


Decarbonization Pathways for Paraguay's Energy Sector

Executive Summary



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Executive Summary

Hydropower is the main source of Paraguay's electricity generation and one of its main exports. To reap the full benefits of its plentiful endowment of low-cost, renewable energy, Paraguay needs a resilient transmission network, an efficient distribution system, an adequate public policy framework, and an integrated South American power market, among other reforms.¹

In light of the upcoming renegotiation of Annex C of the Treaty of Itaipú, the Government of Paraguay constituted an inter-ministerial negotiating team to prepare for the renegotiation. In the same spirit, the government has asked Professor Jeffrey Sachs and his team to revisit the 2013 study published by the Earth Institute,² which is done in the present report, with support from the Development Bank of Latin America (*Banco de Desarrollo de América Latina* [CAF]).

This report integrates the results of three energy models with findings from literature review and expert interviews to provide recommendations for Paraguay to reduce greenhouse gas (GHG) emissions to meet its climate change commitments under the Paris Agreement by decarbonizing the country's energy use sectors by 2050 through economy-wide zero-carbon electrification, massive energy efficiency gains, behavioral changes, and institutional reforms. Understanding what is needed for Paraguay to decarbonize will inform the political choices surrounding the renegotiation of the tariffs, among other issues at stake in the renegotiation of Annex C.

1 Trends in Energy Development

With 191 countries having ratified the Paris Agreement, the world has committed to decarbonization, and technologies are supporting this shift.

Since the 2013 study, the costs of solar and wind energy technology have dropped dramatically and are now competitive with fossil fuels on a non-subsidized basis. In the public transport sector, electric buses are already competitively priced, and forecasts estimate that, by 2030, 84% of global bus sales will be electric. Prices of light electric vehicles (EVs) have declined, and global sales are forecast to outstrip traditional sales of internal combustion engine cars in the mid-2030s (*see Chapter 6*). In addition, there is a range of important technologies for converting high-quality renewable energy into other clean energy sources such as hydrogen, synthetic liquids, and synthetic methane for heavy industry, shipping, and freight. Building codes are also evolving worldwide to promote energy efficiency and smart energy use (*see Chapter 4*).

As of 2020, 134 countries have committed to quantified renewable energy targets within the energy sector, while 44 countries and the European Union—jointly accounting for roughly 70% of global GDP and CO₂ emissions—have committed to a net-zero emissions target as of April 2021. This report considers zero-emission (rather than 'net-zero') decarbonization, emphasizing the need to prioritize the phasing out the use of fossil fuels in the energy sector, while recognizing that nature-based solutions to sequester CO₂ in vegetation and soils will also be needed to achieve net-negative CO₂ emissions in the future. Decarbonization will entail using zero-carbon electricity pervasively, electrifying close to 50% of end use; using green hydrogen-based fuels and biofuels (that is, fuels produced using zero-carbon electricity); implementing carbon capture, use, and storage if necessary or economical in a few hard-to-abate sectors; and ensuring massive gains in energy efficiency.

Paraguay has moved in the right direction to leverage this shift in technology toward modern and clean energies. In 2014, Paraguay established renewable energy targets in its National Development Plan 2014–2030, committing to increase its consumption of renewable energy by 60% and reduce the consumption of fossil fuels by 20% (including 10% that are conditional on international support), targets that are also included in the country's 2016 Nationally Determined Contribution (NDC) under the Paris Agreement, which the government intends to update in 2021. These targets are also included in the National En-

1 This executive summary includes cross-references to chapters and sections of the full report that discuss the topics summarized. For the sources of data and all other references backing up this study, please refer to the notes throughout the full report, available at <http://ccsi.columbia.edu/content/paraguay-energy>.

2 Perrine Toledano, Nicolas Maennling, Jose Acero, Sebastien Carreau, Charlotte Gauthier, and Paloma Ruiz, *Leveraging Paraguay's Hydropower for Sustainable Economic Development* (New York: Columbia Center on Sustainable Investment (CCSI), 2013), <http://ccsi.columbia.edu/work/projects/leveraging-paraguays-hydropower-for-sustainable-economic-development>.

ergy Policy 2040 approved by Decree No. 6092/2016. By Law No. 5681/2016, Paraguay's Congress approved the Paris Agreement into domestic law. Moreover, in 2018 the Secretariat of the Environment was turned into a Ministry of the Environment and Sustainable Development and equipped with a National Office of Climate Change (see *Chapter 1*). The country has also been discussing or has already adopted policies and laws to encourage investment in or consumption of green technologies (such as opening up generation to independent power producers [IPPs], encouraging consumption of EVs, and labelling efficient home appliances), and the basis for deploying a smart grid in three years is in place. Despite these steps in the right direction, many challenges remain. The most concerning reality is that the country's near-100% renewably sourced electricity continues to represent only a small and insufficient proportion—**17%**—of Paraguay's final energy demand (see *Chapter 2*), ranking third after biomass (43%) and fossil fuels (40%) in 2019 (see *Chapters 5 and 6*).

Compared to the rest of Latin America and the Caribbean, Paraguay ranks tenth in terms of total GHG emissions in 2018 excluding land-use change and forestry, and eighth in per capita terms at 7.07 metric tons of CO₂-equivalent (tCO₂e) per capita (see *Chapter 1*). An overwhelming majority of Paraguay's GHG emissions come from the agriculture sector, through enteric fermentation and direct N₂O emissions from managed soils and land-use change through deforestation. While these are critical sectors for

Paraguay's government to consider to reduce the country's GHG emissions, delving into recommendations to mitigate the non-energy-related agriculture practices that cause GHG emissions or modelling the additional GHG impact of land-use change is outside of the scope of this report.

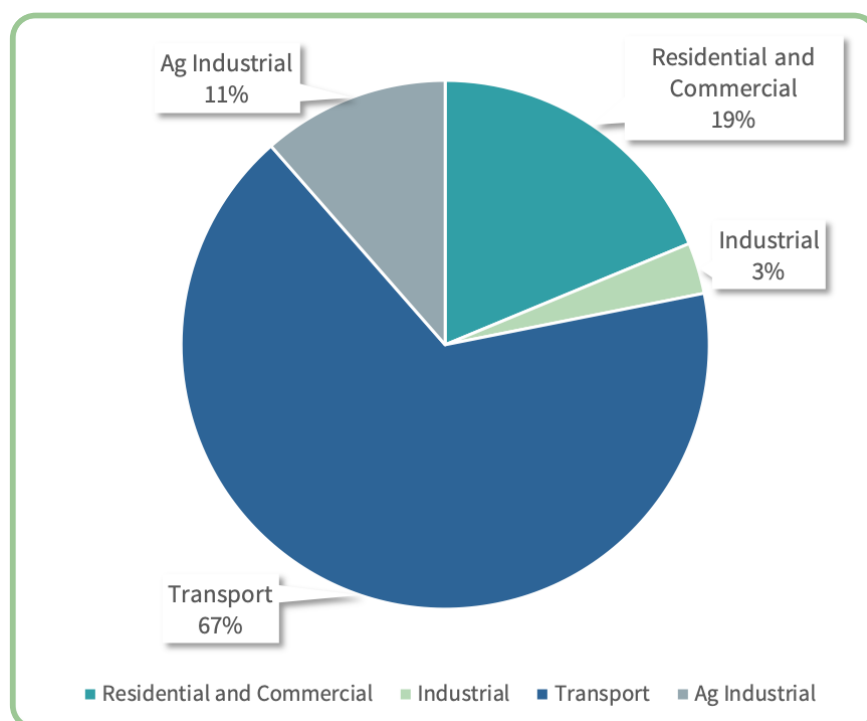
In addition to analyzing how to improve the quality of electricity supply to improve reliability, particularly in a context of a further electrification, this report focuses on the four energy-use sectors causing the largest share of GHG emissions: 1) transport, 2) residential and commercial buildings, 3) agriculture and forestry (use of machineries by these sectors), and 4) the industrial sector. Figure 1 presents the share of each of these sectors in Paraguay's total GHG emissions in 2018, expressed in terms of Global Warming Potential (GWP), which amounted to 9.6 MtCO₂e.

Using the Low Emissions Analysis Platform (LEAP) software and a conservative scenario of a 3.3% economic growth rate between 2018 and 2050, a model was developed to map the trajectory of GHG emissions by 2050 that would result from the implementation of Paraguay's stated policies, such as the Vice Ministry of Mines and Energy (VMME)'s 2040 National Energy Policy and Paraguay's National Development Plan for 2030. In the Stated Policies Scenario, Paraguay can expect an increase in GHG emissions to 2050.

Figure 1:

Global Warming Potential for Energy Use Sectors at Point of Emissions in %, 2018

Source: Prepared by the authors using LEAP.



2 Scenarios for Large-Scale Change

To highlight the policies necessary for zero-emissions decarbonization of energy-use sectors in Paraguay, this report introduces three scenarios for Paraguay's final energy demand matrix from 2018 to 2030, 2040, and 2050 based on the freely available LEAP software and available baseline data as of 2018.

1. Scenario 1, the Business-as-Usual (BAU) Scenario, maintains energy demand tendencies based on historical data and does not consider any additional energy policies (beyond those recently passed and committed pledges).
2. Scenario 2 assumes the implementation of energy policies leading to moderate electrification levels of end uses as well as high biomass supply for heating purposes in the industrial sector, non-electrified transport, and some remaining traditional cooking practices. This high use of biomass will probably entail land use conversion. This scenario also assumes hydrocarbons would persist in industry and transportation, an assumption that would require CO₂ sequestration (not assumed here) to meet the zero-emission goal in 2050 consistent with the Paris Agreement limit of 1.5°C warming.
3. Scenario 3, the Zero-Emissions Scenario, assumes that even stronger energy policies are in place for Paraguay to achieve effective decarbonization in the energy sector by 2050. Scenario 3 assumes aggressive electrification of end use and a moderate level of biomass supply for heating purposes in the industrial sector, non-electrified transport, and legacy cooking purposes. The only hydrocarbons that persist in this model are those presumed necessary as a share of jet fuel.

Scenario 1 shows that Paraguay would see a nearly 2.5-fold increase from 8.1 MtCO₂e in 2018 to 20.13 MtCO₂e by 2050 if no action is taken. Should the country emphasize biomass in reaching zero emissions, Paraguay would reduce emissions to 1.54 MtCO₂e. In the ideal model, Scenario 3, Paraguay would maximize electrification and therefore reduce emissions to 0.43 MtCO₂e in 2050; the remaining emissions are directly linked to hydrocarbon jet fuel, which by then may be eliminated by technologies not considered in this paper (e.g., electrification of short-haul flights and synthetic aviation fuels).

Among all the energy source types, electricity is projected to increase at the greatest rate in Scenarios 2 and 3. Specifically, in 2050 electricity sees an increase of 14 percentage points in its share of energy use in Scenario 2 and a 23 percentage point increase in Scenario 3 as compared to its share of energy use in Scenario 1. However, its demand varies significantly by sector. In particular, while the residential and commercial sectors are the highest electricity consumers by 2050 in Scenario 1, they are outpaced by the industrial and transportation sectors in Scenarios 2 and 3, which benefit from new technologies and policies designed to require electricity use.

3 Sectoral Challenges to Decarbonizing the Energy Demand Profile

The main challenges for each sector related to decarbonization are summarized below.

Electricity Sector

- There continues to be an insufficient number of high-voltage transmission lines despite the investment in two critical 500 kV lines in the past eight years (Itaipú–Villa Hayes and Yacretá–Villa Hayes).
- Total system losses remain quite high at around 25.8% of available electricity (as compared to 15.6% in Latin America), while distribution losses account for nearly 80% of total losses.
- Peak demand growth is driven by the consumption of inefficient AC units in the residential sector. The system is having difficulty meeting growing peak demand, which leads to power cuts during the summer months.
- ANDE has limited incentives to adequately adjust to these changes.
 - Tariff setting is a political as well as politically-sensitive undertaking, and currently tariffs are hardly set above cost-recovery level—that is, the total cost of electricity supply plus investments necessary to expand and improve supply.
 - ANDE suffers from the exchange risk inherently attached to its income flows as practically 54% of ANDE's expenses are in USD and 88% of its revenues are in PYG.

- The COVID-19 crisis has degraded ANDE's finance and ANDE's debt has reached USD 1.4 billion; even an eventual decrease in Itaipú's tariff would not durably restore ANDE's financial health.
- At the same time ANDE has not been subjected to external accounting review, so there is limited transparency with regards to its balance sheet.
- The lack of a robust Ministry of Energy equipped with administrative capacity to oversee the strategy of the sector, require economy-wide energy efficiency measures, and hold ANDE accountable for its performance hampers the reform of the electricity sector and the broader electrification of the economy.

Peak Demand–Related Supply Crunch

- Paraguay's current generation capacity is set to become insufficient to satisfy demand between 2028 and 2033, when taking peak demand into account ('supply crunch').
- The Paraguayan electric system operates using large blocks of electricity at any given time to satisfy peak demand; as such, this system is very costly.
- Paraguay's peak demand is in late at night, which makes the penetration of solar power less effective without consideration of storage, demand reduction programs, complementarity with hydro power, and regional integration.
- The proposal of a regional electricity market—System of Energy Integration of the South (SIESUR)—structured around a series of international transmission lines is promising but filled with potential pitfalls without an appropriate regulation and governance system.
- Establishing an international power trade sector that provides power stability and pays competitive electricity prices without compromising national electricity security is a critical challenge. Negotiations and resolutions with Argentina, Brazil, and Uruguay, among others, are necessary for such a regional market to come to fruition but advance slowly.

Building and Energy Efficiency

- The creation of the National Energy Efficiency Committee in 2011 helped to legitimize energy efficiency within the government, but a series of hurdles and limits on the committee's power have made it unable to enforce decisions.
- The role of energy efficiency is broadly taken up by a number of ministries with no clear leader on regulation from a funding perspective. As a result, the building sector suffers greatly from a lack of duly enforced efficiency guidelines for both material selection (in the case of new buildings), subsidized retrofits (in the case of existing buildings), and incentive programs for efficient home appliances.
- Residential buildings represent a pressing issue for Paraguay because of the high load concentration, mostly related to the high consumption of inefficient air conditioning appliances.
- The only existing tax break program encouraging sustainable construction is in Asunción and experiences very slow uptake for not being adapted to small- to medium-size buildings and not being part of a broader coherent vision and regulatory package on sustainable buildings.

Land Use and Biomass Sector

- Biomass, specifically firewood, is the largest fuel source consumed in Paraguay at 43% of final energy demand. Only 17% of fuel wood demand is met by wood from managed forests.
- The country continues to remove forest at one of the highest rates in all of South America at around 325,000 hectares per year, mostly in the Western Chaco region. Expanding cattle grazing is an important reason; another comes from easy access to unmanaged forests and very low prices for fuel wood.
- Nearly 73% of biomass consumption is from firewood and charcoal in 2019. Biomass energy sources accounted for 80.3% of the industrial sector's energy consumption in 2019, and the share of biomass energy in the industrial sector has increased since 2000. Rural cooking stoves still largely rely on biomass.

- The large majority of the rural population cannot afford efficient electric appliances to transition away from fuelwood for cooking, and the industry does not have the regulatory or economic incentive to switch from biomass to clean power for their thermal needs.
- Well-written policy cannot be efficiently enforced due to a lack of administrative oversight and lack of cross-ministerial coordination, which bog down attempts to reduce deforestation.

Transport Sector

- Imported fuels such as diesel and gasoline not only cost the country USD 1.3 billion per year and exacerbate Paraguay's foreign exchange risk but also make the transport sector the highest GHG emitter among the energy end uses in the country, accounting for approximately 67% of GHG emissions from energy use.
- Efforts thus far to shape electrified public transport have not been successful, including attempts at a Bus Rapid Transit project in Asunción, Ferrocarriles del Paraguay S.A.'s (FEPASA) railroad projects, and an electric bus fleet, which to date has only been partially replaced.
- The lack of minimum fuel efficiency requirements and of penalties for importing vehicles as old as 10 years—the oldest age for imported vehicles in South America—makes electrifying private cars much more difficult. Some bills incentivizing EV penetration are lingering in Congress.
- The expansion of a green hydrogen market has potential to provide alternative heavy duty transport fuel, but there is no installed infrastructure or policy regulation for this type of industry to be built out.
- The production of soy, which could be used for biofuel production is geared towards exportation; biofuel production relies on a few food crops whose productive yields are low and not sufficiently overseen to avoid the risk of exacerbating deforestation or land-use conversion.

Financing Challenges

- The energy sector investments outlined in ANDE's most recent master plan amount to roughly USD 6.3 billion by 2030, with USD 1.2 billion for generation, USD 3.0 billion for transmission, and USD 2.1 billion for distribution. The generation investment up to 2040 will cost USD 3.5 billion. Information and Telecommunications work are expected to cost USD 218 million by 2025. The overall amount of the master plan is USD 9 billion, and financing sources remain unclear.
- While the Government of Paraguay's fiscal discipline has tremendously improved with the 2013 Fiscal Responsibility Law, some issues with public financial management remain: lack of accountability at the municipal level, public wage growth uncorrelated with increase in competencies, weak public participation, and a low effective tax-to-GDP ratio, currently at 14% compared to the Latin American average of 23%.
- There is also a lack of framework for private sector participation in the green energy sector: outdated organic law of ANDE, delayed passing of the implementation decree (Decree No. 5226/2021) of the sovereign guarantee law (Law No. 6324/2019), ill-designed IPP law (Law No. 3009/2006), difficulty of access to finance, and lack of fiscal incentives.
- The challenges of financing the decarbonization of the energy sector is now compounded by the COVID-19 pandemic, bringing the fiscal deficit from 1.7% in 2019 to 6.5% in 2020. Moreover, the recovery package does not include any specific provision to promote green growth, which is a missed opportunity for decarbonization.
- There is political pressure to turn Itaipú's debt payoff into lower tariffs for the consumer, which could deprive Paraguay from much-needed resources.

4 Recommendations for All Sectors and Levels of Government

This report presents six overarching ideas for its vision of the decarbonization pathway of Paraguay's energy sector:

1. The 2050 zero-emissions scenario is feasible and desirable. A robust and capacitated Ministry of Energy should be created to oversee decarbonization of the energy sector. Decarbonization should be implemented by a reformed ANDE that is financially healthy and operationally modern, digitized in the services it provides, and open to private sector participation in electricity generation and distribution.
2. ANDE's master plan should anticipate a massive need for electrification of end-uses (vehicles, appliances, homes, and industry), aligned with the 2050 zero-emissions scenario. This need should translate into massive investments in modern and clean generation, mainly binational hydropower plants and solar generation combined with storage technologies.
3. To optimize investment in generation and ensure a balanced load growth as demand grows, efforts should be conducted on seven fronts:
 - 1) Minimizing commercial and non-commercial distribution losses using digitization
 - 2) Deploying demand response programs
 - 3) Deploying inexpensive storage technologies
 - 4) Deploying incentive programs for efficient home appliances
 - 5) Deploying the soft and hard infrastructure of a regional energy market
 - 6) Encouraging public transportation over private transportation
 - 7) Systematically searching efficiency gains throughout the energy end-uses and developing associated enforceable policies (e.g., building codes, efficiency standards)
4. Green hydrogen and other green fuels should also be introduced to stop all reliance on unsustainable biomass and fossil fuels.

5. Deforestation from unmanaged forests should immediately stop; at the same time, the reforestation policy and the critical biomass certification program in implementation phase since July 2021 should be enforced. The development of green fuels should instead involve the increase in Paraguay's energy crop yields and types for priority domestic use.
6. Financing sources for decarbonization should come from energy efficiency-related savings, tax reforms, strong revenue management systems avoiding wasteful recurrent expenditures, concessional bond issuance from multilateral development bank (MDB) partners, and the amortization of Itaipú's debt, which should not be fully translated into lower consumer tariffs for the domestic economy.

Since economy-wide decarbonization involves five parallel transitions in 1) infrastructure, 2) energy economy, 3) land use, 4) jobs, and 5) law and policy, below are detailed policy and techno-economic recommendations according to these transitions. They are addressed to the Government of Paraguay and meant to be adopted in full collaboration with all stakeholders, including the private sector, financial actors, and civil society.

Infrastructure Transition

- Ground Paraguay's infrastructure transition on four pillars: 1) expansion of renewable energy generation sources, 2) energy efficiency, 3) electrification of end uses, and 4) carbon capture when necessary.
- Leverage digitization and technology (including smart meters) in both hardware and software to ensure that operation is efficient (low technical and non-technical losses), easy to manage (monitor growth, loading of assets, and maintenance), resilient (in case of faults, disruptions), and nimble (addressing changes in demand and supply). These technologies do not require technological breakthroughs and can leverage local talent.
- Massively invest in zero-carbon energy sources and mobilize the complementarity of binational projects and utility-scale solar plants with storage technologies, to address the upcoming peak demand-related supply crunch.
- Implement mechanisms and incentives to ensure a balanced growth of load, especially during time

when the grid does not experience peak loads, and ultimately to ensure that load factors improve as load growth occurs.

- Examine the business case to introduce energy storage, such as hydropeaking and thermal storage (e.g., ice storage), and demand reduction programs as options to manage peak loads.
- Establish the hard and soft infrastructure of a regional power market with neighbors to limit excessive investment in generation while guaranteeing energy security.
- Develop strategies to secure efficiency gains throughout the end uses of energy, and examine the gap-financing needed to determine what policy incentives would be required:
 - In buildings:
 - Adopt building codes that mandate construction patterns based on low-carbon materials, energy-efficient appliances, and storage technologies, and expand the adoption and promotion of certifications (e.g., LEED).
 - Systematically consider the cost-effectiveness of efficient technology for new buildings, such as ice-cooling storage in thermal districts combined with rooftop solar generation.
 - Retrofit existing buildings.
 - Adopt stringent national standards on energy efficiency.
 - Incentivize efficient home appliances.
 - Establish dynamic pricing.
 - In transportation:
 - Revive projects to electrify public passenger transportation (including electric bus and rail systems, particularly in the Asunción metropolitan area).
 - Conduct urban planning and roadway designs to facilitate clean, reliable, and fast public transit.
 - Anticipate the roll-out of electric charging infrastructure for public transportation and private EVs.

- Plan for an all-EV light-duty bus fleet while emphasizing car sharing and public transport to limit the need for, and demand for, individually owned vehicles;
- Advance the piloting of green hydrogen infrastructure for heavy vehicles, developing business models involving the government, hydrogen truck manufacturers and importers, and the freight and cargo business.
- In industry, optimize the energy mix between sustainable biomass and electricity while modernizing all equipment to maximize efficiency.

Energy Economy Transition

- Take immediate action to decarbonize Paraguay's energy sector in a cost-effective and productive way, in conjunction with employment and welfare development, ensuring that utility-side investment addresses not only generation, transmission, and distribution, but also consumer-side end-use equipment needs, especially those of the low-income population.
- Create a program for the large-scale dissemination of safe, efficient, and smartly subsidized home appliances and end-use devices for small- and medium-scale consumers, including for electric cooking and water heating. Electricity at USD 20/MWh is one-fifth the cost of retail LPG cylinders, and a distribution network already exists (i.e., ANDE's grid). Well-designed incentivized adoption over a number of years can create a shift in practices, starting with urban populations.
- Capitalize on revenue from energy savings and massive electrification of energy end-use to finance the decarbonization of the energy sector.
- Invest the unique annual windfall that will potentially stem from the Itaipú debt payoff (accruing to the Government of Paraguay if Itaipú's tariffs are not lowered following a ratified bilateral agreement, or to ANDE if Itaipú's tariffs are lowered, applying the current conditions of Annex C) in the country's decarbonization, and consider that passing on Itaipú's tariff reduction to consumers is likely to leave ANDE worse off, with little benefit for the overall Paraguayan economy.

- Regularly evaluate electricity tariffs and subsidies to effectively improve collection rates and increase revenue.
- Adopt new financing mechanisms, such as sustainable development bonds, green bonds, local currency bonds leveraging pension funds, and carbon tax systems (e.g., fuel tax and auctionable ecosystem certificates), building on positive experiences in other Latin American countries.
- Transparently implement any increases in the tax burden or in electricity tariffs and combine these with incentives for households to motivate behavioral change (e.g., efficient home appliances, reforestation by land owners) and ensure political feasibility.
- Significantly improve the government's capacity to transparently collect tax money and spend it on public goods rather than on recurrent expenditure to maintain macroeconomic discipline while investing in the energy transition.
- Work together with Paraguay's high-income country partners to advocate for long-term MDB partners such as CAF and IDB to support long-term development finance by taking advantage of their highly favorable market terms (such as long maturities and low interest rates) and passing them on to Paraguay as a recipient country, thereby enabling Paraguay to borrow at a scale and terms similar to those enjoyed by developed countries.
- Request that donors maintain and promote strengthened regulation for both public and private investments.
- Promote investment in clean energy and zero-carbon industrial sectors in the country and region—including lithium-ion batteries, ice-storage technologies, and data centers—to create a feedback loop between industry and energy in which industry anchors electricity demand and skill development, and in turn a robust, clean, and modern electricity system supports the thorough and zero-carbon industrialization of the country.

Land Use Transition

- Plan policy around the climate–land–energy nexus, given that decarbonization requires land for forest conservation and the end of deforestation (with priority), carbon land sinks, sustainable biomass feedstocks, and the siting of zero-carbon energy infrastructure.
- Increase Paraguay's energy crop yields, diversify its energy crops, consistently enforce reforestation policy and the critical biomass certification program in the implementation phase since July 2021, and prioritize domestic use over exports to guarantee the supply of biomass for direct consumption and the production of biofuels and ensure the environmental and social sustainability of biomass and biofuel projects.
- Encourage reduced consumption and greater efficiency of biomass by the residential and industrial sectors by requiring minimum efficiency levels for equipment, establishing quotas on biomass consumption for energy use, creating incentives programs to eliminate the consumption of biomass in cooking stoves in urban areas, and progressively introducing green hydrogen as an alternative fuel in the industrial sector.
- Monitor deforestation with drones and aerial satellites to immediately cease the deforestation of virgin forests; intensify reforestation efforts; and seek international support for forest conservation and reforestation.

Jobs Transition

- Enact labor and education policies for retraining and upskilling and provide financial assistance to support those who stand to lose because of the transition, particularly those in fossil fuel- and biomass-dependent sectors.
- Focus on skills-based jobs training in the green industry and building construction, two sectors that will experience drastic changes in the coming decades.
- Prioritize the technology use and computer skills in digitizing the electric sector and promoting a competent workforce.

Law and Policy Transition

- Conduct an in-depth study of the required infrastructure changes over the next 10 years—involving a macro-modeling exercise to prioritize investment and devise associated fiscal scenarios—to establish clear targets and outline policies to reach these targets.
- Establish a robust and well-funded Ministry of Energy as a starting point to oversee the electricity sector, modernize the electricity system, monitor ANDE's performance to improve its efficiency, and open up to the private sector through a master plan to define and implement the country's long-term vision and a costed shorter-term strategy for energy development, including the decarbonization pathway.
- Considerably strengthen the Technical Committee for Efficiency to achieve meaningful efficiency gains throughout the economy in close coordination with ANDE.
- Reform ANDE's governance, purview, and methods through a revision of its organic law, adapting it to a changing electricity sector, to enable ANDE to open up to the private sector (starting with the generation segment), engage in value-added services, and systematically seek efficiency.
- Create strong channels of coordination within the government, notably among MADES, INFONA, the Ministry of Agriculture and Cattle Farming (Ministerio de Agricultura y Ganadería [MAG]), the Ministry of Industry and Commerce, and the Ministry of Labor, Employment, and Social Security.
- Enact and consistently enforce a coherent vision and regulations on sustainable buildings, including codes requiring new higher-end construction to be grid-responsive and efficient and the implementation of strict efficiency standards for home appliances.
- Enact and consistently enforce regulations on the age of imported vehicles (following worldwide and continental trends), emission standards, sustainable biomass, and public participation in policymaking.
- Set up a private-facing interface with the Ministry of Finance to enable the participation of the private sector in infrastructure.

- Conduct cost-benefit analyses prior to granting any fiscal incentives to encourage economy-wide decarbonization, and regularly review fiscal incentives to ensure that expenditure is effective and not wasteful.
- Implement robust policy planning and stakeholder engagement with regards to the difficult trade-offs among technological choices, land use, and jobs.

Finally, the Government of Paraguay should adopt a backcasting approach, starting from the end goal—a zero-carbon energy system as of 2050 at the latest—and work backwards to understand what needs to be done in the short and mid-term. This approach does not imply that policies will stay unchanged and fixed for decades. On the contrary, energy transition policies should adapt to changes and progress in science and technology. Yet urgent action is needed now based on the current knowledge as well as a roadmap toward the end goal. A long-term plan also facilitates stakeholder engagement and societal understanding on ways to accomplish a just transition. This report is meant to support this backcasting-based planning effort to decarbonize the energy end-use sector.

Read the full report at

<http://ccsi.columbia.edu/content/paraguay-energy>



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Columbia Center on
Sustainable Investment

Jerome Greene Hall
435 West 116th Street
New York, NY 10027
Phone: +1 (212) 854-1830
Email: ccsi@law.columbia.edu

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