RENEWABLE ENERGIES IN URUGUAY

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Uruguay XXI
INVESTMENT, EXPORT AND COUNTRY BRAND PROMOTION AGENCY

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1. WHY INVEST IN RENEWABLE ENERGY IN URUGUAY?

URUGUAY AND ITS SUCCESS TOWARDS DECARBONIZATION

- Without resources such as gas, oil or coal, in the 2008-2009 crisis Uruguay faced many uncertainties regarding supply issues and high costs in energy production, due to the global increase in fuel prices.

- In 2010 Uruguay reached a multi-party agreement and adopted energy transition as a national policy, moving to domestic and renewable energy sources, guaranteeing its implementation and continuity.

- The **first stage of the energy transition entailed more than US$ 8 billion in public-private investment.** The transformation was carried out using a model in which the public sector played the role of system coordinator and administrator of the auction, providing assurances to national and international private investors.

- **The International Renewable Energy Agency (IRENA[1]) praised the Uruguayan model**, and highlighted the bidding system carried out by UTE (the Uruguayan electricity company) as an example to follow in its guidelines for designing auctions. The private participation through innovative promotion plans without relying on direct subsidies is noteworthy.

CURRENT ELECTRICITY MATRIX

- In a year with normal rainfall, 97% of the national electricity demand is covered by renewable energy sources, through a combination of wind (32%), biomass combustion (17%), solar power (3%), in addition to traditional hydroelectric power (45%).

- The first stage of the energy transition positioned Uruguay at the forefront regarding renewable energy. **Uruguay is the country with the second highest share of renewable energy electricity**

[1] IRENA - Renewable Energy Auctions

production (such as solar and wind) **globally REN21 (2022)**, and leader together with Denmark, Ireland and Portugal in terms of wind energy production[2].

» Private companies played a crucial role in the energy transformation. For example, Ventus, a Uruguayan company specialized in wind energy, whose experience and success in the local market allowed it to export its services to other countries in the region.

THE SECOND ENERGY TRANSFORMATION

» Uruguay has room for improvement in regards to its energy demand. The transportation and industrial sectors are fairly intensive in terms of fossil fuel use. This translates into a 40% share of fossil fuels in the energy demand of the total energy used in the country. And over half of CO_2 emissions originate from the burning of fossil fuels.

» **Uruguay aims to achieve consistent economic growth with a reduction of greenhouse gas emissions.** The Uruguayan government has developed a series of measures aimed at achieving these targets:

- In 2020 Uruguay created the Ministry of Environment, and included Helsinki guidelines in the Budget Act.
- In 2021 the road map for green hydrogen production in Uruguay was developed. The Central Bank of Uruguay (BCU, for its acronym in Spanish) presented a strategy for the diversification of international reserves based on green bond investment funds. The BCU and the Ministry of Economy and Finance (MEF) agreed to implement a Sustainable Finance Round table, and a tax on CO_2 emissions from the use of fossil fuels was approved.
- In December 2021 Uruguay presented its long-term Climate Change Strategy, which aims for neutral CO_2 emissions by 2050.

» The main objectives of the second stage of the energy transition are:

- Direct electrification of end uses.
- Development of a Green Hydrogen Economy.
- Consolidate a Smart Grid, which will allow efficient coordination of energy supply and demand.
- Continue implementing energy storage technologies.
- Expand the possibilities of generating energy from agricultural waste, transforming an environmental liability into an energy asset.

[2] Source: VRE generation: REN21 – Renewable 2021 Global Status Report (link)

- Make advances in the waste-to-energy of solid urban waste.
- Integrate clean energy into the transportation sector by applying the latest available technologies.

» The **production of green hydrogen** is a natural step taken by Uruguay in its process of decarbonization of the energy matrix. Uruguay offers certain advantages:

- High potential for renewable energy generation
- High availability of water and biogenic CO_2
- Competitive production costs of Green Hydrogen and derivatives
- Strategic location in the region and easy access to the Atlantic Ocean
- Logistics and supply chain continuity
- Fiscal incentives and government support

The **Uruguayan government announced the first major investment in green hydrogen production** in the country by the Chilean company HIF Global. The project, which will be located in the department of Paysandú, will involve an investment of **US$ 6 billion.** Construction of the green hydrogen plant will begin in 2024 and is expected to last around 30 months.

2. FIRST STAGE OF THE ENERGY TRANSITION

In 2008 Uruguay presented its energy policy strategy for 2005-2030, which established guidelines with a long-term view, focusing on the diversification of generation and supply sources, the inclusion of renewable energy and the improvement of energy efficiency. In 2010, an agreement was reached between all the political parties represented in parliament, which laid the groundwork for the construction of a national policy.

As a result of the deployment of this national strategy, Uruguay achieved decarbonization of electric power generation in a short period of time. On average, renewable energy accounted for 93% of the electricity matrix between 2018 and 2022 (53% wind, solar and biomass and 40% hydroelectric), significantly reducing greenhouse gas emissions originating from the energy sector.

2.1.ELECTRICAL ENERGY SUPPLY

In 2022, energy supply reached 5,669 ktoe, which represented a historical record for the country, with an increase of 27% compared to 2012 levels.

The increase in energy output was accompanied by a change in the composition of the overall energy matrix. Energy from fossil sources significantly reduced its share in the total supply, falling from 60% in 2012 to 40% in the 2018-2022 average[3]. In contrast, biomass, wind and solar energy increased their relative importance. In 2022 the shares were 39%, 9% and 1% respectively, while in 2012 neither wind nor solar energy contributed to the supply.

Hydropower, on the other hand, decreased its weight in the supply, reaching 10% between 2018-2022 (9% in 2022), while it was 16% between 2002-2012. The drop in share is due to the increase in electricity demand while the generation capacity remained constant. It should be noted that the country's most relevant water resources are almost fully utilized and the future increase in supply can only be achieved through small hydroelectric power plants.

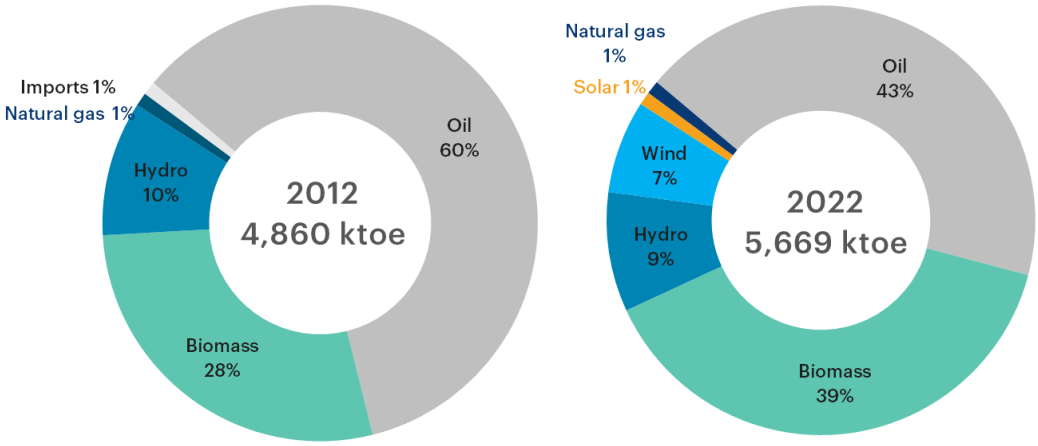
The drought of the last three years 2020-2022 impacted the participation of renewable energy sources in the electricity generation matrix.

Renewable energy represented 56% of the total energy matrix in 2022 (while in 2012 it was only 38%), an excellent number by international standards.

Graph No. 2.1

ENERGY SUPPLY MATRIX - URUGUAY

(2012 VS 2022)



Source: Energy Balance, National Energy Directorate (DNE) - Ministry of Industry, Energy and Mining (MIEM).

[3] The 2016-2021 average is considered to take into account the periods of low rainfall recorded in the last year.

Finally, electricity imports have decreased systematically in recent times, and are currently of very little relevance within the country's energy supply matrix.

2.2. ELECTRICAL ENERGY DEMAND

Demand can be characterized by analyzing the distribution of energy use by the various business sectors.

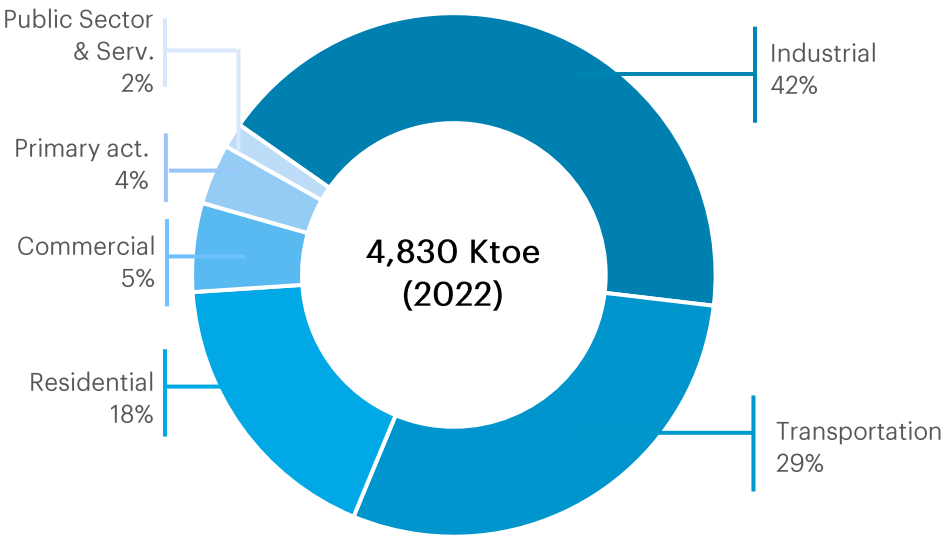
During the last two decades, the Uruguayan economy has experienced the greatest period of economic growth since there are records kept, which led to an uninterrupted increase in energy demand. Increased production levels and the introduction of new energy-intensive activities, particularly in the wood and cellulose sector, led to a greater demand for energy in industry. The second most important sector in energy demand was transportation, due to higher levels of production and mobility by households.

In 2022, the total energy usage was 4,835 ktoe, which entailed an increase of 32% compared to 2012 values. Industry was the main energy demanding sector with 42% of the total amount required, followed by transportation with 29% and the residential sector (18%).

Graph No. 2.2

ENERGY CONSUMPTION MATRIX - URUGUAY 2022

(Ktoe)



Source: Energy Balance, DNE- MIEM.

The industrial sector, since 2008, has the highest energy consumption in the country, and in turn, generates almost half of what it consumes. Biomass is the most required energy source, accounting

for 65%. The main industry in terms of energy consumption is the pulp and paper industry, which uses, to a greater extent, waste from its own activity. It is followed by the chemical, rubber and plastics industries, and in third place by meat processing plants.

The transportation sector is responsible for 71% of the demand for petroleum by-products. In 2022, fossil fuel demand grew by 14% compared to 2020. Demand had fallen in 2020, due to the decline in mobility caused by the pandemic, and accelerated after the recovery to 9% above pre-pandemic levels (2019).

The increase in post-pandemic energy demand was due to the recovery of economic activity, which showed a growth of 5.3% of the GDP in 2021 and 4.9% in 2022, after a drop of 6.3% suffered in 2020.

The DNE conducted a study of prospective energy demand for 2015-2035[4]. Table No. 1 shows the projections of final energy demand by sector for two possible scenarios (both assume the construction of the third pulp mill). The baseline scenario assumes that there will be no significant changes within the structure of the sectors, with the current efficiency measures and presumable technological improvements. The second scenario presented assumes that a series of policies aimed at increasing the efficiency of each sector would have been implemented, enhancing the trend shown by the baseline scenario.

Table No. 2.1

ENERGY DEMAND BY SECTOR
(Average annual growth 2015-2035)

Scenarios	Residential	Commercial Services	Industrial	Primary Activities	Transportation	Total
Trend	2.0%	2.9%	3.2%	2.8%	2.8%	2.8%
Policies and Efficiency	0.5%	1.8%	2.7%	2.5%	2.3%	2.2%

Source: DNE

2.3. ELECTRIC POWER

Electric power represents 32% of the total supply, with a generation of 1,270 Ktoe in 2022. Electric power exports accounted for 10% of the country's production, which meant an available supply of 1,042 Ktoe in 2022.

The power matrix underwent a decarbonization process in the previous decade, with an investment of more than US$ 8 billion, which positioned Uruguay as a leader in the inclusion of renewable energy sources in the power matrix.

[4] Prospective Energy Demand Study - DNE.

During 2022, investments in energy infrastructure reached US$ 303 million. In the power system, works totaled US$ 284 million, accumulating US$ 705 million in the period between 2020-2022, 52% of what was planned for the government's term (US$ 1.367 billion).

Between 2023-2024, **Uruguay will invest US$ 843 million in the energy sector**[5]. The state-owned company UTE will be the main investor, with an estimated amount of US$ 489 million for the biennium, within the five-year plan (2023-2027) of the agency, which intends to make investments for US$ 1.1 billion in that period, 70% of which will be invested in expansion and improvement works for the distribution and transfer of the electric power grid[6].

Other investments outside the state-owned company's fiscal space include: the high voltage line between the Punta del Tigre power plant (San José) and the Cardal substation (Florida), for US$ 60 million; the completion of the northern transmission ring, with a 500 kV line that will connect Tacuarembó and Salto, with an investment of US$ 220 million; the installation of a 30 MW photovoltaic solar park in Punta del Tigre, following an agreement reached after the litigation for the construction of the combined cycle power plant with the company Hyundai. Finally, UPM will invest US$ 70 million to connect its new biomass plant to the national electricity system.

2.3.1. ELECTRICITY PRODUCTION

With an extensive network of 83,277 kilometers, electrification covers 99.8% of the country's households. The national electricity system is composed of two extensive high-voltage transmission grids. A network of 1,078 kilometers of 500 kV connects the Salto Grande dam on the Uruguay River and the Terra, Baygorria and Constitución dams on the Río Negro with the metropolitan area of Montevideo, the main center of consumption. The other network, with a capacity of 150 kV and a length of 3,923 kilometers, connects the generation plants with practically all the departmental capitals and the main consumption centers, covering a total of 72 stations of 150 kV.

Uruguay has an approximate installed capacity of 4,900 megawatts for electricity generation. Wind farms play a significant role, totaling more than 1,500 MW, which is equivalent to 31% of the total capacity. Within this figure, 1,000 MW of private generators and 500 MW of wind farms owned or managed by UTE are distributed. Hydroelectric generation capacity contributes another 1,500 MW; biomass contributes about 400 MW (8%); solar power accounts for about 270 MW (5%); and fossil fuel-based thermal generation plants total roughly 1,200 MW, which is equivalent to about 25% of total generation capacity.

The state-owned energy company UTE plays a key role in the sector, as it produces and purchases electricity from private producers and distributes it to consumers. Contracts entered into with private entities are implicitly guaranteed by the government, and in practice, UTE was the executor of public policies that allowed for the diversification of the energy matrix.

Uruguay's electricity system stands out for its high reliability. According to the World Economic Forum's Global Competitiveness Index, Uruguay ranks first in Latin America in terms of the quality of electricity supply in the country. In November 2022, UTE received for the third time the "Gold

[5] Explanatory Memorandum of the 2022 Financial Statement (Link)
[6] Source: Note from El Observador media outlet to the president of UTE (link) and Portal UTE (link)

Award 2022" granted by the Regional Energy Integration Commission (CIER, for its acronym in Spanish), which qualified it as the best company evaluated by its customers among 35 companies in the region, both public and private. Uruguay's electricity production in 2022 reached 14,759 GWh, one of the highest records, surpassed only in 2019 and 2021.

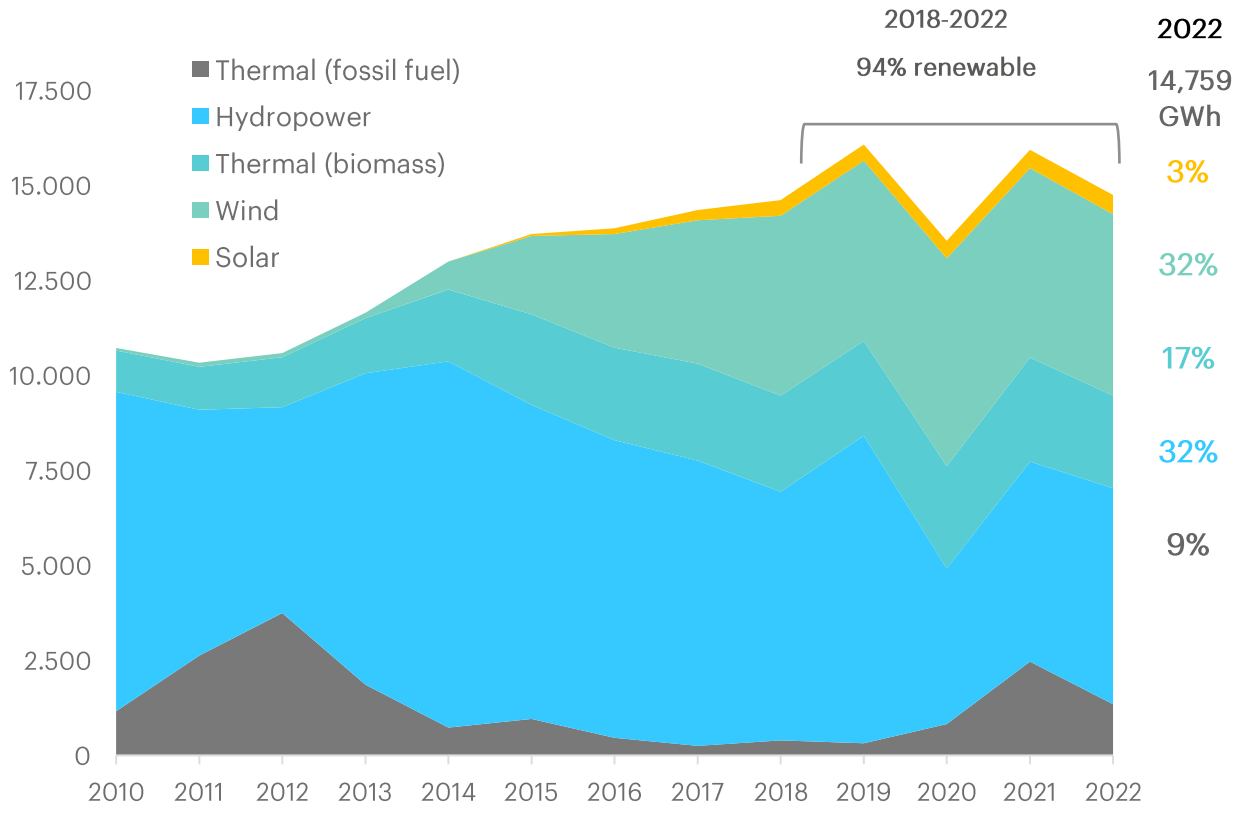
Between 2018 and 2022, electricity generation from renewable sources was 94%, while in 2022 it stood at 91%, due to the drought-related drop in the hydroelectric source. In a year with normal rainfall, 97% of the national electricity demand is covered by renewable sources, through a combination of wind, biomass combustion, solar, in addition to traditional hydroelectric power.

However, despite occasional events in recent years, the trend indicates that non-conventional renewable energy sources, such as wind, biomass and photovoltaic, are gaining weight in the Uruguayan power matrix. In 2022, these sources accounted for 52% of total electricity generation, in contrast to thermal energy production from fossil fuel sources, which has experienced a significant decline in the last decade and represents only 6% on average from 2018 to 2022.

Graph No. 2.3

ELECTRICITY GENERATION BY SOURCE (GWH)

(2010 - 2022)



Source: Compiled by Uruguay XXI based on data from the National Energy Balance (BEN for its acronym in Spanish) 2021[7].

[7] The BEN considers all energy generated in the country, both for self-consumption and generation fed into the National Interconnected System (SIN for its acronym in Spanish).

Three connections with Argentina and two with Brazil allow Uruguay to exchange electricity with other countries in the region. Since 2013, Uruguay has become a net exporter of electricity. In turn, it is worth noting that since the end of 2017 Uruguay allows the export of electricity from the private sector to Argentina. Although this authorization is still in force, the wind farms covered by this measure opted for a long-term contract with UTE and thus there are currently no export records by private companies (no private exports have been recorded since 2019).

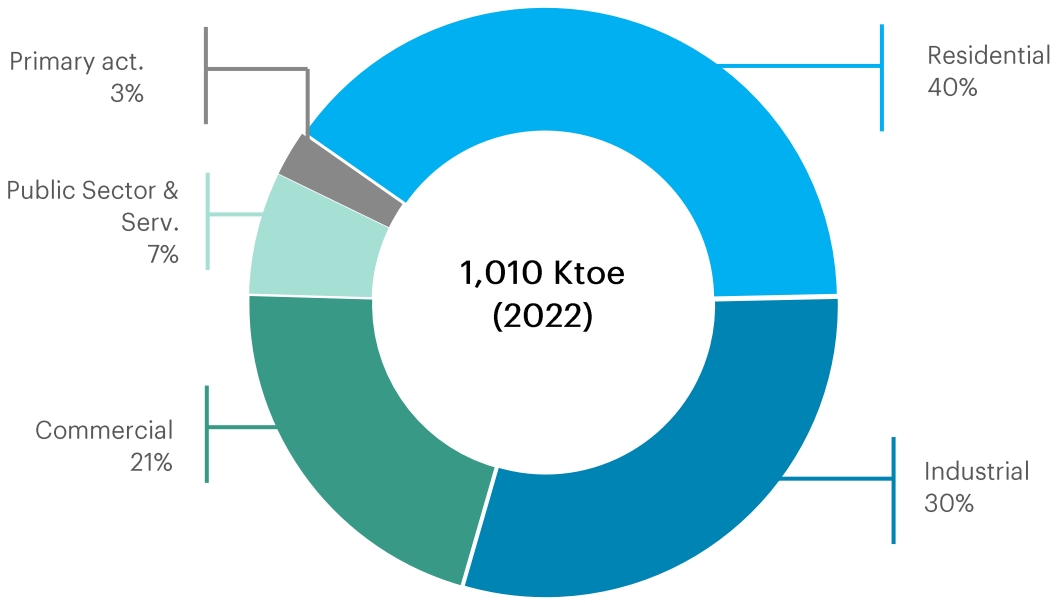
2.3.2. ELECTRICITY DEMAND

Electricity consumption totaled 1,010 Ktoe in 2022, representing a 2% year-on-year increase. The residential sector is the main electricity consumer, with a 40% share of the total, followed by the industrial sector with 30% and the commercial sector with 21% of the total.

Uruguay has established three connections with Argentina and two with Brazil, which allows it to exchange electricity with neighboring countries in the region. Since 2013, Uruguay has undergone a significant transformation, becoming a net exporter of electricity. In addition, since late 2017, Uruguay has allowed the export of electricity from the private sector to Argentina. Although this authorization is still in force, it is important to note that the wind farms that benefited from this measure chose to establish long-term contracts with UTE. Currently, there have been no exports by private companies, and this situation remains since 2019.

Graph No. 2.4

ELECTRICITY DEMAND BY SECTOR (GWH)



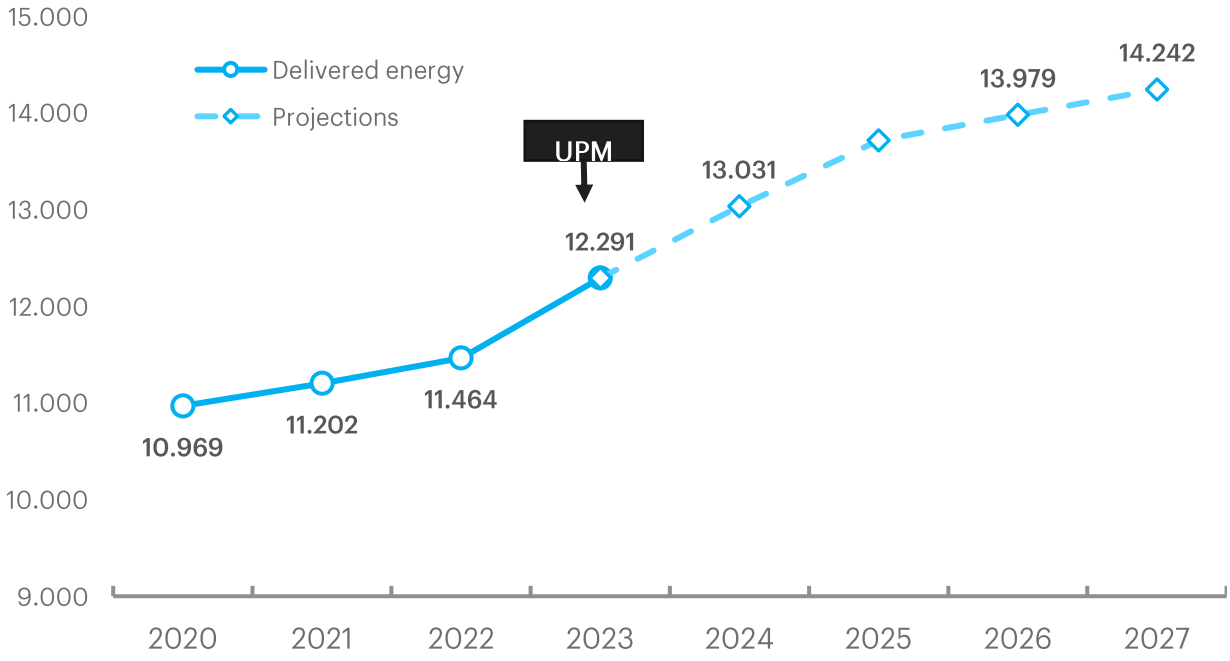
Source: Compiled by Uruguay XXI based on data from the BEN 2021[8].

The most recent Seasonal Programming report, drafted by the Electricity Market Administration (ADME for its acronym in Spanish), projects an increase in energy demand at an average annual rate of 4.5% for the 2023 - 2027 period, considering the effects resulting from the installation of UPM2. A 3.6% increase in base demand is expected, which is equivalent to 191 GWh in new projects, plus an additional increase of 229 GWh due to the UPM plant. This will result in a 7.2% growth in 2023 and 6% in 2024. Thereafter, growth will converge to a 2% rate for subsequent years.

Graph No. 2.5

PROJECTED GROWTH FOR FINAL ENERGY CONSUMPTION

2023 – 2027 (Ktoe)



Source: Compiled by Uruguay XXI based on DNE and Administration of the Electricity Market in Uruguay (ADME).

Examining the production of electric energy, it is expected that the boost to the sector in the medium term will be linked to an increase in electric mobility (associated with the production and addition of battery-electric vehicles).

2.3.3. INTERNATIONAL ELECTRICITY TRADE

Uruguay has historically relied on energy imports to meet its domestic demand. In the last decade, the country has become a net electricity exporter for the region. One of the main reasons for its

[8] The BEN considers all the energy generated in the country, both for self-consumption and generation fed into the SIN.

success lies in the diversification of energy sources, which allows it to produce electricity in a more sustainable manner and at competitive costs.

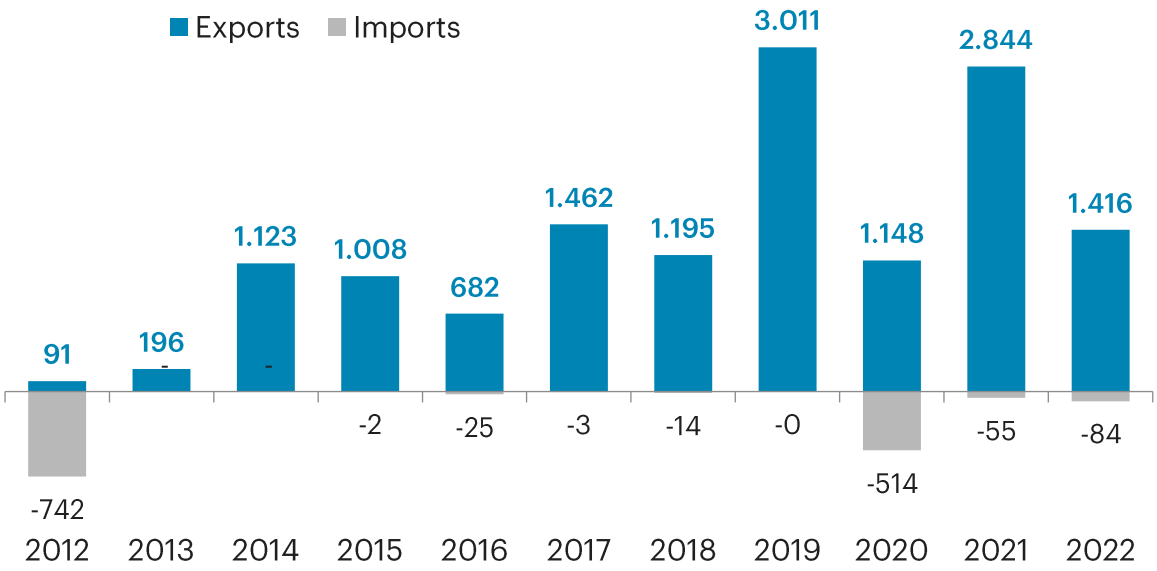
In recent years, Uruguay has improved its electrical interconnection with neighboring countries. Foreign sales are currently a significant source of income for the country, which is positioned as a net exporter of electricity to the region.

According to data from UTE, in 2022 electricity exports totaled 1,368 GWh, which represented 10% of the country's total power generation. It is worth mentioning that as of late 2022 and a significant portion of 2023 was marked by a water deficit that strongly impacted UTE's hydroelectric generation. As a result, Uruguay experienced a decrease in the surplus of electricity available for export, which translated into a 50% drop in the volume of exported electricity.

Graph No. 2.6

ELECTRICITY EXPORTS AND IMPORTS (GWH)

(2012 – 2022)



Source: Compiled by Uruguay XXI based on data from UTE[9].

Even during the most extreme dry months, energy was imported from Brazil to ensure the supply for the demand, lowering the costs of thermal generation and protecting the water resource. To a lesser extent, in February 2023 UTE also imported energy from Argentina.

In 2021, Uruguay exported 2,844 GWh of electricity, earning revenues of US$ 525 million, 5% of total goods exports for the year. This represented a significant contribution to the country's economy. Seventy-eight percent of sales were made to Brazil and the remaining 22% to Argentina. In 2022, sales went entirely to Argentina for **US$ 164 million**.

[9] The BEN takes into account all the energy generated in the country, both for self-consumption and generation fed into the (SIN).

3. SECOND STAGE OF THE ENERGY TRANSITION

The first stage consisted of the reconversion of the power matrix to renewable energy sources: biomass, hydro, wind and solar power. Renewable sources account for 97% of the country's power matrix, under normal weather conditions.

According to the World Economic Forum's 2023 report, Uruguay ranks 23rd in the Energy Transition Index. It is the leader in Latin America, followed by Costa Rica (25th) and Brazil (14th)[10]. Uruguay stands out in the index for its high percentage of renewable energy in the power mix, its low energy intensity and its greenhouse gas emissions. In addition, the country has a solid regulatory framework for the energy transition and a high level of civil society participation in the process.

Uruguay has room for improvement in regards to its energy demand. The country has a high motorization rate and a relatively energy-intensive industrial sector. This translates into a proportionately high energy demand, which could be reduced through energy efficiency and by making the demand more electric based.

The second stage of the energy transition, which Uruguay is beginning to undertake, seeks to establish an efficient institutional framework to turn Uruguay into a CO_2 neutral country. Thus, decarbonization of the rest of the energy sector (transportation and industry) is proposed, as well as decarbonization of raw materials for industrial use. Other measures are the development of a hydrogen economy, maintaining the high participation of renewable energy sources in the power matrix and achieving a more efficient use of the electricity system.

Uruguay's energy transformation strategy is attracting international attention. The International Renewable Energy Agency (IRENA) highlights Uruguay's model of promotion and incentives, and includes the bidding system made by UTE as examples to follow in its guide for the design of auctions. It highlights the achievement of involving strong private sector participation in investment through innovative promotion models without relying on direct subsidies.

Decades of experience in the development of renewable energy projects; solid regulatory frameworks; political, institutional and legal stability; and macroeconomic robustness make Uruguay an attractive country to invest in projects that allow the decarbonization of sectors that present greater difficulty in reducing their climate footprint.

[10] The index measures countries' progress in the transition to a more sustainable, efficient and equitable energy system. World Economic Forum, 2023

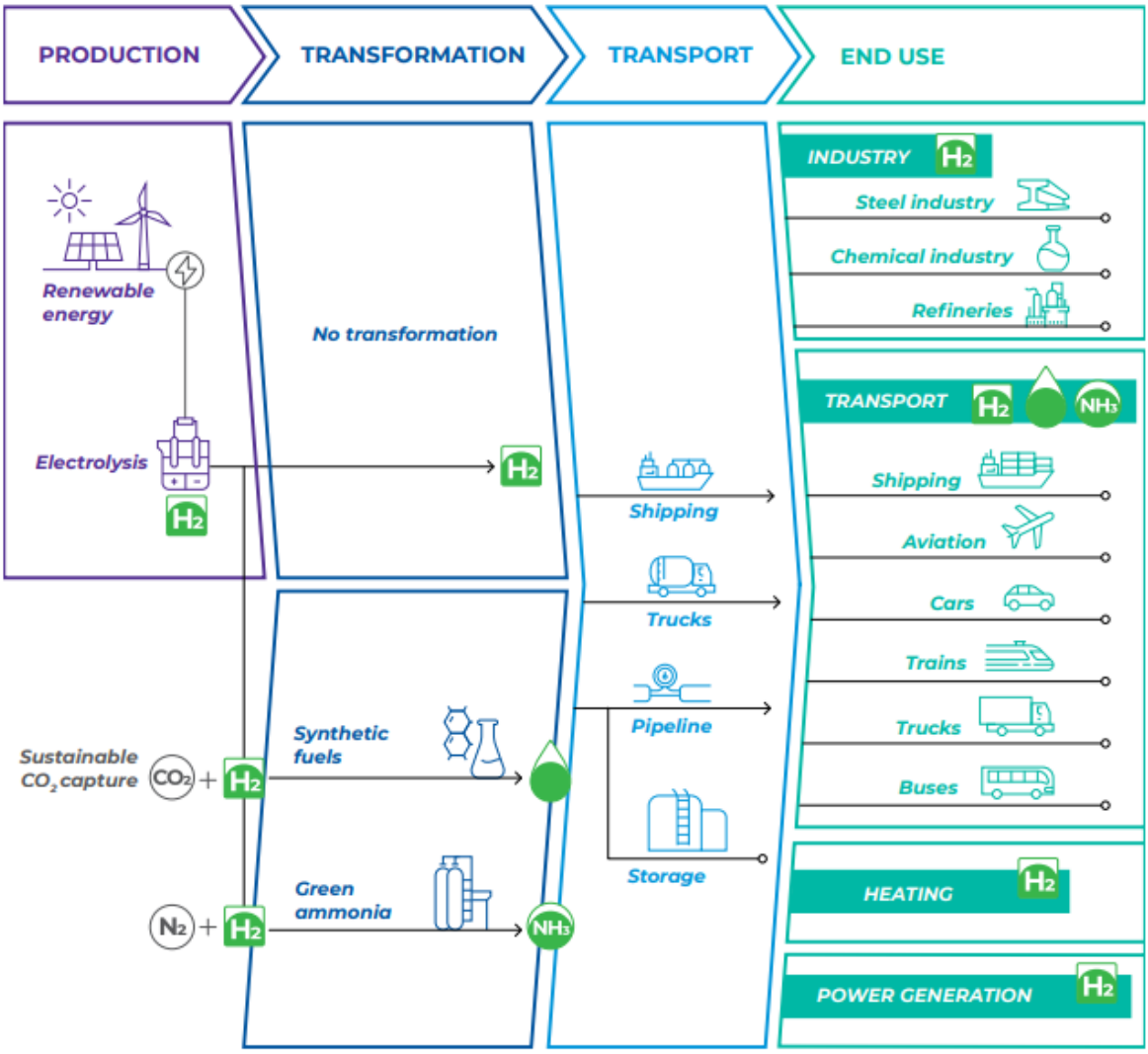
3.1. GREEN HYDROGEN: A NATURAL NEXT STEP FOR URUGUAY TOWARDS DECARBONIZATION[11]

3.1.1. WHAT IS GREEN HYDROGEN?

Hydrogen is one of the most abundant resources on the planet. It allows energy to be stored and transported, which can be used directly or in the production of other energy sources. From renewable electrical energy, hydrogen can be produced for a wide variety of uses.

Figure No. 3.1

HYDROGEN USES AS AN ENERGY SOURCE OR RAW MATERIAL



Source: Compiled by the MIEM based on a document from the International Energy Agency, "Green Hydrogen: A guide to policy making" (International Renewable Energy Agency, 2020).

Green hydrogen allows decarbonization of various utilities (transportation, thermal energy, industrial energy, raw materials and stabilization of highly renewable power grids), making it an energy vector

[11] Green hydrogen road map for Uruguay – 2023 (Link)

with high potential, especially in situations where decarbonization cannot be achieved directly or through electrification.

The cumulative property of hydrogen would allow the participation of renewable energy in the energy system to improve, balancing the peaks and dips in electricity demand, and storing renewable energy at times of high availability to be delivered at peak demand periods.

Green hydrogen favors the integration of renewable energy on a large scale. Its status as an energy vector allows it to be used to store and transport energy from renewable sources from highly productive regions of the world to resource-deficient areas. This process of global transition in energy production will allow countries that historically have not had relevant energy resources to position themselves as new players with diverse roles and possibilities.

3.1.2. WHY GREEN HYDROGEN IN URUGUAY?

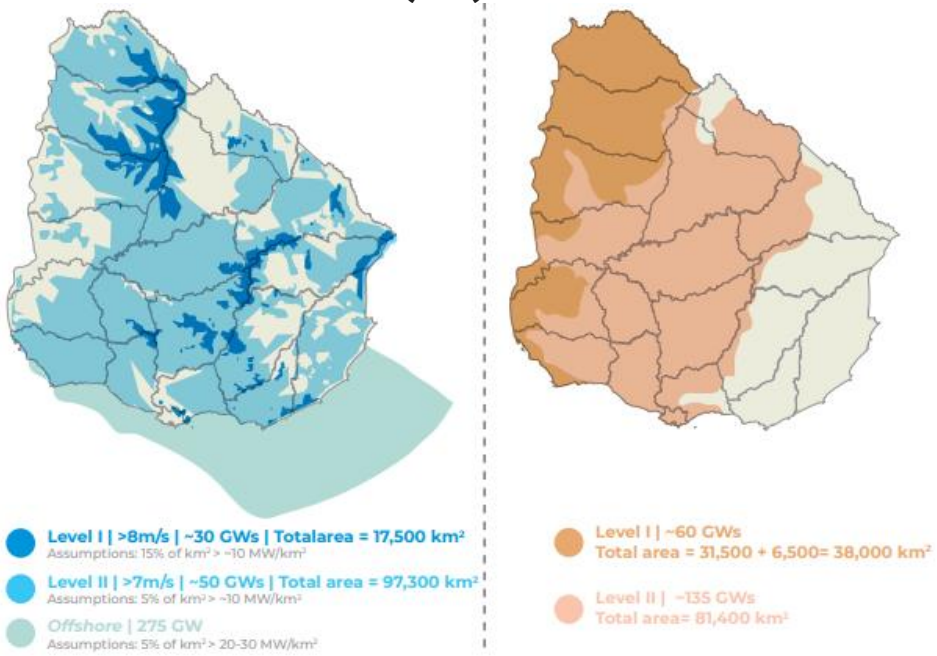
Green hydrogen is a natural next step in the process of decarbonizing the energy demand, following the decrease in the use of fossil fuels in the power grid. In addition, the country has significant competitive advantages to be a relevant producer of green hydrogen and by-products, both for the domestic market and for export.

High potential for renewable energy generation and complementarity of resources

Uruguay has significant potential to generate renewable energy, mainly wind and solar. The country has a good combined resource of wind and sun, which allows to obtain high-capacity factors in electrolysis and low hydrogen production costs.

Solar and wind renewable power in Uruguay would allow achieving, in 2030, a levelized cost of energy (LCOE) of between 16 and 19 US$/MWh. On the other hand, offshore wind energy would have costs ranging between 26 and 28 US$/MWh. In 2040, these costs could drop to 11 US$/MWh for solar energy, 15 US$/MWh for wind energy and 21 US$/MWh for offshore wind energy. The western region of the country has the best characteristics for solar power generation, while the northern and central regions have medium-quality resources.

Figure No. 3.2
POTENTIAL CAPACITY (GW) BY RENEWABLE SOURCE

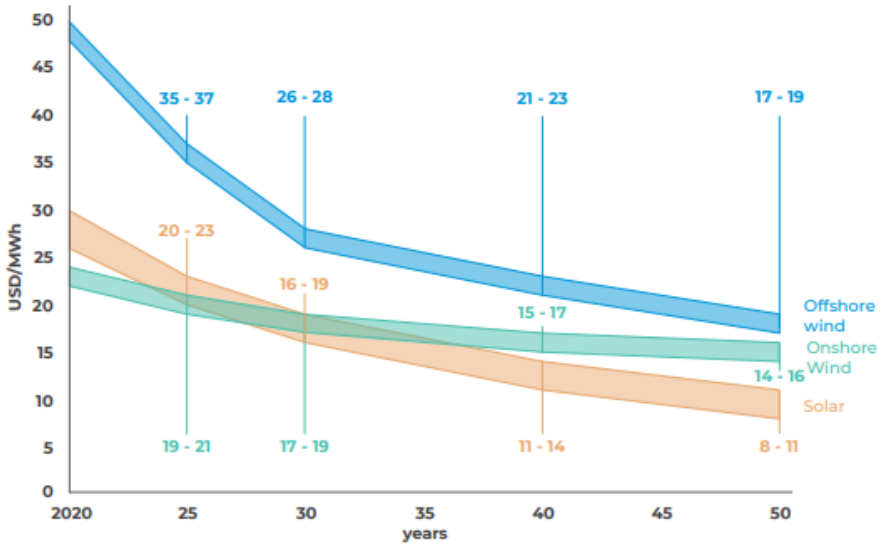


Source: Green hydrogen roadmap for Uruguay - Atlas Solar, MIEM, McKinsey & Company, 2021, according to contract # :C-RG-T3777-P001 signed with the IDB.

For wind energy, high quality areas are located on the border between the departments of Rivera, Tacuarembó and Salto, and between Lavalleja, Florida and Treinta y Tres. The area available for offshore wind energy development would allow an additional capacity of 275 GW.

Graph No. 3.1
LEVELIZED COST OF ENERGY

(BASED ON 5% WACC, NOT INCLUDING TRANSPORTATION COSTS) AT SCALE (+500 MW), US$/MWH.



Source: Green hydrogen roadmap in Uruguay - Atlas Solar, MIEM, McKinsey & Company, 2021.

Large availability of water

Uruguay has a large potential to produce green hydrogen, but it is necessary to analyze an important input for this industry, which is water.

The potential water consumption for green hydrogen production is relatively low, representing about 0.5% of the total water available in 2022. However, it should be considered that green hydrogen production will be concentrated in some regions of the country, where impacts could be expected.

To guarantee the sustainability of hydrogen production, it is necessary to carry out specific studies and to have accurate information regarding the aspects related to water usage. These studies should consider usage on a spatial and time scale, taking into account other existing uses and the projections defined for the specific territory.

Biogenic CO_2 availability

Uruguay has the potential to produce hydrogen derivatives, such as raw materials, fuels and green fertilizers. The country has availability of biogenic CO_2, which is carbon dioxide produced by biomass decomposition. This CO_2 is used in the production of hydrogen derivatives through processes such as artificial photosynthesis or hydrogenation.

It is estimated that in 2024 Uruguay will emit approximately 11 million tons of biogenic CO_2 that could be used for producing hydrogen derivatives. These emissions occur mainly in industrial facilities that use biomass to generate energy, such as cellulose pulp production plants and smaller-scale energy production plants. National forest biomass production is sustainable; Uruguay is very well positioned in terms of sustainable development certifications in forestry production.

Logistics

Uruguay has access to the Atlantic Ocean and a developed logistics infrastructure. The country has access routes throughout the territory, including rail, river and road transportation. In addition, it has a successful track record in building energy infrastructure, which gives it the ability to overcome the logistical challenges associated with hydrogen exports.

The country has no major geographical features and has access routes throughout the territory as well as infrastructure for local transportation of hydrogen and its derivatives. It is important to point out that the Central Railway will connect the area with the greatest renewable energy potential to the port of Montevideo, providing very good opportunities for the transportation of hydrogen derivatives and facilitating their potential for export.

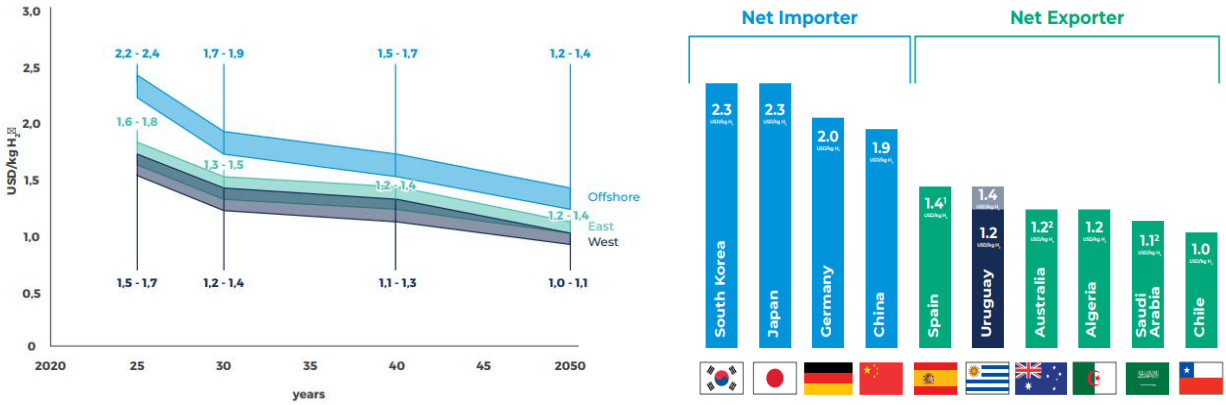
Competitive Green Hydrogen production costs

Renewable energy production costs would allow Uruguay to reach green hydrogen (LCOH) production values between US$ 1.2 and US$ 1.4 /kgH_2 in the western region and between US$ 1.3 and US$ 1.5 /kgH_2 in the eastern region, for a scale greater than 500 MW, by 2030.

Graph No. 3.2

PRODUCTION COST CURVE FOR HYDROGEN BY REGION IN URUGUAY, PRODUCTION COST COMPARISON 2030.

(WACC: CHILE 6%, AUSTRIA 5.4%, SAUDI ARABIA 5.3%, SPAIN 5%) (US$/KG H_2)



Source: Green hydrogen roadmap for Uruguay - McKinsey & Company, 2021.

These production costs would allow Uruguay to position itself to compete with net exporters such as Chile, Saudi Arabia, Oman, Namibia or Australia.

For projects larger than 500 MW in scale, local transportation and storage of hydrogen by pipeline emerges as the most cost-effective option. This is achieved through the construction of electrolysis plants next to the renewable energy generation plants. The cost associated with local transportation and storage is between US$ 0.3 and US$ 0.5 /kgH_2[12].

Competitive production costs of derivatives

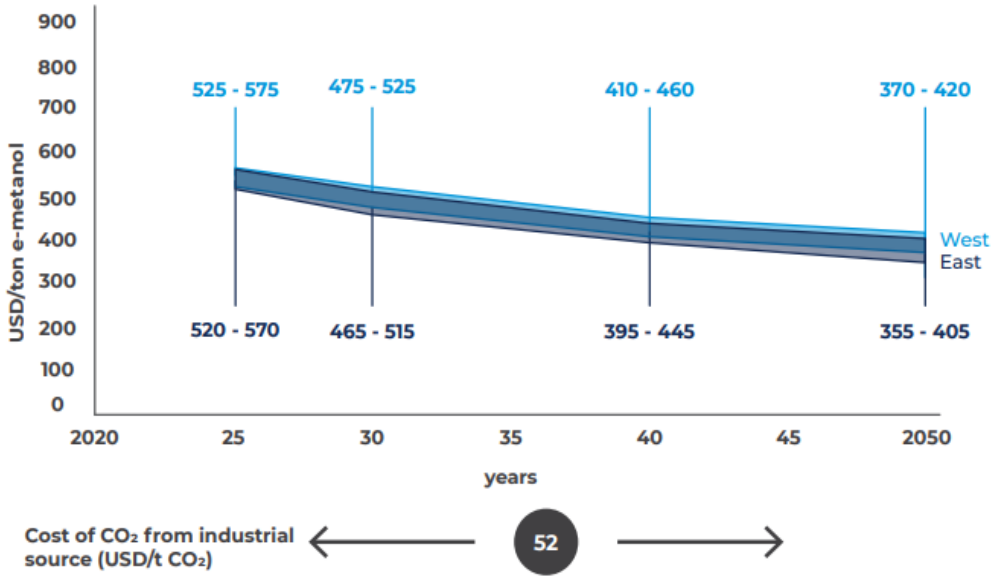
Regarding the production of derivatives, by 2030 the production costs of green e-methanol and e-Jet Fuel could reach US$ 465/t and US$ 1,205/t respectively, considering industrial sources for biogenic CO_2.

[12] For more information, see Green hydrogen roadmap in Uruguay.

Graph No. 3.3

PRODUCTION COST CURVE FOR E-METHANOL

(US$/TON E-METHANOL).



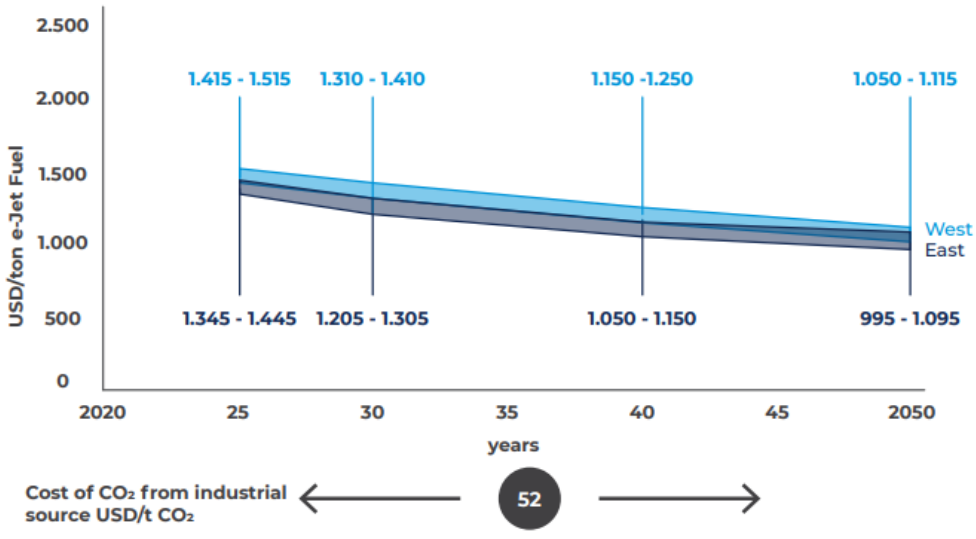
Source: Green hydrogen roadmap in Uruguay - McKinsey & Company, 2021.

The ability of these products to compete with fossil fuels is linked to the application of CO_2 taxes in importing countries, as well as to the definition of quotas for green products in specific sectors, such as maritime and aviation.

Graph No. 3.4

PRODUCTION COST CURVE FOR JET FUEL

(US$/TON JET FUEL)



Source: Green hydrogen roadmap in Uruguay - McKinsey & Company, 2021.

Government commitment

- Uruguay's government is moving forward in promoting its green hydrogen ecosystem through the development of its national strategy, which had its final version presented in November 2023[13].
- The government launched the Hydrogen sector fund, an instrument that promotes a call for innovation and production pilot projects with up to US$ 10 million (non-refundable).
- There are also fiscal advantages for the development of large-scale projects for production of green hydrogen and its derivatives.

Based on these actions, the government is advancing in regulatory aspects, formalizing the country's interest, attracting the participation of private parties, deepening the knowledge of the technology applied, its production and logistics, and the development of local capacities, among other aspects.

3.1.3. INVESTMENT PROJECTS

HIF Global

The Chilean company HIF Global will invest US$ 6 billion in green hydrogen production in Uruguay[14]. The proposal aims to produce 180,000 tons of synthetic fuels per year, getting a share of the 710,000 tons of carbon dioxide from ALUR's ethanol plant in Paysandú[15]. A 1 GW alkaline hydrogen electrolyser will be built and an additional 2 GW of renewable electricity will be available in the country, from solar photovoltaic and wind sources. The green hydrogen will be used to produce e-fuels, such as e-gasoline and e-diesel, which can be used in traditional vehicles[16].

The HIF Paysandú e-Fuels project has been divided into two phases. The first phase, which will last until 2026, consists of the construction of the electrolyser plant and the green hydrogen storage and distribution infrastructure. The second phase, which will last until 2027, will consist of the construction of the e-fuel production plant.

Tambor Green Hydrogen Hub

Tambor Green Hydrogen Hub is a green hydrogen production project located in the department of Tacuarembó. It is an initiative led by the German company Enertrag, in collaboration with the Uruguayan company SEG Ingeniería. The project consists of the construction of a wind farm and a solar farm with a total capacity of 350 megawatts (MW). This renewable energy will be used to power an electrolyser that will yield green hydrogen.

[13] Final version of the Green Hydrogen Roadmap 2023 (link)
[14] MOU signature
[15] ALUR is the acronym for Alcoholes del Uruguay. It is a sustainable agro-industrial company that produces biodiesel, bioethanol, chemicals, animal feed, energy and sugar cane. ALUR is part of the ANCAP Group (link).
[16] News Chilean company to invest millions in Uruguay to produce eFuels from green hydrogen (link). HIF Uruguay official website (link)

The annual production of green hydrogen generated by the project will be about 15,000 tons. This green hydrogen will be used to produce renewable e-methanol, a sustainable fuel that can be used in the chemical industry and in the transportation sector.

H24U Pilot

The H24U pilot is a green hydrogen development project for heavy-duty transport in Uruguay. It is an initiative undertaken by several companies including Saceem, CIR, Air Liquide and Fraylog, and was the winner of the Green Hydrogen Sector Fund of the Ministry of Industry, Energy and Mining (MIEM). The project comprises the conversion of 17 trucks from the forestry sector to run on green hydrogen. The trucks will be retrofitted with hydrogen storage tanks and engines adapted to run on this kind of fuel.

The production of green hydrogen for the project will be carried out by a 1MW electrolyser plant located in Pueblo Centenario, Durazno. The plant will be powered by solar energy generated by a 2MW solar farm.

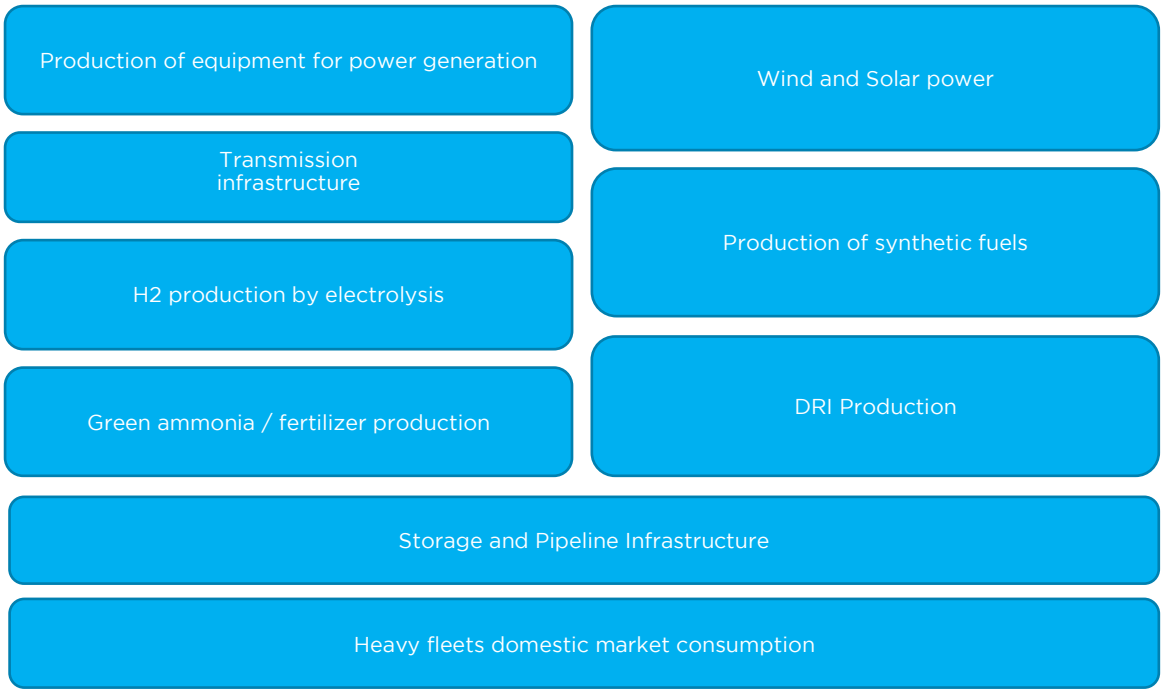
The H24U pilot is scheduled to begin operations in 2024. The project will last for three years, and will assess the technical and economic feasibility of using green hydrogen in heavy-duty transport.

The H24U project has been divided into two phases. The first phase, which will run until 2023, will consist of the construction of the electrolyser plant and the solar farm. The second phase, which will continue until 2024, will consist of converting the trucks and conducting test runs.

The project will cost a total of US$ 43.5 million. The Ministry of Industry, Energy and Mining (MIEM) will contribute US$ 10 million through the Green Hydrogen Sector Fund. The rest of the financing will be supplied by the companies participating in the project.

The H24U project is an example of Uruguay's commitment to the development of renewable energy. The project shows Uruguay's potential to become a regional leader in the development of green hydrogen.

3.2. INVESTMENT OPPORTUNITIES



Wind Farms

The policy of including wind energy as a renewable and competitive fuel source for the country has been a very successful one. Prior to 2008, there were no large-scale wind farms in the country. There are currently 41 wind farms in operation with an installed capacity of 1,514 MW[17]. This major investment was possible thanks to a varied range of business models.

Regarding the development of medium-scale wind farms, since 2014 Uruguay enables its subscribers to generate their own electricity from any energy source, without losing their subscriber status. This framework has no limitations on the grid connection voltage and does not enable the feeding of electricity into the national grid[18]. Within this scenario, 9.1 MW of wind power capacity have been installed by 2020.

In the case of wind farms financed through the local capital market, participation in the financial trusts structured for the Pampa and Arias wind farms proved the eagerness of retail and institutional investors to include these instruments in their investment portfolios.

Solar Farms

The use of solar energy transformation technology has undergone significant development in the country. To date, there are 19 large-scale photovoltaic plants that feed their energy into the power grid, with a total capacity of around 229 MW. The facilities range from a few installed MW up to 50

[17] These totals do not include microgeneration facilities or subscribers with generation.
[18] For more information see: (subscriber with generation without feed-in).

MW (in facilities such as "*La Jacinta*" or "*El Naranjal*", located in the area of Salto, in the northwest of the country). In addition, small-scale grid-connected PV generation increased from 0.04 MW in 2011 to 30MW in November 2021. PV capacity was also expanded under off-grid generation. Within this off-grid generation framework, the solar photovoltaic energy installed as of 2020 was 5 MW.

Bioenergy Facilities

The development of energy production from non-traditional biomass occurred alongside the growth of forestry and the pulp industry, as well as agricultural production in crops such as soybeans, rice and wheat, under the umbrella of an institutional framework for the development of instruments and incentives for the energy use of biomass by-products from forestry and other sectors.

The main raw materials used to generate energy from biomass (heat and electricity) are black liquor, forest residues, firewood, sugarcane bagasse, rice husks and biogas from dairy sector residues, wool production and urban solid waste. Existing bioenergy facilities in the country represent 9% of the installed capacity (425 MW). By 2023, this will increase with the start-up of the new pulp mill, which will generate a firm, predictable and renewable energy surplus of over 150 MW, which will be fed into UTE's power grid.[19]

Today, the low price of generating electricity from other renewable sources is the key challenge for the development of new bioenergy facilities in the country. For this reason, it is likely that new bioenergy projects will operate in an integrated manner, associated with other industrial processes in combined complexes (biorefineries).

Other alternatives for bioenergy development could be the generation of advanced fuels (renewable diesel, green hydrogen, methanol, renewable natural gas, aviation and marine biofuels), as well as solid biofuels (pellets).

Waste thermovalorization facility

The urban waste valorization through its transformation into energy is one of the stated objectives of the energy policy and one of the pillars of the National Waste Management Plan, which proposes the efficient management and waste valorization[20].

According to a study carried out by the National Department of Environmental Control & Monitoring (DINACEA), with over 1 million tons of solid waste generated annually, the Metropolitan area of Montevideo would be the most attractive area to establish a large-scale facility that would produce energy from the thermal treatment of waste.

There is also the possibility of a project that encompasses urban waste from the entire country or regional partnerships that would allow the feasibility of generating energy from waste produced by several departments.

[19] More information (link)
[20] National Waste Management Plan (link)

On the other hand, based on the technology available worldwide, it is now possible to profitably manage smaller volumes (e.g. 100-150 tons/day), which makes the possibility of building several facilities in the interior of the country more feasible.

Energy Storage

In order to continue expanding the generation capacity based on wind and solar resources (which are non-dispatchable energy sources), in the long term it will be necessary to introduce management systems for the more complex variabilities. One possible strategy is to obtain a greater exchange dynamic with the neighboring countries' systems (Argentina and Brazil), while another option is to implement energy storage methods. The technologies available today are in the process of becoming increasingly efficient and competitive (e.g. batteries) or are associated with high investment costs and long construction periods (dams and/or storage and pumping stations). However, it is expected to be a technically and economically viable option for the country in the future.

In terms of the advantages of energy storage, it allows moving the supply from one moment to the next, reducing the need for back-up thermal power plants in the system. In addition, it is very useful if the storage is deployed in a distributed manner for a more efficient use of the grids. On the other hand, storage is not a good mechanism to use the surplus of structural electric energy that Uruguay has, since it has an almost 100% renewable matrix with an important hydroelectric participation, which is characterized by a high variability and increasing share of wind and solar energy.

The first energy storage system began operating in September 2021. This is a 30-kW power system and 12 lithium-ferro-phosphate batteries that accumulate a capacity of 97 kWh. In Uruguay, the deployment of storage systems was enabled for UTE customers in 2020. Investments in this technology are also eligible for tax benefits by the Commission for the Application of the Investment Act (Comap, for its acronym in Spanish).

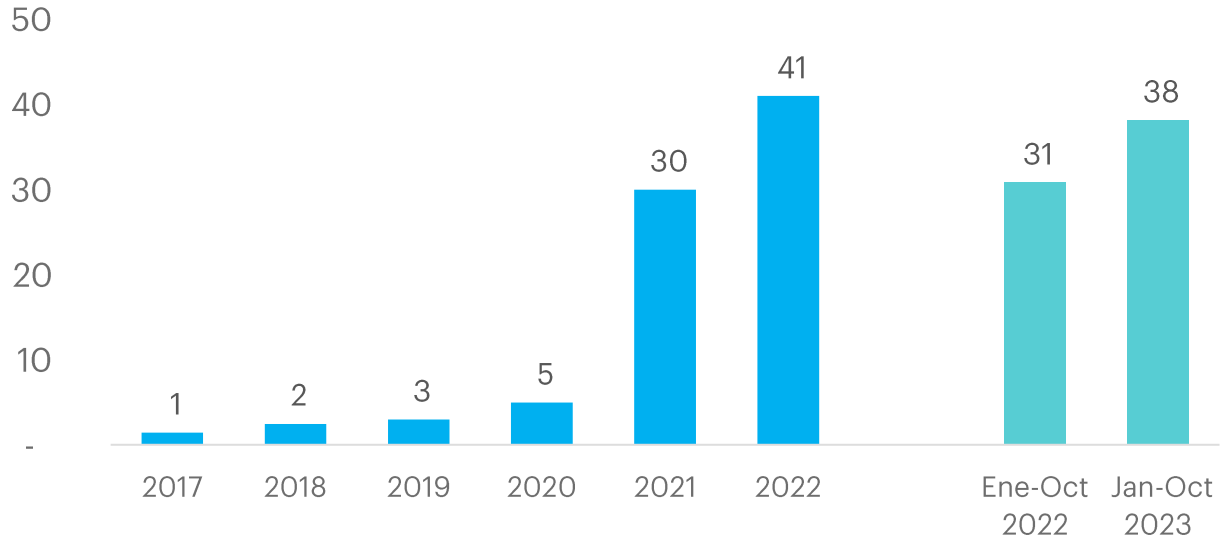
3.3. ELECTRIC MOBILITY

In Uruguay, the transportation sector is the main consumer of petroleum derivatives and the second largest consumer of energy after the industrial sector. Electric mobility means reducing polluting gas emissions, noise pollution and making progress in energy sovereignty in the transportation sector. The objective is to electrify public urban transport, company and application fleets, as well as to promote electrification among private vehicles.

In terms of infrastructure, Uruguay is a pioneer in the region; the country has the first electric highway in Latin America, with 180 charging posts[21]. Throughout this year, **UTE** plans to invest approximately US$ 5.5 million in 124 new charging posts. In the context of the electrification of transportation, MIEM has implemented the *MOVÉS* project for battery electric vehicles.[22]

[21] Charging - UTE
Among the incentive measures for electric vehicles that have been promoted since 2010 is the reduction of the Internal Specific Tax (IMESI for its acronym in Spanish) applicable to hybrid and electric vehicles, the inclusion of electric utility

Graph No. 3.5
ELECTRIC VEHICLE IMPORTS[23]
(IMPORT VALUE IN MILLIONS OF US$)



Source: Compiled by Uruguay XXI based on data from Customs.

Imports of electric vehicles, which include purchases made by various public entities and companies, also show increased momentum. In 2022, 620 vehicles were imported, for a value of US$ 41 million. Between January and October 2023 there was a 24% increase in the value of imports in year-on-year comparison, totaling US$ 38 million.

Uruguay's strong track record in electric mobility and the solid development in clean energy generation was strategic to become the country chosen by Volkswagen for the launching of its electrification strategy in Latin America[24]. Uruguay received the first ten units of the e-up! model, 100% electric vehicles that were tested and inspected in the country. In addition to the availability of energy and charging infrastructure, one of the reasons that led Volkswagen to choose Uruguay was the technological infrastructure and connectivity, which will allow to manage all the information generated by the electric vehicles with permanent and reliable connectivity[25].

Uruguay is experiencing significant growth in the adoption of electric vehicles, although they still represent a minority percentage of the total vehicle fleet in the country. According to data published by the Automotive Trade Association (ACAU, for its acronym in Spanish), 1,043 new electric vehicles were sold in 2022, 2% of total sales and double that of 2021. In the first half of 2023, electric vehicles accounted for 3% of car sales and it is estimated that they will again double the 2022 figures.

vehicles in the cleaner production indicator of the Investment Promotion Act, and the amendment of the Global Tariff Rate for cars with an exclusively electric propulsion engine, set at 0%.

[23] Mercosur common nomenclature (NCM) 870380 and 870490.
[24] Why did VW choose Uruguay to start its 100% electric landing in the region after a seven-year process? – El Observador.
[25] For more information see the ICT Sector Report in Uruguay.

Although electric vehicles do not yet dominate the automotive market in Uruguay, the growth in sales shows a growing interest on the part of consumers in cleaner and more sustainable mobility alternatives. This trend reflects Uruguay's commitment to the adoption of more environmentally friendly technologies.

The government continues to make progress in improving the infrastructure for electric mobility, and is currently installing fast charging stations to improve user comfort. In turn, there is a set of incentives for electric mobility[26].

As the charging infrastructure for electric vehicles continues to develop and stimulus policies are implemented, it is possible that the adoption of electric vehicles in Uruguay will continue to grow in the coming years. This will not only contribute to reducing greenhouse gas emissions, but will also promote sustainability and energy efficiency in transportation.

Uruguay offers access to more than 400 million people in the region. The country has free access to the Argentine and Brazilian markets for products in the automotive sector, with origin regimes to export to both countries with zero tariffs. Under one of the agreements, for new models, only 25% of the minimum regional content is required for the first year, reaching 40% from the third year onwards. Within this regime, which has quantitative restrictions, there is still significant margin for companies that want to export to both Argentina and Brazil. Uruguay has an important benefit for vehicle assembly companies, which can exempt the extra-zone and intra-zone Global Tariff Rate of SKD and CKD Kits intended for vehicle assembly. In addition, the automotive and auto parts sector can benefit from a 10% FOB refund on the value of its exports[27].

3.4. ENERGY EFFICIENCY

As a supplement to the changes in the energy matrix, government authorities are implementing the National Energy Efficiency Plan[28]. This plan aims to promote measures that include an economically convenient reduction in the amount of energy required to produce a product or service and, at the same time, guarantee equal or higher levels of quality. This concept also includes the substitution in the end use of traditional energy sources for non-conventional renewable energy sources.

In order to achieve this goal, one of the necessary actions is to finance and/or guarantee investment projects and technical assistance in Energy Efficiency (EE) in both the public and private sectors. For this purpose, different economic and financial instruments are available for promotion.

3.4.1. SMART GRID

As different energy sources are introduced, the management of the electricity system becomes increasingly complex, both at the generation and distribution stages. On the one hand, it is necessary to integrate the different energy resources in order to maximize generation capacity at the lowest possible cost. On the other hand, as consumption peaks - throughout the year and throughout the

[26] Incentives for Electric Mobility UTE (link)
[27] Decree N°316/992
[28] National Energy Efficiency Plan (link)

day - do not usually coincide with the times of most abundant and cheapest generation, it is also necessary to optimize use.

4. ANNEXES

4.1. URUGUAY'S ENERGY SYSTEM

The BEN summarizes the information related to energy production, transformation, and consumption, and its main objective is to be a source of reference on the evolution of the country's energy situation, as well as on the different variables considered. At the same time, it provides information to all agencies, companies and individuals related to the energy planning process.

Link: BEN - MIEM

UTEi provides information on management, usage, billing and status of the services of the main company in the Energy Sector within Uruguay. It is engaged in generating, transferring, distributing and commercializing electric energy, as well as providing advisory services and technical assistance in the areas of its expertise and related areas throughout the country.

Link: UTEi

The commitment to green hydrogen is one of the cornerstones of the second energy transition that Uruguay is beginning to undergo. The Green Hydrogen site of the Ministry of Industry has relevant information on this process.

Link: H2U

4.2. MAIN PRIVATE COMPANIES IN RENEWABLE ENERGY

The remarkable transformation of the sector was possible due to the careful coordination between the public sector (soliciting proposals, selecting and signing the long-term power purchase agreements - PPAs - that allowed for the financing and effective implementation of the projects) and the involvement of the private sector. Both national and foreign companies contributed to the development and deployment of new technologies. As a result, these companies - many of them SMEs - expanded their capabilities and are now providing services to the countries of the region.

Some of these stakeholders are listed in this annex.

4.3. INSTITUTIONAL AND REGULATORY FRAMEWORKS

The success of this sector is partly possible due to the existence of an Energy Policy that sets the course, a solid Institutional framework and a Regulatory Framework that is attractive to investors.

Both aspects are detailed in this annex.

4.4. ACTIVE RENEWABLE ENERGY SOURCES

Uruguay has natural resources that allow the use of renewable energy sources. A high-water flow, constant and predictable winds, uniform solar irradiation throughout the territory (although with seasonal variation) and a thriving agro-industrial sector provide opportunities from biomass.

Both aspects are detailed in this annex.

5. URUGUAY AT A GLANCE (2023)

URUGUAY IN NUMBERS

Official name	Oriental Republic of Uruguay
Geographical location	South America, borders with Argentina and Brazil
Capital city	Montevideo
Surface Area	176,215 km^2
Population (2023)	3.57 million
Population growth (2023, annual)	0.3%
GDP per capita (2023)	US$ 21,164
Currency	Uruguayan Peso ($)
Literacy rate	0.98
Life expectancy at birth	77.9 years of age
Type of government	Democratic Republic with presidential system
Political division	19 departments
Time Zone	GMT - 03:00
Official language	Spanish

MAIN ECONOMIC INDICATORS

Indicators	2018	2019	2020	2021	2022	2023*
GDP (Annual % Variation)	0.16%	0.74%	-6.26%	5.28%	4.92%	1.97%
GDP (US$ Millions)	65,118	61,992	53,613	61,380	74,182	75,484
Population (Millions of people)	3.51	3.52	3.53	3.54	3.55	3.57
GDP per capita (US$)	18,573	17,619	15,184	17,324	20,867	21,164
Unemployment rate - Annual Average (% EAP)	8.3%	8.9%	10.4%	9.3%	7.9%	8.1%
Exchange rate (Pesos per US$, Annual Average)	30.8	35.3	42.1	43.6	39.5	40.9
Exchange rate (Annual Average Variation)	7.3%	14.7%	19.2%	3.6%	-9.4%	3.5%
Consumer prices (annual accumulated % change)	8.0%	8.8%	9.4%	8.0%	8.3%	6.7%
Exports of goods and services (US$ Millions)**	17,216	17,185	13,735	19,336	22,605	23,283
Imports of goods and services (US$ Millions)**	13,964	13,499	11,364	14,903	18,716	20,057
Trade surplus / deficit (US$ Millions)	3,252	3,687	2,371	4,433	3,889	3,227
Trade surplus / deficit (% of GDP)	5.0%	5.9%	4.4%	7.2%	5.2%	4.3%
Global Fiscal Result (% of GDP)	-3.9%	-4.4%	-5.8%	-4.1%	-3.4%	-
Gross Capital Expenditure (% of GDP)	14.9%	14.3%	16.4%	19.2%	18.8%	-
Gross Public Sector Debt (% of GDP)	59.1%	60.1%	74.5%	69.1%	64.3%	-
Foreign Direct Investment (US$ Millions) ***	-11	2,018	746	2,244	3,839	-
Foreign Direct Investment (% of GDP)	0.0%	3.3%	1.4%	3.7%	5.2%	-

Sources: BCU, INE, MEF and estimated data (*). The fiscal result data includes the effect of Law N°19590 (fifty-year-olds). In 2017 the BCU adopted the methodology of the 6th balance of payments manual. Data based on this new methodology include purchase and sale of goods and re-exports and have been available since 2012. The data refers to net flows and may therefore have negative values (**).