based on these technologies due to regulatory uncertainty. In this context, institutions such as BNDES or BNB and other state-owned and international banks such as the Inter-American Development Bank Group (IDB and IDB Invest) and the World Bank Group (WB and IFC) can play a key role in channeling financial resources and managing the risks associated with projects of this nature. These banks may initially progressively add to their role in filling large funding gaps and in developing medium- and long-term financing.

These types of investments present barriers such as: (i) high cost of capital; (ii) short concession terms in some market segments; (iii) perceptions of business risk that may limit access for micro and small enterprises; (iv) lack of access to preferential interest rates and subsidies to cover capital costs; (v) lack of well-structured projects; (vi) complex regulatory framework, (vii) new technologies that have not yet been proven and/or are not financially viable without concessional financing, among others. Thus, concessional financing, risk mitigation, and credit enhancement mechanisms will be required to manage the spectrum of financing risks and attract private sector financiers to these types of projects.

Complementary Activities of Other Development Partners

Several multilateral and bilateral donors are actively involved promoting renewable energy. Some of the main supports are described below:

International Bank for Reconstruction and Development and International Finance Corporation – World Bank Group (WBG): WBG has supported the integration of renewable energy sources in Brazil into its energy matrix through technical assistance and/or financing products. WBG is conducting various technical assistance to support the development of new technologies, such as modernization and flexibility of the hydroelectric, offshore wind and low carbon H2 sectors in Brazil. In addition, the WBG published the Climate Change Development Report[31], in which political priorities are identified to accelerate the decarbonization and resilience of the energy sector. Other areas of support include, for example, financing the country's first GH2 hub and the Partnership for Market Implementation (PMI) focusing on carbon pricing. IFC also supported the energy transition in Brazil through technical assistance and through projects with private sector clients, which should translate into future investments in the sector. For example, IFC with BNDES and WB signed an agreement to create a program that aims to allocate financial and technical resources to the structuring and modeling of infrastructure projects in the form of public concessions and Public Private Partnerships (PPP) in Brazil, loans to projects of Brazilian companies, combating Green Laundering, among others.

IDB and IDB Invest: The IDB Group has supported Brazil's energy transition through investment policies, operations, and technical assistance. The IDB Group has already financed several projects related to solar projects for the development of FTA contracting Energy Purchase Agreements (PPA), guarantees for wind and solar projects to develop the capital market, and modernization of the CELESC-D distribution network. In addition, it has developed the SEB modernization projects (technical assistance to promote DG and digitalization of T&D networks), energy transition program, development, and consolidation of the Battery Energy Storage System (BESS) market, hydroelectric storage development in Latin America, among other projects.

Further details of the activities supported by the cooperation partners can be seen in ANNEX VI of this report.

Socio-economic context related to women and diverse groups

Brazil presents significant inequalities in relation to gender and race. It is estimated 56.2% of Brazil´s population is black and 51.8% women. Social inclusion with equal opportunities is still a necessary task in Brazil, which remains a country with profound inequalities in income levels, education, access to the labor market and physical security, which are especially manifested in women, indigenous peoples, and Afro-descendant communities. Afro-Brazilians represent approximately 78% of the lowest-income 10% of the population and only 24% of the richest 10% of the population. The Institute for Applied Economic Research (IPEA), in partnership with UN Women reported that between 1995 and 2015, whil black women's in 80%, the pay scale remained t having the worst salaries in the labor market. Regarding gender, the I DsBdócument on Challenges for the Development of the Country (CDC, 2018) shows that the participation rate of

[31] Brazil CCDR – Energy Sector Deep Dive. PSR-World Bank.

the female workforce in Brazil is only 53%, compared to 75% for men. Women are underrepresented in the formal sector and occupy only 13.6% of the executive positions in the 500 largest Brazilian companies, although the workers of these companies have on average a greater number of years of formal education and participate in most learning and training programs. The presence of black women in leadership positions has increased in last years, but they only hold 1.6% of managerial positions and 0.4% of executive positions in companies according to the IDB and the Ethos Institute. Supporting women in climate and energy in Brazil means emphasizing the importance of intersectionality and that structural racism plays a major role in allowing women to access education, formal jobs, and career growth.[32]

According to the International Renewable Energy Agency (IRENA)[33], women hold only 32% of renewable energy jobs worldwide. In Brazil, in addition to being predominantly male, the sector is still very permeated by prejudices. When analyzing the participation of women in areas such as Science, Technology, Engineering, and Mathematics (STEM), their low representation can be observed both at the technical level and in decision-making positions. According to IBGE, despite having more years of study, women earn on average 77.7% of men's salary[34]. In engineering, only 39% of jobs are held by women, this number drops to 32% in the exact sciences[35]. The main barriers and challenges to entering and staying in the sector are related to gender bias and male culture, as well as the lack of credibility in the quality of the work developed by women, particularly in relation to STEM.

Moreover, the best primary and secondary schools in Brazil are private institutions, which offer the highest level of education, while the best universities are public and require an extremely competitive SAT exam (known as vestibular) for enrollment. Since only middle- and higher-income groups can afford private schools, public universities are mostly comprised of wealthier Brazilians, with few exceptions due to affirmative action policies and racial quotas. In private high schools, there is little to no incentive for women to pursue STEM careers, and these incentives are even smaller in public schools since many students have to work while studying to support their families and/or never enroll in universities because they are not competitive to the cost-free public ones nor are able to afford private universities. The relationship between access to education and income is a critical piece in understanding the very limited presence of women in STEM in Brazilian universities. To address this challenge, efforts at the local level have to be considered since middle and high school education is constitutionally a state responsibility. STEM campaigns and programs targeting women should be a topic of discussion with national policymakers but most importantly, with governors.

The participation of women in leadership positions is limited, especially in senior positions, such as director or executive, which makes it difficult to debate and address important issues, thus contributing for the replication of inequalities. Therefore, women face double discrimination: in addition to being underrepresented in leadership positions (which tend to have higher salaries),

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32 Numbers are cited in a report produced by GIZ, C40 and Rede Mesol identifying the challenges for women in solar energy in Brazil. https://www.c40cff.org/knowledge-library/solar-energy-in-brazil-which-are-the-barriers-and-opportunities-for-women-professionals-in-the-field

33 Renewable energy: A gender perspective (irena.org).

34 IBGE (2019b): https://educa.ibge.gov.br/jovens/conheca-o-brasil/populacao/18314-trabalho-e-rendimento.html 11 BOLZANI (2017).

35 Mulheres na ciência: por que ainda somos tão poucas? Vanderlan da Silva Bolzani, 2017.

they are overrepresented in the service sectors, which tend to have lower salaries. In the energy sector, only 11% of women participate in decision-making positions in private companies[36].

Additionally, Brazilian patriarchy is enrooted men received pieces of land to exploit as part of the Portuguese Crown's mandate. its history, landowners gained more power, and as Brazil developed its agricultural economy, these families continued to exert their dominance in politics and economics with a strong male figure. These agricultural elites are predominant in Congress and still have a lot of leverage in Brazilian policymaking, which very often collides with sustainable development and the adoption of climate policies. Cultural norms are deeply intertwined with this narrative as landowners still reduce their partners to domestic roles. While having a lot of political power, these groups also strongly believe women should not be in leadership positions or start careers that are historically occupied by men. Religion also plays a part in reinforcing these values. Evangelical churches will often support these worldviews, and in Brazil, they are deeply connected to the agribusiness sector, both representing 2/3 of seats in Congress.

Maintaining a balance between personal and family life is also a barrier, since most responsibilities for domestic and family care lie with women. Gender violence and racial inequality are strong and widespread issues in Brazil, resulting in great barriers also for women in the sector, since 57% of professionals have already suffered some type of violence and 71.7% have already been discriminated against in their professional environment[37]. Some actions are being taken as a project called "Yes, they exist" (Sim, Elas Existem)[38], that produces every four years during the presidential election period, a list of women in the energy sector they recommend for government positions. In 2022, the list had 1,000+ nominations to prove how much women are highly equipped to occupy these roles. Although there was progress in comparison to the previous governments, the presence of women is still very low. Most executive positions are political nominations, and as mentioned before, the agribusiness sector will continue having political influence to dictate government agendas. In addition to this initiative, there are four other female-led networks worth noting in Brazil: *Damas de Energia*, *Mulheres da Energia*[39], *Rede Brasileira de Mulheres na Energia Solar* (MESol)[40] and Women in Energy (WIN).[41]

According to ESMAP's SDG 7 tracking, Brazil ha clean cooking. Although there are many women lacking access to clean cooking in the North and Northeast regions of the country, this is not a key challenge as it is in most of the Global South. Most households, even the poorest in both rural and urban areas, have a gas-powered cookstove, and the biggest issue now is affording Liquefied Petroleum Gas (LPG). With the war in Ukraine, gas prices are higher, and the government has been subsidizing energy bills and the cost of gas cylinders. Another pressing issue affecting women is the lack of cooling. With the growing frequency of heat waves, lower-income groups, and especially those living in urban centers, have been demanding cooling appliances. Due to the high costs of air conditioners, most people rely on fans and very low efficiency appliances that also consume more energy and

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36 Guia de Mulheres na Liderança (Função Getúlio Vargas, 2018). The report evaluated the participation of women in decision-making positions in 88 companies (national and multinational) in 14 economic sectors in Brazil. Of the 30 companies with the best results, only two were in the energy sector: Shell and AES Eletropaulo.

37 Solar energy in Brazil: which are the barriers and opportunities for women professionals in the field, C40 Cities Finance Facillity and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 2021.

38 https://www.simelasexistem.com/.

ttps://mulheresdaenergia.com.br/

40 https://www.mesol.com.br/

41 https://instabio.cc/WINBrazil

lead to higher electricity bills. Women suffer the most from the lack of cooling in their households as they are expected to conduct domestic labor after their full-time jobs. Moreover, Brazil has a strong cultural reliance on housekeepers due to colonial and slavery roots, where women will work long hours doing manual labor at a home without access to cooling or rest.[42]

More than 820,000 indigenous people live in Brazil, representing approximately 0.4% of the country's total population. They represent 305 different ethnic groups and have more than 270 native languages. The state of Amazonas is home to 20.6% of the indigenous population. About 61.5% of the total indigenous population lives in rural areas, while the city of São Paulo has an indigenous population of approximately 12,000, the largest of any urban area. Only 12.5% of the land remains in the possession of indigenous people and only 73.7% are literate compared to the national average of 89%[43]. In terms of access to services, 75% have access to electricity, 65% to sanitation and 36% to piped water[44].

IV. Program Description

The objective of the Investment Plan (IP) of the CIF Renewable Energy Integration Program (CIF-REI) in Brazil is support the decarbonization of the economy, mainly by accelerating the country's clean and inclusive energy transition. Specifically, the CIF-REI will: (i) decrease or eliminate, to the extent possible, the economic, financial, technical, and operational barriers that prevent the integration of energy VREs (basically, solar and wind technologies) in SEB, and (ii) support the development and implementation of the appropriate infrastructure, maintaining the conditions of quality, reliability, and security in the energy supply, in addition to creating the favorable conditions, so that increasing amounts of VRE are incorporated, both connected to NIS and SISOL.

CIF-REI's concessionary resources will catalyze the financing of MDB partners (Inter-American Development Bank Group and the World Bank Group), private investment and other co-financing in technologies/projects necessary to meet the country's NDC and decarbonization commitments.

Supported activities

The types of eligible technologies, infrastructure, and transformational activities prioritized by the program for co-financing of MDBs are described in the next sections. They will contribute to decarbonize Brazil's economy by promoting the development of a GH2 market, and increase the flexibility, adaptability, and resilience of SEB to absorb higher volumes of VRE in the following strategic areas of intervention prioritized in the CIF-REI IP:

- Modernization and digitalization of HPP.
- Digitalization and automation of T&D networks in the NIS and VRE integration in SISOL.
- Storage technologies (PHS, H2, and batteries).

The CIF-REI IP will be articulated and implemented through two interventions led by each of the MDB partners.

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[42] Cooling for all and Gender: Towards Inclusive, Sustainable Cooling Solutions https://www.seforall.org/publications/cooling-for-all-and-gender

[43] Indigenous peoples of Brazil, Woodrow Wilson International Center, Brazil Institute.

[44] IBGE, 2010 Demographic Census.

The MDBs will identify opportunities to apply innovative green funding schemes to leverage co-funding resources in order to support the implementation of the eligible transformational activities identified in the focus areas of CIF-REI´s IP.

IDB Group Intervention (IDBG)

Specific Objectives. The resources of the CIF-REI in the intervention of the IDBG will be destined to:

i) Reduce financial, technical, and operational barriers that prevent or limit the integration of renewable energy generation in SEB;
ii) Support the automation and digitalization of the SEB infrastructure, in addition to the enabling conditions, to increase its flexibility and capacity to absorb large volumes of VRE that are planned to integrate into the electrical matrix in the coming years, both centralized and distributed;
iii) Promote the scaling and implementation of energy storage technologies that allow increasing the flexibility, reliability, and resilience of SEB to enhance the integration of VREs.

In the intervention of the IDBG, the concessionary and non-refundable resources of the CIF-REI will be implemented through two Components led and executed by BNB, which will act as Implementing Entity (IE) of the resources of the CIF-REI.

Component 1: Funding to provide greater flexibility to SEB in Brazil's Energy Transition Process (412 million USD IDB, 33.5 million USD CIF-REI, 286.3 million USD Pro-Amazon Legal Program, and 325 million USD, others[45]). BNB will use the resources assigned from the IDB loan in preparation[46], together with the resources of the CIF-REI, to provide financial support through loans to public and private developers of projects aimed at decarbonizing the Brazilian economy and a clean and inclusive energy transition in Brazil. Through this component, CIF-REI funding will be made available for any transformational activities/technologies that increase the flexibility and resilience of SEB to absorb higher volumes of VRE, in the defined strategic areas of intervention (see the section on eligible transformational technologies/activities for more details). This component does not establish specific values to be allocated to each activity/technology. The resources of the CIF-REI will be applied in the financing rights granted by BNB based on the portfolio of eligible projects that are identified in its portfolio of projects[47]. In order to achieve the expected leverage of private sector resources, it would be desirable to have additional concessionary resources from CIF-REI, in order to structure blended finance operations with IDB Invest resources.

[45] It is included here capital, financing from commercial and local development banks, IDB Invest, and other international financial institutions. This amount is indicative, but in any case, considered as the minimum possible co-funding expected from third parties, in particular from the private sector, in the case of having concessionary resources in addition to the 35 million USD initially foreseen under the IDBG intervention (at least 15 million USD), to structure blended finance operations with IDB Invest resources.

[46] Programa de Desenvolvimento Produtivo da Região Nordeste (Productive Development Program of the North-East Region) (PRODEPRO).

[47] The Northeast region is one of the largest generators of renewable energy, with a large volume of investment in the last 10 years. According to the study carried out by the Technical Office of Economic Studies of the Northeast (ETENE) of BNB in 2022, in the next 5 years investments of around 61 billion BRL are expected in wind projects and around 57 billion BRL in photovoltaic projects. BNB has a portfolio of energy projects of almost 290 billion BRL, divided into 1,666 projects.

The expected outcomes of the implementation of this component include[48] (for more details on the impacts on results IDBG`s intervention, see ANNEX IX):

- Acceleration of the decarbonization of the Brazilian economy as a result of the mobilization of the rights and induced investments provided for in the framework of the IDBG intervention, and its impact on the insertion of centralized and distributed VREs and the reduction of GHG emissions and fossil fuel consumption. According to the estimates and simulations developed as a result of the implementation of the IDBG intervention, an emission reduction of about 16 $MtCO_{2eq}$ is expected during the period of execution and disbursement of the operations provided for in the IDBG intervention (2023-2029). It was estimated that if the operations incorporated in the intervention of the IDBG were to materialize under the conditions provided, the equivalent to approximately 5 GW of VRE could be incorporated in SEB.
- Acceleration of the energy transition process by focusing efforts on prioritizing and financing projects in the defined strategic areas, increasing resource leverage and achieving greater effectiveness of interventions to integrate greater volumes of VRE in SEB. Third-party funding mobilized by the IDBG intervention is estimated at 1 billion USD.
- Deployment of infrastructure and systems that increase the flexibility of operation and resilience of power grids and energy markets to absorb centralized and distributed VRE. It is expected that as a result of the implementation of the IDBG intervention, approximately 1.5 million smart meters will be installed, which will favor the empowerment of consumers (prosumers), and the flexibility of the operation and the absorption capacity of the RED distribution infrastructure.
- Promotion of economic activity, productivity, and competitiveness as a consequence of the mobilized investments, and the promotion of innovation, the strengthening of technical capacities, and the emergence of new business models associated with the development and implementation of new technologies at SEB.

Incentives for access to funds will be implemented as an instrument to overcome some of the current gender and social inclusion challenges in the energy sector. Some of the actions that will be required from public and private companies to be eligible for access to funds are: (i) having adequate hiring policies to ensure a percentage of workers in all hierarchies and divisions of companies are women and/or belonging to minority groups (such as African Brazilian, indigenous peoples, people with disabilities); (ii) developing and implementing incentives to increase the participation of women and diverse groups in leadership and STEM technical areas; (iii) strengthening human resources with a perspective of gender equality and social inclusion, promoting a culture that accommodates the needs, schedules and safety concerns of women, an environment free of gender-based violence and sexual harassment in the workplace; (iv) conducting courses or workshops on inclusion of people with disabilities in the labor market and analyzing the feasibility of work activities for people with disabilities according to their competences; (v) creating procurement mechanisms that include preferential scoring systems and factors unrelated to the price offered (for example, if companies provide scholarships or

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[48] The estimated results are indicative, as the final results will depend on the specific projects financed by BNB with the resources of the CIF-REI, and those financed by BNB and the rest of the financial institutions and investors that will participate in the mobilization of resources within the framework of the areas prioritized by the GoB. However, to obtain indicative results considering the CIF-REI + leverage resources totaling 1,060.8 million USD, it is estimated that the resources of the IDB Group intervention will be applied as follows: HPP modernization 209.2 million USD, modernization and digitalization of transmission and distribution networks 785.31 million USD, and insertion of storage technologies 66.3 million USD.

training for women and diverse groups); (vi) conducting consultations and public meetings during the design, implementation and closing of projects to increase the participation of women, indigenous peoples, people with disabilities, and members of local communities in decision-making processes, and asses the impacts and benefits of projects outcomes. These activities are intended to allow these groups to have their voices heard and considered in the development of the projects. Social inclusion and gender activities will continue to be planned and coordinated with a view to implementation with the support of the MDB and alignment with sectoral policies.

Component 2. Project Factory and technical assistance (1 million USD IDB and 1.5 million USD CIF-REI non-reimbursable sources, and 1.5 million USD IDB reimbursable resources). The sources of this component will be applied to develop technical, prefeasibility/feasibility studies, and for the structuring of projects within the scope of the loan to be granted by the IDB to the BNB and the development of technical studies that contribute to overcoming the barriers identified in the development of projects that increase the flexibility of the SEB and promote the integration of VRE.

Expected results:

- 6 Projects based on eligible transformational activities/technologies of the intervention with prefeasibility and/or feasibility studies ready for funding.
- Increase in the number of people (including women and diversity groups) trained in aspects related to the importance of the promotion and implementation of VRE, both centralized and distributed, in the energy transition process to achieve the decarbonization of the Brazilian economy, taking into account the social and cultural particularities of the different regions of the country, and the implementation and use of intelligent measurement (Advanced Metering Infrastructure, AMIs).

Specific gender and social inclusion analyses will be carried out for the 6 projects, considering the specific geographical areas of implementation. Training activities will be carried out to improve the technical knowledge of women and minority groups (indigenous peoples, people with disabilities, youth, local communities) on the process of energy transition for the decarbonization of the Brazilian economy; Workshops may also be held for the development of leadership skills and to increase female participation in decision-making processes. Materials for these activities will be translated to English since a major challenge for women entering this sector in Brazil is not knowing English, especially in the case of indigenous women. In addition, capacity building activities on cultural and social norms targeting men will also be delivered.

Learning activities on the use of AMIs, the efficient use of energy, and customer rights will also be carried out, with the aim of promoting the employment of women and diverse groups in advanced measurement operations and customer service operations centers. Greater knowledge about the use of AMIs can increase employment opportunities for women and diverse groups in service operations centers where they can support energy customers in areas such as online energy monitoring or consumption rewards that can reduce customer bills. Women are often the main users of energy in homes. By having a good knowledge of how to efficiently manage energy use, they can reduce electricity generation and therefore greenhouse gas emissions. This may also help to prioritize and improve access and efficiency of appliances such as Air Conditioning (ACs) which are currently extremely expensive in Brazil. Urban centers are very exposed to heat waves during the summer and women who are responsible for domestic work suffer the most.

Main transformational activities/technologies eligible for the application of the concessionary resources of the CIF-REI in the intervention of the IDBG:

1. **Modernization and digitalization of HPP**

- Sensing.
- Creation of a supervisory system and database for the application of computational intelligence.
- Measurement, protection, control, supervision, communication, and monitoring systems.
- HPP Operation and Maintenance (O&M) Optimization Digital Solutions.
- Repowering of HPP.

2. **Digitalization and automation of T&D networks**

- Transmission:
    - FACTS (SVC, STATCOM, TSSC, TCSC, SSSC, UPFC), and similar synchronous compensation systems.
    - Sensors and control and communications systems.
    - Transmission equipment associated with VRE projects.
    - Computational models to support the evaluation of power grid planning;
    - Auxiliary equipment for DLR, such as communication systems, measurement sensors, fall detectors, weather stations, data storage systems.
    - Computational models for calculating the DLR in the operation of transmission systems.
    - Data logging software for storing and analyzing DLR equipment data.
    - Data analysis software deployed by system operators to analyze data generated by DLR systems.
- Distribution:
    - Technologies that bring flexibility to the system, such as advanced control and automation solutions (e.g.: D-FACTS).
    - Intelligent Metering Infrastructure (AMI).
    - Distribution system equipment that contributes to increase its resilience and integration capacity of renewable DG, reducing its vulnerability.
    - Sensors and control and communications systems.
    - Implementation of a Demand Response program.
    - Computational models to support the evaluation of the planning and operation of the distribution networks with RED penetration.
    - Computational models to support the evaluation of the operational integration of the transmission and distribution systems.
- Decarbonization of SISOL: The Pro-Amazon Legal Program, provided for in the law authorizing the privatization process of Eletrobras, seeks the Structural Reduction of Energy Generation Costs in the Legal Amazon and Navigability of the Madeira River and the Tocantins River. Benefitting about 3 million people served by SISOL.
    - Digitalization and automation of networks and implementation of microgrids.
    - Development of energy efficiency programs.
    - Interconnection of SISOL each other and/or to the NIS.
    - Hybridization of SISOL with VRE, with or without energy storage.

3. Storage technologies

- Batteries.
- Hydrogen.
- Pumped Storage Hydropower Plants.

Table 1 below summarizes the estimated investments and the respective impacts of the different activities that can be supported by CIF-REI´s IP, in the strategic areas of intervention prioritized:

Table 1. Data of activity areas.

Operation areas	Investment (USD M/yr)	Investment (%)
UHE Modernization	360.4	30.6
T&D Modernization	703.4	59.7
Storage systems	114.2	9.7
Total	1178.0	100.0

<u>WB Group Intervention (WBG)</u>

In 2021, GoB established the guidelines of the National Hydrogen Program (PNH2), which establishes the strategic vision for the development of the Brazilian hydrogen industry and market.

The PNH2 is formed by six action axes (Figure 4), accompanied by specific guidelines. Axis three, energy planning, is relevant in terms of renewable energy integration, with guidelines for the incorporation of hydrogen supply and demand and the effects on the expansion of the electricity sector. In addition, the National Hydrogen Program Committee (Coges PNH2) was established in order to coordinate and supervise the planning and implementation of PNH2, as well as a Triennial Plan (2023-2025) of PNH2 was prepared and submitted to public consultation, which highlights the country's commitment to develop the low-carbon hydrogen market and to integrate it into the electricity sector.

The actions foreseen under this component align with the activities projected under the three-year plan framework plan of PNH2, in particular, market growth and competitiveness, training, and human resources. International cooperation has also been identified as one of the priority axes of the Program.

In addition to initiatives at the executive level, in March, this year the Federal Senate of Brazil established the Special Commission for Public Policy Debate on Green Hydrogen (CEHV) with the objective of promoting green hydrogen as an energy source in Brazil, also recognizing the importance of hydrogen integration in electricity and energy matrices.

Figure 4 – PNH2[49] thematic axes

According to the Brazil CCDR, the Brazilian electricity matrix has unique characteristics that allow both its decarbonization in an economical way, as well as supporting the decarbonization of the economy through increased electrification. To decarbonize the economy and achieved net-zero emissions, it will be necessary to invest massively in VRE capacity by 2050: compared to the baseline scenario (with PDE 2031 as a reference), it would be necessary to increase solar capacity by 146 GW, onshore wind capacity by 83 GW, offshore wind capacity by 18 GW and HPP capacity by 29 GW.

GH2 allows greater integration of intermittent sources in the electrical matrix, by allowing the absorption of excesses of supply from the expansion of VREs in a flexible energy vector that can support both the stability of the electrical system, as well as enable the expansion of the scope of these sources to enable the integration of VRE in the broader energy matrix, in addition to the electrical sector, thus contributing to the broader decarbonization of the Brazilian economy. In addition to supporting the achievement of the national goal of zero-net emissions by 2050, the production of GH2 and derivatives would create a new economy for the country, thus being a way to boost economic development through the industrialization of the Brazilian economy. For example, the country, which today exports about 20% of the world's iron demand (WITS, 2023), could become a green steel exporter.

In Brazil, the development of the GH2 market achieved through hubs, combining in one place the production, transformation, and use/commercialization of GH2 and derivatives. This is a way to take advantage of economies of scale and scope through shared infrastructure (such as water supply, power grid, and industrial and port infrastructure), in addition to the strategic location for the production and commercialization of products (since the main GH2 hubs planned for Brazil are in industrial and port zones). Another benefit would be to couple the production of offshore wind with GH2 as a way to reduce costs and allow the greater integration of offshore wind energy: the production of GH2 directly at the offshore terminal allows to decrease the cost of the investment of the generation itself, since the transportation cost of GH2 is on average 80% less than the subsea transmission line that connects the offshore substation to the NIS.

49 https://www.gov.br/mme/pt-br/assuntos/noticias/mme-apresenta-ao-cnpe-proposta-de-diretrizes-para-o-programa-nacional-do-hidrogenio-pnh2/HidrognioRelatriodiretrizes.pdf.

Brazil has at least five port and industrial complexes, four of which are located in the Northeast region. Those are: Pecém (Ceará), Suape (Pernambuco), Camaçari (Bahia), and the new port complex that is being built in Rio Grande do Norte. In these examples, there is a strong complementarity between offshore wind production, GH2, and derivatives production, and domestic use, in addition to being aligned with the need for economic development in the Northeast to reduce regional economic disparities in Brazil. Pecém's GH2 hub is currently the most advanced in the country, as: (i) it has four pre-contracts and more than 20 Memoranda of Understanding (MoU) signed with private sector companies, (ii) it is be located near large industries (such as steel and cement, which will be important consumers of GH2 for decarbonization), and (iii) it has federal and state tax benefits for being an Export Processing Zone (ZPE) already constituted. The model being created in Pecém represents a pioneering effort in the country for the development of hydrogen value chains, and could be replicated in other hubs, both in the Northeast region and in other regions of Brazil.

In the case of GH2, one of the main barriers to the development of this new market is the high initial cost for GH2 projects, combined with uncertainty about demand. Many call this challenge the chicken-and-egg dilemma: without production, there will be no demand, and without demand, there will be no interested producers and investors. According to a market analysis conducted by the World Bank, one of the ways to promote GH2 projects would be through public financing of shared infrastructure, such as utility corridors (for water, electricity, hydrogen and ammonia) and port infrastructure, which is a way to reduce the risk of investment for the private sector and at the same time giving a clear policy direction.

In this context, the WBG intervention proposal intends to support the development of Brazil's first GH2 hub, located in Pecém. This investment is both aligned with the objectives of the CIF-REI of greater integration of renewable sources in the energy matrix, as well as the climate objectives of decarbonization of the Brazilian economy and the PNH2.

Specific Objectives. The resources of the CIF-REI in the intervention proposed by the WBG will be destined to:

i) Support the large-scale integration of VRE, through the development of the GH2 hub in the Northeast region, with a view to decarbonizing the energy sector and the economy as a whole,

ii) Develop the shared support infrastructure necessary for the development of clean hydrogen value chains in order to generate favorable conditions for a healthy business environment,

iii) Mobilize private capital, unlocking investments for the development of value chains and the creation of a GH2 market in Brazil,

iv) Promote an energy transition that encourages the training of labor for new sectors, the support to technological innovation and the promotion of the socioeconomic development, including for vulnerable communities around the GH2 hub.

To achieve these objectives, in the proposed WBG intervention, CIF-REI resources will be applied to cover part of the shared infrastructure investments necessary to implement Pecém´s GH2 hub, to attract private capital and accelerate the development of this market in the country, as well as to create a GH2 innovation hub in the Northeast region (containing research center and certification laboratories, training and capacity building center, and actions aimed at RD&I). Buy mobilizing these and other resources, the WBG intends to support the decarbonization of the Brazilian economy.

The expected outcomes of the implementation of this component include:

- The feasibility of a greater integration of VREs in the Brazilian energy matrix, facilitating the integration at scale of new renewable energy sources, such as offshore wind (an estimated 8GW of offshore wind capacity by 2034 is expected considering solely the demand of the four GH2 investors with pre-contracts already signed with the CIPP).
- Support the acceleration of the decarbonization of the Brazilian and world economies, through the financing of Brazil's first GH2 hub, promoting the effective mitigation of GHG emissions and contributing significantly to achieving the net zero goal by 2050 (more details about the expected impacts on GHG emissions can be found in ANNEX X),
- Mobilization of at least 8 billion USD from private sector,
- Employment and engagement of vulnerable communities around the GH2 hub, leveraging the number of people (especially women) with the appropriate skillset to supply the GH2 and VRE industries, focusing on one of the poorest regions in Brazil.
- Key lessons for other Brazilian State´s regarding the large-scale expansion of coupled GH2 and VRE projects.

V. Financing Plan and Instruments

Requested budget allocation for investments

Intervention of the IDBG

The IDBG intervention proposes that the CIF-REI resources co-finance two components: (i) Component 1. The Financing Program to provide Greater Flexibility to SEB in Brazil's Energy Transition Process; and ii) Component 2. The Project Factory Program. Both components will be managed by Banco do Nordeste (BNB). Table 2 shows the funding structure.

Table 2. Funding structure of the IDBG intervention

		FINANCIAL RESOURCES						
		CIF-REI (through IDB)	LEVERAGE					
			IDB			Pro-Amazon Legal Program (6)	Capital, Commercial Banks, and Local Development Banks, IDB Invest, other institutions International Financial Institutions	Component Subtotal
COMPONENTS		Banco do Nordeste (Northeast Bank)	Banco do Nordeste (BR-L1611)(2)	CELESC-D (BR-L1491) (3)	Modernization of the Brazilian Energy Sector (BR-T1529) (4)			
1	Funding to provide Greater Flexibility to SEB in Brazil's Energy Transition Process	33.5 m USD	35 m USD (300 m USD operation)	377 m USD		286.3 m USD	325 m USD	1,056.8 m USD
2	Project Factory	1.5 m USD(1)	1.5 m USD		1 m USD(5)			4 m USD
Sub-total		35 million USD	1,025.8 million USD					
TOTAL		1,060.8 million USD (33.5 m USD concessional + 4 m USD AT + 1,023.3 m USD ordinary and 3rd party capital)						

(1) Non-refundable technical assistance (TA) from CIF-REI
(2) IDB Loan in preparation with Letter of Inquiry approved in November 2022 (expected approval date December 2023 - January 2024)
(3) IDB Loan in execution with CELESC, distributor of the State of Santa Catarina, to promote the digitalization, automation, and reinforcement of its high, medium, and low voltage networks, in order to reduce vulnerability and losses in the SEB, and facilitate the insertion of distributed renewable resources
(4) AT non-refundable from the IDB in operation
(5) IDB Non-Refundable Technical Assistance (TA)
(6) The main objective of the Program is to structurally reduce the costs of electricity generation in SISOL by promoting its interconnection and the installation of VRE and the use of renewable fuels, with or without energy storage

Costs and sources of funding

Component 1: Funding to provide greater flexibility to SEB in Brazil´s Energy Transition Process (412 million USD IDB, 33.5 million USD. CIF-REI, 286.3 million USD. Pro-Amazon Legal Program, and 325 million USD, others). The resources of the CIF-REI will be channeled through the execution of the operation Productive Development Program of the North-East Region (BR-L1611), a loan from the IDB to the BNB under way[50].

The BNB will receive 35 million USD from CIF-REI (33.5 million USD from concessional resources and 1.5 million USD from non-refundable technical assistance resources) that will be applied to finance projects and reduce barriers to the implementation of eligible transformational activities/technologies in the defined strategic areas.

BNB will use the IDB and CIF-REI resources to reduce its financing costs and lengthen loan periods, and to diversify its financing sources, thus better responding to the financing needs of private and public investors in the promotion and implementation of projects that promote the integration of VRE in SEB.

This component will be leveraged with investments financed through the Energy Infrastructure Investment Program of CELESC-IDB (BR-L1491), an ongoing loan granted by the IDB to CELESC-D (electricity distribution company of the State of Santa Catarina)[51].

The Pro-Amazon Legal Program[52] will leverage 286.3 million USD in the period 2023-2029, within the framework of the IDBG intervention, to support the development of projects for the insertion of VRE and use of renewable fuels in SISOL, and the interconnection of SISOL each other and/or to the NIS, using smart transmission and distribution networks, and microgrids.

In addition, IDBG intervention is expected to mobilize third-party co-funding for an estimated additional 325 million USD (including capital, financing from local commercial and development banks, IDB Invest, or other international financial institutions).

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[50] Programa de Desenvolvimento Produtivo da Região Nordeste (Productive Development Program of the North-East Region) (PRODEPRO). Loan of 300 million USD from IDB to BNB in preparation, with consultation letter approved in October 2022. The loan is expected to be approved by the IDB's Board of Directors in 2023, and to begin implementation in mid-2024. The loan aims to finance sustainable infrastructure in sectors such as logistics and transport, energy, connectivity, and infrastructure for business competitiveness. PRODEPRO will also have a 20 million USD component to support the creation of a Project Factory within BNB. According to the analyses carried out in the preparation of the operation, it is expected that the BNB will allocate at least 35 million USD of the IDB loan for the financing of investments in the strategic areas of intervention of the IDBG identified, in addition to providing investments with own resources for the financing of eligible projects within the framework of the CIF-REI IP.

[51] CELESC-IDB Energy Infrastructure Investment Program (BR-L1491). Program through which resources are mobilized for a total amount of 377 million USD (276 million USD from the IDB loan and 101 million USD from CELESC-D's own resources), in order to meet the growth of electricity demand through the expansion and modernization of the CELESC-D distribution network, increase reliability, and resilience and improve efficiency in the operation of the electricity system, and encourage greater gender participation in CELESC-D.

[52] The Pro-Amazon Legal Program has an expected duration of ten years (2023-2032), a period in which 295 million BRL will be contributed annually by Eletronorte, of which 206.5 million BRL will be allocated to the implementation of projects that structurally reduce the costs of electricity generation in the Legal Amazon. This Program will benefit about three million inhabitants served by SISOL, in Acre, Amapá, Amazonas, Pará, Rondônia, and Roraima. Normally, the communities served by SISOL, being more remote, use fossil fuels, especially diesel oil, for the generation of electricity. The objective of the Program is to replace fossil fuel with the use of VRE or renewable fuels, with or without storage; improving energy efficiency measures, exchanging equipment and improving energy use in these remote locations; developing solutions to reduce the level of losses; and, if possible, integrating these locations between themselves, or NIS, using smart transmission and distribution networks, and microgrids. The IDBG intervention considers 286.3 million USD corresponding to the investments mobilized by the Program in the period 2023-2029, with the objective of structurally reducing the costs of electricity generation from SISOL.

The recipients/beneficiaries of the resources channeled through the IDBG will be companies or public entities, and public-private entities, that meet the eligibility criteria of the intervention and the environmental and social safeguard policies of the IDB.

Costs, fees, and financial conditions applicable to the resources of the CIF-REI, will correspond to the Financial Terms and Conditions of the CIF funds published in November 2020[53].

Component 2. Project Factory and technical assistance (1 million USD IDB and 1.5 million USD CIF-REI non-refundable resources, and 1.5 million USD IDB reimbursable resources). The technical cooperation resources of the CIF-REI will be channeled through the IDB and implemented by BNB to co-fund technical studies and prefeasibility and feasibility in the strategic areas of the intervention, and to structure pilot projects. BNB will contribute with 1.5 million USD from the IDB loan. In addition, the IDB will mobilize 1 million USD in technical assistance[54] to develop technical studies, in order to contribute to overcoming the barriers identified for the development of investments in the strategic areas of activity identified.

It is estimated that the period of execution and disbursement of the operations provided for in the IDBG intervention will have a duration of 6 years, between the years 2023 until 2029.

<u>WBG Intervention</u>

The WBG proposes that the CIF-REI resources co-fund the creation of the first GH2 hub in Brazil, located in the Pecém Complex, Ceará. The proposed intervention includes financing of shared support infrastructures to enable the development of GH2 value chain, accelerating the carbonization of the economy and leveraging the private investments, as well as investments in an innovation hub, including training of labor to support the energy transition process. This intervention could be replicated in other hubs across the country, which are currently being identified through technical assistance conducted by the WBG for the federal government.

In the intervention of the WBG, the concessionary and non-refundable resources of the CIF-REI will be implemented through the following Component, to be executed by the CIPP, in which the Government of the State of Ceará has 70% participation.

Component 3: Support for GH2 development in Brazil 90 million USD WB, 10 million USD CIPP, 35 million[55] USD CIF-REI, and 8 billion USD private sector. The CIPP will receive 35-55 million USD from CIF-REI (35 million USD from concessional resources) that will be applied to cover part of the necessary shared infrastructure and the development of an innovation hub (containing research center and certification laboratories, training and capacity building center and actions aimed at R&D&I).

Investments in shared infrastructure will facilitate the development of GH2 hubs. In the case of Ceará GH2 hub, it will be necessary to invest about 150 million USD, covering the necessary shared infrastructure and the development of an innovation hub.

53 https://www.cif.org/documents/climate-investment-funds-financial-terms-and-conditions.

54 Modernization of the Brazilian Electricity Sector (BR-T1529). The objective of this IDB Technical Cooperation is to support the GoB to strengthen its institutional, technical, and regulatory capacities to promote a greater integration of low-carbon technologies in the Brazilian energy matrix.

55 Given the existing financing barriers for the development of GH2 value chains and the financing needs of the proposed intervention, it would benefit from additional concessional resources, should they be made available. IFC, in particular, has strong experience in structuring blended finance mechanisms to maximize private sector participation in the GH2 value chain.

This component will be co-funded by investments from the WB (90 million USD), the CIPP (10 million USD), and the private sector (estimated at 8 billion USD), reaching a project leverage that significantly exceeds the 1:10 ratio.

CIPP will use the resources of the WB loan, which is being prepared through a letter of inquiry[56], together with the resources of the CIF-REI, to finance the necessary infrastructure of the Pecém GH2 hub. It is expected that between 35-55 million USD in concessional funds will be required to cover the following items, shown in Table 3.

Table 3. WBG funding structure for USD 35 million CIF-REI financing

Item	Description	Financing
Shared infrastructure for the GH2 production chain	Utility corridors and access infrastructures to the Export Processing Zone - ZPE	5 million USD
	Expansion of the Port of Pecém Multiple Utilities Terminal (TMUT) and new attraction cradle	10 million USD
	Expansion of Pier 2 for ammonia operation	10 million USD
	Implementation of New Operating and Security and Control Systems in the CIPP and the ZPE, aiming at New Demands and Legal Requirements of the GH2 Chain	2 million USD
Development of a National Innovation hub in the GH2 chain located in Pecém	Structuring of laboratory infrastructure for the Northeast region (Ammonia Storage, Energy Management Software, Typologies for Fertilizer Industry, Transport, Synthetic Fuel, Energy Transmission), in partnership with educational and training institutions (including other institutions located in the Northeast)	6 million USD (1.5 million USD non-refundable)
	Parameterizations for Safety Certifications in all Stages of the GH2 Production Chain and by-products, Preparation of Technical Courses, Undergraduate, Postgraduate, and Technical Specializations in partnership with other educational and training institutions, with a focus on gender equality	2 million USD

For Components 1 and 3, costs, fees, and financial conditions applicable to the resources of the CIF-REI, will correspond to the Financial Terms and Conditions of the CIF funds published in November 2020[57].

VI. Additional Activities Developed

<u>Parallel Activities Funded by Other Development Partners</u>

- **Agreement on German-Brazilian Cooperation for Sustainable Development. Energy Storage, E2 Brasil Project – Energy Storage Technologies**. This project is an initiative that integrates German-Brazilian Cooperation for Sustainable Development and is implemented by GIZ and MME, with the support of the Federal Ministry of Economic Cooperation and Development (BMZ) of Germany. With financial support from GIZ, the volume of funding for this project is up to 5 million EUR. The goal of the project is to create pre-requisites for the

56 The World Bank is supporting the CIPP through a 100 million USD consultation letter, which has 90 million USD from the WB for a 10 million USD counterpart from the CIF.

57 https://www.cif.org/documents/climate-investment-funds-financial-terms-and-conditions.

widespread use of energy storage technologies, to improve grid stability and security in the electricity service in Brazil. The project is divided into four components:

  - Analysis of the structuring conditions for the wide use of energy storage systems.
  - Integration of energy storage as a component of SEB.
  - Demonstration and example of technical, economic, and environmental feasibility of energy storage in SEB.
  - Establish networks for application-oriented research, product development, industrial manufacturing, and distribution of storage technologies.

- **Analysis of existing battery storage projects in Brazil**. With financial support from GIZ, this project aimed to identify and analyze the main challenges and learnings in the implementation of battery storage projects carried out previously in Brazil. Its main activities are: analysis of existing projects and standardized interviews with a relevant number of key industry players, manufacturers or local integrators of storage systems.

- **Standardization/Normatization of BESS**. With financial support from GIZ, this project aims to take advantage of international experience to develop recommendations capable of subsidizing voluntary or mandatory standards and guidelines, through which the safe and efficient use of storage systems is allowed, especially the use of lithium-ion technology. Its main activities are: analysis of guidelines, standards and rules for lithium-ion batteries and recommendations of guidelines, technical standards, standardizations, and safety guides for battery storage in Brazil.

- **Training – Project feasibility analysis with BESS**. With financial support from GIZ, this project aims to discuss the necessary preconditions for the execution of a project that uses energy storage systems. Training aimed at enabling companies, small and medium-sized enterprises (SMEs) and individuals in the renewable energy sector. Its main activities are: preparation of didactic and relevant materials, which subsequently serve as open/public support for consultation after the course; provision of detailed content on the most relevant issues in the development of a BESS project, such as fundamentals and applications, which includes the mapping of different technologies and how they are applied in on-grid and isolated contexts and adaptation of a tool for analysis and illustration of techniques and economic spheres, with a complete explanation of the terminology, BESS assessment and relevant tools to assess the feasibility of the project.

- **Green Hydrogen in Brazil (Tractebel)**. German-Brazilian Partnership in Energy Storage Technologies (H2Brasil) written by Tractebel - ENGIE. With financial support from GIZ, the project aims to analyze the potential of GH2 production in Brazil considering the export of products. Focus: Hydrogen Potential and Production Costs Export Opportunity Regulatory Aspects.

- **Modernization of the Brazilian Electricity Sector**. This project is an initiative that integrates the IDB and MME, with financial support from the IDB, the volume of funding for this project was 1,000,000 USD. The goal of the project was to support the GoB to strengthen its institutional, technical, and regulatory capacities to promote a greater integration of low-carbon technologies in the Brazilian energy matrix. The project is divided into four components: promote the decarbonization, digitalization, decentralization, and democratization of SEB; strengthen the liberalization and competitiveness of the electricity sector in Brazil, increase the mobilization of private low carbon investments and boost the development of new technologies to support the decarbonization of the Brazilian energy matrix.

- **Strengthening the Energy and Mineral Sectors II**. This project is an initiative that integrates WB and MME. With financial support from the World Bank, the investment cost of the project is 38 million USD. The main expected outcomes of the project are smart and strengthened climate institutions, more efficient markets, and more effective policies and regulations in the energy and mining sectors to increase resilience to climate events aggravated by climate change, accelerate the delivery of regulatory adjustments, planning, and support for infrastructure modernization. For the purpose of the project, climate resilience is defined as the ability to anticipate, prepare for, and respond to hydrological crises and/or dangerous events, trends or disturbances related to or exacerbated by climate change. For the purpose of the project, Market Efficiency is defined as the existence of market arrangements that are fit for purpose and incorporate all available information, providing agents throughout the value chain with incentives to operate their systems economically, with an appropriate balance of risk and reward that is in the interest of the end consumer. The main direct beneficiaries are several public institutions, sectoral bodies and secretariats such as (i) MME, including its Secretariats and the Environmental Affairs Office (AESA); (ii) EPE; (iii) ANEEL; (iv) CEPEL: (v) CPRM; (vi) ANM; (vii) ANP; and, (viii) ONS.

VII. Potential for Implementation and Risk Assessment

The implementation of the actions and interventions provided for in the Investment Plan of the CIF-REI of Brazil contributes to supporting and accelerating the Brazilian energy transition process, concentrating the mobilization of resources on favorable financial conditions to support innovative activities/technologies that promote the insertion of VRE in the country's energy matrix. However, implementation may face risks related to the new regulatory framework, new technologies, financial issues, political stability, environmental, and social impacts.

Regulation

Brazil has been working to reduce its regulatory barriers in the electricity market with the modernization process that its electrical system has been going through. The legal framework is solid, and the electricity sector is made up of robust institutions. However, there are areas where the regulation requires adjustments and definitions, such as technical standardization (regulatory definitions), compensation models (both for the implementation of energy storage technologies and smart meters), new markets where these storage technologies can market their products and/or services, the massification of smart meters, adoption of new business models for offshore wind and GH2. New codes are being discussed in the Legislative Branch that seeks to unify the regulations, laws, and ordinances in a single document, which can bring more clarity to the understanding of Brazilian regulation. However, the delay in defining the planned regulations may compromise the implementation of the projects in these strategic areas. Therefore, greater commitment from sectoral authorities is required so that new standards and regulations are issued in a timely manner.

Technology

Based on the experience of pilot projects developed internationally and domestically, the development of photovoltaic panel and wind generator solutions (onshore and offshore), digital technologies, batteries, hydraulic pumping, and deployment of AMI infrastructure should not pose a high technological risk. However, clean hydrogen technologies are still relatively unknown and may represent a moderate technological risk, considering the degree of knowledge, low level of technological maturity, reduced commercial availability, uncertainty regarding the overall performance and useful life of the assets. In relation to technologies that allow an increase in the flexibility of the transmission and distribution system, FACTS and D-FACTS present themselves as relatively known technologies and Brazil is starting to acquire knowledge in this regard, making these technologies should be adopted in the NIS, in the short/medium term. The involvement of specialized engineering companies and/or research and development institutions with experience in knowledge and technology transfer, training and technical support may be necessary to mitigate these technological risks.

Finance

The Brazilian energy sector expansion requires high levels of investment with both reimbursable and non-reimbursable resources. The country has a history of successful project financing, mainly due to the solidity of its financial institutions. However, depending on the financing conditions offered by the financial entities participating in the financing structure of Brazil's CIF-REI, there may be a certain level of risk that the planned allocation and application of financial resources in the Program is lower than initially estimated. In this sense, the participation and close monitoring of the execution of the Program by the MDB partners, in their capacity as implementing agencies of the resources of the CIF-REI, contribute to mitigate this risk.

In addition, due to the depreciation trend of the Brazilian Real, the associated volatility and the increase in the basic interest rate, contracting debts in US dollars can represent a high-risk exposure not only for local financial institutions, but also reduce hedging options. Therefore, financing with resources from the CIF-REI, in local currency, can mitigate this risk. Similarly, CIF-REI financing can serve as collateral to facilitate lending for investments in new technologies listed in strategic themes.

Political Stability

The Government transition process which took place at the beginning of the year in Brazil could give rise a sense of caution and risk perception for various investors. The priorities and objectives considered by the current Government show a clear alignment with efforts to boost the energy transition and combating climate change as fundamental pillar as a state policy, significantly reducing this risk.

Environmental Impact

It is well known that the possible and incorrect handling and disposal of elements contained in batteries, fuel cells, photovoltaic panels, wind generators, fuel cells or electrolyzers may represent a potential environmental risk that must be considered and addressed. In this context, mitigation measures should be used in order to reduce or eliminate harmful effects. Such measures may include the classification of components to be used, recycled, and disposed of, in accordance with applicable national and international regulations and the safeguards policies of the MDB partners. Project feasibility studies should identify these risks and formulate and ensure the application of appropriate mitigation measures. For example, depending on the location of the project, the water used for H2 production could eventually decrease the availability of water for other uses (e.g., agriculture, human consumption, animal consumption, recreation, among others). To mitigate such risk, it is possible to foresee the use, for example, of reused water or desalination, whose environmental impacts must also be considered. An example is the strategy proposed in South Africa, where water scarcity exists, and the oversizing of the desalination plant was seen as a factor in mitigating environmental risks, so that during periods of drought the plant provides water for other activities.

In addition, depending on the scale and location of the projects, the deadlines for requesting and obtaining environmental licenses or permits, as well as carrying out social consultation processes, should be considered as a necessary item in the project planning phase, trying to anticipate any delays that may arise and compromise the execution and implementation of the project. This issue must be especially considered on the basis of new safeguards that could be implemented in the near future, derived from the SEB modernization process.

Social Impact

The deployment of digital technologies such as the massification of AMI, can cause people to lose their jobs associated with tasks such as meter reading, delivery of energy consumption invoices, and user disconnection and reconnection procedures. But on the other hand, smart measurement can generate, in addition to the development of the national industry, new employment opportunities in areas such as data analysis, network management, equipment maintenance. In this context, the training of new staff and new employment opportunities, for the allocation of these people, in the management and maintenance of the AMI can help to mitigate the adverse social impacts. Table 4 summarizes the risks considered, the proposed mitigation actions and a qualitative assessment of the expected residual risk.

Table 4. Risks considered and mitigation

Item	Description/Mitigation	Risk
Regulation	Delay in implementing a new regulatory framework could compromise the implementation of storage technologies, AMI infrastructure and, mainly, Hydrogen and offshore wind energy development activities. A high commitment by Brazil's sectoral authorities must be required in order to speed up the process of new standards and regulations in a timely manner.	Low
Technology	Due to the country's expertise, technologies such as photovoltaic panels, wind generators (onshore and offshore), AMI infrastructure deployment and batteries do not pose considerable technological risks or uncertainties. However, clean hydrogen and power electronics projects (FACTS and D-FACTS) must require the participation of specialized local and/or international engineering companies, also participating in training and technical support programs to mitigate this risk.	Low
Finance	To avoid problems, on the part of some entrepreneurs, of lack of credibility or inability to comply with the conditions imposed by MDBs and intermediary banks to access the resources of the CIF-REI, loans could be guaranteed through specific collateral or guarantees.	Low
	The trend of depreciation of the Brazilian Real over time and the increase in the basic interest rate can make the loans in US dollars more expensive compared to the loans in local currency. It should be noted that borrowing CIF-REI resources in local currency would mitigate this risk. However, if this is not possible, the residual risk may be considered high.	Moderate
Political Stability	Despite the current situation of government transition, the state's priority policies reaffirmed by the current government, given their alignment with the CIF-REI Investment Plan, must ensure the protection of proposed investments.	Low

Environment	There are potential environmental risks if there is improper handling or disposal of elements such as hardware, batteries, fuel cells, photovoltaic panels, fuel cells, electrolyzers, and others. Mitigation measures must manage this risk, and may include activities such as proper reuse, recycling and disposal, complying with strict regulations and MDB safeguards policies. In addition, feasibility studies of projects should include appropriate analysis and mitigation measures to avoid problems related to the use of water for H2 production.	Low
	In order to avoid possible delays that may impair the technical and economic viability of the project, the times and complexities associated with obtaining environmental licenses and permits must be considered, in accordance with applicable local standards and regulations.	Moderate
	Brazil has an electrical matrix with a significant contribution from hydroelectric power. Thus, the system may face energy crises in some periods, as has happened in the past. Diversification of the power matrix and the construction of transmission infrastructure helped the system overcome these periods. Furthermore, the measures proposed in this PI, such as the modernization of hydroelectric power plants, will bring more flexibility to the system as they add better operating points to the hydroelectric plants. Additionally, measures to modernize the transmission network and include storage systems are significant mitigating measures against the risk of supply shortages.	Moderate
Social	Socially, the deployment of digital technologies such as AMI can be observed as a source of job loss for employees associated with tasks such as meter reading, delivery of energy consumption invoices, and user disconnection and reconnection procedures. In this context, the qualification of personnel in the maintenance and employability of AMI could help mitigate this social impact.	Low

Absorption capacity for the REI Program and associated investments.

As highlighted by the MME, with the prospect of economic growth, the country should present a dynamic of recovery and maintenance of a high level of renewability in the energy and electricity matrices in the coming years. According to (EPE, 2022a), planned investments for electricity supply should be 528 billion BRL by 2031 (this value represents 16.2% of total investments in the energy sector in Brazil). Of this value, approximately 292 billion BRL must be for centralized generation, 135 billion BRL for DG and 101 billion BRL for projects related to transmission lines.

The country's macroeconomic context, along with the comprehensive legal and regulatory framework, allows the country to receive funding and technical assistance cooperation to support its energy transition to a low-carbon economy.

In addition, both Brazil's financial system and the developers' execution capabilities are appropriate to absorb the necessary capital and development challenges of the projects, in line with the economic recovery and sustainable green growth provisions. In addition, the provision of resources for financing through the CIF-REI program, directed to specific investments, represents a clear signal to investors of those pillars in which the country intends to accelerate its development.

The fact that the country is among the most qualified countries in the world in terms of economic transformation (No. 30 of 137) according to the BTI 2022 Transformation Index[58] and other related categories (for example, position No. 85 of 137 in good governance and position 29 of 137 in political transformation), in addition to its application to belong to the OECD, show the favorable conditions that the country has to attract local and foreign investment. Brazil is ranked 124th among 190 countries in the World Bank's *Ease of Doing Business*[59] (2020) index. In addition, according to Bloomberg's 2022 Climatescope survey[60], Brazil, along with other countries in the region, is considered one of the most attractive countries for renewable energy investments in Latin America, these aspects contribute to showing evidence of Brazil's ability to absorb these investments.

VIII. Integrated Approach to Monitoring, Evaluation, and Learning

The Monitoring, Evaluation, and Learning approach for the IP of Brazil, based on the Integrated Results Framework (IRF) of the CIF-REI, is established by the Government and the national implementing entities, in cooperation with the MDBs, to allow the monitoring of progress throughout the achievement of the results and objectives. Within this integrated approach, measurement of program and project impacts is captured through multiple dimensions of monitoring, evaluation, learning, and other important cross-cutting approaches, such as gender inclusion, merged in order to provide a differentiated and holistic understanding of program progression and thematic specificities, while providing a complex and multifaceted program goal.

Integrated Results Framework

Generally speaking, each Support Activity considered in this IP aims to address specific barriers in order to achieve greater VRE integration, both in the NIS and SISOLs. Through the execution of these activities and due to the use of concessionary resources, it is expected obtain specific results, as illustrated in Table 5, which presents the general focus of the Theory of Change of the program applied to the IP of Brazil. In addition, specific indicators are defined within the IP Integrated Results Framework (IRF), as presented in Table 6, which should allow the monitoring and evaluation of the results to be obtained based on the programmatic expectations conceived. In any case, it should be noted that, having been made assumptions about the type of investments that sub-borrowers will finally make and the type of projects that must meet the eligibility criteria, the targets established for these indicators are indicative, the results to be obtained are highly dependent on what the preferences of sub-borrowers and IE financing evaluation decisions will be.

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58 https://bti-project.org/en/reports/country-report/BRA.

59 https://archive.doingbusiness.org/en/rankings.

60 Climatescope 2022: Power Transition Factbook.

Table 5. Conceptual map of Theory of Change

	Component 1					Component 2	Component 3
Challenges/ Barriers	• Lack of public resources and combined private investment for the electrification of SISOL to achieve universal access by 2030. • Di [illegible] locations and low user income/revenue locations as challenges to building the necessary infrastructure by reaching users not served by NIS and providing them with reliable and sustainable power solutions.	• Lack of hu digitalization. • Lack of telecommunication infrastructure. • Lack of a regulatory and financial framework. • High costs availability and cybersecurity.	• Lack of r offers security to network operators to implement plans and invest in AMI. • High inv.es • Lack of a charging scheme.	• Lack of regulation (for example energy storage). • Lack telecommunication infrastructure. • Lack of a market (e.g. ancillary services). • Lack of pricing mechanisms. • Lack of m encourage the use of FACTS technologies.	• High cost. • Lack of l knowledge. • Lack of a regulatory framework. • Lack of ap mechanism. • Lack of a market (e.g. ancillary services market). • Lack of ad and telecommunication infrastructure.	• Lack of [illegible] • Lack of local.	• Investor.risk • Need for investments outside the specialty of investors to enable projects, for example, the export cradle. • Lack of s.kill • Lack of [illegible] hydrogen compared to alternative sources.
Supported Activities	**Electrification of SISOL**	**Enhancing Technologies**	**AMI Massification**	**T&D Infrastructure Digitalization**	**Expansion of storage technologies (GH2, PSH and batteries)**	**Project and Technical Assistance Factory**	**1. Shared infrastructure for the GH2 value chain** **2. Development of a National Innovation and Capacity Building hub for the GH2 value chain** **3. Mobilization of private commercial capital**
	• Serving users with VRE-based solutions (including batteries). • Replacin diesel-based generation solutions with VRE-based systems (may include hybrid systems and batteries).	• Implementa technologies in existing HPPs. • Increase t capacity (efficiency improvement) of existing HPPs.	• Accelerate of AMI (e.g. smart meters and other related infrastructures).	• Increased capacity and network interconnection. • Deployment network-t connected storage systems (centralized or decentralized) • Deployme STATCOM, FACT, D-FACT or HVDC systems.	• Accelerate of storage projects (centralized or distributed).	• Execution of the development of projects that increase the flexibility of SEB and promote the integration of VREs.	• Implementatio and infrastructure for access to EPZ. • Expansion of Multiple Utilities Terminal (TMUT) and Pier 2 for ammonia operation, and a new attraction cradle. • Construction support RD&I in the areas related to hydrogen and renewable energy. • Capacity build the development of the skills required for the hydrogen value chain, focusing on young low-income women.

							• Decrease the cost of financing for private investors in storage technologies to encourage and accelerate investment in the hub.
Intermediate activities/ results	• Increase the public private sector participation in the electrification projects. • Developme regulatory framework and new business models to enable the expansion of access to energy with new technologies.	• Improve t capital in digitalization training professionals to deal with digital technologies and apply them effectively in existing hydroelectric plants. • Enhance telecommunication infrastructure to have a robust and adequate infrastructure to support communication and data exchange. • Establish appropriate regulatory and financial framework to incentive the existing HPP modernization. • Increase availability and cybersecurity.	• Establish regulatory framework that ensures security for network operators to implement AMI plans and invest. • Reduce th costs for AMI implementation considering the large-scale implementation to achieve economies of scale. • Developme tariff schemes to incentive the AMI use.	• Establis appropriate regulations for energy storage. • Impr telecommunication infrastructure to have an efficient and reliable communication network to allow the flow of information and data between different components of the electrical system. • Establish appropriate market for ancillary services considering the provision of ancillary services such as frequency regulation and voltage control to the new technologies. • Developm expansion planning methodologies that capture the benefits of FACTS equipment and batteries.	• Reduce investment costs accelerating deployment of storage projects to achieve economies of scale and lower upfront costs, making technologies more accessible and affordable. • Establishm appropriate regulatory framework that encourages and facilitates the use of storage technologies, addressing issues such as licensing, interconnection, security standards, and operational regulations. • Development of expansion planning methodologies that capture the benefits of storage.	• Development pipeline of projects to identify and define technical and operational strategies to maximize the flexibility of the electrical system. • Build local skills and knowledge involving local professionals in these studies and in the execution of projects related to the VREs, promoting training and the development of specific skills necessary for the implementation of these projects. • Training in t and operational aspects related to renewable energies, allowing more people, including women, to be trained and involved in this area.	• Decrease in t for private investors in storage technologies encouraging and accelerating the investments through favorable financial conditions.
Top expected results	• Contribut expansion of access to energy in SISOL through the VRE and achieve the goal of universal access to energy by 2030, through the incorporation of	• Recovery existing HPPs in order to increase their flexibility and operational efficiency. • VRE installed capacity increase.	• Contribute the number of users in NIS with AMI by 2030, and accelerate massification by offering financial facilities to network operators.	• Contribut incorporation of VRE with start-up scheduled for the end of the decade, through the financing of network support infrastructures.	• Contribute development of storage technologies as a key element of the Energy Transition, through the progressive reduction of	• Increase the (including women) trained in aspects related to the implementation of VRE projects. • Exploit the VRE that minimizes the impacts on the population and communities.	• Create the ide development of the clean hydrogen value chain in Brazil, unlocking private investment and enabling the creation of the first hydrogen hub in Brazil, integrating renewable energy and creating value, not only for

	financing and participation of private. **Transformational Change**: Private investors take a more active participation in SISOL electrification projects and inclusive based on financing facilities combined with available regulatory instruments.	**Transformational Change**: The hydro generation infrastructure is modernized in response to the integration needs of the VRE.	**Transformational Change**: AMI allows consumers to make the network more flexible and participate in the market as Prosumers, while supporting the development of energy communities, contributing to the democratization of the electricity sector.	**Transformational Change**: Network support infrastructure is built to respond to VRE integration needs.	initial costs. **Transformational Change**: First projects developed as a necessary step to achieve reductions in investment, learning, and local capacity building costs.	**Transformational Change**: Local technical capacity, experience, and knowledge begin to be built for the development of VRE projects.	Ceará and the Northeast, but the entire Brazil. **Transformational Change:** Enable the development of a frontier value chain necessary to meet global climate goals, leveraging private investments (~8 billion USD) to create the first hydrogen hub in Brazil. The hub will promote innovation and workforce capacity building as well as generate jobs and income to support the national energy transition process. As a point of reference, the knowledge and experience acquired can be adjusted and replicated in other locations in the country.

While the columns on the left side of the IRF (see Table 6 below) are intended to track key program and project performance, through basic indicators defined in the CIF-REI baseline IRF, in response to country IP specific objectives, the right side of the side columns focus on assessment and learning approaches, encompassing signs of transformational change across 5 pertinent dimensions, including scale, speed, relevance, systemic change, and adaptive sustainability.

Scale. In terms of scale, although the amounts of investment that the country plans to make to achieve the Energy Transition, economic development and sustainable global growth are considerable, and the resources of the CIF-REI program represent only a small fraction of this total, this IP aims, rather, to support marginal progress and objectives that are somehow significant in terms of replicability and scalability, to the extent that other agents and programs are able to build experiences and expected results to be obtained.

Speed. The speed factor to be applied in the energy transition implies that the introduction of new technologies, such as the implementation of AMI, must be accompanied by the generation of new employment opportunities to be offered equitably and with priority to the actors that are negatively impacted. In this sense, the allocation to be produced by the interested parties, such as, for example, personnel responsible for recording readings from similar meters or deliverers of energy bills, must be duly considered in the initial phase of financing these projects. In addition, actions must be taken to mitigate the negative effects especially on vulnerable communities.

Relevance. Brazil's IP is based on the considerations the country requires to achieve transformational change, based on the types of activities supported here considered. While some of these activities, such as electrification of SISOL through VRE, may be considered to incorporate a higher priority based on the associated social benefit or a higher impact on GHG emission reductions to be achieved, in principle these types of activities will have equal opportunities to access CIF-REI financing based on the initiatives that investors will present in alignment with the IP and in compliance with all eligibility criteria.

Systemic Change. Through the transversal incorporation of gender approaches and inclusion of minorities in all potential projects to be financed with resources from the CIF-REI, this IP hopes to achieve a punctual but progressive impact in terms of how this vision and approach can be integrated in the development of various types of projects in the energy sector and more specifically in those framed in the development of the Energy Transition.

Adaptive Sustainability. In the case of electrification projects in SISOL, the identification of productive activities can be associated and encouraged thanks to the energy solutions provided, becoming highly relevant since such revenue can be decisive in ensuring the sustainability and scalability possibilities of the project. Similarly, the generation of initiating human capabilities in terms of knowledge and skills around new technologies, in fields such as electrolysis or storage systems, should contribute as a catalyst for the progressive development of sufficient quantities and levels of knowledge to meet the scale of transformation that the country's Energy Transition should require.

Different signals about transformational changes to be produced throughout the execution of the program can be addressed and analyzed through impact assessments, energy transition studies, including analyses of co-benefits or social and gender inclusion, as well as through other specific activities aimed at learning. These signals can take different forms, such as increased investment, expansion of access to energy, modernization of infrastructure, adoption of clean technologies, training of human resources, job creation, promotion of social inclusion and creation of favorable conditions for the development of supply chains, such as the aforementioned clean hydrogen chain.

The expected signals of transformational change can be identified as follows:

- Private investors actively participating in SISOL electrification projects through financing facilities and regulatory instruments:
    - Private investment in SISOL projects increases, indicating a shift towards more inclusive and sustainable energy solutions.
    - Increased access to energy in SISOL regions, contributing to the goal of universal access to energy by 2030.
- Modernization of hydro generation infrastructure to accommodate the integration of variable renewable energy (VRE):
    - Existing HPPs are upgraded to improve flexibility and operational efficiency.
    - Increased installed capacity of VRE, indicating the expansion of clean energy sources.
- Accelerated deployment of AMI:
    - Financial supports are provided to distribution companies, promoting the widespread adoption of AMI.
    - Consumers are empowered to participate in the electricity market supporting the democratization of the electricity sector.
    - Increased operational efficiency and reduced energy losses due to the enhanced monitoring and control capability provided by the AMI.
    - Promoting a smarter and more resilient electrical grid, enabling faster detection and response to outages and failures.
    - Allow new tariffs structure, such as hourly tariffs or dynamic tariffs, promoting greater energy efficiency and allowing consumers greater participation in the management of their energy expenditures.
    - Stimulating the development of innovative applications and services based on real-time measurement data, opening up new opportunities for companies and consumers in the energy sector.
- Development of network support infrastructures for the incorporation of VRE:
    - Financing is provided for the construction of infrastructure necessary for the successful integration of VRE into the energy system.
    - VRE projects with scheduled start-up dates contribute to the overall growth of renewable energy in Brazil.
- Progress in the development of storage technologies for the Energy Transition:
    - Initial costs of storage technologies are progressively reduced, indicating advancements in research, innovation, and cost-effectiveness.
    - First projects in storage technology demonstrate the feasibility and potential for future expansion.
- Increase in the number of trained individuals (including women) in VRE implementation:

    - More people are equipped with the necessary skills and knowledge to support the deployment of VRE projects.
    - Local technical capacity and expertise are built, contributing to the long-term sustainability of renewable energy initiatives.
- Creation of the hydrogen hub in Brazil, integrating renewable energy and attracting private investment:
    - Private investment is unlocked, enabling the establishment of a hydrogen hub.
    - The hub promotes innovation, workforce capacity building, job creation, and income generation, supporting the national energy transition process.

These signals reflect the transformative changes taking place in various aspects of the energy sector, such as electrification, renewable energy integration, storage technology development, and the emergence of clean hydrogen as a key element of the energy transition in Brazil.

This task must be addressed through evaluations and studies promoted by the CIF, the country and the MDBs, as they deem appropriate based on the program`s activities that will eventually receive financial support. In short, the proposed approaches should allow combining systematized monitoring with research and evaluations that complement each other, taking advantage of mixed methods that, through different tools and forms of evidence, contribute to the construction of a comprehensive and clear view of what will be achieved and learned from the implementation of the program.

Table 6. Brazil's IRF IP[61]

RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
INTEGRATED RESULTS TABLE CIF – RENEWABLE ENERGY INTEGRATION PROGRAM BRAZIL						
CIF IMPACT Accelerated transformational change towards net-zero emissions and climate-inclusive and resilient development pathways						
	INDICATORS	DESCRIPTION	BASELINE	MEANS OF VERIFICATION	TARGET (2030)	KEY AREAS
CATEGORY 2. IMPACTS AT REI PROGRAM LEVEL						
Flexibility of energy systems for a harmonious integration of larger portions of variable renewable energy generation in networks, and increased access to renewable energy in SISOL, are made possible	**REI Impact Proxy 1: NCRE country´s installed capacity**	Renewables based electric generating capacity excuding Hydro (i.e. solar, wind, biogas and biomass generating capacities)	43.7 [GW] based on the installed capacity of Dec/2020.	EPE reports	89.1 [GW] based on the installed capacity of Dec/2030.	**Signs of Transformational Change:** Signals at the program level will focus on more limited aspects of the transformation of energy systems than on the impact section at the CIF level. The signals proposed to be observed and analyzed throughout the implementation of the IP in Brazil include those that arise from the general framework in which it is expected to enter into operation resulting from the modernization of HPP, modernization of T&D, energy storage and GH2 production to achieve support the GoB´s efforts in the energy transition and decarbonization process.
	REI Impact Proxy 2: NDC compliance	Achieving emission reductions against BAU scenario, in order to reach 2030 goals.	Reduce your carbon emission by 50% by 2030 in relation to the base year 2005.	MMA and/or MME reports	In relation to the base year 2005 resulting in emissions absolute values around 1.3 GtCO2eq.	
	REI Impact Proxy 3: % renewable installed capacity.	Share of renewable energy generation in national, grid-connected energy systems (%)	86% (2020)	EPE reports	87% (2030)	

[61] The proposed goals are indicative, as the final results will depend on the final decisions of the sub-borrowers. This table is also provided in Excel format as a reading aid.

RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
	INDICATORS	DESCRIPTION	BASELINE	MEANS OF VERIFICATION	TARGET (2030)	KEY AREAS
CATEGORY 3. REI PROGRAM LEVEL RESULTS						
A. Increased penetration of variable renewable energy into countries' energy systems and maximized renewable energy potential	**REI CORE 1 (= CIF 1). GHG emissions reduced or avoided (MtCO2eq) – direct/indirect**	Built based on the quantification of emissions reductions derived from SIN integrated VREs as a result of the implementation of hydroelectric modernization projects, the reduction of losses and centralized and distributed VRE integration considering reinforcement, automation and digitalization of T&D networks, the implementation of solutions based on electrification of SISOLs with VRE against projected BAU diesel consumption, the production of clean H2 replacing fossil fuel consumption in transport and/or industrial applications, and other emissions reductions in SIN as a result of investments mobilized through the CIF-REI IP in energy storage technologies, and other resources that add flexibility to electrical systems.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	Reductions of at least 24,7 $MtCO_{2eq}$ by 2030 and 235 MtCO2eq by the end of projects life - mostly indirect.	The Brazil CIF REI IP performs analysis of "complete energy systems" generating representative indicators of the country, as a contextual reference on which the financing of eligible transformational activities/technologies will take place and within which the project evaluation process and the aspects of monitoring, evaluation and learning to be incorporated will be addressed. Based on these analysis and the initial assumptions about the investments that the sub-buyers will eventually carry out, it is expected to integrate renewable energy into the network and non-interconnected solutions for energy access, annual production, energy end-use applications, reduction of GHG emissions and social empowerment through access and democratization of energy use and production. Both estimated and actual operating data should be effectively consolidated to report on these various indicators.Going down the chain of results, the monitoring function becomes increasingly important for capturing program outcomes and products, while the assessment and learning function will complement the basic indicators by filling in strategic knowledge gaps. Assessment and learning activities will be selected based on overall stakeholder demand, evidence gaps, and cross-learning opportunities.
	REI CORE 2. Installed Capacity: Installed capacity of variable renewable energy available to the grid (MW) – direct/indirect	Based on the installed VRE capacity that can be integrated into the SEB as a result of the investments provided for in the CIF-REI IP in hydroelectric modernization projects; reinforcement, automation, and digitalization of T&D networks; hybridization of SISOL with VRE; the integrated capacity associated with the production of clean H2; and the integrated capacity linked to energy storage technologies.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	8.0 GW - mostly indirect.	
	REI CORE 3. Renewable Energy Production: Annual renewable energy output (MWh)	Generation of energy produced based on installed capacity that can be integrated into the SEB due to the effect of investments mobilized by CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	5,800 GWh/year (average per year); 40,500 GWh by 2030 and 689,000 GWh by the end of projects life.	
	REI CORE 4. Grid Services: Increase in available grid services and improvements (#)	# of consumer units served by the renewable production integrated in SEB by CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	About 1,500,000 AMI.	
	OPTIONAL: Increase in network interconnections to accommodate higher amounts of VRE (#)	# of VRE projects connected to the network.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	About 15 projects in transmission systems.	
	OPTIONAL. Production of H2V and its derivatives	Green ammonia production (ton/year).	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	1.850.000 ton/year.	
B. Better policies, plans, and institutional capabilities	**REI CORE 5. Policies: Number of policies, regulations, codes, or standards related to renewable energy integration that have been changed or adopted (#)**	N/A	N/A	N/A	N/A	N/A
C. Public and private capital mobilized	**REI CORE 6 (= CIF 4). Co-finance: Leveraged co-finance volume (USD)**	Volume of co-finance really leveraged by CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	Around USD 9 billion (leverage ratio 1 : 128)	
D. Increased access to renewable energy	**REI CORE 7. Renewable Energy Access: Number of women and men, businesses, and community services benefiting from improved access to electricity and/or other modern energy services – direct/indirect (# of people/businesses)**	# of consumer units of SIN and SISOL benefiting from access to VRE and AMI solutions.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	About 1,074,000 consumers (40% of these consumers are expected to be female-led households).	**Gender-sensitive aspects** of energy access can be studied in more detail through targeted research assessments and/or case studies. Examples of relevant issues include: supporting gender mainstreaming in all projects and technical assists while increasing knowledge about gender and diversity issues, offering training activities to increase technical knowledge and skills in new technologies while promoting female participation in the workforce, targeting women and other social subgroups, selecting suppliers willing to promote gender equality, and increasing women's awareness and ability to use access to electricity for productive purposes.
E. Reduce total system cost	**REI CORE 8. System costs: Reduce total energy system cost (USD)**	Based on SEB cost reductions as a result of materializing the projects and implementing the technologies to be supported through the CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	N/A	
F. Fostering innovation in renewable energy	**REI CORE 9 (= CCV 1). Innovation: Number of innovative businesses, entrepreneurs, technologies, and other ventures demonstrating a strengthened climate-responsive business model (#)**	# of ventures promoted in innovative technologies (digitization of networks, microgrids, storage technologies, production of clean H2 for decarbonization, and the like), directly or indirectly, through the implementation of the CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	1 GH2 innovation hub with laboratories and partnerships with education and research institutions.	Additional support can be provided by the MDBs and their innovation promotion platforms, to conduct learning-based activities, with the aim of improving the understanding of the innovation and entrepreneurship aspects of the CIF-REI.
	REI CORE 9 (= CCV 2). Innovation: Number of innovative businesses, entrepreneurs, technologies, and other ventures demonstrating a strengthened climate-responsive business model (#)		0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	3 direct (GH2, green ammonia, green methanol) + indirect (such as green steel, green fertilizer).	

RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
	INDICATORS	DESCRIPTION	BASELINE	MEANS OF VERIFICATION	TARGET (2030)	KEY AREAS
CATEGORY 4. CO-BENEFITS						
Co-benefits of social and economic development	**Co-benefit 1: Employment and livelihoods: jobs created - direct and indirect**	# of direct or indirect jobs created through the implementation of the CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	About 75,500 direct or indirect jobs in the VRE implementation and in the construction and operation of the GH2 hub. 5,000 female jobs related to the use of AMIs, use of energy and customer rights.	**Quality and distribution of jobs**: Through energy transition approaches with attention to aspects of gender equity, and diversity and social inclusion, a more evaluative and learning-oriented analysis can focus on the types of jobs created (and lost), which in the case of the Brazil IP was initially and provisionally identified as expected to be obtained in technology for the production of clean H2, installation, operation and maintenance, implementation of AMI, basic community maintenance services in PV-based solutions, energy storage, while expected losses can occur in activities such as reading and maintaining old measurement infrastructure and other works based on the fossil fuel industry (such as gas supply services). Broadly speaking, as the new technologies to be adopted will be technically more advanced and at the same time cleaner than those replaced, the jobs to be created will be of higher quality, remunerated and equally demanded, requiring greater qualification of workers, making training and capacity-building programs play a central role in this transformative change.
	Co-benefit 2: Just Transition, Social inclusion, and distributional impacts	# people trained/qualified to perform a more qualified and better paid job thanks to the implementation of the CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	6,200 people considering workforce training directly and indirectly. The project will encourage female participation in the capacity-building sessions. It is expected that about 30% are women 30% and diverse groups).	The **just transition framework analysis** in the case of the Brazil IP must analyze the extent to which diverse social inclusion is possible within the supported activities, including how provider selection processes can be executed, how stakeholder engagement at the local and national level is possible within each type of activity, and the extent to which vulnerable groups in impacted areas can receive employment opportunities or other benefits derived from provided solutions. Distributive impacts, which already form a central aspect of Co-Benefit 1, can also be further examined in their evaluated lines or with additional focus on specific populations, such as ethnic, religious, and racial minorities, female families, indigenous peoples and local communities, migrants, youth, and people with disabilities.

RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
	INDICATORS	DESCRIPTION	BASELINE	MEANS OF VERIFICATION	TARGET (2030)	KEY AREAS
CATEGORY 5. OPTIONAL INDICATORS						
A. Improved Design and Market Systems	**OPTIONAL: Number of technical/financial analyses completed to enhance the enabling environment for renewable energy uptake (#)**	Prefeasibility/feasibility studies sponsored in Component 2 (Project Factory and Technical Assistance).	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	6	
B. Improved Supply and Demand Management	**OPTIONAL: Number of supply management technologies, infrastructure, or other solutions deployed (#)**	STATCOM, FACTS, and/or other storage technology projects implemented to improve SEB flexibility and facilitate support to the grid.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	3	

RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
	INDICATORS	DESCRIPTION	BASELINE	MEANS OF VERIFICATION	TARGET (2030)	KEY AREAS
CATEGORY 7. ENERGY STORAGE PROJECTS						
Deployment of Energy Storage Systems	**GESP 1. Energy Rating: Energy rating (MWh) of storage systems installed**	Energy storage systemes deployed.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports by projects	60 MWh in batteries, and 16,200 GWh considering the energy stored in GH2 and its derivatives.	
	GESP 2. Power Rating: Power rating (MW) of storage systems installed	Power storage systems deployed.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports by projects	30 MW in batteries and 2.65 GW based on nominal installed capacity of electrolyzers for GH2 production.	

Power System Analysis

The investments proposed in this IP are expected to have a positive transformative effect on Brazil's energy sector, as follows:

- The use of digital technologies in HPPs should allow their modernization, promoting not only their operational flexibility and improvement in their performance, obtaining better management, predictability, and maintenance of their assets, but also bringing innumerable benefits that can range from environmental and safety issues to reduction in their O&M costs.
- Encouraging the development of innovative green financing mechanisms, with the aim of encouraging a greater participation of renewable technologies and, mainly, offshore wind energy.
- Modernization of the T&D infrastructure through the installation of new technologies of power electronics and development of methodologies and/or improvement of computer models for planning the electrical system, which allow adding its flexibility and allowing a greater integration of VREs.
- Encouraging the participation of storage technologies such as batteries, H2, and UHR, which should allow greater participation of VREs.
- AMI must be massively implemented and enhanced, benefiting the system and users[62], since it must allow the implementation of new hourly pricing mechanisms, greater development of demand response programs and development of new business models.
- Due to the high potential of renewable sources, the country will have the possibility of becoming a world leader in the production of GH2. GH2 will play an important role in decarbonizing the electricity sector, through a slow but gradual replacement of fossil fuels, using surpluses of VREs and avoiding their restriction. Potentially, GH2 can also contribute to the decarbonization of other sectors that are difficult to reduce emissions, such as transport.

Anticipated impacts at the program level

The proposed IP will contribute to Brazil's NDC, allowing a 30% reduction in total GHG emissions reductions expected from the electricity sector by 2030. In addition, the IP will assist the government plan by:

1. Contributing to installing a cumulative installed capacity in 2030 of 17 or 25 GW of DMMG (EPE, 2020b).
2. The smart meter market in Brazil for low-voltage residential consumers is expected to grow from 901,000 units in 2022 to 3.9 million units in 2030, a compound annual growth of 20.1% (OSE, 2023).
3. Increase installed offshore wind capacity by 16 GW by 2050 (if there is a 20% reduction in CAPEX).[63]

62 The participation of consumers in the electricity sector will be more active, called Prosumers, even allowing their association through energy communities.

63 https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/Plano-Nacional-de-Energia-2050

Tracking protocols

Monitoring and reporting of results will be a collaborative process among all stakeholders. Country focal points and AIs, in collaboration with the CIF Monitoring and Reporting team, will lead the tracking of the country-level IP impact indicators set out in the IP approval. Implementation MDBs will monitor and report annually to CIF AU all relevant key outcome level indicators for each approved project in accordance with the methodologies, reporting requirements and timelines set out in the REI IRF and the upcoming REI M&R Toolkit. As such, MDBs will be responsible for incorporating these outcome level indicators into the monitoring and reporting frameworks and mechanisms for each project implemented, together with any optional outcome indicators and at least one co-indicator per project, also in accordance with the REI IRF and REI M&R Toolkit. Country-level IP M&R workshops, expected at the beginning, mid-term, and in the IP conclusions, together with any interim country M&R workshops as needed, will allow for multi-stakeholder consensus on indicators, targets, methodologies and related gaps, lessons, or enhancements.

The BNB, as borrowers and IE, acting as intermediary banks for the correct allocation of CIF-REI resources, will be responsible for reporting annually to the MDB the IRF indicators. Sub-borrowers implementing projects associated with the activities supported by the IP will have within their responsibilities with the IE the provision of information necessary to comply with the monitoring and reporting requirements, based on the commitments incorporated in the sub-credit agreements.

As part of the funding eligibility criteria, it is important to note that sub-borrowers must be in a position to periodically report different indicators related to project performance and achievements, inclusion aspects, reductions associated with GHG emissions, beneficiary users, including their gender distribution and inclusion principles applied, along with progress of core achievements and other cross-cutting co-benefits that will be applied according to the context of each project.

The program will be monitored in general through periodic Project Monitoring Reports (PMR) to be prepared based on IE and sub-borrower reports. MDBs will conduct regular evaluations to support and evaluate the implementation of the program.

The financial statements of the program will be audited according to the procedure previously agreed in the MDB. Within 120 days after the end of each project fiscal year, during the original disbursement period or its extensions, the IE will submit the audited financial statements of the program, duly signed/endorsed by an independent audit firm accepted by the MDB.

Tracking and evaluating aspects of transformational change and aspects of social inclusion.

More than measuring linear results through indicators, the concept of transformational change[64] is based on the identification of signals in their various dimensions, covering complex systems[65] as its main unit of analysis, and its evaluation is reflected in the specific context and in the learning approaches. The energy transition perspective highlights how the relative risks and benefits of transformational change processes and effects are optimally and ethically managed in terms of social inclusion and distributional impacts. The results related to gender and social inclusion can be evaluated with respect to the transformative impacts of gender and results by sector, for example, share of women and other diverse groups working in the renewable energy

[64] Fundamental change in climate-relevant systems with large-scale positive impacts that change and accelerate the trajectory of progress toward sustainable, inclusive, resilient, and climate-neutral development pathways.
[65] For example, ecological, social, economic, and technical systems.

sector, and quality of participation of women and minority groups in decision-making processes, among others.

Also, the transformational change, energy transition and social inclusion effects of the implementation of the proposed Investment Plan should be evidenced in the training of labor, quality of job creation and its distribution, use of gender-sensitive approaches and achievement of impacts such as clean energy generation and reduction of emissions and pollution. The implementation of AMI infrastructure, together with the REDs, can be identified as the program activities with the greatest potential to generate transformative social impact through new opportunities to improve the quality of life of end users.

The energy transition creates new business opportunities in the renewable energy value chain, and capacity building activities can provide a new skill set, for example, technical skills to apply and adopt new technologies and interpersonal skills to improve cooperation. In a sector currently dominated by men, women and minorities will be targeted by the Program to ensure they benefit equally from these initiatives.

In terms of business opportunities, innovation is hard in the energy sector due to major constraints associated to establishing new enterprises. Brazil is prominent in the global junior enterprise movement[66] and many startups with great potential start during college, but many times fail to scale because of regulation and lack of skills in accounting and management. Considering the importance of youth stemming from college junior enterprises, there are youth-led enterprises such as Atmos that sells smart meters and monitors energy consumption for commercial and residential use to improve energy efficiency. It is important to adopt a youth lens to female-led energy entrepreneurship and providing building capacity to youth-led enterprises since most of them are created by men.

The Program will monitor and evaluate activities, in particular related to progress with: i) inclusive social training and employment of community members and women in the services and maintenance of implemented projects/solutions; ii) training programs that enable the current and future workforce to enhance skills that facilitate access to new and green jobs, focusing on essential and job-specific skills, iii) on-the-job training, or in specific occupational training facilities, to enhance practice and employability, considering time demands and location limitations; iv) consultation processes with the sector and training providers to identify and anticipate the evolution of skills needs and the review and alignment of skills and training profiles; v) equal access to training facilities, focusing on young people, women, workers who need to be relocated, rural communities, informal workers and owners and workers of MSMEs; vi) development of productive activities and local economic growth thanks to insertion of new technologies.

The scope of social inclusion in terms of ethnic, religious, and racial minorities, women-headed families, local communities, migrants, youth and people with disabilities, should depend on the final projects to be supported, but will be in any case an essential aspect of follow-up to assess the positive transformational change of the program.

[66] The Junior Enterprise movement was founded in Paris, France, in 1967. It has grown into a thriving global network of 40,000 passionate student members, in 840 enterprises, spread across 40 countries. It is mostly present in universities, where youth start developing entrepreneurial skills to manage an existing university company that provides consulting services. Students work for free in a startup culture to learn managerial skills, and many of these inspire youth to create their own companies upon graduation. It is a very strong movement that supported the creation of many enterprises in Brazil.

In addition, the Program will monitor and help verify which policies adopted are sensitive to gender and diversity, for example, involving the equity of female and male installers and minorities for AMI or in the O&M of the various equipment and project developers, among others. Safeguards monitoring will include ongoing assessment based on the potential for sexual exploitation and gender-based violence.

ANNEX

ANNEX I. Assessment of the absorption capacity of the country for integration activities

Macroeconomic Context:

After suffering a strong recession in 2015 and 2016 and recovering slightly in the following two years, the Brazilian economy maintained its moderate upward trend and GDP grew by 1.1% in 2019. After falling 3.9% in 2020, the first year of the COVID-19 pandemic, the Brazilian GDP increased by 4.6% in 2021. In the accumulated of the two years (2020 and 2021), there was an advance of 0.6%, which indicates that the level of activity already exceeds that of 2019 (pre COVID-19 levels). The country maintained its leadership status in South America in 2021, accounting for more than 50% of the region's GDP in the year.

Compared to the G7 countries, the Brazilian advance surpassed the median performance (-2.2%) and was below only the growth of the United States (whose economy advanced by 2.0% in 2020 and 2021). In the G20 countries, the Brazilian performance was above the median (-0.9%), but far from the top of the ranking. The group's most significant gains in these two years were from Turkey (13.1%), China (10.5%) and South Korea (3.1%). In a list of 19 countries in Latin America, the country occupied the sixth largest advance in the last two years, surpassing the group's median (-2.1%). Economic growth in Latin America was led by Chile (4.5%), Guatemala (3.9%) and Paraguay (3.9%).

As mentioned, in 2020 the Brazilian economy was severely affected by the global recession resulting from the COVID-19 pandemic and, in the year 2022, domestic consumption in the country had to be supported by government transfer programs.

By 2023[67], the OECD forecasts an increase of 1.2% in the country's GDP[68], the economy should slow down due to the unfavorable external scenario, domestic monetary tightening, and the rise in uncertainty. For 2024, the OECD[69] forecasts a slight improvement in Brazilian GDP, with growth estimated at 1.4%, below the world average, which should be 2.7%.

At the end of 2019, the Extended Consumer Price Index (IPCA) recorded a national rate of 4.31%, slightly above the ceiling of the target of 4.25% defined by the Central Bank of Brazil (BCB). In 2020, annual inflation was 4.52%, the highest level since 2016, when it was 6.29%. This was mainly due to a 14% increase in food and beverage prices after the pandemic.

In 2022, the IPCA recorded a deflation of -0.29% in September. This was the third consecutive month of falling prices (in July it was -0.68% and in August, it was -0.36%. In the year-to-date, official inflation was 4.09% and 7.17% in 12 months[70]. These results were achieved due to an expansionary fiscal policy[71] in 2022, driven by tax exemptions to deal with higher energy prices

67 https://www.bbc.com/portuguese/brasil-63701894.
68 Below the world average of 2.2%.
69 https://www.bbc.com/portuguese/brasil-63701894.
70 https://www.suinoculturaindustrial.com.br/imprensa/brasil-registra-deflacao-de-029-em-setembro/20221013-092100-d912.
71 https://www.bbc.com/portuguese/brasil-63701894.

(reduction of ICMS on products) and a 50% increase in the Brazil Aid program[72]. Yet, cumulative inflation[73] in 2022 closed at approximately 5.62%.

The Institute for Applied Economic Research (IPEA)[74] forecasts inflation of 4.9% for 2023, a result that would be above the ceiling of the target of 4.75%. This forecast indicates that the deflation presented for the administered prices in 2022 will be over in 2023. In addition, contractual readjustments by energy distributors and health plan operators, the most pronounced restoration of public transport tariffs, are expected to exert pressure on this price group this year[75].

Commodities with lower prices and an economic slowdown by the country's major trading partners are expected to slow demand. In addition, stricter credit conditions should limit household consumption, generating a slowdown in job creation in the country in 2023, the OECD says[76].

Brazil has one of Latin America most developed and sophisticated financial sectors. The country's banking system and capital market are well-differentiated, internationally competitive and aligned to international standards. The banking infrastructure is strong and there is a banking supervision operating system. Capital markets are open to domestic and foreign capital. The banking sector is dominated by national financial institutions, with significant participation of public banks. International investors have important roles in the capital and derivatives markets.

The Basic Interest Rate (SELIC) has been drastically reduced recently. While in January 2017, the SELIC was 13.0%, in 2018, only 6.5%. At the end of 2019, the BCB's Monetary Policy Committee (COPOM) cut the SELIC to 5%. In line with the global economic slowdown caused by the pandemic, 2020, the SELIC was reduced to a historic low of 2.0%. The BCB justified this by arguing that current economic conditions required extraordinarily high monetary stimulus. However, in February 2023, the COPOM determined to increase the SELIC Rate to 13.75% to contain a rising inflation scenario.

Legal, regulatory and institutional context[77]:

The current conditions of Brazilian institutions indicate a robustness developed over the last years in which, due to the current legal and regulatory framework, entrepreneurship is promoted, and foreign direct investment is encouraged[78]. Generally, the government does not distinguish between foreign and domestic capital. Foreign and domestic private entities are authorized to establish, own and dispose of commercial enterprises. Tax regulations do not differentiate between foreign and domestic companies.

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[72] This income transfer program must be maintained in the new government. Brazil Aid will be restructured, and benefit of 600 BRL should be maintained.

[73] https://www.camara.leg.br/radio/programas/914609-deflacao-pelo-terceiro-mes-consecutivo-provoca-reavaliacao-dos-parametros-economicos-no-orcamento/.

[74] https://www.cnnbrasil.com.br/business/inflacao-deve-estourar-a-meta-e-chegar-a-49-em-2023-preve-ipea/.

[75] https://www.cnnbrasil.com.br/business/inflacao-deve-estourar-a-meta-e-chegar-a-49-em-2023-preve-ipea/.

[76] https://www.bbc.com/portuguese/brasil-63701894.

[77] https://bti-project.org/fileadmin/api/content/en/downloads/reports/country_report_2022_BRA.pdf.

[78] For decades, state-owned companies have dominated nearly every economic sector in the country. In the 1990s and early 2000s, the government privatized state-owned enterprises across a broad spectrum of industries.

However, organizing new investments is a rather bureaucratic process[79]. Brazil ranked 124th among 190 countries in the 2020 ease of doing business index. Despite this, the process for starting a business has improved slightly (from 140 to 138). It takes an average of 16.6 days, involving 11 procedures and 4.2% of per capita income costs. According to BloomberNEF's Climatescope report, in 2021, Brazil ranked 6th (investments in the order of 7.0 billion USD), in the 15 main markets for financing renewable energy assets (excluding China), surpassing countries such as Spain, France, and Sweden. In addition, the country ranks 29th out of 137 countries in political transformation and 85th in governance[80].

Currently, there are 133 companies in Brazil that are directly or indirectly state-owned (for example: postal operator, Petrobras oil company, port authority, among others). Its net worth corresponds to 9.5% of GDP and employs approximately half a million people. The financial performance of state-owned enterprises has improved in recent years. From a deficit of 0.5% of GDP in 2015, it evolved to a surplus of 1% of GDP in 2019, including the sale of assets in this calculation.

Political and independent civil groups can form freely. The Federal Constitution of 1988 guarantees the freedom of association and assembly, and these rights are respected. Through the Law on Access to Information (LAI), any person, individual or legal entity, without the need to present a reason, can obtain public information from bodies and entities. While institutionalized NGOs are more influential, with international ties, there are also a number of active community organizations, social movements, and informal platforms.

In recent years, Brazil has established the first steps to improve fiscal policy. In 2000, the Fiscal Responsibility Act (LRF) was passed[81]. In 2017, Brazil made a formal application to join the OECD. In 2019, the pension reform law (Constitutional Amendment 103/2019) was approved. The state has been engaged in expanding and strengthening basic administrative structures. However, large swathes of territory remain without access to efficiently and reliably providing public services. Corruption, gaps in basic infrastructure, and a lack of technical and personnel capacity all affect the state`s capacity. In Brazil, the functions and activities of the State are significantly decentralized. Municipalities are responsible for providing water supply, basic health, and education services.

Technical and Management Context:

Banco do Nordeste do Brasil S.A. is a Brazilian bank, incorporated as a mixed-capital company, with the participation of the Federal Government as the largest shareholder. It is a multiple bank with characteristics of an MDB and aims to promote the sustainable development of the Northeast Region of Brazil, through financial support to regional productive agents. Its mission is to promote sustainable regional development. BNB operates as the executing body of several public policies, the main source of funds operated by the company. In addition to federal resources, BNB has access to other sources of financing in domestic and foreign markets through partnerships and alliances with national and international institutions, including multilateral institutions such as the World Bank (WB) and the Inter-American Development Bank (IDB).

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79 Entrepreneurs face high costs associated with starting a business, registering properties, accessing credit, paying taxes, and more.

80 https://bti-project.org/en/reports/country-report/BRA.

81 It imposed order and responsibility on Brazilian state spending through a general budget planning, execution and accountability framework applicable to all levels of government.

The BNB carries out investment attraction work, supports the conduct of studies and research with non-refundable resources and structures development through high-impact projects. In addition, BNB proposes to provide integrated service to those who decide to invest in their area of expertise, providing a knowledge base on the Northeast and the best investment opportunities in the region. Thus, in recent years, the bank has progressively increased its role in filling large funding gaps and in developing infrastructure financing, highlighting: (i) FNE Sol (financing of up to 100%, to DMMG and SISOL with a maximum limit of R$100,000 for individuals) and FNE Verde (financing renewable energy and energy efficiency).

ANNEX II. Outline of studies

Enhancing Technologies, Modernizing, and Digitalizing Hydroelectric Plants

Diagnosis

Although the installed capacity of HPP increased continuously between 2006 and 2021 (2.7% p.a.), the production of energy from this source did not behave the same. There was an increase of 4.2% p.a. in the period from 2006 to 2011, followed by a reduction of 1.7% p.a. between 2011 and 2021 (EPE, 2022).

This is because HPPs are vulnerable to the increasing impacts of climate change. In addition, the aging of current assets results in lower efficiency and generation capacity. Thus, thermal plants are more dispatched, increasing the country's generation costs and GHG emissions.

According to EPE (2022a), from the beginning of 2030, the expansion of generation in SEB must be sustained in the increase of centralized and decentralized VRE. The installed water capacity, which at the beginning of the century was 83%, will decrease to 46% by 2031 (with the increase of other renewables). In addition, approximately 50% of the hydroelectric capacity currently installed in the country has more than 25 years of operation. Therefore, it is necessary to invest both in its rehabilitation to restore its original efficiency and its generation capacity, and, if possible, in its repowering. This in order to ensure future supply in a context of high penetration of VRE with the support and flexibility that HPPs with regulation capacity offer.

Eligible transformational activities/technologies

To try to maintain the high share of hydroelectric generation, it is necessary to increase efficiency, greater management, predictability, and maintenance of its operation, in addition to the reinforcement of other technologies; so that they can be used to accommodate load variations and the increased participation of VREs.

Due to aging, the level of interruptions of hydroelectric turbines, with forced stops, outside the maintenance schedule, is increasing, reducing the electricity produced (EPE, 2019a). From 2007 to 2018, the cost of forced shutdowns was 4 billion USD (Martins and Alarcón, 2019). In this sense, the Repowering[82] and/or modernization[83] of existing HPPs gains importance.

Digital technologies can be a crucial factor in the modernization of HPPs, improving decision-making processes to manage HPP, supporting the best use of water resources (Alarcón, et. al., 2018; Arch, et. al., 2020): control center modernization; remote monitoring of reservoir integrity (machine learning, unmanned vehicles, and robots, as well as visualization of Key Performance Indicators (KPI)[84] in real time); measurement, protection, control, supervision, communication and monitoring systems (predictive O&M and digital twins[85]); prediction and negotiation (prediction models through AI, big data, and machine learning) and digital workforce management (O&M platforms).

[82] Interventions aimed at increasing the power and/or efficiency of hydroelectric turbines.

[83] Use of new technologies in the operation of power plants, automating, digitizing, and computerizing their controls and commands, which result in increased productivity and efficiency.

[84] Management tool to perform the measurement and consequent level of performance and success of an organization or a given process.

[85] Virtual representations of HPP in real time through AI, mathematical models and measurement of operational parameters of the plant, including hydrology measurements upstream and downstream of the plant (Alarcón, et. al., 2018).

Also, it is interesting to use prediction models dealing with VRE`s stochastic nature. In this context, it is important to consider AI and machine learning techniques to improve the predictability of both centralized and decentralized VRE generation (Dos Santos, 2019; Paiva, et. al., 2020; Pelisson, 2021).

Barriers

Despite the various benefits[86] of digitizing HPP, some barriers must be overcome. These technologies are relatively new and therefore, little has yet to be done. Some challenges include: a need for more human capital for digitalization, a lack of adequate sensing and telecommunication infrastructure (capable of supporting processing and communication of large volumes of data), technological costs and availability, and cybersecurity (data protection).

On the other hand, a review of the regulatory framework is also required. In this sense, the inclusion of HPP in capacity reserve auctions (to obtain additional remuneration[87]) must be considered. In addition, the concepts of expansion and improvements used in concession contracts must also be clarified, as well as the allocation of the physical guarantee resulting from improvements and expansion to the generator for free flow. The possibility of extending the concession term by up to 20 years to amortize the investment in modernization and adequate remuneration for the provision of ancillary services and an attribute of "flexibility" conferred on the system by HPP should also be analyzed.

It is also important to assess the physical risk of climate changes (such as: floods, droughts, and extreme rain) for the assets of hydroelectric power generation, with the purpose to informing climate resilience initiatives in the entire country and at the asset level.

Costs/Investments

According to (EPE, 2022b), the specific cost of repowering/modernizing HPP varies between a minimum of 1,150/kW BRL and a maximum of 2,250/kW BRL. In addition, it is considered that in the coming years, it will be necessary to modernize approximately 55 GW of HPP, mobilizing investments in the order of 15 billion BRL (IDB, 2020).

In EPE, (2022b), by 2029, 51 existing plants were identified that could provide 4,947 additional MW of installed capacity through investments in rehabilitation and repowering (equivalent to 400 MW of firm capacity, displacing approximately 4,700 MW of open-cycle gas turbine), reducing the total NIS cost by 6%. Considering the HPP repowering/modernization cost data provided by EPE. The necessary investment would be between 5.7 billion BRL and 11.1 billion BRL. In this context, the reductions achieved by BRL invested range from 0.0051 $MtCO_{2eq}$/BRL to 0.0100 $MtCO_{2eq}$/BRL.

On the day of this information, in the next 10 years, it will be necessary to mobilize investments in the repowering/modernization of hydroelectric plants of between 1.1 and 2.1 billion USD. According to recent experiences, in HPP modernization projects, the investments associated with the digitization and automation of the plant are equivalent to about 30% of the total value of the investments required[88]. Therefore, considering the volume of investments projected in the next 10 years, the investment resource needed for the digitization and automation of

86 Ability to collect data, communicate and process data; improve the decision-making process; reduce O&M costs; increase plant and network performance; etc.

87 The investment made in the modernization of HPP could not be remunerated only with the sale of additional energy generation.

88 The investment cost of modernizing a HPP of 1,710 GW of capacity is approximately 100 million BRL.

hydroelectric plants alone can be located in an environment of between 326 and 640 million USD. These costs include: remote sensing; digitalization of safeguards (improve reliability and safety); digitalization of control and regulation command (improve ramps); online monitoring and analysis system, among others.

Results

The repowering/modernization of HPP can be a cost-effective alternative to recover and, eventually, increase the efficiency of the machines and, consequently, their production. Efforts should be made to establish incentive mechanisms to promote HPP repowering/modernization investments.

The modernization of HPP by 2029 would result in 4,782 MW of capacity gain for Brazil, as well as a reduction of 57 $MtCO_{2eq}$ due to the displacement of natural gas thermoelectric plants (Accenture, 2021; EPE, 2019a). Considering the HPP repowering/modernization cost data provided by EPE. The necessary investment for the 4,782 MW would be between 5.5 billion BRL and 10.8 billion BRL. In this context, the emissions reduction achieved by BRL invested ranges from 0.0053 tCO_{2eq}/BRL to 0.0104 tCO_{2eq}/BRL. Although there are already repowered HPP, new cases still need to be studied (EPE, 2019a).

Also, data from PSR and the World Bank[89] indicate that repowering and improving the efficiency of an additional 8 GW of existing hydroelectric assets by 2030 could allow the incorporation of an additional 28 GW to 59 GW of VRE. Considering that this capacity is all photovoltaic, this increase would allow an emission reduction between 16.7085 $MtCO_{2eq}$ and 35.2071 $MtCO_{2eq}$, if all this capacity is wind, this increase would allow an emission reduction between 33.4169 $MtCO_{2eq}$ and 70.4143 $MtCO_{2eq}$.

<u>Digitalization, modernization, and automation of T&D infrastructure and promotion of VRE integration in SISOLs</u>[90].

Diagnosis

The projections of the Brazilian electricity matrix indicate an increase in the participation of VREs, both centralized and decentralized. Specifically, centralized wind and solar power are forecast to reach installed capacity of 30.3 GW and 10.5 GW in 2031, respectively, compared to 20.8 GW and 4.6 GW in 2021. In addition, installed DMMG capacity is expected to grow from 15.3 GW in 2021 to 37 GW in 2031 (EPE, 2022a).

However, the massive insertion of centralized and distributed VRS brings significant challenges for the system, especially regarding the connection of the sources to the T&D system, regulation, planning, and operation.

In recent years, the demand for the expansion of the transmission system has intensified due to the accelerated development of the FTA, in addition to the so-called "gold rush" effect triggered by the withdrawal of the transmission tariff subsidy for renewable sources and the methodological change in the calculation of tariffs.

Therefore, considering the objectives of expanding the transmission system, such as providing the safe integration of generation, maintaining competitiveness in the generation sector, and

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[89] Brazil CCDR – Energy Sector Deep Dive. PSR-World Bank.

[90] This issue is considered transversal to the digitization, modernization and automation of T&D infrastructures and increase of energy storage technologies, so they may have the same eligible transformational activities.

providing safe service to the NIS demand, considering reliability and cost criteria, the PDE for the period from 2022 to 2032 presents a transmission system expansion plan with an increase of 41,000 kilometers of transmission lines until the year 2032.

This expansion plan needs to mobilize investments of 110.3 billion BRL in transmission lines and 48 billion BRL in substations, for the reference scenario, based on the values of March 2022. The investment is mainly intended for the construction of new transmission lines and new substations and their components, a set that we call conventional equipment, except for the new corridors expressed in direct current: the HVDC Graça Aranha - Miltônia link and a second HVDC corridor that connects the region of Ceará/Rio Grande do Norte with São Paulo.

The remarkable expansion plan stems from the need to provide an adequate, robust, and secure transmission network to support the connection of 57 GW VRE generation by 2033. However, the indispensable construction of the transmission infrastructure is not only to ensure the flow of energy, it must also add reliability, flexibility, and resilience to the system also in the short term.

The long-term planning cycle and its execution have a horizon of about 8 to 12 years. Thus, all the works listed above are expected to operate after 2028. However, there are limitations and bottlenecks in the transmission system in the short term that de-optimize system operation by limiting the power injection of VRE. Thus, the electrical system operators must be aware of the increased risk of congestion in the transmission networks at certain times of high VRE production, which can threaten the stability and reliability of the system and increase the operating costs of the system by the inefficient use of the primary resource (wind and sun). Thus, the evaluation of new technologies that can be added to the transmission system in order to reduce the planning and execution cycle is crucial for maintaining the optimal operation and minimum cost of the system. The technological challenge adds regulatory and transmission network planning challenges by integrating these technologies with characteristics different from conventional ones, called flexible equipment.

Another challenge to be faced by short- and long-term transmission planning is linked to the aging of network equipment. According to the EPE (PDE 2032), several transmission assets should have their regulatory lifetime[91] expired between 2023 to 2032, which would require potential investments of 37.6 billion BRL. It is understood that compromising the system`s safety is associated with technical overcoming of the facilities, however the information of the lifetime of the equipment is currently in possession only of the transmission agents. This issue also presents the short- and medium-term planning of the transmission system with opportunities to insert flexible technologies, always promoting the growth of the expansion of VREs as well as the best use of their generation by eliminating operational inefficiencies, such as the curtailment of unconventional renewable generation.

Distribution systems also face challenges that require a new look at the planning, operation, and regulation of this system. With the advent of the increase of DER[92], distribution systems need modernization and digitization, since the insertion of DER brings challenges such as:

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91 The physical life of the components is the factor that compromises the security of the system. However, the regulatory useful life is an important reference that must be monitored in the scope of sectoral planning, configuring an important input for the expansion strategies of the transmission system. Typically, the physical useful life is longer than the regulatory useful life.

92 There are many definitions of RED. This report categorizes RED as DG, distributed batteries, demand response and electric vehicles.

- Distribution system operation: Need for greater voltage and frequency control given the presence of load lifting ramps, bidirectional flow, and mobile loads such as those of electric vehicles;
- Distribution system planning: constant re-evaluation of expansion plans given the accelerated diffusion of new technologies and business models arising from DER, microgrids, and virtual power plants;
- Economic: distributors increasingly decrease their revenues and may have economic problems due to increased losses;
- Environmental: consumers are increasingly demanding that their energy be cleaner;
- Management of internal system uncertainties: Resulting from uncertainties regarding the system`s demand since it is no longer a passive element.

Finally, distribution systems are important for improving SISOL consumers' energy supply. In Brazil, there are approximately 3.1 million people (representing 0.6% of the country's total load) who are in isolated areas (SISOL), which do not have a connection to the NIS, mainly located in the Northern region of the country, in 7 states (see Figure II.1). These systems mostly use diesel oil as a fuel for power generation.

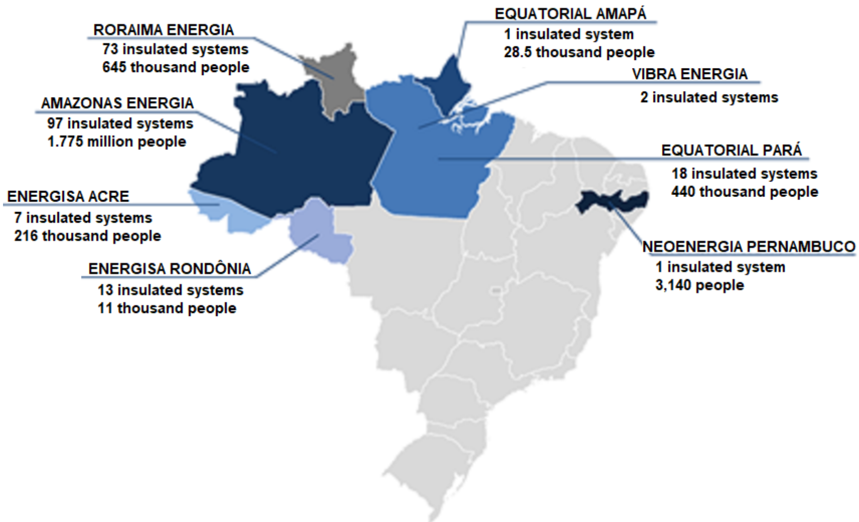

Figure II.1. Isolated Systems
Source: EPE, 2022c

Even if the total burden of SISOL is small, the impact on sectoral accounts is high since the generation of these systems is subsidized by the burden paid by all NIS consumers through the FCA.

Eligible transformational activities/technologies

Increased flexibility in T&D infrastructure can be achieved through two options: construction of new transmission lines and/or inclusion of new technologies or modernization of existing lines. However, the construction of new transmission lines can have significant social and environmental impacts, in addition to involving high costs and time necessary for their completion and may thus not be the best solution (MME, 2020).

To deal with this challenge, some transmission system control and monitoring technologies have been proposed: (***i***) Dynamic Line Rating (DLR) (auxiliary equipment, such as communication systems, measurement sensors, fall detectors, weather stations, data storage systems, data recording software for storing and analyzing DLR equipment data, computer models for calculating DLR in the operation of transmission systems); (***ii***) digital substations; (***iii***) Flexible AC Transmission System (FACTS) (Static Compensators (SVC), Direct Current Converters (HVDC), STATCOM, TSSC, TCSC, SSSC and UPFC); (***iv***) Fault Current Limiters (FCL); (v) Voltage Source Converters (VSC) and (***vi***) transmission equipment associated with VRE projects (EPE, 2019b; EPE, 2022a). The use of these technologies can increase the flexibility of the transmission system, bringing more opportunities for VRE insertion and better control to the system.

As an example of using these technologies we can highlight the projects in England[93] and Colombia[94]. In England, NGET installed 48 Smart Valves (SmartValves*)* in three substations in the north of England, creating 1.5 GW of additional capacity for the flow of energy from renewable sources. In the case of Colombia, EPM installed D-FACTS technologies-Smart valves in its distribution system, thus allowing the connection of 400 MW of small additional hydraulic and solar generators in its distribution network.

EPE has also been monitoring and analyzing proactive transmission expansion studies, currently underway in the North and Northeast regions, based on High Voltage Direct Current (HVDC), which have been showing increasing application in NIS[95]. The EPE also points out that among the diversity of Flexible AC Transmission System (FACTS) devices available in the market, the ones that have been considered by this institution the most are the Static Compensators (SVC). The HVDC alternative becomes a potential application in the Brazilian transmission system, as it allows the generation of at least two different points of the network and the flow of this energy to a point of high load concentration. EPE has also been monitoring the development studies of these new technologies and interacting with manufacturers of direct current equipment, with a view to evaluating the feasibility of its application in NIS, in medium or long-term horizons (EPE, 2022a).

Storage in batteries is also a solution, given the expectation of falling costs until 2030, in addition to the low implementation time required and low socio-environmental impact expected compared to transmission lines. Energy storage can be used in T&D, improving system flexibility (MME, 2020).

The service of SISOL can be done by adopting solutions such as smart grids, microgrids[96] or individual generation systems[97] with VRE with or without battery energy storage systems.

In addition, the development and/or improvement of computer models must be used to support the evaluation of expansion and planning with flexible T&D equipment (PSR, 2022). In

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93 https://www.smartwires.com/2021/10/13/power-flow-project-extension-to-unlock-further-500-mw-of-capacity-on-electricity-system/.

94 https://www.smartwires.com/2023/01/26/epm-culmina-proyecto-tecnologico-que-permitira-a-pequenos-generadores-inyectar-400-megavatios-a-su-red-de-distribucion-de-energia-en-antioquia/.

95 For example, the Graça Aranha - Silvânia DC links that will be tendered at the end of the year and the new DC link (not yet localized) presented in PDE 2032. Costs of implementing this technology (construction and expansion of substations and direct current line) have a value of 3.1 billion USD (EPE, 2023a).

96 MIGDI (Microsistema Isolado de Geração e Distribuição de Energia Elétrica, Isolated Electric Energy Generation and Distribution Microsystem), RN ANEEL no. 493/2012.

97 SIGFI (Sistema Individual de Geração de Energia Elétrica com Fonte Intermitente, Individual Electric Energy Generation System with Intermittent Source), RN ANEEL no. 493/2012.

transmission, automation of the calculation of the Transmission Margin (TM)[98], currently done manually by the ONS manually can be implemented (Miranda, et. al., 2018; Pinto, et. al., 2019).

Distribution systems also have challenges to overcome. Deepening in-depth knowledge of distribution networks and VRE penetration is required. For this, the implementation of the Hosting Capacity (HC) calculation is an important tool for greater penetration of VREs and sustainable maintenance of the operation and expansion of distribution systems (Visconti, et. al., 2022). In addition, the use of technologies such as D-FACTS has been considered in distribution systems. These devices are used to improve system performance, being able to control system quantities: voltage, bus power injections, power flows and line losses (Barbosa, 2019).

Distribution companies have been steadily decreasing their revenues. This issue is reflected in the so-called death spiral. DMMG along with other DERs and microgrids should make this loss of revenue greater in the future. Consequently, new business models for distributors[99] can also be studied and developed.

Intelligent measurement and dynamic tariffs with greater temporal granularity[100], through intelligent meters, would allow combating some existing problems in the electricity sector (non-technical losses and low reliability) and allow the implementation of new pricing mechanisms[101], demand response programs and business models (MME, 2020).

Other technologies that can be employed in the digitization of distribution. Technologies of Information and Communication (ITC), digital twins, and Low Power Instrument Transformers (LPIT) (Arteche, 2023).

Barriers

FACTS and D-FACTS devices have no incentives to use them. In the regulatory framework, network operators or owners are not affected by the increase or decrease in congestion costs[102], which are passed on to market participants (Tsuchida and Gramlich, 2019). With respect to smart measurement, there is no regulatory remuneration mechanism for these investments (unlike conventional assets, the smart meter is an asset that has a shorter depreciation time, so the tariff review period for remuneration of these investments can be very long).

Technologically, the adoption of FACTS and D-FACTS devices depends on greater knowledge of the technology, these are relatively new (started in the 2000s), not being sufficiently recognized for their capabilities and the lack of experience on the part of operators and planners[103] (Tsuchida and Gramlich, 2019). In addition, other technological barriers refer to the modernization of T&D, stand out: lack of IT infrastructure (capacity to support high data flow

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98 Represents the maximum power injection in a NIS region without the need for transmission system reinforcement. MT is also important in offshore wind expansion, as it would allow to evaluate the insertion of large quantities in NIS.

99 Currently, the distributors' business model consists of the purchase and sale of electricity to consumers.

100 They can also be used to serve SISOL.

101 Smart meters were used in the implementation of the White Tariff in the country, which was instituted through RN ANEEL No. 733/2016. This was an important step towards the dissemination of intelligent measurement, basically due to the demand for the modernization of measurement systems and the treatment of information from consumer units.

102 In Brazil the transmitters are regulated by availability only. Some companies even prefer to operate with their lines empty, operating inefficiently as they do not pay fines.

103 SVC and HVDC, have been increasingly applied in SEB. The EPE considered the SVC devices in the context of energy planning and the HVDC is being analyzed.

and storage loads); information management (ability to unify all data in a single platform); data quality; cybersecurity (protection of customer data), and ethics (who should be the real responsible for reasoning and decision-making) (Rodriguez, et. al., 2020).

Although it is not a regulatory or technological barrier, there are also certain issues on the part of consumers that would prevent the greater insertion of smart meters, some of which are: lack of security about their data, lack of familiarity, decreased freedom of choice (which occurs when these meters represent a mandatory character[104]), and lack of trust of users with respect to energy suppliers.

Costs/Investments

It is estimated that between 2022 and 2031, investments to reach DER's share, between 27 GW and 47 GW, are in the order of 73 billion to 168 billion BRL. By 2032, several transmission assets will have their regulatory useful life expired, requiring investments of around 37.6 billion BRL to replace all equipment related to substations. In addition, by 2022, there will be 96,000 pieces of equipment with an expired regulatory useful life, with a total investment of 21 billion BRL (MME, 2019).

Integrated and flexible transmission system planning. Project developed by PSR/MRTS/HPPA, EPE and ISA CTEEP within the scope of ANEEL's R&D. The object of the project was to develop a flexible transmission planning methodology considering an VRE penetration. The methodology developed covered flexibility measures both in the operational scope, considering the application of the DLR in 28 230 kV transmission lines, as well as the inclusion of flexible equipment for system expansion such as batteries and FACTS. The simulations considering the DLR showed an average operating cost reduction of 76 million BRL per year, considering an investment estimate of about 100 million[105] BRL in monitoring equipment.

Copel has been making investments in order to modernize its T&D infrastructure (AEN, 2022; OSE, 2023). This year, its distribution network will receive 1.878 billion BRL from the resources, to intensify its modernization and expansion. In addition, the company has been developing its Intelligent Power Grid initiative, promoting the automation of its power grid. With an investment of 820 million BRL, it is bringing the new technology to 4.5 million people, in residential units and urban and rural companies, 430,000 digital meters have already been installed in 73 municipalities (plans to install 500,000 in the next two years), which should communicate directly with the company's operation center. In addition, Copel will also invest 274.9 million BRL in power generation and transmission, in the transmission sector Copel plans to invest 100 million BRL in the improvement and modernization of the lines.

EDP also announced investments of 4 billion BRL in the distribution segment in Espírito Santo, until 2025 (OSE, 2023; Petronotícias, 2023). EDP has installed 50,000 smart meters in Espírito Santo and plans to surpass the mark of 1 million by 2025. These investments have as main objective the strengthening of the distribution network to allow the implementation of DMMG. This investment is almost double what was invested between 2016 and 2020. In addition, this

[104] For example, in Poland, Indonesia and Turkey the deployment of these meters was mandatory. In certain regions of Canada and the United States, there was even a judicial challenge to the obligation to implement it (Gums and Castro, 2021).

[105] Estimated considering a 4.8 million BRL investment for 8 transmission lines in Texas according to IRENA, 2020 - DYNAMIC LINE RATING INNOVATION LANDSCAPE BRIEF.

investment has as secondary objectives the operational improvement of the network; the reduction of losses (combating energy theft); investment in digitization and customer service.

According to research carried out in distributors in Brazil, the unit cost of acquiring the meter is approximately 150 BRL. Cost of acquisition and installation of telecommunication equipment is approximately 142 BRL per consumer unit (O&M costs of 3.55 BRL). Cost of acquisition and installation of automation infrastructure is approximately 53.25 BRL per consumer unit (O&M cost of 2.55 BRL) and information technology infrastructure of approximately 53.25 BRL per consumer unit (O&M cost of 2.55 BRL). Logistics cost of approximately 12.50 BRL per consumer unit (Lima, et. al., 2022). The total cost of the smart meter per consumer unit is approximately 419.65 BRL.

Results

Studies developed by PSR show that investments considering new flexible[106] transmission planning methodologies have a value of 2,070.8 million BRL, compared to the conventional planning methodology of 4,606.1 million BRL, representing a 55% reduction in transmission investments. In addition, the use of conventional expansion methodology indicates a thermal generation of 68,443 GWh in the year 2030, while the flexible expansion of the transmission resulted in a generation of 68,003 GWh in the same year, a reduction of almost 1% (avoided GHG emissions of 0.1499 $MtCO_{2eq}$). Also, the VRE spill was 27,075 GWh in the case of conventional expansion and 26,404 GWh, representing a 2.5% reduction (avoided GHG emissions of 0.2285 $MtCO_{2eq}$) when considering the flexible expansion methodology.

The implementation of the DLR would bring an annual operating cost savings for Brazil of up to 1% (R$76 million), considering the application of the DLR for BN transmission lines with loading above 90%. Due to this it is possible to reduce the dispatch of thermoelectric plants from 63,817 GWh to 63,522 GWh (1% reduction), this would avoid the emission of GHG in the amount of 0.1005 $MtCO_{2eq}$. In addition, there would be a decrease in the curtailment of wind and solar plants, decreasing from 5,436.1 GWh to 5,041.3 GWh (7% reduction), this would avoid GHG emission in the amount of 0.1345 $MtCO_{2eq}$.

ENEL Distribuição de São Paulo installed 300,000 smart meters during 2022 and plans to invest 1.33 billion BRL by 2025 to deploy more than 3 million smart meters. CEMIG finished 2022 with 250,000 smart meters (an investment of 155 million BRL) and plans to install 1 million by 2025. CELESC has 33,000 smart meters installed during 2021 and is planning to install another 262,000 during 2023. ENERGISA, CPFL, and NEOENERGIA have proposals to install more than 4 million meters together. Also noteworthy is the inclusion of the evaluation of measurement systems for energy transition and modernization of distribution in ANEEL's agenda for the 2023-2024 biennium (OSE, 2023).

If we consider a hypothetical scenario where, in a year, smart meters are installed in the amount of 3 million for residential consumers (whose average consumption is 300 kWh/month) and 0.5 million for commercial consumers (whose average consumption is 800 kWh/month); the total investment cost would be 1.5 billion (the cost of the smart meter for each consumer unit is 419.65). In addition, considering that the installed photovoltaic system meets the energy needs of the consumer and that the average radiation is 5.5 kWh/(m^2-day), the total installed power

[106] It is important to understand that flexible methodology has not resulted in investment in flexible equipment. PSR makes an expansion plan that has multiple scenarios, demand with a time profile and system redispatch. This is different from conventional methodology.

of photovoltaic DMMG[107] is 9.8 GW. Using a NIS 0.3406[108] tCO_{2eq}/MWh emission factor, the total avoided GHG emissions is 5.3134 $MtCO_{2eq}$/year.

On the other hand, EPE data show that SISOL emissions are around 1,825 $MtCO_{2eq}$/year considering diesel and natural gas plants. EPE estimates indicate that the maintenance of current generation conditions in SISOL (predominance of diesel generation plants), for example, for the cases of Acre, Amazonas and Rondônia, would have an impact of 4 billion BRL on CCC, in the next 15 years. In this context, solutions such as the partial or total replacement of diesel generation by VRE generation with or without energy storage could help to reduce not only these costs, but also emissions.

Promotion of Energy Storage Technologies.

Diagnosis

Recently, in the distribution segment, DMMG are being installed, consisting mainly of VRE. These have the potential to reverse energy flows (from the consumer to the grid), making it bidirectional, generating complications, not only in the operation and management, but in the O&M of the system.

Increased VRS raises concerns about reliability, safety, and quality. Only in the Pecém GH2 hub, in Ceará, 8 additional GW of VRE are foreseen by 2032 to meet the production requirements estimated only by the four main actors in the private sector who have already signed pre-contracts for the use of the area. In Brazil, greater penetration of VRE threatens system~s stability, but they consider the projections for DMMG, which is expected to reach 37 GW in 2031, with photovoltaics standing out with 92% of installed capacity.

Energy storage is a viable solution in providing flexibility and other services required by the system. HPP with reservoirs could help supply the flexibility required by the system. Other solutions identified are, mainly, batteries, H2, and PHS. Each with different applications that allow you to get different benefits.

In Brazil, the predominance of HPP enabled the postponement of the implementation of PHS technologies. However, recently, in 2019, EPE resumed the subject through the publication of inventory studies on PHS, trying to update the studies on PHS developed in the 1970s and 1980s, which identified great potential in the Southeast region. Brazil has 20 MW of installed capacity in PHS that is not operational (IDB, 2023).

Eligible transformational activities/technologies

Energy storage can be used in a centralized and distributed manner[109]. Centralized storage aims at the large-scale accumulation of VRE surpluses. Decentralized storage can be used both behind the meter (BtM) and at the front of the meter (FtM).

Implement procedures and models that coordinate the operation of hydroelectric reservoirs for the implementation of PSH. The implementation of procedures and models for reservoir operation is a curtailment mitigation measure that *can* complement the implementation of PSH,

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107 It is considered that each consumer can install an DMMG to meet their consumption.
108 https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/dados-e-ferramentas/fatores-de-emissao.
109 They can also be used to serve SISOL.

given that the services that this technology would provide must be adequately valued (MME, 2020).

Water electrolysis is a traditional form of GH2 production that can take advantage of excess supply of electricity. For this purpose, the production and use of GH2 may include the dealing with intermittencies produced in some technologies, in the case of VREs in the electricity sector. However, the surplus in the supply of VREs may not be sufficient for the need for the process, with the need for energy integration with other sources of supply.

Although H2 already has an[110] established chain in relation to production[111] and consumption[112] in the country, currently produce H2 is classified as gray H2 because it comes from the burning of fossil fuels. Currently, Brazil produces about 550 tons/year of gray H2, mainly used by the oil industry (for refining) and to produce fertilizers (GIZ, 2021). The country has great potential to become one of the world leaders in GH2 production, due to the high potential of renewable resources and the high level of NIS integration and may have one of the most competitive LCOH (*Levelized Cost Of Hydrogen*) in the world, reaching less than 1 USD/kg in 2030 (BNEF, 2021). This would allow to decarbonize sectors such as heavy industry and place the country in a relevant position as a global producer and exporter not only of GH2 but of minerals, steel, metals, ammonia, agricultural commodities and other low or zero-carbon industrial goods and services (EPE, 2022a).

In Brazil, the development of the GH2 market would benefit from being done from hubs, combining in one place the production, transformation, and use/commercialization of GH2 and derivatives. This is a way to take advantage of economies of scale and scope through shared infrastructure (such as water supply, power grid, and industrial and port infrastructure), in addition to the strategic location for the export of products (since the main GH2 hubs planned for Brazil are on the coast). Another benefit would be to couple the production of *offshore* wind with GH2 as a way to reduce costs and allow the integration of *offshore* wind: the production of GH2 directly at the *offshore* terminal allows to decrease the cost of the investment of the offshore wind generation itself, since the transportation cost of GH2 is on average 80% less than the subsea line that connects the *offshore* substation to NIS.

Brazil has at least five port and industrial complexes, four of which are located in the Northeast region, where this model could be replicated. Those are: Pecém (Ceará), Suape (Pernambuco), Camaçari (Bahia), and the new port complex that is being built in Rio Grande do Norte with the support of the World Bank. In these examples, there is a strong complementarity between offshore wind production, GH2, and derivatives production, and industrial decarbonization. Pecém's GH2 hub is currently the most advanced, as: (i) it has four pre-contracts and 20 Memoranda of Understanding (MoU) signed with private sector companies, (ii) it is be located near large industries (such as steel and cement, which will be important consumers of GH2 for decarbonization), and (iii) it has federal and state tax benefits for being an Export Processing Zone (ZPE) already constituted.

Centralized and distributed production of H2. Centralized H2 production plants are of high capacity which allows economies of scale; however, they require an important storage and distribution infrastructure. Decentralized H2 production plants, the infrastructure is less

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110 Supply is almost exclusively based on fossil fuels and demand is almost entirely for industrial purposes as raw material.

111 International companies: Air Liquide, Air Products White Martins/Linde and Messer.

112 Refineries, food, metallurgy, welding, refrigeration, industrial equipment etc.

relevant in economic terms allowing to scale the plant for local service, but the project may lose scalability (EPE, 2022b).

Large battery banks in FtM applications. Technological improvement, cost reduction, and incentives have contributed to this end. Large battery banks are already being connected to power systems or power plants. Example, a CTEEP project that implemented a 30 MW/60 MWh battery bank, to improve network reliability (MME, 2020).

Distributed storage. In BtM applications, one of the aspects may be the use of vehicles (which would provide transport and network services). Another aspect is employment in consumer units or in DMMG facilities or in microgrids, providing services not only to consumers, but to the network. It is expected that these applications will also develop as a favorable market for second-life batteries from vehicle applications. In FtM applications, they can be used as part of distribution infrastructure or in microgrids.

Barriers

In addition to the lack of a telecommunication infrastructure, these are relatively new technologies in the electricity sector, there is still no regulatory framework and a consolidated market environment for their implementation. Although the sectoral authorities are analyzing several alternatives and proposals, so far the regulation does not recognize this type of investment (regulatory uncertainty of incorporation of storage assets in T&D, for example, non-incorporation in the Reference Price Bank (RPB)[113], depreciation time[114], cybersecurity, absence for the load aggregation activity). In the market, it can be said that they are technologies with prices still high for the Brazilian context (mainly in BtM applications), uncertainty in business models, lack of monetization of some of their services, lack of appropriate pricing[115] (greater temporal granularity that better specifies the temporal scarcity) and lack of market of ancillary services[116] (revenue is not recognized for the services they provide) (Bellido, et. al., 2022; Bellido, et. al., 2020; MME, 2020).

Also, there is currently in the country a regulatory uncertainty about how batteries could be considered as generators or consumers or even transmitters. In addition, regarding the PHSs there is an uncertainty about what this should be called: PHS or hydraulic pumping, which, if the first denomination is accepted, it would be necessary for them to operate as a form of concession, in the second case this contracting mechanism would not be necessary.

In the case of GH2, one of the key barriers to the development of this new market is the high initial cost for GH2 projects, combined with lack of demand. Many call this challenge the chicken-and-egg dilemma: without production, there will be no demand, and without demand, there will be no interested producers and investors. According to a market analysis conducted by the World Bank, one of the ways to promote GH2 projects would be through public financing of

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113 Reference used by ANEEL to estimate the value of investment in electricity sector infrastructure.

114 These technologies have a shorter depreciation time than conventional technologies at SEB. Need to update the Electricity Sector Asset Control Manual (MCPSE).

115 The absence of economic signals causes systemic requirements to be perceived as externalities, in the sense that the social value provided is not reflected in the price of energy.

116 The public consultation 145/2022, which aims to discuss topics related to the provision of ancillary services in NIS, is noteworthy. The main suggestions of the agents were: development of an appropriate regulatory framework, creation of an ancillary services market, creation of new ancillary services (rapid frequency response, improvement of frequency response, among others), development of competitive mechanisms for contracting ancillary services (considering, adequate remuneration (fixed revenue + variable revenue) and technological neutrality), revenue stacking and provision of ancillary services in distribution.

shared infrastructure, such as utility corridors and port infrastructure, which is a way to reduce the risk of investment for the private sector and at the same time giving a clear signal of the state's development policy.

Costs/Investments

The following are some examples regarding the costs/investments required to implement the activities/technologies identified in the case of Brazil. 30 MW/60 MWh battery bank installation. Project developed by ISA CTEEP, with an investment of approximately 146 million BRL and AAR of 27 million BRL. Batteries proved to be the most economical solution to solve peak load service problems in the South Coast of São Paulo. In this project, the following solutions were analyzed: implementation of phase-shift transformers in some points of the network; battery bank and phase-shift transformers; diesel generation at the tip and battery bank.

It is estimated that turn-key solutions of DMMG & Batteries, for commercial or residential purposes, have an estimated price of 2,000 BRL/kWh in the year 2030. In 2020, the price of these systems was approximately 4,500 BRL/kWh, a reduction rate of 8.3% p.a. (EPE, 2020b). On the other hand, the projected costs for 2030 of lithium-ion batteries would be in the range of 254 BRL[117]/kWh (MME, 2020). Also, for the year 2031, the cost of HRU installations in the country is expected to be 2,400 BRL/kW - 12,000 BRL/kW, while O&M costs are expected to be 70 BRL/kW/year (EPE, 2022a).

Results

The estimated annual production of H2 by 2050 is around 1850 Mt/year, with offshore renewable resources with a huge technical potential for hydrogen production standing out. According to EPE studies, the need for energy to supply the peak load will be about 13,200 MW in 2027, considering both storage and thermoelectric technologies. Of this total, approximately 2,500 MW are indicated in the Northeast region, from 2025, 3,700 MW in the South region from 2022 and 7,000 MW in the Southeast/Midwest region, from 2023.

According to data from (EPE, 2023), the 30 MW/60 MWh battery bank installed by CTEEP, which is the first large-scale battery power system implemented in the country and whose objective is to act as a reinforcement to the electricity network, at peak consumption times, as occurs in the summer. The project has a useful life of 17 years and the potential to avoid the emission of 0.0101 $MtCO_{2eq}$ in this period (in this context, the ratio of the ratio of avoided emissions/investment is 0.00007 tCO_{2eq}/BRL).

For batteries, it is considered that for each unit of installed power, the same amount of power in VRE, solar photovoltaic, and/or wind, can also be absorbed. The 30 MW battery bank would have the potential to absorb the installation of also 30 MW in VRE, i.e., wind and/or solar photovoltaic. Considering the NIS emission factor in 2022 of 0.3406 tCO_{2eq}/MWh. On the one hand, if we consider only the installation of a 30 MW wind power plant (capacity factor of 0.4), the avoided GHG emissions would be approximately 0.0358 $MtCO_{2eq}$. On the other hand, if we consider only the installation of a 30 MW photovoltaic plant (capacity factor of 0.2), the avoided GHG emissions would be approximately 0.0179 $MtCO_{2eq}$.

According to studies developed by (IDB, 2023), there is currently in Brazil a potential in PHS of approximately 13 GW. Regarding costs, they had a wide spectrum of possible projects. The minimum specific cost for these projects was 740 USD/kW, while the maximum specific cost was

[117] The indicated value range is 395 BRL/kWh and 113 BRL/kWh.

1,504 USD/kW; the average specific cost verified in these projects was 1,067 USD/kW. Consequently, considering the information related to the potential in UHR and the average specific cost, the total investment to deploy these systems in Brazil would be approximately 13.7 billion USD.

ANNEX III. Additional data to SEB

Table III.1. Thematic Groups for the modernization of SEB

Subject	Definition
Short Term Price	Verification of the relationship between supply and demand and their oscillations, allowing a system more adherent to the operational reality, generating the appropriate signal for the adequate contracting of needs
Supply criteria	Establish parameters that signal the need to contract the attributes that the system requires
Ballast and energy	Need to contract ballast and energy separately, as the electrical system has presented restrictions in terms of power capacity
Market opening	Reduction of the limits of access to the free market and the effects of the expansion of the free market. There is a proposal to open up the free market for all Group A consumers
Insertion of new technologies	Ensuring technology neutrality. The idea is that technologies in the sector can compete on equal terms, without specific barriers and/or subsidies
Sustainability of distribution	Appropriate compensation from the distributor. A portion of consumers have a volumetric tariff. Currently, the distributor is remunerated through tariffs for the sale of energy, however, not all costs depend on the amount of energy consumed and produced
Hiring processes	Ensure greater efficiency in the hiring process, reducing costs, and mitigating impacts. Relevance of creating a Contract Centralizing Agent
Rationalization of charges and subsidies	Development in subsidies funded by CDE
Energy relocation mechanism	Analysis of the conjunctural and structural causes of the effects caused by the recent sequence of years of low hydrological fluency, presenting a diagnosis and proposals for solving the problem
Sustainability of the transmission	Issue of quantity of end-of-life transmission installations and simplification of the settlement of Transmission System Usage Charges (EUST)
Auction systematics	Adjustments and improvements to be executed in the short term, without requiring profound modifications to normative resolutions and existing regulations on auctions
Cost and risk allocation	Identification of most significant distortions in the current model, highlighting: prices, expansion of system reliability and guarantee of supply
Reducing bureaucracy and improving processes	Survey of the main processes and activities of SEB that have or do not have involvement of external agents, evaluating the possibility of simplifying, excluding or improving the way they are carried out
Governance	Relevant processes or themes that require coordination, structuring or better definition of the role of each institution. This includes topics that transcend the electric sector

Source: MMM, 2019

Table III.2. Solar energy auctions

Year	Auction	MWaverage contracted	Supply start	Comments
2014	6 LER	202.1	2017	--
2015	7 LER	214.0	2017	--
	8 LER	262.0	2018	--
2016	9 LER	--	--	Cancelled
	10 LER	--	--	Cancelled
2017	25 LEN (A-4)	170.2	2021	--
2018	27 LEN (A-4)	228.5	2022	--
2019	29 LEN (A-4)	62.0	2023	--
	30 LEN (A-4)	163.0	2025	--
2020	31 LEN	--	--	Cancelled
	32 LEN	--	--	Cancelled

Source: Adapted from Greener, 2021

Table III.3. Some characteristics of SISOL compared to NIS

Year	Load (MWaverage)		Consumption (GWh)		Losses (%)	
	Isolated	NIS	Isolated	NIS	Isolated	NIS
2012	1,453.0	58,540.0	7,823.0	440,304.0	38.7	14.4
2013	1058.0	58,608.0	5,783.0	457,359.0	37.6	10.9
2014	650.0	61,593.0	3,769.0	471,054.0	33.8	12.7
2015	562.0	64,625.0	3,341.0	462,367.0	32.1	18.3
2016	446.0	64,613.0	2,940.0	458,840.0	25.0	19.2
2017	472.0	65,585.0	2,893.0	464,268.0	30.0	19.2
2018	459.0	66,559.0	2,913.0	472,852.0	27.5	18.9
2019	461.0	67,835.0	2,914.0	479,613.0	27.9	19.3
2020	483.0	66,839.0	2,997.0	473,571.0	29.4	19.3
2021	442.0	69,449.0	2,918.0	494,586.0	24.7	18.7

Source: EPE, 2022

ANNEX IV. Stakeholder consultations

Brazil's CIF-REI Investment Plan is the result of an advisory process led by the GoB led by the Ministry of Finance (MF), MME, and the Ministry of Science, Technology and Innovation (MCTI), to identify and prioritize lines of action, in which financial support mechanisms are needed to accelerate the integration of VREs. This plan was conceived as an important instrument to advance the Energy Transition and climate action paths that the country has set, in terms of policy, towards the goals of sustainable growth, emissions reductions and climate change mitigation in 2030 and 2050. This consultation process included government agencies such as EPE, ANEEL, ONS, CCEE, BNDES, and representatives of the private sector, academia, and development partners of international cooperation. There were two main consultations throughout the IP preparation, the first of which took place during the Joint Mission, held on July 2022, and was used to initiate conversations with different levels of government and relevant stakeholders. Based on these discussions, the main strategic themes that should be included to be supported through this IP were determined. The participants of these discussions are listed in Table IV.1, Table IV.2 and Table IV.3.

Table IV.1. Participants of the Joint Mission held on July 6, 2022

NAME	ORGANIZATION	POSITION
Marcelino Madrigal	IDB	Energy Division Chief
Gloria Visconti	IDB	Lead Climate Change Specialist
Carlos J. Echevarria	IDB	Regional Lead Energy Specialist
Juan Roberto Paredes	IDB	Senior Renewable Energy Specialist
Michelle Carvalho	IDB	Senior Energy Specialist
Rafael Cavazzoni	IDB	Financial Markets Lead Specialist
Gisela Ferrari	IDB	Gender Focal Point at the Climate Change and Sustainability Division
Ana Champloni	IDB	Consultant at the Climate Change and Sustainability Division
Ricardo Goncalves	IDB	Consultant at the Climate Change and Sustainability Division
Fernando Cubillos	IDB	Head Energy - Principal Investment Officer
Chandrasekar Govindarajalu	WB IBRD	Lead Energy Specialist - Energy Climate Finance
Pierre Audinet	WB IBRD	Lead Energy Specialist
Megan Meyer	WB IBRD	Senior Energy Specialist
Carlos Antonio Costa	WB IBRD	Senior Energy Economist
Alexandre Kossoy	WB IBRD	Senior Financial Specialist - Climate Change Group
Jimmy Pannett	WB IBRD	Energy Specialist
Luis Alberto Andres	WB IBRD	Sector Leader, Brazil, Infra & Water
Andrey Shlyakhtenko	WB IFC	Senior Operations Officer
Tendai Madenyika	WB IFC	Operations Officer
Diogo Falchano Bardal	WB IFC	Associate Operations Officer
Marco Aurélio dos Santos Rocha	ME	Secretary of International Economic Affairs
Alexandre Ywata	ME	Special Secretary for Productivity and Competitiveness
Raquel Breda dos Santos	ME	General Coordinator of Global Development Institutions

Luiz Mauricio de Araujo Navarro	ME	Coordinator for Policies and Funds for Development Finance
Patricia Vieira da Costa	ME	Advisor for Policies and Funds for Development Finance
Flavio Daniel Baran	ME	Advisor for Policies and Funds for Development Finance
Agnes Maria de Aragao da Costa	MME	Head of the Special Advisory on Regulatory Affairs
Patricia Naccache Martins da Costa	MME	Advisor to the Executive Secretary
Luís Badanhan	MME	General Coordinator of Environmental Sustainability of the Energy Sector
Chris Salgado Faria	MME	Special Advisor for Economic Affairs
Daniela Nogueira	MCTI	General Coordinator of Project Modeling (Financial Structures and Projects)
Andrea Nunes	MCTI	Researcher
Gustavo Ramos	MCTI	Coordinator and Specialist in Public S,T&I Policies
Leandro Viegas	MCTI	Science and Technology Analyst at the Special Advisory for International Affairs
Felipe Sereno	MCTI	Technologist
Guilherme Arantes	BNDES	Electric Energy Sector Manager
Luciana Peixoto Gonçalves de Oliveira	ANEEL	Specialist in Regulation at the Superintendence of Regulation of Generation Services
Rafael Costa Ribeiro	ANEEL	Specialist in Regulation at the Superintendence of Regulation of Generation Services
Aurélio Calheiros de Melo Junior	ANEEL	Deputy Head of the International Advisory
Jaiane Batista Alves Padilha	ANEEL	Administrative Support
Gustavo Pires da Ponte	EPE	Deputy Superintendent of Generation Planning
Mariana de Assis Espécie	EPE	Chief of Staff
Angela Barbosa Greenhalgh	ONS	Strategic Transformation Specialist
Elusa Moreira Barroso Brasil	ONS	Assistant to the Director General
Galdino Barros	CCEE	Advisor to the Presidency

Table IV.2. Participants of the Joint Mission held on July 7, 2022

NAME	ORGANIZATION	POSITION
Gloria Visconti	IDB	Lead Climate Change Specialist
Carlos J. Echevarria	IDB	Regional Lead Energy Specialist
Juan Roberto Paredes	IDB	Senior Renewable Energy Specialist
Gisela Ferrari	IDB	Gender Focal Point at the Climate Change and Sustainability Division

Ana Champloni	IDB	Consultant at the Climate Change and Sustainability Division
Ricardo Goncalves	IDB	Consultant at the Climate Change and Sustainability Division
Michelle Carvalho	IDB	Senior Energy Specialist
Fernando Cubillos	IDB Invest	Head Energy - Principal Investment Officer
Marcelino Madrigal	IDB	Energy Division Chief
Rafael Cavazzoni	IDB	Financial Markets Lead Specialist
Chandrasekar Govindarajalu	WB IBRD	Lead Energy Specialist - Energy Climate Finance
Pierre Audinet	WB IBRD	Lead Energy Specialist
Megan Meyer	WB IBRD	Senior Energy Specialist
Carlos Antonio Costa	WB IBRD	Senior Energy Economist
Stephanie Gil	WB IBRD	Practice Manager for LAC in the Energy and Extractives Global Practice
Tendai Madenyika	WB IFC	Operations Officer
Diogo Falchano Bardal	WB IFC	Associate Operations Officer
Raquel Breda dos Santos	ME	General Coordinator of Global Development Institutions
Luiz Mauricio de Araujo Navarro	ME	Coordinator for Policies and Funds for Development Finance
Patricia Vieira da Costa	ME	Advisor for Policies and Funds for Development Finance
Flavio Daniel Baran	ME	Advisor for Policies and Funds for Development Finance
Claudia Girotti	ME	Advisor to the Special Secretary for Productivity and Competitiveness
Patricia Naccache M. da Costa	MME	Advisor to the Executive Secretary
Luís Badanhan	MME	General Coordinator of Environmental Sustainability of the Energy Sector
Daniela Nogueira	MCTI	General Coordinator of Project Modeling (Financial Structures)
Andrea Nunes	MCTI	Researcher
Felipe Sereno	MCTI	Technologist
Guilherme Arantes	BNDES	Electric Energy Sector Manager
Luciana Peixoto Gonçalves de Oliveira	ANEEL	Specialist in Regulation at the Superint. of Regulation of Generation Services
Rafael Costa Ribeiro	ANEEL	Specialist in Regulation at the Superint. of Regulation of Generation Services
Carmen Silvia Sanches	ANEEL	Deputy Superintendent of R&D and Energy Efficiency (Specialist in Regulation)
Fabio Stacke Silva	ANEEL	Specialist in Regulation at the Superintendence of R&D and Energy Efficiency
Lucas Dantas Xavier Ribeiro	ANEEL	Specialist in Regulation at the Superintendence of R&D and Energy Efficiency
Marcos Venicius Leite Vasconcelos	ANEEL	Specialist in Regulation of the Superint. of Regulation of Distribution Services

Carlos Marcel Ferreira da Silva	ANEEL	Specialist in Regulation - Superint. of Regulation of Distribution Services
Davi Rabelo Viana Leite	ANEEL	Specialist in Regulation – Superint. of Regulation of Distribution Services
Ailson de Souza Barbosa	ANEEL	Specialist in Regulation - Superint. of Regulation of Distribution Services
Aurélio Calheiros de Melo Junior	ANEEL	Deputy Head of the International Advisory
Jaiane Batista Alves Padilha	ANEEL	Administrative Support
Gustavo Pires da Ponte	EPE	Deputy Superintendent of Generation Planning
Mariana de Assis Espécie	EPE	Chief of Staff
Angela Barbosa Greenhalgh	ONS	Strategic Transformation Specialist
Elusa Moreira Barroso Brasil	ONS	Assistant to the Director General
Galdino Barros	CCEE	Advisor to the Presidency
Alessandra B. Coelho de Oliveira	BDMG	Senior Financial Analyst
Henrique Schmidt dos R. Lacerda	ABDE	Economic Studies Management
Roberto Luis Castro Thome	GIZ	Project Manager - Renewable Energies and Energy Efficiency - GIZ Brazil
Joisa Campanher Dutra Saraiva	CERI/FGV	Director
Roberto Brandão	GESEL/UFRJ	Senior Researcher
Genilson Pavão Almeida	CONFEA	Board member
Daniel Sobrinho	CONFEA	Board member
Everlin Kaori Akagi	CONFEA	Analyst
Monica Azevedo Lannes Ribeiro	CONFEA	Analyst
Camila Ramos (CELA)	ABSOLAR	Vice President of Finance
Elbia Gannoum	ABEEOLICA	Chief Executive Officer
André Themoteo	ABEEOLICA	Senior Technical Analyst
Carolina Kimura	ABEEOLICA	Technical Analyst
Mario Coelho	ABIOGAS	Director of International Affairs
Paulo Emílio de Miranda	ABH2/LabH2/COPPE/UFRJ	President
Gustavo Nunes	ABH2/LabH2/COPPE/UFRJ	Chief Financial Officer
Gabriel Lassery	ABH2/LabH2/COPPE/UFRJ	Executive Superintendent
Marina Domingues	ABH2/UFMG	Executive Secretary
Luiz Roberto Morgenstern Ferreira	APINE	Consultant
Mayra Santana	Thymos Energia	Head of Renewables and Regulatory Affairs
Giovanna de Lorenzi Canever	Thymos Energia	Regulatory Affairs Analyst

Table IV.3. Participants of the Joint Mission held on October 17, 2022

NAME	ORGANIZATION	POSITION
Gloria Visconti	IDB	Lead Climate Change Specialist
Carlos Echevarria	IDB	Regional Lead Energy Specialist
Michelle Carvalho	IDB	Senior Energy Specialist
Ricardo Goncalves	IDB	Consultant at the Climate Change and Sustainability Division
Fernando Cubillos	IDB Invest	Head Energy - Principal Investment Officer
Pierre Audinet	WB IBRD	Lead Energy Specialist
Carlos Antonio Costa	WB IBRD	Senior Energy Economist
Andrey Shlyakhtenko	WB IFC	Senior Operations Officer
Alexandre Messa Peixoto da Silva	ME/SEAE	Secretary
Henrique Cavalieri da Silva	ME/SEAE	Advisor to the Secretary
Cláudio A. de Arêa Leão Navarro	ME/SEAE	Planning and Budget Analyst
Emmanuelle L. de Oliveira Freitas	ME/SEAE	Foreign Trade Analyst
Claudinéia Raquel da Silva	ME/SEAE	Member of the SEAE Team
Raquel Breda dos Santos	ME/SEAE	General Coord. of Global Development Institutions
Patricia Vieira da Costa	ME/SEAE	Advisor
Flavio Daniel Baran	ME/SEAE	Advisor
Adalberto J. F. de Sousa Alencar	ME/SEAE	Advisor
Patricia Naccache Martins Da Costa	MME/SE	Advisor to the Executive Secretary
Laerte Gomes de Brito	MME/SE	General Coordinator of Energy Information
Gustavo Pires da Ponte	EPE	Deputy Superintendent of Generation Planning

The second consultation process happened during the Joint Mission held on March 2023, for which local development banks, experts in matters of gender and social inclusion, operators on and off the grid, potential promoters, and investors were invited. The participants of the different meetings held during this mission are listed in Tables IV.4 and IV.5.

Table IV.4. Participants of the Joint Mission held on March 8, 2023

NAME	ORGANIZATION
André Campos	Ministry of Finance
Thiago Longo	Ministry of Finance
Gustavo Luedemann	Ministry of Finance
Mariana Espécie	Ministry of Mines and Energy
Patricia Costa	Ministry of Mines and Energy
Karina Araujo	Ministry of Mines and Energy
Eduardo Soriano	Ministry of Science, Technology, and Innovation
Gloria Visconti	Inter-American Development Bank (IDB)
Carlos Echevarría	Inter-American Development Bank (IDB)

Eduardo Sierra	Inter-American Development Bank (IDB)
Katia Queiroz	Inter-American Development Bank (IDB)
Juan Roberto Paredes	Inter-American Development Bank (IDB)
Christiaan Gischler	Inter-American Development Bank (IDB)
Irati Jiménez	Inter-American Development Bank (IDB)
Eric Daza	Inter-American Development Bank (IDB)
Rafael Lima	Inter-American Development Bank (IDB)
Gisela Ferrari	Inter-American Development Bank (IDB)
Martha Carvalho	Inter-American Development Bank (IDB)
Ricardo Gonçalves	Inter-American Development Bank (IDB)
Ana Champloni	Inter-American Development Bank (IDB)
Fernando Cubillos	Inter-American Development Bank (IDB-Invest)
Silvana Bianco	Inter-American Development Bank (IDB-Invest)
Pierre Audinet	World Bank Group (IBRD)
Carlos Antonio Costa	World Bank Group (IBRD)
Guido Couto	World Bank Group (IBRD)
Michael Wilson	World Bank Group (IBRD)
Gustavo Vargas	World Bank Group (IFC)
Tendai Madenyika	World Bank Group (IFC)
Diogo Falchano	World Bank Group (IFC)
Amaro Pereira	Consultant
Marlon Huamani	Consultant
Giovanni Machado	EPE
Gustavo Pires da Ponte	EPE
Galdino Barros	CCEE
Elusa Moreira	ONS
Aurelio Calheiros	ANEEL
Waldenir Alexandre da Silva	ELETROBRAS
Mauricio Lisboa	CEPEL
Erika Borba	SPIC
Rafael Kelman	PSR
Mario Pereira	PSR
Tarso Vilela	INESC P&D Brasil
Fabio Micerino	Santo Antonio Energia
Mario Augusto Caetano	ITAIPU
Guilherme Arantes	BNDES
Claudia Noel	BNDES
Bruno Pena	BNB
Bruno Gabai	BNB
João Pereira	BNB
Sâmia Araujo	BNB
Henrique Vasconcelos	BB
Cristopher Braga	CAIXA
Milena Bauber	CAIXA
Igor Fonseca	SANTANDER
Marina Marquez	ITAU
Newton Hamatsu	FINEP

Table IV.5. Participants of the Joint Mission held on March 9, 2023

NAME	ORGANIZATION
André Campos	Ministry of Finance
Thiago Longo	Ministry of Finance
Gustavo Luedemann	Ministry of Finance
Mariana Espécie	Ministry of Mines and Energy
Patricia Costa	Ministry of Mines and Energy
Karina Araujo	Ministry of Mines and Energy
Eduardo Soriano	Ministry of Science, Technology and Innovation
Gloria Visconti	Inter-American Development Bank (IDB)
Carlos Echevarría	Inter-American Development Bank (IDB)
Eduardo Sierra	Inter-American Development Bank (IDB)
Katia Queiroz	Inter-American Development Bank (IDB)
Juan Roberto Paredes	Inter-American Development Bank (IDB)
Christiaan Gischler	Inter-American Development Bank (IDB)
Irati Jiménez	Inter-American Development Bank (IDB)
Eric Daza	Inter-American Development Bank (IDB)
Rafael Lima	Inter-American Development Bank (IDB)
Gisela Ferrari	Inter-American Development Bank (IDB)
Martha Carvalho	Inter-American Development Bank (IDB)
Ricardo Gonçalves	Inter-American Development Bank (IDB)
Ana Champloni	Inter-American Development Bank (IDB)
Fernando Cubillos	Inter-American Development Bank (IDB-Invest)
Silvana Bianco	Inter-American Development Bank (IDB-Invest)
Pierre Audinet	World Bank Group (IBRD)
Carlos Antonio Costa	World Bank Group (IBRD)
Guido Couto	World Bank Group (IBRD)
Michael Wilson	World Bank Group (IBRD)
Gustavo Vargas	World Bank Group (IFC)
Tendai Madenyika	World Bank Group (IFC)
Diogo Falchano	World Bank Group (IFC)
Giovanni Machado	EPE
Gustavo Pires da Ponte	EPE
Galdino Barros	CCEE
Elusa Moreira	ONS
Aurelio Calheiros	ANEEL
Renato Gribeiro	ISA CTEEP
Guilherme Gamaral	ISA CTEEP
Rafael Kelman	PSR
Mario Pereira	PSR
Gerardo Pontelo	ABRATE
Tiago Soares	ABRATE
Edson Watanabe	URFJ
Fernanda Rodrigues	ENEL
Vanderlei Martins	ENEL
Jefferson Scudeler	CPFL
Ricardo Gazolla	NEOENERGIA
Marco Aurelio Gianesini	CELESC
Julio Omori	COPEL
Djalma Falcao	UFRJ
Carlos Divino	GIZ

Luciano Schweizer	KfW
Camila Gramkow	CEPAL
Issei Akoi	JICA
Eiri Taniguchi	JICA
Luiza Lisboa	UK

Finally, the Investment Plan draft was published for comments on the MF`s website in May 2023, receiving comments from relevant stakeholders, associations, and the general public, which were considered for the final round of revision to which the document was subjected leading to this final presented version.

ANNEX V. Co-benefit development

The main co-benefits to be obtained from the development of projects to be financed under this IP have been identified to correspond to the following:

Policy and planning: Coherence between sectors

Improving the services provided by the public sector does not only involve hiring employees or investing in technology, but it is necessary to prioritize planning in public management, enabling the management of actions to be done according to the demands of the population. For example, making the electrical system cleaner and cleaner, therefore, the implementation of renewable sources or other technologies/techniques that allow this increase should be prioritized. In this context, in order to achieve the best results, working in coordination and cooperation with other development partners should be a priority, as should doing so with different national and territorial government agencies. Within the framework of this project, territorial entities are expected to receive support from the national government and entities that develop increasing capacities and experiences, in order to be able to replicate successful strategies throughout the country.

Energetic Transition: Social Inclusion and Distributive Impacts

The Program will consider activities for capacity building and relocation assistance to achieve co-benefits for specific projects to be supported. In this way, the replacement of jobs (for example, employees who previously read analog meters of the network being replaced by smart meters or even who performed disconnection and reconnection procedures of the service that started to be carried out remotely or even who delivered the electricity consumption invoices that started to be developed remotely, receiving training to perform O&M tasks in relation to the new infrastructure deployed) must always be sought as far as possible.

On the other hand, the training and hiring of women who can perform technical functions in the installation and maintenance of new infrastructure and new equipment, and provide support to consumers, must also be prioritized. This issue must also be a priority in the case of minority groups belonging to underserved communities for job opportunities related to installation and maintenance and services of deployed solutions or other tasks. As a relevant point, gender-balanced holdings in management and leadership positions should also be promoted to the extent possible.

In general, the implementation of AMI infrastructure must have as a fundamental objective to offer consumers the possibility of having, increasingly, a more active role in an increasingly inclusive and increasingly democratic electricity sector, along with the promotion of socioeconomic development activities. In this sense, the development of energy communities, which could occur through the implementation of smart meters, DER (DG and/or energy storage) and microgrids, should play a fundamental role, giving representation to consumers, facilitating their participation in the electricity market, and enabling the achievement of benefits for both the system and the consumers themselves.

Employment and livelihoods: jobs created - direct and indirect

Through the implementation of AMI infrastructure/smart meters, batteries, digital technologies, and clean hydrogen production facilities, among other possible activities to be financed, new temporary and long-term jobs are created, being an important parameter that must be evaluated, subsequently monitored and reported for projects to be financed/co-financed with CIF-REI resources. The rapid growth of VREs can become a significant source of jobs, having effects on the growth of the respective industries.

In recent years, wind energy in the country has been growing rapidly. IRENA[118] estimated that wind power installations between 2022 and 2026 and O&M over the life of the project would create about 115,000 full-time direct and indirect equivalent jobs in Brazil. In this context, the expansion of offshore wind energy in the country would have a significant impact. Wind power could not only increase employment in industry, agriculture, and construction, but also raise wages in all sectors of the economy, including trade and services[119]. In this context, Brazil could capitalize on its comparative advantage by harnessing the synergies between the offshore wind and oil and gas industries, supporting the energy transition, and accelerating the technological learning curve for decarbonization.

Also, considering that the greatest potential of renewable resources is found in the North and Northeast regions, less economically developed regions, the expansion of these resources can also offer new employment opportunities in those regions, thus improving the socioeconomic development indices of those regions. In addition, the greater penetration of distributed solar generation in Brazil can support the creation of local jobs, since specialized training for construction and O&M is required.

Reduction of Air Contamination

Industrial and electricity generation processes, in addition to motor vehicles, where there is the burning of diesel oil in mobile and static sources, are, among anthropogenic activities, the major causes of the introduction of polluting substances, such as GHG and Particulate Matter (PM), many of them toxic to human health and responsible for damage to flora and materials. The emission level of these substances will depend mainly on the the fuel quality and the combustion technology used. Often, the effects of poor air quality are not as visible when compared to other factors that are easier to identify. However, they can be related to respiratory and cardiovascular problems[120]. With the elimination or reduction of these sources of energy conversion from diesel oil or coal, this contamination can be eliminated or reduced, in order to contribute not only to the reduction of GHG emissions, as well as the decrease in the concentration of PM in the air, notably, causing a health problem, as highlighted above. Consequently, as renewable-based electricity generation begins to increase and replace fossil fuels, more so with the participation of GH2 and offshore wind power, fewer polluting sources should be used at SEB.

Brazil, a global leader in the decarbonization of the energy sector

Brazil has a unique alignment of conditions that can enable it to become a global leader in new clean energy technologies and that can decarbonize other energy sectors. In addition to deriving

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[118] Renewable Energy and Jobs Annual Review 2022.

[119] http://www.repec.eae.fea.usp.br/documentos/Goncalves_Rodrigues_Chagas_41WP.pdf.

[120] World Bank estimates indicate that the current value of human health benefits from reducing air pollution associated with a net-zero scenario by 2050 in Brazil would be approximately US$5 billion.

the benefits of decarbonization in terms of energy security, economic competitiveness and innovation leadership, the country also has a huge advantage in growing and opening new export markets for GH2, for example in terms of zero-carbon commodities such as green ammonia, green steel, and green ceramics. In addition, with a widely (or fully) decarbonized power grid, zero-carbon product certification will be essentially important, offering another competitive advantage compared to other major export economies.

ANNEX VI. Existing Renewable Energy Activities by Other Development Partners

In recent years, Brazil has received assistance and financial support from various agencies and cooperation institutions, to develop an adequate structure and deploy growing renewable energy capacities. Some of the entities that have contributed the most are presented, accompanied by a brief description of the activities they have developed or are currently developing in order to support each of the possible lines of investment that this IP intends to support.

WBG (World Bank Group): Providing technical assistance in several areas related to the energy transition, including:

- The World Bank is supporting two technical assistance in the area of H2, one at the federal and one at the state level, which aims to develop business models for the low carbon H2 market. Technical assistance at the federal level has two main focuses: (i) cover the 5th axis of PNH2 that seeks market growth and competitiveness, and (ii) develop a methodology for the certification of low carbon hydrogen. Technical assistance at the state level (initially dedicated to the Government of Ceará) focuses on the development of the Pecém GH2 hub, based on a technical-economic feasibility study of the hub's shared infrastructure and a mapping of governance for the shared infrastructure.
- Project development, in partnership with EPE, for the modernization of Hydropower plants in Brazil; two large and one small hydroelectric plant.
- Project catalyzing GH2 to support the energy transition:
    - Supporting the development of the GH2 HUB in Pecém (Ceará).
    - Shared infrastructure, solar DG, private capital mobilization.
    - Technical Assistance at the federal level to support the H2 National Plan.
- Utilities of the Future:
    - Preliminary engagement with power utilities to support: modernization, AMI, solar power, and transport electrification.
    - Target to increase the resilience, flexibility, and reliability of the system to support the expansion of renewable energy.
- Improving energy and water security:
    - Preliminary engagement with the Federal Government for modernization of hydroelectric assets.
    - Increase generation, efficiency, resilience, and flexibility to support the expansion of renewable energy without compromising water availability.
- Offshore Wind Energy:
    - Engagement of the MME to support the development of offshore wind resources.
    - Accelerate investment in the sector to reach the country's potential.
- Project META II. The main expected outcomes of the project are smart and strengthened climate institutions, more efficient markets, and more effective policies and regulations in the energy and mining sectors to increase resilience to climate events aggravated by climate change, accelerate the delivery of regulatory adjustments, planning, and support for infrastructure modernization. For the purpose of the project, climate resilience is defined as the ability to anticipate, prepare for, and respond to hydrological crises and/or dangerous events, trends or disturbances related to or exacerbated by climate change. For the purpose of the project, Market Efficiency is defined as the existence of market arrangements that are fit for purpose and incorporate all available information, providing agents throughout

the value chain with incentives to operate their systems economically, with an appropriate balance of risk and reward that is in the interest of the end consumer.

- Proactive Safe and Resilient Investment and Maintenance Program for Roads in Bahia.
- Bahia Sustainable Rural Development Project - Phase 2.
- Integrated Sustainable Mobility Project in the Foz do Rio Itajaí Region.
- Sustainable Landscapes Project of the Brazilian Amazon Phase 2.
- Transition to Electromobility in Brazilian Cities.
- CCDR study: CCDR study (*Country Climate and Development Reports*), with the objective of identifying political priorities to accelerate the decarbonization and resilience of the energy sector in order to achieve the commitment of zero net emissions (net zero) in the Brazilian economy.

GIZ (German Agency for International Cooperation): Providing technical assistance in several areas related to the energy transition, including:

- **Energy Systems of the Future**: This study was carried out within the framework of the German Cooperation for Sustainable Development, through GIZ, within the framework of the Energy Systems of the Future Program. On the Brazilian side, the Program has as coordinating political partner the MME, also counting on the participation of ANEEL, technical partner executing this study.
- **Agreement on German-Brazilian Cooperation for Sustainable Development**. Green Hydrogen Expansion, Project H2 Brasil - Green Hydrogen Expansion. This project is being developed through a partnership between GIZ and MME, whose financial volume is up to 34 million EUR. The objective of the project is to support the Brazilian Government in the implementation of large-scale energy storage technologies, advising decision makers, regulators, energy concessionaires and electricity grid operators on the evaluation of technical possibilities of use and energy storage options and the definition of the necessary and appropriate structures (GIZ, 2023; H2verdebrasil, 2023).
- **Agreement on German-Brazilian Cooperation for Sustainable Development**. Energy Storage, E2 Brasil Project – Energy Storage Technologies. This project is being developed through a partnership between GIZ and MME, whose financial volume is up to 5 million EUR. The goal of this project is to create the pre-requisites for the widespread use of energy storage technologies to improve grid stability and security in the electricity service in Brazil (GIZ, 2023a; MME, 2023).
- Providing technical assistance in several areas related to the energy transition, including, among others:
    - Green Hydrogen in Brazil (Tractebel).
    - Mapping of the Brazilian Hydrogen Sector - Current and Potential Scenario for GH2.
    - Analysis of the demand for training in Green Hydrogen Power at X.
    - Reference of International Strategies H2.
    - Regulatory and legislative reference
    - Evaluation of the national supply potential of the various components of the Green Hydrogen value chain in Brazil, focusing on the state of Ceará.

IDB and IDB Invest (Inter-American Development Bank Group): The IDB Group has supported the energy transition in Brazil through investment policies and operations, as well as technical assistance:

- Financing solar projects for the development of the free energy market with the contracting of dollarized *Power Purchase Agreements*: IDB Invest was a pioneer in the structuring of these projects, financing more than 3 billion BRL: 531 MW Mendubim Photovoltaic Solar Energy Project, 359 MW CasaBlanca Photovoltaic Solar Energy Project and 80 MW New Juazeiro Solar Project.

- Ebes Sistemas de Energia S.A. The project consists of the subscription of a senior and/or mezzanine quota of up to 40 million BRL including a Blended Finance participation through the UK Sustainable Infrastructure Program. The quotas will be issued by Green FIDC Órigo, a credit rights fund to be constituted in accordance with Brazilian laws and regulations. The fund is designed to disintermediate access to the Brazilian capital market for renewable energy projects - reducing the cost of capital and facilitating long-term financing. The fund will purchase the receivables from the long-term financing contracts for solar roofing systems originated by Órigo. IDB Invest will provide conditions that are not available from commercial sources to help Órigo develop a new product and business model to promote energy efficiency, finance access, and support capital market development in Brazil. The proposed project will be approved according to the following IDB Invest delegated facility: “Debt Capital Markets Program.” IDB Invest w framework that defines the selection, monito portfolio in line with the SDG defined under the United Nations Development Program so that the issue is catalogued as green.
- Energy Efficiency Guarantee Mechanism. Total project cost 26 million USD. The objective of the operation is to develop the energy efficiency investment financing market for buildings in Brazil and assist in the shift to a less carbon-intensive and more sustainable energy consumption trajectory in the country.
- Guarantees for solar and wind projects with the objective of developing the Brazilian capital market: IDB Invest provided more than 500M BRL in guarantees: 207 MW Santa Vitória do Palmar Wind Project 184 MW Pirapora Solar Project.
- *CELESC-D Energy Infrastructure Investment Program*. Investment program of 377 million USD (276 million IDB financing), which aims to meet the growth of electricity demand through the expansion and modernization of the CELESC-D distribution network, increase reliability and resilience and improve efficiency in the operation of the electricity system, and encourage greater gender participation in[121] CELESC-D.
- Support for Innovation in the Energy Sector - Rio Grande do Sul, Paraná, and Santa Catarina. Total project cost 325,000 USD. The objective of this technical cooperation is to support innovation in the electricity sector in the Brazilian states of Rio Grande do Sul, Paraná and Santa Catarina. The specific objectives are: (i) support the development and implementation of innovative solutions to improve the quality of energy supply and energy efficiency with the three concessionaires of these states (CEEE, CELESC and COPEL); (ii) support the evaluation and design of an electric vehicle corridor between the three states and with neighboring countries; (iii) support the coordination and exchange of experiences between the electricity concessionaires of these states and between concessionaires and innovation specialists.
- Support for the Development of Renewable DG and Energy Efficiency Projects in Brazilian Municipalities[122]. Total project cost 400,000 USD. The objective of this technical cooperation is to support the municipalities of Brazil to develop studies, tools and financing mechanisms for the implementation of DG and Energy Efficiency (EE) projects (including street lighting).

[121] For more information, see: https://www.iadb.org/en/project/BR-L1491.
[122] For more information, see: https://www.iadb.org/en/project/BR-T1539.

The specific objectives are: (i) to support the development of studies of DG and EE projects in Brazilian municipalities; and (ii) to support the development of financing tools and mechanisms for DG and EE in Brazilian states and municipalities. This project should support the implementation of the Global Credit Program (in preparation), which will have financing for EE, street lighting and DG at the municipal level.

- Support for the Diversification of the São Paulo Energy Matrix[123]. Total investment of 700,000 USD. The overall objective of this Technical Cooperation (TC) is to support the State of São Paulo to develop, implement and demonstrate sustainable energy measures in order to promote their implementation on a large scale. The specific objectives are: (i) to develop financial mechanisms to achieve the DG with solar energy and its large-scale implementation; (ii) to support the development and implementation of DG projects with solar energy in public buildings; (iii) to support both the development and implementation of electricity generation projects from solid waste; and (iv) to disseminate the results obtained for a potential replication of this type of projects. This TC is expected to contribute to the promotion of new DG public policies, reduce: public spending, CO_2 emissions, energy dependence and help diversify the state's energy matrix. It is important to highlight the potential for replication of measures and projects developed with this TC in other states and cities in Brazil.
- CEEE Generation and Transmission Project. Total investment cost 148 million USD. The objective of the operation is to expand, rehabilitate, and modernize CEEE-GT's generation and transmission infrastructure, in order to improve the reliability of the service that covers the metropolitan region of Porto Alegre in Rio Grande do Sul, to meet the growing demand for electricity demand and technologically update the infrastructure. The Investment Programme helped to ensure the construction of the necessary electrical infrastructure to support the increase in demand expected to peak during the 2014 World Cup.
- Loans for repowering/modernizing hydroelectric plants (HPP and SHP). Furnas HPP (1,216MW), Luiz Carlos Barreto de Carvalho HPP (1,050MW), Itaúba HPP (500.4MW), Passo Real HPP (158MW), Canastra HPP (44.8MW), Guarita SHP (1.76 MW), Ernestina SHP (4.96 MW), and Capigui SHP (4.47 MW)[124].
- Modernization of SEB, a project that mobilizes technical assistance to promote, mainly, DG, the digitalization and automation of transmission and distribution networks for the insertion of VRE, the production of low carbon hydrogen, and gender equity and diversity in SEB[125].
- Energy Transition Program – Brazil, through which a process was developed, with the participation of relevant actors from the public and private sectors, academia and civil society, in which 3 scenarios of Brazil's energy transition were developed to achieve carbon neutrality in the country by 2050[126].
- Development and consolidation of the Battery Energy Storage Systems (BESS) market in Brazil. This project aims to support the initial development of the BESS market in Brazil, helping in the proper identification and evaluation of BESS projects, providing initial demonstration at the micro, small and medium-sized companies and miniredes levels,

[123] For more information, see: https://www.iadb.org/en/project/BR-T1340.
[124] For more information, see: https://www.iadb.org/en/project/BR-L1278 and https://www.iadb.org/en/project/BR-L1303.
[125] For more information, see: https://www.iadb.org/en/project/BR-T1529.
[126] For more information, see: https://www.iadb.org/en/project/BR-T1432.

improving project regulation and identification, and supporting BNDES in project monitoring and evaluation[127].

- Development of hydroelectric storage in Latin America. Identification of Case Studies and Initial Project Analysis. The project aims to develop and apply a multi-criteria methodology to identify and select the sites with the greatest potential to develop reversible hydroelectric projects in Argentina, Brazil, Chile, Colombia, Panama, and Peru[128].
- Implementation of innovative technologies to improve the quality of distribution considering resilience to climate change, a project that aims to evaluate the feasibility for the implementation of innovative technologies in distribution networks in order to improve energy quality (frequency and duration of interruptions), and make electricity networks more resilient to climate change[129].
- Intelligent Power Management: A Tool for Reducing Inequality in Cities. This project aims to adapt and test a SEM (Smart Energy Manager) to be applied in energy management in municipal public buildings in Brazil that, with the use of Artificial Intelligence (AI), enables better management and generates savings for municipalities, in addition to establishing a viable commercial model for the sale of the service to the public sector[130].

KfW (KfW Development Bank):

- Project: Renewable Energy Investment Program. At the time of the project evaluation, the project involved the construction of four SHP in the state of Santa Catarina, in southern Brazil, with a total capacity of 53 MW. In the end, two SHP (water) were built with a total capacity of 34 MW, composed of dam, conduit/catchment tunnel, lock, powerhouse, transformer station/power plant and high voltage power plant line to transport the energy produced. The goal of the outcome-level project was to contribute to an efficient and reliable supply of energy from renewable (unconventional) energy sources that would be guaranteed in the long term. Thus, the project intended to contribute to the protection of the environment and climate by preventing carbon emissions (impact objective).
- Project: BNDES Wind Farm Program. This project consisted of financing wind farm installations through the state-funded bank BNDES, which lent the funds to private investors over long terms. It was part of the national renewable energy promotion program PROINFA and thus supported the Brazilian government's efforts to give greater importance to the generation of energy from alternative energy sources to meet the growing demand for energy. Counterpart contributions from final borrowers and BNDES totaled around 113 million EUR. German contribution consisted of a development loan at low interest rates in the amount of 97.3 million EUR.
- Modern Transportation Systems for Brazilian Cities. Under the banner of climate protection, the two major development banks KfW and BNDES have signed a contract to finance modern transportation systems in Brazilian cities. The 265 million USD loan agreement, signed on the sidelines of consultations with the German-Brazilian government, aims to improve municipal public transport systems and protect the environment in Brazil.
- On behalf of the German federal government, KfW is also helping to ensure that tropical forests are used sustainably, thereby helping to preserve biodiversity. For the residents and small farmers who live there, new sales markets are opened for their products, such as açaí,

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127 For more information, see: https://www.iadb.org/en/project/BR-T1497.
128 For more information, see: https://www.iadb.org/en/project/RG-T4126.
129 For more information, see: https://www.iadb.org/en/project/BR-T1422.
130 For more information, see: https://www.iadb.org/en/project/BR-T1431.

pirarucu, Brazil nuts and various ingredients for natural cosmetics. Digital tracking systems and transparent biological labels will be introduced for selected forest products.

- The Brazilian development bank BNDES will be supported with a donation of 25 million euros for the establishment and implementation of an innovative guaranteed fund for loans to small and medium-sized companies that invest in energy efficiency. In this way, a large amount of private sector investments can likely be mobilized for energy saving projects. In addition to meeting climate protection targets, these investments also contribute to securing jobs and income for small and medium businesses.
- KfW is also financing the sustainable disposal of wastewater in several metropolitan regions, such as Belo Horizonte, Curitiba, and Salvador, which will benefit about three million people. This will help keep rivers cleaner, conserve scarce water resources and prevent disease. Brazil's emerging economy will only be able to tap its enormous potential in the long term if cities develop sustainably.

International Finance Corporation (IFC)*:*

- IFC, with BNDES and IDB signed an agreement to create a program that aims to allocate financial and technical resources to the structuring and modeling of infrastructure projects in the form of public concessions and Public Private Partnerships (PPP) in Brazil. The initial contribution is 3.9 million USD, which can reach up to 11.99 million USD.
- Loans to projects of Brazilian companies to take advantage of the emerging opportunities in sustainable development in the country.
- Fighting Greenwashing, one of the projects financed was for the state sanitation company of Rio Grande do Sul, Corsan, with a focus on reducing water loss, in IFC's first infrastructure financing linked to sustainability metrics in Latin America.
- In 2021, the institution conducted investments in the country of 2.85 billion USD, which represented 30% more than expected. This places Brazil as the fourth largest IFC portfolio in the world.
- Loan of 100 million USD to Banco ABC Brasil for credit lines for sustainable projects in the areas of energy and agriculture.

ANNEX VII. Energy Storage

There are several storage technologies, which have varying levels of maturity and ability to provide multiple services[131] (see Figure VII.I and Figure VII.2). Different applications and technologies can be mapped according to their main characteristics: power capacity and discharge duration. However, not all storage technologies will be able to provide all the services required by the system. For example, pumped hydro and hydrogen may be suitable for long-term storage (hours to weeks) and batteries used for applications that require both long-term and short-term storage (minutes to hours). These applications can range from self-establishment to arbitration in generation or reduction in energy costs to improvement in energy quality and consumption.

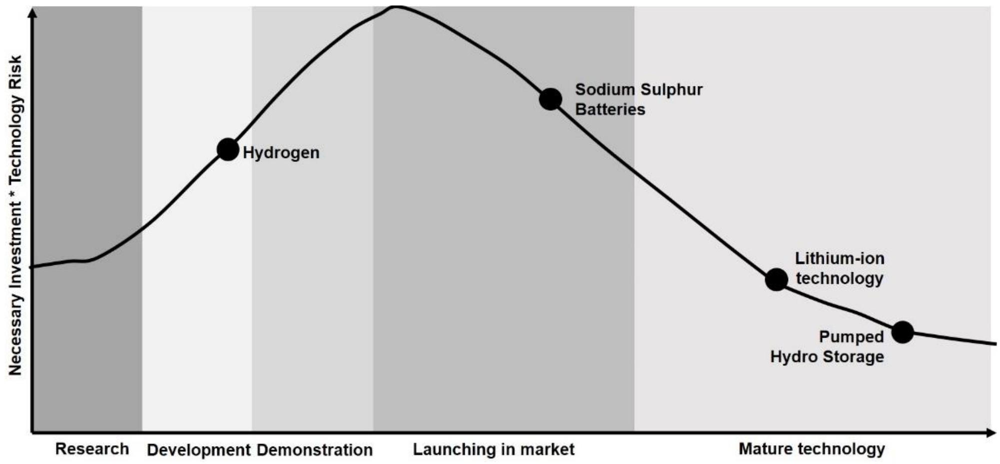

Figure VII.1. Maturity Level of Energy Storage Technologies
Source: Adapted from Nordling, et. al., 2016

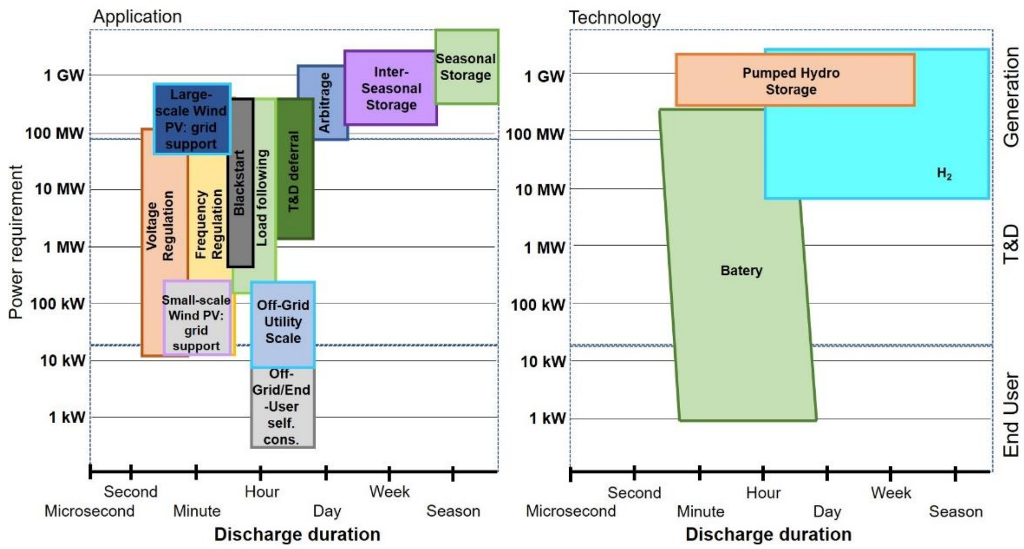

Figure VII.2. Applications and Technologies of Energy Storage. Source: Adapted from IEA, 2014

Although there are different technologies competing with each other, each with the prospect of a future price fall, the bets of most research institutions in the sector fall on Lithium-ion batteries (Brinsmead, et. al., 2015). The expectations for this technology are mainly due to the projection in the reduction in costs, social and environmental requirements, technological advances,

[131] However, the principle of technological neutrality should also be highlighted here, in order not to favor or harm a given technology.

expectations regarding its insertion in the global transport matrix (use in electric vehicles[132]) and its uses in electronic equipment, which can make this technology become increasingly viable for use in applications in the electricity sector (BNEF, 2017; EPE, 2019d; SEPA, 2018).

Alternatives such as hydrogen, batteries, and hydraulic pumping, as energy carriers and facilitators for the increase of VRE, are in stages of development. Among these three technologies, renewable hydrogen (GH2[133]) is considered to be a driver of the decarbonization of sectors that are difficult to reduce emissions (for example, transport and industries such as steel, cement or cellulose) and as a connection between the electricity, transport and industrial markets.

The potential benefits of greater insertion of storage technologies can be evaluated from three points of view: technical-economic (systemic benefits in electricity and energy operation), environmental (impact of GHG emissions) and social (impact on job and income generation). In this last question, the study developed by (Correia, et. al., 2021) stands out, which indicates that the implementation of 1 MW of Battery Energy Storage System (BESS) has the potential to generate about 15.75 direct and indirect job vacancies.

Specifically, regarding hydraulic pumping[134], the issue is even more complex, since this type of storage technologies requires certain geographic conditions suitable for their implementation, for example, greater unevenness between reservoirs and better distance ratio between reservoirs/associated unevenness. Therefore, it is necessary to develop potential studies for the implementation of hydraulic pumping (EPE, 2019c).

With respect to H2, since this energy vector is still in the early stages of development, investment costs and risks are relatively high. The process (Haber-Bosch) has been around for a long time and is well established. Uncertainties are more related to the electrolyzer (cost and economic useful life) and whether there is sufficient demand market (internal or external). Due to the great potential that the country has, there are several technological routes that it can develop[135]: ethanol, hydro, wind, solar, biomethane, and natural gas, in addition to natural or geological hydrogen[136]. Brazil has the potential to be an important player worldwide in GH2, however it maintains a technological neutrality, since other forms of hydrogen production are also important. Compared to batteries (such as lead or lithium-ion acid), GH2 allows storing energy for a longer period of time, and can be used to control seasonal variations and thus facilitate a greater participation of VRE (Guerra et. al., 2020).

It is estimated that Brazil has highly competitive production costs for blue and green hydrogen. In the case of blue hydrogen, this is driven largely by its high existing offshore gas reserves in São Paulo and Rio de Janeiro, in the southeast of the country, pipeline infrastructure and potential for Carbon Capture, Utilization and Storage (CCUS). In the case of GH2, it is driven by

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132 Due to their greatly reduced cost and satisfactory remaining service life, Lithium-ion batteries from electric vehicles could be reused in applications in the electricity sector, where charge density and reliability are not critical factors as in electric vehicles.

133 Currently, investments in GH2 in the country already exceed 22 billion USD, concentrated in the ports of Pecém (Ceará), Suape (Pernambuco) and Açu (Rio de Janeiro) (EPBR, 2022).

134 In Brazil, the predominance of HPPs made it difficult to implement the PSH.

135 Depending on the input used for H2 production, it can be called: Gray-H2C (when using natural gas), Green-GH2 (when using photovoltaic solar energy), among others. Each of which has different production costs. In a research developed by EPE, the production costs of H2C ranged from 1.02 to 3.36 USD/kg, for plants with a capacity of 20 and 1000 t H2/day and natural gas prices between 4 and 12 USD/MMBtu. The cost of H2T production ranges from 2.20 to 2.60 USD/kg, considering the natural gas price of 6 USD/MMBtu.

136 Of relevant potential in the states of Ceará, Goiás, Roraima, Minas Gerais, and Bahia.

its high penetration of renewable energy (driven by hydropower), abundant onshore wind and solar resources, and the anticipated potential for abundant and low-cost offshore wind production, particularly in the Northeast region. CNPE identified hydrogen as one of the priority topics for R&D, and Brazil released its National Hydrogen Program (PNH2) in July 2021.

PNH2 seeks to contribute to the sustainable development of the country, through increased competitiveness and the participation of H2 in the Brazilian energy matrix, considering its economic, social, and environmental importance. To this end, PNH2 proposes to define a set of actions that facilitate the development of H2, based on three pillars: public policies, technology and market, which need to evolve synchronously to promote an acceleration in the achievement of expected results. Within this context, PNH2 structures six axes with the objective of promoting communication with society and interested agents, which are: strengthening the scientific-technological bases; training of human resources; energy planning; legal-regulatory framework; opening and growth of the market and competitiveness and international cooperation (MME, 2021).

These characteristics have attracted several international companies and startups[137]. Some are already operating in the market, while others with an interest in developing activities in the country, especially in low carbon H2, which can be relevant partners in overcoming barriers. In addition, other important partners for the development of the H2 value chain may be the various governmental institutions,[138] national and international associations, universities,[139] national and international research centers, among others.

137 Hytron, Electrocell, Ergostech, Unitech, and Novocell.

138 Example: International Association for Hydrogen Energy (IAHE), Brazilian Hydrogen Association (ABH2).

139 Advanced Energy Technology Institute (CNR-ITAE, Italy), Itaipu Technological Park Foundation (PTI), Fuel Cell and Hydrogen Research Center of the Institute of Energy and Nuclear Research - IPEN (USP), Hydrogen Laboratory (LABH2) of Coppe/UFRJ, among others.

ANNEX VIII. Regulation/Laws supporting VRE integration

Some issued regulations that have contributed to the promotion and penetration of VRE are shown in Table VIII.1:

Table VIII.1. Regulation for grid-connected photovoltaic systems

Regulation	Description
ABNT NBR IEC 62116:2012	Anti-islanding test procedure for grid-connected photovoltaic system inverters
ABNT NBR 16149:2013	Photovoltaic (PV) Systems – Characteristics of the connection interface with the electrical distribution network
ABNT NBR 16150:2013	Photovoltaic (PV) Systems - Characteristics of the connection interface with the electrical distribution network - Compliance test procedure
ABNT NBR 16274:2014	Minimum requirements for documentation, commissioning tests, inspection, and performance assessment of grid-connected photovoltaic systems

Some Strategic R&D that have contributed to the promotion and penetration of VRE are presented in Table VIII.2:

Table VIII.2. Strategic R&D to promote VRE integration in Brazil

Strategic R&D	Description
R&D No. 011/2010	Smart Grids Program. It aims to carry out the technological migration of the current state of SEB, for the full adoption of the concept of Intelligent Grids in the country
R&D No. 013/2011	Proposal for technical and commercial arrangements for the electricity generation project through photovoltaic solar technology, in an integrated and sustainable way, seeking to create conditions for the development of a technological base, and technical and technological infrastructure for the insertion of photovoltaic solar generation in the national energy matrix scenario
R&D No. 017/2013	Incentive to the national technological development of the production chain of the wind energy industry, with a focus on stimulating the reduction of equipment and component costs, professional, and technological training, regulatory improvement and optimization of energy resources
R&D No. 001/2016	Energy Efficiency and Mini-Generation in Public Institutions of Higher Education. It aims to reduce the obstacles to the implementation of energy efficiency and self-generation projects (mini-generation) through the implementation of pilot projects in public institutions of higher education. 27 proposals were submitted from 15 companies, totaling 310 million BRL in investments, benefiting 30 public institutions of higher education in the country
R&D No. 021/2016	Technical and Commercial Arrangements for Insertion of Energy Storage Systems in SEB. This R&D is part of a strategic plan to increase the share of renewable energy in the electricity

	sector. It started in 2016, with 23 projects approved, costing 71.6 million USD. The proposed projects had an expected duration of 24 to 48 months

Some edited laws that have contributed to the promotion and penetration of VRE are presented in Table VIII.3:

Table VIII.3. Some laws to support VRE integration in Brazil

Law	Description
Program to Encourage Alternative Sources of Electricity (PROINFA)	Created by Law No. 10.438/2002 and regulated by Decree No. 5.025/2004. One of the first programs in renewable sources, which stimulated the implementation, mainly, of small hydroelectric plants, wind and biomass in the electricity sector. PROINFA had two phases. In the first, special credit lines with interest rates subsidized by BNDES were made available, with Eletrobras buying energy with a feed-in rate, in 20-year contracts. In the second, adapted to the new regulatory model of the electricity sector, adopting the bidding regime. Subsequently, Decree No. 6.048/2007 regulated the auctions of alternative sources, as a way of continuing the objectives of PROINFA
Decree-Law No. 5.163/2004	Regulates DG and establishes how electricity can be marketed, as well as the process of granting authorizations and concessions for electricity generation
Law no. 11.484/2007	Support Program for the Technological Development of the Semiconductor Industry (PADIS) - federal tax incentives that apply to the installation and operation of renewable sources
Law No. 11.4882007	Special Infrastructure Development Incentive Scheme (REIDI) - federal tax incentives that apply to the installation and operation of renewable sources
ICMS Agreement No. 16/2015 (Confaz) and ICMS Agreement No. 10/2014 (Confaz)	State tax exemptions from ICMS to encourage the injection of energy into the grid and for the acquisition of components for solar and wind energy operation
DG Electricity Development Program (ProGD)	Implemented by the MME at the end of 2015, with the objective of expanding the DG based on renewable sources and cogeneration in public, commercial, industrial and residential buildings. The program covers large, medium and small DGs; with expected investments of 100 billion BRL and adherence of 2.7 million consumer units by 2030
RN ANEEL No. 733/2016	White Tariff. A tariff option for consumer units served at low voltage (127, 220, 380 or 440 Volts), called group B. Consumers of the classes can join the White Tariff: Residential (subgroup B1); Rural (subgroup B2) and Industrial, Trade, Services and other activities, Public Service, Public Power and Own Consumption (subgroup B3). Unlike the Conventional modality, which has a single tariff value, the White Tariff has differentiated values throughout the day: Peak (highest rate); Intermediate (intermediate rate) and Off-peak (lowest rate). On weekends and national holidays, the value is always the off-peak rate

RN ANEEL No. 482/2012	Allows the installation of DG in different places from the point of consumption, being able to use it in the place of generation or other units previously registered within the same concession area and characterized as remote self-consumption, shared generation, or part of projects with multiple consumer units (condominiums). This shift option opens up opportunities for differentiated business models for DG deployment
Law no. 13.203/2015	Creates the Specific Reference Value, which enabled the contracting of cargo of generation projects distributed by the distributors
Art. 5 of Law no. 13.203/2015	BNDES, when granting financing, may allocate resources at different rates for the installation of electricity generation systems from renewable sources and energy efficiency in hospitals and public schools
Law no. 13.169/2015	Exemption from PIS/PASEP and COFINS on energy injected by the consumer into the electricity grid and subsequently compensated
Ordinance No. 643/2017 of the Ministry of Cities	Mandatory inclusion of energy generation systems in the housing units of the Minha Casa, Minha Vida Program
MME Ordinance No. 65/2018	Established the Specific Annual Reference Values (Rues) regulating the provisions of art. 2-B of Law 10.848/2004 with art. 15 of Decree 5.163/2004, which allows energy distribution agents to contract up to 10% of their DG project load, provided that it is preceded by a public call promoted directly by the distribution agent
FINAME, FINEM, INOVA ENERGIA	Special financing lines for installation of equipment from renewable sources established by public financial institutions, such as Caixa Econômica Federal, BNDES, and BNB

ANNEX IX. Impact and results of IDBG`s intervention

The proposed IDBG´s intervention aims to implement a series of actions that promote GHG emissions reduction by facilitating the deployment of Variable Renewable Energy (VRE), like solar and wind. Integrating VRE, including solar and wind energy, into the existing Brazilian´s Electrical System (Sistema Elétrico Brasileiro -SEB-) presents operational challenges that require investments to accommodate a more significant share of VRE, and enhance the efficiency and resilience of the system.

One of the primary challenges associated with operating a electrical system with a high penetration of VRE is managing the variability of power generation. To effectively tackle these challenges, it is imperative to invest in technologies and strategies that enhance the flexibility and adaptability of the system, reducing its vulnerability.

Therefore, the IDBG´s intervention emphasizes the significance of investing in technologies that allow to boost the inception of VRE sources accelerating the energy transition and the decarbonization process of the Brazilian´s economy. Key components of this intervention include the modernization/repowering/automatization of Hydropower power plants (HPP), the digitalization and modernization of the transmission and distribution networks, and the adoption of new technologies and energy storage systems. These elements play a crucial role in driving the energy sector's transformation towards a more sustainable future.

The modernization and digitalization/repowering of the HPP, which allows the increase of the installed capacity of the plants, is a good opportunity for VRE. HPPs play a crucial role in electrical systems with a high penetration of VRE due to their dispatchable generation and operational flexibility. They provide quick responses to fluctuations in the generation-demand balance, offering valuable services to the system. These HPP contribute to inertia, support frequency control, supply-demand, and ensure the operational stability necessary for the successful integration of VRE.

Modernizing the transmission and distribution system is crucial to address the challenges posed by increasing demand and the integration of intermittent renewable energy sources. By incorporating advanced technologies such as smart grids, power electronic equipment, and real-time monitoring systems, the management of the electrical grid becomes more efficient. This results in reduced energy losses during transmission and distribution and facilitates the seamless integration of VRE. Digitalization plays a pivotal role in optimizing the electrical system. Through digital solutions such as real-time monitoring, remote control, and accurate demand forecasting, the operation of the grid becomes more efficient. This enables rapid fault detection, and agile responses to unforeseen events, and contributes to the stability and reliability of the system.

Another strategic area considered in the IDBG´s intervention is energy storage solutions, particularly batteries, which are an additional key topic to facilitate the integration of VRE in the electrical systems. Batteries play a crucial role in storing energy generated during low-demand periods for later use. This enhances the flexibility of the electrical system and reduces reliance on non-renewable sources.

IDBG's intervention includes actions that improve the operational aspects of the system and generate new opportunities to a greater integration of VRE. The impact of this intervention was estimated considering some hypothesis and assumptions in the process of implementation of the transformational activities contemplated in the different strategic areas of action proposed until the year 2030. The impact was measured through the estimation of total GHG emissions mitigated/avoided through the integration of VRE energy generation, taking into account the following factors:

(i) The calculation of GHG emissions mitigated/avoided considers the emission factor of the National Interconnected System (NIS) in 2022: 0.3406 [tCO2eq/MWh].

(ii) A centralized wind and solar capacity factor of 37% was utilized to estimate the generation of centralized VRE added.

(iii) A distributed solar capacity factor of 15% was used to assess the generation of distributed VRE.

(iv) The IDBG´s intervention includes the modernization/repowering/automatization of 4.9 GW of hydropower plants, resulting in the expansion of 1 MW of VRE for each 1 MW of HPP modernized.

(v) The efficiency of HPP will be increased by modernizing 8 GW, leading to an expansion of 0.5 MW of VRE for each 1 MW of HPP modernized.

(vi) Two batteries with a capacity of 30 MW each are estimated to be installed in the Basic Network (BN), resulting in 1 MW of VRE for each 1 MW of installed batteries.

(vii) Pumped Storage Hydropower (PSH) is expected to enter the system starting in 2030, with each 1 MW of installed PSH resulting in an additional 1 MW of VRE integrated. 674 MW installed capacity.

(viii) The intervention aims to insert a percentual[140] of 704 MW of photovoltaic distributed generation (GD) in the Southern States by 2030.

(ix) The IDBG´s intervention estimates the insertion percentual[141] of 2,475 MW of GD in the Northeastern States by 2030.

(x) A reduction of 60% in GHG emissions in SISOL by the year 2030, is estimated based on the investments to be mobilized and implemented through the IP.

(xi) The lifetime of wind and solar projects is estimated in 20 years.

The following table outlines the implementation progress schedule considers for the IDBG´s intervention impacts and results. It is important to understand that the schedule presented is cumulative, indicating, for instance, that by 2030, 50% of the total gigawatts (GW) of HPP to be modernized will have been achieved.

Table IX.1. IDBG´s Intervention Implementation Progress Schedule

	2023	2024	2025	2026	2027	2028	2029	2030
Repowering/Modernization and digitalization of HPP	0%	0%	5%	10%	15%	25%	35%	50%
Storage technologies (batteries)	0%	0%	0%	0%	50%	100%	100%	100%
Storage technologies (PSH)	0%	0%	0%	0%	0%	0%	0%	5%
DG capacity installed (Southern State)	50%	100%	100%	100%	100%	100%	100%	100%
DG capacity installed (Northeastern States)	0%	0%	10%	20%	30%	40%	50%	60%

140 See IDBG´s Intervention Implementation Progress Schedule.

141 See IDBG´s Intervention Implementation Progress Schedule.

Table IX.2. IDBG´s Intervention Results.

Results from 2023 to 2030	Repowering/Modernization and digitalization of HPP	T&D Modernization and Digitalization	Storage technologies [UHR + Batteries]	Total
Additional FRV by 2030 [MW]	3,674	774	94	4,541
FRV Generation by 2030 [MWh]	36,629,126	3,122,984	802,326	40,554,435
Total Avoided Emissions by 2030 [MtCO2eq]	12.5	3.5	0.3	16.3

The above values are indicative and could be higher based on the IDBG´s intervention performance.

The investments estimate and the allocation across strategic focus areas are the outcomes of extensive sector research and data collection. Herein, we present a summary of the investments as projected by the sector studies to determine the share among the IDBG's strategic focus areas of intervention.

Table IX.3. Investments by each strategic focus area.

Operation areas	Investment (USD M/yr)	Investment (%)
Repowering/Modernization and digitalization of HPP	360.4	30.6
T&D Modernization and Digitalization	947.2	59.7
Storage Technologies	142.5	9.7
Total	1,178.0	100.0

The IDB Group's intervention estimates the mobilization of about 1 billion USD, considering the CIF-REI concessional resources, and the mobilization of IDBG, and third-parties´s financial sources (mainly other development and commercial Banks, and private sector investors). It has been estimated that the resources allocated for the IDBG´s intervention will be distributed as follows: 209.2 million USD for HPP modernization and digitalization, 785.31 million USD for modernization and digitalization of transmission and distribution networks, and 66.3 million USD for the integration to the SEB of storage technologies.

ANNEX X. GHG emission reduction potential of the intervention proposed by the WBG

GH2 is seen internationally as a crucial technology for the global energy transition and, therefore, for the fulfillment of the national net-zero commitments and of the Paris Agreement temperature target. This is because, being a clean, flexible, and transportable energy vector, it can be used in numerous ways as a substitute for GHG-emitting fossil fuels. Therefore, whether in the electricity, industrial, transport or agricultural sector, the use of clean hydrogen can play a key role in mitigating GHG emissions.

The mitigation potential realized by each GH2 production project, however, will depend on its end use, in particular which energy source it will replace. Fuels derived from clean hydrogen used in electricity production, for example, may be replacing natural gas, mineral coal, fuel oil, among others. The one used to produce green steel will potentially replace coal, while the one used for activities such as long-distance navigation will potentially replace bunker fuels. Each of these alternatives generates a particular baseline and, as a result, a different level of emissions mitigation from the use of GH2. In addition, the technological routes used themselves affect the levels of efficiency and carbon intensity of the sources, which also affects the mitigation carried out.

Finally, the duality of geographic destinations for the use of GH2 – domestic use vs export – is also key to determining the effective national mitigation potential. Although from a climate point of view it does not matter in which country the mitigation of emissions is done and, therefore, the role of GH2 in the process of mitigating global climate change is similar, from a perspective of seeking to fulfill the international commitments assumed by the country, notably the NDC, this aspect is crucial.

It appears, therefore, that the process of estimating the mitigation of emissions to be carried out by GH2 projects is complex and strongly depends on the hypotheses made about the sources of demand for the product. Therefore, it is common practice to establish some scenarios to anchor the orders of magnitude associated with the mitigation of emissions derived from the application of GH2.

In the present case, the resources of the CIPP would be leveraging resources to make the ambitious plan for the development of GH2 chains in the CIPP a reality. Using only the pre-contracts already signed in the CIPP, and being conservative in our estimations, an installed capacity of 2,65 GW of electrolyzers for GH2 production is expected as early as 2030, with a resulting production of more than 330,000 tons per year from 2030.

With these projected values, it is possible to perform some hypothetical exercises to infer the resulting emission reduction. For example, in the extreme case where all the GH2 produced would be used for energy production replacing coal-fired generation, annual emissions mitigation would reach about 15.6 $MtCO_{2eq}$ in 2030.[142] In case of gas generation substitution, such value would be about 7.2 $MtCO_{2eq}$. If all the GH2 produced were used to produce green steel, between 8.3 and 13.2 $MtCO_{2eq}$ would be mitigated in 2030[143]. If all the projected hydrogen

142 Considering emissions mitigation parameters estimated by (IEA, 2022), using nuclear as a proxy for capacity factor reasons.

143 Considering emissions intensity of coal-fired steel between 1.5 and 2 tCO2e/ton and between 50 and 60 kg of hydrogen per ton of steel.

production in the CIPP were destined for fertilizer production (urea, for example), the annual emissions reduction would be about 3.3 $MtCO_{2eq}$ in 2030.[144]

If we consider, for example, a hypothetical scenario where: 50% of the GH2 production resulting from the project is consumed domestically, with 10% for energy generation to replace coal, 10% for fertilizer production and 30% for green steel production, we would have a potential annual reduction in domestic emissions between 4.4 and 5.9 $MtCO_{2eq}$ in 2030. In addition, there would be emissions reductions globally by exporting 50% of the hydrogen produced, which would depend on the destination and end use of such a product.

The previous examples illustrate the orders of magnitude associated with the GHG mitigation potential of GH2. Are added to this the potential gains of adaptation to climate change that such an energy vector presents, by providing flexibility the electrical system.

[144] Considering the emissions avoided in urea production estimated in (Nallapaneni & Sood, 2022), considering the differences between SMR and water electrolysis processes.

ANNEX XI. Stakeholders Consultations on Gender and Social Inclusion Issues

During the IP preparation, consultations with stakeholders from the public and private sector and representatives from the civil society were carried out to understand existing gender barriers as well as opportunities in the Brazilian context particularly in the energy sector. During the IP implementation, additional possibilities for actively including women and diverse populations will be considered- depending on the areas of intervention - in line with the Government of Brazil's pr inclusion, and following the MDB gender equ gender policies, strategies, and gender action Gender Action Plan.

During April 2023, virtual interviews were conducted with members from the Government of Brazil, the private sector, and representatives from Civil Society Organizations (CSOs), including leaders, Gender, Race and Diversity Committee coordinators, human resources managers, researchers, consultants, engineers and businesswomen from the energy sector in Brazil. Interviews were based on the following questions:

- What are the barriers that women may differentially face in benefitting from projects that this IP will support? How can these barriers be addressed?
- What opportunities women have to benefit from these projects?
- With what activities and strategies can CIF-REI funds promote gender equality and social inclusion and the women`s economic empowerment?

Table XI.1. List of organizations and persons consulted through virtual meetings and interviews.

#	GOVERNMENT/ PUBLIC SECTOR	DESCRIPTION	CONTACT PERSON	DESIGNATION
1	SETEC/MEC	Secretariat of Professional and Technological Education of the Ministry of Education.	Marco Antônio Juliatto	Special Advisor to the Innovation Policy Structuring Center and Coordinator of the EnergIF Program - Program for Development in Renewable Energies and Energy Efficiency in Federal Education Institutions.
2	MME	The Ministry of Mines and Energy (MME) of Brazil aims to formulate and adopt policies aimed at the sustainable use of mineral and energy resources to contribute to the economic and social development of the country. MME has four Secretariats that propose guidelines and implement national policies in their areas of operation: (i) the Secretariat for petroleum, natural gas and biofuels, (ii) the Secretariat for geology, mining and mineral transformation (iii) the Secretariat for electric power, and (iv) the Secretariat for energy planning and development.	Márcia Figueiredo	General Coordinator of the Gender, Race and Diversity Committee of MME and Related Entities.
			Samira Sousa	General Coordinator for Energy Efficiency

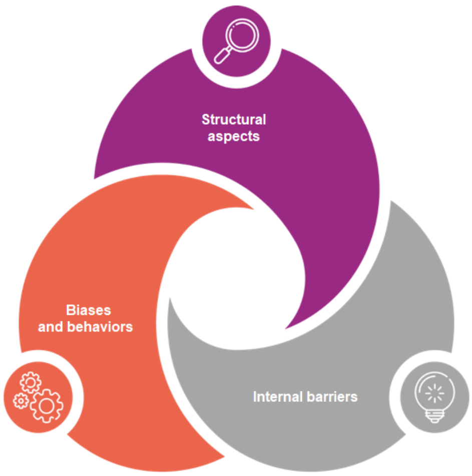
3	EPE	The purpose of Empresa de Pesquisa Energética - EPE (Energy Research Company) is to provide services to the MME in the area of studies and research to support the planning of the energy sector, covering electricity, oil and natural gas their derivatives, and biofuels. It is a federal public company, dependent on the federal budget.	Ângela Livino	Corporate Management Director.
	ASSOCIATION	**DESCRIPTION**	**CONTACT PERSON**	**DESIGNATION**
4	ABEEólica	The Brazilian Wind Energy Association (ABEEolica) is a non-profit institution that brings together and represents the wind energy industry in the country, including companies from the entire production chain. Since its foundation, it has contributed effectively to the development and recognition of wind energy as a clean, renewable, low environmental impact, competitive and strategic source for the composition of the national energy matrix.	Elbia Gannoum	President of ABEEolica
5	ABiogás	The Brazilian Biogas Association (ABiogás) is the interlocutor channel between the biogas sector and civil society, the Federal and State Governments, and agencies responsible for the Brazilian energy planning. ABiogás aims to transform the electric, fuel and thermal energy generated by biogas into widely used energy commodities, with a 10% share in the Brazilian energy matrix.	Tamar Roitman	Executive Manager
	CONSULTING	**DESCRIPTION**	**CONTACT PERSON**	**DESIGNATION**
6	Finergreen	Finergreen is a financial advisory boutique for renewables, focused on energy transition and sustainable development. Founded in 2013, the company has completed over 170 transactions. The company provides a full range of financial services including project finance, strategic advisory, offtake advisory and support on mergers and acquisitions.	Vladimir Olarte Cadavid	Managing Partner
7	Machado Meyer	Machado Meyer The purpose is to provide legal intelligence that leverages opportunities and helps preserve and create value for business. It provides consultancy, administrative, and judicial advice in energy.	Ana Karina Souza	Executive Manager
	ENERGY GENERATOR	**DESCRIPTION**	**CONTACT PERSON**	**DESIGNATION**

8	Auren	Auren Energia is one of the largest companies for the generation and commercialization of renewable energy in Brazil. The company operates with a clean and diversified matrix of assets located in different regions and has one of the largest installed capacities in the country (3.1GW).	Mario Bertocini	Vice President of Finance & New Business
			Kamila de Marchi Sugano	Senior Human Resources and Diversity & Inclusion Manager
9	Lightsourcebp	Lightsourcebp is a global leader in the development and management of solar energy projects. It provides sustainable and affordable energy to businesses and communities across Brazil, integrating in-house development, asset finance and operational management to optimize competitiveness and capture maximum value throughout each clean energy project lifecycle	Maíra Galuzio Barile	Financial Controller
10	Santo Antônio Energia	Energy trading company.	Solange David	Counselor for the Santo Antônio Energia hydroelectric plant.
	TRADING COMPANY	**DESCRIPTION**	**CONTACT PERSON**	**DESIGNATION**
11	Comerc	The Comerc Energia Group was created in 2001, two years after the effective start of the free energy market in Brazil. Initially focused as a leader in the commercialization of electricity, the company contributed to the development of a culture of freedom among Brazilian consumers in the choice of their electricity supplier.	Ana Carla Gómez Petit	Diretora de Assuntos Regulatórios e Institucional
			Thatiana Faria	Corporate Communications and Social Responsibility Manager
	DISTRIBUIDORA DE ENERGIA	**DESCRIPTION**	**CONTACT PERSON**	**DESIGNATION**
12	LIGHT	Energy trading company in Rio de Janeiro.	Alexandra Amaral	Distributor Director
	REGULATOR	**DESCRIPTION**	**CONTACT PERSON**	**DESIGNATION**
13	IBP	Brazilian Institute of Oil and Gas (IBP). Founded in 1957, IBP is a private, non-profit organization focused on promoting the development of the oil and gas industry, aiming at a competitive, ethical,	Fernanda Delgado	Executive Director

		and socially responsible industry.		
	NON-PROFIT ORGANIZATION	**DESCRIPTION**	**CONTACT PERSON**	**DESIGNATION**
14	MEsol	The Brazilian Network of Women in Solar Energy (MESol) is a socio-political organization that aims to give visibility, promote, strengthen, inspire, and connect women who work in the sector.	Aline Pan	Co-Founder.

Methodology

Consultations were carried out applying a systemic approach that integrates the different dimensions that affect gender equality, women’ regulations, protocols, social norms, biases and behaviors, as well as internal barriers for women (Figure 1)[145]. Applying these concepts to the energy sector crucial to understand (a) the barriers women and diverse groups face in the sector, and (b) the opportunities to address these barriers with practical solutions that can be implemented in the short, medium, or long term.



1. **Structures** affecting gender equality include legislation, institution protocols and norms (supply side), laws, regulations, written norms affecting access to productive assets, land, and infrastructure. Within businesses, it can also relate to policies and protocols that affect or enable gender equality.

2. **Biases and behaviors**, conscious or unconscious biases of trainers, technical assistants, financial institutions, and communities affect women's opportunities to start and open a business, access jobs in certain sectors, and live free from violence.

3. **Women's internal barriers** resulting from gender socialization processes through which gender norms are internalized from an early age, such as lack of confidence and risk aversion, among others.

In addition, consultations were carried out considering Gender-Lensed Investment (GLI) tools. GLI is a strategy that incorporates gender analysis into investment and decision-making processes to improve social, environmental, and business outcomes.

[145] Consultations were carried out by a consulting firm, CoreWoman, which uses the systemic approach framework of Naila Kabeer (1999, 2008) and the adaptation made by Susana Martinez-Restrepo (Director of CoreWoman and founding partner) for Latin America and the Caribbean region.

Table XI.2. Gender-Lens Investing Indicators (GLI)

Strategic Focus	Description
Leadership	Representation of women in leadership positions including the presence of women in executive positions and boards of directors.
Contractors/Employees	Committed to a gender-diverse and equitable workforce.
Supply Chain	Committed to a gender-inclusive value chain.
Products and services	Committed to offering and designing products or services that consider the specific needs of women as a consumer segment.
Community	Institutions that are committed to ensuring that their operations do not harm women in the community.

Source: CoreWoman's adaptation based on CDC Group and IFC, 2020.

II. Consultation Results

A description of the main barriers and opportunities identified during the interviews, as well as the main conclusions, are described below:

Structural barriers

(refers to policies, regulations, protocols, and standards that affect gender equity, see Figure 1)

- **Low representation of women workforce in the sector:** The lack of incentives and opportunities for women to qualify and work in technical areas such as engineering, and technology is one of the main reasons for the low representation of women in the energy sector in Brazil. This puts women at a disadvantage compared to men to access leadership positions or to be hired, or even to access jobs. A research report released in 2020 by the International Renewable Energy Agency (Irena), indicates that 45% of administrative positions in the renewable energy sector are held by women. When it comes to leadership positions, the percentage is around 25%. The percentage decreases to 8% when it comes to leadership positions in the wind energy sector. Additionally, although there are plenty of women with technical knowledge, panels are predominantly all male with very little sensitivity to adding women's presence. Ofte they will be reduced to serving positions, but men in leadership positions do not recognize the value of giving up their spot for a woman like it happens in many developed countries. Companies in the industry can work in partnership with schools and universities to promote women participation in STEM careers, through scholarships or by implementing internship programs.
- **Time constraints**: It is common for jobs in this sector to pay little attention to work-life balance while women remain primarily responsible for household chores, childcare, and

other family responsibilities due to social norms. Time constraints negatively affect women in different ways: (a) they do not have enough time to develop the needed skills to become successful suppliers in the energy sector, which at the same time limits their ability to develop and access to business opportunities, (b) they do not have enough availability to work in projects located in rural and/or remote areas that require professionals to travel and be away from home for long periods of time, (c) they do not have enough time available to participate in training on technical and leadership skills.

- **Geographical and economic inequalities:** Many women in Brazil live in poverty or economic vulnerability which can limit their access to energy products and services. This may include lack of access to electricity in rural areas or lack of resources to invest in renewable energy technologies. Lack of information and education about clean and efficient energy can limit women's ability to make informed choices about energy products and services. Most energy companies operate in the southeast region while women in the north and northeast cannot find jobs in energy and decide to follow other STEM related careers where they can find jobs. Given cultural norms, they also have to stay at home and continue helping the family (culturally, children stay with their parents until they get married) and women have the role of caretakers.
- **Lack of knowledge in management**: Most women in remote areas lack information on how to run their businesses, which limits their opportunities for entrepreneurship and innovation. Without management knowledge, women experience difficulties in making decisions to establish and manage their own energy-related businesses. This negatively impacts on the development of certain areas and limits employment opportunities for women.
- **Restricted participation of women in the supply chain**: The main suppliers of the supply chain in Brazil are large companies, mostly represented by men due to the patriarchal history of the Brazilian energy industry. In addition, women face difficulties in accessing financing and credit, limiting their ability to compete with other companies in the market. The lack of networks and connections in the sector is also an obstacle.

Conscious and unconscious bias

(refers to conscious or unconscious biases that affect women's opportunities, see Figure 1)

- **Discrimination:** The main bias is related to machismo, which permeates business groups/organizations/companies affecting wome access to promotions, the type of work they get and differences in their salaries when compared to men. There is a widely held belief that women do not have the technical skills needed to work in technical areas or in roles that require more physical strength that limit their opportunities to work in technical and operational areas of the industry.
- **Gender-based violence:** Most gender-based violence in the energy sector in Brazil include: (a) sexual harassment which can occur both among co-workers and by customers or suppliers, (b) moral harassment through abusive conduct aimed at humiliating, embarrassing or disqualifying a person, and (c) unequal or unfair treatment based on gender, either through explicit prejudice or lack of opportunities and recognition in comparison to colleagues of the opposite sex. These forms of violence are harmful to

women and can create an unsafe and demotivating work environment both for their growth as leaders in companies and for their development as entrepreneurs.

- **Difficulties in providing training for women in local communities:** Training specifically designed for women can create conflicts within communities. It is usually seen as unfair to men and due to stereotypes and social norms, men usually believe they are more entitled to training because of the idea that men are the head of the household and contribute more of the income in most couples.
- **Existing stereotypes in STEM careers**: prejudices, and social norms interest in pursuing STEM careers as well as their interest in the energy sector. At the same time, lack of representation of women in the industry is demotivating for women willing to pursue careers that can position them in the industry. It is also key to consider the importance of role models. For example, the survey with Brazilian youth asking who their role model was in the energy sector. Most people answered their inspiration was Elon Musk. Others left it blank. Despite having brilliant women in the energy sector, they have no visibility or exposure.

Internal barriers
(refers to the individual's internal constraints, based on their own prejudices and stereotypes, see page 7)

- **Lack of self-confidence:** women perceive themselves as less competent and less capable than men in certain areas, including the energy field. This may lead them not to seek professional development opportunities, not to take the risk of starting or running their own businesses, or not to applying for higher positions. In addition, lack of self-confidence can lead women to accept less pay than they deserve or to not report harassment or discrimination in their workplace.

Areas of opportunities to promote gender equality and social inclusion

- **Increase the number of women in the industry** by promoting specific type of education among women, especially related to STEM careers. In terms of long-term goals on educational achievements, Brazil c jobs to promote make the sector more gender diverse.
- **Decentralization of energy systems:** Currently, energy supply to consumers comes mainly from the Brazilian Interconnected System, given its centralized operation. With the increase in distributed generation still the presence of isolated systems, the activities of the Program can contribute to decentralize the system and positively impact women in rural areas.
- **Promoting gender equality in companies:** The energy sector can significantly improve its efforts to become gender inclusive. For most of the interviewees, several actions can be implemented especially in the private sector to achieve gender equality such as setting targets to hire professional women in different areas and levels; introducing recruitment and selection policies that value diversity and promote equal opportunities for men and women; offering specific training and development programs for women in technical, managerial, and leadership areas; creating mentoring and coaching programs for women who seek to advance in their careers; creating an inclusive and respectful work environment that promotes diversity and combats harassment and discrimination; implementing

measures to ensure the safety of female workers, especially in remote areas; implementing equal pay and merit-based promotion policies; and adopting more flexible and inclusive maternity and paternity leave policies. This may include extending maternity leave to six months, in line with World Health Organization (WHO) recommendations and creating paid paternity leave policies. These policies can help ensure that women are not hindered in their careers by the need to care for their newborn children, and that men can also play an active role in childcare, promoting a more equal division of family responsibilities.

- **Women-owned businesses:** Activities can support women in their ventures so that they can benefit from the economic progress through technical assistance and training.
- **Meeting energy demands:** Renewable energy projects can help meeting the energy demands of women's households and productive units. Women prioritize time-saving appliances, such as stoves, electric kettles, and washing machines, which have positive impacts on their workload and the time spent on household chores. The use of these types of appliances can free up time for them to grow as entrepreneurs and generate income activities. This includes enabling the use of their appliances and other machines. In addition, by offering capacity-building activities on the use of Advanced Measurement Infrastructure (AMIs), the Program can help women to be more energy efficient.
- **Promotion of technical education:** Companies can work with public (including the Ministry of Education, SENAI, SESI, SENAC) and private educational institutions, such as technical schools, public and private universities, and other institutions that provide training on professional and technological education in the energy sector to provide information on STEM careers and encourage the participation of girls and women in them. It is also important to remove gender biases in training materials, train the trainers and strengthen the STEM curricula to expose girls and women to science and create a capable renewable energy workforce.
- **Planning with a gender lens:** The projects must be developed with a perspective of sustainability over time. Hence, the joint participation of government institutions linked to the energy sector and energy companies is crucial. Getting women to participate implies thinking about women from the planning phase. This requires more dissemination, communication and socialization of this type of initiatives, the actors responsible for the projects must lead the way consciously.
- **Gender guidelines**: Companies implementing the projects must have a gender equality policy and guidelines, as well as an action plan.
- **Local economic development:** Activities under the IP have the potential to boost the development of economy in remote locations. To raise awareness about these issues, it is critical to empower and strengthen the communities located in the areas of intervention, involving local leaders, and leveraging their leadership to improve the economic and social impact on communities.
- **Development of women as suppliers:** The supply chain in the energy sector is predominantly male-led. However, there is room for the inclusion of women in new businesses, especially in the areas of energy use, energy efficiency, operation, and maintenance. To promote significant change, it is important to encourage more young

women to enter STEM careers, review internal processes and requirements for suppliers or contractors, and determine targets values for women-led suppliers.

- **Inclusion of men to help change existing social norms:** Men at all levels of the energy sector, whether public or private, should be included in project coordination and discussions together with women. Men are often not involved in gender initiatives, especially on leadership issues. This applies not only to potential leadership roles, but also to positions at any hierarchical level. It is essential that men become aware of the real dimension of gender gaps and begin to be part of the process of breaking down patriarchal patterns that are limiting to the progress not only of women, but of society at large.
- **Addressing prejudices and behaviors:** People often avoid confronting their own prejudices and behaviors, which makes it important to raise awareness about how little progress has been made about gender equality and the negative consequences these attitudes bring. Although companies often communicate in a positive and motivational way, it is critical to expose the reality and put it at the center of the dialogue. To support this change, it is necessary to strengthen women's visibility and capability, and to provide training with a gender perspective that addresses both gender biases and the internal barriers women face, such as a lack of self-confidence.
- **Women-led and youth-led businesses**. Importance of fostering energy entrepreneurship in Brazil and bringing in successful components from other countries, such as Solar Sister. Training needs to encompass fundraising, accounting, monitoring and evaluating and human resources, among others.
- **Meeting energy demand with more efficient appliances**: Issue in Brazil is not access but cost. Better appliances can reduce energy costs and improve wellbeing.
- **Technical education:** Women in private education suffer from bias and other structural barriers, but they are more likely to succeed due to class, income and race. Training courses and empowerment should prioritize public education and later in college where women have a hard time finding energy career opportunities (career fairs, internships, and traineeship). Work with existing civil society networks such as WIN and Rede Mesol. Also, offer scholarships for private secondary education since most Brazilians coming from public schools do not make it to public post graduate degree.

Activities to consider based on the results of consultations

<u>Enhance women's technical and leadership skills and provide more job opportunities for women and members of diverse groups</u>:

The activities included in the IP are a great opportunity to increase the number of women in the industry and in leadership positions. However, an important barrier to increasing the number of women in high-level positions is the existence of social norms and behaviors. In a male dominated sector such as the energy sector, women are not perceived as capable as men to lead projects or perform technical and even manual work. In contrast, men are perceived as more efficient and with more time available to work.

It is important to seek a change in social norms and stereotypes within each participating company in the Program by encouraging gender equality training, promotion of women in leadership positions, mentoring programs, and technical training. As SETEC noted, men should also be included in promoting gender equality. One way to motivate men to participate in gender equality efforts is to find allies within the company who can be multipliers of the messages and motivate other men to participate in these efforts. Companies should also ensure a safe work environment by establishing gender-based violence protocols.

When it comes to training and capacity building for women in leadership roles, many women are not able to participate due to lack of time, as mentioned by Abiogas. In addition, women in leadership positions say they are not able to commit to long-term programs because they are already too busy due to social norms and stereotypes that make women the primary caregivers at home leading to double shifts. Time scarcity is a common barrier to women's leadership and participation in the industry, its consideration when creating training and leadership programs, as well as a flexibility in schedules is key. Human resources policies also need to consider the of bias-free hiring policies (resumes without names, gender, age, among others) as suggested by Lightsourcebp.

Women are underrepresented in STEM careers, which already puts them at a disadvantage if they want to be part of the energy sector. Education and training for women should be considered so that women can increase their participation in technical and leadership positions.

There are some barriers to increasing the number of women-owned and -led companies in the sector, especially when it comes to funding. Developing business ideas in the renewable energy sector requires large capital investments to which very few women have access. It is necessary to identify and empower women to promote their participation in the sector. SETEC and MESol suggested to create training and capacity building opportunities focused on how to overcome financial obstacles usually faced by women.

Encourage female economic participation along the renewable energy value chain:

The energy sector supply chain is primarily established with male-owned companies.

The energy sector supply chain is established primarily with male-owned companies. Women-led businesses often do not benefit equally from procurement processes for large sustainable energy projects due to several factors, among the main ones are gender discrimination and bias in the industry. Creating procurement mechanisms that include preferential scoring systems and non-price factors to promote participation of female-owned can encourage female entrepreneurs to enhance their willingness and capacity to respond to bids.

Additionally, it is common to find that women do not have access to adequate training and/or education to become entrepreneurs. Companies can provide training and education for women and create entrepreneurial platforms to promote and provide technical assistance to women in developing their own businesses. Even if contractors are still mostly men, there are some initiatives like the one from Auren Energia in Jaíba where 68% of the local workforce are women. This is a joint effort that is being carried out between Auren and its contractors to diversify the workforce and is expanding to other locations in Brazil. Many of these initiatives are known as seed programs that attract women to the industry and in which women are given information about opportunities, and higher-skilled, higher-paid technical roles available. Companies developing projects should review their internal processes and requirements for suppliers or any contractors or ventures, seeking to promote opportunities for women and other diverse groups. Recognition should be provided for women's participation at industry events.

Increase the participation of women and diverse groups in decision-making processes: Infrastructure projects are often implemented in rural areas and remote regions (riverine or indigenous communities) that do not have a strong government structure and that lack the provision of most public services. Renewable energy projects can be beneficial to all if they provide products and services to the community in which they operate while aiming to create new jobs and bring economic growth to these regions. To promote gender and diversity equality, companies need to work around existing social norms in these communities and aim to change stereotypes and behaviors.

In fact, social norms and behaviors are often a barrier for women and other diverse groups to benefit from projects in their communities. In many locations, women may not be allowed to work due to social norms or if they work, income differences between men and women may limit women's independence. In addition, the different incomes between men and women limit women's power of choice.

The participation of women and representatives of diverse groups in consultations during the design and implementation of projects is fundamental to allow them to express their needs, as they are often aware of the most urgent problems in their communities. In general, women are collaborative and good communicators which makes them allies for the success and sustainability of the projects over time.

The government has multiple working groups and consultation processes to make decisions related to funding and public policies. It would be beneficial to create a quota policy for representation of women in these gatherings so they are empowered to represent their organizations and decision-making.

The GLI perspective:

Table 3 shows that different strategic focuses, most of which were addressed during the interviews, can be considered for differential impact on different population groups.

Table XI.3. CIF-REI Funds from a GLI perspective

Strategic Focus	Result	Actions to achieve desired results
Leadership	Increased female representation in management	Increasing the number of women in leadership and management positions in established institutions can be achieved through mentoring and training of women to strengthen their capacities and competencies. This can also encourage the creation of women-owned businesses and offer them more opportunities to access networks.
Hired/ Employees	Diverse and gender-equitable workforce	To have a gender-diverse workforce, actions must aim to ensure that a higher percentage of workers across all hierarchies and divisions are women, particularly in traditionally male-dominated sectors. Human talent departments should work to promote a culture that meets women's needs, schedules, and concerns for their physical and psychological safety. This includes a work environment free from gender-based violence and sexual harassment, and the implementation of hiring policies free from bias and stereotypical behaviors.
Supply Chain	Increased female participation in the renewable energy supply chain.	The companies/projects involved must prioritize the purchase of goods and services from producers and suppliers led by women. Companies may also need to modify their procurement and human resource policies to become more inclusive. Small and medium-sized businesses owned by women may need technical assistance to compete in the market
Products and services	Specific needs of women adequately considered	More companies serve the female market by offering products and services tailored to women's needs. This includes, for example, whether women benefit from clean energy products that are more affordable, or that reduce the time they allocate to cooking, laundry, and, in some rural communities, fuel collection.
Community	Increased participation of women and diverse groups in decision-making processes	Institutions should ensure that their operations do not harm women in the community. To address gender inequalities within communities, it is necessary to include women in consultations and decision-making processes.

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Independent Technical Review of the CIF-REI Investment Plan for Brazil (IPBR)

1. Title of the investment plan: REI – Investment Plan for Brazil (IPBR)
2. Program under the GCAP: Renewable Energy Integration Program (REI)
3. Name of the Reviewer: Joisa Campanher Dutra Saraiva
4. Date of Submission: June 14, 2023

5. ***Part I: General Criteria***

Questions to be answered in the IP assessment:

- **Does the IP comply with the principles, objectives, and criteria (with an emphasis on investment criteria) of the relevant program as specified in the design documents and programming modalities?**

Yes, the two proposed interventions in the IP through its three components comply with the principles, objectives and criteria established by the CIF-REI program that aims to develop more flexible and resilient energy systems. The IP compliance can be inferred from the specific objectives of IDBG's intervention that focus on funding to provide greater flexibility for the Brazilian Energy Transition Process; and the activities and technologies eligible for the application of concessionary resources (p.24-25). Similar reasoning applies to the WBG interventions. In this case, the specific objectives will target supporting the large-scale integration of renewables, contributing to deploy infrastructure to advance clean energy technologies – Low carbon hydrogen and offshore wind – in the CIPP.

- **Does the IP consider the country's capacity to implement the plan?**

Yes, in the "Absorption Capacity for the REI Program and associated investments" section (p.36-37) the IP presents relevant and articulated information on the macroeconomic scenario and commitment to expand the Brazilian Electricity Power System (BEPS) securing a high penetration of clean energy technologies. Moreover, Energy Research Company's (EPE) projections confirm the increase of clean energy share, as stated in the PDE 2031 – the Ten-Year Plan developed by the Energy Research Office (EPE). The volume of funds underlying the proposed interventions can be part of the proposed investments and help catalyze additional investments aligned with the CIF-REI goals. For instance, the IDBG intervention also includes activities to enhance infrastructure to be renewable-ready through SG technologies and grid interconnections in South Brazil, contributing beyond specific funds to be mobilized through the CIF-REI.

- **Has the IP been developed based on sound technical assessments?**

Yes, the IP presents reliable information on the Country and Renewable Energy integration also addressing barriers to promote investments in technologies that could accelerate the deployment of VRE. This is the case for Component 1 – modernization and digitization of HPP. Also, the barriers are included in Table 5 (Conceptual map of Theory of Change) for each of the three Components. Annex II (Outline of the Studies) includes relevant information on technical assessments for each of the proposed operation areas (UHE modernization, T&D modernization, and energy storage technologies).

- **Does the IP demonstrate how it will initiate transformative impact?**

The Investment Project (IP) under CIF REIP establishes a clear connection between expected results and indicators to effectively monitor progress. These indicators are designed to track performance in terms of emissions mitigation, climate change adaptation, inclusiveness, and the volume of leveraged co-finance in USD. A comprehensive Integrated Results Framework is presented in Table 6, outlining these indicators.

To measure and evaluate the impact or transformational change, the IP proposes an assessment methodology that encompasses five dimensions: scale, speed, relevance, systemic change, and adaptive sustainability. This integrated approach aims to capture the full extent of the project's impact and ensure its alignment with the targeted accelerated transformational change.
It is important to highlight that the IP recognizes the importance of employing additional learning approaches to assess and gain a deeper understanding of CIF's role in driving the intended transformational change. Valuable references considered for this purpose include official sources of information such as EPE, ANEEL, ONS, as well as organizations like BNEF (BloombergNEF) and IRENA (International Renewable Energy Agency). By leveraging these diverse resources, the IP aims to enhance its effectiveness and contribute to informed decision-making throughout the project lifecycle.

- **Does the IP provide for prioritization of investments, stakeholder consultation and engagement, adequate capturing and dissemination of lessons learned, and monitoring and evaluation and links to the results framework?**

The IP provides clear guidance for prioritizing investments aligned with the desired accelerated transformational change. However, component 1 does not provide information on the projects-activities prioritization which will be subject to the IE decision. According to information reported in the IP (p.21) "*Through this component, CIF-REI funding will be made available for any transformational activities/technologies that increase the flexibility and resilience of SEB to absorb higher volumes of VRE, in the defined strategic areas of intervention. (…) This component does not establish specific values to be allocated to each activity/technology."* Since the activities/technologies eligible reported (p.24) are aligned with the principles, objectives, and criteria for allocation of CIF-REI funds the answer to this question is positive.
Components 2 and 3 more clearly state mechanisms to prioritize investments. As per the stakeholder consultation, the IP presents extensive information on the stakeholder consultations' process including several opportunities and modalities of engaging experts to bring inputs and give feedback.

- **Does the IP adequately address social and environmental issues, including gender?**

Social and environmental considerations are clearly emphasized throughout the Investment Project (IP) document, underscoring the risks associated although not fully addressing them. The IP places particular emphasis on projects and technologies aimed at advancing the integration of Variable Renewable Energies (VREs) in Northeast Brazil. This context presents a significant opportunity to effectively address these concerns, as they lie at the heart of the ongoing energy transition.
The decentralization and digitization of energy systems, which empower consumers, are integral components of this transition and offer avenues for addressing social and environmental challenges. By prioritizing these aspects, the IP seeks to foster sustainable and inclusive energy development in the region.
The top results expected through the IP implementation described in the Theory of Change (Table 5, p.38-9) address social and environmental concerns. The described monitoring approach includes specific indicators to measure impact. These indicators are defined within the IP Integrated Results Framework (Table 6) to measure benefits such as: GHG emission reductions; adaptation to the impacts of climate change (resilience); gender impacts (number of women benefiting from the IP investments); job creation in clean energy technologies; social inclusion; and distributional impacts.

- **Does the IP support new investments or is funding additional to on-going/planned MDB investments?**

The IP's Components include opportunities to support new investments through:

- Component 1: Funding to be provided to BNB (Bank of Northeast Brazil, a regional development bank-RDB) (35 million USD from CIF-REI) will be applied to finance new projects through a loan operation from IDB (300 million USD) in preparation.
- Component 2: The project factory and technical assistance. Project IDB BR-T1529 is currently under implementation. However, the projects to benefit from funding (technical studies, pre-feasibility, feasibility, and pilot projects) will be detailed and executed in the period from 2023 and 2029.
- Component 3: the WBG intervention in the CIPP is a new investment in the development of the first GH2 hub in Brazil. Investments include financing shared infrastructure.

There are additional references to wider IDB financing aligned with the specific criteria of the CIF-REI. **Component 1** refers to investments in modernization of electricity networks (SG technologies). For instance, the CELESC-IDB Energy Infrastructure Investment Program (BRL-1491) is an ongoing program (Status: under implementation) whose contract was signed in October 2018.[1]

As per the Pro-Amazon Legal Program, even though the projects may represent additional investments, it poses a challenge for BNB in the capacity of Implementation Entity (IE) to fund/finance investments to phase-out fossil fuel generation through the deployment of clean energy technologies in the Amazon region, a geographic area outside its remit of actions. One possible approach to overcome such a challenge is establishing an agreement (sub-agreement) with another RDB with focus for the Amazon region. The approach may allow coupling other IDB resources that are aligned with the CIF REIP and currently outside BNB's focus area. Such strategy is permitted under BNB's articles of incorporation (Art. 47, paragraphs 8 and 9).

- **Does the IP consider institutional arrangements and coordination?**

The IP describes BEPS' legal and regulatory framework as well as environmental legislation, policies, programs, initiatives, and actions related to combating climate change. It also presents elements of the underlying macroeconomic conditions – such as high interest rates – that challenge investments, making it more important to benefit from programs such as the CIF-REI.

The IDBG intervention is well articulated regarding the objective of decarbonizing the energy sector and the economy in Middle-income country that still faces high costs of capital, that should be able to promote investments in clean energy technologies that are already competitive but currently facing the challenge of flexibility to integrate VRE at a large scale.

Investments in Component 3 align with the planned activities outlined in the National Hydrogen Program Plan (PNH2) framework, which has been established by the Government of Brazil (GoB). Recent developments to promote H2 include the National Hydrogen Program Committee (Coges PNH2) created to coordinate and supervise the planning and implementation of PNH2 and a Special Commission for the Public Debate on Green Hydrogen (CHEV) established at the Senate. These initiatives demonstrate the commitment of the Administration to advance investments in Hydrogen. The high uncertainty underlying the technology at the initial stages makes the investments in shared infrastructure, such as the CIPP, critical instruments to promote its development.

- **Does the IP promote poverty reduction?**

Brazil is a diverse country plagued by severe income inequality. By helping catalyze funds to promote investments in clean energy technologies in the Northeast (Components 1-3), the IP contributes to promoting poverty alleviation through the deployment of capital, job and income creation, and gender transformation, in a region exhibiting one of the lowest levels of human development in the country.

The IP design focusing on social and environmental concerns can produce a higher impact in the region benefiting less affluent groups of society. Moreover, component 3's focus on investments in emerging technologies may have positive impacts on productivity and growth, improving competitiveness in the economy.

- **Does the IP consider the cost effectiveness of investments?**

The IP activity areas of HPP modernization, deployment of (innovative) storage systems, and modernization of electricity networks contribute to the integration of renewable energy in a region that has exhibited success in its ability to attract and democratize investments in clean energy technologies.
The electricity auctions have awarded contracts of 70,114 MW[2] of renewable capacity from 2005 to 2022 expanding the installed generation capacity that attracted capital to investments in the regulated market. The scenario was altered in recent years. Lately, investments in VREs have changed this landscape by attracting capital to projects supported by contracts in the liberalized market (the free market).
However, some challenges emerge to further support the integration of substantial amounts of VREs through the BEPS' storage capacity. The IP includes reference to studies concluding that this storage capacity can support even higher levels of VRE by expanding the storage capacity and modernizing 4,947 MW of HPPs capacity- a critical initiative to provide such a flexibility for absorbing even larger volumes of VREs rendering the IP investments cost effective.

6. ***Questions specific to REI***

Does the IP broadly demonstrate the country's commitment to:

- Reducing or avoiding energy-related greenhouse gas (GHG) emissions via deployment of Renewable Energy

The country's commitment to reduce GHG emissions by 37% (50%) below 2005 levels by 2025 (2030), neutralizing emissions by 2050 strongly relies on securing a development trajectory of its energy sector that preserves a high share of CET in its energy mix. Recent legislation approved in 2021 mandates investments in CCGTs in the North and Northeast. However, the Brazil Country and Climate Development Report (CCDR) produced by the WB presents scenarios of extremely high penetration of renewables and even deep decarbonization that ensure energy security and cost reductions for the electrical system through flexible methodologies.
The investments allowed by the IP contribute to displace fossil fuel generation while also avoiding additional investments in new gas power plants increasing the probability of occurrence of (extremely) high decarbonization scenarios.

- Integrating large amounts of variable renewable energy generation into the power system.

The IP paves the way for unveiling highly decarbonized trajectories in the energy transition in line with the commitments to secure GHG reductions through the deployment of renewable energy. By supporting investments in the modernization of HPP, of electricity networks and development of storage systems, the IP reinforces the country's commitment to combating GHG emissions through the integration of renewable energy.

- Grounding such commitments in official document(s) such as NDC, energy sector strategies, SDG-related plans, or other relevant low-emission and climate-resilient development plan or strategy referenced or annexed in the EoI.

The IP reports a set of policies, programs, plans, and initiatives conducive to the achievement of the NDC goal set by the GoB (p.11). Even though there is no formal distribution across sectors, meeting these goals relies on (indicative) objectives of expanding renewables (beyond hydropower) in the energy mix to about 45% by 2030. The indicative 2031 10-year national energy expansion plan (EPE PDE 2031) increases this participation to 48% in 2031. Annex VIII presents some of the components of the country's legal and regulatory framework that reaffirm the commitment to an increasing penetration of renewables.

According to the Brazil CCDR, the country "could have a power sector with zero (gross) emissions by 2050 at a negligible incremental cost to the power system compared with business as usual". The scenario analysis presented in the report supports this conclusion: different technologies combinations could deliver a resilient decarbonized energy system (even forgoing the additional 8 GW of inflexible gas capacity.) The activities included in the IP are part of the suite of technologies that could deliver these objectives, adding flexibility to integrate renewables at a competitive cost.

In addition, the IP should address the following areas:

- Clear focus on RE integration: Proposed projects and activities contribute directly to the goals of 1) increasing the flexibility of power grids to enhance the penetration of renewable energies into the energy mix, 2) piloting or scaling up innovative renewable energy flexibility solutions, 3) supporting actions for regional power system integration, and or 4) harnessing the potential for electrifying end-use sectors, such as building, transport, and industry sectors.

Table 1 presents the contributions of IP proposed projects and activities to the stated goals.

- Catalyze increased investments in RE integration: The investment plan describes how REI investments will attract other public and private finance and **lead to replication through demonstration effects**, institutional learning, and increased private sector engagement. The investment plan should **mobilize additional resources from non-CIF sources**, including lending operations of MDBs, complementary funds from other developmental partners such as bilateral, public sector resource allocations, and private sector commercial investments.

The IP presents detailed information on the mobilization of capital, including third-party funds, to leverage resources that can be achieved through CIF-REI funds.

IDBG intervention

Component 1: In addition to the US$ 33.5 million from CIF-REI concessional resources, the IP is expected to mobilize US$ 35 million in IDB funds (from a 300 million USD IDB loan to BNB, in preparation) to be directed to Banco do Nordeste; 377 million USD from the CELESC-D Loan; 286.3 million USD from the Pro-Amazon Legal Program (PALP); and 325 million USD from third-party co-funding (other financial institutions).

There is no explicit description on how BNB as IE will implement its credit lines. The IP states that BNB will use the IDB and CIF-REI resources to "reduce its financing costs and lengthen loan periods" (p.29/114). In this framework it is possible that some projects may not reach the minimum threshold for leverage funding at project level. However, the whole Program should. Hence, at a minimum BNB must set explicit requirements that meet the CIF-REI Program criteria.

Even though the PALP and the CELESC-D funds can be allocated to activities and technologies in line with CIF-REI principles and objectives, since the IP funds will be directed to BNB, it is challenging to include them in the leverage ratio calculation. Excluding these funds from the calculation may undermine achieving the leverage ratio on a separate basis, specifically for Component 1 alone. However, considering the lower financing costs and longer tenure loans that could benefit CIPP (Pecém Industrial and Port Complex) within the BNB operation area, a combined leverage ratio would significantly exceed 1:10 when both interventions are considered collectively.

Component 2. The project factory (Project preparation facility). No further comments needed.

Component 3 aims to secure concessional financing of 35-55 million USD from CIF-REI, with 35 million USD sourced from concessional funds to support the development of a GH2 in the CIPP. The financing from CIF-REI will complement the 100 million USD provided by the WBG (90 million USD, under preparation) and CIPP (10 million USD). The WBG intervention has been collaboratively developed by IBRD and IFC with the objective of maximizing synergies and mobilizing private capital. Considering that the overall business plan associated with this initiative aims to attract up to 8 billion USD in private investments for the GH2 value chain, the proposed intervention significantly surpasses the 1:10 project leverage. The achievement of this leverage ratio also reflects the strong complementarity between the WBG and IDBG interventions in addressing crucial elements of renewable energy integration.

- Enabling environment: The investment plan should present the country's long-term commitment to including integration in broader country strategies and goals such as NDCs, national energy strategies, etc. The investment plan should also demonstrate how REI support would assist the country in strengthening its policies and institutions with a view towards enhancing the enabling environment for investments in integration.

The desired outcome of the Investment Plan is to contribute to decarbonizing the Brazilian economy. A crucial success factor is clearly identifying interventions that effectively reduce emissions. In the case of CIF-REI, this is achieved by implementing a cost-effective strategy and mobilizing additional public and private funds. The enabling environment for this includes the Brazilian NDC, sectoral and economy-wide government plans and SDGs. The official commitments are made through aligned and coordinated interventions, as presented in the document.

The country's energy mix has successfully evolved, adopting new RE technologies (wind, solar, etc.) and sustaining a significant share of renewable energy sources (86.94% in 2022, according to Hanna et al., 2022). Further expansion of VREs could benefit from improved system efficiencies – a concern addressed in the IP through the proposed activities and technologies included in the intervention, such as grid and HPP modernization. Successful outcomes from these initiatives can inform and underpin adaptations in policy and regulations.

To facilitate the integration of renewable energy, the Investment Plan includes monitoring and evaluation mechanisms that support activities and technologies outlined in the framework. CIF and MDB's past experience will be shared and informed in the technical assessment through lessons learned. Summing up, the CIF-REI IP Brazil presents a comprehensive framework to drive impact through renewable energy integration, aiming for an energy transition that encompasses the entire economy, promotes fairness, and enhances resilience.

- Implementation capacity: Programs will be executed through government and sub-sovereign agencies, financial intermediaries, private sector or civil society organizations, and should build local and national implementation capacity and institutions. The IP should address the viability of proposed implementation models, including models to engage the private sector.

The Investment Project (IP) suggests utilizing BNB (Bank of Northeast Brazil) as the intermediary for both interventions. BNB is a Regional Development Bank with a well-established record of accomplishment in financing the renewable energy sector and electricity networks. In recent years, BNB has made significant strides in closing funding gaps and implementing innovative, agile instruments and structures to support the financing of renewable energy, energy efficiency, and infrastructure projects in the northeast region. There is a significant increase in BNBs participation as a major financier of utility scale solar and wind power plants particularly after 2017[3]. For illustration, the Bank surpassed BNDES in financing wind power plants in 2017-2019. Dedicated lines of finance are also available for micro and mini distributed generation, technologies that have experienced a surge and today respond for almost 10% of the country's installed capacity of electricity production. With its experience and expertise in these areas, BNB is well-positioned to facilitate the successful implementation of the proposed interventions and contribute to the sustainable development of the region.

7. ***Recommendations - Point of Attention***

The leverage ratio calculation for the IDBG intervention should exclude funds from the Pro Amazon Legal Program (PALP) and the Energy Infrastructure Program of CELESC-IDB (BR-L1491). This is because the IDB loan is granted within the framework of the Productive Development Program of the North-East Region (PRODEPRO), indicating that CIF-REI funds will be primarily deployed in the BNB operational area, which encompasses the states of Northeast and part of the South-East Brazil, while the PALP benefits states in the North of Brazil.

While excluding these funds from the calculation may pose challenges in meeting the threshold leverage ratio for Component 1 alone, considering the lower financing costs and longer tenure loans that could benefit CIPP within the BNB operation area, the combined leverage ratio would significantly exceed 1:10 when both interventions are considered together.

Alternatively, the BNB could establish operational agreements with other RDBs that have operational areas covering the Amazon region states, where funds are allocated for promoting interventions to decarbonize SISOL. In the case of the CELESC-IDB program, collaborations could be pursued through RDBs operating in South Brazil to effectively utilize the funds and achieve the desired outcomes.

8. ***Concluding Remarks/Comments***

The CIF-REI Investment Project in Brazil has several important implications and benefits. Firstly, it goes beyond simply providing access to funds and concessionary resources for transformative activities and technologies. The IP brings discipline and focus to the process of integrating renewable energy by targeting the modernization of critical assets such as hydroelectric power plants (HPPs) and electricity networks. This approach improves operational efficiency in the energy system and paves the way for further deployment of variable renewable energy (VRE) sources, which have already made noteworthy progress in the region. By prioritizing these elements, the IP contributes to poverty eradication and income inequality reduction in an area that has faced such challenges.

The World Bank Group's intervention, with a focus on developing shared infrastructure at the Pecém Industrial and Port Complex (CIPP), expands the frontiers of innovative clean energy technologies. This includes green hydrogen (GH2) and offshore wind, which have enormous potential in Brazil. Leveraging resources for investments in these areas is crucial to break the pattern of low productivity growth that the country has experienced in recent decades.

The CIF-REI IP Brazil serves as an important instrument for the country to align with its Nationally Determined Contributions (NDCs) and long-term goals under the Paris Agreement. It not only reduces emissions but also enhances resilience and promotes social inclusiveness. The commitment of multilateral development banks (MDBs) to evaluate results through verifiable indicators and produce periodic assessments and reports further promotes improved governance practices.

In summary, the CIF-REI IP Brazil can act as a catalyst for investment resources that can drive a transformative change towards a low-carbon, resilient future. It fosters improved operational efficiency in critical assets, de-risks investments in innovative clean energy technologies, and mobilizes additional capital for the development of cutting-edge technologies like GH2 and offshore wind. This comprehensive approach is essential for achieving deep decarbonization and sustainable development in the country.

Annex 1.

Table 1. Contributions of CIF-REI IP Brazil proposed projects and activities to the stated goal.

	IDBG Intervention						WB Intervention		
	Component 1					Component 2	Component 3		
Supported Activities	Electrification of SISOL	Enhancing Technologies	AMI Massification	T&D Infrastructure Digitalization	Expansion of storage technologies (GH2, PSH and batteries)	Project and Technical Assistance Factory	1. Shared infrastructure for the GH2 value chain	2. Development of a National Innovation and Capacity Building hub for the GH2 value chain	3. Mobilization of private commercial capital
Increasing flexibility of power grids to enhance the penetration of renewable energies into the energy mix	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Piloting or scaling up innovative renewable energy flexibility solutions	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
Supporting actions for regional power system integration	✓	✓	✓	✓	✓✓	✓	✓✓	✓✓	✓✓
Harnessing the potential for electrifying end-use sectors, such as building, transport, and industry sectors.	N/A	✓✓	N/A	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓

Note: Strong - ✓✓✓, Moderate - ✓✓; and Low Impact - ✓

Source: Own elaboration.

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Response to the independent evaluation from the MDBs - Brazil CIF-REI´s IP

The **Interamerican Development Bank (IDB)** thanks the independent evaluator for the carefully analyzing of the CIF-REI IP for Brazil and welcomes the overall positive feedback on its compliance with CIF-REI criteria and guidelines.

Regarding the comments received on IP's Component 1 to be executed by the IDB, the following considerations should be taken into account:

1. The IDB has a successful history in deploying concessional climate resources through National Development Banks (NDBs) in Latin America. Both in the CIF (CTF and SCF) and GCF, the execution through NDBs has proven to be an efficient way to reach private and public beneficiaries and translate into investments the climate goals set up at the Countries' level. Operating through NDBs has also been effective in terms of additional resources mobilized by the NDBs and the private sector.

2. The investments outlined in the IP will be fully developed after the endorsement of the programmatic document (IP). Once the projects will enter into the design phase, the MDBs can provide many of the specifications that are mentioned in the evaluation. For example, a Project manual will be agreed between the IDB and the Executing Entity (BNB) regarding the subprojects eligible for CIF-REI funding. The IDB will monitor closely that the Executing Entity will be in compliance through the regular supervision process that takes place in the execution phase. At the same time, the IP already provides a list of technologies for which REI resources can be applied.

3. Regarding the choice of choosing a single Executing Entity, given the limited amount of CIF-REI resources (still unclear at this stage), we will have to be mindful of an effective execution of resources through BNB, avoiding a "dispersive" approach that might create a complex implementation.

4. With respect of the leverage ratio of the IP, we are pleased that the overall Investment Plan will reach at least 1:10. The IDB decided to consider in the leverage of Component 1 also resources that are currently under execution under CELESC and PALP. The fact that the Executing Entity of the CIF resources in Component 1 is BNB, is not an obstacle for both, the IDB and the GoB, to make an effort to commit and align additional financial resources, such as those of the loan to CELESC or those of PALP, to enhance the achievement CIF-REI's objectives of promoting the implementation of technologies that will increase the flexibility of the Brazilian electricity system and accelerate the absorption of greater volumes of variable renewable. These investments will all concur to prove the viability of the technologies considered in the strategic areas prioritized by the IP to boost the insertion of renewable energies in Brazil's electricity matrix. The risks perceived with the implementation of these new technologies should decrease over time, boosting private sector investments and making it less and less necessary to resort to concessional financing to achieve the financial structuring of project based on these technologies. In this context, we consider the above investments key in the CIF-REI context, creating an enabling environment and a financial supply that go beyond regional borders.

   A similar approach has been taken also in previous IPs in the context of CTF and SCF.

The **World Bank Group** (WBG) takes note of the Independent Reviewer's comments, and would like to stress the following:

- The WBG intervention is being conceived jointly between IBRD and IFC to maximize synergies and commercial capital mobilization.
- The WBG intervention is complementary of that of IDBG as both tackle critical facets of renewable energy integration.
- The WBG intervention is part of a broader energy sector dialogue with the Government of Brazil to support energy transition policies and care will be taken during project preparation that lessons from the CIF-REI supported intervention as Brazil are learnt and disseminated beyond the proposed project jurisdictional or state boundaries.

INTEGRATED RESULTS TABLE CIF – RENEWABLE ENERGY INTEGRATION PROGRAM BRAZIL						
CIF IMPACT Accelerated transformational change towards net-zero emissions and climate-inclusive and resilient development pathways						
RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
	INDICATORS	DESCRIPTION	BASELINE	ANS OF VERIFICAT	TARGET (2030)	KEY AREAS
CATEGORY 2. IMPACTS AT REI PROGRAM LEVEL						
Flexibility of energy systems for a harmonious integration of larger portions of variable renewable energy generation in networks, and increased access to renewable energy in SISOL, are made possible	**REI Impact Proxy 1: NCRE country´s installed capacity**	Renewables based electric generating capacity excuding Hydro (i.e. solar, wind, biogas and biomass generating capacities)	43.7 [GW] based on the installed capacity of Dec/2020.	EPE reports	89.1 [GW] based on the installed capacity of Dec/2030.	**Signs of Transformational Change:** Signals at the program level will focus on more limited aspects of the transformation of energy systems than on the impact section at the CIF level. The signals proposed to be observed and analyzed throughout the implementation of the IP in Brazil include those that arise from the general framework in which it is expected to enter into operation resulting from the modernization of HPP, modernization of T&D, energy storage and GH2 production to achieve support the GoB´s efforts in the energy transition and decarbonization process.
	REI Impact Proxy 2: NDC compliance	Achieving emission reductions against BAU scenario, in order to reach 2030 goals.	Reduce your carbon emission by 50% by 2030 in relation to the base year 2005.	MMA and/or MME reports	In relation to the base year 2005 resulting in emissions absolute values around 1.3 GtCO2eq.	
	REI Impact Proxy 3: % renewable installed capacity	Share of renewable energy generation in national, grid-connected energy systems (%)	86% (2020)	EPE reports	87% (2030)	

RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
	INDICATORS	DESCRIPTION	BASELINE	ANS OF VERIFICAT	TARGET (2030)	KEY AREAS
CATEGORY 3. REI PROGRAM LEVEL RESULTS						
A. Increased penetration of variable renewable energy into countries' energy systems and maximized renewable energy potential	**REI CORE 1 (= CIF 1). GHG emissions reduced or avoided (MtCO2eq) – direct/indirect**	Built based on the quantification of emissions reductions derived from SIN integrated VREs as a result of the implementation of hydroelectric modernization projects, the reduction of losses and centralized and distributed VRE integration considering reinforcement, automation and digitalization of T&D networks, the implementation of solutions based on electrification of SISOLs with VRE against projected BAU diesel consumption, the production of clean H2 replacing fossil fuel consumption in transport and/or industrial applications, and other emissions reductions in SIN as a result of investments mobilized through the CIF-REI IP in energy storage technologies, and other resources that add flexibility to electrical systems.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	Reductions of at least 24,7 $MtCO_{2eq}$ by 2030 and 235 MtCO2eq by the end of projects life - mostly indirect.	The Brazil CIF REI IP performs analysis of "complete energy systems" generating representative indicators of the country, as a contextual reference on which the financing of eligible transformational activities/technologies will take place and within which the project evaluation process and the aspects of monitoring, evaluation and learning to be incorporated will be addressed. Based on these analysis and the initial assumptions about the investments that the sub-buyers will eventually carry out, it is expected to integrate renewable energy into the network and non-interconnected solutions for energy access, annual production, energy end-use applications, reduction of GHG emissions and social empowerment through access and democratization of energy use and production. Both estimated and actual operating data should be effectively consolidated to report on these various indicators.Going down the chain of results, the monitoring function becomes increasingly important for capturing program outcomes and products, while the assessment and learning function will complement the basic indicators by filling in strategic knowledge gaps. Assessment and learning activities will be selected based on overall stakeholder demand, evidence gaps, and cross-learning
	REI CORE 2. Installed Capacity: Installed capacity of variable renewable energy available to the grid (MW) – direct/indirect	Based on the installed VRE capacity that can be integrated into the SEB as a result of the investments provided for in the CIF-REI IP in hydroelectric modernization projects; reinforcement, automation, and digitalization of T&D networks; hybridization of SISOL with VRE; the integrated capacity associated with the production of clean H2; and the integrated capacity linked to energy storage technologies.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	8.0 GW - mostly indirect.	
	REI CORE 3. Renewable Energy Production: Annual renewable energy output (MWh)	Generation of energy produced based on installed capacity that can be integrated into the SEB due to the effect of investments mobilized by CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	5,800 GWh/year (average per year); 40,500 GWh by 2030 and 689,000 GWh by the end of projects life	
	REI CORE 4. Grid Services: Increase in available grid services and improvements (#)	# of consumer units served by the renewable production integrated in SEB by CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	About 1,500,000 AMI.	

	OPTIONAL: Increase in network interconnections to accommodate higher amounts of VRE (#)	# of VRE projects connected to the network.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	About 15 projects in transmission systems.	opportunities.
	OPTIONAL. Production of H2V and its derivatives	Green ammonia production (ton/year).	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	1.850.000 ton/year.	
B. Better policies, plans, and institutional capabilities	**REI CORE 5. Policies: Number of policies, regulations, codes, or standards related to renewable energy integration that have**	N/A	N/A	N/A	N/A	N/A
C. Public and private capital mobilized	**REI CORE 6 (= CIF 4). Co-finance: Leveraged co-finance volume (USD)**	Volume of co-finance really leveraged by CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	Around USD 9 billion (leverage ratio 1 : 128)	
D. Increased access to renewable energy	**REI CORE 7. Renewable Energy Access: Number of women and men, businesses, and community services benefiting from improved access to electricity and/or other modern energy services –**	# of consumer units of SIN and SISOL benefiting from access to VRE and AMI solutions.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	About 1,074,000 consumers (40% of these consumers are expected to be female-led households).	**Gender-sensitive aspects** of energy access can be studied in more detail through targeted research assessments and/or case studies. Examples of relevant issues include: supporting gender mainstreaming in all projects and technical assists while increasing knowledge about gender and diversity issues, offering training activities to increase technical knowledge and skills in new technologies while promoting female participation in the workforce, targeting women and other social subgroups, selecting suppliers willing to promote gender equality, and increasing women's awareness and ability to use access to electricity for
E. Reduce total system cost	**REI CORE 8. System costs: Reduce total energy system cost (USD)**	Based on SEB cost reductions as a result of materializing the projects and implementing the technologies to be supported through the CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	N/A	
F. Fostering innovation in renewable energy	**REI CORE 9 (= CCV 1). Innovation: Number of innovative businesses, entrepreneurs, technologies, and other ventures**	# of ventures promoted in innovative technologies (digitization of networks, microgrids, storage technologies, production of clean H2 for decarbonization, and the like), directly or indirectly, through the implementation of the CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	1 GH2 innovation hub with laboratories and partnerships with education and research institutions.	Additional support can be provided by the MDBs and their innovation promotion platforms, to conduct learning-based activities, with the aim of improving the understanding of the innovation and entrepreneurship aspects of the CIF-REI.
	REI CORE 9 (= CCV 2). Innovation: Number of innovative businesses, entrepreneurs, technologies, and other ventures		0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	3 direct (GH2, green ammonia, green methanol) + indirect (such as green steel, green fertilizer).	

RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
	INDICATORS	DESCRIPTION	BASELINE	ANS OF VERIFICAT	TARGET (2030)	KEY AREAS
CATEGORY 4. CO-BENEFITS						

Co-benefits of social and economic development	**Co-benefit 1: Employment and livelihoods: jobs created - direct and indirect**	# of direct or indirect jobs created through the implementation of the CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	About 75,500 direct or indirect jobs in the VRE implementation and in the construction and operation of the GH2 hub. 5,000 female jobs related to the use of AMIs, use of energy and customer rights.	**Quality and distribution of jobs**: Through energy transition approaches with attention to aspects of gender equity, and diversity and social inclusion, a more evaluative and learning-oriented analysis can focus on the types of jobs created (and lost), which in the case of the Brazil IP was initially and provisionally identified as expected to be obtained in technology for the production of clean H2, installation, operation and maintenance, implementation of AMI, basic community maintenance services in PV-based solutions, energy storage, while expected losses can occur in activities such as reading and maintaining old measurement infrastructure and other works based on the fossil fuel industry (such as gas supply services). Broadly speaking, as the new technologies to be adopted will be technically more advanced and at the same time cleaner than those replaced, the jobs to be created will be of higher quality, remunerated and equally demanded, requiring greater qualification of workers, making training and capacity-building programs play
	Co-benefit 2: Just Transition, Social inclusion, and distributional impacts	# people trained/qualified to perform a more qualified and better paid job thanks to the implementation of the CIF-REI IP.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	6,200 people considering workforce training directly and indirectly. The project will encourage female participation in the capacity-building sessions. It is expected that about 30% are women 30% and diverse groups).	The **just transition framework analysis** in the case of the Brazil IP must analyze the extent to which diverse social inclusion is possible within the supported activities, including how provider selection processes can be executed, how stakeholder engagement at the local and national level is possible within each type of activity, and the extent to which vulnerable groups in impacted areas can receive employment opportunities or other benefits derived from provided solutions. Distributive impacts, which already form a central aspect of Co-Benefit 1, can also be further examined in their evaluated lines or with additional focus on specific populations, such as ethnic, religious, and racial minorities, female families, indigenous peoples and local communities,

RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
	INDICATORS	DESCRIPTION	BASELINE	ANS OF VERIFICAT	TARGET (2030)	KEY AREAS
CATEGORY 5. OPTIONAL INDICATORS						
A. Improved Design and Market Systems	**OPTIONAL: Number of technical/financial analyses completed to enhance the enabling environment for renewable energy**	Prefeasibility/feasibility studies sponsored in Component 2 (Project Factory and Technical Assistance).	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	6	
B. Improved Supply and Demand Management	**OPTIONAL: Number of supply management technologies, infrastructure, or**	STATCOM, FACTS, and/or other storage technology projects implemented to improve SEB flexibility and facilitate support to the grid.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports and throughout the implementation period of the projects.	3	

RESULT STATEMENT	MONITORING APPROACH					EVALUATION AND LEARNING APPROACH
	INDICATORS	DESCRIPTION	BASELINE	ANS OF VERIFICAT	TARGET (2030)	KEY AREAS
CATEGORY 7. ENERGY STORAGE PROJECTS						
Deployment of Energy	**GESP 1. Energy Rating: Energy rating (MWh) of storage systems installed**	Energy storage systemes deployed.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports by p	60 MWh in batteries, and 16,200 GWh considering the energy stored in GH2 and its derivatives.	

Storage Systems	**GESP 2. Power Rating: Power rating (MW) of storage systems installed**	Power storage systems deployed.	0 based on assumed BAU scenario (no intervention from CIF-REI IP) to capture only IP contributions	Annual reports by p	30 MW in batteries and 2.65 GW based on nominal installed capacity of electrolyzers for GH2 production.	

The Climate Investment Funds

The Climate Investment Funds (CIF) were established in 2008 to mobilize resources and trigger investments for low carbon, climate resilient development in select middle and low income countries. To date, 14 contributor countries have pledged funds to CIF that have been channeled for mitigation and adaptation interventions at an unprecedented scale in 72 recipient countries. The CIF is the largest active climate finance mechanism in the world.

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