Supported by
Marsh

Mobilizing Investment for Clean Energy in Brazil
Country Deep Dive

SUMMARY 2021-2022

JULY 2022

Cover: Gettyimages/marchello74

Contents

Executive summary

Innovative solutions and collaborative actions are required to unlock the $90 billion of international and domestic capital needed to achieve Brazil's clean energy ambitions until 2030.

In 2021-2022, the World Economic Forum, supported by Marsh, partnered with the Empresa de Pesquisa Energética (EPE) and the Inter-American Development Bank (IADB) to explore opportunities for Brazil to unlock more investment for clean energy as part of the *Brazil Country Deep Dive*. Over eight months, they jointly convened more than 50 Brazilian stakeholders from the public and private sector to uncover country barriers and risks to investment as well as identify solutions to unlock investment for Brazil's clean energy priorities.

After careful analysis of the country context and consideration of the different needs to close financing gaps, the working group selected three areas for acceleration: distributed generation (solar PV); hydropower modernization; and clean energy access for isolated systems.

Through detailed analysis and rounds of consultations, various obstacles to investment in these areas were identified – from inadequate regulatory frameworks to increasing levels of risks caused by the growing impact of climate change, to the scale and transactional cost of financing projects in remote regions.

In order to overcome some of the major challenges and unlock new capital at scale, five key solutions were proposed, including a detailed implementation pathway for each to ensure maximum impact.

TABLE 1 **Summary of solutions and implementation pathways**

Priority area	Solution	Description	Implementation lead
Distributed generation	Distributed Generation Financing Toolbox	Create a toolbox of existing financing best practices across different financing stages of distributed generation projects. (e.g., credit risk assessment, project finance structuring, etc.). The toolbox will support developers, banks and equity financiers while accelerating the standardization and scaling of existing good practices and successful financing models.	ABSOLAR
Hydropower modernization	Regulatory revision suggestions	Propose a collection of necessary regulatory changes to remove barriers to the commercialization of hydropower plant services post modernization, refurbishment, or repowering, thereby increasing both plant operator and investor appetite to carry out/finance modernization works.	SPIC/EPE
	Climate Risk & Resilience Mapping	Assess the physical risk of climate change (selected perils: flood, droughts, extreme rainfall) to all/selected hydropower generation assets, with the aim to inform climate resilience initiatives nationwide and on an asset level.	EPE/Marsh
	Climate Bonds' Hydropower Criteria dissemination and uptake	Raise awareness of the Climate Bond Standard Hydropower Criteria (recently released by the Climate Bonds Initiative) among investors and potential issuers in Brazil.	IADB
Isolated systems	Isolated Systems Accelerator	Create a platform for existing Independent Power Producers (IPPs) (post-auction) to find developers, technical, marketing and financial support to integrate renewables and create hybrid generation models in isolated systems.	EPE

1 Distributed generation (solar PV)

The Brazilian distributed generation industry has been growing quickly since 2015, driven by proper regulations (including net metering regulations), financing availability and technological developments, in addition to the natural incentive for electricity cost reduction. According to the Brazilian regulator, ANEEL, there are 1,069,576 operational distributed generation projects, adding up to11.5 GW of installed capacity, of which 98% are photovoltaic installations. This represents approximately 6% of the total installed capacity in Brazil.

The EPE forecasts that the installed capacity of distributed generation will reach 37.2 GW by 2031 under latest regulatory changes introduced by the Law 14,300/2022, which would mean a 220% increase in 10 years. Scaling distributed generation capacity would bring multiple benefits to Brazil, including the reduction of the amount of natural gas and diesel generation needed, which would translate into substantial CO_2 emissions reductions for the country.[1]

Some $23.2 billion of investment will be required to achieve the forecasted growth of distributed energy resources in Brazil over the next 10 years.

There are over 10,000 companies in the distributed generation value chain and more than 5,000 states and municipalities that may structure public-private partnerships (PPP) for such projects in Brazil. More than 70 financing lines are currently available for distributed generation developers and customers, from public and private financial institutions. However, while the Brazilian market is attractive from a financing perspective, obstacles remain for wider adoption of the distributed generation technologies by all parts of society.

1.1 Risks and challenges

The analysis of the Brazilian context revealed that the key risks impacting distributed generation investments in Brazil are policy design risks, market design, regulatory risks and grid and transmission risks. The implementation of Ordinary Law 14.300/2022 is anticipated to have recently created an adequate legal framework which will make investment in various business models of distributed generation more viable and attractive.

While issues related to the ease and length of the connection processes remain, the working group recognized that a meaningful increase of distributed generation projects would be best supported by the standardization and scaling of existing good practices and successful financing models.

1.2 Proposed solutions to increase investments

Distributed Generation Financing Toolbox

Priority area	Distributed generation
Solution	Distributed Generation Financing Toolbox
Description	Create a toolbox of existing financing best practices across different financing stages of distributed generation projects. (e.g., credit risk assessment, project finance structuring, etc.). The toolbox will support developers, banks and equity financiers while accelerating the standardization and scaling of existing good practices and successful financing models.
Implementation lead	ABSOLAR

In Brazil, distributed generation financing is a relatively young market that would benefit from an increased standardization of best practices. Improving investor confidence and familiarity with those practices across the various types of distributed generation projects is imperative for capital to materialize in this sector. The popularization of best practices at every stage of the financing journey is thought to reduce transactional costs for financiers while improving affordability for developers and residential or commercial offtakers alike.

The Distributed Generation Financing Toolbox will be created using input from industry associations, banks and financiers. Once collated, the dissemination of best practices will be sought via several recognized industry platforms in Brazil, including

– ABSOLAR's Finance Working Group

– Brazil's Finance Innovation Lab (Laboratório de Inovação Financeira), hosted by the IADB

– FEBRABAN

2 Hydropower modernization

Brazil is the world's second largest hydropower producer by installed capacity and has the largest installed hydropower capacity in South America, with two-thirds of the continent's total capacity. A total of 110 GW of hydropower installed capacity and an additional 30 MW of pumped storage installed capacity supply the Brazil's energy system. The hydropower sector makes up two-thirds of Brazil's total energy capacity and meets more than three-quarters of the electricity demand.

With many large Brazilian hydropower plants having been in service for over 30 years, modernizing existing infrastructure would present advantages such as increasing their energy output (thereby reducing the need for new generation sources), increasing their efficiency and availability, reducing unplanned outages, increasing safety and reserve capacity as well as lowering negative socio-environmental impacts.

It is estimated that hydropower modernization would result in 4.7 GW of capacity gains for Brazil[2], as well as a decrease of 57 MMt of CO_2 on account of modernization projects displacing natural gas-fired thermoelectric plants.[3]

The IADB estimates suggest that close to $15 billion of investment will be required to fully modernize, upgrade and refurbish Brazil's existing hydro infrastructure.

2.1 Risks and challenges

The analysis of the Brazilian context indicates that the key risks impacting hydropower modernization investments are market design and regulatory risks, as well as climate risks. Although initially highlighted in the assessment, and highly relevant for greenfield projects, social acceptance and reputational risks were found as having a low impact in the case of modernization projects.

Benefits associated with hydropower refurbishment and modernization projects are not yet recognized or incentivized by the current regulatory framework. Coupled with the absence of a secondary market for ancillary and flexibility services, the current Brazilian environment provides little or no incentive for asset owners and financiers to modernize or repower hydropower assets.

Climate risk – specifically, the change in hydrological patterns due to climate change – is also a major risk for hydropower production, particularly in an energy system where 64% of the generation capacity is dependent on availability of sufficient water resources. As of now, regulation does not mandate any climate risk assessment as part of the planning and design process of modernization, nor does it mandate hydroelectric plants to have robust climate change mitigation plans in place.

2.2 Proposed solutions to increase investments

Regulatory revision suggestions

Priority area	Hydropower modernization
Solution	Regulatory revision suggestions
Description	Propose a collection of necessary regulatory changes to remove barriers to the commercialization of hydropower plant services post modernization, refurbishment or repowering, thereby increasing both plant operator and investor appetite to carry out/finance modernization works.
Implementation lead	SPIC/EPE

In order to scale investment to the levels needed for Brazil to modernize its hydropower infrastructure, it is critical for policy and market frameworks to create a conducive environment.

The following list of recommendations for revision of the current regulatory framework is thought to increase the willingness of generators and the appetite of investors to modernize and repower existing infrastructure. They have been compiled by the working group for the attention of the regulator (ANEEL) and the Ministry of Mines and Energy (MME). Detailed suggestions can be consulted here.

Proposed revision of the regulatory framework to incentivize investment in hydropower modernization and repowering in Brazil:

- Inclusion of hydropower plants in capacity reserve auctions
- Clarify the concepts of expansion ("Ampliação") and improvements ("Melhorias") used in concession agreements
- Allocation of the physical guarantee arising from improvements and expansion to the generator for free disposal
- Possibility of extending the concession period by up to 20 years to amortize investment in modernization
- Adequate remuneration for the provision of ancillary services and the "flexibility" attribute provided to the system by hydropower plants

A series of discussions is to be initiated by the EPE for the proposed changes to be reflected upon and possibly implemented in future regulatory revisions.

Climate risk and resilience mapping

Priority area	Hydropower modernization
Solution	Climate risk & resilience mapping
Description	Assess the physical risk of climate change (selected perils: flood, droughts, extreme rainfall) to all/selected hydropower generation assets, with the aim to inform climate resilience initiatives nationwide and on an asset level.
Implementation lead	EPE/Marsh

As extreme weather events become more frequent worldwide due to climate change, it is imperative for governments and businesses to take the necessary steps to assess implications on their operations as well as build resilience to climate-induced stresses. Brazil's electricity generation sector is especially vulnerable to the impacts that changes in hydrology such as floods, droughts and extreme rainfalls may have on hydropower infrastructure and output.

A thorough analysis of the vulnerability of Brazil's hydro infrastructure is proposed in order to inform national energy planning, guide federal climate resilience initiatives and legislation, and improve asset-level resilience building efforts.

Climate Bond’s Hydropower Criteria dissemination and uptake

Priority area	Hydropower modernization
Solution	Climate Bonds’ Hydropower Criteria dissemination and uptake
Description	Raise awareness of the Climate Bond Standard Hydropower Criteria (recently released by the Climate Bonds Initiative) among investors and potential issuers in Brazil.
Implementation lead	IADB

The Climate Bonds Initiative has already developed more than 10 taxonomies to facilitate the access of renewable energy projects to international green finance. In 2021, it published the Climate Bonds’ Hydropower Criteria to provide guidance for developers on ways to ensure climate change resilience and improve environmental and social sustainability.

Raising awareness and support of the criteria in Brazil among both the investor community and potential issuers such as asset owners, governments and municipalities should allow significant green investment in sustainable hydropower projects. It will also promote transparency and credibility for hydro modernization projects that are consistent with the goals established in the Paris Agreement.

Workshops and focus groups will be hosted via recognized industry platforms, including Brazil’s Innovation Lab (Laboratório de Inovação Financeira) hosted by the Inter-American Development Bank, as well as the EPE’s technical platforms for hydro asset owners. Further engagement with the Climate Bonds Initiative was also proposed as a possible avenue to refine the criteria by further streamlining the requirements to support modernization and brownfield projects specifically.

3 Clean energy access to isolated systems

While 98% of the Brazilian population currently has access to electricity, a large portion of the country (in the north and north-east) is not connected to the National Interconnected System. Communities in these regions either have no access to electricity or are predominantly supplied with fossil-based electricity.

These "isolated systems" refer to a largely heterogeneous group of the Brazilian population in terms of cultural, socio-economic and environmental profiles. Providing access to clean energy to these systems, therefore, also represents a largely different investment opportunity, both in terms of technology solutions as well as of risk profiles.

The Brazilian Ministry of Mines and Energy (MME) estimates that close to $1.9 billion of investment would be required in the next six to eight years to provide electricity access to isolated systems.

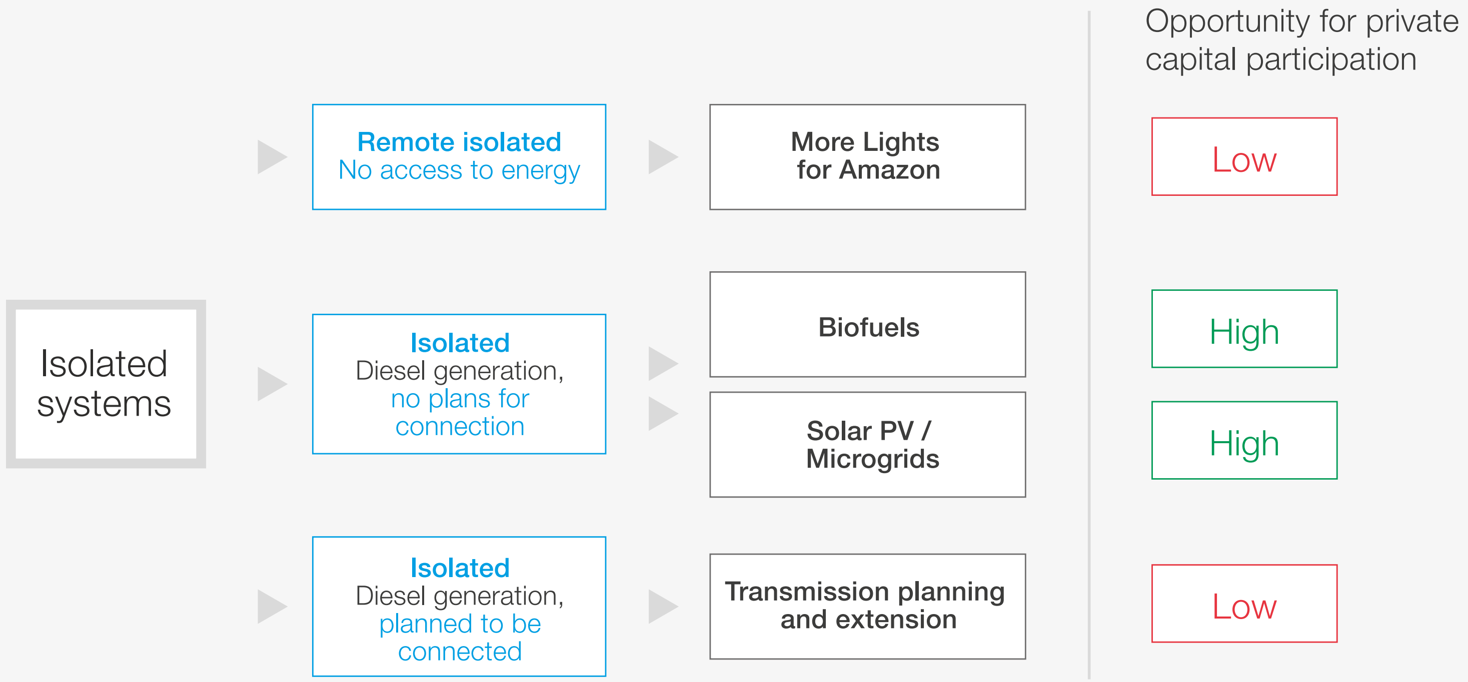
There are 257 isolated systems with an installed capacity of 1,218 MW in the Brazilian Amazon. More than 90% of this capacity is based on diesel generation, in stark contrast with a national electricity sector dominated by clean energy. Diesel generation is also not justified from an economic point of view as the cost of diesel generation in those systems is extremely high (0.42 $/KWh versus 0.1 $/KWh in the rest of Brazil).

There are a variety of technologies capable of substituting the current diesel generation for these communities, a combination of which needs to be deployed based on structured economic and socio-environmental considerations.

3.1 Risks and challenges

Figure 1 (below) represents three homogenous groups of communities within the isolated systems and evaluates the likelihood, and relevance, of creating opportunities for private capital participation to accelerate the adoption of clean energy solutions.

FIGURE 1 **Isolated systems in Brazil and opportunity for private capital participation**



It has been recognized that individual consideration is required and, therefore, that a risk assessment covering all isolated systems would only have resulted in general conclusions without much regard to individual system and community requirements. The working group highlighted that isolated systems – if taken individually – represent a small investment opportunity which typically tends to lower investors' appetite.

3.2 Proposed solutions to increase investments

Isolated Systems Accelerator

Priority area	Isolated systems
Solution	Isolated Systems Accelerator
Description	Create a platform for existing Independent Power Producers (IPPs) (post-auction) to find developers, technical, marketing and financial support to integrate renewables and create hybrid generation models in isolated systems.
Implementation lead	EPE

Hybrid generation models represent a technically valid and relatively easily accessible decarbonization pathway for most isolated systems. The regulatory framework (REN ANEEL N°961-2021, replaced by REN ANEEL n°1016/2022) already provides clarity on rules to follow when adding renewables to existing thermal power generation systems.

Building on the existing regulatory framework, the working group recommends the creation of an Accelerator Platform, which would allow existing IPPs in isolated systems to:

- Secure necessary financing thanks to the sheer bundling of numerous isolated systems hybridization projects, providing the necessary scale to be financially attractive
- Access technical support via a technical resource hub (including evaluation of technology mix for feasibility, project delivery support, etc.)
- Access economic feasibility assessments in collaboration with ANEEL, depending on the technology of choice

The creation of the Isolated Systems Accelerator will be pursued by the EPE with the goal to reach a pilot project by 2023. The accelerator should encourage the design of specific credit lines for renewable projects in Isolated Systems.

Conclusion

In the months after the end of the Brazil Country Deep Dive, local institutions identified as leads for each of the proposed solutions will seek their operationalization following the implementation plans defined by the working group. Leads will meet periodically to review progress.

The working group hopes that insights from the exercise can eventually support similar decarbonization and energy transition processes in other Latin American countries and beyond.

Contributors

Anna Seremet
Vice-President, Energy and Power, Marsh

Justine Roche
Energy, Materials and Infrastructure Project Specialist, World Economic Forum

Acknowledgements

Contributors are grateful for the participation of active members of the Brazil Country Deep Dive working group:

Apex-Brasil, ArcelorMittal, Associação Brasileira de Energia Solar Fotovoltaica (ABSOLAR), Banco BTG Pactual, Banco Safra Brasil, Banco Santander, Brazilian Development Bank (BNDES), Centrais Elétricas Brasileiras – Eletrobras, Columbia University, Enel, Energy Research Office (EPE), Fundação Getulio Vargas, IDB Invest, Itaú Unibanco, KPMG, Marsh McLennan, Ministry of Economy of Brazil, Ministry of Mines and Energy of Brazil, Petroleo Brasileiro – PETROBRAS, SPIC Brasil, Inter-American Development Bank (IADB), International Renewable Energy Agency (IRENA), US Department of Energy, World Economic Forum

Contributors would especially like to thank the following for their leadership and contribution:

Ariel Yepez-Garcia (IADB), Camila Ramos, (ABSOLAR), Carlos Echevarria Barbero (IADB), Daniel Moro (EPE), Erika Borba-Breyer (SPIC Brasil), Espen Mehlum (World Economic Forum), Gustavo Naciff de Andrade (EPE), Michele Almeida de Souza (EPE), Thiago Barral (EPE).

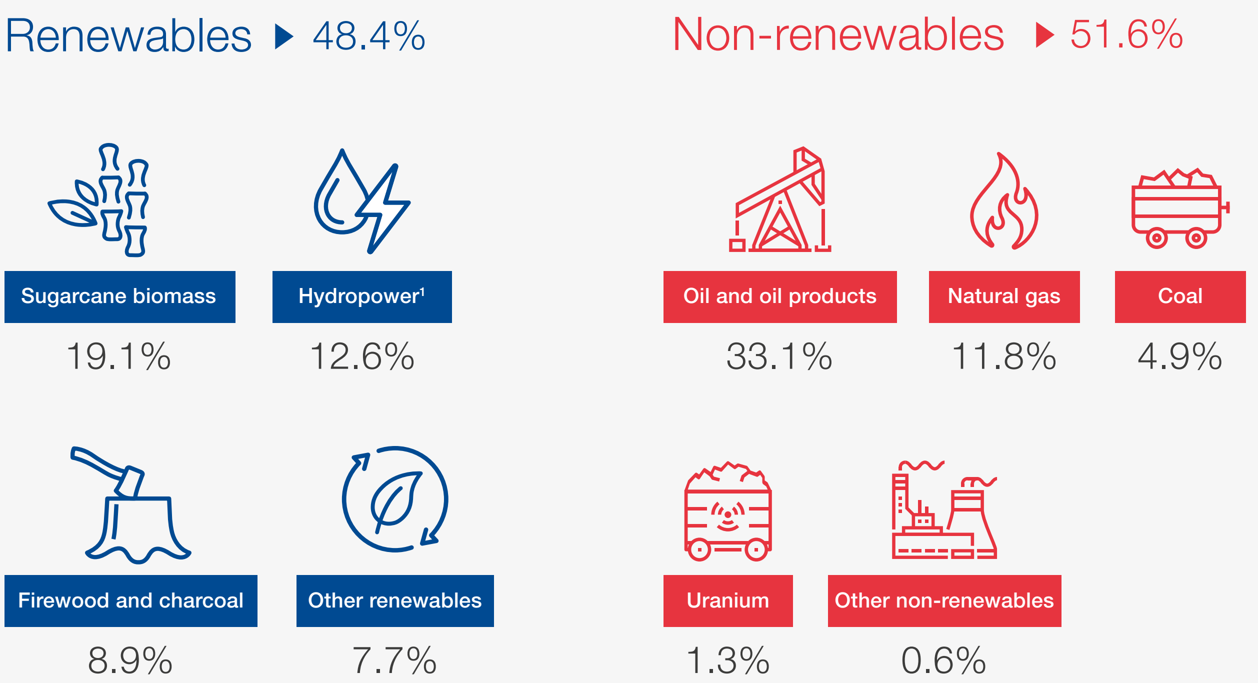
Appendix A – Brazil country profile

To ensure the relevance and highest possible impact of the Brazil Country Deep Dive, the working group looked at the current state of the Brazilian energy market as well as its investment landscape.

Current energy mix

In 2020, the total energy supply reached 287.6 million toe (ton oil equivalent), 48% of which came from renewable sources. In the past five years, the increasing share of renewables in Brazil is largely associated with the increase of sugar cane and biodiesel supply (included in “other renewables”), combined with a reduction of 5.6% in oil supply. The country remains Latin America’s top oil producer, owning the largest recoverable ultra-deep oil reserves in the world, with 94% of Brazil’s oil production produced offshore.

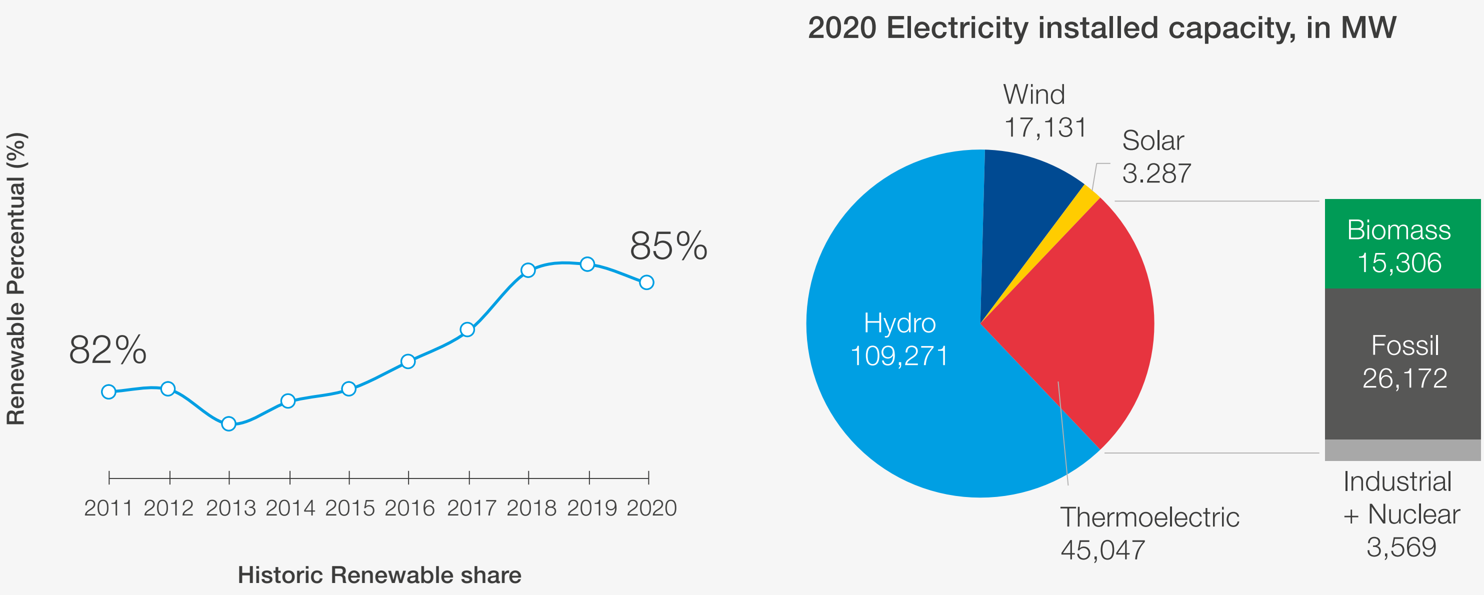
FIGURE 2 **Domestic energy supply in Brazil (2020)**



Source: EPE, Brazilian Energy Balance, 2021

The total installed capacity in the electricity sector reached 174,737 MW in 2020, including 85% of renewable sources. In recent years, increasing amounts of solar and wind were incorporated in the electricity mix. To date, however, installed capacity remains largely dominated by hydropower plants, which represent more than 63% of the total capacity. In spite of the National Interconnected System spanning 145,000 km of grid lines, a few isolated systems remain unconnected to the main network.

FIGURE 3 | **Electricity generation installed capacity**

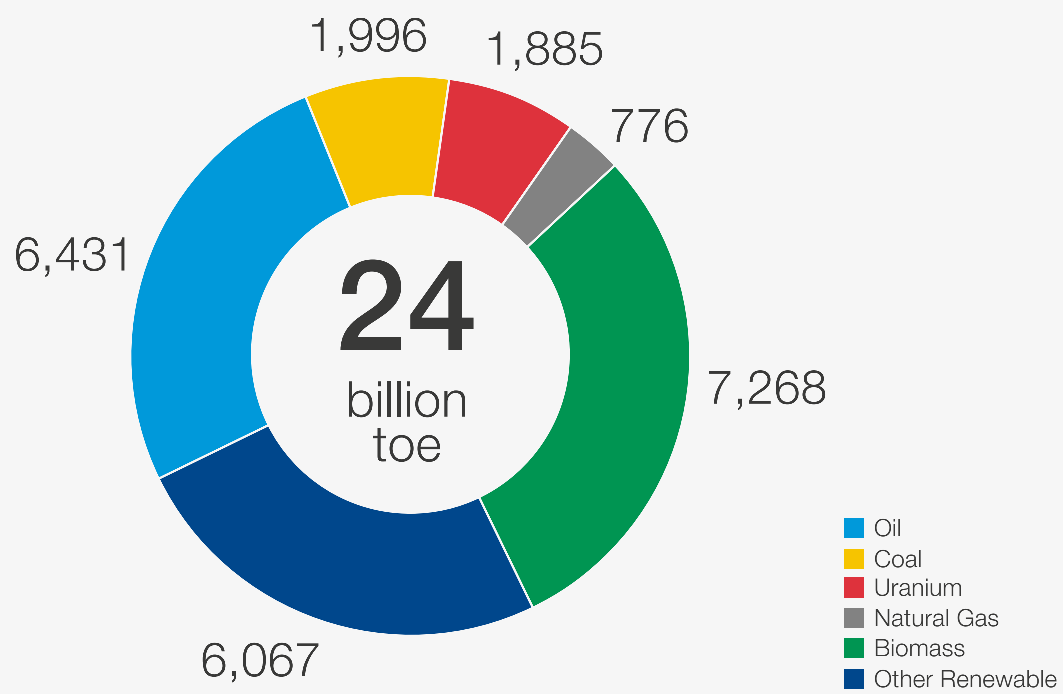


Source: EPE, Brazilian Energy Balance, 2021

National energy strategy

The National Energy Plan[4] (PNE 2050), created by EPE, in coordination with the Ministry of Mines and Energy (MME), is the main document guiding Brazil's long-term strategy related to the expansion of the energy sector. Until 2050, demand is estimated to grow from 300 to 600 million toe annually, resulting in an accumulated demand equivalent to just under 15 billion toe. Most easily exploitable resources total over 24 billion toe, of which 13 billion toe come from renewable sources. These include biomass power plants, hydroelectric power plants outside protected areas, solar, onshore and offshore wind.

FIGURE 4 | **Potentials for most easily exploitable resources (million toe)**



Source: EPE, Plano Nacional de Energia 2050, 2020

The National Energy Plan also defines strategic guidelines related to the electricity sector, such as:

– The modernization of existing hydroelectric[5] plants and management of operational and environmental constraints

– The expansion and modernization of transmission assets to increase the resilience of the electrical system and make the best use of the country's energy resources

– The target of maintaining a low-carbon electrical matrix (i.e., integration of wind and solar photovoltaic sources in the electrical system, distributed energy resources, flexibility requirements)

– The promotion of conditions for the replacement of diesel generation in isolated systems, seeking to take advantage of local resources

Per Brazil's 10-year energy plan[6] (PDE 2030), the percentage of renewable energy in the Brazilian energy matrix is estimated to reach 48% in 2030, with renewables growing, on average, 2.8% a year. Wind, solar and biodiesel should see a 6.9% average growth a year.

In terms of electricity supply, renewable sources such as hydropower, biomass, wind and solar are expected to maintain their predominance over a 10-year horizon. Overall, renewables are expected to reach 86% of the installed electricity generation capacity in 2030.

Required capital and investment landscape

The PDE 2030 estimates investment needs for the next 10 years at about BRL 2.7 trillion in the energy sector, BRL 2.3 trillion in oil, natural gas and biofuels, and BRL 365 billion in centralized generation, distributed generation and transmission of electricity.

The table below shows the forecasted investment requirement per energy source.

TABLE 2 **Forecasted investment per energy source, IADB projection (in $ million)**

	Oil	NatGas	Nuclear	Hydro	Solar	Wind	Biofuels	Total
2019	-	-	-	-	-	-	-	**-**
2020	-	-	-	7,584	723	-	2,749	**11,057**
2021	230	712	-	576	209	1,224	53	**3,006**
2022	-	-	-	523	464	63	50,	**1,101**
2023	-	1,385	-	244	146	927	161	**2,864**
2024	-	-	-	160	21	1,258	31	**1,472**
2025	-	-	-	567	360	1,042	161	**2,131**
2026	-	929,	-	1,962	527	2,390	63	**5,872**
2027	-	1,394	6,205	2,538	526	2,390	63	**13,118**
2028	-	1,154	-	3,273	527	2,390	63	**7,409**
2029	-	1,307	-	3,706	526	2,390	63	**7,994**
2030	-	1,307	-	1,348	526	2,389	63	**5,635**
Total	**230**	**8,191**	**6,205**	**22,485**	**4,559**	**16,468**	**3,523**	**61,664**

Source: IADB, 2021

Financing mechanisms available in a given jurisdiction play a critical role in supporting the energy transition pathways charted by governments. A complete analysis of the instruments and funding sources available for the energy transition in Brazil was prepared by the EPE and is accessible here.

Appendix B – Priorities for accelerating investment in Brazil's energy sector

Brazil's energy sector has been expanding rapidly to adjust to the growing demand for reliable, sustainable and affordable energy. Recognizing the more than $90 billion of investment required to support the expansion of the national energy sector as defined in the national energy strategy, key priorities for investment were established, considering:

- The planned growth of all energy sources and the associated energy system infrastructural requirements, based on the medium-term energy strategy
- Investment needed to enable the realization of the planned growth objectives, as forecasted by various expert organizations such as the EPE, IADB and APEX Brasil
- Strategic system requirements to ensure and enable the continued reliability of the energy ecosystem, the adoption of new sources of energy to meet future demand and ensure equitable access of the whole of the Brazilian population to electricity

Building on this analysis, our working group provided validation and expert input to identify and prioritize areas as follows:

TABLE 3 **Priorities for accelerating investment in the Brazilian energy sector**

Focus area *(Strategic Priorities of the Brazilian Energy system)*	Planned growth 2019-2029, PDE	Planned investment 2019 – 2030 ($ million)	Impact 1 (low) - 5 (high)	Comment	Priority order
Distributed generation	**153%** (Installed capacity)	**36,600**	5	Major growth in solar DG (738%), various barriers of incentives for scaling	1
Clean energy access to isolated systems	N/A	**N/A**	4	Equitable energy access priority, UN Global Compact	2
Hydropower modernization	**6%** (Installed capacity)	**15,498**	4	Energy security priority, hydroelectric generation being 66% of total supply, reliability and flexibility considerations	3
Non-hydro renewables expansion	**105%** (Installed capacity)	**53,800**	3	Large growth and investment need, sufficient investor appetite	4
Transmission infrastructure	**38%** (km of T lines) **45%** (MVA, substations)	**20,000**	4	Both a growth consideration (integration of new generation sources) and ageing infrastructure	5
Biofuels	**28.14%** (Installed capacity)	**3,523**	4	Moderate investment need	6
Clean hydrogen	N.A.	N.A.	3	Growth priority (blue/green hydrogen), low technology maturity and infrastructure	7

After careful consideration of the different needs to close the financing gap for each priorities, our working group elected to focus the Brazil Country Deep Dive exercise on three key priority areas for the Brazilian energy system:

- Distributed generation (solar PV)
- Hydropower modernization
- Clean energy access to isolated systems

Appendix C – Country Deep Dive process

FIGURE 5 **Country Deep Dive guiding framework**

1 Country Profile & Goals

Analysis of market design
And local investment landscape.

Intermediate Output
Priority areas for exercise are established.

Stakeholder Consultations
Local co-leads

2 Risk Assessment

Risk analysis via proprietary risk matrix developed by Marsh.

Intermediate Output
Key barriers and risks increasing cost of capital and deterring investments are identified.

Stakeholder Consultations
Local co-leads
Financial sector
Energy experts, developers
Government/regulator

3 Solutioning

Evaluation and selection of solutions to solve highest barriers to investments.

Intermediate Output
List of solutions matched against risks/barriers identified.

Stakeholder Consultations
Local co-leads
Financial sector
Energy experts, developers
Government/regulator

4 Implementation Pathways

Selection of solutions based on impact and feasibility.

Final Output
Select list of solutions, implementation pathways and identified leads.

Stakeholder Consultations
Local co-leads
Financial sector
Energy experts, developers
Government/regulator

5 Country Roundtable / Dissemination

Dissemination of output and coalition building for solutions implementation.

Handover To Local Co-Lead For Implementation

Stakeholder Consultations
Local co-leads
Solutions leads

★ Kick-off Workshop ★ Taskforce Workshop ★ Taskforce Workshop ★ Country Roundtable

Appendix D – Risk assessment methodology

Investment flows are predominantly determined by the cost of capital, which, in turn ,is highly dependent on levels of risks associated with a country or project. In order to understand whether underlying barriers driving risk factors can be sufficiently lowered to increase investors' appetite, each priority area was analysed across 11 types of risks, evaluated in the context of Brazil.

TABLE 4 **Risk categories assessed**

Risk factor	Description
Political risk	Defined as the risk of loss or interruption to a business arising from government action (such as confiscation, expropriation, nationalization, deprivation, currency inconvertibility and transfer risk, political violence, operating licence/concession agreement repudiation or cancellation, export embargo, forced abandonment, selective discrimination, forced divestiture or arbitration award default)
Social acceptance / Reputational risk	Defined as the risk of various forms of social opposition due to the nature of a technology and associated reputational damage
Market design and regulatory risk	Defined as the reduced viability of investment due to regulation deterring/not recognizing viable revenue streams occurring from business models and technologies
Administrative risk	Defined as the increased time and cost a project will face due to the length and complication of administrative procedures as well as the general ease of doing business; also assesses bureaucratic risk
Policy design risk	Defined as the reduced viability of investments due to incentives/lack of incentives and policies in place
Financing risk	Defined as the lack of availability of a varied source of competitive financing options
Currency risk	Defined as the loss of project returns due to foreign exchange rate fluctuation
Distribution and supply risk	Defined as the lack of revenues due to non-payment of the product/service offtaker due to default, cash flow shortage or business interruption
Technology risk	Defined as loss of revenues/interruption of business due to lack of expertise and resources to build, operate and maintain the project infrastructure
Grid and transmission risk	Defined as the loss of revenues and interruption to the business due to unavailability/ inefficiency of the required transmission/distribution infrastructure
Climate risk	Defined as a disruption to the project due to natural weather events, climate-related transition policies or change in human resource availability due to changing climate patterns, as well as the associated liability and reputational risk of the project

Endnotes

1. Brazil System Value Analysis, 2021 update, Accenture, 2021
2. Expansão da Geração, Repotenciação e Modernização de Usinas Hidrelétricas, EPE, 2019
3. Brazil System Value Analysis, 2021 update, Accenture, 2021
4. Plano Nacional de Energia 2050, Ministério de Minas e Energia / Empresa de Pesquisa Energética. 2020
5. PNE 2050 identifies that considering current hydro installed capacity (more than 100 GW), the set of plants eligible for modernization (refurbishment) is estimated to 50 GW spanning over 51 plants. The increase in capacity through repowering actions (with an estimated 5%-20% increase in installed power) and efficiency gains (through better project engineering and recovery of generation capacity) would increase hydraulic generation with positive economic effects for the whole system
6. Plano Decenal de Expansão de Energia 2030, Ministério de Minas e Energia/Empresa de Pesquisa Energética, 2021

WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

The World Economic Forum, committed to improving the state of the world, is the International Organization for Public-Private Cooperation.

The Forum engages the foremost political, business and other leaders of society to shape global, regional and industry agendas.

World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org