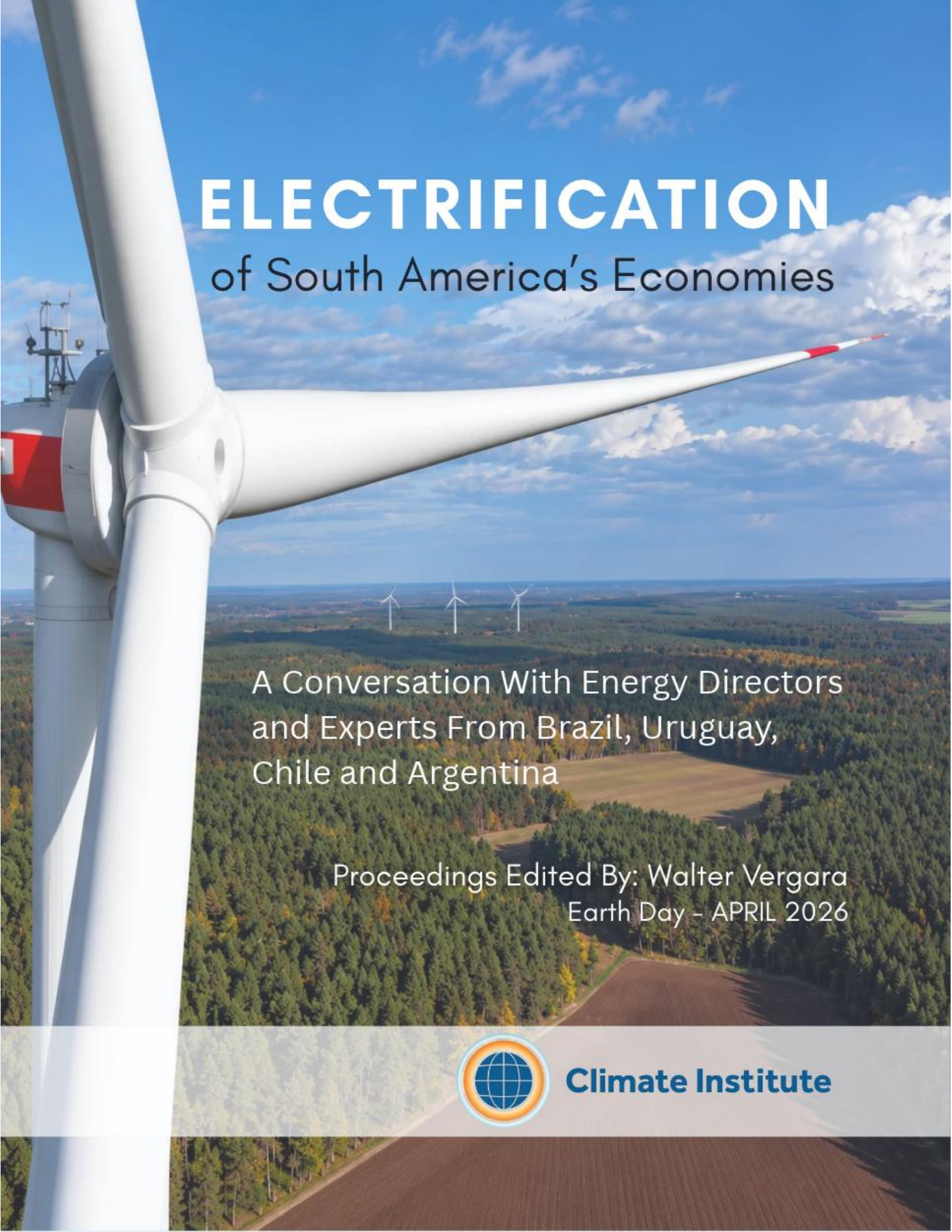


ELECTRIFICATION
of South America's Economies

A Conversation With Energy Directors and Experts From Brazil, Uruguay, Chile and Argentina

Proceedings Edited By: Walter Vergara

Earth Day - APRIL 2026

Climate Institute

Electrification of South America's Economies:

A Conversation With Energy Directors and Experts From Brazil, Uruguay, Chile and Argentina

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Foreword

For four decades, the Climate Institute has worked from a simple but enduring belief: that leadership, cooperation and innovation can help shape a more prosperous future. Over that time, we have brought together scientists, policymakers, business leaders, and communities to advance real-world solutions to pressing environmental challenges. This publication continues in that tradition.

The global energy transition is now entering a decisive phase. The question is no longer whether the world will move toward cleaner energy, but how quickly it will happen—and which regions will help lead the way. Increasingly, that leadership is coming from places that combine extraordinary renewable resources with ambitious public policy and a vision for long-term economic development.

South America stands at the forefront of this transformation.

With abundant solar, wind, hydro and other resources, the region is well positioned not only to decarbonize its own economies, but also to play a larger role in supplying the clean energy needed for global growth. As the discussions in this volume show, this is both an environmental opportunity and an economic one.

What stands out in the experiences of Brazil, Chile, Uruguay, and Argentina is not a single model, but a shared direction of travel. Each country is following its own path, shaped by its geography and institutions. Yet, common threads are clear: a focus on long-term planning, growing policy stability, investment in infrastructure, and increasing recognition that renewable energy and electrification can strengthen competitiveness, energy security, and resilience.

Just as importantly, these conversations remind us that the energy transition is ultimately about people. It is about jobs and livelihoods, public health, access to affordable energy, and the ability of communities to thrive. Progress on climate and development goals will depend on sustained collaboration across governments, financial institutions, academia, industry, and civil society. No single actor can do this alone.

The Climate Institute is proud to have convened this dialogue and to share its insights with a wider audience. We are especially grateful to Walter Vergara for his leadership in shaping this initiative, and to the representatives from Brazil, Chile, Uruguay, and Argentina who generously shared their experience and perspective. Their contributions make clear that the transition to a low-carbon economy is not a distant concept—it is already underway, being designed and implemented in real time.

As you read this publication, I hope you see it not only as a record of an important exchange, but also as an invitation. An invitation to think differently about what is possible when countries take a long-term view. An invitation to recognize that climate action and economic opportunity can reinforce one another. And an invitation to move faster, together, toward a cleaner and more resilient future.

The challenges ahead are real, but so is our capacity to meet them. What matters now is leadership—clear, sustained, and collaborative. The examples in these pages show that such leadership is already emerging.

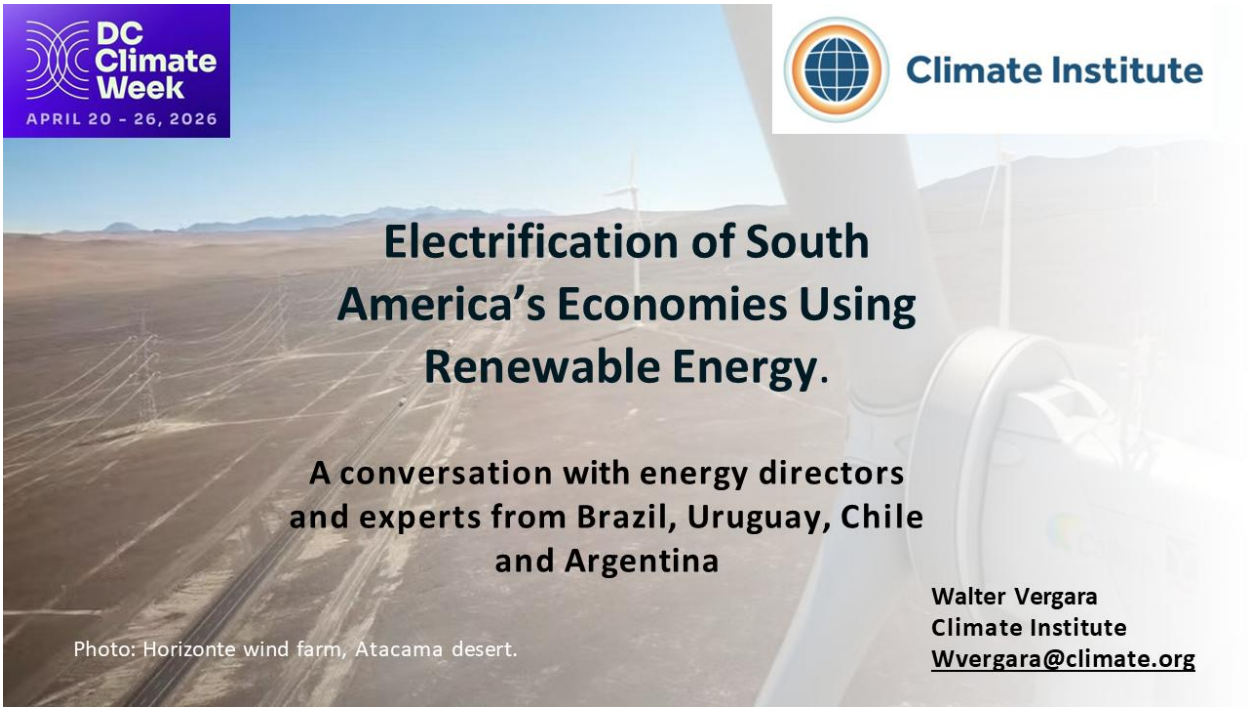
Michele Fetting
Vice Chair, Board of Directors
Climate Institute

Introduction

by **Walter Vergara**

Vice President, Latin American Programs, Climate Institute

In the context of the discussion regarding the electrification of South America's economies using renewable energy there is a need to set some context and highlight four core facts.

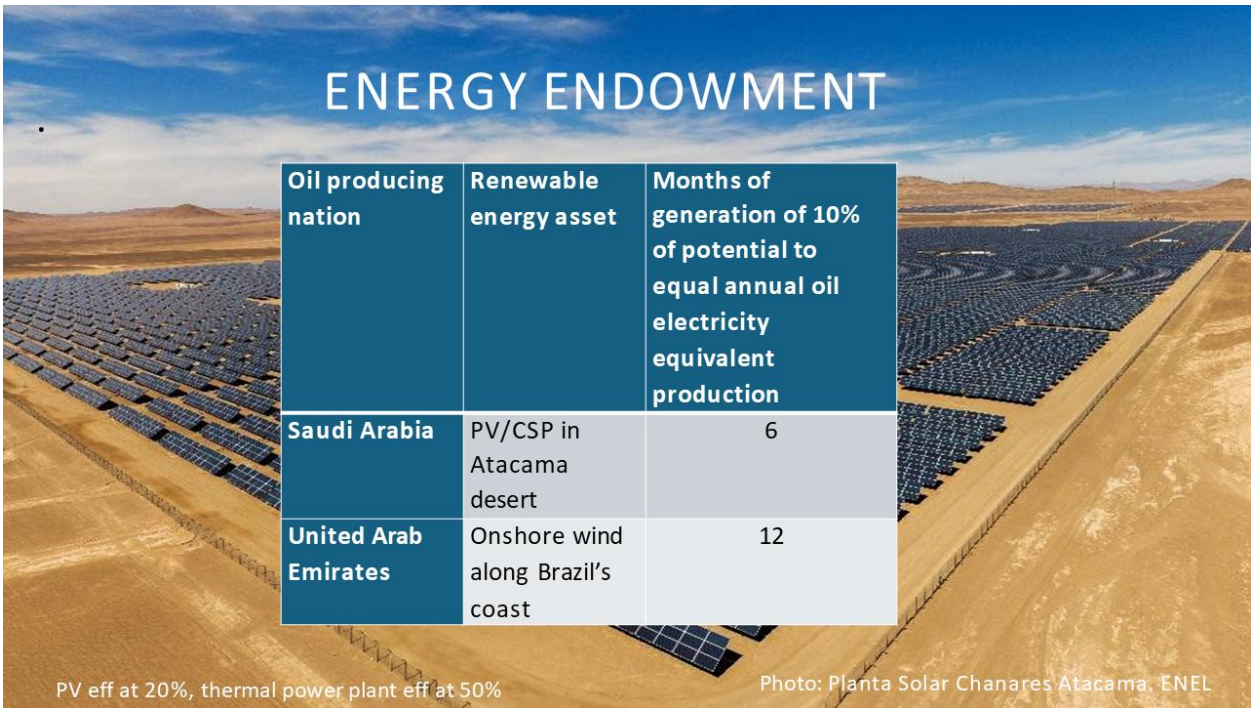


Energy Endowment of South America

First, South America has a significant endowment of renewable energy. It includes some of the areas with the highest solar irradiance in the planet, like Atacama in Chile where in the Chajnantor Plateau average global horizontal shortwave irradiance has been measured as higher than 308 watts per square meter and the Guajira peninsula of Colombia. It also has strong wind fields across the Atlantic and Pacific coasts, including Patagonia where in some areas, winds can routinely exceed 20 m/s.

South America's energy endowment goes beyond solar and wind. Geothermal potential is also significant. One assessment has placed it at 7000 MW over the length of the Andes mountains. Also of size, is the marine energy potential, which in the southern coasts of Chile has been estimated by the IDB at over 160,000 MW.

A good measure of the potential in the region can be obtained by comparing the electric potential of current oil production in the Middle East with that of the local endowments in the region. For example, in just 6 months 10 percent of the area of the Atacama Desert, using solar PV at 20 percent efficiency, could generate the electricity equivalent of Saudi Arabia's entire annual oil production. Likewise, in twelve months, 20 percent of the onshore wind energy potential along Brazil's Atlantic coast could generate the equivalent of the United Arab Emirates' annual oil production. The region is extraordinarily renewable-energy rich.



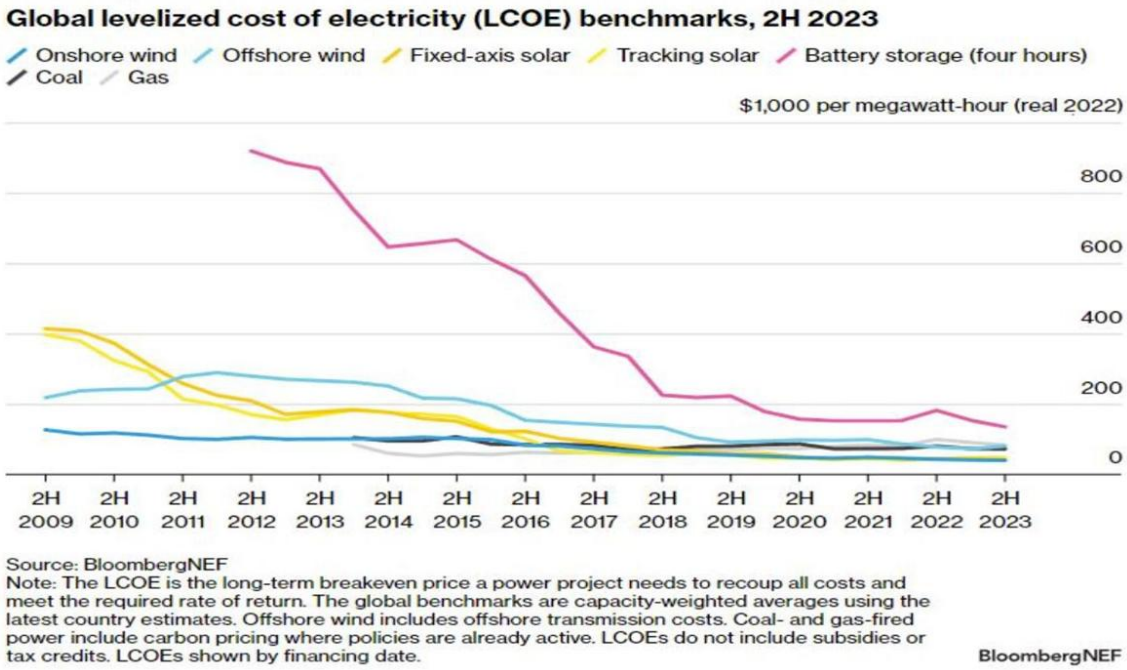
Oil producing nation	Renewable energy asset	Months of generation of 10% of potential to equal annual oil electricity equivalent production
Saudi Arabia	PV/CSP in Atacama desert	6
United Arab Emirates	Onshore wind along Brazil's coast	12

The cost of electricity generated using renewables is falling fast.

Second, global electricity generation costs using renewables have been falling. According to Bloomberg New Energy Economy data from 2023, wind and solar are now the cheapest sources of electricity generation globally. The next chart shows that at a global level, renewables have won the cost competition against fossil fuels and continue to increase its competitive edge.

In many regions of the world coal power plants have been mothballed as these cannot compete with renewable energy. Also, in many cases, natural gas has fallen behind solar and wind. Prices continue to fall. Oil, gas, and coal are mature technologies — their cost

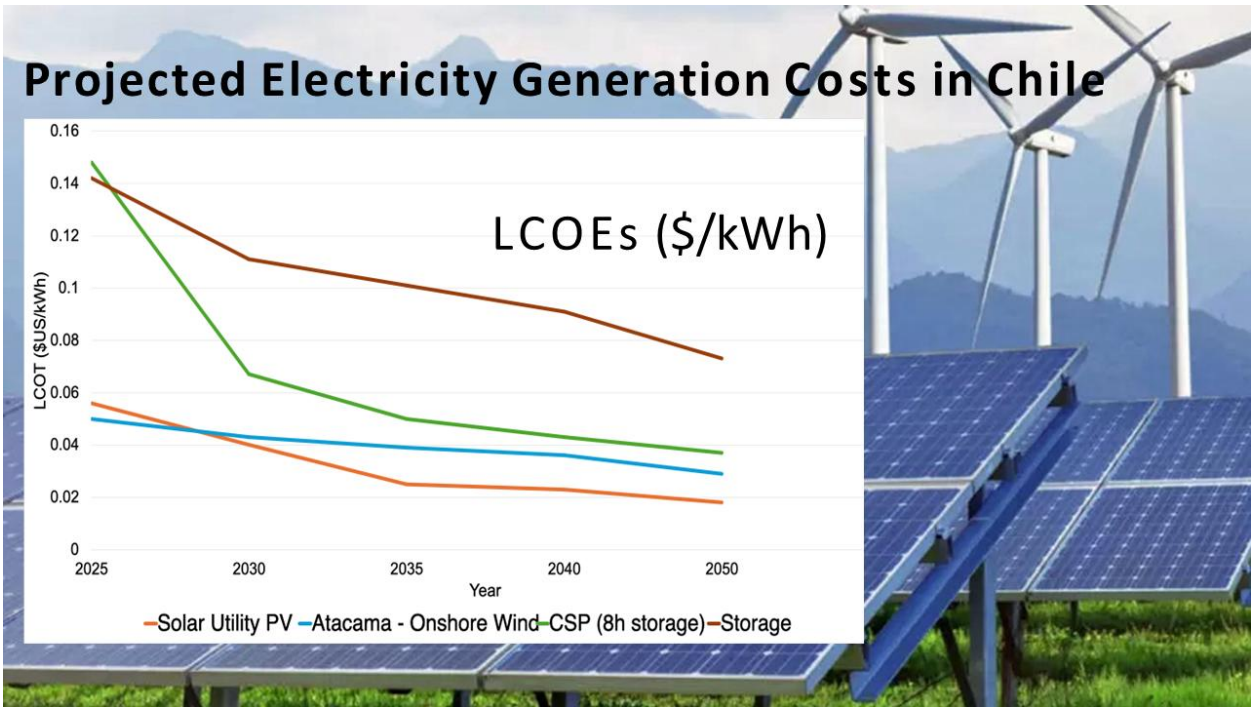
curves are flat. While wind and solar continue to benefit from technology and cost improvements.



Projected Electricity Generation Costs in Chile

In Chile, the situation resembles the global trends. Today, the Levelized Cost of Electricity Generation (LCOE) is estimated to outperform coal and natural gas. Our projections show that by mid-century, and in the context of the policy decisions and significant endowment, Chile will be able to generate electricity at less than two cents per kilowatt-hour. That is remarkable, and it has major implications for the competitiveness of electrification. Besides electricity generation, the graph also shows the anticipated trends in the cost of storage of electricity.

In fact, if the trends continue, as expected, Chile's very competitive electricity prices would enable a transformation of the economy, not just the transport sector, but also the many other economic activities that today rely in the use of fossil fuels. More on this later.



Energy Efficiency of Engines, Pumps, and Furnaces

The third point is that when you compare the efficiency of thermal devices — those powered by fossil fuels — with electric devices, electric devices are substantially more efficient. This is primarily because electricity is a low-entropy, well-organized form of energy that delivers more work per unit than fossil fuels.

Gasoline engines run at 20–40% efficiency; electric motors reach 85–95%. Natural gas-fired furnaces now reach 80–95% efficiency, while comparable electric furnaces easily reach 97%+ efficiency. Likewise, natural gas boilers are rated at between 90 to95%, while electric boilers reach 95% or higher. Turbines: fossil at 40–60%, electric at 95–99%. Heat pumps deliver a coefficient of performance (COP) of 2 to 5, meaning they deliver 2 to 5 times the energy input as useful heat. Electrification therefore delivers an additional efficiency dividend on top of renewable generation cost reductions. Electrification is a powerful tool to improve the efficiency of use of energy.



TUFF electric furnace

Energy efficiency of engines, pumps and furnaces

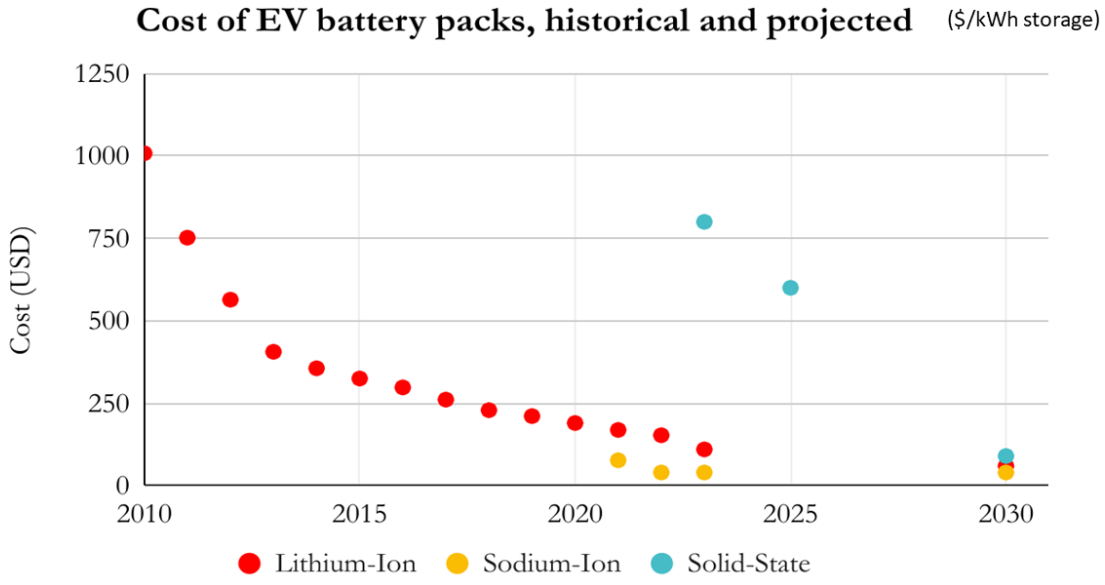
	Fossil powered	Electric
Motor engines	20-40%	85-95%
Furnaces	80-95%	97%+
Boilers	90-95%	95%+
Heat pumps (COP)	1<	2-5
Turbines	40-60%	95-99%

Electrical devices tend to be more efficient than fossil fuel-powered devices because of **how energy is delivered, converted, and used** in each system.

Cost of EV Battery Packs: Historical and Projected

Finally, and as mentioned earlier, the cost of storing electricity is falling rapidly. For lithium-ion, sodium-ion, and solid-state batteries, costs have plummeted and continued to fall. Sodium batteries, while heavier, are less expensive and suitable for stationary services, where weight is not as important an issue. On the other hand, the energy density of solid-state batteries makes them ideal for transportation vehicles. As the cost of solid-sate batteries closes the gap with traditional Lithium ion batteries, it is expected that they will substantially increase their market share in the near future.

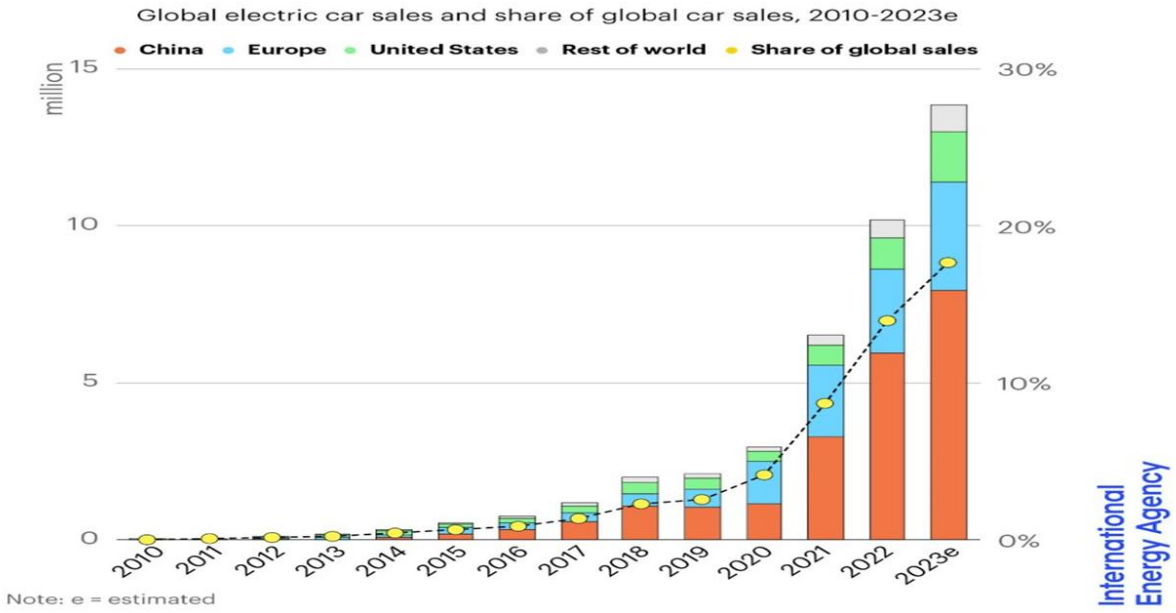
As of recent estimates, it is now possible to store energy at less than $100 per kilowatt-hour. A decade ago, most analysts considered that threshold impossible. This makes storage an increasingly viable tool for managing the inclusion of variable and intermittent sources of renewable energy in the power systems of regions and countries.



DOE, 2022

Global Electric Car Sales and Share of Global Car Sales, 2010–2023

The cumulative effect of falling generation costs, device efficiency gains, and falling storage costs has resulted in an explosion in electric devices. Global electric car sales in 2023 reached an estimated 14 million electric cars. In 2010, the number was just a few thousand — three orders of magnitude of growth in under 15 years. The trajectory is unmistakable.



Levelized Cost of Transport (LCOT) for Mining Trucks and Fishing Vessels

The electrification of transport services extends even to very heavy vehicles. Our analysis of the levelized cost of transport (LCOT) shows that battery-powered mining trucks are already cost-competitive with diesel trucks today and are projected to be significantly cheaper by 2050. The same holds for battery-powered fishing vessels versus marine diesel. In both cases, electric options are competitive now and will improve further.



LCOT ($/km)

	2030	2050
Diesel	2.7	2.7
H2 Fuel Cell	1.6	1.2
Battery	**0.8**	**0.7**

LCOT ($/km)

	2030	2050
Marine Diesel	26	26
H2 Fuel Cell	31	24
Battery	**22**	**21**



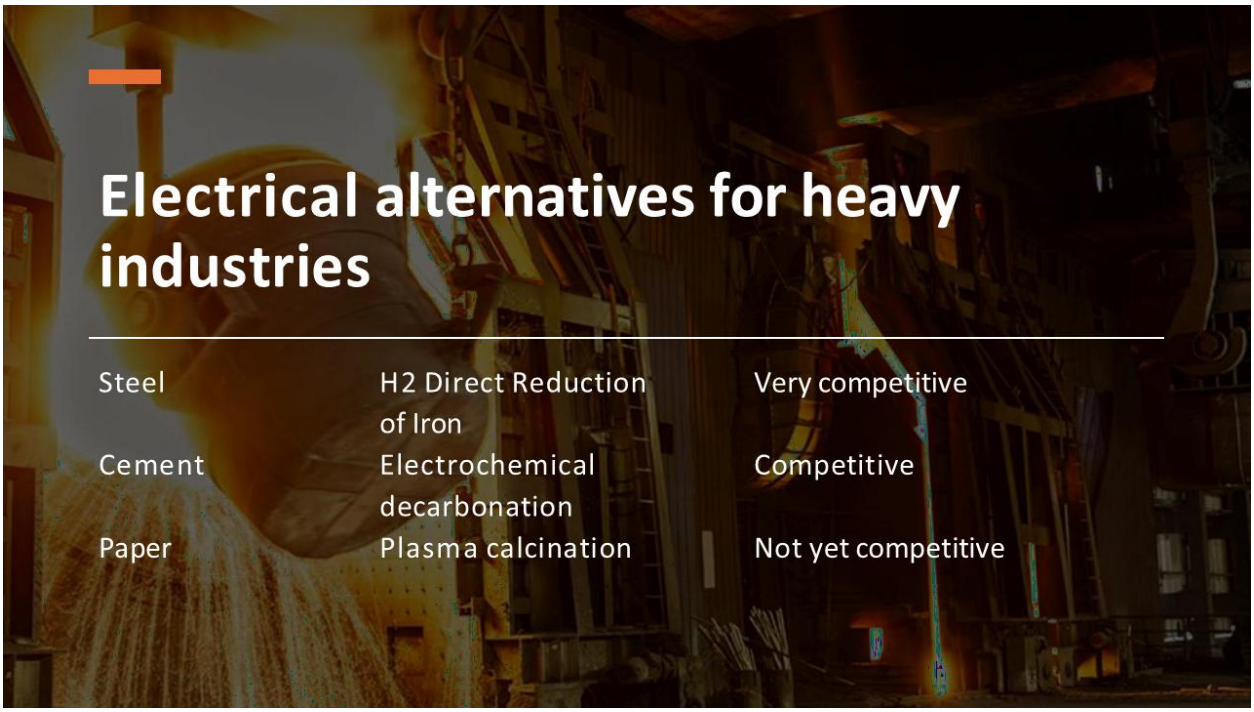
Electrical Alternatives for Heavy Industries

A primary benefit of industrial electrification in the region is the synergy between the renewable-energy based character of the power grid and the intrinsic efficiency of electricity to deliver usable work.

For steel, hydrogen direct reduction of iron (H2-DRI) has been shown to already be very competitive. Germany has launched its first green steel plants, and Chile has opened the first green iron facility in the Americas.

For cement, electrochemical decarbonization processes are being developed and shown that they could be competitive. For paper, plasma calcination is not yet competitive but is advancing. Other industrial processes like glass making and mining. The electrification of mining operations has the potential to reduce production costs and further contributes to improvements in the economics of the industrial sector. For example, fully electric

operations for iron and bauxite mining are either being implemented or being considered. As rolling stock in mining operations has an oversized contribution to production costs, the electrification of this type of heavy equipment is also a priority.



Electric Heat and Steam — Levelized Cost of Heat (LCOH)

More generally, shifting basic industrial systems—such as boilers, furnaces, pumps and assembly lines—from fossil fuels to electric power directly passes energy efficiency gains to the end users. This grants manufacturers a distinct advantage in the global market, where consumers are increasingly demanding competitive and sustainably produced goods.

Beyond industry, heat and steam are used across all sectors, including commerce, residential and buildings. The levelized cost of heat for industrial-scale electric heat pumps and electric boilers is already cheaper than natural gas equivalents — both today and in 2050. Electric heat pumps: $62/MWh today, falling to $48 by 2050, vs. natural gas at $68 both years. Electric boilers: $56/MWh today, $42 by 2050, vs. natural gas at $65 and $64.



Photo: BOSCH Electric Boiler. BOSCH

Electric Heat and Steam

(LCOH $/MWh)

100,000 MMBTU	2025	2050
Heat pumps		
Electric	**62**	**48**
NG	68	68
Boiler		
Electric	**56**	**42**
NG	65	64

Key Barriers

This transition will not happen overnight. There are significant barriers to overcome and important economic interests that will insist on maintaining a fossil-fuel economy. Key barriers include:

a) Social acceptance and perception. Social acceptance will depend on how the general public engages with the changes brought about by electrification and perceives the net benefits in daily life. In the region, acceptance of wind and solar is already high with very strong support across the political landscape and a strong concern for the impacts of climate change. There is however the need to maintain continuous information on the benefits and costs of the transition to an electric economy.

b) Effective community engagement. Strong bonds with the local communities and society at large are crucial to facilitating ownership of the changes being undertaken. For example, the political process in Chile has already delivered a mandate to move toward a low-carbon society. Additional steps, like participation in local decision-making, transparent communication, and dissemination of impacts (job creation, improvements in environmental quality) further facilitates the process.

c) Disruption of the fossil economy, including the value of stranded assets and the inertia of fossil fuel use. The fossil fuel economy will fight, and is fighting, to delay this process. Operators of natural gas facilities, refineries, and gas depots are expected to resist the transition due to economic concerns, job losses, and closure of productive infrastructure. The best antidote is to document that the changes will bring economic benefits, new jobs, and productive assets. A significant training component to redirect affected workers toward emerging opportunities will help.

Key Barriers

Social Acceptance and Perception

Community Engagement

Disruption of the Fossil Economy
- Value of stranded assets
- Inertia of fossil use

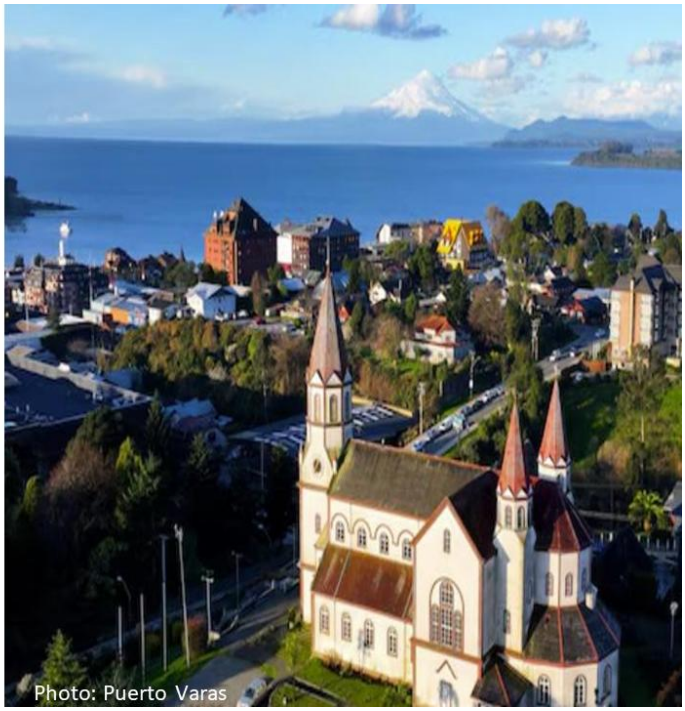


Photo: Puerto Varas

Benefits from Electrification

The benefits are substantial: energy efficiency gains; lower cost of services including heat and transport; avoidance of curtailment; lower-cost products such as steel and cement; and broader benefits including avoided health costs, avoided carbon emissions, and net job generation. With that context, the next chapters will detail the actions and prospects in Brazil, Uruguay and Chile.

Energy Transition in Brazil: Achievements and the Road Ahead

Karina Araujo Souza

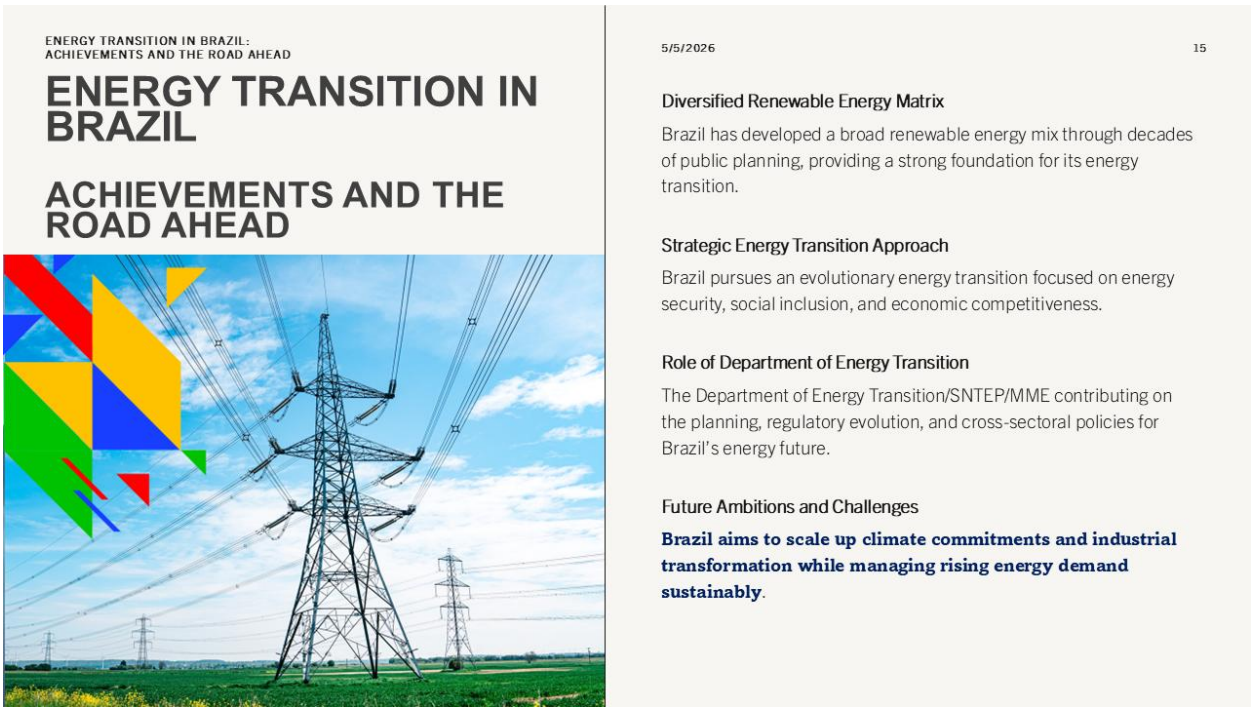
Director
Department of Energy Transition

Ministry of Energy

Brazil

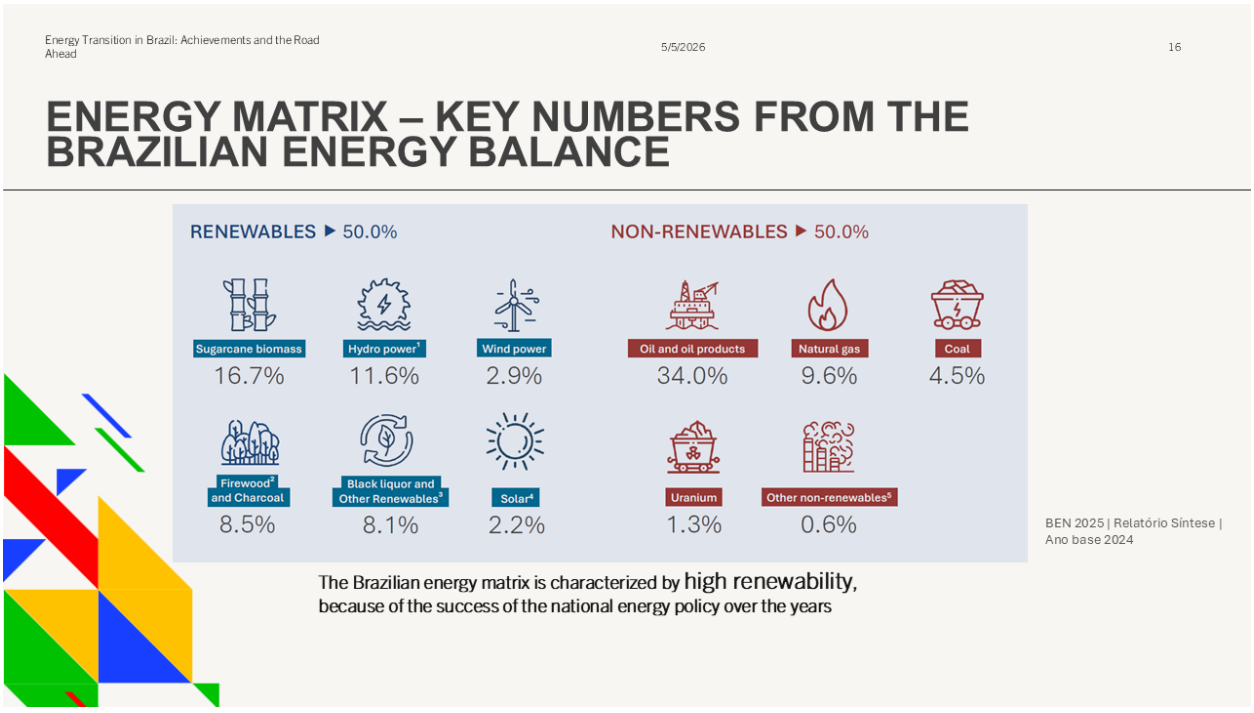
Overview

Brazil's energy transition story rests on four foundations: a diversified renewable energy matrix developed through decades of public planning; a strategic approach focused on energy security, social inclusion, and economic competitiveness; cross-sectoral planning and regulatory coordination through the Department of Energy Transition; and the challenge of scaling up climate commitments while managing rising energy demand sustainably.



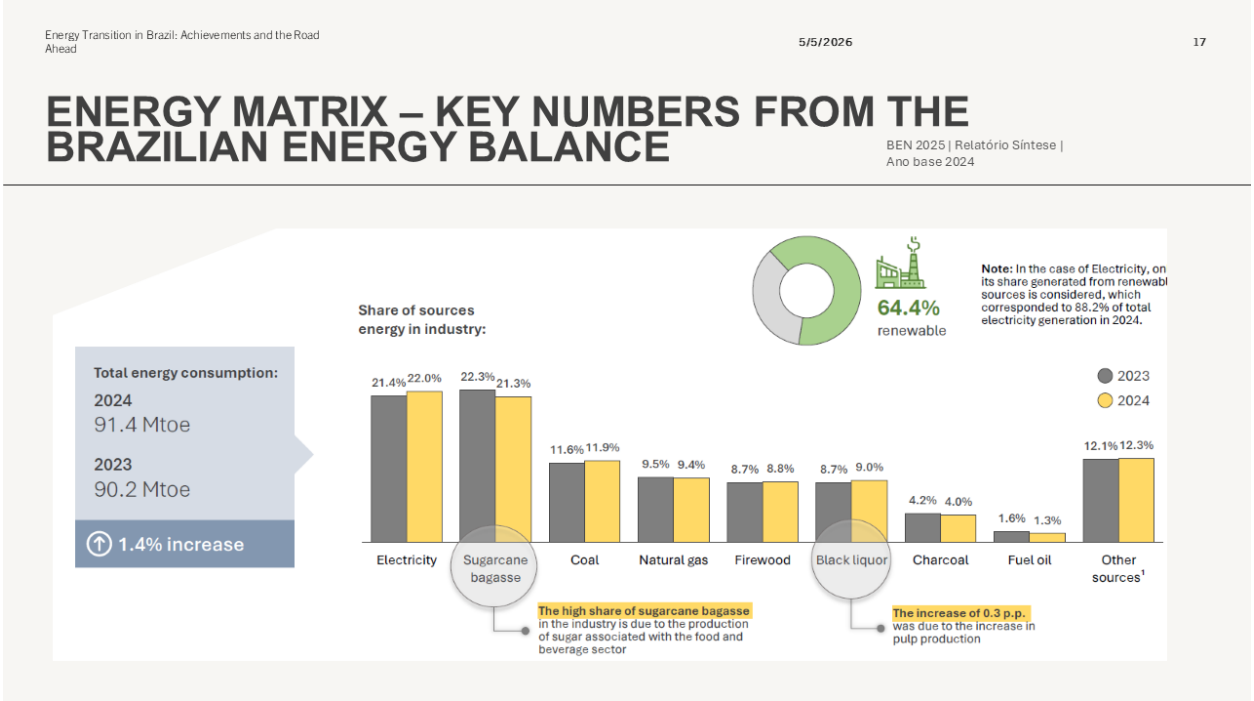
Energy Matrix — Key Numbers: Overview (BEN 2025, Base Year 2024)

Brazil's energy matrix is characterized by a high share of renewables, owing to the success of national energy policy over many years. Brazil generates approximately 50 percent of its total energy supply from renewable sources — well above global averages of 14.3 percent (World, 2022) and 13.2 percent (OECD, 2023).



Energy Matrix — Key Numbers: Industry Sector

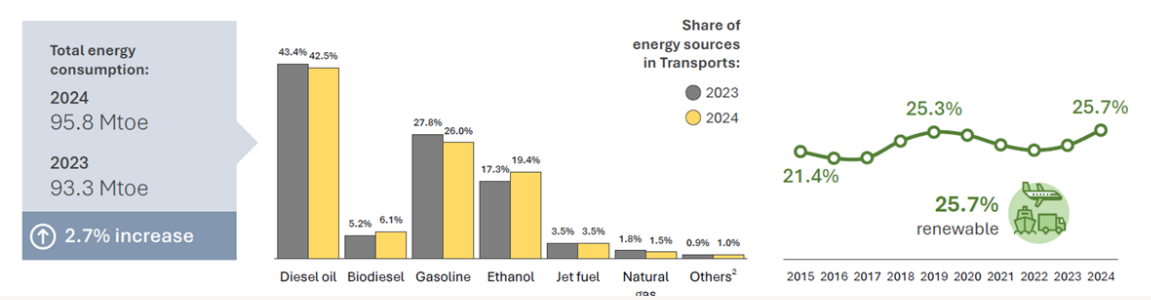
In the industrial sector, electricity and bioenergy — particularly sugar cane bagasse — play central roles. Brazil's industrial energy mix reflects the country's long tradition of integrating biomass into its energy system.



Energy Matrix — Key Numbers: Transport Sector

Energy consumption in transport in 2024 increased by 2.7 percent compared to 2023. The main highlights were increases in biodiesel consumption (+19.3 percent) and hydrous ethanol (+30.1 percent), which drove the transport sector's renewable share up to 25.7 percent — a significant and internationally distinctive market penetration.

ENERGY MATRIX – KEY NUMBERS FROM THE BRAZILIAN ENERGY BALANCE



Energy consumption in transport in 2024[1] showed an increase of 2.7% compared to 2023.

The main highlights were the increases in the consumption of biodiesel (+19.3%) and hydrous ethanol (+30.1%), which led to an increase in the sector's renewability to 25.7%.

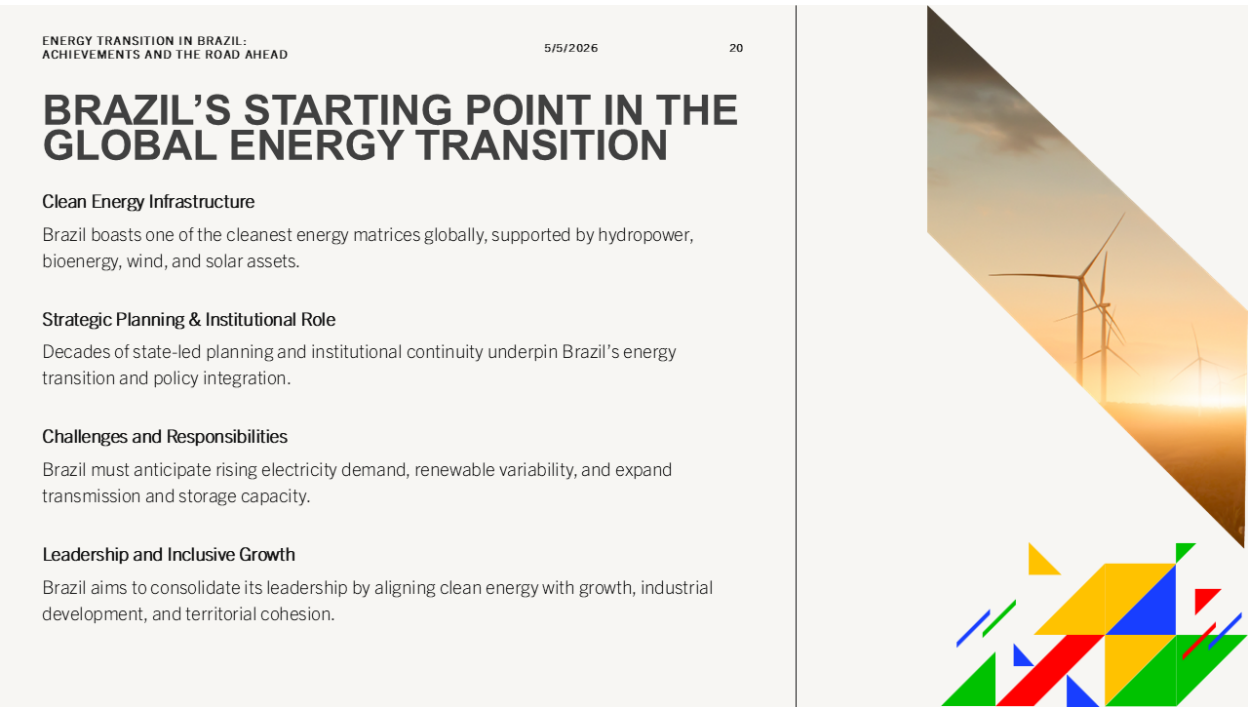
Energy Matrix — Key Numbers: Summary Statistics

To summarize Brazil's starting position: 50 percent of total energy supply is renewable, exceeding global averages. Renewables account for more than 85 percent of electricity generation, led by hydropower, wind, and solar. About two-thirds of Brazil's final energy use is renewable, with bioenergy playing a central role in transport and industry. The core challenge is expanding these renewable shares while meeting growing total energy demand.



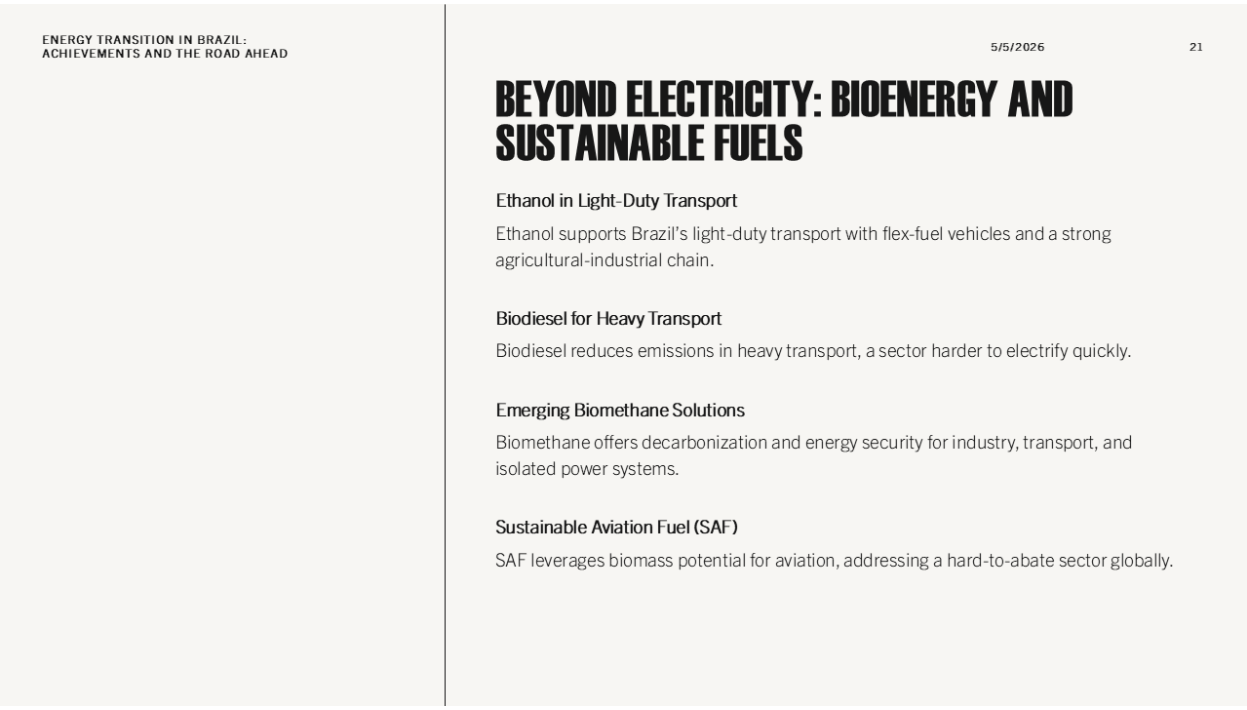
Brazil's Starting Point in the Global Energy Transition

Brazil's starting point is strong: one of the cleanest energy matrices globally, supported by hydropower, bioenergy, wind, and solar. Decades of state-led planning and institutional continuity underpin its energy policy. However, Brazil must now anticipate rising electricity demand, manage renewable variability, and expand transmission and storage capacity — all while consolidating its leadership in inclusive, territorially cohesive clean energy growth.



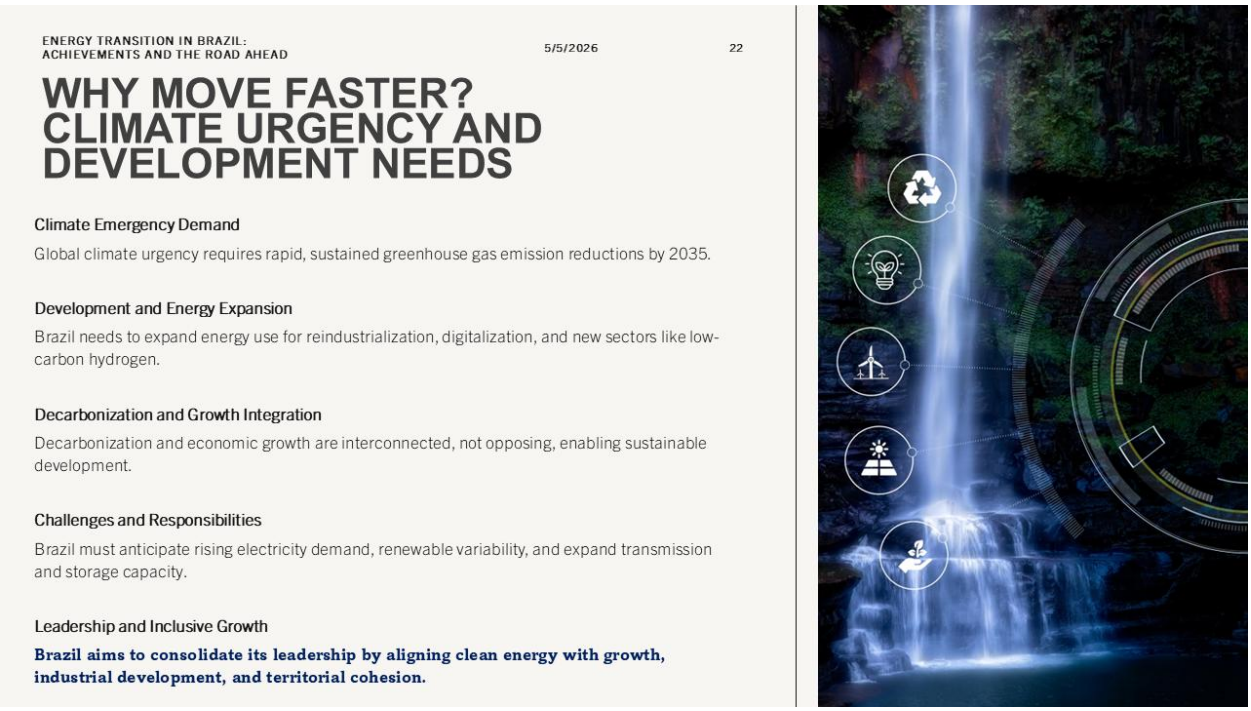
Beyond Electricity: Bioenergy and Sustainable Fuels

Brazil's energy transition extends well beyond electricity. Ethanol supports light-duty transport through flex-fuel vehicles and a strong agricultural-industrial chain. Biodiesel reduces emissions in heavy transport, a sector harder to electrify quickly. Biomethane offers decarbonization and energy security for industry, transport, and isolated power systems. And sustainable aviation fuel (SAF) leverages Brazil's biomass potential to address one of the hardest-to-abate global sectors.



Why Move Faster? Climate Urgency and Development Needs

Global climate urgency requires rapid, sustained GHG reductions by 2035. At the same time, Brazil needs to expand energy use for reindustrialization, digitalization, and new sectors such as low-carbon hydrogen. Decarbonization and economic growth are not opposing forces — they are interconnected, enabling sustainable development. Brazil must anticipate rising demand, manage variability, and scale transmission and storage, all while leading with clean growth and territorial cohesion.

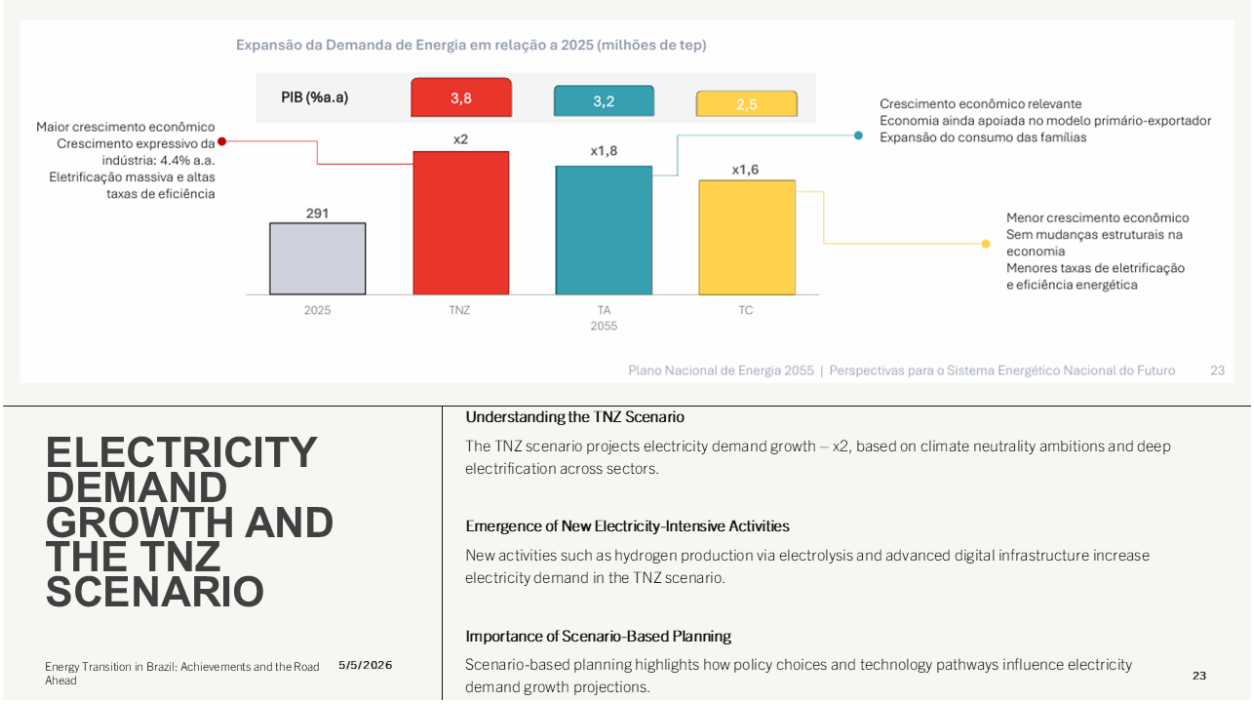


Electricity Demand Growth and the TNZ Scenario

Brazil's national long-term energy plan (PNE 2055) includes three demand scenarios. The most ambitious — the TNZ, or Transition Needs Zero scenario — projects electricity demand approximately doubling over the next 30 years, driven by:

a) deep electrification across sectors,
b) hydrogen production via electrolysis, and
c) digital infrastructure such as data centers.

This scenario is the reference base for policy and infrastructure planning, and the foundation for identifying what investments and regulatory changes are needed.

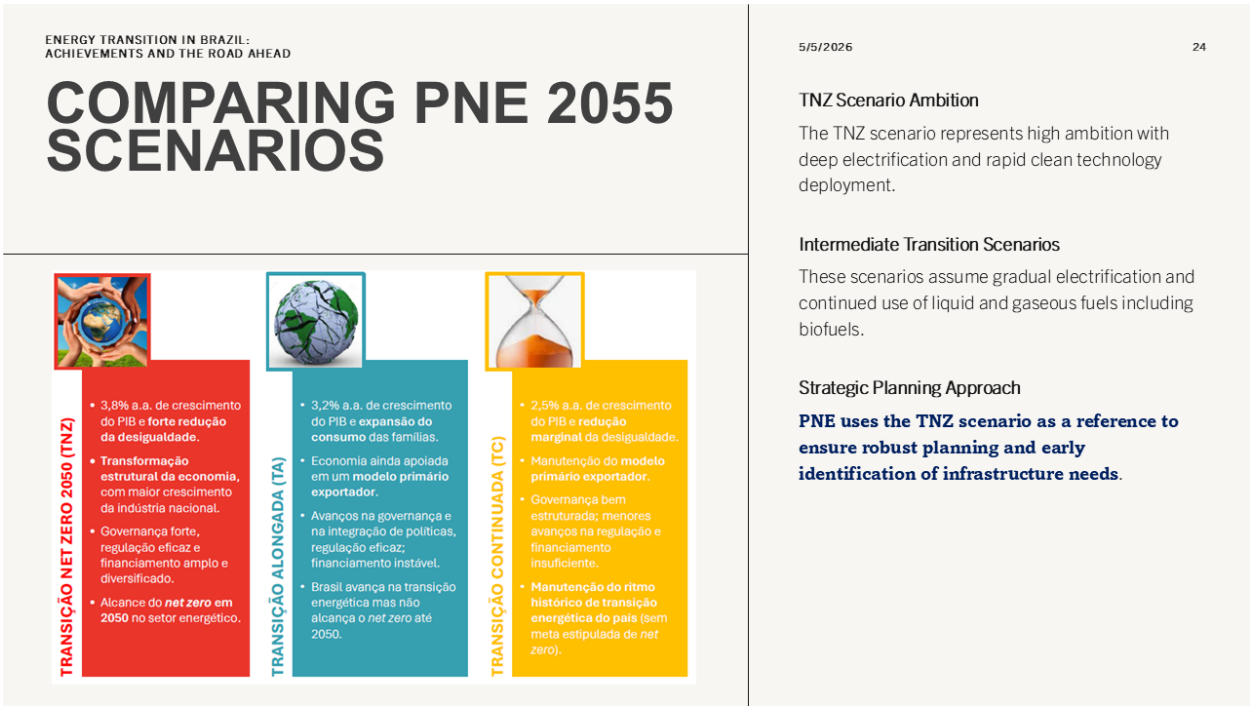


Comparing PNE 2055 Scenarios

The TNZ scenario represents the highest ambition, with deep electrification and rapid clean technology deployment.

Intermediate transition scenarios assume gradual electrification with continued use of liquid and gaseous fuels, including biofuels.

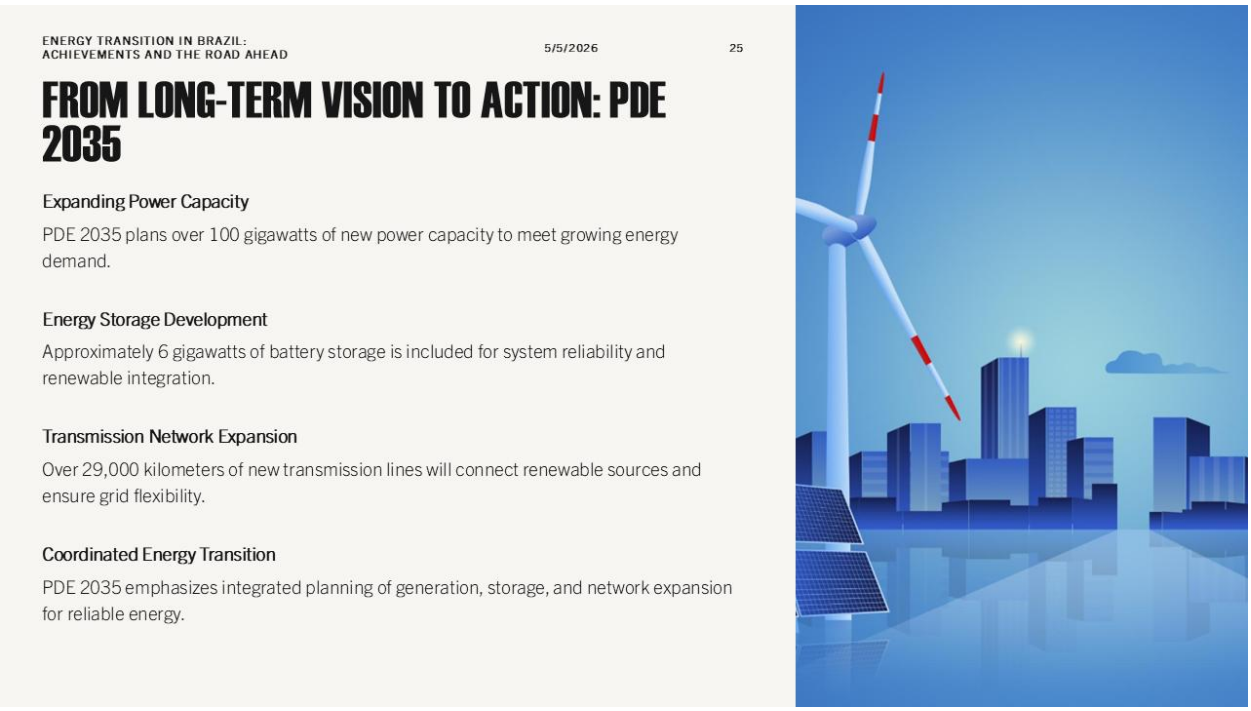
Brazil uses the TNZ scenario as the reference to ensure robust planning and early identification of infrastructure needs — even if actual deployment follows a more gradual path.



From Long-Term Vision to Action: PDE 2035

Brazil's ten-year energy expansion plan, PDE 2035, translates the long-term vision into concrete near-term investment targets:

a) over 100 gigawatts of new power capacity;
b) approximately 6 gigawatts of battery storage for system reliability and renewable integration; and
c) over 29,000 kilometers of new transmission lines to connect renewable sources and ensure grid flexibility. The plan emphasizes integrated coordination of generation, storage, and network expansion.



Core Challenges of the Energy Transition

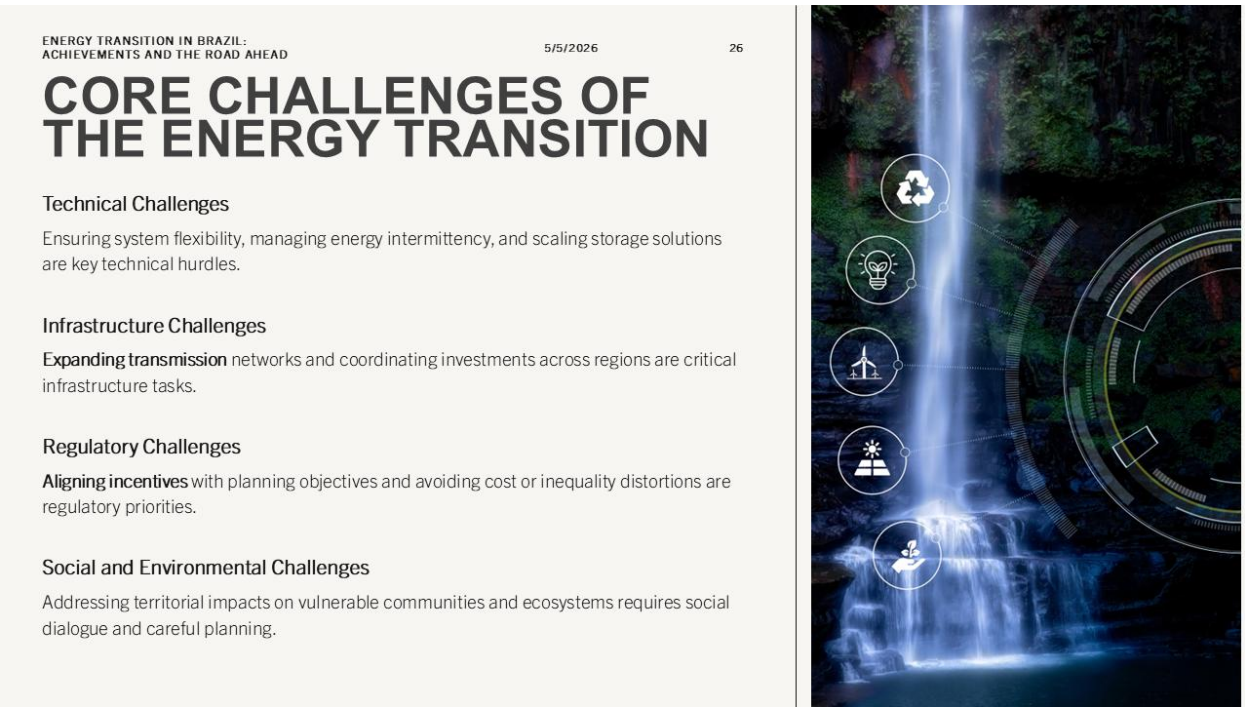
Brazil faces four categories of core challenges:

Technical: ensuring system flexibility, managing intermittency, and scaling storage solutions.

Infrastructure: expanding transmission networks and coordinating investments across regions.

Regulatory: aligning incentives with planning objectives and avoiding cost distortions or inequalities.

Social and environmental: addressing impacts on vulnerable communities and ecosystems, particularly in the Amazon and Northwest regions, which requires careful social dialogue.



National Energy Transition Policy — PNTE

In 2024, a decisive institutional step was taken: Brazil published its National Energy Transition Policy (PNTE), structured around two key instruments — PLANTE and FONTE.

The National Energy Transition Plan (PLANTE) is the bridge between PNE 2055 long-term scenarios and concrete government action. It integrates energy policy with climate action, industrial growth, mining, innovation, finance, and social policy, and provides regulatory clarity to investors.

The National Energy Transition Forum (FONTE) is Brazil's institutional space for multi-stakeholder dialogue, coordination, and governance — bringing together civil society, the productive sector, and government.

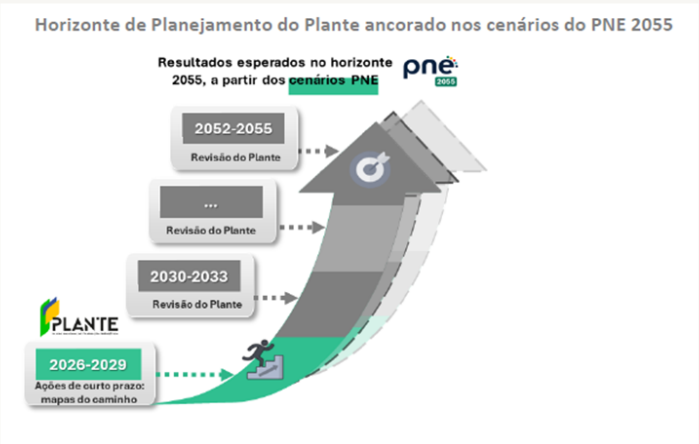
PLANTE and FONTE

PLANTE provides strategic policy coordination across sectors, mobilizes investor confidence through regulatory clarity, and embeds social and environmental justice criteria to ensure an inclusive transition.

FONTE provides the governance and participatory architecture — a forum bringing together the full range of stakeholders needed to make cross-sectoral policy work in practice.

FOOTER TEXT

PLANTE – NATIONAL ENERGY TRANSITION PLAN



5/5/2026 28

Strategic Policy Coordination

PLANTE bridges long-term energy scenarios and government action with coordinated policy measures and priorities.

Integration Across Sectors

The plan integrates energy policy with climate action, industrial growth, mining, innovation, finance, and social policies.

Investor Confidence and Capital Mobilization

PLANTE provides regulatory clarity and clear signals to investors, reducing uncertainty and encouraging investment.

Commitment to Social and Environmental Justice

Social and environmental criteria are embedded in PLANTE to ensure a just and inclusive energy transition.

FOOTER TEXT 5/5/2026 29

FONTE – GOVERNANCE AND PARTICIPATION



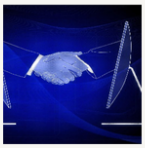
Inclusive Governance Platform

FONTE serves as an institutional space for dialogue among government, private sector, academia, and civil society.



Transparency and Regional Perspectives

FONTE ensures transparency and incorporates regional and sectoral views to enhance energy policy recommendations.



Strengthening Social Legitimacy

Institutionalizing participation builds consensus and prevents conflicts in Brazil's long-term energy transition.

Planning to Grow Well

In summary, Brazil is a global leader in clean energy and is committed to responsible, sustainable growth. Its integrated planning architecture — PNE 2055 for long-term vision, PDE 2035 for medium-term action, and PNTE (PLANTE and FONTE) for governance and

implementation — links ambition with concrete delivery. The mission is clear: articulate policies to reduce risks, expand social benefits, and drive sustainable development through the energy transition.

FOOTER TEXT

PLANNING TO GROW WELL



5/5/2026 30

Leadership in Clean Energy

Brazil is a global leader in clean energy, requiring ongoing planning and strong institutional coordination.

Integrated Energy Planning and Police driving

PNE 2055, PDE 2035, with PNTE - PLANTE and FONTE link long-term vision with medium-term actions and governance.

Sustainable Growth Goals

Focus on energy security, social inclusion, and environmental integrity to ensure growth is responsible and sustainable.

Mission of Energy Transition

Articulating policies to reduce risks, expand social benefits, and drive sustainable development through energy transition.

Brazil, World Leader in Energy Transition — Ministério de Minas e Energia

Uruguay: A Model Renewable Energy Transition

Arianna Spinelli

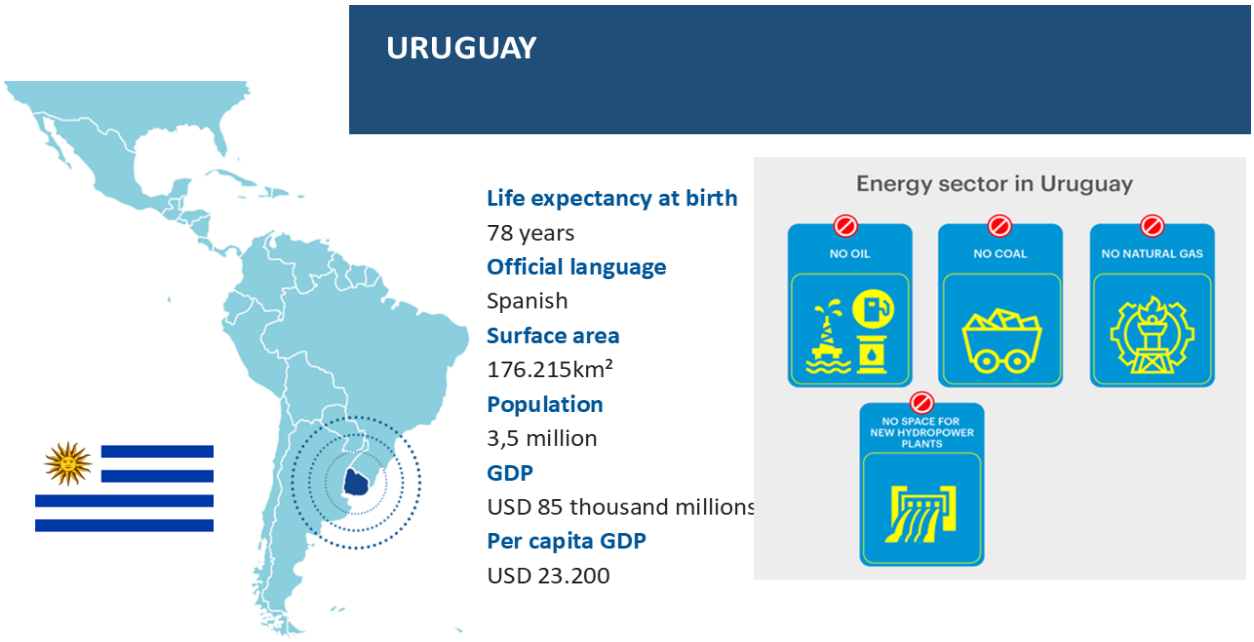
Director for Energy,

Ministry of Industry, Energy and Mining, Uruguay

Country Overview

Uruguay is one of the least densely populated countries in South America, with a population of 3.5 million, a surface area of 176,215 km^2, and a GDP of approximately USD 85 billion (per capita GDP: USD 23,200). Life expectancy at birth is 78 years. The country has strong indicators in human development, civil rights, legal certainty, and institutional strength.

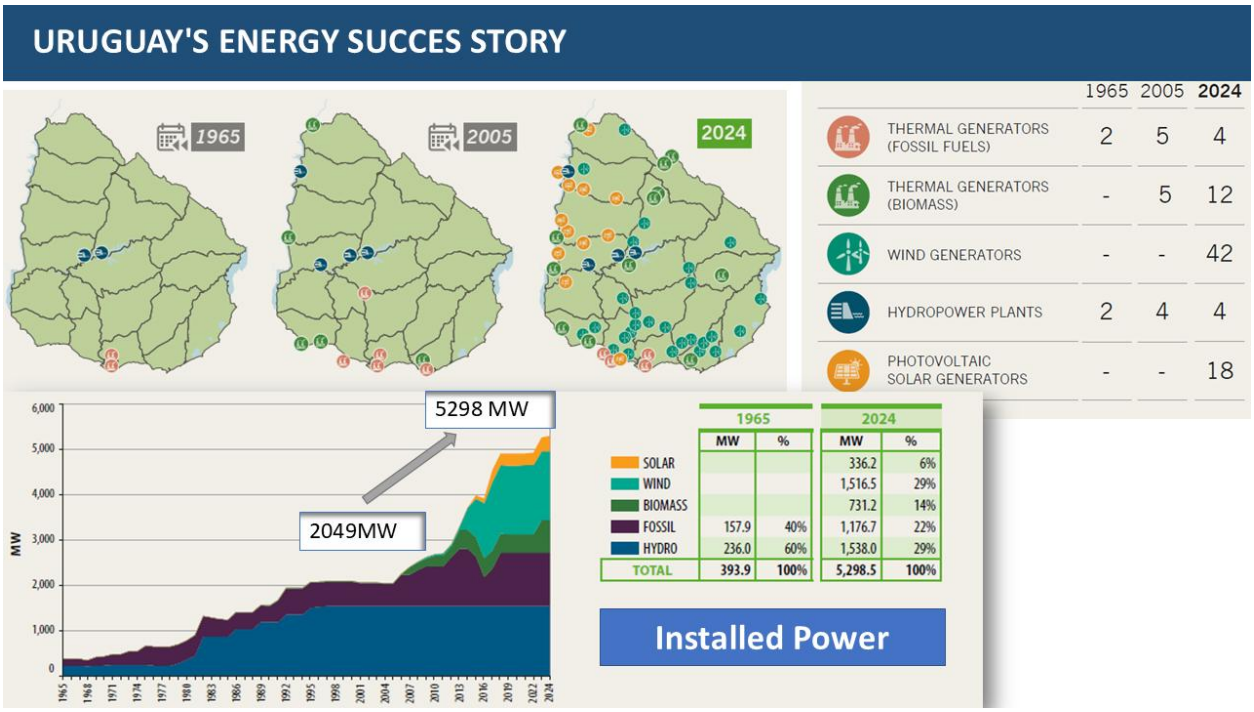
From an energy perspective, Uruguay has no proven reserves of petroleum, coal, or natural gas. It has turned this constraint into a strategic advantage by leveraging its renewable resource base intensively.



Uruguay's Energy Success Story

Installed Power

Over the past decade, Uruguay has transformed its electricity sector. Installed power capacity has grown substantially — from 2,049 MW in 2005 to 5,298 MW in 2024 — through the deployment of wind farms, solar plants, and biomass facilities alongside the country's traditional hydroelectric infrastructure. This growth has occurred across all these sources and is geographically distributed throughout the national territory.



	1965	2005	2024
THERMAL GENERATORS (FOSSIL FUELS)	2	5	4
THERMAL GENERATORS (BIOMASS)	-	5	12
WIND GENERATORS	-	-	42
HYDROPOWER PLANTS	2	4	4
PHOTOVOLTAIC SOLAR GENERATORS	-	-	18

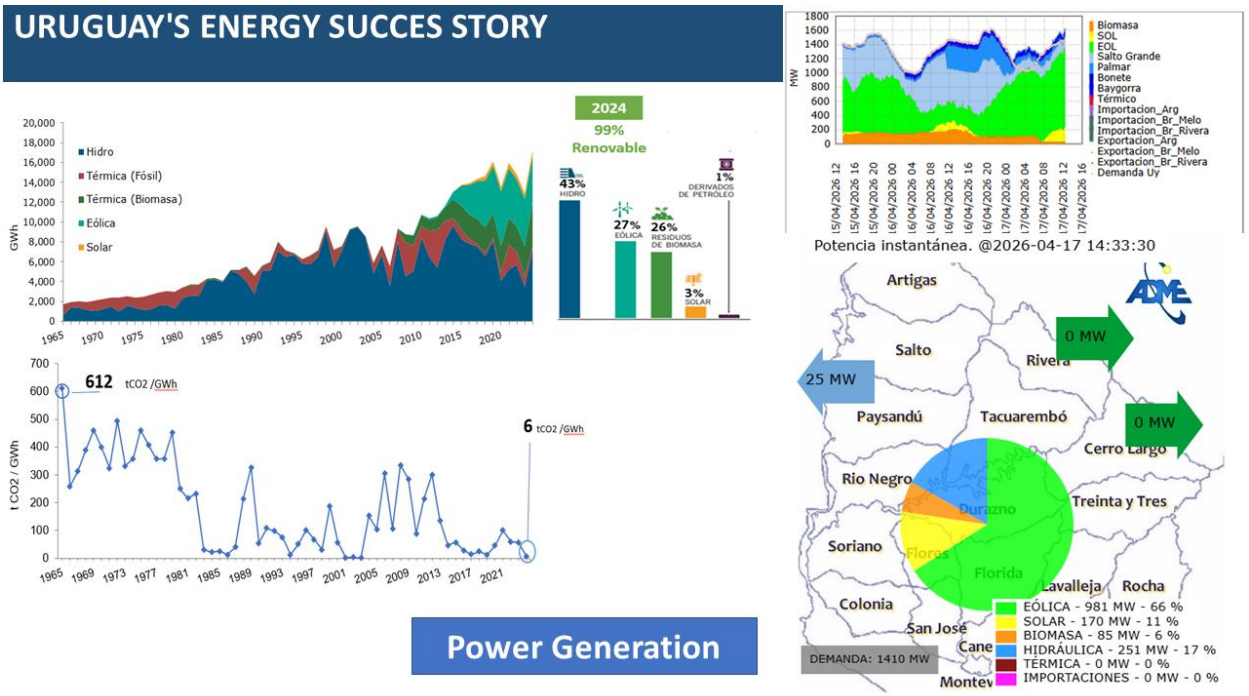
	1965		2024	
	MW	%	MW	%
SOLAR			336.2	6%
WIND			1,516.5	29%
BIOMASS			731.2	14%
FOSSIL	157.9	40%	1,176.7	22%
HYDRO	236.0	60%	1,538.0	29%
TOTAL	393.9	100%	5,298.5	100%

Power Generation

As a result, Uruguay has achieved an average renewable share in electricity generation of approximately 95 percent in recent years. In 2024, the renewable share reached 99 percent. Even in 2023 — the driest year on record in Uruguay's history — renewables exceeded 90 percent.

This high level of renewable energy is clearly reflected in a significant decrease in CO2 emissions per GWh generated.

On the day this presentation was prepared, 100 percent of electricity was being generated from renewable sources, while the country was simultaneously exporting power to Argentina.



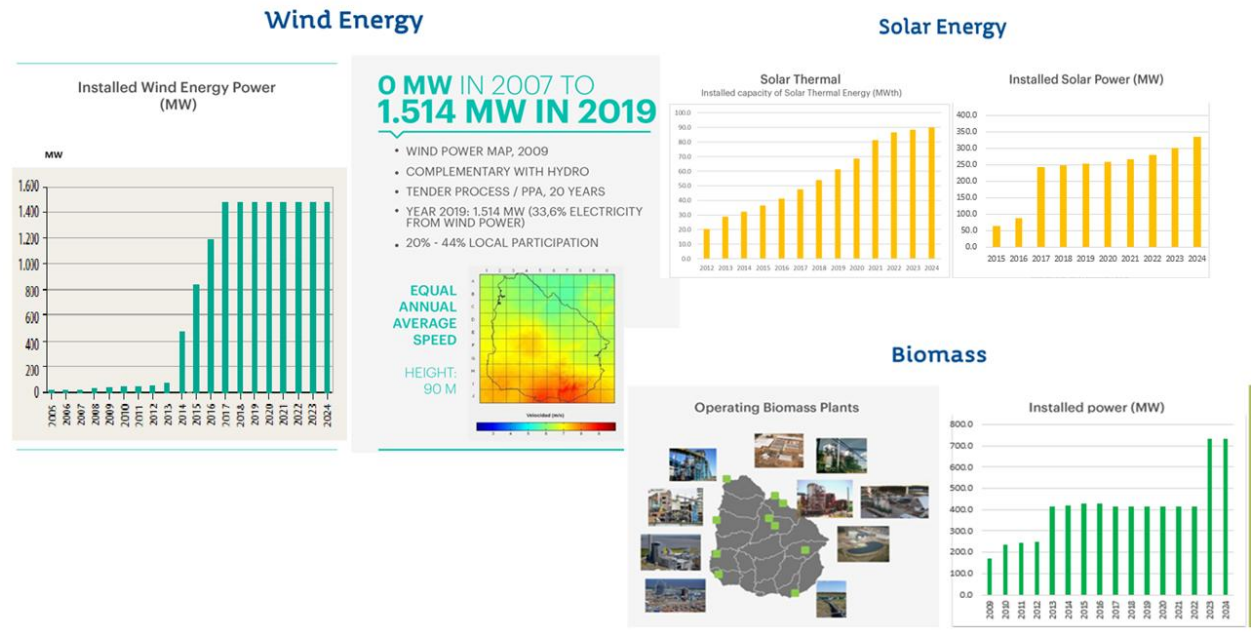
Electricity Generation in Uruguay

Wind, Solar, and Biomass Detail

Wind energy was the first source to see dramatic expansion due to the number of wind farms and installed capacity in such a short period. Solar energy, while introduced more recently, is expected to grow significantly in coming years and will likely follow a steep growth curve, as the country has favorable solar conditions that complement wind generation both across the day and across seasons.

Biomass played an important early role, with several notable production peaks corresponding to the installation of cellulose pulp production plants that use a portion of their process residues for electricity generation.

A key feature of Uruguay's system is the high complementarity between wind, solar, and biomass — not only across hours of the day but across seasons — which has enabled reliable and cost-effective generation year-round.

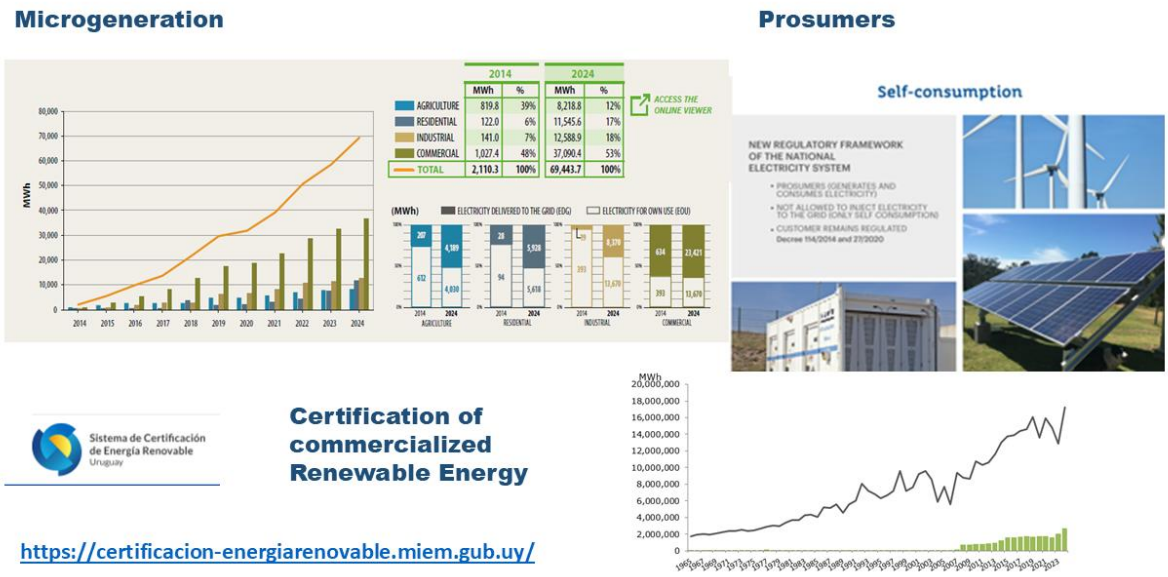


Other Changes in the Electricity Market — Microgeneration, Prosumers, and Renewable Energy Certification

Uruguay has also seen growth in distributed microgeneration — self-use of renewable energy, with surplus power sold back to the grid. Growth has been more moderate than in some neighboring countries, and the country is currently reviewing its regulatory framework for micro-generators connected at low voltage to maintain system-wide balance.

Additionally, Uruguay is now offering renewable energy origin certification— primarily for medium and large consumers, self-producers, and subscribers with their own generation capacity. This certificate specifies the percentage share of each energy source used to generate the electricity consumed in each period, an increasingly important tool for sustainability reporting.

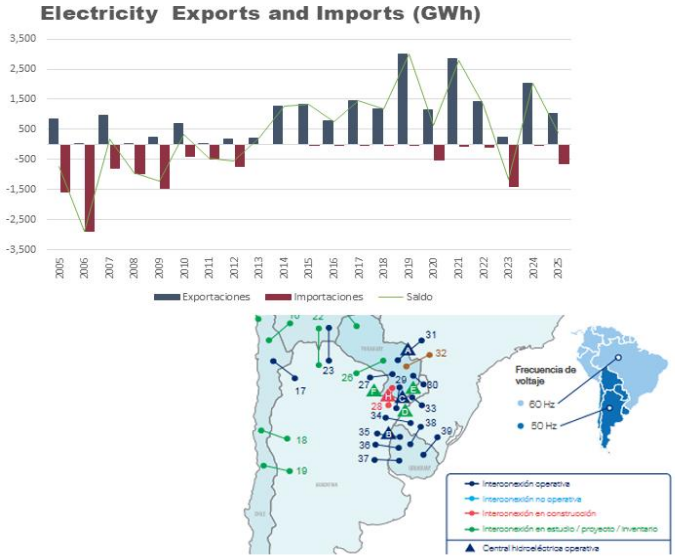
OTHER CHANGES IN THE ELECTRICITY MARKET

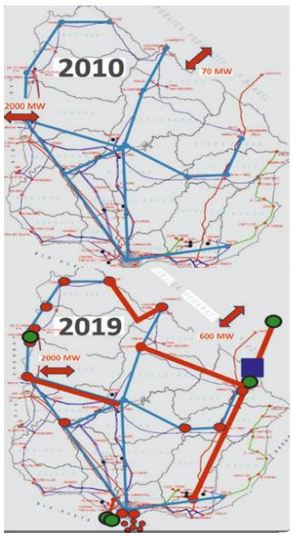


Interconnections in the Electricity Market

Uruguay is interconnected with both Argentina and Brazil. In recent years, it has reinforced its transmission infrastructure and upgraded its connection with Brazil. A critical result of this, and of the country's renewable abundance: Uruguay has transitioned from being a net energy importer to a net energy exporter. In years of strong wind and adequate rainfall, it exports substantial quantities of electricity to its neighbors.

INTERCONECTIONS IN THE ELECTRICITY MARKET





Other Highlights of Uruguayan Energy Policy — Energy Efficiency, Biofuels, Bioenergy

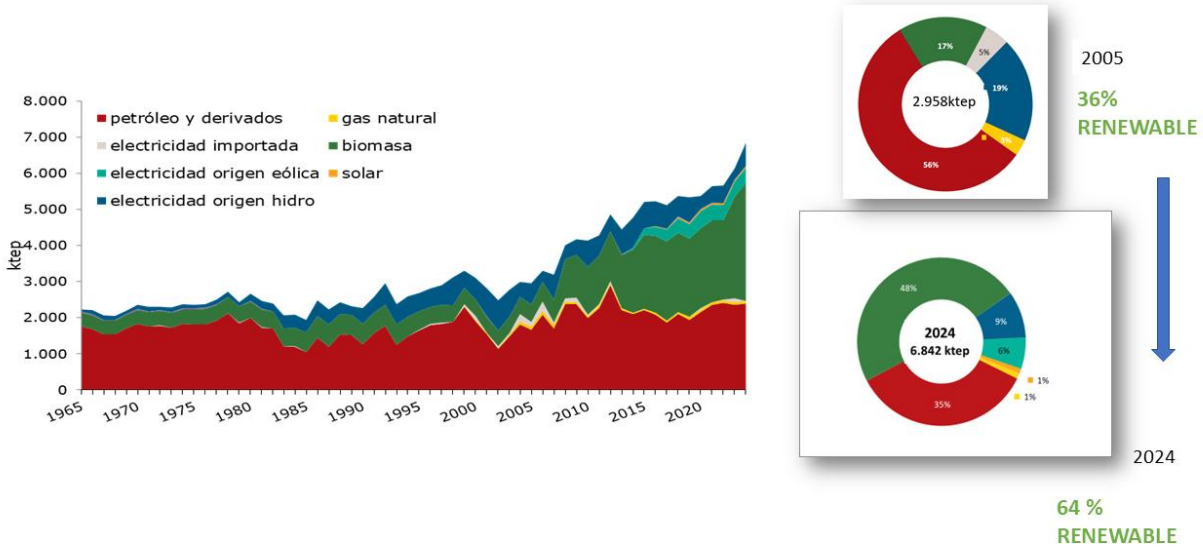
Uruguay's energy transition extends beyond electricity. The country has made significant progress on energy efficiency, biofuels, and waste-valorization bioenergy. These contributions — while less visible internationally than the electricity transformation — have also contributed meaningfully to the overall energy transition and to reducing fossil fuel dependence.



Energy Supply Matrix: 2005 vs. 2024 (36% → 64% Renewable)

Looking at the primary energy supply matrix, the total absolute consumption of fossil fuels has remained essentially stable since 2005 — meaning that all demand growth over the past nearly two decades has been met entirely by renewable energy. The renewable share has grown from 36 percent in 2005 to 64 percent in 2024. This is an exceptionally significant achievement, especially in the context of today's global energy discussions.

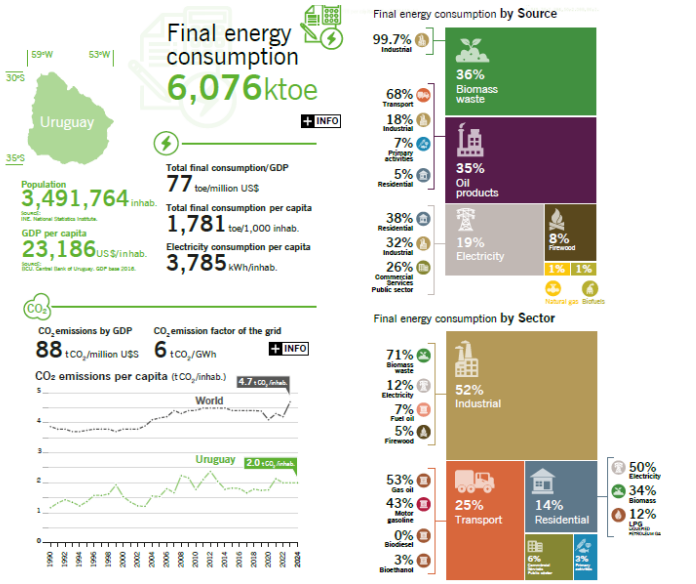
ENERGY SUPPLY MATRIX

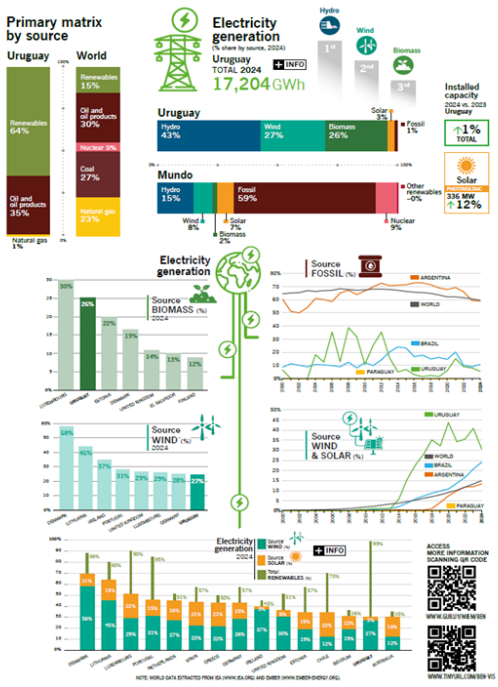


Uruguay Compared to the World

Uruguay's low carbon emissions and high renewable share compare favorably to virtually every country globally. When mapped against international benchmarks, Uruguay stands out as a clear leader in renewable penetration, low per-capita emissions, and decoupling of energy demand growth from fossil fuel use.

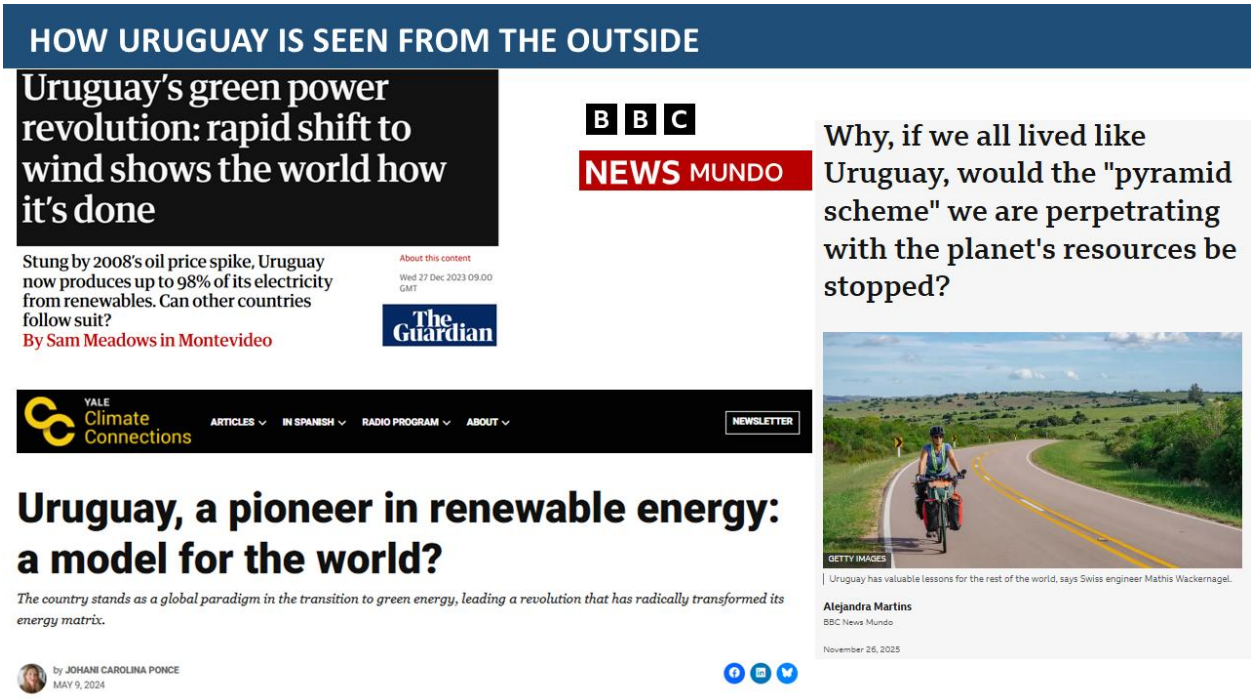
URUGUAY COMPARED TO THE WORLD





How Uruguay Is Seen from the Outside

Uruguay's energy transition has drawn significant international attention and recognition. The country regularly appears in global media and rankings as a leading example of a rapid, successful, and replicable renewable energy transition — with headlines from outlets across the world citing it as a model for other nations to study and emulate.



The key to Uruguay's success was a paradigm shift in how the energy transition was conceived: not as a simple technical or economic problem, but as a complex, multi-dimensional process spanning economic, social, geopolitical, technological, regulatory, and ethical dimensions.

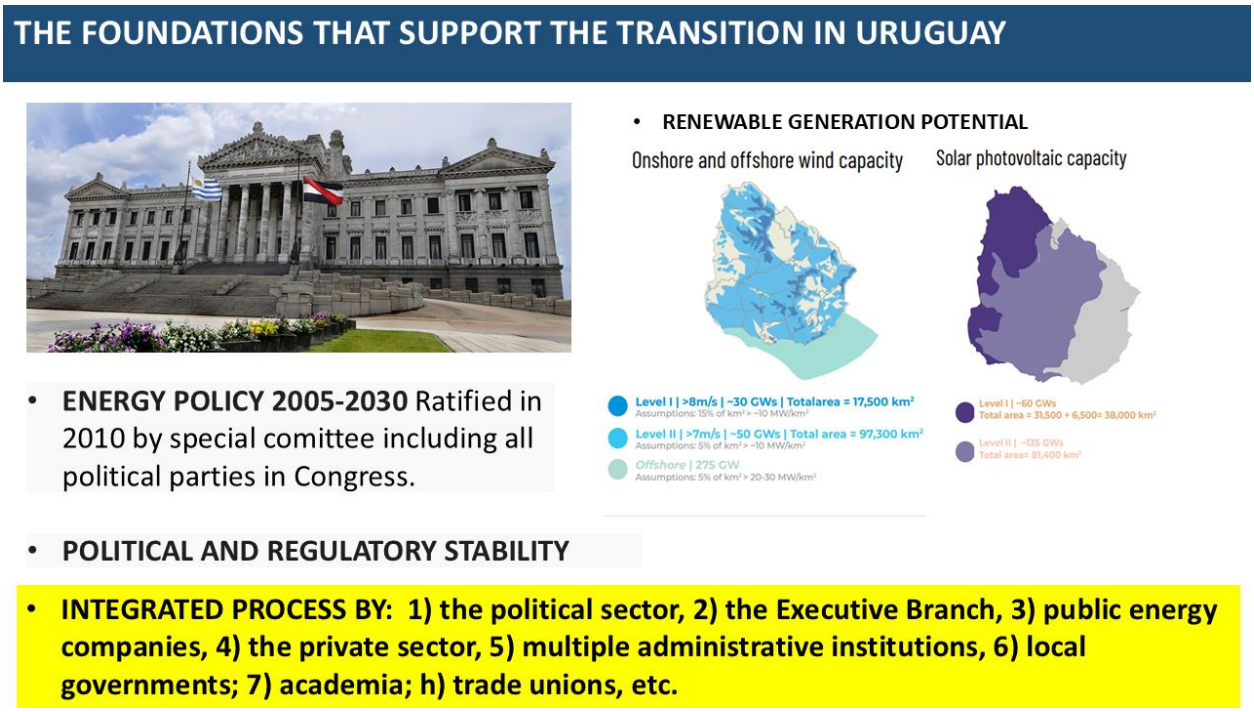
The foundations that made this possible include:

Energy Policy 2005–2030: Ratified in 2010 by a special committee including all political parties in Congress, creating multiparty consensus across government cycles.

Renewable generation potential: Uruguay's natural endowment in wind, solar, and biomass, and their strong seasonal complementarity.

Integrated process: Involving the political sector, the Executive Branch, public energy companies, the private sector, multiple administrative institutions, local governments, academia, trade unions, and civil society — ensuring that the decisions taken would be durable across administrations.

Political and regulatory stability: Despite changes in government and political leadership, the energy policy framework has been broadly respected through to the present day.



New Challenges for Uruguay: More Decarbonization, More Sovereignty, and Future Priority Areas

Uruguay still has much to accomplish. The next phase of decarbonization must extend beyond electricity to the demand side — transport, industry, buildings. Key challenge areas include: the role of natural gas; alternative fuels; and affordable energy. Therefore, we are working on the development of a new energy policy to 2050.

Future priority areas currently under active development:

Sustainable mobility: Uruguay's Interministerial Commission for Sustainable Mobility has begun sessions to coordinate electric vehicle policy and infrastructure.

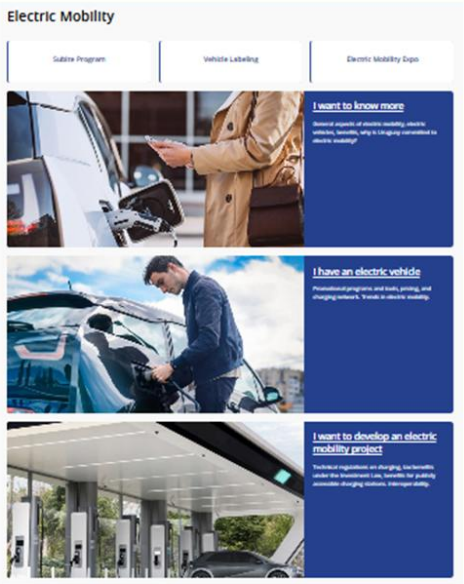
Green hydrogen: Uruguay is developing a national strategy for green hydrogen, with significant wind and solar resources making it a potential producer and exporter.

Energy and circular economy: As an example, through the ReValora platform, Uruguay is integrating circular economy principles into its energy strategy.

Energy Policy Review Process: Uruguay is currently undertaking a formal review of its energy policy, structured around the OLADE multi-actor planning framework. The process updates the 2017 planning cycle and is targeting a product with a 2050 horizon.



SUSTANAIBLE MOBILITY



https://www.gub.uy/ministerio-industria-energia-mineria/MovilidadElectrica

Improvements in planning processes

The Interministerial Commission for Sustainable Mobility began its sessions

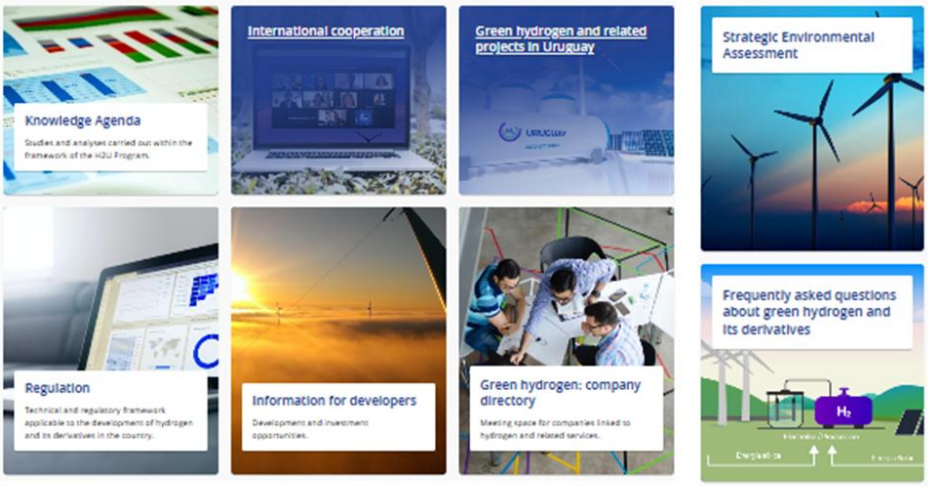
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The Ministers of Transport, Housing, Industry, and Environment participated in the first meeting of this commission, whose mission is to develop a public policy that brings together strategic aspects for developing sustainable urban mobility for people and goods. The secretariat of this body will rotate and, in this initial phase, will be led by the Ministry of Industry.



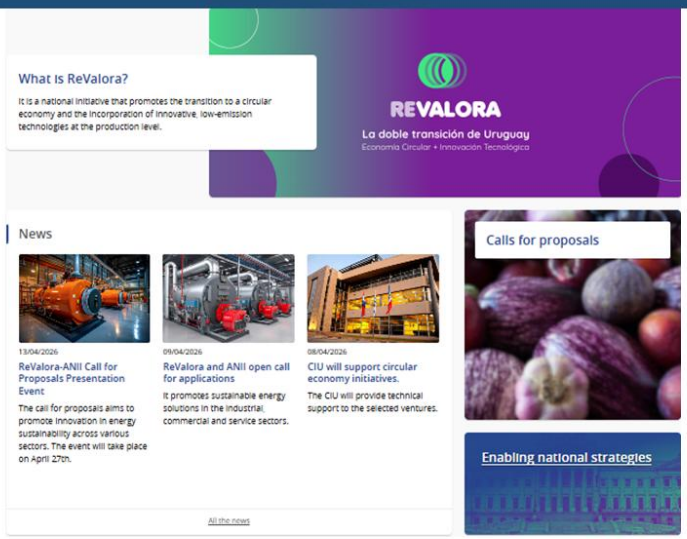
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GREEN H2



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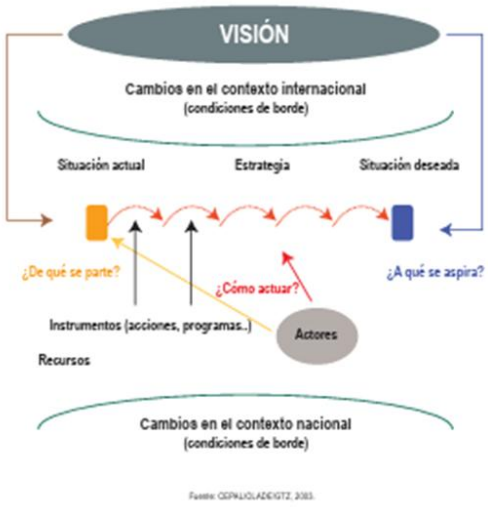
ENERGY AND CIRCULAR ECONOMY



https://www.gub.uy/ministerio-industria-energia-mineria/ReValora

ENERGY POLICY REVIEW PROCESS





Chile: Long-Term Energy Planning Process (PELP)

Isabella Villanueva-García |

Head of Planning and Climate Change Unit, Ministry of Energy, Chile

PELP Context

PELP is a process established under Chile's General Electricity Services Law and developed by the Ministry of Energy. It is fully reviewed every five years, with the possibility of issuing an annual update report.

Its objective is to project the country's energy supply and demand for various future scenarios over a period of at least 30 years, so that these projections can inform the planning process for the electric transmission system developed by the National Energy Commission (CNE).

What is included in each PELP cycle:

- Scenarios for energy supply and demand projections, with particular focus on electricity
- Identification of power generation hubs — geographic zones with high renewable potential
- Distributed generation modeling
- International energy exchanges and interconnections
- Environmental policies and energy efficiency targets
- Regional energy strategic plans across all 16 of Chile's regions

This legal mandate is critically important. In 2016, Chile introduced PELP as part of one of its major energy transition reforms, responding to the new wave of renewable energy in the electricity matrix. It is a planning process mandated not just within the Ministry of Energy but also in the National Energy Commission — creating two complementary state planning instruments.

Policy Linkages — Connecting Energy Planning to Climate Commitments

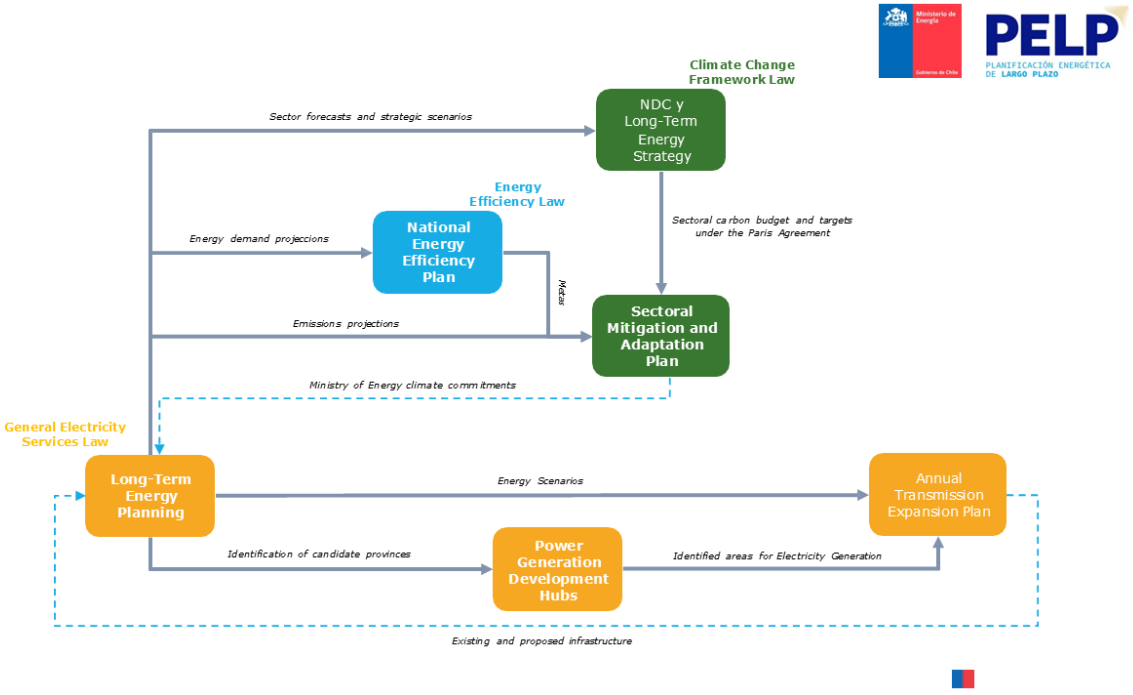
A central question for our team has been: what is the connection between energy planning and climate commitments? The answer drives how we structure our work.

On the electricity side PELP provides the energy scenarios for the CNE's annual Transmission Expansion Plan. The power generation development hubs identified in PELP feed into that process as identified areas for electricity generation.

On the climate side PELP provides sector forecasts and strategic scenarios to inform Chile's NDC and long-term energy strategy. Those national climate instruments set sectoral carbon budgets and resilience targets under the Paris Agreement, which in turn flow back into PELP — creating a continuous feedback loop. The Sectoral Mitigation and Adaptation Plan sits in the middle of this cycle, receiving emissions projections from PELP and returning Ministry of Energy climate commitments back to the planning process.

In the middle of this architecture is Chile's Energy Efficiency Law. PELP provides energy demand projections to this process, and the resulting efficiency targets feed back into the modeling environment.

This is why our team is specifically named the Planning and Climate Change Unit — because these two streams are integrated in one modeling environment, not treated as separate exercises.

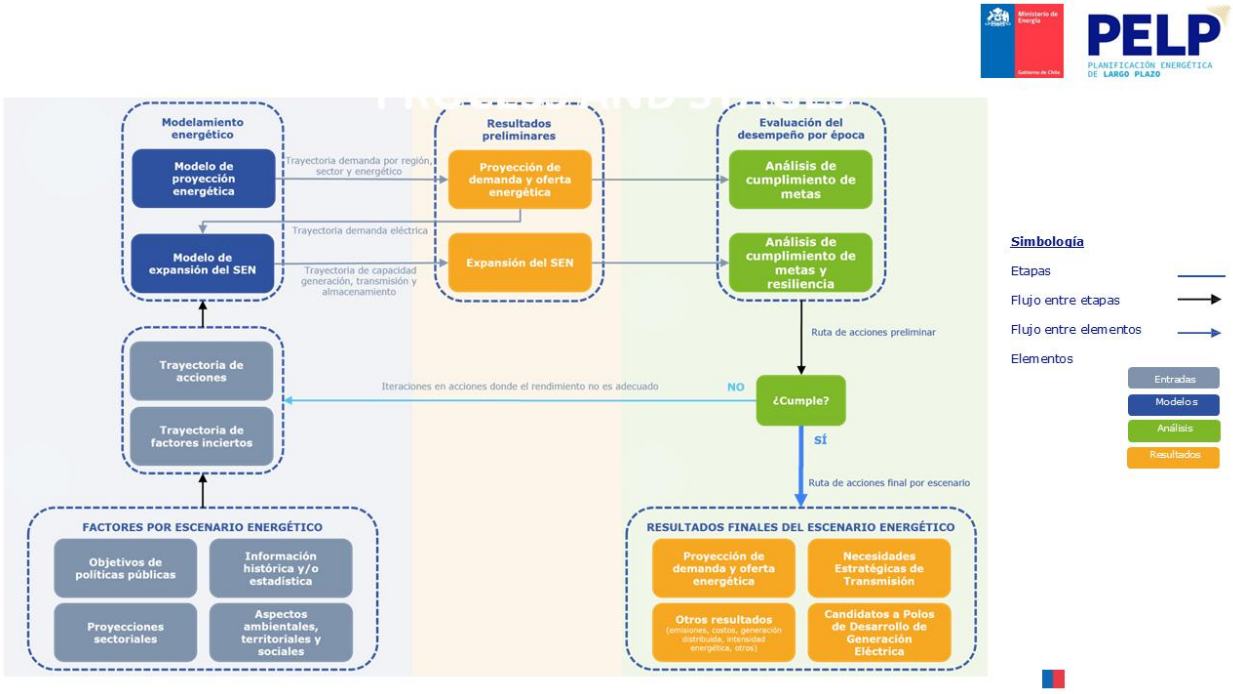


Process and Stages — Modeling Environment

The modeling environment at the core of PELP has two main models: an energy demand projections model — producing projections by region, year, and fuel or electricity type — and a national electricity system expansion model (SEN), which uses electricity demand projections to determine the optimal expansion of transmission, generation, and storage across Chile's national interconnected grid.

The process is iterative: results are evaluated against the targets and commitments defined for each scenario. If targets are not being met, specific actions are adjusted and the process iterates. Once targets are achieved, the final results are compiled.

Key outputs include: long-term energy demand and supply projections; strategic transmission needs between zones; generation hub candidates; and secondary results such as emissions, costs, energy intensity, and generation distribution — all of which inform public policy across different ministries. PELP is, in effect, a shared national calculator for energy and climate policy analysis.



Energy Projection Model — Final Energy Consumption to 2040

This chart shows the final energy consumption projection to 2040 from the Carbon Neutrality Scenario of PELP 2023–2027, with actual 2022 figures from the National Energy Balance for reference. Despite Chile's rapidly greening electricity generation mix, the country currently relies on fossil fuels for 64 percent of final energy consumption. By 2040, even under the carbon neutrality scenario, fossil fuels are projected to remain at approximately 46 percent.

This is a major challenge. The electrification of consumption — transport, industry, buildings — must accelerate significantly to change this trajectory.

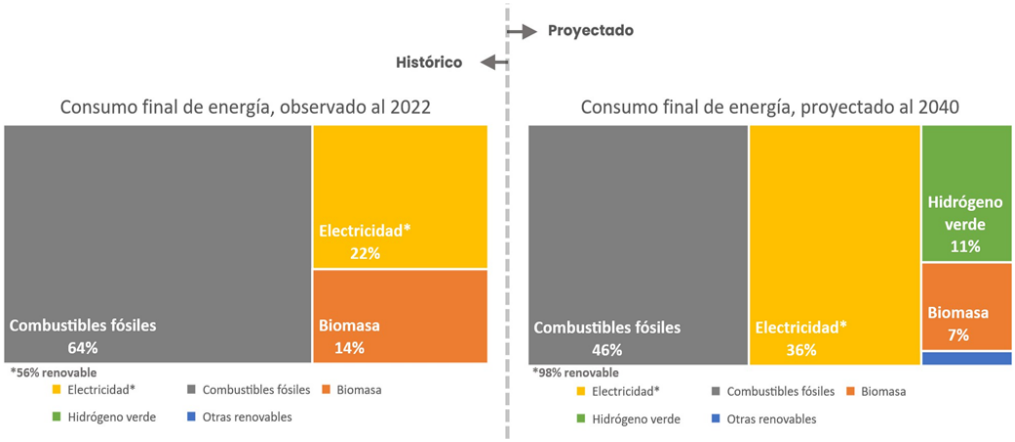


Figure 1. Final energy consumption by 2040, projection from the Carbon Neutrality Scenario of the PELP 2023–2027. Actual figures for 2022 are taken from the National Energy Balance.

SEN Expansion Model — Historical vs. Projected Generation

The electricity generation picture, by contrast, is considerably more optimistic. Historical generation data show the rapid growth of solar PV and wind in recent years, and projections to 2042 show this trend continuing strongly. The eruption of storage — from virtually nothing two years ago to a major projected component of the future mix — is a defining feature of the outlook.

Under the Carbon Neutrality scenario, we expect more than 90 percent of electricity generation to come from renewable sources in the long-term perspective, with solar PV and wind dominating, complemented by storage and hydro.

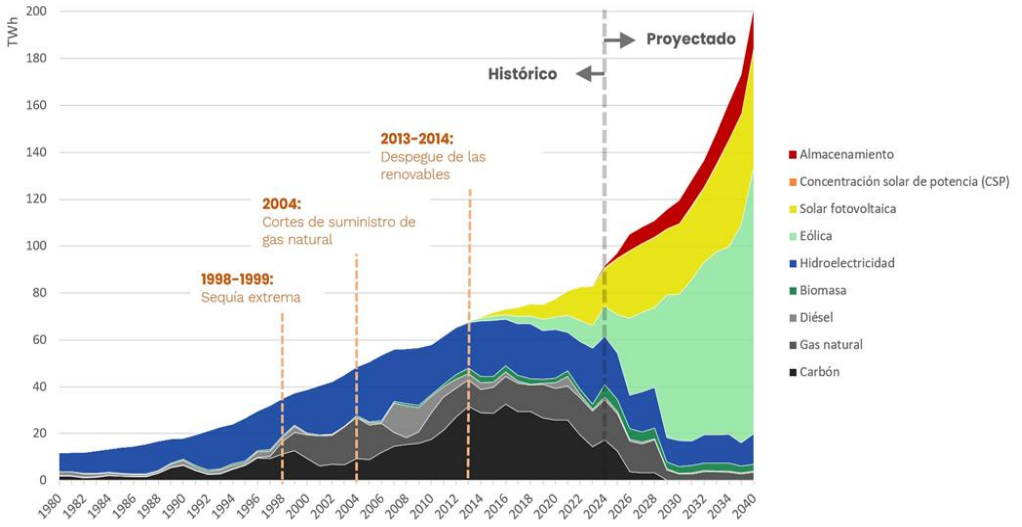


Figure 2. Historical vs. projected generation. Carbon neutrality scenario. National power system.

Policy and Regulatory Recommendations.

By Walter Vergara,

Vice-president Climate Institute

Brazil, Chile and Uruguay have already enacted, and are further complementing, a comprehensive policy framework for their energy transition. The foundational elements for the complete transition to an electrically driven economy using renewable energy are already in the process of being established. Moreover, many of the actions necessary are already embedded into existing policy decisions. However, complete transformation of the energy system and of the broader economy will still require additional measures, some are outlined below:

Facilitate expansion of transmission infrastructure. The expansion of the power system required to meet the demand of a fully electrified society will require a major revamping of the transmission capacity, at a size many times the current capacity of the transmission system. Given the magnitude of the task, there is value in the consideration of new technologies including:

a) At the outset of the expansion there is an opportunity to reconduct (replace traditional cable cores with lighter, high strength materials) existing high voltage lines. This will at least double transmission capacity of affected lines without requiring new rights of way;
b) Ensure that new HVDC lines allow for multi-entry points available to different generators, to reduce the set-up of new transmission corridors. Both requirements will reduce land tenure issues, and the overall cost of the system, if not of individual operators;
c) Given the potential benefits from the use of Low Frequency AC lines (reduced losses, reduction of the inductive reactance of transmission lines, allowing more power to be transferred over the same line), it might be convenient to support R&D activities in LFAC applications even financing the set-up of a demonstration line for offshore wind facilities.

Promote the development of storage capacity. The appropriate amount of storage is essential for the effective operation of a fully renewable grid by addressing issues of intermittence and variability. Adequate storage capacity will minimize curtailment and ensure adequate supply. Investment in storage tends to be more costly than in generation, which may lead to underinvestment in storage solutions, in turn potentially resulting in

curtailment. It would be beneficial if new licenses for generation capacity investments were linked to investment in storage facilities.

Promote adoption of smart grid tools. Distribution power grids will encounter increased variability from renewable resources and the need to integrate distributed energy resources. The digitalization of the grid will assist in load forecasting, fault detection, and enhance reliability. Advanced digital technologies (Advanced Metering Infrastructure, Smart Meters; Sensors and Monitoring Systems) would enable two-way communication between utilities and consumers, real time monitoring and optimization of energy flow all of these are tools that would promote efficient transmission of electricity. To support a smart distribution grid there is a need to:

a) integrate digital grid technologies into long-term planning, considering distributed resources;

b) develop standards to ensure seamless communications and integration between different grid components; and

c) provide support to utilities and consumers to invest in smart grid tools. Pass the savings in electricity generation costs to end users.

Reduce power costs for vulnerable households. Additionally, efforts aimed at reducing electricity costs for vulnerable households and provided benefits to communes with coal-fired generation facilities. The region's transition to renewable energy is expected to significantly reduce electricity costs. This affordability will support broader economic electrification, provided that savings reach end users.

Support the expansion of infrastructure for electric transportation. For most light and medium transportation modes, electric drives are or will shortly become competitive in the region. A growing fleet will accelerate investment in maintenance and repair facilities. However, there is a role to play for the State in the development of charging infrastructure. It could include measures such as preferential parking spaces with charging stations and exempting EVs from road space rationing.

But, as the electrification of transport accelerates and covers other segments of the fleet, including heavy vehicles, the need for DC fast charging stations will increase at bus stations, ports and other facilities. Financing for set-up of rapid charging networks may need to be considered to facilitate market penetration.

For fleets, **return-to-base charging** at depots or yards during off-peak hours is more efficient than on-route charging and should be promoted. This allows full charging overnight or between shifts, reducing the need for public chargers and lowering peak demand

Incentivizing hosting capacity at distribution substations—through dedicated feeders or new substations—can allow more chargers to be added without overloading existing infrastructure. This is especially important for heavy-duty fleets with high charging power demands.

Ease adoption of green hydrogen. Countries in the region are developing **national hydrogen strategies** that define ambition levels, policy priorities, and support mechanisms for private investment Legal frameworks also address the use of hydrogen in industrial and transport sectors, reflecting its role as a versatile energy carrier. Technological advancements in electrolysis should be considered in regulatory updates to improve efficiency and scalability.

Some of the governments in the region are already promoting electrolyzer technology with subsidies, financial support and strategic partnerships. To ensure sustainable green hydrogen production capability for transport, industry, and power generation, there may be a need for support in:

a) the development of fuel cells for heavy vehicles (ferries, heavy trucks);

b) use of hydrogen as a reducing agent in steel production;

c) assistance in the retrofitting of existing Combined Cycle Power plants to run on hydrogen.

Maximize value of Lithium resources. In Chile, there are ongoing discussions about balancing exports with value-added domestic production. In Chile, The National Lithium Company aims to facilitate further industrial processes, including battery assembly and recycling. CORFO tenders are managing value added manufacturing This analysis indicates a potentially significant impact on employment and enterprise development from the production of lithium cathodes. Given the country's advantages in terms of both the quality and quantity of the resource, investment in planning and research and development, aimed at achieving vertical integration of the industry within Chile, with the final product being batteries for electric vehicles and power storage, is warranted.

Promote large scale production of green steel and electrification of other heavy industries. As with lithium, the quality and quantity of iron ore in Brazil and Chile, summed to the availability of low-cost green hydrogen and electricity, supports a national strategy for green steel manufacture. A green steel strategy could target the supply to the domestic and regional markets. Likewise, the report indicates that there is a strong incentive for Chile to promote the electrification and use of Hydrogen in other heavy industries, where technology is in active development and where at least in Brazil and Chile may offer competitive advantages in terms of the cost of electricity and hydrogen (electrochemical decarbonation in cement manufacture and plasma calcination in pulp and paper production).

Finally, there are options for electrification of energy services in commerce (space heating) and households (space heating, provision of hot water, and cooking) that warrant promotion campaigns, including regulatory incentives.

An effort is required to support the vocational and higher education infrastructure. The shift toward electrification is not only a technological challenge but also required the transformation of the workforce. Vocational training and higher education are central in preparing this workforce.

Higher education plays a critical role in advancing the research, innovation, and leadership necessary for the electrification of the economies in the region. Support is required to allow Universities tointegrate interdisciplinary programs that combine engineering, environmental science, economics, and policy studies, enabling graduates to address complex energy challenges holistically. For example, renewable energy engineering degrees can be paired with courses in climate policy and sustainable finance, producing professionals who understand both the technical and regulatory dimensions of the sector. Moreover, higher education institutions can serve as hubs for applied research, partnering with industry to pilot new technologies such as advanced battery storage or hydrogen fuel systems.

Vocational education and training (VET), on the other hand, ensures that the technical workforce is ready to implement these innovations on the ground. The installation of solar panels, maintenance of wind turbines, retrofitting of buildings for energy efficiency, revamping of the transmission system and operation of smart grids all require specialized, hands-on skills. VET programs can be rapidly adapted to meet evolving industry standards, offering modular courses, apprenticeships, and certifications that allow workers to upskill or reskill quickly. This flexibility is particularly important for supporting workers transitioning from fossil fuel industries into renewable sectors.

Collaboration between higher education, VET providers, and industry should be promoted. Joint curriculum design ensures that training aligns with real-world needs, while work-based learning opportunities give students practical experience. Governments can incentivize such partnerships through funding, tax credits, and national skills strategies that prioritize green competencies.