Energy Balance 2023

Ministerio de Industria, Energía y Minería

BEN
BALANCE ENERGÉTICO NACIONAL URUGUAY

República Oriental del Uruguay
Ministry of Industry, Energy and Mining
National Energy Directorate

Ministerio **de Industria, Energía y Minería**

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Foreword

The National Energy Directorate presents the National Energy Balance (BEN) 2023, which completes 59 uninterrupted years of this study. In terms of state policies, Uruguay's energy sector is an internationally recognized example, and it is important to acknowledge these processes, recognizing that they involve components with a long history, such as BEN.

This study is a relevant input to analyze, evaluate and implement energy policies. It reveals which energy sources are consumed in the country, identifies the main sectors of energy consumption, and shows how energy sources complement each other across different sectors.

The energy supply matrix increased by 8%, a notably high value compared to recent years. The most significant events were: the entry of the third cellulose plant, the shutdown of the refinery as of September, and the drought that significantly affected the country in the first half of the year, directly impacting the electricity generation matrix.

Total CO_2 emissions decreased by 1% compared to the previous year. The transport sector had the highest share (58%). For this reason, the efforts made in energy efficiency and in encouraging electric mobility are very important.

CO_2 emission factor of the grid dropped by 7 % compared to 2022. This is a direct consequence of the lower consumption of fossil fuels for electricity generation that was delivered to the National Interconnected System. It is important to highlight the electrical interconnection with neighboring countries, which allowed the import of cheaper energy during droughts compared to local thermal generation, reducing impacts, and demonstrating the system's resilience.

In conclusion, we extend our gratitude to the official organizations and private institutions that provided the valuable information contained in this work, as well as to the team that meticulously integrated and processed the data.

Christian Nieves Lauz, B.S.
National Energy Director

Ministerio de Industria, Energía y Minería

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1. Introduction

The National Energy Balance (BEN) is a statistical study that gathers information on different energy flows. It comprises the supply, transformation, and sectoral consumption of energy (demand), which is expressed in a common unit and corresponds to a calendar year. It is a necessary tool for energy planning as it shows the structure of energy production and consumption in the country. It is also an input for the definition, monitoring, and evaluation of energy and environmental policies, as well as for the preparation of other studies such as National Greenhouse Gas Inventory (INGEI) of the energy sector. In turn, this information source in conjunction with other variables, such as socioeconomic ones, becomes a very valuable input for decision making in this area.

The National Energy Directorate (DNE) of the Ministry of Industry, Energy and Mining (MIEM) prepares and published the annual BEN through the area "Planning, Statistics and Balance" (PEB) and includes data since 1965. Thus, 59 years of the historical series are completed with BEN 2023. Uruguay is one of the few countries in Latin America and the Caribbean to have published such an uninterrupted and public series of BENs. This publication follows a series that began in 1981 with the "National Energy Balance-Historical Series 1965-1980", prepared with the support and methodology of the Latin America Energy Organization (OLADE).

For comparison purposes, the figures corresponding to the different sources that make up the energy supply (which have different heating values) are expressed in ktoe (kilotonnes of oil equivalent), where one tonne of oil equivalent (toe) corresponds to ten million kilocalories. The conversion of each source's corresponding magnitudes to their expression in ktoe is done through their respective lower heating value (LHV).

Implemented improvements:

The presentation of the information has varied significantly over the years. Below are the modifications and improvements included in BEN 2023:

Sources:

- Electricity: since 2023, non-technical losses in the "not identified" sector have been attributed, except for social losses that continue to be reported in the residential sector.

- Non-energy products: imports and exports of lubricants are no longer considered, as they are not linked to the refinery's production flow. This change in criteria aligns with the International Recommendations for Energy Statistics (IRES) [1] and was implemented starting in 2023. Meanwhile, the classification of non-energy products by type has been carried out since 2013.

- Solar thermal: The efficiency factor used to estimate the energy obtained from solar thermal collectors, as defined by the International Energy Agency (IEA), was adjusted for the 2014-2023 series.

- Industrial waste: improvements were made in the characterization of these energy products, and a correction was applied to the CO_2 emission factor, analyzed by type of waste, for the entire series (2011-2023). At the same time, new consumers of these products were identified.

Other improvements:

- Sectorial energy intensity: Based on the series *"Cuenta producción industrias a precios constantes de 2016"* from the Central Bank of Uruguay (BCU), energy intensities were estimated for the sectors considered in the BEN starting in 2016.

1- United Nations, International Recommendations for Energy Statistics, <https://unstats.un.org/unsd/energystats/methodology/ires> (07/22/2024).

- CO_2 emissions: A new series of CO_2 emissions data associated with electricity generation for export was created for the period 2015–2023.

- Primary energy matrix: the series of energy supply by source, origin and type was extended, starting in 1965.

Relevant events of 2023:

In 2023, Uruguay experienced low economic growth, with gross domestic product (GDP) increasing by only 0.4% compared to 2022, evaluated at constant 2016 prices. It is worth noting that, the economy showed varied behaviors over the past four years. After a 7.4% drop in GDP in 2020 compared to the previous year, the following two years saw growth of 5.6% in 2021 and 4.7% in 2022, respectively.

In 2023, three significant events influenced the behavior of Uruguay's national energy sector to varying degrees. First, the third cellulose plant in the country began operations. Second, the refinery underwent a scheduled maintenance shutdown starting in September, resulting in no oil refining during the fourth quarter of 2023. Finally, the drought affecting the country in recent years continued through the first half of 2023, adversely impacting hydroelectric power availability. This situation, however, was reversed in the second half of the year.

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SUMMARY OF CHAPTER 2

Infrastructure of the Uruguayan energy system

The infrastructure of the Uruguayan energy system is made up of three major sectors: “power generation”, “hydrocarbons” and “other sources and energy uses”.

Regarding **power generation**, there are four hydroelectric power plants in the country; three are located on the Río Negro and one on the Río Uruguay (shared with Argentina). There are also thermal power plants operated by steam turbines, gas turbines and engines that run on fossil fuels and biomass. Additionally, it includes public, private, and mixed-capital wind and solar generators. There are electrical interconnections with Argentina (2,000 MW) and Brazil (570 MW) (including frequency conversion).

In 2023, the installed capacity of the generation park was of 5,263 MW. The total installed capacity was composed of 1,538 MW from hydropower, 1,517 MW from wind, 1,177 MW from fossil, 731 MW from biomass and 300 MW from solar energy. 78% corresponded to renewable energy (hydro, biomass, wind, and solar), while the remaining 22% was non-renewable energy (gas oil, fuel oil, and natural gas). In 2023, the installed capacity of thermal power plants using biomass waste grew by 75%, driven by the commissioning of the country’s third cellulose plant.

Regarding **hydrocarbons**, Uruguay has a sole refinery, owned by the state-owned ANCAP, located in the department of Montevideo. Its refining capacity is 50,000 barrels per day (8,000 m^3/day), and it primarily produces gas oil, gasoline, fuel oil, LPG (LP gas and propane), and jet fuel. A desulfurization plant is also in place to produce low-sulfur gas oil and gasoline in accordance with international fuel specifications.

Crude oil enters the country through the Terminal Petrolera del Este in José Ignacio (Maldonado), through a buoy located 3,600 meters off the coast. It is then transported 180 kilometers by pipeline to the refinery in Montevideo. Fuels and other fuel products are distributed across the country by land and sea, using distribution plants located in the departments of Montevideo, Colonia, Durazno, Paysandú, and Treinta y Tres.

Natural gas is supplied to the country from Argentina through two gas pipelines with a total capacity of 6,000,000 m^3/day.

Regarding the infrastructure for **other energy sources and uses**, it is important to mention those associated with biofuel production and solar thermal energy. In 2023, Alcohols of Uruguay (ALUR) operates two bioethanol production plants in the northern part of the country (Artigas and Paysandú), with a total installed capacity of 95,800 m^3/year. In terms of biodiesel production, ALUR has two industrial complexes, only one of which was operational last year, with a capacity of 62,000 m^3/year. It is worth noting that, due to regulatory changes, the obligation to blend biodiesel with gas oil has been removed, and no blending volume has been registered since December 2022.

Finally, in 2023, a total installed surface area of 126,359 m^2 of solar thermal collectors was recorded, distributed across the country.

2. Infrastructure of the Uruguayan energy system

The infrastructure of the Uruguayan energy system is made up of three major sectors: "power transformation," "hydrocarbons," and "biofuels."

2.1. Power generation

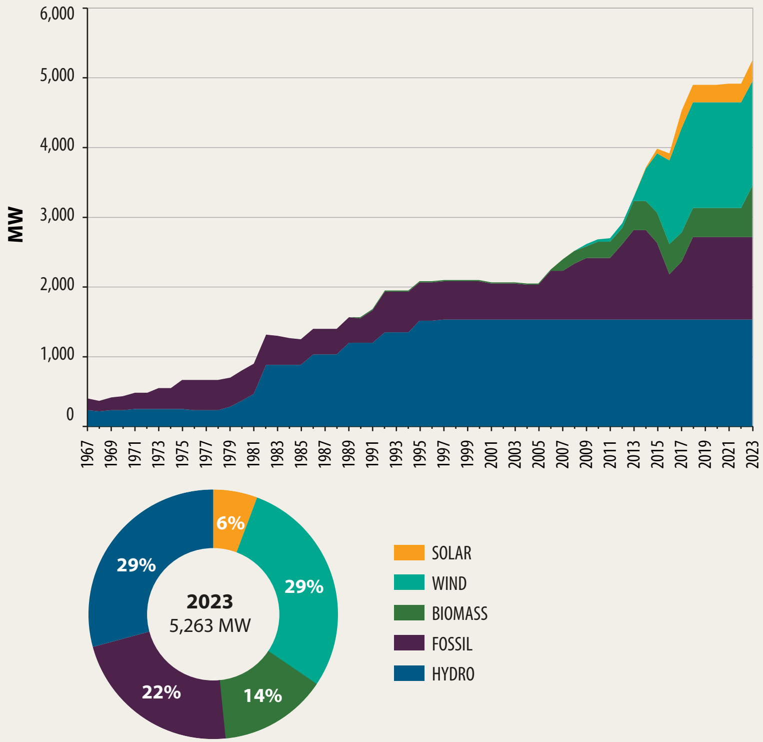
There are four hydroelectric power plants in the country; three are located on the Río Negro and one on the Río Uruguay (shared with Argentina). There are also thermal power plants operated by steam turbines, gas turbines and engines that run on fossil fuels and biomass. Additionally, the power generation sector is composed of wind and solar generators. The power transformation sector includes public, private, and mixed-capital wind and solar generators The National Interconnected System (SIN) has interconnections with Argentina (2.000 MW) and Brazil (570 MW).

The installed capacity of the generation park has undergone significant changes throughout the 1967-2023 series. Significantly growth was recorded throughout the period, in which the total power went from 394 MW (1967) to 5,263 MW (2023). Historically, the evolution was marked by variations recorded for fossil and hydraulic thermal generators. However, starting from 2005, there was a notable growth in the installed capacity of the generation park. This was influenced by new local energy sources, which complemented traditional sources, and the diversification of the energy matrix. It is worth noting that, while there was a net growth over the entire period, there were years where the total installed capacity decreased compared to the previous year. This was due, for example, to the decommissioning of fossil thermal plants.

Between 2019 and 2022, the total installed capacity remained practically constant, but in 2023, it recorded outstanding growth (7%) and reached its maximum value. This increase was primarily due to the commencement of thermal power using biomass, as detailed below.

By the end of 2023, the total installed capacity was composed of 1,538 MW from hydropower, 1,517 MW from wind, 1,177 MW from thermal fossil, 731 MW from thermal biomass, and 300 MW from photovoltaic solar generators. Considering the installed capacity by source, 78% corresponded to renewable energy (hydro, biomass, wind, and solar) while the remaining 22% was non-renewable energy (gas oil, fuel oil and natural gas).

FIGURE 1. Installed capacity by source



NOTE: Between 1967 and 1989, only fossil and hydropower installed capacities are included, accounting for practically 100% of the total installed capacity.

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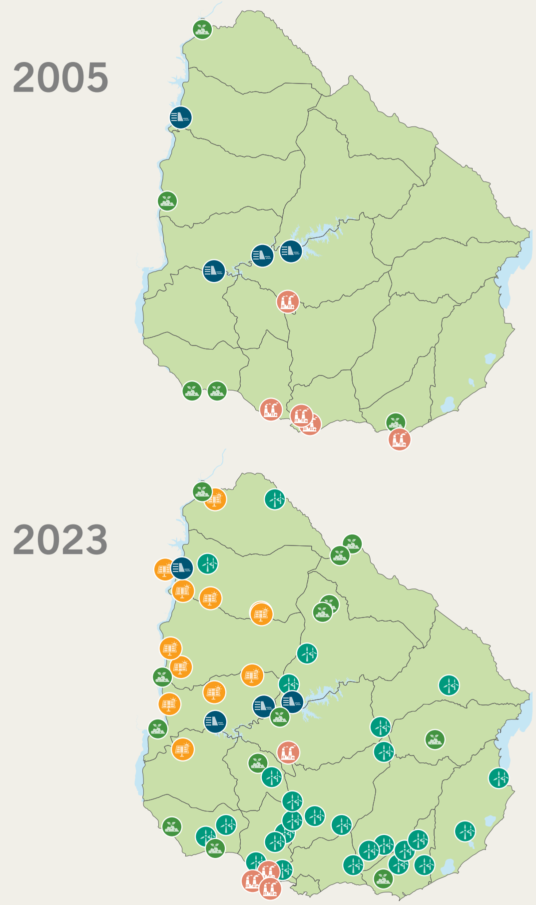
It is interesting to compare the situation with the year 2005, where a similar participation of renewable sources was recorded. However, the total installed capacity was less than half. This evidences the significant penetration of installed capacity associated with renewable sources, as mentioned above.

Below is an analysis of the evolution of the installed capacity of each source.

TABLE 1. Installed capacity by source

MW	1967	1975	1985	1995	2005	2015	2023
Fossil							
Steam turbines		333.0	313.0	255.0	255.0	205.0	**180.0**
Gas turbines		31.0	55.0	249.7	235.7	815.7	**925.7**
Engines		55.0	2.0	44.4	5.5	81.0	**71.0**
Total Fossil	**157.9**	**419.0**	**370.0**	**549.1**	**496.2**	**1,101.7**	**1,176.7**
(%)	**40%**	**62%**	**30%**	**26%**	**24%**	**28%**	**22%**
Biomass							
Steam turbines				16.4	13.5	426.1	**728.6**
Engines					1.0	1.6	**2.6**
Total Biomass				**16.4**	**14.5**	**427.7**	**731.2**
(%)				**1%**	**1%**	**11%**	**14%**
Hydro							
Total Hydro	**236.0**	**252.0**	**881.0**	**1,519.0**	**1,538.0**	**1,538.0**	**1,538.0**
(%)	**60%**	**38%**	**70%**	**73%**	**75%**	**39%**	**29%**
Wind							
Total Wind					**0.2**	**856.8**	**1,516.5**
(%)					**0%**	**21%**	**29%**
Solar							
Total Solar						**64.5**	**300.6**
(%)						**2%**	**6%**
TOTAL	**393.9**	**671.0**	**1,251.0**	**2,084.5**	**2,048.8**	**3,988.6**	**5,262.9**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

FIGURE 2. Geographical distribution of electricity generators, 2005 vs 2023



	2005	2023
THERMAL GENERATORS (FOSSIL FUELS)	5	4
THERMAL GENERATORS (BIOMASS WASTES)	5	12
WIND GENERATORS	0	42
HYDROPOWER PLANTS	4	4
PHOTOVOLTAIC SOLAR GENERATORS	0	17

NOTE: Only power plants with higher capacity than 1MW are considered.

Regarding **hydropower plants**, the growth in installed capacity occurred mainly in the 1980s and the first half of the 1990s. Until 1981, the country had two hydropower plants on the Río Negro *(Rincón del Bonete and Baygorria)*, and in 1982, the *Constitución* plant (Palmar) began operations. The incorporation of power from the Salto Grande plant to Uruguay occurred gradually between 1979 and 1995, reaching 50% of installed capacity in 1995. Since then, the country filled its installed capacity in large-scale hydropower, which has remained constant to date (1,538 MW). The contribution of hydropower plants to the total power went from 60% in 1967 to 29% in 2023.

The installed capacity of the **thermal generators that run on fossil** fuel averaged 250 MW in the early 1970s. In 1975, the sixth thermal unit at the Batlle power plant began operations and total power increased to 419 MW. In subsequent years, this power remained relatively constant up to 1984, when there was a decrease due to the shutdown of the 1st and 2nd units, as well as of several autonomous generation systems. In 1990, a relative minimum in fossil-fuel capacity was recorded (349 MW), increasing again in subsequent years, mainly due to the entry into operation of *La Tablada* backup thermal power plant, which resulted in a total fossil-fuel capacity of 576 MW for 1992.

From 1995, the installed capacity remained relatively constant, followed by a significant growth between 2006 and 2013, when 600 MW corresponding to turbines and 179 MW corresponding to engines (of which 100 MW were leased) were added. In 2013-2014, the maximum value of installed capacity from fossil fuels was recorded and a trend change was observed. In the following two years, it decreased. In 2015, the capacity of fossil thermal generators decreased by 173 MW as Sala B of the Batlle power plant, the turbine in Maldonado, and the leased engines since 2012, ceased to operate. Between 2015 and 2016, the decrease was 455 MW as the 5th and 6th units of the Batlle power plant, as well as the APR A and APR B leased equipment, ceased to operate.

Between 2017 and 2018, the three combined cycle turbines of Punta del Tigre B (540 MW) started operating. This meant a new increase in the installed capacity of fossil fuels, which remained up to date (1,177 MW), and resulted in a share of 22% compared to the total installed capacity of 2023. This Punta del Tigre plant is essential to provide the system with the necessary security and reliability to meet domestic demand and as a source of energy that can be exported to neighboring countries. It is considered the thermal backup for the next 30 years.[2]

FIGURE 3. Installed capacity of hydropower plants

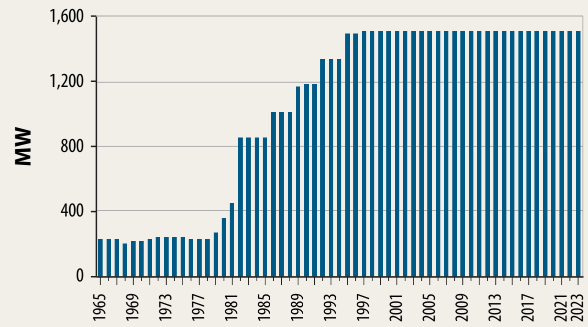
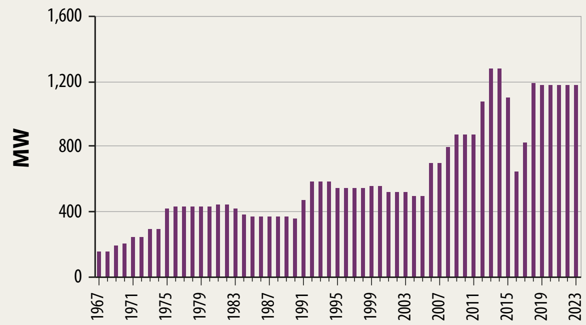


FIGURE 4. Installed capacity of thermal generators that run on fossil



2- National Administration of Power Plants and Electrical Transmissions (UTE), *Ciclo Combinado: respaldo a menor costo,* <https://portal.ute.com.uy/noticias/ciclo-combinado-respaldo-menor-costo> (08/01/2024).

Historically, the installed capacity of the **thermal generators using biomass** did not exceed 23 MW; this was the case until 2006, when a significant growth was recorded. In 2007, electricity purchase contracts between UTE and private generators came into force. This resulted in an installed capacity growth of more than 700 MW from biomass over the last years. Particularly, the increases recorded in 2007, 2013 and 2023 were due to the installation of the cellulose plants currently operating in the country. Biomass share accounted for 1% of total generation capacity until 2006, reaching a peak value of 14% in 2023 (731 MW).

In 2008, large-scale **wind energy** became a part of the electricity generation mix, with the startup of the first wind farms in the country. Both public and private **wind generators** have been incorporated since that year, and there has been a significant development of this energy source, mainly between 2014 and 2017.

By 2013 59 MW of wind generators had been installed. As of 2014, between 300 to 400 MW came into operation each year. Thus, as of December 2017, there were a total of 43 large-scale wind farms connected to the grid. When considered together with microgenerators and autonomous plants, they amounted to an installed capacity of 1,513 MW. In the last six years, there were no changes, except for 2019, when 2.2 MW associated with off-grid autoproducers (not connected to the SIN) were installed, and a single park increased its capacity by 1 MW. Wind generators' share in these last years has remained constant at 31% between 2018 and 2022 and dropped by 29% in 2023 (1,517 MW).

In 2023, installed capacity using biomass grew by 75%, due to the commissioning of the third cellulose plant in the country.

FIGURE 5. Installed capacity of thermal generators that run on biomass

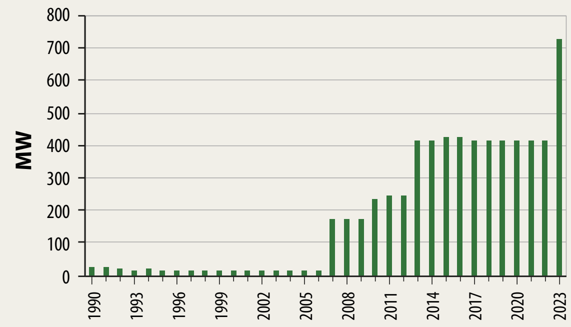
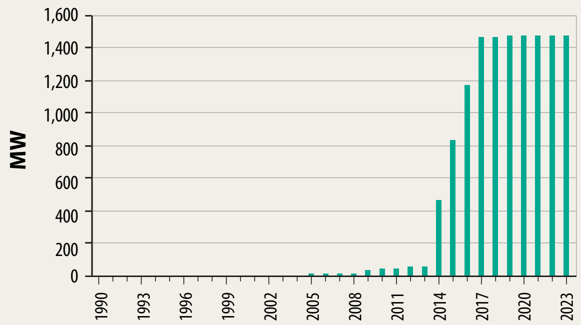


FIGURE 6. Installed capacity of wind generators



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Finally, **photovoltaic solar energy** is worth mentioning. Although it is a source that has been used in the country for many years, its values are small compared to those of other energy sources. It is worth noting that the installed capacity has shown a significant increase since 2015, rising from 4 MW (2014) to 300 MW (2023) and reached a 6% share of the country's total installed capacity.

Regarding large generators, between 2017 and 2023, 15 grid-connected photovoltaic plants came into operation, totaling 164 MW. In turn, stand-alone autoproducers have been installed, with a total installed capacity of 10.5 MW over the last eight years.

Micro-scale photovoltaic solar energy also exhibited an outstanding development. The commissioning of over one thousand installations in the last four years, totaling 20 MW, is particularly noteworthy. Regarding sectoral distribution, new microgeneration solar power installations have been recorded in all cases year after year, albeit with slightly different trends. Commercial/services has been the sector with the highest installed capacity, showing values higher than 50% since 2015. It is noteworthy that more than half of the installed capacity in 2023 was in the residential sector, leading to an 83% increase for that sector. In the last year, the distribution ranked by importance was the following: commercial/services (54%), industrial (18%), residential (15%) and agriculture (13%).

FIGURE 7. Installed capacity of photovoltaic solar generators

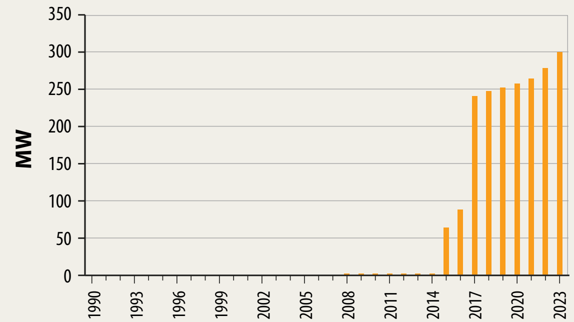


FIGURE 8. Installed capacity of solar microgeneration by sector

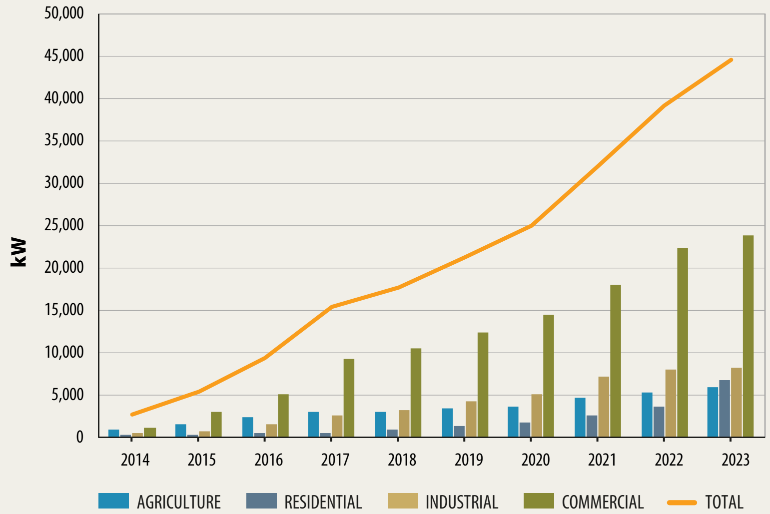


TABLE 2. Installed capacity of solar microgeneration by sector

kW	2014	2017	2020	2023
Residential	133	576	1,764	**6,703**
(%)	5%	4%	7%	**15%**
Commercial	1,206	9,312	14,542	**23,908**
(%)	45%	60%	58%	**54%**
Industrial	473	2,667	5,066	**8,127**
(%)	18%	17%	20%	**18%**
Agriculture	875	2,895	3,656	**5,858**
(%)	33%	19%	15%	**13%**
TOTAL	**2,687**	**15,450**	**25,028**	**44,596**
(%)	**100%**	**100%**	**100%**	**100%**

2.2. Hydrocarbons

As for hydrocarbons, Uruguay has only one refinery that belongs to the state-owned company ANCAP, located in the department of Montevideo. At present, its refining capacity is 50,000 barrels per day (8,000 m^3/day) and it mainly produces gas oil, gasoline, fuel oil, LPG (LP gas and propane) and jet fuels, among others. Crude oil enters the country through the *Terminal Petrolera del Este*, in José Ignacio, department of Maldonado. The oil is received through a buoy located 3,600 meters from the coast and transported through a 180-kilometer pipeline to the refinery located in Montevideo.[3] Fuels and other oil products are transported across the country by road and sea, through distribution plants located in the departments of Montevideo, Colonia, Durazno, Paysandú, and Treinta y Tres.

The refinery has a refining capacity of 50,000 bbl/day.

According to data provided by ANCAP, the refinery began operating in 1937 and, over the years, its equipment and oil processing capacity have undergone changes. The remodeling that took place between 1993 and 1995 is particularly noteworthy, as it meant that there was no production throughout 1994. At that time, a new catalytic cracking unit and a visbreaking unit were installed. In addition, plant changes aimed at increasing the energy efficiency of the atmospheric and vacuum distillation units were made. After this remodeling, the refinery's processing capacity amounted to 37,000 barrels/day (5,900 m^3/d).

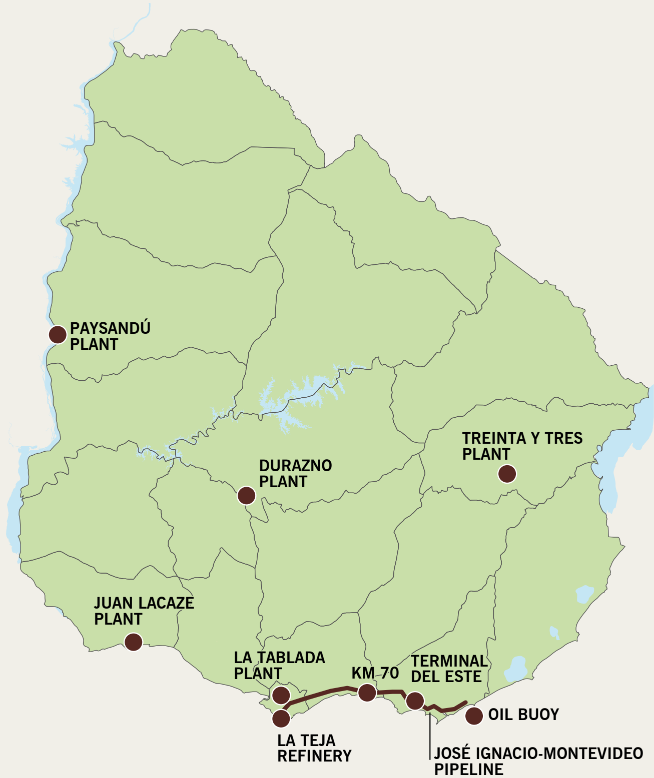
In 1999, another important period of remodeling began, aimed at producing high-octane, unleaded gasoline. So, back then, a gasoline hydrotreating unit, an isomerization unit, and a continuous catalytic reforming unit were installed. Thus, increasing crude-processing capacity to 50,000 barrels per day. Between September 2002 and March 2003, as well as between September 2011 and January 2012, the refinery was out of service for scheduled maintenance.

3- National Administration of Fuels, Alcohol, and Portland (ANCAP), *Operación Terminales*, <https://www.ancap.com.uy/2158/1/operacion-terminales.html> (08/01/2024).

In 2014, the desulfurization plant completed its first year of operation to produce low-sulfur gas oil and gasoline, according to international fuel specifications.

The plant's capacity was and still is 2,800 m^3/day of 50S gas oil and 800 m^3/day of 30S gasoline.[4] There is also a sulfur recovery plant with an installed capacity of 30 tonnes/day, providing liquid sulfur that is sold on the domestic market as raw material for fertilizers.[5]

FIGURE 9. Geographical distribution of infrastructure related to oil and oil products



4- 50S gas oil and 30S gasoline have a maximum sulfur concentration of 50 and 30 parts per million, respectively.
5- National Administration of Fuels, Alcohol, and Portland (ANCAP), *Historia de la Refinería*, <https://www.ancap.com.uy/1581/1/historia-de-la-refineria.html> (08/01/2024).

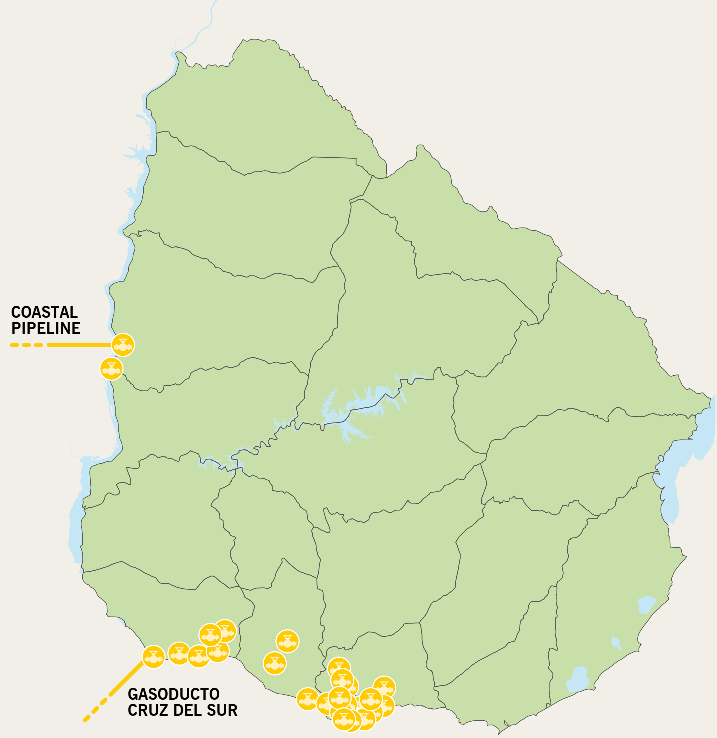
In September 2023, the refinery was out of operation due to scheduled maintenance of its units. The same had been the case during most of 2017 (from February to September). Consequently, there was a decrease in crude oil imports and an increase in the import of oil products to meet the demand. Outside these periods, the refinery has operated as usual with similar crude oil processing levels as in 2016.

Natural gas is supplied by Argentina through two gas pipelines with a total capacity of 6,000,000 m^3/day. The coastal gas pipeline, operated by ANCAP, is located in the northwest region of the country and has a capacity of 1,000,000 m^3/day. It opened in October 1998 and its route begins in Entre Ríos (Argentina) and ends in the city of Paysandú. The pipeline spans a total length of 27,200 meters (including distribution branches in Uruguay and the section over the international bridge) while supplying the local distribution network.[6]

There are two operating gas pipelines with a total capacity of 6,000,000 m³/day.

The second pipeline has been operating since November 2002 in the southwestern part of the country and is run by *Gasoducto Cruz del Sur* (GCDS). The system spans from Punta Lara (Argentina) to the city of Montevideo and its surroundings, passing through the departments of Colonia, San José, and Canelones. It has a capacity of 5,000,000 m^3/day and consists of two trunk pipelines: an underwater one for crossing the Río de la Plata and a land one between Colonia and Montevideo. There are also several side pipelines that feed the different localities with a total extension of 400 kilometers.[7]

FIGURE 10. Geographical distribution of natural gas delivery points



6- National Administration of Fuels, Alcohol, and Portland (ANCAP), *Gasoducto del Litoral*, <https://www.ancap.com.uy/1572/1/gasoducto-del-litoral.html> (08/01/2024).
7- Gasoducto Cruz del Sur, *Operaciones*, <https://www.gcds.com.uy/#operaciones> (08/01/2024).

2.3. Other sources and energy uses

As of 2010, the BEN has included biofuels production and consumption, mainly used in gasoline and gas oil blends within the transport sector. Law 18,195 (November 14, 2007) and its Regulatory Decree 523/008 (October 27, 2008) provided the legal framework for agrofuel production, commercialization, and use in the country.

As for **bioethanol production**, Alcohols of Uruguay (ALUR) currently has two bioethanol production plants located in the north of the country. Since 2006, ALUR has been managing the sugar factory of the CALNU cooperative in Bella Unión (Artigas department) through an energy and food project that involved an industrial investment plan for the assembly of a distillery for ethanol production, (among other measures). This agriculture-energy-food complex produces bioethanol, sugar, electric energy and animal feed, mainly from sugarcane juice and molasses, as well as sweet sorghum juice (albeit to a lesser extent).[8] According to data supplied directly by the company, the capacity of this plant is 120 m³/day of bioethanol, and it operates from May to October. The plant has operated at higher than nominal capacity (140-190 m³/day) on several occasions.

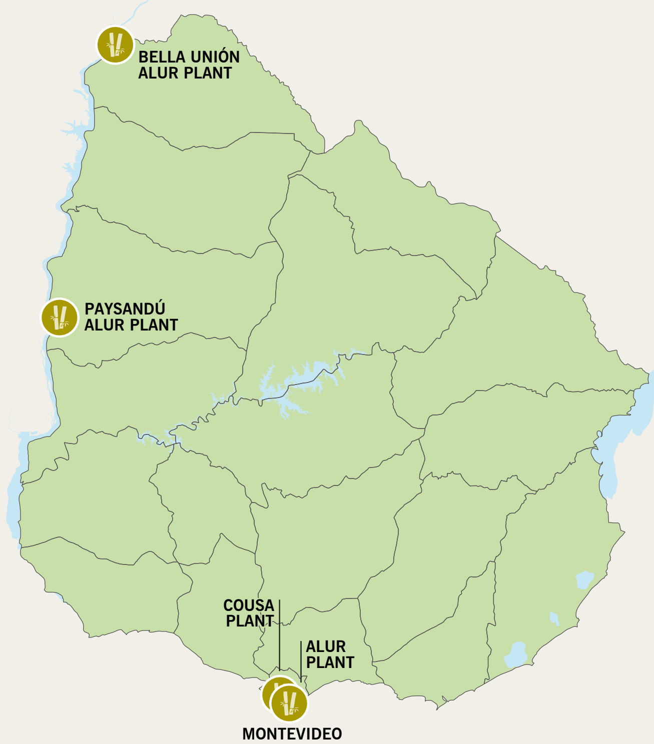
Furthermore, in October 2014, a new ethanol production plant was inaugurated in Paysandú department, with an installed capacity of 70,000 m³/year. The plant can process grain sorghum, corn, wheat, and barley, running continuously throughout the year to produce bioethanol and animal feed. The selected technology comes from the U.S. company Katzen. It stands out for its efficient energy arrangement, providing the flexibility to utilize both summer and winter crops, while also being low-impact environmental technology.[9]

8- Alcohols of Uruguay (ALUR), *Complejo Agroenergético - Bella Unión, Artigas*, <https://www.alur.com.uy/agroindustrias/bella-union> (08/01/2024).
9- Alcohols of Uruguay (ALUR), *Planta Bioetanol – Paysandú*, <https://www.alur.com.uy/agroindustrias/paysandu> (08/01/2024).

As for **biodiesel production**, ALUR has two industrial complexes located in Montevideo department. Plant No. 1 is located in Paso de la Arena and has a biodiesel production capacity of 18,000 m³/year from refined oil, used frying oil, and beef tallow. Glycerin is also produced as a byproduct. This plant is not currently operating. Plant No. 2, currently operating, is located in Capurro and has a biodiesel installed capacity of 62,000 m³/year, generated from vegetable oil, used frying oil, and beef tallow. The products are biofuel, olein, and glycerin.

Installed production capacity (operational) to 2023:
bioethanol: 95,800 m³/year
biodiesel: 50,000 tonne/year

FIGURE 11. Geographical distribution of biofuel plants



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Moreover, an agreement was signed with the company COUSA to ensure the efficient production of biodiesel, enabling the utilization of its infrastructure. At the same time, this private company contributes grain milling and oil production services, thereby supplying the raw material for both biodiesel plants. Soybeans and canola seeds are processed to produce crude degummed oil and protein meals.

In 2015, the industrial processes of plants No. 1 and No. 2, along with the final product, received certification under the European standard International Sustainability and Carbon Certification (ISCC) for the production of biodiesel from frying oil and tallow.[10]

It should be noted that Law 19,996 of November 3, 2011, repealed Article 7 of the Agrofuels Law described above. Consequently, the obligation to blend biodiesel in gas oil ceased to exist.[11] In this context, starting from January 1, 2022, ANCAP decided to decrease the biodiesel blending level to 2.5 % in gas oil.[12] From December of that year, no blending volume was recorded.

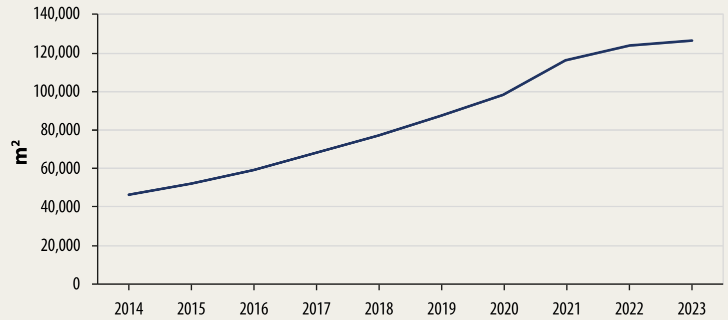
Regarding the infrastructure associated with **solar thermal energy**, significant growth has been recorded over the years. In 2014, the first year with solar energy estimates in the BEN, the installed area of solar thermal collectors was 46,261 m^2 (13 m^2/1,000 inhab). Over the following six years, this area grew at an average annual rate of 13%, reaching nearly 100,000 m^2 in 2020 (28 m^2/1,000 inhab). By 2021, the series recorded its most significant increase, with almost 20,000 m^2 installed that year alone. However, in 2022 and 2023, the installation of solar thermal collectors slowed, reaching a total of 126,359 m^2 (35 m^2/1,000 inhab).

10- Alcohols of Uruguay (ALUR), *Planta 2 Biodiesel – Capurro, Montevideo*, <https://www.alur.com.uy/agroindustrias/capurro> (08/01/2024).
11- National Directorate of Official Printing and Publications (IMPO), Law No. 18,195, <https://www.impo.com.uy/bases/leyes/18195-2007> (08/01/2024).
12- National Administration of Fuels, Alcohol, and Portland (ANCAP), Resolution of the Board of Directors No. 848/12/2021, <https://resoluciones.ancap.com.uy> (08/01/2024).

It is worth mentioning Law 18,585 (September 18, 2009) and its regulatory decree 451/011 (November 15, 2011), which established the initial legal framework for the development of solar thermal energy in the country. This law mandates the installation of solar thermal energy systems in new developments within sectors with higher hot water demand (such as health centers, hotels, clubs, heated swimming pools), as well as in public organizations. Over the years, various mechanisms have been developed and implemented to promote solar thermal energy at the residential level (such as the Solar Plan), alongside support for research and local capacity-building initiatives.

The installed area of solar thermal collectors was 126,359 m^2 in 2023; 35 m^2 per thousand inhabitants.

FIGURE 12. Installed area of solar thermal collectors



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SUMMARY OF CHAPTER 3

Energy supply

Energy supply registered a new record value in 2023 (6,126 ktoe). The sources consumed were, in order of importance: biomass (2,805 ktoe), oil and oil products (2,363 ktoe), wind electricity (410 ktoe), hydroelectricity (302 ktoe) and, to a lesser extent, imported electricity (120 ktoe), natural gas (66 ktoe) and solar energy (50 ktoe). The consumption of industrial waste, coal and coal derivatives was very small compared to the rest of the sources.

In 2023 renewable energy sources grew by 58% share in the supply matrix, while 40% corresponded to non-renewable sources. The remaining 2% was imported electricity.

In the last year, electricity generation was 12,877 GWh (1,107 ktoe), which represented a decrease of 13% compared to 2022, with an installed capacity that grew by 7%. Production was made up of 84% from public service power plants (929 ktoe), while the remaining 16% was generated by auto-production power plants (178 ktoe).

Domestic demand for electricity grew 5% compared to 2022. It was supplied mostly by domestic production (89%) and had to resort to high imports from neighboring countries (120 ktoe).

2023 was a year marked by drought, especially in the first half of the year. Hydroelectric power generation decreased 38% compared to 2022 and was the lowest value since 1990.

On the other hand, fossil fuel electricity generation dropped by 24%. The main fuel used was gas oil, whose consumption for generation (166 ktoe) decreased 25% with respect to the previous year, followed, to a lesser extent, by fuel oil, with a consumption for generation of 32 ktoe, similar to 2022.

In 2023, wind power generation remained practically similar to the previous year, while solar power generation (492 GWh) decreased 2% compared to 2022. Grid-connected photovoltaic microgeneration was 58,801 MWh and had the following sectoral distribution: commercial and services (55%), industrial (19%), agriculture (14%) and residential (12%).

The most outstanding change in the generation matrix in 2023 was the large increase in thermal generation with biomass (26%), largely influenced by the entry into operation of the third cellulose plant in the country. This offset the drop in hydro, wind and solar sources, which allowed maintaining (and even increasing by one percentage point) the share of renewable sources in the generation matrix: for 2023 it was 92%.

In September 2023, the refinery began a programmed maintenance shutdown of its units, and therefore, as of that date, the refinery was not operational. In this context, the amount of crude oil processed during the year was significantly lower than the previous year (-31%) and consequently so was the **production of oil products**. The main product was gas oil (697 ktoe), followed by motor gasoline (439 ktoe) and fuel oil (117 ktoe). To a lesser extent, there was production of LPG (LP gas and propane), kerosene and jet fuel, among other products.

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3. Energy supply

In 2023, the total gross energy supply in the country was 6,564 ktoe, 16% higher than the previous year. Among the main sources involved in the 2023 energy supply, it is worth mentioning:

Oil and oil products:

The shutdown of the refinery due to scheduled maintenance of its units as of September 2023 resulted in a lower gross oil supply with respect to 2022 (31%). Refinery loadings also showed a similar behavior to that of the gross supply. During 2023, 1,354 ktoe of virgin crude oil (1,600 thousand m^3) was imported, 35% less than in 2022.

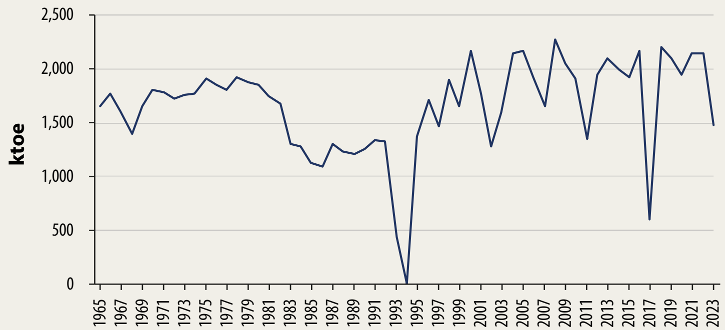
It should be noted that the years when the refinery was shut down for maintenance, there were lower values of gross oil supply, such as 2002-2003, 2007, 2011, 2017, or even a null value for 1994, year in which the refinery was shut down for remodeling.

As for oil products, gross supply in 2023 was 2,388 ktoe, 1% lower than in 2022 y 5% lower than in 2021. It should be noted that the shutdown of the refinery in 2023 also had an impact on the production and import of oil products. Thus, the level of production was 31% lower than in the previous year (1,469 ktoe) while imports were 140% higher (1,202 ktoe).

In 2023, gas oil was the main oil product imported, followed by gasoline. Regarding fuel oil, imports in 2023 were five times higher than in 2022, with more than 80% destined for the free trade zone. Additionally, imports of petcoke increased by 123% compared to the previous year.

In 2023, exports of oil products were very small (0.7 ktoe) and corresponded to LPG and non-energy products. In the flow of international bunker, there was an increase in the last year (11%), mainly due to growth in jet fuel and gas oil, while sales to international bunker of fuel oil decreased in 2023.

FIGURE 13. Gross oil supply



Natural gas:

Natural gas imports in 2023 totaled 66 ktoe, 9% lower than in 2022. It is worth noting that in 2019, imports were higher than the average of recent years. The increase was associated with natural gas consumption recorded in the electricity sector, specifically in the tests run by UTE in the combined cycle power plant.

Hydropower:

Gross hydropower supply varies greatly from year to year, as it relies on hydrological characteristics. In 2023, a significant drought was recorded in the first half of the year. However, gross hydropower supply improved in the second half, reaching 701 ktoe for the year—an increase of 16% compared to 2022. It is worth noting that 2020 recorded one of the lowest values in the last 30 years (400 ktoe), surpassed only by a minimum recorded in 2006 (343 ktoe).

Discharged water (not used or not passing through turbines) is another variable for monitoring this energy source. In 2023, hydropower not used accounted for 51% of production. This situation was highly unusual, as an analysis of the complete historical series since 1965 reveals that not used hydropower averaged 20% of production, with the value recorded in 2023 being exceeded only once, in 1967 (59%).

FIGURE 14. Gross natural gas supply

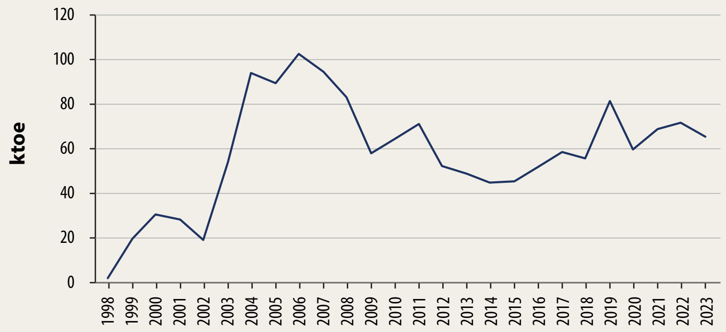
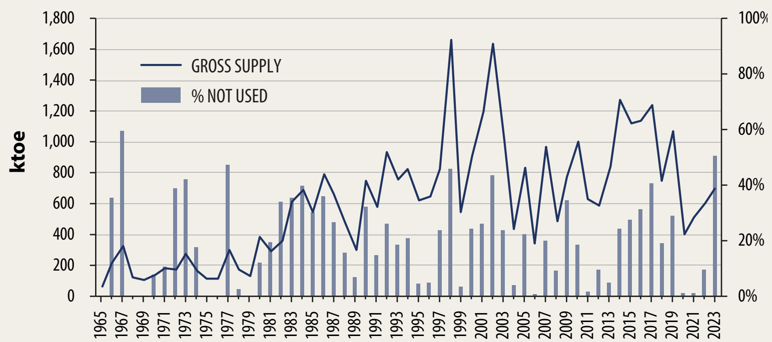


FIGURE 15. Gross hydropower supply



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Wind and solar energy:

In 2023, the gross wind power supply had a 5% growth compared to 2022. Since 2017, the installed capacity for electricity production has remained constant, except for 2019, when only 3.2 MW were installed, as mentioned above. Meanwhile, the gross supply of solar energy increased again, this time by 2%. Since 2014, both solar thermal and photovoltaic energy have been included in the results matrix.

Both sources recorded more not used energy in 2023 compared to 2022. In the case of wind energy, 7% of production in the last year corresponded to not used energy, while only 4% for solar energy. Similar values occurred in 2019 and were lower between 2020 and 2022.

Biomass:

In 2023, gross biomass supply reached 2,808 ktoe, marking a substantial increase of 27% compared to 2022. It accounted for 51% of the gross supply of primary sources, significantly exceeding oil, which had a share of 26%. To analyze biomass behavior, it is convenient to disaggregate it into the different sources that fall under this denomination: firewood, biomass waste (rice and sunflower husks, sugarcane bagasse, black liquor, odorous gases, methanol, barley husk, forestry and sawmill waste (chips, sawdust, pellets), glycerin and rumen), and biomass for biofuel production.

In the case of firewood, the gross supply was 472 ktoe, 2% higher than in 2022. Regarding biomass waste, the gross supply increased by 35% in 2023 (2,279 ktoe) compared to 2022 (1,692 ktoe). In the case of biomass for biofuel production, the gross supply for 2023 was 56 ktoe and registered a 4% decrease compared to the previous year, mainly due to the drop in biodiesel consumption.

FIGURE 18. Gross wind energy supply

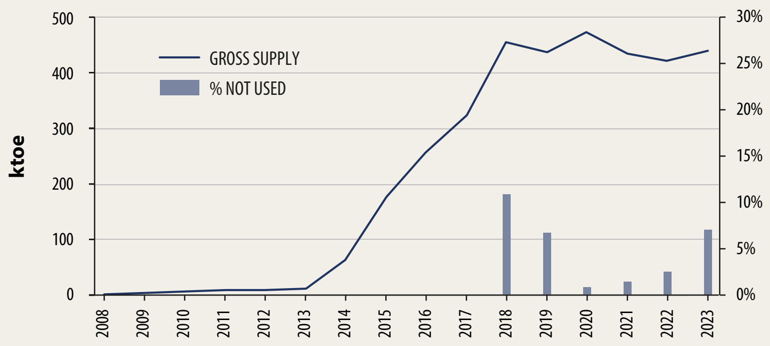


FIGURE 16. Gross solar energy supply

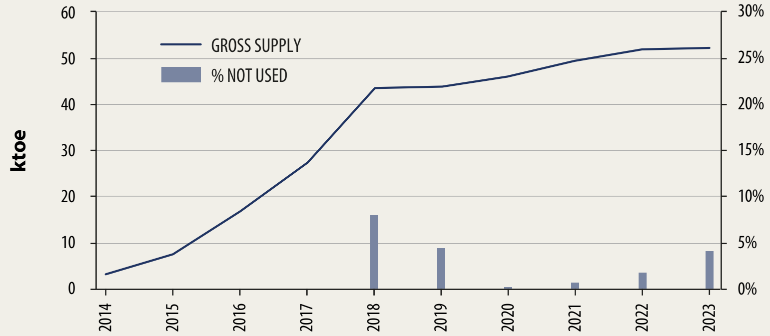
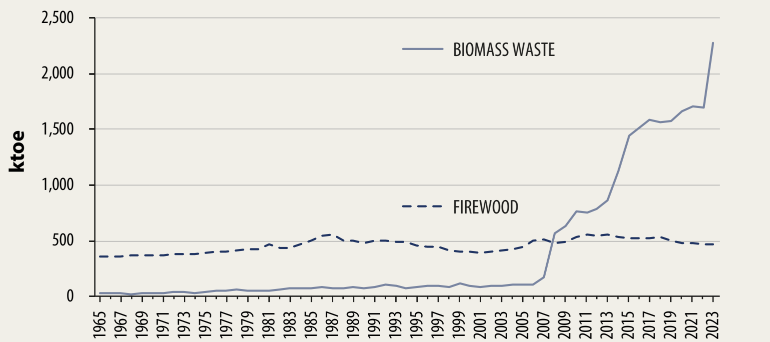


FIGURE 17. Gross supply of firewood and biomass waste



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Industrial waste:
This source includes non-renewable waste such as end-of-life tires (ELT), alternate liquid fuels (ALF), used oils, and solid recovered fuels (SRF). In the case of ALF, they are mostly composed of hydrocarbons recovered from bilge water.[13] The gross supply in 2023 saw a 19% increase compared to the previous year and recorded a maximum value since 2011.

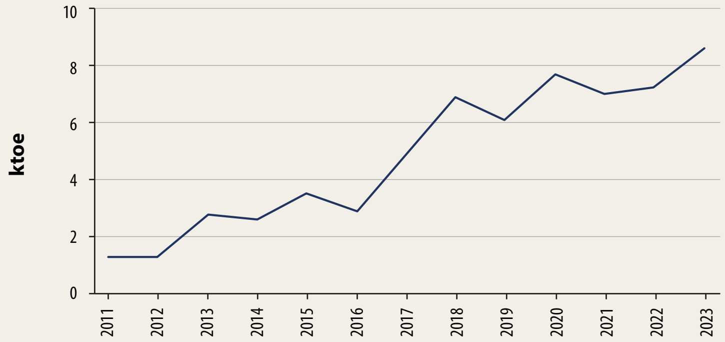
Coal and coke of coal:
In 2023, gross supply of coal was 2 ktoe, compared to previous years to 2021 when it had been insignificant. As for coke of coal, gross supply has remained similar to recent years, at values of less than 1 ktoe.

Electricity:
In 2023, the total electricity import was 120 ktoe (1,398 GWh), much higher than in the previous ten years (70 GWh annual average).

In 2023, electricity exports were 21 ktoe (244 GWh), 83% lower than in 2022. In turn, these exports represented 2% of the generation. It is noteworthy that the maximum electricity export of the entire historical series since 1965 occurred in 2019 (259 ktoe; 3,011 GWh).

2023 was the year of highest electricity imports since 2009.

FIGURE 19. Gross industrial waste supply



13- Bilge water is made up of leaking salt water, cooling water, fuel oil and lubricating oil, it is produced by dewatering of sludge and sedimentation tanks, by drainage from various cleaning processes and also by the presence of soot and dirt particles.

3.1. Energy supply

The country's primary energy matrix, also called "energy supply matrix," has had a net growth of 175% between 1965 and 2023, with an average rate of 2%. This last year, after increasing only 8% compared to 2022, it registered a new record value of 6,126 ktoe.

3.1.1. Primary matrix by source

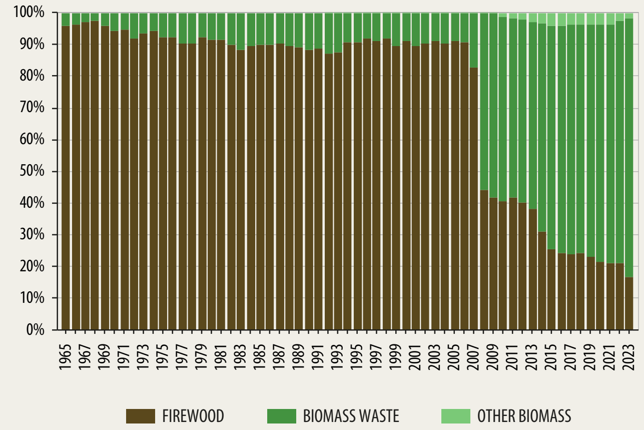
In 2023, the energy supply ranked by importance was the following: biomass (2,805 ktoe), oil and oil products (2,363 ktoe), wind electricity (410 ktoe), hydroelectricity (302 ktoe) and, to a lesser extent, imported electricity (120 ktoe), natural gas (66 ktoe) and solar energy (50 ktoe). Supply values for industrial waste, coal and coal products were very small in relation to the other sources. Solar energy supply included both solar thermal energy and electricity from photovoltaic solar energy.

Historically, oil and oil products have been the main sources of supply, only surpassed by biomass between 2016-2020 and 2023. Hydropower ranked second until 2003-2005, years in which it began to be surpassed by biomass. Since 2020, the third position has alternated between wind and hydroelectric electricity, depending on the specific characteristics of each year.

It is worth noting the diversification of energy sources and the increased share of renewable sources in Uruguay's primary energy matrix in recent years. Oil and oil products supply grew by 34% since 1965. However, total energy supply increased by 175% over the same period. This growth was a direct consequence of incorporating new energy sources. For instance, in the first 40 years of the series, supply increased by 762 ktoe (34%), while in the last two decades, growth reached 3,137 ktoe, 86% of which came from renewable sources.

Upon analyzing each energy source separately, **biomass** was one of the sources that underwent the most significant changes, not only in terms of percentage share but also in absolute value. This category includes production of firewood, biomass waste and biomass for biofuels, as well as the net foreign trade balance of biomass waste, bioethanol, biodiesel and charcoal, calculated as the difference between imports and exports. It should be noted that the supply of biomass was mainly associated with firewood between 1965 and 2007, with an average contribution of 91%. Since 2008, the share of biomass waste has been gaining importance and has positioned itself as the majority in the supply for this source. In 2023, 81% of biomass supply corresponded to biomass waste.

FIGURE 20. Share in biomass supply by type



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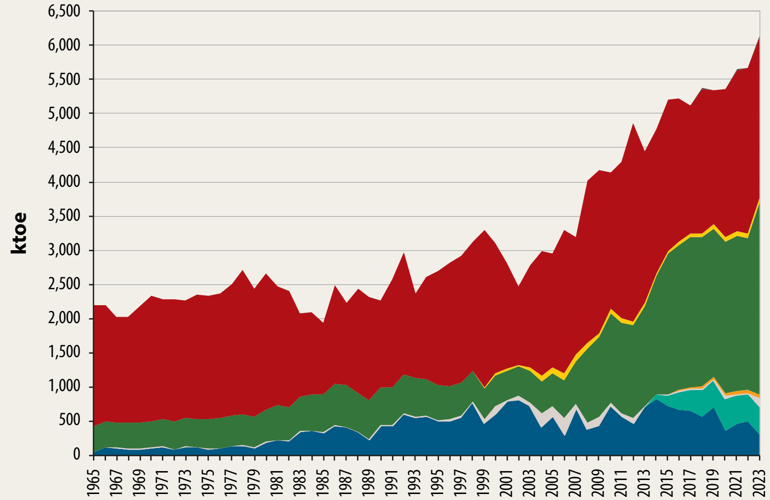
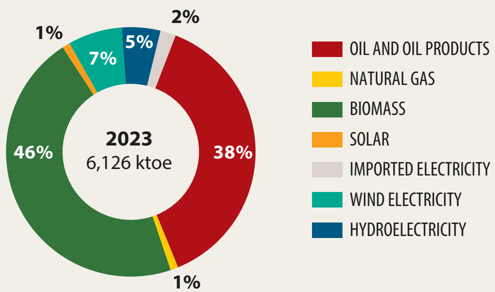
Between 1965 and 2007, biomass behaved in a relatively constant manner. However, from 2008, it adopted a more prominent role and showed significant growth up to and including 2023. This behavior was directly associated with the installation of the three cellulose plants in the country. In 2008, the supply of biomass was 75% higher than in the previous year and consolidated as the second most important source in Uruguay's primary matrix. This exponential growth decelerated between 2010 and 2011, and, as of 2012, resumed its steep growth, increasing from 1,366 ktoe (2012) to a 2,187 ktoe (2017) and reaching its highest share in the primary matrix (43%). Between 2016 and 2020, biomass was the most important source in the primary matrix. In 2023, it once again recorded an outstanding growth of 27% compared to the previous year and returned to the first place in supply, after two years of being surpassed by oil and products.

As for **oil and oil products**, supply includes the import of crude oil for the production of oil products at the refinery and the net balance of foreign trade in oil products. The share of this category in the primary matrix has varied, mostly depending on the needs of oil products for electricity generation. In 1965, practically the entire primary matrix was oil and oil products (79%). Interestingly, although the share dropped by 38% (2023), over these 59 years the supply grew 34%, as mentioned above. Over the last ten years, the lowest levels of oil and oil products' share in the primary matrix were recorded. In 2019, the lowest historical minimum (36%) was recorded; and in 2023 was of 38%. It is worth noting that in 2020, the final consumption of oil products decreased due to the mobility reduction during the pandemic.

Hydroelectricity decreased 38% between 2022 and 2023. During the first half of this past year, the country was affected by a severe drought that resulted in low levels of hydroelectricity. Although in the second half of the year this situation was reversed, considering the whole year as a whole, 2023 had the lowest hydroelectricity record since 1990.

FIGURE 21. Energy supply by source





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It is important to highlight the **evolution of wind electricity** in the primary matrix. In 2008, the first year the country had large-scale wind energy in Uruguay, electricity generation amounted to 0.6 ktoe and increased to a peak of 471 ktoe in 2020. In 2023, wind electricity was 13% lower than the historical peak, however, it was similar to the average of the last six years. It should be noted that in this last period the installed capacity has remained constant. It is also noteworthy that, in just 15 years since its incorporation, wind energy has become the third most important energy supply source after biomass and oil and products.

The remaining sources that comprised the 2023 supply matrix had very small shares: imported electricity (2%), natural gas (1%), solar (1%), industrial waste (< 1%) and coal and coke (< 1%).

TABLE 3. Energy supply by source

ktoe	1965	1975	1985	1995	2005	2015	2023
Imported electricity	0.1	2.0		16.2	136.3	0.2	**120.2**
(%)	0%	0%		1%	5%	0%	**2%**
Hydroelectricity	52.5	97.4	336.4	503.5	574.8	710.9	**302.4**
(%)	2%	4%	17%	19%	19%	14%	**5%**
Wind electricity						177.6	**409.8**
(%)						3%	**7%**
Solar						7.5	**50.3**
(%)						0%	**1%**
Natural gas					89.3	45.8	**65.7**
(%)					3%	1%	**1%**
Oil and oil products	1767.5	1811.7	1045.8	1,661.0	1,666.9	2,207.8	**2,363.0**
(%)	79%	77%	54%	62%	56%	42%	**38%**
Coal and coke	34.8	28.7	0.7	0.5	1.9	0.1	**1.7**
(%)	2%	1%	0%	0%	0%	0%	**0%**
Biomass	372.7	423.4	559.6	510.2	488.9	2,051.3	**2,804.7**
(%)	17%	18%	29%	19%	17%	39%	**46%**
Industrial wastes						3.5	**8.6**
(%)						0%	**0%**
TOTAL	**2,227.6**	**2,363.2**	**1,942.5**	**2,691.4**	**2,958.1**	**5,204.7**	**6,126.4**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTE: Solar energy supply includes solar thermal energy and photovoltaic solar electricity.

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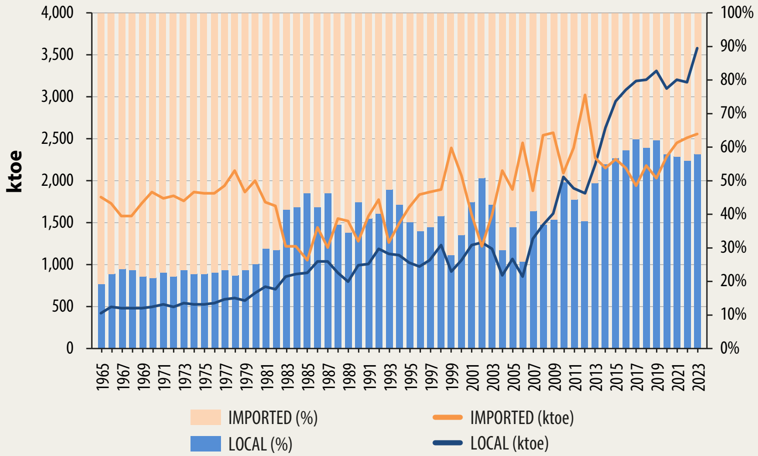
3.1.2. Primary matrix by origin

In 2023, energy supply was 58% from local sources and 42% from imported sources. When considering the entire series, the last few years have recorded the highest shares of local energy in the supply, with values higher than 56%. In absolute terms, it is worth noting that there has been a net increase in local energy supply in recent years. Between 1965 and 1990, local energy supply increased from 425 ktoe to 989 ktoe and in the following fifteen years it remained at values between 854 ktoe (2006) and 1,260 ktoe (2002). There has been steady growth since 2007, reaching a peak value of 3,310 ktoe in 2019. In the following three years, it remained at slightly lower values and in 2023 it grew again to reach a new historical maximum (3,570 ktoe).

The imported energy supply fluctuated throughout the period; it recorded a maximum value of 3,023 ktoe (2012) and a minimum of 1,047 ktoe (1985). In 2023, imported energy was 2% higher than in 2022. It is interesting to note that over these 59 years, the evolution of the share of local and imported energy in the supply has completely reversed: in the 1970s, about 80% of the energy was imported, whereas in recent years, the share of locally sourced energy has reached 60%.

FIGURE 22. Energy supply by origin



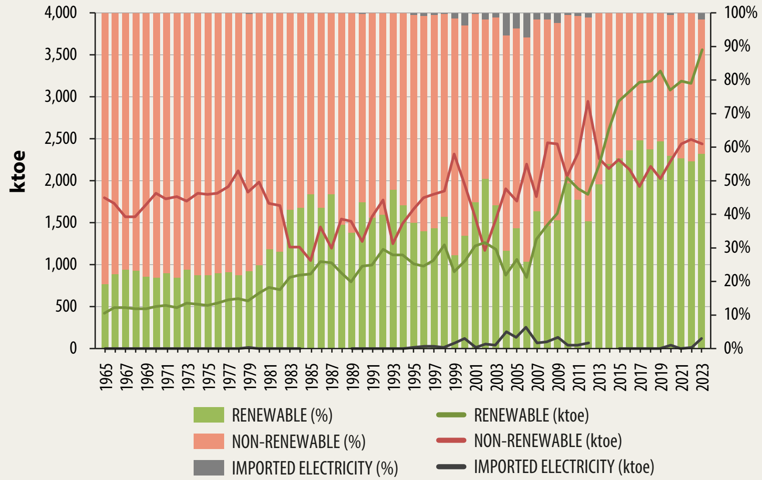
3.1.3. Primary matrix by type

In terms of energy supply, sources are also classified as renewable or non-renewable. In 2023, renewable energy sources (biomass/ solar thermal/ hydroelectricity, wind, and solar photovoltaic electricity) had a 58% share in the energy supply matrix, while non-renewable sources (oil and oil products/natural gas/coal and coke/industrial waste) had a 40% share. Imported electricity is reported separately as it cannot be classified as renewable or non-renewable. In 2023, it was only 2%.

2023 Primary energy matrix: 58 % renewable energy.

There is a strong correlation between energy origin and energy type. Renewable energy supply is mainly sourced from domestic production, while non-renewable sources are imported to supply the country.

FIGURE 23. Energy supply by type



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The supply of renewable energy increased significantly in recent years and in 2023 was more than triple the average recorded in the 15 years prior to 2005. In 2023, the highest historical supply from renewable sources was recorded (3,567 ktoe), while the highest share was in 2017 (62.2%).

Historically, the share of renewable sources in the primary matrix has been strongly influenced by rainfall levels. However, due to the diversification of energy sources and the substantial inclusion of local sources, a decrease in the influence of the variability of the hydro source in the primary matrix was observed. For instance, a comparison between the structure of the 2006 primary matrix and that recorded in 2022 (both featuring similar shares of hydroelectricity) reveals that in 2006, renewable sources comprised 26% of the supply. However, by 2022, the share of renewable sources had increased to 56%. Thus, it is concluded that diversifying the matrix also makes the national energy system stronger.

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3.2. Electricity generation

In 2023, electricity generation was 12,877 GWh (1,107 ktoe), representing a 13% decrease compared to the previous year. It is worth noting that the capacity grew by 7% in the last year, primarily due to the increase in the capacity of thermal generators based on biomass as mentioned in the chapter on infrastructure.

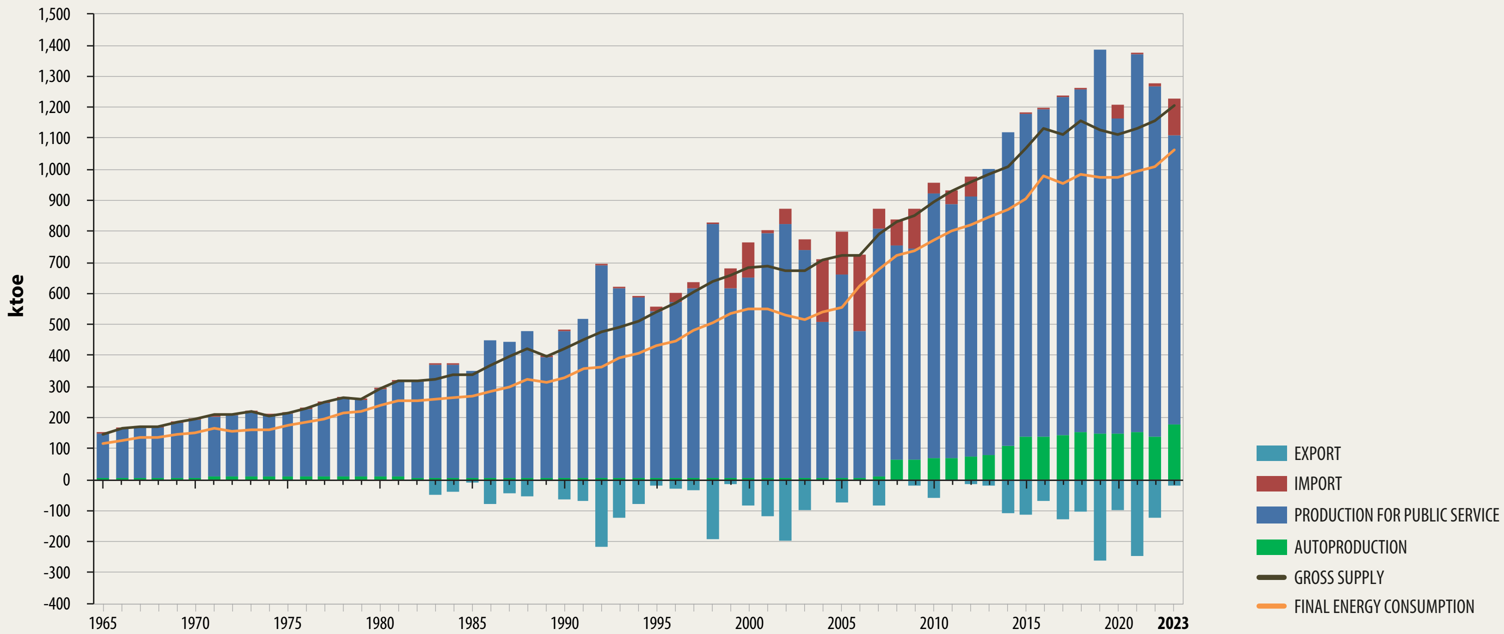
84% of production came from public service power plants (929 ktoe), with a 18% decrease compared to 2022. While the remaining 16% was generated by autoproduction power plants (178 ktoe) with a 31% increase in the last year.

Domestic demand for electricity was supplied to a greater extent with domestic production (89%) and had to depend on high imports from neighboring countries (120 ktoe). It should be noted that in the last decade, domestic production recorded shares between 99% and 100% of the local electricity supply, except in 2020, when 44 ktoe of electricity had to be imported.

In 2023, Uruguay exported 244 GWh (21 ktoe) of electricity, 83% less than the previous year, and the lowest one in the last decade. As for export destinations in the last year, 94% of the electricity was exported to Argentina and 6% to Brazil, similar to 2022. Particularly notable are 2019 and 2021, which recorded the highest levels of electricity exports since 1965 (259 ktoe and 245 ktoe, respectively).

Regarding energy sources in 2023, more than half of exported electricity originated from hydropower, while only 2% was from fossil fuels. It should be noted that between October 2017 and July 2020, Uruguay sold wind electricity to Argentina through generating agents other than UTE.

FIGURE 24. Electricity balance



Final electricity consumption (calculated as generation plus imports minus exports, technical losses, and own use) increased by 5% compared to 2022. It is noteworthy that the final energy consumption supplied from the SIN (without considering the electricity generated by autoproduction power plants) had a slightly higher growth (1%).

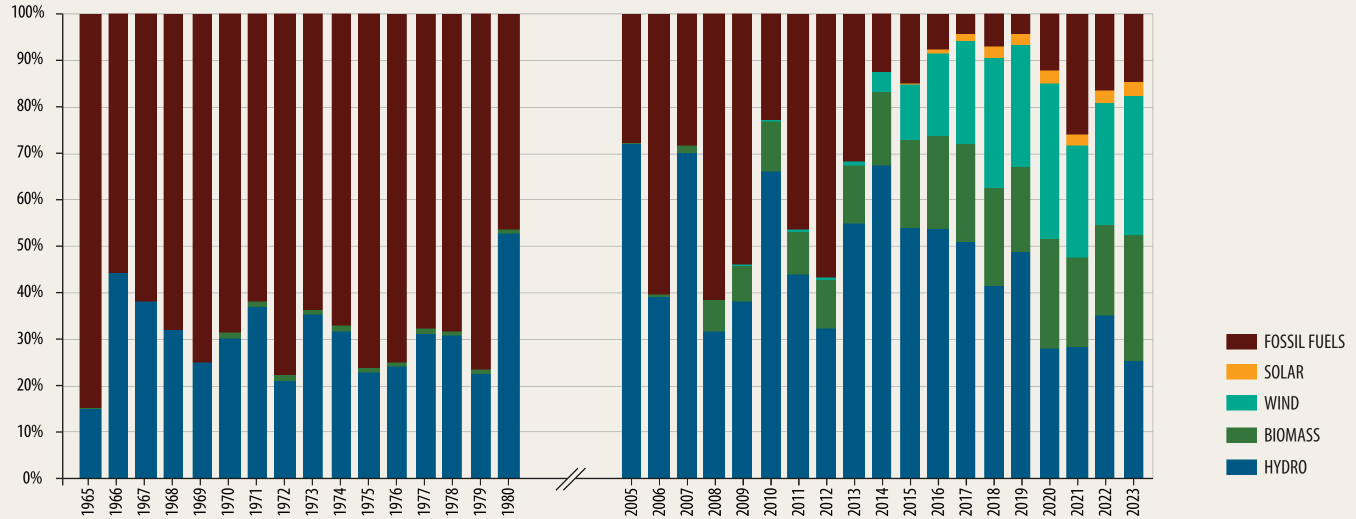
Historically, hydropower has had a major role in the generation of electricity in the country. In particular, as of 1979, its share began to increase in the generation matrix with the Salto Grande plant installation on the Río Uruguay. It was not until 1995 that the right to 50% of the power and production was granted to Uruguay under an agreement with Argentina.

One of the characteristics of electricity generation in the country is the diversification of sources that have occurred in recent years. Between approximately 1965 and 2000, only three energy sources accounted for the majority of the generation matrix: hydropower, fuel oil, and gas oil. However, new sources began to be used for electricity generation, some of which are still marginal but show a growing consumption trend (biomass waste, wind, and solar energy). Although natural gas has entered the market in 1998, its share remains marginal.

There is also a complementarity between hydropower availability and the consumption of fossil fuels for electricity generation. This characteristic is more evident in the first years of the historical series. However, in recent years, the diversification of sources in the electricity generation matrix has shown a reduced consumption of fossil fuels due to a lower availability of hydropower as input for generation.

In 2023, **hydropower** generation decreased 38% compared to the previous year, and was the lowest value since 1990. Electricity from solar energy decreased 2%, while electricity from wind was similar to the previous year. In the case of electricity from biomass waste, there was a 26% increase between 2022 and 2023, while fossil fuel electricity generation dropped 24%. The main fuel used was gas oil, whose consumption for generation (166 ktoe) dropped 25% compared to the previous year, and was followed, to a lesser extent, by fuel oil with a consumption of 32 ktoe, similar to 2022.

FIGURE 25. Share of inputs for electricity generation



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Wind energy became part of the generation matrix in 2008 and had a slow growth in its first years of development. However, as of 2013, electricity generation increased significantly. In 2020, it increased from 144 GWh to 5,476 GWh, year in which the highest level of generation and share (40%) was recorded, making it the year's main source of electricity generation. As of 2021, wind power generation has decreased and was once again surpassed by hydroelectricity. It should be noted that since 2020 there was no additional installed capacity of wind generators, thus the increased production compared to 2019 was achieved through low levels of energy not used (1% of production). It should be noted that for 2019, energy not used was 7% of production. This situation was repeated in 2023.

As for **biomass**, its share as an input for electricity production began to increase as of 2006, with a remarkable rise from 2008 onwards. This was the result of the contracts between UTE and private producers connected to the SIN—related to purchasing electricity from biomass—coming into force. This included mainly biomass waste for electricity generation in the cellulose pulp industry. In recent years, electricity generation from biomass has increased significantly to the point that, in ten years, its value has tripled. In any case, and despite this steady growth, by 2016 biomass had lost its second place in the electricity matrix (achieved in 2014) and was displaced by wind power to third place. Particularly for 2023, electricity generated from biomass increased 26% compared to the previous year, largely associated with the commissioning of the third cellulose plant in the country.

Solar energy constitutes an input for electricity generation that, although in recent years has had a very small share compared to the rest of the sources, has started to become increasingly important. In 2023, electricity generation from solar energy (492 GWh) decreased 2% compared to 2022, reaching a new generation record since its 2014 incorporation in the country. The years 2017, 2018, and 2019 are highlighted as photovoltaic electricity generation surpassed that of fossil fuels.

FIGURE 26. Microgeneration of electricity from solar energy by sector

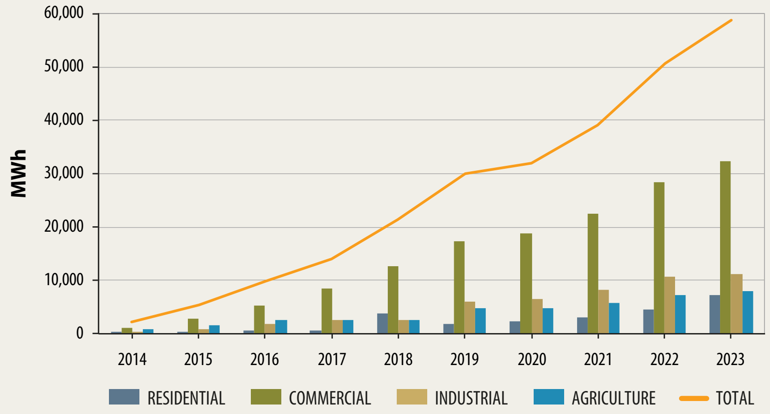

TABLE 4. Microgeneration of electricity from solar energy

MWh		2014	2017	2020	2023
Residential	EDG	94	437	1,536	4,211
	EOU	28	92	590	2,971
	TG	**122**	**528**	**2,126**	**7,182**
Commercial	EDG	393	4,834	10,012	13,988
	EOU	634	3,567	8,684	18,364
	TG	**1,027**	**8,401**	**18,696**	**32,352**
Industrial	EDG	122	1,070	2,844	4,685
	EOU	19	1,413	3,619	6,553
	TG	**141**	**2,483**	**6,464**	**11,238**
Agriculture	EDG	612	2,019	3,650	4,780
	EOU	207	433	1,085	3,249
	TG	**820**	**2,452**	**4,735**	**8,029**
TOTAL	EDG	1,222	8,359	18,043	27,664
	EOU	889	5,505	13,979	31,137
	TG	**2,110**	**13,864**	**32,021**	**58,801**

NOTES:
EDG: Electricity delivered to the grid; **EOU:** Electricity for own use; **TG:** Total generation.

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Regarding on-grid photovoltaic microgeneration, there was a very significant increase in the last period, from 2,110 MWh (2014) to 58,801 MWh (2023). From a sectoral perspective, the 2023 distribution ranked by importance was the following: commercial and services (55%), industrial (19%), agriculture (14%) and residential (12%). In the agriculture and residential sectors, most of the electricity generated from photovoltaic microgeneration was delivered to the grid (59% and 60%, respectively). On the other hand, in the industrial and commercial/services sectors, the electricity generated by photovoltaic microgeneration was consumed to a greater extent by the establishments themselves (58% and 57%, respectively).

Electricity generation can be analyzed from two perspectives: firstly, by considering the inputs for generation, and secondly, by considering the electricity generated by the source. It should be noted that the electricity generation matrix has a different structure than the matrix of inputs for generation as it considers transformation efficiency for the various sources. Some sources are considered to be 100% efficient based on the energy balance methodology. Such is the case of wind and solar photovoltaic electricity, whose primary source (wind or solar energy) matches the electricity produced. For the remaining cases, transformation efficiencies have values lower than 100% depending on the characteristics of the electricity generation processes. In 2023, a global transformation efficiency of 81% was recorded, similar compared to 2022.

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3.2.1. Matrix of inputs for electricity generation

Inputs for generation recorded a net growth throughout the period and increased from 399 ktoe (1965) to 1,366 ktoe (2023). The lowest consumption was recorded in 1966 (315 ktoe) and the maximum in 2021 (1,780 ktoe).

The matrix of inputs for generation has undergone strong changes over the years, as well as a diversification of energy sources towards the end of the period, as mentioned above. In 2023, the highest share in inputs for generation corresponded to wind energy (410 ktoe), followed by biomass (370 ktoe), hydropower (346 ktoe) and gas oil (166 ktoe). To a lesser extent, solar power (42 ktoe) and fuel oil (32 ktoe) were also involved.

FIGURE 27. Inputs for electricity generation

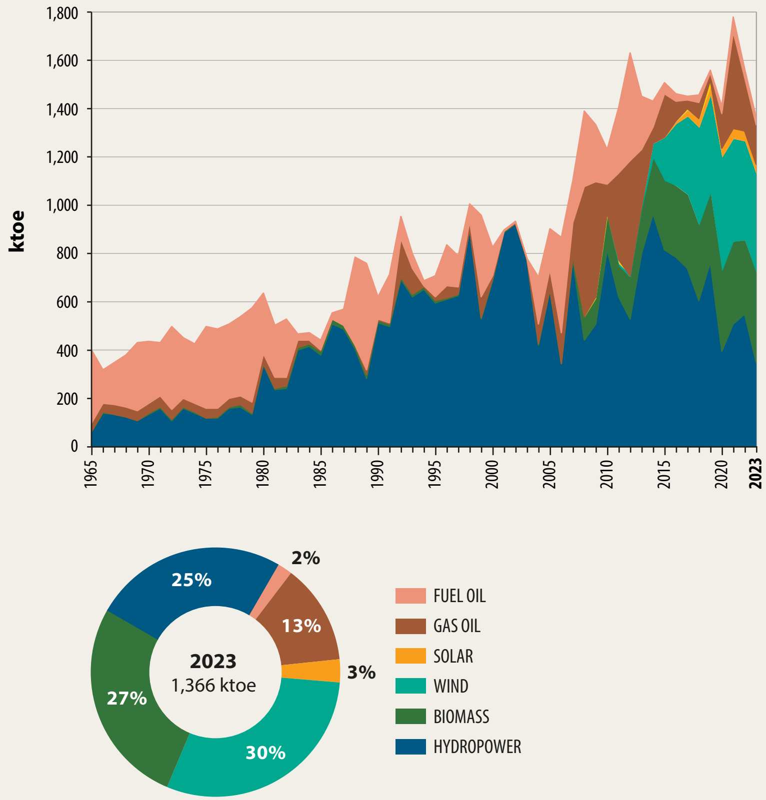

TABLE 5. Inputs for electricity generation

ktoe	1965	1975	1985	1995	2005	2015	2023
Hydropower	60.2	113.7	379.8	596.4	647.2	814.0	**345.7**
(%)	15%	23%	86%	84%	72%	54%	**25%**
Wind						177.6	**409.8**
(%)						12%	**30%**
Solar						4.2	**42.3**
(%)						0%	**3%**
Firewood			5.0	5.0	0.8	4.8	**2.6**
(%)			1%	1%	0%	0%	**0%**
Biomass wastes	0.4	4.8	10.0	1.8	2.0	283.8	**367.1**
(%)	0%	1%	2%	0%	0%	19%	**27%**
Gas oil	37.3	39.5	5.1	14.6	84.3	178.9	**166.4**
(%)	9%	8%	1%	2%	9%	12%	**13%**
Gasoline							**0.0**
(%)							**0%**
Fuel oil	301.1	340.8	42.6	91.5	165.3	47.5	**32.0**
(%)	75%	68%	10%	13%	18%	3%	**2%**
Natural gas					0.6	0.0	
(%)					0%	0%	
TOTAL	**399.0**	**498.8**	**442.5**	**709.3**	**900.2**	**1,510.8**	**1,365.9**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTE: Gas oil includes diesel oil until and including 2003.

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3.2.2. Electricity generation matrix by source

In 2023, electricity generated from wind and solar energy was slightly lower than in the previous year. However, the shares in the generation matrix increased for both sources because total generation was significantly lower.

In the case of hydropower, 2023 was a very particular year, since the drought that the country went through during the first half of the year caused a significant decrease in hydroelectric production compared to 2022 and its consequent lower participation in the generation matrix. This meant that hydroelectricity took second place in electricity production, leaving the first place to wind power.

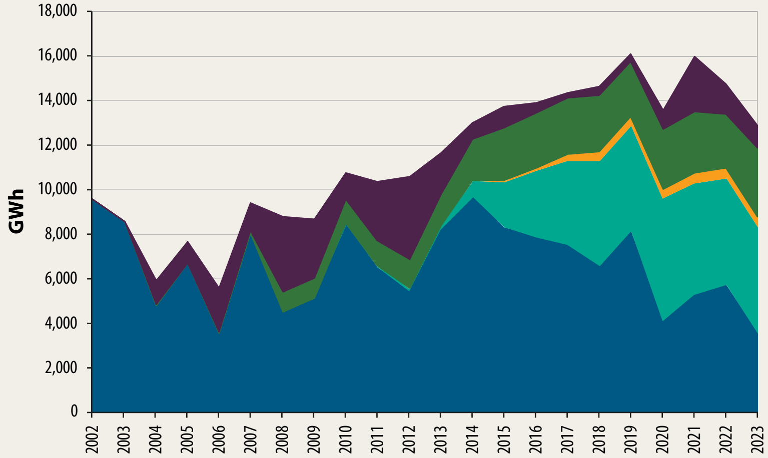
It is also worth noting that in 2023 there was a substantial amount of not used energy, meaning that certain amounts of hydro, wind, and solar energy could not be utilized due to insufficient electricity demand, both locally and for export. For hydro energy, not used energy accounted for 51% of production, while for wind and solar energy it was 7% and 4%, respectively.

Another significant aspect of 2023 was the substantial growth in thermal generation from biomass (26%), largely driven by the entry into operation of the country's third cellulose plant, as previously mentioned. This increase offset the decline in hydro, wind, and solar sources, enabling the share of renewable sources in the generation matrix to be maintained (and even to rise by one percentage point) to reach 92% in 2023.

Fossil fuel electricity generation decreased by 24% between 2022 and 2023, while its share in the electricity matrix dropped from 9% to 8%.

In 2023, 92 % of electricity generation came from renewable sources.

FIGURE 28. Electricity generation by source



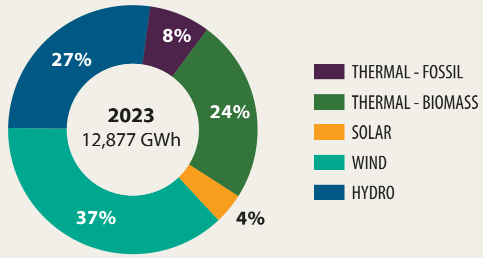


TABLE 6. Electricity generation by source

GWh	2002	2005	2010	2015	2020	2023
Thermal (fossil)	26.4	956.3	1,165.1	962.6	824.9	**1,020.6**
(%)	0%	12%	11%	7%	6%	**8%**
Thermal (biomass)	0.0	24.5	1,089.8	2,388.4	2,700.8	**3,083.3**
(%)	0%	0%	10%	17%	20%	**24%**
Hydropower	9,535.3	6,683.6	8,407.2	8,266.0	4,093.9	**3,516.3**
(%)	100%	87%	78%	60%	30%	**27%**
Wind			69.9	2,065.1	5,475.5	**4,764.8**
(%)			1%	15%	40%	**37%**
Solar				48.7	462.1	**492.0**
(%)				0%	4%	**4%**
TOTAL	**9,561.7**	**7,664.4**	**10,732.0**	**13,730.8**	**13,557.1**	**12,877.0**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

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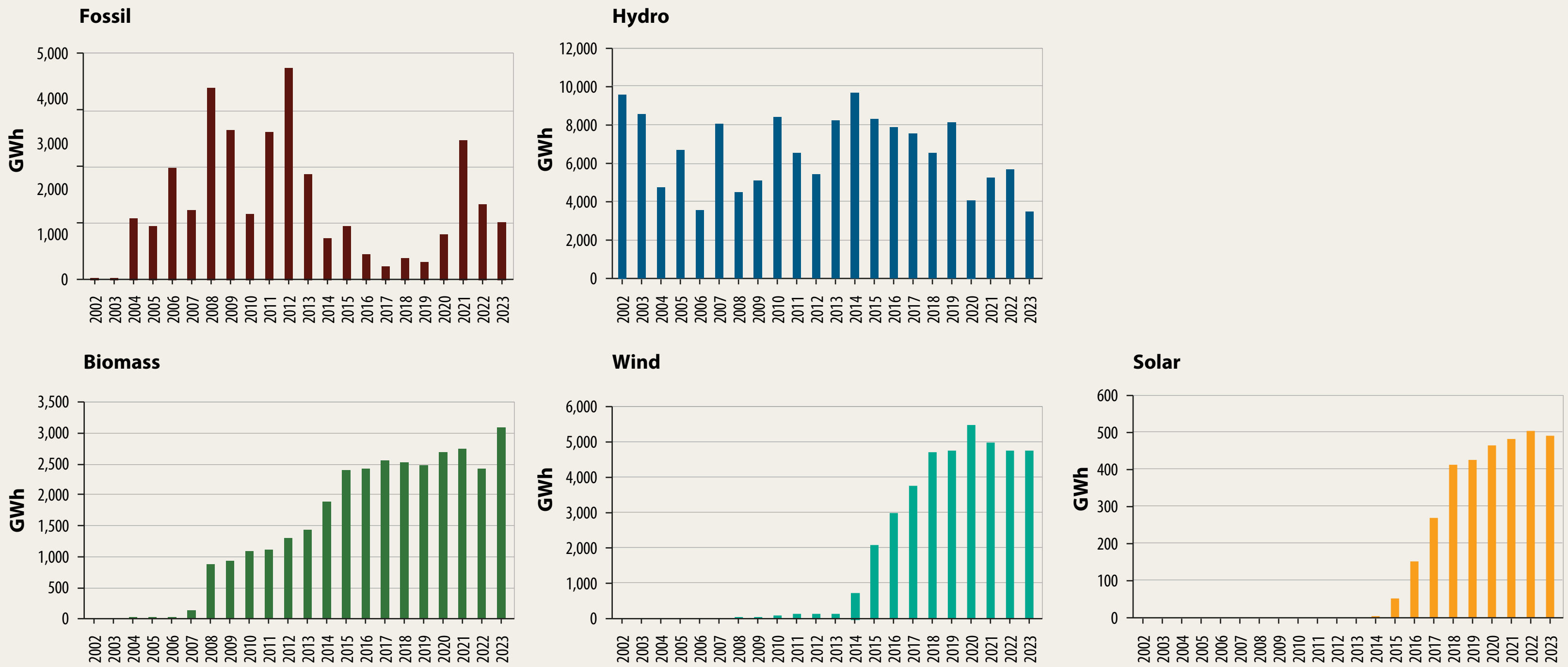
The evolution of the electricity generation matrix by source also reflected the above features: variability, complementarity, and diversification. Until the 80s, electricity generation came mainly from fossil fuels. Since 1979, hydroelectricity has had a high share in the generation mix. In recent years, new energy sources have been incorporated.

When comparing the year 2023 to 2012, it is evident that total electricity generation has grown by 22%. In terms of sources, hydroelectricity generation dropped by 35% and fossil fuel generation dropped by 73%. Thus, it is evident that the incorporation of local sources has become more prominent over the last years, providing clear advantages in the diversification of the generation matrix.

FIGURE 29. Electricity generation from each source



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3.2.3. Electricity generation in Antarctica

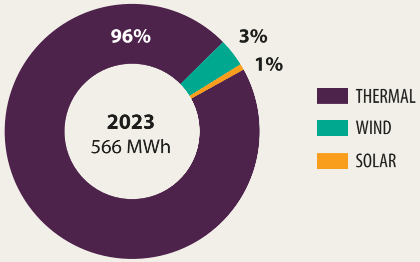
Uruguay has two bases in Antarctica, which are located near the Antarctic Peninsula: the Artigas Base and the Ruperto Elichiribehety Research Station.[14] They have different types of electricity generators: two photovoltaic panels of 1 and 6 kW power, respectively, a 6 kW wind generator, and a diesel generator.

In 2023, a total production of 566 MWh of electricity was recorded, 13% less than the previous year. Regarding generation by source, 542 MWh of electricity was produced from fossil fuels, followed to a lesser extent by 19 MWh of electricity from wind and 4 MWh of electricity from solar photovoltaic sources.

As for fossil fuel consumption, 160 m^3 of gas oil was used to generate electricity, while 1,8 m^3 of gas oil was used for transport, 11% y 39% less than in 2022, respectively.

It is noted that, due to IRES methodology, electricity generated at the Uruguayan base in Antarctica is not included in the national statistics. For this reason, it is presented in this section for informational purposes.

FIGURE 30. Electricity generation by source in Antarctica



14- Ministry of National Defense (MDN), *Antarctic Bases*, <https://www.gub.uy/ministerio-defensa-nacional/politicas-y-gestion/bases-antarticas>, (08/01/2024).

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3.3. Production of oil products

In September 2023, the refinery began a scheduled maintenance shutdown of its units and ceased operations from that date onward. Consequently, the amount of crude oil processed during the year was significantly lower than in the previous year, decreasing by 31%, with a total refinery load of 1,475 ktoe (1,742 thousand m^3).

In 2023, 1,469 ktoe of oil products were produced, with 6 ktoe of transformation losses. The main product was gas oil (697 ktoe), followed by motor gasoline (439 ktoe) and fuel oil (117 ktoe). LPG (LP gas and propane), kerosene, and jet fuel, among other products, were produced to a lesser extent.

The refining process generates products that are consumed in the same process. In 2023, 42 ktoe fuel gas and 20 ktoe of petcoke were produced. Such consumptions are recorded in the results matrix under “own use” of the energy sector. For fuel gas, there is an amount that is recorded as energy “not used” and another one as “losses,” if applicable.

The refinery’s production structure has undergone some changes over the past 59 years. Until the early 80s, the main production was fuel oil (45% in 1965; 39% in 1982). However, since 1983, the main product has been gas oil (except for a few specific years). Its production recorded a net growth throughout the period, both in absolute value and in share; 47% was reached in 2023. Conversely, the production of fuel oil declined throughout the period under study and recorded a share of only 11% since 2018 and 8% in 2023.

Although motor gasoline historically ranked third in terms of share, as of 2011, it surpassed fuel oil and became the second in the production structure.

In years when the refinery underwent maintenance shutdowns, there was a decrease in crude oil processing and product output. Such years include 2002, 2003, 2011, 2012, 2017, and most recently, 2023. Notably, in 1994, the refinery was out of operation for the entire year, primarily due to remodeling activities.

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FIGURE 31. Refinery production structure

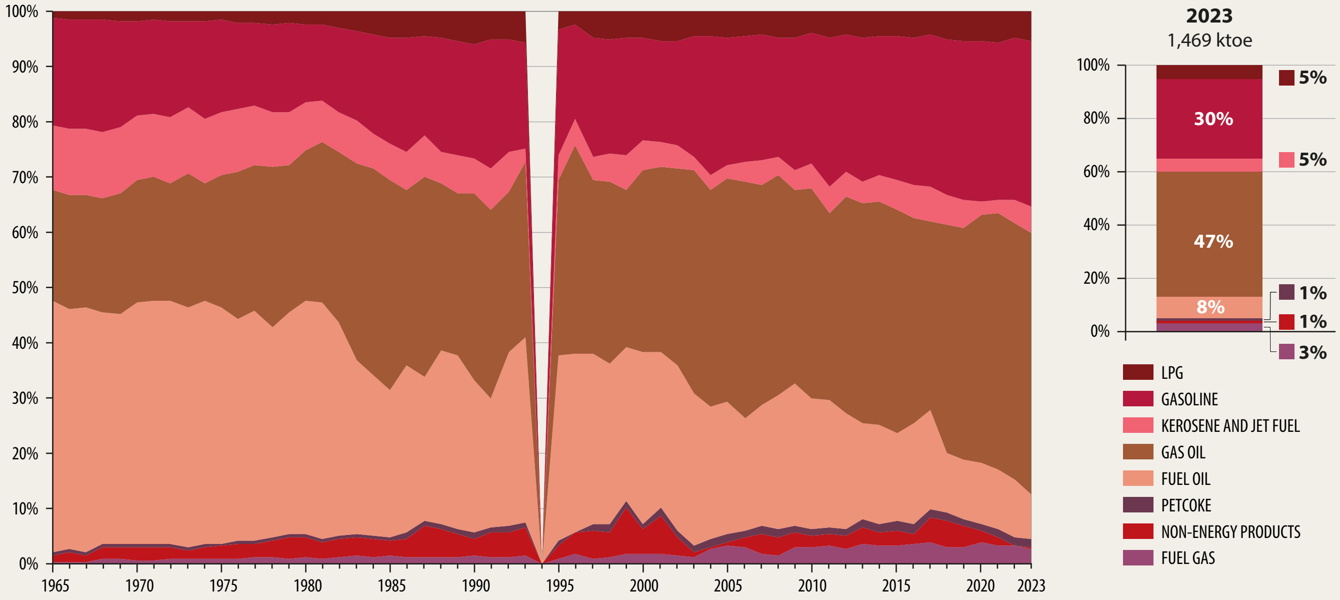

TABLE 7. Refinery production

ktoe	1965	1975	1985	1995	2005	2015	2023
Liquefied petroleum gas	21.1	29.5	52.4	46.8	99.4	87.6	**78.3**
(%)	1%	2%	5%	4%	5%	5%	**5%**
Gasoline	290.7	294.7	199.8	301.9	469.6	492.9	**439.1**
(%)	19%	17%	19%	23%	23%	26%	**30%**
Kerosene and jet fuel	177.9	201.0	72.2	57.0	51.9	103.4	**69.6**
(%)	12%	11%	7%	4%	3%	5%	**5%**
Gas oil	301.2	429.1	400.6	422.7	825.9	760.7	**696.8**
(%)	20%	24%	38%	32%	40%	40%	**47%**
Fuel oil	683.2	756.5	279.1	446.8	486.8	304.6	**117.3**
(%)	45%	43%	26%	33%	24%	16%	**8%**
Petcoke	7.5	8.5	7.6	14.1	29.7	29.9	**19.8**
(%)	0%	0%	1%	1%	1%	2%	**1%**
Non-energy products	18.6	38.6	29.3	31.5	12.6	50.8	**5.6**
(%)	1%	2%	3%	2%	1%	3%	**1%**
Fuel gas	7.3	20.0	15.8	13.0	72.6	67.3	**42.2**
(%)	0%	1%	1%	1%	4%	4%	**3%**
TOTAL	**1,507.5**	**1,777.9**	**1,056.8**	**1,333.8**	**2,048.5**	**1,897.2**	**1,468.7**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) Although motor gasoline with bioethanol has been sold since 2010, the gasoline production data does not include biofuel. **2)** Gas oil includes diesel oil until 2012. Diesel oil has not been produced since 2013. Although gas oil with biodiesel has been sold since 2010, the data on gas oil production does not include biofuel.

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SUMMARY OF CHAPTER 4

Energy demand

In 2023, final energy consumption reached a new peak of 5,337 ktoe, 10% higher than the previous year. Biomass led the mix at 41% (including firewood, biomass waste, charcoal, and biofuels), consistent with the seven years prior to 2022. Oil products accounted for the second largest share at 37%, followed by electricity consumption at 20%, while natural gas consumption remained minimal at 1%.

From a sectoral perspective, the 2023 final consumption matrix was composed as follows: industrial (48%), transport (26%), residential (16%), commercial/services/public sector (6%), primary activities (3%), and not identified (1%). In the past year, the industrial sector remained the largest final consumption sector, a characteristic of Uruguay's energy demand since 2008.

Final energy consumption in the **industrial sector** was 2,544 ktoe in 2023, 25% higher than in the previous year. In 2023, industrial establishments generated more than half of the electricity they consumed (53%). For its part, the "paper and cellulose" branch accounted for 68% of industrial consumption for that year, based mainly on the use of biomass waste.

Final energy consumption in the **transport sector** was 1,403 ktoe in 2023, representing a 1% decrease compared to the previous year. This consumption was entirely comprised of secondary energy sources, with gas oil and motor gasoline being predominant. In 2023, the average bioethanol blend in motor gasoline was 9.8% by volume, while no biodiesel blend was recorded in diesel.

Fuel consumption in the transport sector is directly influenced by the vehicle fleet, both in terms of its size and the distribution of vehicle types by fuel. Notably, the penetration of hybrid vehicles electric and hybrid vehicles represented only 1% of the total vehicle fleet (considered altogether) in 2023, although their sales have been increasing year by year.

Final energy consumption in the **residential sector** in 2023 was 842 ktoe, 1% lower than the previous year. Although a wide variety of sources were consumed, the distribution was primarily concentrated on three main energy sources: electricity, followed by biomass (firewood and biomass waste), and LPG. In 2023, 37% of electricity consumption occurred in Montevideo and 63% in the rest of the country. LPG consumption had a similar distribution, with 46% in Montevideo and 54% elsewhere. The highest consumption of natural gas was recorded in the capital (91%), while firewood consumption was predominantly in other regions (80%).

On the other hand, the final energy consumption of the **commercial/services/public sector** was 328 ktoe in 2023, with a decrease of 4% compared to the previous year. The main energy consumed in this sector has historically been electricity, with shares close to 80% since 2006.

Finally, the **primary activities sector** comprises the agriculture, mining and fishing sectors. Final consumption was 183 ktoe in 2023, similar to the previous year. Gas oil was historically the most consumed energy with a value of 133 ktoe and a share of 73% in 2023.

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4. Energy demand

"Total final energy consumption" is defined as the consumption of the following sectors: residential, commercial/services/public sector, transport, industrial, and primary activities (agriculture, mining, and fishing). It does not include the consumption of the energy sector used for energy production or transformation (energy consumption of refineries, power plants, etc.), also called "own use" of the sector (it is not the input used for transformation). Final energy consumption can be for energy uses (cooking, lighting, process heat, driving force, etc.) or for non-energy uses (lubrication, cleaning, etc.).

Total final consumption rose from 1,715 ktoe in 1965 to 2,677 ktoe in 1999. After that year, total final consumption began to drop until and including 2003, when it reached a relative minimum of 2,251 ktoe due to Uruguay's economic crisis in the first years of the 21st century. This downward trend was reversed in 2004, when it started to grow again. The consumption values before the crisis were only surpassed in 2007. In the years that followed, total final consumption grew steadily until 2020, when it dropped again. In 2021, it grew again and, by 2023 a new consumption peak of 5,472 ktoe was reached.

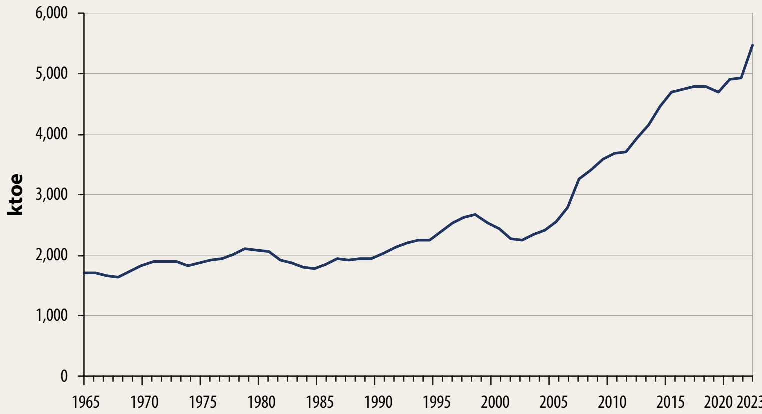
The 2020 decline was directly related to the pandemic that began on March 13 with the first positive cases of COVID-19 in the country. Among the measures taken by the government was the restriction on mobility, which affected the final energy demand, especially oil products (gas oil and gasoline), which are linked to transport. Another reason for the drop in final consumption that year was the country's economic recession; GDP dropped by 6.3% that year. If the entire Energy Balance historical series from 1965 to 2023 are considered, only three years with such sharp drops in the economy were recorded: 1982, 1983 and 2002.

As previously mentioned, between 2004 and 2019, the total final energy consumption showed a growing trend at a 5% average annual rate. This value exceeded the 90s trend, when an average rate of 4% was recorded. In 2008, there was an increase in the total final consumption of 17%, as well as in 2023 (11%), mainly associated with the strong growth of the cellulose industry.

In 2023, non-energy final consumption was 136 ktoe, 26% higher than the previous year. Non-energy products accounted for practically all of this consumption.

Given that final consumption for non-energy uses was only 2% of total final consumption, an analysis by source is not justified. For this reason, below is an analysis of final energy consumption and its breakdown by source and sector.

FIGURE 32. Total final energy consumption



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4.1. Final energy consumption by source

The energy sources consumed in the different activity sectors mainly include oil products, biomass, electricity, and natural gas.

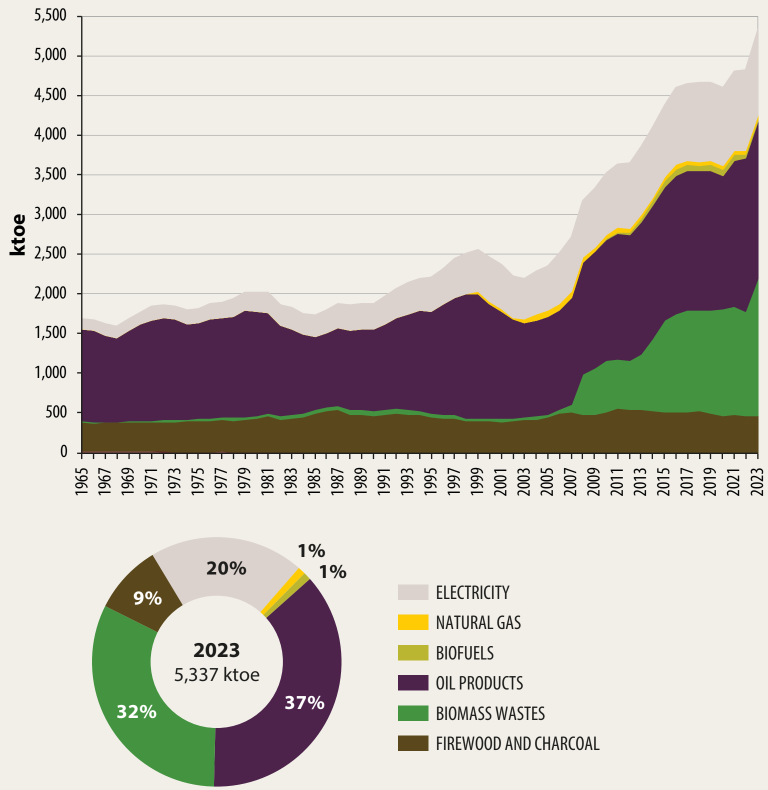
In 2023, final energy consumption was once again led by biomass (firewood, charcoal, biomass waste, and biofuels), a trend observed since 2015, with the exception of 2022 when oil products took the lead. In 2023, final energy consumption by source was distributed as follows: 2,231 ktoe of biomass (42%), 1,979 ktoe of oil products (37%), and 1,063 ktoe of electricity (20%). Natural gas consumption was recorded at a lesser extent (45 ktoe; 1%).

Historically, oil products have had the largest share in the final energy consumption matrix. In the last 20 years, they behaved very similarly to electricity, although their consumption was affected during the crisis at the beginning of the century, with negative rates until 2003. From 2004 onwards, the consumption of oil products increased again, with annual growth rates ranging from 0.4% to 7.7%. In 2020, consumption dropped again (-5%), followed by a subsequent growth that was maintained in the last three years.

As for biomass, its consumption has prevailed throughout the historical series, with one particular feature: it has been relatively constant for more than 40 years, with an average of 470 ktoe of final energy consumption, mainly associated with the use of firewood as an energy source. It was not until 2007 that it recorded an increase that was maintained until 2021; this was influenced by biomass waste consumption. In 2022, all biomass-related sources recorded declined in consumption -2% for firewood and charcoal, -3% for biomass waste, and -39% for biofuels. In 2023, the most notable change was in biomass waste, which saw a 30% increase in final consumption, rising from 1,322 ktoe to 1,713 ktoe. Firewood consumption grew slightly (1%), while biofuel consumption decreased once again, by 8%, between 2022 and 2023.

Biomass waste encompasses forestry and sawmill waste, black liquor, sugarcane bagasse, rice husks, sunflower husks, barley husks, among others. As of 2007, there has been a significant increase in waste consumption in the pulp industry, particularly black liquor. For 2007 and 2008, the increase rates in biomass waste consumption were 91% and 447%, respectively. In 2014 and 2015, this happened again, with increasing rates of 30% and 28%. Furthermore, in 2011, consumption fell by 3%, which can be explained by the decrease in the Gross Domestic Product in the paper and timber industries. These industrial sectors consume approximately 80% of the biomass waste of the industrial sector. In 2023, the commissioning of the third cellulose plant in the country, as previously mentioned, had a direct impact on the national consumption matrix.

FIGURE 33. Final energy consumption by source



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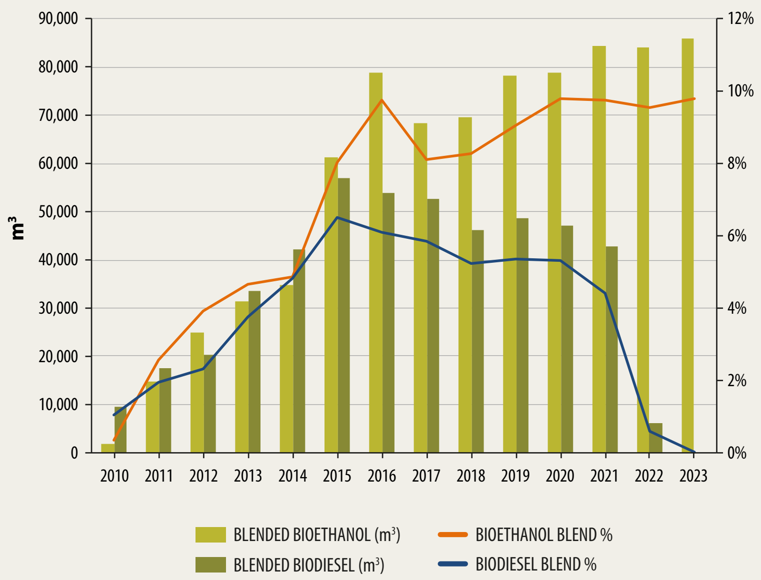
It is noted that the value of firewood consumption shown for the different sectors was obtained from statistical studies carried out by DNE-MIEM.

Since 2010, two new secondary energy sources, namely bioethanol and biodiesel[15], were included under the term "biofuels." They are mainly consumed in blends with fossil fuels: gasoline-bioethanol and gas-oil-biodiesel. The incorporation of biofuels made it possible to meet demand while reducing fossil fuel consumption and, therefore, helped reduce greenhouse gas emissions. After showing an increasing consumption since its first year, its peak consumption was recorded in 2016 (85 ktoe) and remained at an average of 78 ktoe until 2021. In the last two years, consumption was less than 50 ktoe, with a 1% share in the final consumption matrix.

During 2022, biodiesel consumption dropped to zero. This was due to amendments made to the legal framework associated with biofuel blending, as mentioned above. This resulted in a significant decrease in overall biofuel consumption when bioethanol and biodiesel are evaluated together. It is worth noting that bioethanol consumption has remained relatively stable in recent years. In 2023, the average bioethanol blend in motor gasoline was 9.8% by volume, with no biodiesel blend recorded in gas oil.

In 2023, the average blend (volume) consisted of 9.8 % bioethanol in motor gasoline.
Biodiesel was not used in blend with gas oil.

FIGURE 34. Biofuels consumption and blending percentages



15- Until BEN 2012, they were called "fuel ethanol" and "B100", respectively.

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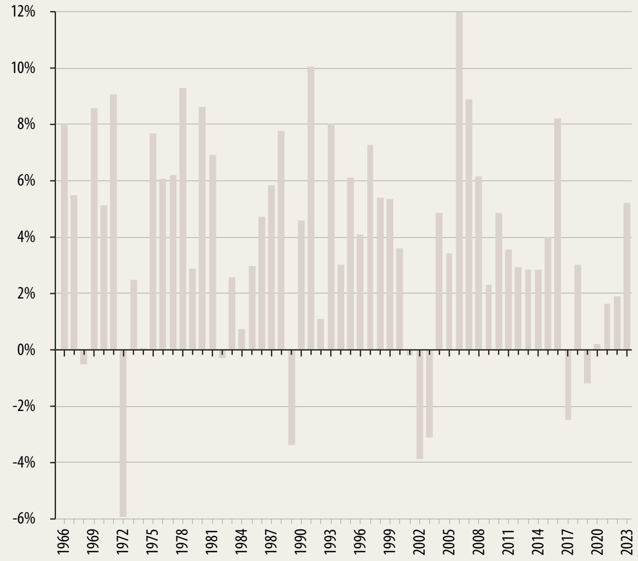
As for electricity consumption, it has shown a steady net growth since 1965 with some occasional years in which it recorded decreases. In 2023 the historical maximum was reached (1,063 ktoe). It is worth highlighting the electricity consumption increase recorded in 2006 (12%), which was associated with a change in the methodology used to evaluate non-technical losses.[16] From that year on, such losses began to be included in the final sectors of consumption. Social losses were included in the residential sector. The remaining non-technical losses were distributed according to the remaining sectors' share in electricity consumption. In 2023, the latter were imputed to the "not identified" category of final consumption. Significant increases in electricity were recorded in the industrial sector due to the entry into operation of cellulose plants, for the years 2007-2008 and 2013-2014, as shown below in the sectoral analysis. These variations were mitigated when considered jointly with the rest of the sectors.

Despite natural gas has been involved in the national energy matrix for 25 years, its penetration has been marginal since it was introduced in 1998. The highest consumption was recorded in 2006 (84 ktoe) with a 3% share in the matrix of final energy consumption. However, since 2009, its share in the consumption matrix has remained at 1%. One major disadvantage of this energy source is the sole supplier being Argentina; this leaves no room for negotiation to secure favorable conditions that would facilitate the minimum requirements for the penetration of this energy source.

Solar thermal energy has been included in the matrix of results since 2014. In 2023, final energy consumption grew 3% compared to the previous year and resulted in a value of 8 ktoe, associated with a surface of solar thermal collectors estimated at 126,360 m^2.

FIGURE 35. Interannual variation of final electricity consumption



16- Non-technical losses are related to unbilled electricity consumption

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TABLE 8. Final energy consumption by source

ktoe	1965	1975	1985	1995	2005	2015	2023
Coal	5.1	1.2	0.3	0.3	0.9		**2.0**
(%)	0%	0%	0%	0%	0%		**0%**
Natural gas					73.5	43.7	**44.8**
(%)					0%	1%	**1%**
Solar						3.2	**8.0**
(%)						0%	**0%**
Firewood and charcoal	355.8	389.4	495.8	456.1	444.5	519.0	**473.8**
(%)	21%	21%	29%	21%	19%	12%	**9%**
Biomass wastes	15.1	27.2	46.2	46.0	41.5	1,159.9	**1,713.3**
(%)	1%	1%	3%	2%	2%	26%	**32%**
Industrial wastes						3.5	**8.6**
(%)						0%	**0%**
Oil products	1,164.1	1,209.2	920.4	1,274.5	1,234.5	1,672.4	**1,979.0**
(%)	69%	67%	53%	58%	52%	38%	**37%**
Biofuels						78.8	**43.7**
(%)						2%	**1%**
Coal products	22.6	16.7	0.9	0.2	0.9	0.1	**0.1**
(%)	1%	1%	0%	0%	0%	0%	**0%**
Electricity	118.5	173.7	271.1	429.8	556.7	906.2	**1063.4**
(%)	7%	10%	16%	19%	24%	21%	**20%**
TOTAL	**1,681.2**	**1,817.4**	**1,734.7**	**2,206.9**	**2,352.5**	**4,386.8**	**5,336.7**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTE: Manufactured gas is included in coal products in1965, and has been included in oil products in 1980 and 1995. As of 2005, it has been fully replaced by natural gas.

TABLE 9. Biofuels consumption

	2010	2012	2014	2016	2018	2020	2022	2023
Bioethanol production (m^3)	13,225	20,040	42,549	77,539	79,622	75,829	91,062	**96,574**
Blended bioethanol (m^3)	1,777	24,920	34,754	78,735	69,763	78,907	84,068	**86,072**
Commercialized gasoline with bioethanol (m^3)	503,919	633,804	714,442	806,944	844,886	804,077	881,652	**879,920**
Bioethanol blend percentage (%)	**0.4%**	**3.9%**	**4.9%**	**9.8%**	**8.3%**	**9.8%**	**9.5%**	**9.8%**
Biodisesel production (m^3)	11,068	20,585	45,234	53,482	47,704	46,045	14,962	**8,790**
Blended biodiesel (m^3)	9,549	20,227	42,319	53,749	46,189	47,070	6,158	
Commercialized gas oil without biodiesel (m^3)	66,678	62,355	49,582	38,743	44,714	37,814	40,139	**1,058,729**
Commercialized gas oil with biodiesel (m^3)	908,827	871,954	877,096	880,317	883,402	886,730	1,023,631	
Biodiesel blend percentage (%)	**1.1%**	**2.3%**	**4.8%**	**6.1%**	**5.2%**	**5.3%**	**0.6%**	

NOTES: 1) Only bioethanol and biodiesel for energy purposes are reported. **2)** For years when the volume of blended biofuels exceeds production, the diference is mainly due to stock change. **3)** The global blend percentage is represented for the total gasoline and not by type of gasoline (super, premium). **4)** For the purposes of the calculation, the total amount of gasoline sold is used. In the early years, bioethanol was not blended in all commercialized gasoline. **5)** Biodiesel is blended in all the gas oil to be used as "gas oil 50S", or as "regular gas oil" until 2013. Marine gas oil and imported gas oil do not contain biodiesel.

▸ **DOWNLOAD spreadsheet GASOIL AND BIODIESEL**

▸ **DOWNLOAD spreadsheet GASOLINE AND BIOETHANOL**

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4.2. Final energy consumption by sector

Historically, final energy consumption has been distributed among three sectors with similar shares (residential, transport, and industrial), with the residential sector recording the highest consumption. However, in 1994, transport became the leading consumption sector, closely followed by the residential sector until 2008, when the consumption structure changed again with the industrial sector's significant growth.

Since 2007, consumption in the industrial sector has grown significantly, with almost double the amount in 2008 compared to 2006. Over the last 16 years, final energy consumption of the industrial sector rose from 626 ktoe (2007) to 2,544 ktoe (2023), with three clear growth periods (2008-2010, 2014-2015 and 2023). This was due to the entry into operation of new cellulose plants in the country.

It is worth noting that, despite the entry of cellulose plants had a significant impact on the energy matrix, they have been self-sufficient as more than 90% of their consumption came from their own energy sources. Also, part of the electricity generated in these plants has been and is still being delivered to the SIN.

The growth in final energy consumption in 2023 was primarily driven by the industrial sector, as the residential, commercial/services/public sector, and transport sectors all recorded decreases in consumption. The primary activities sector maintained its energy consumption at 2022 levels, while the "not identified" category showed an increase, which was associated with the change in methodology for the allocation of non-social technical losses in electricity.

As of 2013, final energy consumption has been reported with a broader breakdown of sectors. For sectoral consumptions lower than 1 ktoe, the breakdown is not reported, as they are very small values; except for cases corresponding to a single sub-sector. In other cases, there is no breakdown if the data corresponds only to one company by sector (group consumption must then be reported) or if there is no adequate information for its classification.

FIGURE 36. Interannual variation of final energy consumption of the industrial sector

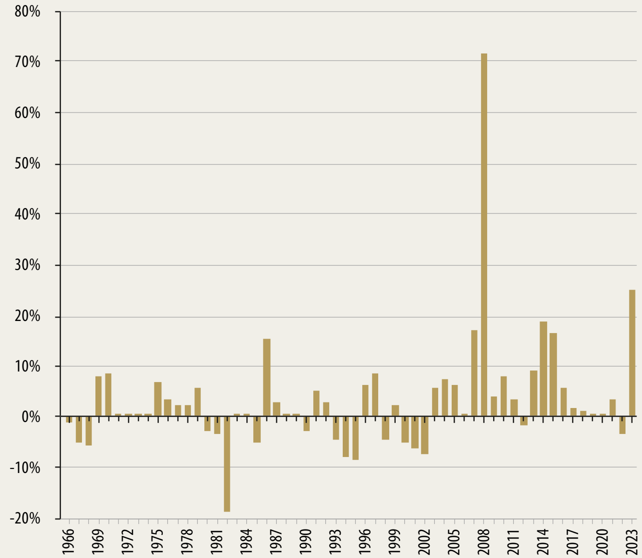
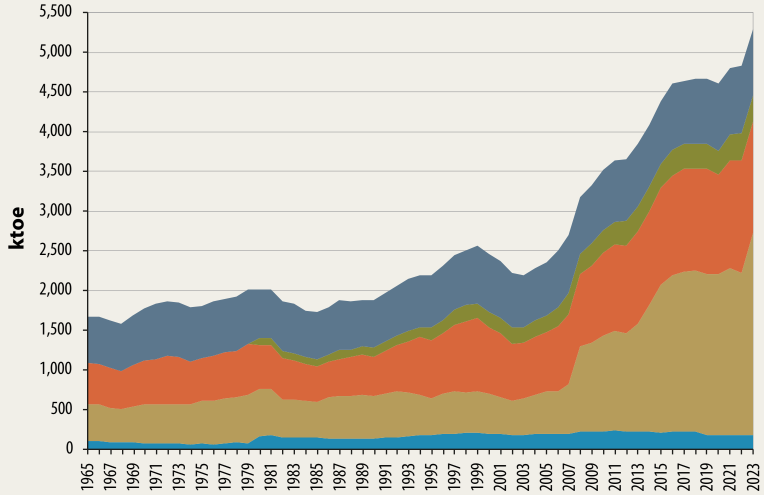


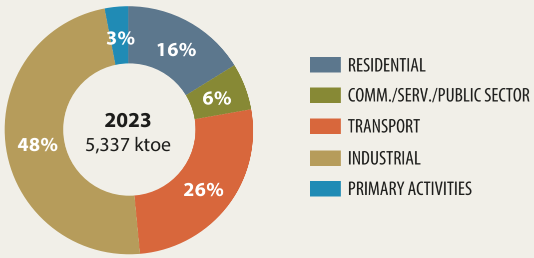
TABLE 10. Final energy consumption by sector

ktoe	1965	1975	1985	1995	2005	2015	2023
Residential	606.0	602.6	666.1	667.3	794.4	842.0	**854.8**
(%)	33%	35%	30%	28%	18%	16%	**18 %**
Commercial/services/ public sector	54.0	84.5	160.8	207.4	299.3	328.3	**341.3**
(%)	3%	5%	7%	9%	7%	6%	**7 %**
Transport	542.5	443.5	724.7	748.2	1,216.4	1,402.8	**1,419.1**
(%)	30%	26%	33%	32%	28%	26%	**29 %**
Industrial	533.0	452.1	465.5	529.9	1,859.4	2,543.7	**2,036.4**
(%)	29%	26%	21%	23%	42%	48%	**42 %**
Primary activities	74.8	149.3	182.5	197.9	215.3	182.5	**180.9**
(%)	4%	9%	8%	8%	5%	3%	**4 %**
Non-specified	7.1	2.7	7.3	1.8	2.0	37.4	3.1
(%)	0%	0%	0%	0%	0%	1%	0 %
TOTAL	**1,817.4**	**1,734.7**	**2,206.9**	**2,352.5**	**4,386.8**	**5,336.7**	**4,835.6**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100 %**

NOTE: In 1965 and 1975, the final energy consumption of the commercial/services/public sector corresponds to firewood and electricity. The rest of the energy sources are included in the residential sector.

FIGURE 37. Final energy consumption by sector





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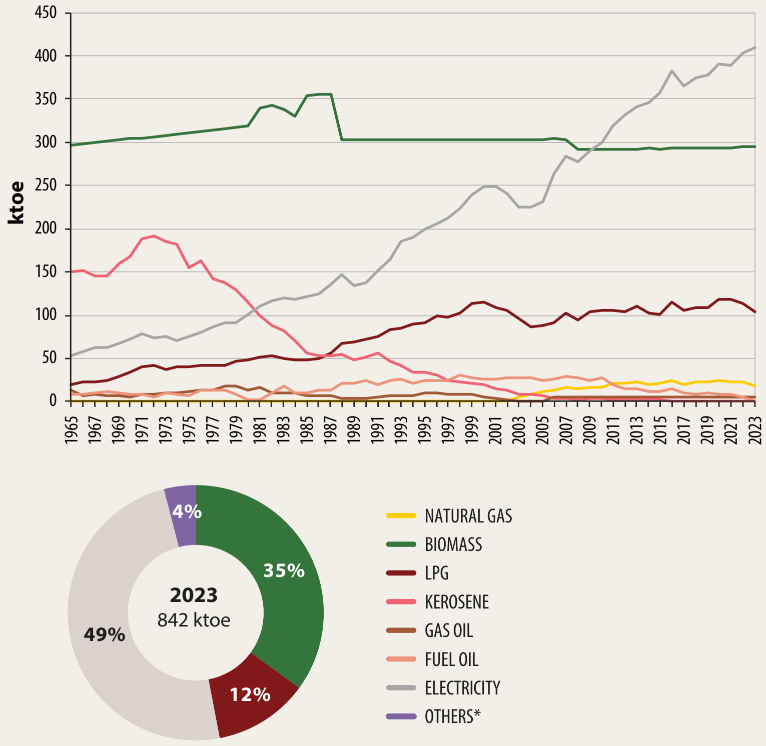
4.2.1. Residential sector

Final energy consumption in the residential sector was 842 ktoe in 2023, 1% lower than the previous year. Although the consumption of the residential sector includes a wide variety of sources, the main ones are 3-4. In the first years of the historical series, between 1965 and 1980, the highest consumption corresponded to firewood, followed by kerosene, and, to a lesser extent, electricity, and LPG (mainly LP gas). However, throughout the years, electricity and LPG increased their share, while firewood consumption remained constant and kerosene consumption decreased. Thus, since 2010, the primary energy source consumed in the residential sector has been electricity, followed by biomass (firewood and biomass waste) and LPG. The residential sector is the main sector of electricity consumption, which is partly explained by the country's low level of industrialization.

Once again, it should be noted that surveys were used to determine firewood and biomass waste consumption. Consequently, the drop in biomass consumption since 2006 was not related to changes in the consumption patterns but to a change in the evaluation methodology. As for firewood, the value recorded in the 1988 Survey (302 ktoe) remained the same until 2005. From 2006, the results of the "Energy Use and Consumption Survey" (295 ktoe) were incorporated. And, from 2008, the consumption included in the updated version of the survey was also considered (284 ktoe). Biomass waste was included in 2006 with the information collected in the above survey. In turn, a new residential survey was conducted in 2013, reporting similar firewood and biomass waste consumption to the previous years. In 2023, biomass (firewood, charcoal, and biomass waste) accounted for 35% of consumption in the residential sector.

Other sources used in the residential sector are gas oil and fuel oil, mainly for heating and water heating. Their combined shares were between 1% and 7% in the entire study period (1965-2023). In 2023, they recorded a consumption of 5 ktoe and 1 ktoe, respectively. The use of natural gas in the residential sector began in 2000, with a steady share of 3% (averaging 22 ktoe) over the last 10 years. Since early 2005, the manufactured gas used in Montevideo was replaced by natural gas.

FIGURE 38. Final energy consumption in the residential sector by source



***NOTE:** For the ring chart, the "others" category includes natural gas, solar, gasoline, kerosene, gas oil, and fuel oil.

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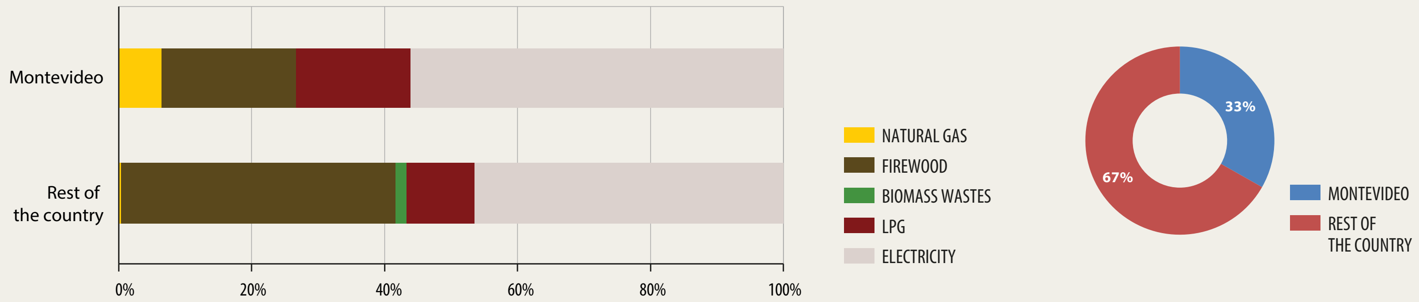
Residential consumption is reported for Montevideo and the rest of the country following the breakdown implemented in 2013. There is some correlation between consumption and population, as about 40% of the country's total population lives in Montevideo[17] and approximately a third of residential consumption corresponds to the capital city.

The primary distinction was in consumption patterns, with residential consumption in Montevideo being predominantly divided: nearly half comprised electricity, followed to a lesser extent by firewood, LPG, and natural gas. In the rest of the country, the main energy sources consumed in households were electricity and firewood, and, to a lesser extent, LPG and biomass waste.

In terms of energy sources, electricity consumption was split between Montevideo and the rest of the country (37% and 63%, respectively). Similarly, LPG consumption (LP gas and propane) was 46% in Montevideo and 54% in the rest of the country. Most natural gas consumption took place in the capital (91%) whereas the highest firewood consumption was recorded in the rest of the country (80%).

A breakdown of kerosene, solar energy, gas oil, fuel oil, and charcoal consumption in the residential sector was not made for Montevideo and the rest of the country, as adequate data were not available for their classification. For other energy sources (such as gasoline and biofuels), there was no breakdown either since their consumption was lower than 1 ktoe.

FIGURE 39. Breakdown of consumption in the residential sector in 2023



17- National Institute of Statistics (INE), *Poblaciones Estimadas y Proyectadas por Sexo y Edad según Departamentos*, <https://www5.ine.gub.uy/documents/Demograf%C3%ADay-EESS/SERIES%20Y%20OTROS/Estimaciones%20y%20proyecciones/Revisi%C3%B3n%20 2013/Departamentos_poblacion_por_sexo_y_edad_1996-2025%20(1).xls> (08/12/2024).

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As of March 2020, mobility restriction measures were taken by the government. Thus, an increase in energy consumption could be expected as people spent longer periods of time in their homes. However, although consumption in the residential sector increased by 3% in 2020 compared to the previous year, this was within the historical growth values. Additionally, it must be noted that winter 2020 was colder than 2019, which could explain the increase in LPG and electricity consumption. Therefore, the effect of the pandemic does not fully account for this consumption trend.

TABLE 11. Final energy consumption in the residential sector

ktoe	1965	1975	1985	1995	2005	2015	2023
Natural gas					11.8	21.2	**18.9**
(%)					2%	3%	**2%**
Solar						2.6	**6.6**
(%)						0%	**1%**
Firewood and charcoal	296.5	311.1	354.6	303.0	302.3	285.0	**287.5**
(%)	54%	51%	59%	45%	45%	36%	**34%**
Biomass wastes						7.6	**7.6**
(%)						1%	**1%**
LPG	20.1	40.2	47.9	91.5	88.7	101.6	**104.6**
(%)	4%	7%	8%	14%	13%	13%	**12%**
Gasoline						0.3	**0.4**
(%)						0%	**0%**
Kerosene	150.2	155.2	56.2	33.4	7.4	2.3	**0.9**
(%)	27%	26%	9%	5%	1%	0%	**0%**
Gas oil	13.5	11.3	6.8	9.5	0.9	4.8	**5.4**
(%)	2%	2%	1%	1%	0%	1%	**1%**
Fuel oil	8.9	6.4	10.7	24.1	24.6	12.0	**0.7**
(%)	2%	1%	2%	4%	4%	2%	**0%**
Manufactured gas	9.5	7.1	5.0	5.4	0.0		
(%)	2%	1%	1%	1%	0%		
Electricity	53.1	74.8	121.4	199.2	231.6	357.0	**409.4**
(%)	10%	12%	20%	30%	35%	45%	**49%**
TOTAL	**551.8**	**606.1**	**602.6**	**666.1**	**667.3**	**794.4**	**842.0**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) In 1965 and 1975, the consumption of kerosene, diesel oil, gas oil, fuel oil and manufactured gas in the commercial/services sector are included in the residential sector.
2) Until and including 2013, gas oil consumption includes diesel oil; between 2010 and 2022 it includes biodiesel.

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4.2.2. Commercial/services/public sector

The final energy consumption in the commercial/services/public sector was 328 ktoe in 2023, 4% lower compared to the previous year.

By analyzing the overall consumption in this sector, the importance of electricity is noteworthy; historically, it has been the main energy source, with a net and sustained growth throughout the series. Following a 3% decrease in electricity consumption in 2020 compared to the previous year, it increased by 4% in 2021 and by 6% in 2022. Since 2006, the electricity share in the sector's final consumption has remained close to 80%.

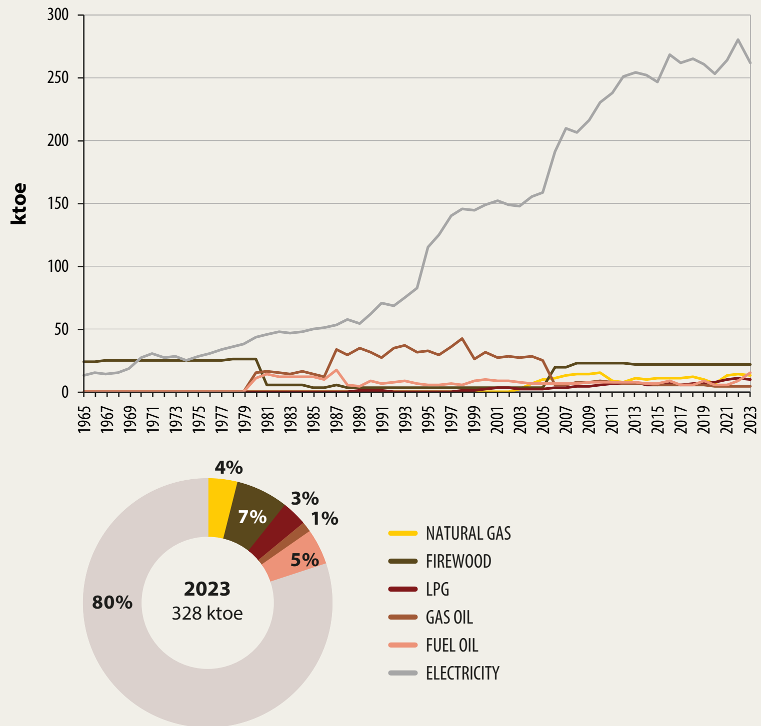
To a lesser extent, firewood consumption was recorded at 22 ktoe in 2023 (7% of the sector). This value has remained constant over the last eleven years and reflects the results of the "Survey on energy consumption and use in the commercial and services sector 2013." It should be noted that the significant changes in firewood consumption throughout the 1965-2023 series respond to new survey results and not to changes in consumption patterns.

In the case of fuel oil, it is worth noting that its consumption in the commercial/service/public sector has remained below 10 ktoe for 35 years. However, in 2023, consumption almost doubled compared to the previous year, reaching 15 ktoe. This growth was accompanied by a decrease in consumption in the residential sector, but when considering these variations as a whole, consumption has remained relatively constant. It should be noted that these changes do not necessarily reflect a genuine evolution in sectoral fuel oil consumption, as they may be influenced by changes in the criteria used to characterize the administrative data.

Following an 8% increase compared to the previous year, the remaining energy sources consumed in the sector (solar, gas oil, fuel oil, LPG, gasoline, kerosene, and natural gas) collectively accounted for 10% of the sector's consumption in 2023.

Since 2013, consumption has been reported within the commercial/services/public sector in four subsectors: "public lighting," "public administration and defense," "electricity, gas, and water," and "others." In 2023, the consumption of the "electricity, gas, and water" subsector accounted for 9% of the entire sector. The "public administration and defense" and "public lighting" recorded 7% and 5% shares in sector consumption, respectively. Meanwhile, the "others" subsector, which includes all energy consumption not falling within the above categories, accounted for the majority of the sector's consumption (almost 80%).

FIGURE 40. Final energy consumption in the commercial/services/public sector by source



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From a consumption structure perspective, electricity was the main energy consumed in all subsectors in 2023. In fact, it was the only one in the "public lighting" subsector. Regarding "public administration and defense," apart from electricity (79%) consumption of firewood (9%), fuel oil (6%), LPG (6%) and gas oil (1%) was also recorded. In "electricity, gas, and water," in addition to electricity consumption (96%), there was a very small consumption of LPG (3%) while firewood and fuel oil consumption was practically insignificant. The "others" subsector recorded the following consumption matrix: electricity (77%), firewood (8%), fuel oil (5%), natural gas (5%), LPG (3%) and gas oil (2%).

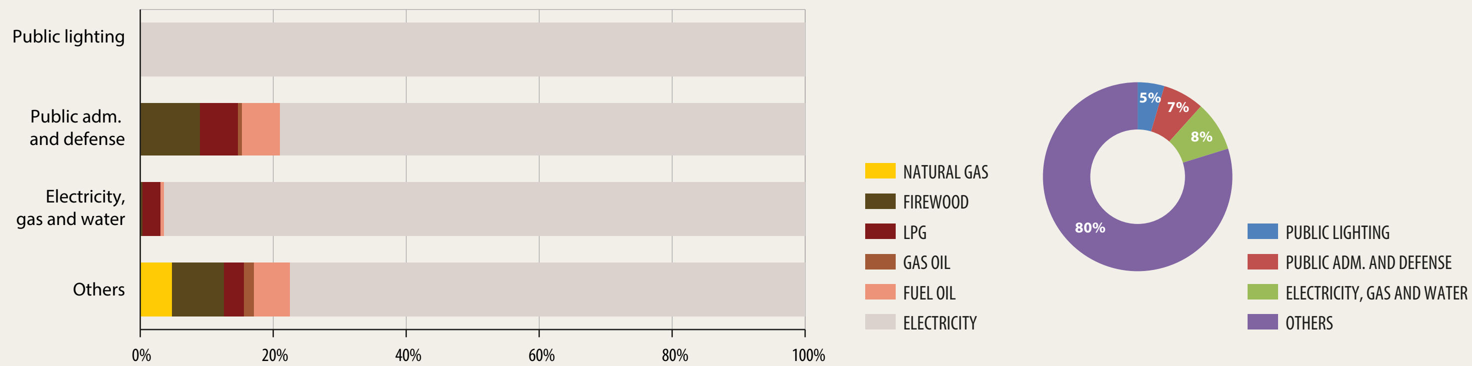
The breakdown for solar energy was not performed due to a lack of information for its classification, and for kerosene, it was excluded because it represented small values (less than 1 ktoe). As for charcoal, the recorded consumption in the commercial/services/public sector was insignificant in recent years and was thus included in the "others" category.

TABLE 12. Final energy consumption in the commercial/services/public sector

ktoe	1965	1975	1985	1995	2005	2015	2023
Natural gas					10.1	10.8	**12.8**
(%)					5%	4%	**4%**
Solar						0.5	**1.2**
(%)						0%	**0%**
Firewood and charcoal	24.2	25.4	3.8	3.1	3.1	22.1	**22.1**
(%)	64%	47%	4%	2%	1%	7%	**7%**
LPG				0.3	2.8	5.8	**9.8**
(%)				0%	1%	2%	**3%**
Gasoline						0.9	**1.1**
(%)						0%	**0%**
Kerosene	*	*	0.6	0.3	0.1	0.1	**0.0**
(%)			1%	0%	0%	0%	**0%**
Gas oil	*	*	14.9	32.8	25.4	6.2	**4.3**
(%)			18%	20%	12%	2%	**1%**
Fuel oil	*	*	11.8	6.2	7.3	6.6	**15.2**
(%)			14%	4%	4%	2%	**5%**
Manufactured gas	*	*	3.2	3.4	0.0		
(%)			4%	2%	0%		
Electricity	13.4	28.6	50.2	114.7	158.6	246.3	**261.8**
(%)	36%	53%	59%	71%	76%	82%	**80%**
TOTAL	**37.6**	**54.0**	**84.5**	**160.8**	**207.4**	**299.3**	**328.3**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) In 1965 and 1975, the consumption of kerosene, diesel oil, gas oil, fuel oil and manufactured gas in the commercial / services / public sector was included in the residential sector. **2)** As of 2010 motor gasoline includes bioethanol. **3)** Until 2013, gas oil consumption includes diesel oil; between 2010 and 2022 it includes biodiesel.

FIGURE 41. Breakdown of consumption in the commercial/services/public sector in 2023



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4.2.3. Transport sector

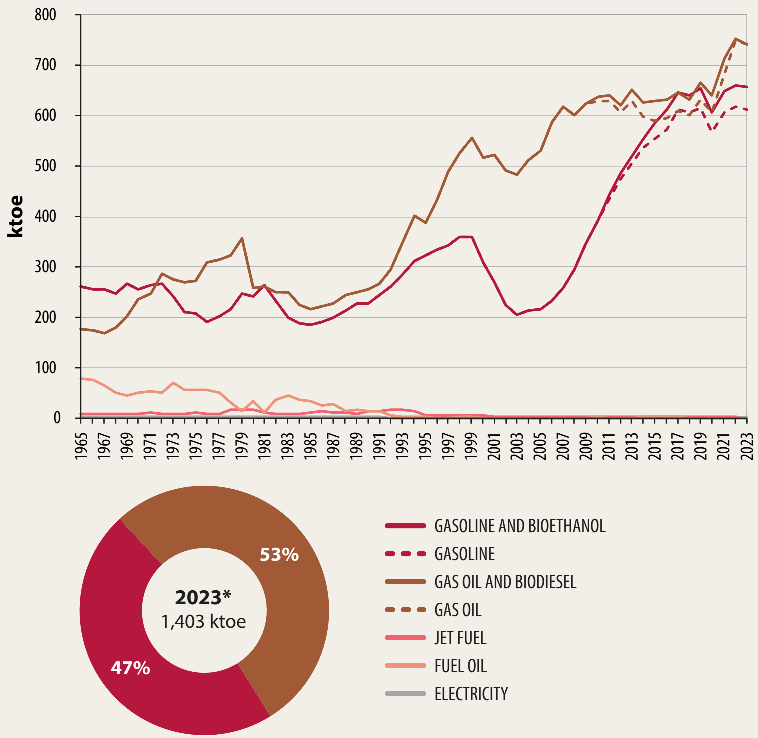
The final energy consumption in the transport sector was 1,403 ktoe in 2023, representing a decrease of 1% compared to the previous year. It corresponded entirely to secondary energy sources, mainly gas oil and motor gasoline. Regarding final consumption, since 2008, the transport sector has been the second most important sector, after the industrial sector.

The share of the different sources fluctuated between 1965 and 2023. At the beginning of the period, motor gasoline was the source with the highest consumption. However, as of 1972, this trend was reversed, and gas oil took over first place. Towards 1980-1981, their consumption was practically the same, but from 1982 onwards, the difference widened again, due to a greater growth in gas oil consumption. During the 2002 crisis, both fuels had a drop in their demand, especially gasoline. This situation further widened the gap between their consumption. However, as of 2004, amidst a growing trend for both sources, gasoline showed a higher growth rate, thus further reducing the difference between gasoline and gas oil consumption. This behavior was directly influenced by the vehicle fleet, both in terms of its size and the share of vehicles according to the fuel used. In 2005, 75% of vehicle sales were for gasoline-powered vehicles, and this share increased to 99% in 2010, in line with the de-dieselization of the vehicle fleet promoted under the energy policy.

From 2010 onwards, biofuels (bioethanol and biodiesel) have been included in the final consumption matrix. Their share in the transport sector increased from 1% (2010) to 6% (2015), remaining constant until 2020. In 2023, bioethanol consumption remained steady and so did its share. Meanwhile, biodiesel consumption dropped by one percentage point in 2021 and was no longer consumed during the course of 2022. Considering both biofuels jointly, consumption went from 7 ktoe to 43 ktoe over these 13 years, with a peak of 78 ktoe in 2016. As mentioned above, these sources were mainly consumed in blends with fossil fuels, gasoline-bioethanol, and gas oil-biodiesel, enabling demand to be met together with a decrease in the consumption of fossil fuels. In 2022, the blending percentage recorded was 9.8% for bioethanol in gasoline and none for biodiesel in gas oil.

The transport sector was one of the most affected by the mobility reduction measures introduced at the beginning of the pandemic, mainly between March and May 2020. In that year, motor gasoline and gas oil consumption dropped by 8% and 4%, respectively. By 2021 and 2022 this situation was reversed and both fuels had higher consumption; in contrast to 2023, when they again showed a slight decrease. For the last year, shares were 44% for gasoline and 53% for gas oil.

FIGURE 42. Final energy consumption in the transport sector by source



***NOTE:** 44 % gasoline; 3 % bioethanol; 53 % gas oil; 0 % biodiesel.

Gas oil consumption has varied somewhat in recent years. In contrast, gasoline recorded its first drop in 2018, after 15 years of continuous growth. The trend of the last few years led to an equal consumption of both fuels in 2017. However, the sharp drop suffered by gasoline in 2020 and the strong growth of gas oil in 2021-2022 determined a gap in consumption once again. The same behavior was observed when considering fossil fuels blended with biofuels (gasoline-bioethanol and gas oil-biodiesel).

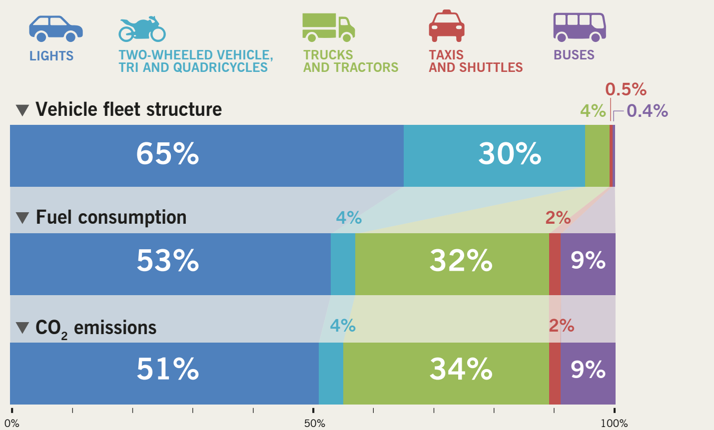
Other sources used in the transport sector are jet fuel and aviation gasoline. Over the last eight years, aviation consumption has remained constant (4.5 ktoe), considering both fuels as a whole. It is worth noting that practically one third of this consumption corresponds to aerial-agricultural spraying activities. This data is based on the annual surveys conducted by the DNE-MIEM for such branch of activity.

In the BEN historical series, there were records of electricity consumption in the transport sector from 1965 to 1992, year in which the use of vehicles that consumed this source was discontinued. As of 2016, the estimation of electricity consumption in the transport sector was resumed, albeit with values that are still small compared to other energy sources. Anyhow, an increase in electricity has been recorded year after year in transport; in 2023 reached a value of 1 ktoe (11,353 MWh)[18], 67% higher than the previous year. Currently, electric vehicles are used in public transport, as well as in the fleet of UTE vehicles and private vehicles. For years before 2016, these consumptions are included in the residential and commercial/services/public sector.

Fuel consumption behavior in the transport sector is directly influenced by the vehicle fleet, both in terms of size and share of the different types of vehicles according to the fuel used. In the last six years, the vehicle fleet increased by 12%. When considering the type of fuel, between 2017 and 2023 vehicle fleets running on gasoline increased by 12%, while the number of gas oil vehicles increased by only 5%. In turn, the penetration of new technologies, such as electric and hybrid vehicles, is noteworthy. Although in 2022 they accounted for only 1% of the vehicle fleet (considered jointly), sales have been increasing year after year.

By relating the structure of the vehicle fleet to fuel consumption in the transport sector, it is observed that in 2023 the "light" category ranked first both in terms of number of vehicles and consumption. However, two-wheeled vehicles (including tricycles and quadricycles) accounted for almost a third of the fleet, while they accounted for only 4% of fuel consumption. On the contrary, the "trucks and tractors" category, with only 4% share of the vehicle fleet, was accountable for about one third of the energy consumption of the transport sector. Meanwhile, the "buses" and "taxis and shuttles" categories had a similar behavior, as they accounted for less than 1% of the fleet in 2023. Nonetheless, they consumed 9% and 2% of the sector's fuel, respectively.

FIGURE 43. Vehicle fleet structure, fuel consumption and CO_2 emissions in 2023



18- Value estimated by MIEM-DNE, since the information from UTE was not available at the closing date of this publication.

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Consumption in the transport sector has been reported since 2013, with a breakdown by means: “road,” “rail,” “air,” and “sea and fluvial.” In 2023, road transport consumption accounted for almost the total consumption of the entire sector (99%); and it was gas oil and gasoline (in its blend with bioethanol for the latter fuel). In turn, consumption of jet fuel and aviation gasoline was entirely attributable to air transport. For rail and sea-fluvial transport, consumption corresponded to gas oil. In 2019, no fuel oil was consumed in the transport sector, which had been the case of sea and fluvial transport in previous years. However, as of 2020, a 0.1 ktoe consumption of this source was recorded again.

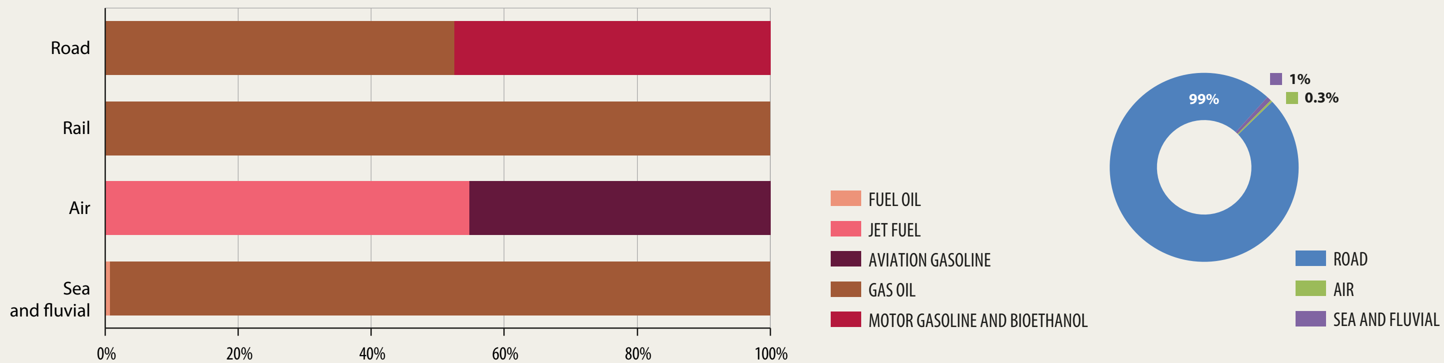
It is important to note that, according to the energy balance methodology (IRES/OLADE), the consumption of air and fluvial transport whose airport/port of departure is from a different country than the airport/port of arrival is not considered under final consumption. Instead, these consumptions must be recorded as international bunker.

TABLE 13. Final energy consumption of the transport sector

ktoe	1965	1975	1985	1995	2005	2015	2023
Aviation gasoline			3.5	3.2	2.2	2.5	**1.9**
(%)			1%	0%	0%	0%	**0%**
Motor gasoline	260.5	206.4	182.0	320.6	214.6	550.7	**611.7**
(%)	50%	38%	41%	44%	29%	45%	**44%**
Bioethanol						30.8	**43.2**
(%)						3%	**3%**
Gas oil	175.3	272.2	215.1	388.1	530.0	590.8	**742.6**
(%)	34%	50%	49%	54%	71%	49%	**53%**
Biodiesel						38.1	
(%)						3%	
Kerosene	3.4	6.4					
(%)	1%	1%					
Jet fuel			7.5	12.0	1.4	2.7	**2.3**
(%)			2%	2%	0%	0%	**0%**
Fuel oil	77.5	56.0	33.9	0.8		0.8	**0.1**
(%)	15%	10%	8%	0%		0%	**0%**
Electricity	2.1	1.5	1.5				**1.0**
(%)	0%	0%	0%				**0%**
TOTAL	**518.8**	**542.5**	**443.5**	**724.7**	**748.2**	**1,216.4**	**1,402.8**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) Until and including 2013, gas oil consumption includes diesel oil. **2)** Electricity consumption associated with transportation since 2016 includes captive and private fleets. For previous years, it is very small and is included within the residential and commercial / services / public sector. **3)** As of December 2022, due to a change in regulations, biodiesel is no longer mixed with gas oil.

FIGURE 44. Breakdown of consumption in the transport sector in 2023



NOTE: In 2023 there was no biodiesel blended in gas oil.

4.2.4. Industrial sector

The final energy consumption of the industrial sector was 2,544 ktoe in 2023, 25% higher than that recorded in 2022. Note that the industrial sector includes the manufacturing industry and construction. The main source consumed in the last year was biomass waste and accounted for 67% of the total industrial consumption. To a lesser extent, electricity consumption was recorded (13%), followed by fuel oil (8%) and firewood (6%).

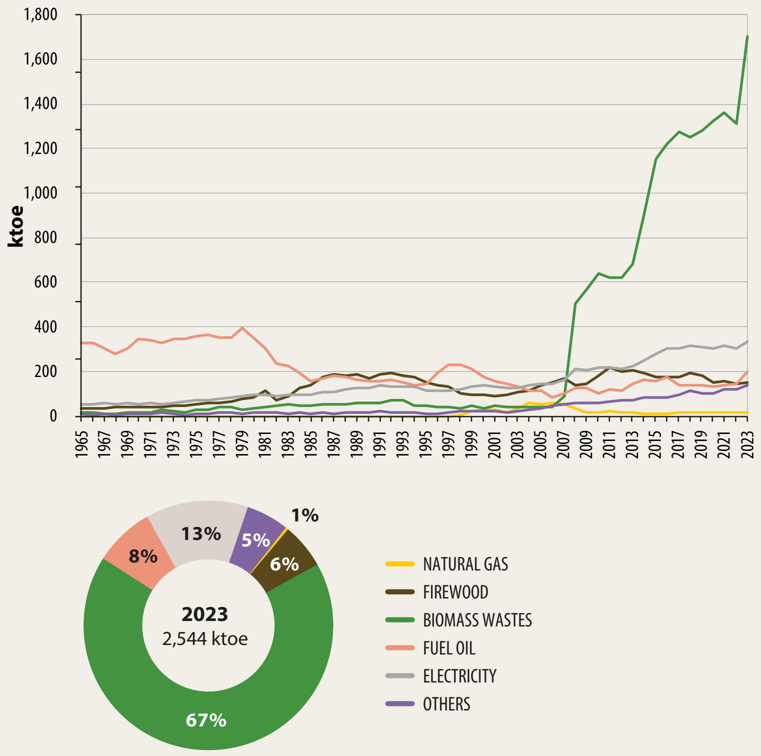
Since 2008, the industrial sector has been the main final consumption sector in Uruguay. In the 1965-2023 period, it recorded a significant fluctuation in its energy consumption from various sources. In the first years of the series, fuel oil was the main energy source for industrial consumption, with a 70% share. It is worth noting the years where firewood and electricity consumption was higher than other sources (1986-1995 and 2003-2007), as well as the complementarity between fuel oil and firewood consumption throughout the years.

As for biomass waste (rice and sunflower husks, sugarcane bagasse, black liquor, odorous gases, methanol, barley husks, and wood industry waste, among others), a historically low consumption has been recorded in the industry, with average shares of 7% up to and including 2006. In 2008, biomass waste consumption peaked, mainly due to the growth of black liquor consumption in the cellulose industry. Additionally, the consumption of forestry and sawmill waste, which was not recorded in previous BEN editions, began to be recorded in 2008.

In 2010, the consumption of biomass waste alone (638 ktoe) already exceeded the industrial sector's total consumption in 2007 (626 ktoe). In later years, the consumption of this source continued to increase until it reached a maximum of 1,361 ktoe in 2021. In 2022, a 3% drop was recorded, and biomass waste consumption was 1,314 ktoe. However, another significant increase was recorded in 2023, reaching the maximum consumption of 1,706 ktoe. As already mentioned, this significant growth experienced by biomass waste since 2008 has transformed the industrial sector into the leading sector in energy consumption.

In 2002, electricity reported its maximum share in industrial consumption (29%) and remained relatively constant at an average share of 15% over the last decade. Despite this percentage decline, absolute electricity consumption experienced net growth, with an historic peak in 2023 (337 ktoe).

FIGURE 45. Final energy consumption of the industrial sector by source



NOTE: "Others" include gas oil, petcoke, LPG, propane, and industrial waste.

It is important to highlight that, in the last decade, electricity autoproduction has developed significantly in the industrial sector; this is the electricity generated by the establishments themselves, without joining the National Interconnected System. Between 1965 and 1980, the share of electricity from autoproduction, with respect to industrial electricity consumption, remained between 10% and 15% and then dropped to shares lower than 10% for almost 30 years. From 2008, the share of electricity from autoproduction rose to values between 30% and 35%. and since 2014 reached values higher than 44% of the industry's electricity consumption, in particular 53% in 2023. Thus, in the last decade, industrial establishments generated practically half of the electricity they consumed.

Firewood consumption has been increasing and reached a 29% share in 2006, subsequently dropping to 6% towards 2023. In the last year, firewood consumption in the industrial sector dropped by 4%, resulting in a share of one percentage point lower than in 2022.

As for fuel oil, its highest historical consumption has been recorded in the industrial sector, with shares over 70% of the final energy consumption. Its consumption was particularly important in the first years of the series, as mentioned above, and then declined to a share of less than 10% of industrial consumption since 2010. In 2023, fuel oil consumption grew 36% with respect to the previous year and represented 8% of final energy consumption in the industrial sector.

In 2020 and 2021 the total fuel oil consumed in the industrial sector was supplied by ANCAP, while in 2022 5% was acquired through other suppliers. In particular, in 2023 more than one third of the fuel oil consumed in the industry came from direct imports from the companies themselves. This was due, in part, to the refinery shutdown in the last months of the year. It should be noted that this applies only to companies under the free trade zone regime.

In 2023, industrial facilities autogenerated 53% of the electricity consumed and directly imported more than one third of the fuel oil.

Natural gas, introduced in the country by the end of 1998, reached a 12% share of industrial consumption in 2004 and decreased to 1% in 2010; percentage that remained the same until 2023. This drop was partly explained by the decrease in consumption and the increase in the sector's total consumption. Furthermore, Argentina's difficulties in supplying natural gas (the only supplier of this energy source), as mentioned above, must be considered.

Other energy sources consumed by the industry have been gas oil, petcoke, and LPG (LP gas and propane). Petcoke consumption has remained relatively constant, with a share of 3-4%. However, it doubled in absolute terms in the last ten years, rising from 36 ktoe (2013) to 97 ktoe (2023). In turn, LPG consumption has increased in the last few years, but it remains marginal within the industrial sector's total consumption.

It should be noted that since 2011, records of industrial waste consumption have been available. While the consumption was initially very low, there has been a growing use of industrial waste as an energy source in certain establishments. This includes end-of-life tires, alternative liquid fuels (CLA), and residual solid fuels (CSR), among others. In 2023, industrial waste consumption reached 9 ktoe, marking a 19% increase compared to the previous year.

As for solar energy, in 2023, it was possible to estimate a consumption of 0.2 ktoe associated with an installed area of solar thermal collectors covering 3.866 m^2. This value was obtained from annual surveys of industrial establishments, as well as from imports of equipment by companies in the sector. In any case, it is considered a preliminary value since the information regarding solar energy is difficult to collect in

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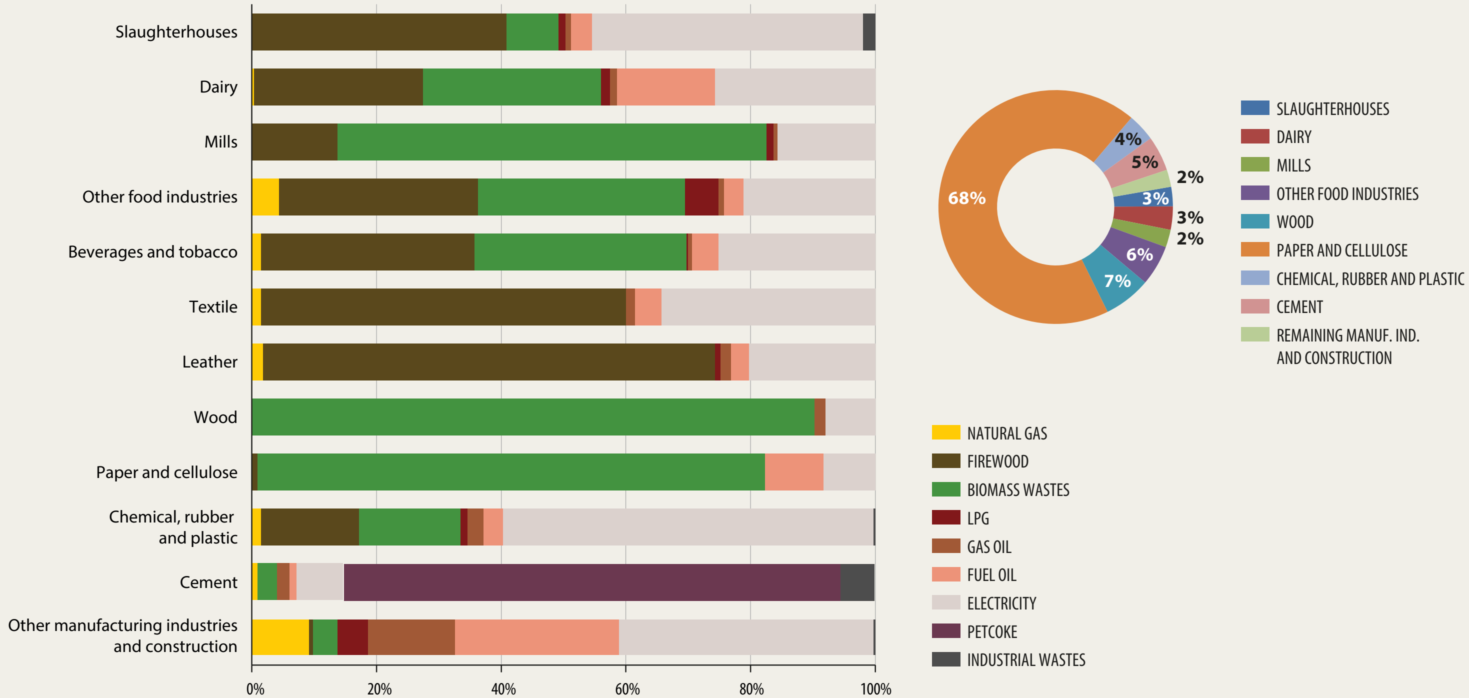
sectoral surveys, since the sample size does not capture the population that uses this technology.

Since 2013, consumption in the industrial sector has been reported in 12 sectors. The main sector in terms of energy consumption was "paper and cellulose," whose share was always higher than 50% of the total consumption of the industrial sector. Specifically, in 2023, its share was 68%, followed, to a lesser extent, by the "wood" (7%), "cement" (5%) and "chemical, rubber, and plastic" (4%) sectors.

The industrial sectors showed differences not only in energy consumption levels but also in the types of energy used, thus enabling the identification of specific consumption patterns. In 2023, both "paper and cellulose" and "wood" sectors consumed mainly biomass waste (more than 80%), and, to a lesser extent electricity (less than 10%). In turn, the "chemical, rubber, and plastic" sector had electricity-based consumption in 2023 (59%), followed by "biomass waste" (16%) and "firewood" (16%), Meanwhile, "cement" consumed mostly petcoke (78%) and electricity (7%). In the last year, the consumption matrix of "slaughterhouses" was composed of electricity (43%), firewood (41%), biomass waste (8%) and fuel oil (4%), Meanwhile, "mills" consumed mostly biomass waste (69%), electricity (16%) and firewood (14%).

In the "dairy" subsector, the consumption in 2023 was distributed among four sources: biomass waste (28%), firewood (27%), electricity (26%) and fuel oil (16%). The "beverages and tobacco" consumption pattern was headed by firewood (34%) and biomass waste (34%), followed by electricity (25%). Meanwhile, "other food industries" featured a consumption pattern distributed among biomass (33%), firewood (32%) and electricity (21%). In the "textiles" and "leather"

FIGURE 46. Breakdown of consumption in the industrial sector in 2023



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sectors, energy consumption was headed by firewood (59% and 71%) followed by electricity (34% and 20%). Finally, for “other manufacturing industries and construction,” 2023 consumption was distributed among more sources: electricity (40%), fuel oil (26%), gas oil (14%), natural gas (90%) and LPG (5%), among others.

As per the energy sources consumed, and as mentioned above, biomass waste has been the source with the highest consumption in the industrial sector in 2023; mainly black liquor from the cellulose industry. The highest electricity consumption was recorded in the “paper and cellulose industry” (42%), followed by the “chemical, rubber and plastic” sector (17%) and “slaughterhouses” (9%). Fuel oil was the third most important energy consumed by the industrial sector; mainly in the “paper and cellulose” industry (82%), followed to a lesser extent by “dairy” (6%). As for firewood, industrial consumption was distributed among the different industrial branches: “other food” (20%), “slaughterhouses” (19%), “dairy” (15%), “beverages and tobacco” (12%), “paper and cellulose” (11%) and the rest of the subsectors with shares of less than 10%.

The rest of the energy sources had a smaller share of industrial consumption. It is important to note that petcoke consumption came exclusively from the cement industry. There was no breakdown of solar nor biofuels given their small values (lower than 1 ktoe).

TABLE 14. Final energy consumption in the industrial sector

ktoe	1965	1975	1985	1995	2005	2015	2023
Coal	5.1	1.2	0.3	0.3	0.9		2.0
(%)	1%	0%	0%	0%	0%		0%
Natural gas					51.6	11.7	**13.1**
(%)					10%	1%	**1%**
Solar						0.1	**0.2**
(%)						0%	**0%**
Firewood and charcoal	35.1	52.9	137.4	150.0	139.1	176.9	**149.1**
(%)	8%	10%	30%	32%	26%	10%	**6%**
Biomass wastes	15.1	27.2	46.2	46.0	41.5	1,152.3	**1,705.7**
(%)	3%	5%	10%	10%	8%	62%	**67%**
Industrial wastes						3.5	**8.6**
(%)						0%	**0%**
LPG	0.6	1.2	1.9	1.6	5.1	17.3	**10.7**
(%)	0%	0%	0%	0%	1%	1%	**0%**
Gasoline	5.6	4.5	1.0	0.2	0.2	0.3	**2.0**
(%)	1%	1%	0%	0%	0%	0%	**0%**
Kerosene	7.0	6.0	0.3	1.4	0.9		
(%)	2%	1%	0%	0%	0%		
Gas oil	7.3	6.3	9.6	9.6	8.2	15.9	**20.2**
(%)	2%	1%	2%	2%	2%	1%	**1%**
Fuel oil	324.7	355.3	155.5	141.4	111.7	154.8	**198.8**
(%)	70%	67%	34%	30%	21%	8%	**8%**
Petcoke	0.0	0.0	0.0	0.8	23.7	47.0	**96.6**
(%)	0%	0%	0%	0%	4%	3%	**4%**
Manufactured gas	0.6	0.8	1.0	1.4	0.0		
(%)	0%	0%	0%	0%	0%		
Coke of coal	12.5	8.8	0.9	0.2	0.9	0.1	**0.1**
(%)	3%	2%	0%	0%	0%	0%	**0%**
Electricity	49.9	68.8	98.0	112.6	146.1	279.5	**336.6**
(%)	11%	13%	22%	24%	28%	15%	**13%**
TOTAL	**463.5**	**533.0**	**452.1**	**465.5**	**529.9**	**1,859.4**	**2,543.7**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) As of 2010, motor gasoline includes bioethanol. **2)** As of 2010, gas oil includes biodiesel, and until 2013, it includes diesel oil.

4.2.5. Primary activities sector

The primary activities sector[19] comprises the agriculture, mining, and fishing sectors. The final consumption of primary activities was 183 ktoe in 2023, similar to the previous year. Gas oil was historically the most consumed energy source with a value of 133 ktoe and a share of 73% in 2023. Throughout the entire series, this source had variations in consumption and recorded its maximum historical value in 1996 (184 ktoe). It must be noted that, between 2010 and 2022 gas oil reported in this sector has included blended biodiesel.

The second most important source within this sector has varied throughout the series: until 1996 it was gasoline, between 1997 and 2005 it was electricity, and then, it was firewood. In 2019, electricity secured the second position in consumption again.

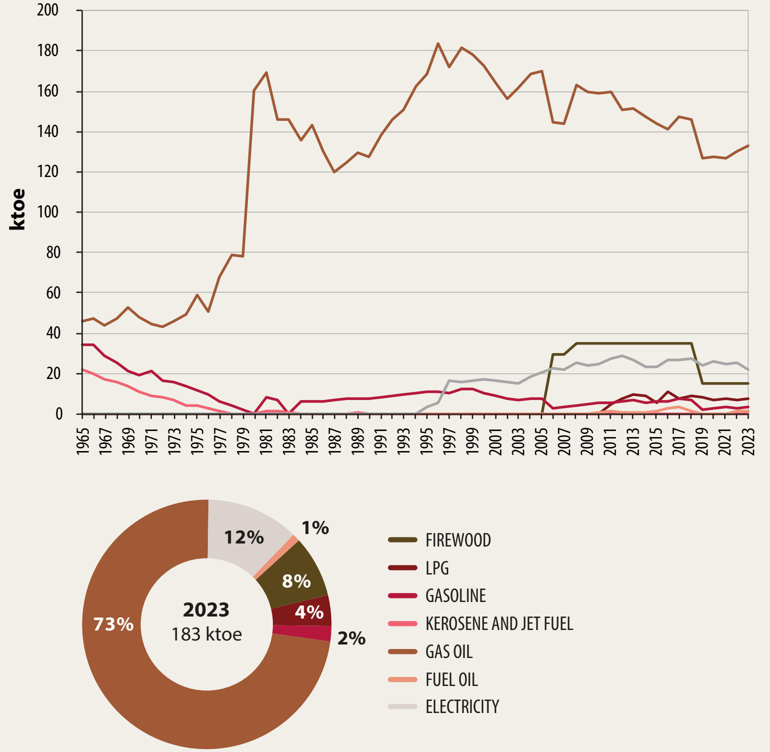
Electricity consumption increased until 2012 (29 ktoe), with a share of 13%, and decreased towards 2015 (23 ktoe), reaching an 11% share. In 2023, electricity consumption dropped by 14% compared to the previous year and being the lowest consumption value since 2005.

Regarding firewood, it should be noted that the drop in the consumption of primary activities between 2019 and 2019, from 35 ktoe to 15 ktoe, resulted from new data survey, particularly in the “poultry” subsector. The results indicated that, in recent years, there has been a substitution of sources used in this subsector, specifically, firewood for LPG. This decline was likely more gradual, but the survey contemplated the 2019-2020 period.

LPG consumption for the primary activities sector has been recorded since 2011. In 2023, such consumption was 7 ktoe, which was 4% higher than in the previous year. In the last year, motor gasoline and fuel oil had a 2% and 1% share in the sector’s consumption. It is worth noting that, in this sector, kerosene consumption has not been recorded since 1993.

19- Until BEN 2019, it was referred to as the agriculture/fishing/mining sector.

FIGURE 47. Final energy consumption of the primary activities sector by source



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For primary activities, the agriculture, mining, and fishing breakdown have been included since 2013. In turn, poultry consumption in the agriculture sector is disaggregated from the rest within this sector; a breakdown implemented in 2019. These improvements have been possible thanks to the implementation of new statistical operations.

In 2023, the **agriculture sector** accounted for 84% (154 ktoe) of the consumption in the primary activities sector. Gas oil was the main source consumed (110 ktoe), constituting 71% of the sector's share. It was followed by electricity, which reached 13% (20 ktoe) in 2023 and firewood ranked third with a share of 10% (15 ktoe).

As for the **mining sector**, its consumption accounted for 5% of total primary activities (10 ktoe), 13% less than the previous year. Gas oil was the main energy source consumed, accounting for 83% of the sector's own consumption (8 ktoe). The remaining 17% corresponded to electricity consumption. The other sources consumed in this sector had values below 0.1 ktoe.

Finally, the **fishing sector** recorded a consumption of 19 ktoe in 2023 with a 11% share in the consumption of the primary activities sector. In the last year, the most consumed source was gas oil (16 ktoe) associated with industrial fishing, followed by gasoline (3 ktoe) in non-industrial fishing. Marine gas oil used in ships does not include biodiesel.

FIGURE 48.
Final energy consumption of the agriculture sector by source

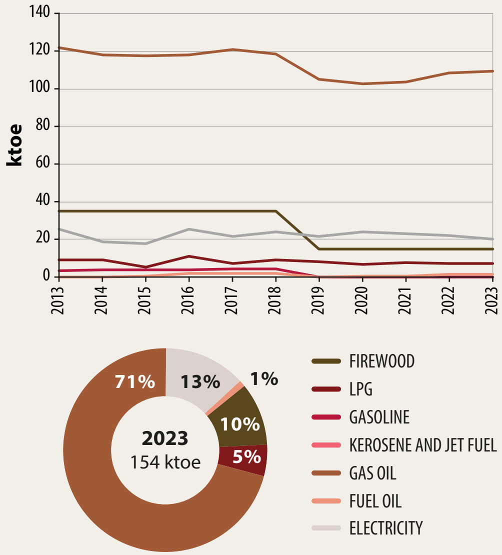

FIGURE 49.
Final energy consumption of the mining sector by source

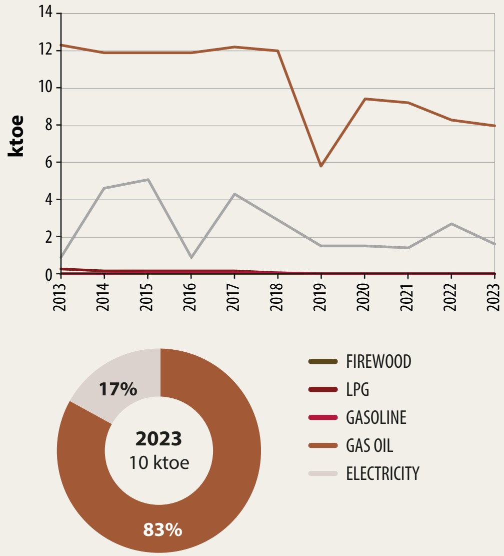

FIGURE 50.
Final energy consumption of the fishing sector by source

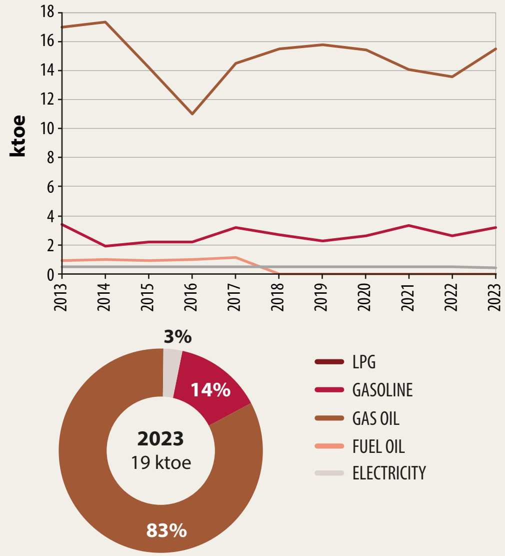

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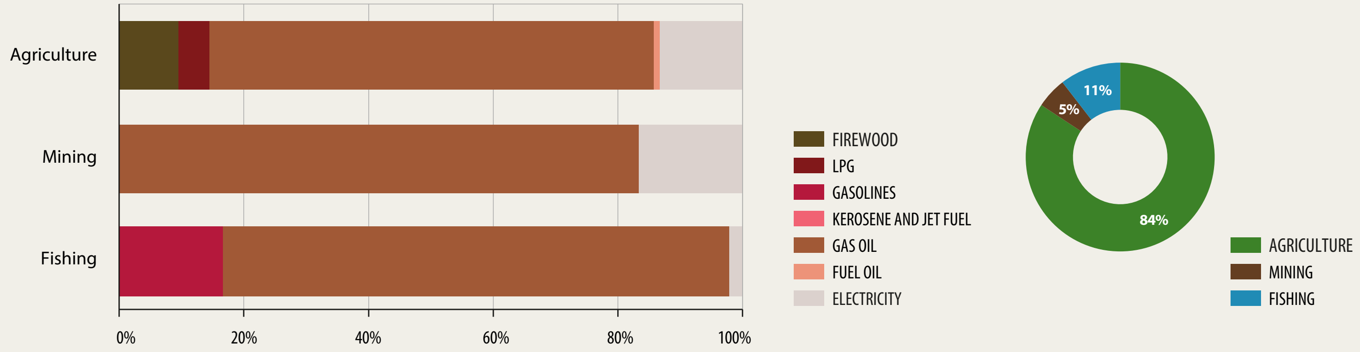
TABLE 15. Final energy consumption of the primary activities sector

ktoe	1965	1975	1985	1995	2005	2015	2023
Firewood						35.0	**15.1**
(%)						16%	**8%**
LPG						5.4	**7.4**
(%)						3%	**4%**
Motor gasoline	34.0	11.5	6.3	10.7	7.4	6.0	**3.2**
(%)	33%	15%	4%	6%	4%	3%	**2%**
Kerosene	22.0	4.1					**0.0**
(%)	22%	5%					**0%**
Gas oil	46.2	59.2	143.0	168.5	170.1	143.9	**133.2**
(%)	0.5	0.8	96%	92%	86%	67%	**73%**
Fuel oil						1.6	**1.6**
(%)						1%	**1%**
Electricity			0.0	3.3	20.4	23.4	**22.0**
(%)			0%	2%	10%	11%	**12%**
TOTAL	**102.2**	**74.8**	**149.3**	**182.5**	**197.9**	**215.3**	**182.5**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) As of 2010, motor gasoline includes bioethanol. **2)** Until 2013, gas oil consumption includes diesel oil; between 2010 and 2022 it includes biodiesel.

FIGURE 51. Breakdown of consumption in the primary activities sector in 2023



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SUMMARY OF CHAPTER 5

Carbon dioxide emissions

The BEN includes carbon dioxide (CO_2) emissions from fuel-combustion activities in the energy industries and the final consumption sectors. For 2023, total emissions were 7,099 Gg, 1% lower than the previous year and 13% lower than the historical maximum recorded in 2012.

They corresponded to the following categories in decreasing order: transport (4,092 Gg), industrial (1,219 Gg), public service power plants (605 Gg), primary activities (447 Gg), residential (344 Gg), own use (258 Gg) and, finally, commercial/services/public sector (122 Gg).

Thus, 12% of CO_2 emissions came from the energy industries and 88% from fuel combustion in the different final consumption sectors.

With respect to the energy industries, **emissions associated with public service power plants** decreased 24% compared to the previous year, due to lower consumption of fossil fuels in electricity generation.

Emissions from the energy sector's own use are mainly due to the operation of the refinery. In 2023, there was a 31% decrease in these emissions due to the shutdown of the refinery for maintenance.

In terms of **emissions from the final consumption sectors**, transport has historically been the main category, with an average share of 54% of total CO_2 emissions for the period 2010-2023.

It is worth noting the behavior of the industrial sector, whose emissions in the last 13 years had a net growth from 583 Gg (2010) to 1,219 Gg (2023), mainly due to a higher consumption of petcoke and fuel oil in the industry. However, the intensity of emissions per unit of energy consumed in the industry showed a downward trend.

Finally, with regard to informative items, in 2023, CO_2 emissions from biomass burning were 10,757 Gg, 21% higher than the previous year. Biomass waste had the greatest impact on these emissions (78%). International bunker emissions were 588 Gg of CO_2, which represented an increase of 11% with respect to 2022. In turn, it is worth noting the 45% reduction recorded between 2019 and 2020, linked to the pandemic, as the operation of ports and airports was greatly affected in that period.

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5.
Carbon dioxide emissions

The BEN includes carbon dioxide (CO_2) emissions from fuel-combustion activities in the energy industries ("power plants for public service" and "own use") and the final consumption sectors ("residential," "commercial/services/public sector," "transport," "industrial," "primary activities"). While the country has had National Greenhouse Gas Inventories (INGEI) publications since 1990, CO_2 emissions in the BEN have had a longer historical run, beginning in 1965.

CO_2 emissions are calculated according to the 2006 guidelines by the Intergovernmental Panel on Climate Change (IPCC) for INGEI. It is noteworthy that, according to this methodology, CO_2 emissions from biomass fuel combustion are not considered in the totals, despite clearly being a combustion activity with energy purposes. The reason for this is that, simultaneously with these gas emissions (when biomass is combusted), there is an absorption process (through photosynthesis) by plant species during their growth. It is advisable to evaluate this process jointly, to avoid drawing misleading conclusions based on partial results. Consequently, the calculation of CO_2 emissions and absorption from biomass is recorded in the "Agriculture, Forestry and Other Land Use" (AFOLU) sector of the above-mentioned INGEI. Nonetheless, it is interesting to estimate CO_2 emissions from biomass combustion (firewood, biomass waste, biofuels, etc.), presented as memo items in the energy sector (without including them in the totals, as explained above). In turn, CO_2 emissions from international bunkers are included as informational items, as these emissions occur outside national territory.

In 2023, **total CO_2 emissions** were 7,099 Gg[20], 1 % less than the previous year. Different behaviors are observed throughout the entire period under study. Between 1965 and 1979, CO_2 emissions remained at an average of 5,000 Gg of CO_2, peaking at 5,748 Gg (1979). From 1980 onwards, CO_2 emissions decreased sharply and dropped by 42 % over six years, reaching a historical minimum in 1986 (3,039 Gg). Subsequently, there was a net growth trend until 2022, when CO_2 emissions reached 7,204 Gg, with increases and decreases that alternated depending on the specific consumption characteristics. Particularly, the drop in emissions during the 2000-2003 period overlapped with the decrease in energy demand caused by the crisis faced by the country at the beginning of the century, as well as a few years of favorable rainfall. In 2012, the highest levels of the entire historical series were recorded (8,185 Gg).

In 2023, CO_2 emissions from fuel combustion decreased by 1 % and were 13 % lower than the historical maximum (2012).

20- 1Gg (1 billion grams) equals to 1 kt (one thousand tonnes).

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In 2023, CO_2 emissions were associated with the following categories in decreasing order: transport (4,092 Gg), industrial (1,219 Gg), power plants for public service (605 Gg), primary activities (447 Gg), residential (344 Gg), own use (258 Gg) and lastly, commercial/services/public sector (122 Gg).

Thus, 12% of CO_2 emissions came from the energy industries (electricity generation and own use in the energy sector) while 88% corresponded to fuel-combustion activities in the different final consumption sectors.

As for the **energy industries**, emissions from electricity generation power plants vary greatly because they are strongly associated with the availability of renewable energy sources in the country. For dry years with low hydroelectricity shares, the consumption of oil products in power plants has been high, thus contributing to total CO_2 emissions.

FIGURE 52. CO_2 emissions by sector

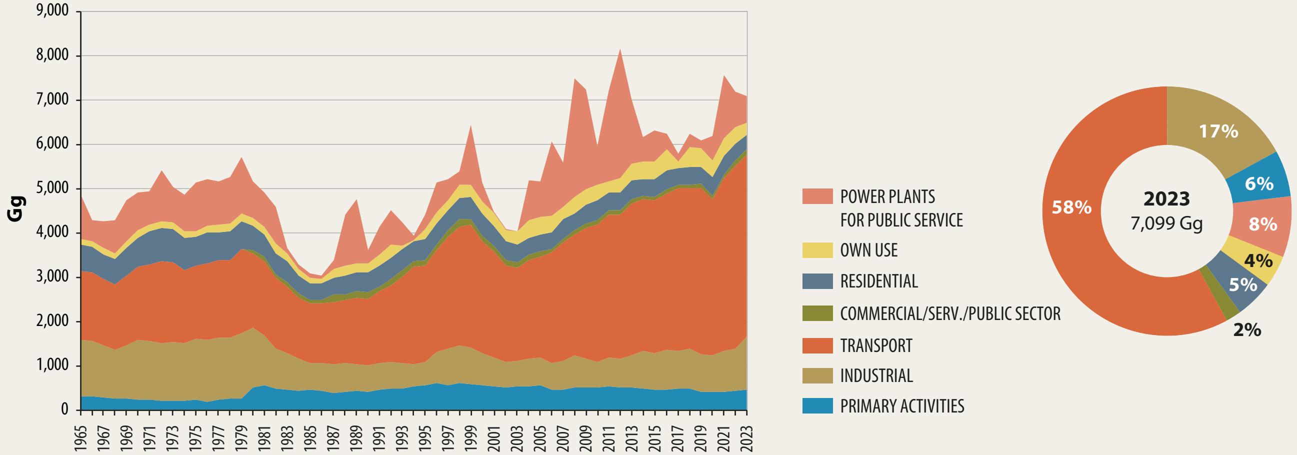
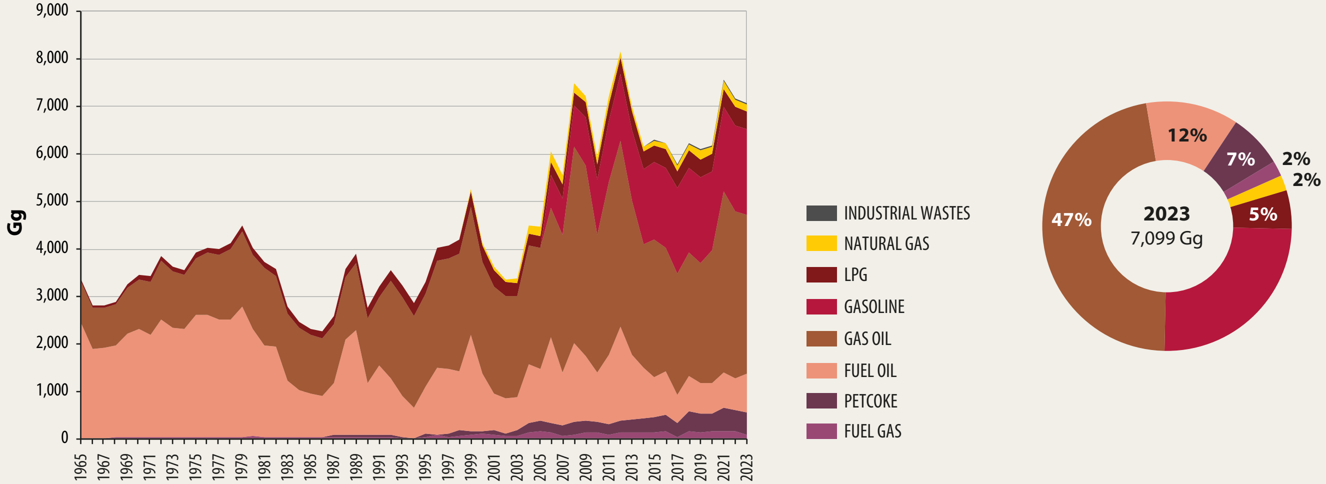


FIGURE 53. CO_2 emissions by source



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In the last 20 years, the greatest records corresponded to 2008, 2009, and 2012, with 36 %, 31 %, and 36 % in total emissions, respectively. Similarly, 2010 and the years following 2013 are highlighted with good rainfall levels for electricity generation, with a consequent lower consumption of oil products. In particular, hydroelectricity decreased between 2014 and 2018, while the significant increase in electricity from wind power and photovoltaic solar energy made it possible to counteract the situation without resorting to fossil fuel consumption.

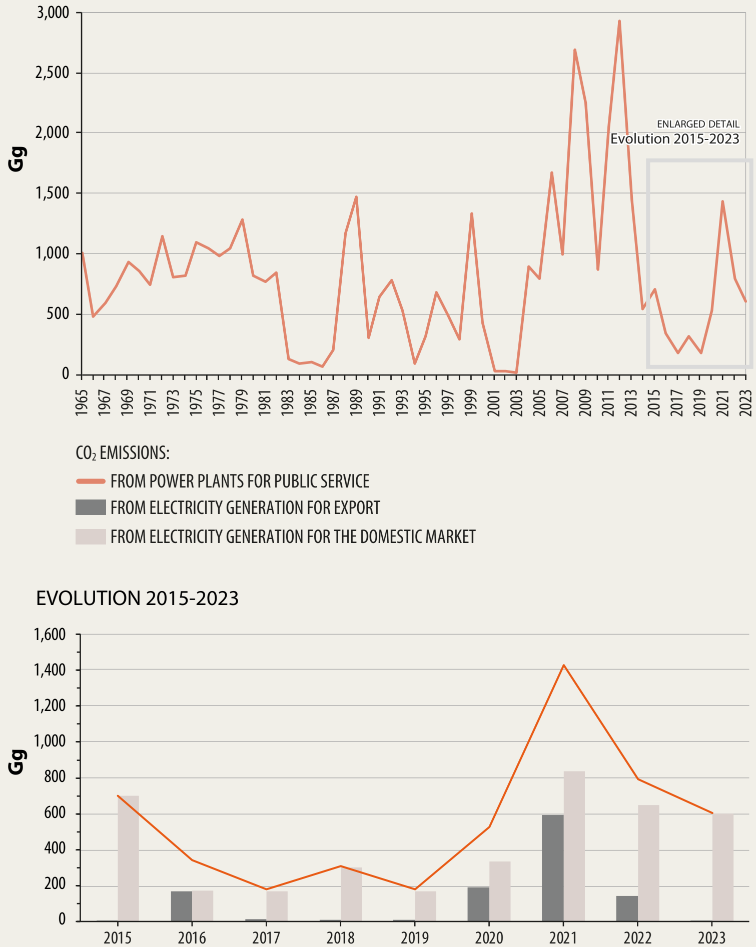
In 2023, electricity production delivered to the grid was 18% lower than in the previous year. When analyzing the inputs used, it is observed that the consumption of oil products decreased by 24%. This largely contributed to a 24 % decrease in CO_2 emissions associated with power plants for public service compared to the previous year. When considering the last 20 years, it is observed that 2017 (179 Gg) and 2019 (181 Gg) recorded the lowest CO_2 emissions by power plants, while 2008 (2,688 Gg) and 2012 (2,927 Gg) recorded the highest.

It is important to mention, that in 2021 high CO_2 emissions were registered in power plants (1,429 Gg), however, 42 % was associated to electricity that was finally exported. If an analysis is made since 2015, other years with high shares of CO_2 emissions associated with export electricity generation can be identified, for example 2016 (49 %) and 2020 (36 %), although with considerably lower CO_2 emissions in power plants (341 Gg and 528 Gg, respectively).

Emissions from the energy sector's own use are mainly due to the operation of the refinery. These emissions have remained relatively constant throughout the series, with shares between 5-8 % of total CO_2 emissions. Particularly noteworthy is the 2017 and 2023 decrease in emissions in this category, due to the shutdown of the refinery for maintenance, similar to the 1994 situation, when it was remodeled.

In 2018 and 2019, refinery operations were as usual and CO_2 emissions due to the energy sector's own use returned to those recorded in previous years. Particularly, in 2020, there was a drop associated with lower refinery production, which was due to the measures adopted by the country in response to the pandemic, which affected consumption in the transport sector.

FIGURE 54. CO_2 emissions from electricity generation for export



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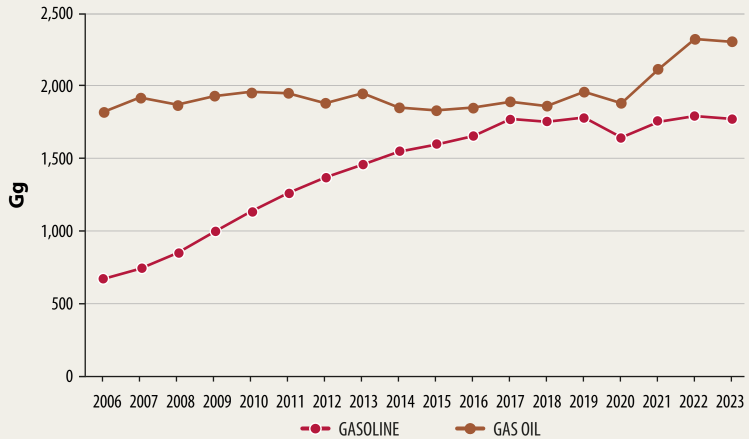
It is worth mentioning that in 2022, the same quantity of crude oil was processed as in 2021. Meanwhile, emissions from own use were 8% lower. This resulted from a substitution of sources: more natural gas and less fuel oil were used, a measure that has been implemented in recent years. Lastly, in 2023 refinery load levels were 31 % lower than in the previous year, mainly due to the maintenance shutdown in the last four months of the year, and there was a decrease of the same magnitude in CO_2 emissions due to own consumption. However, if we consider the period from January to August, when the refinery had production, we observe that the same amount of crude oil was processed as in the same period of the previous year, and the trend of lower fuel oil consumption and higher natural gas and LPG consumption was repeated.

Transport was the main category responsible for CO_2 emissions in 2023.

As for emissions from the **consumption sectors**, the main category has historically been the transport sector, whose share has been increasing over the years. Between 1965 and 1989, transport-related emissions averaged 35% of total CO_2 emissions (including energy industries). In the following 20 years (1990-2009), this share was 46 %, while for the 2010-2022 period it reached an average of 54 %. The evolution of emissions accompanied the trend of energy consumption in this sector; there was sustained growth between 1987 and 1999, followed by a drop for four years, and finally a net increase until 2022, after the 2020 decrease mentioned above. Since 2006, the increase in CO_2 emissions in the transport sector was mainly marked by emissions associated with gasoline consumption, which increased 165 % in these 17 years. Meanwhile, for gas oil, they only increased 27 %. In 2006, it is noted that CO_2 emissions associated with gasoline consumption in transport were only 27%, while this share has grown to more than 40 % since 2012.

In comparison to the transport sector, CO_2 emissions in the other consumption sectors, considered as a whole for the 1965-1991 period, averaged a higher value of 2,000 Gg. In 1992, emissions from transport surpassed the combined total of all remaining sectors, and thereafter, the growth in emissions from these sectors exhibited a lower rate compared to those of the transport sector. Thus, in 2023, their share was 30% of total CO_2 emissions. The performance of the industrial sector is noteworthy. Despite remaining relatively constant throughout the series, it has exhibited a net increase in CO_2 emissions over the past 13 years rising from 583 Gg (2010) to 1,219 Gg (2023). This was mainly due to higher consumption of petcoke and fuel oil in the industry. CO_2 emissions from the residential, commercial/services/public sector, and primary activities sectors have consistently remained low compared to the remaining sectors, maintaining relative stability throughout the years.

FIGURE 55. CO_2 emissions in the transport sector by source



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Finally, CO_2 emissions from biomass combustion and international bunkers are presented as **memo items**, since they are not included in the totals according to the methodology applied.

In 2023, emissions from biomass combustion amounted to 10,757 Gg of CO_2, 21 % than the previous year. This growth was influenced by the entry into operation of the third cellulose plant in the country, as mentioned above. As for fuels, biomass waste had the highest share (78 %), followed by firewood and charcoal (21%), and, to a lesser extent, biofuels (1 %).

The international bunkers category includes CO_2 emissions from sea and fluvial navigation, as well as aviation, pertaining to journeys originating from one country and concluding in another. In 2023, international bunker emissions reached 588 Gg of CO_2, marking a 11% increase compared to 2022. Furthermore, a notable reduction of 45 % was observed between 2019 and 2020, attributed to the pandemic, which significantly affected the operations of ports and airports during that period.

In 2023, 52 % of emissions in this category came from sea and fluvial transportation through the consumption of marine gas oil (275 Gg) and fuel oil (31 Gg). The remaining 48 % corresponded to air transportation, mainly due to the consumption of jet fuel. (282 Gg).

FIGURE 56. Memo items of CO_2 emissions

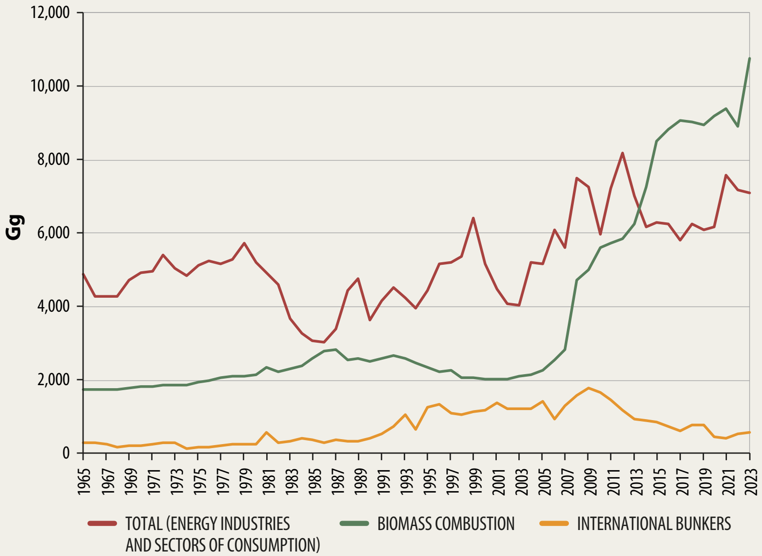

FIGURE 57. CO_2 emissions by source and sector

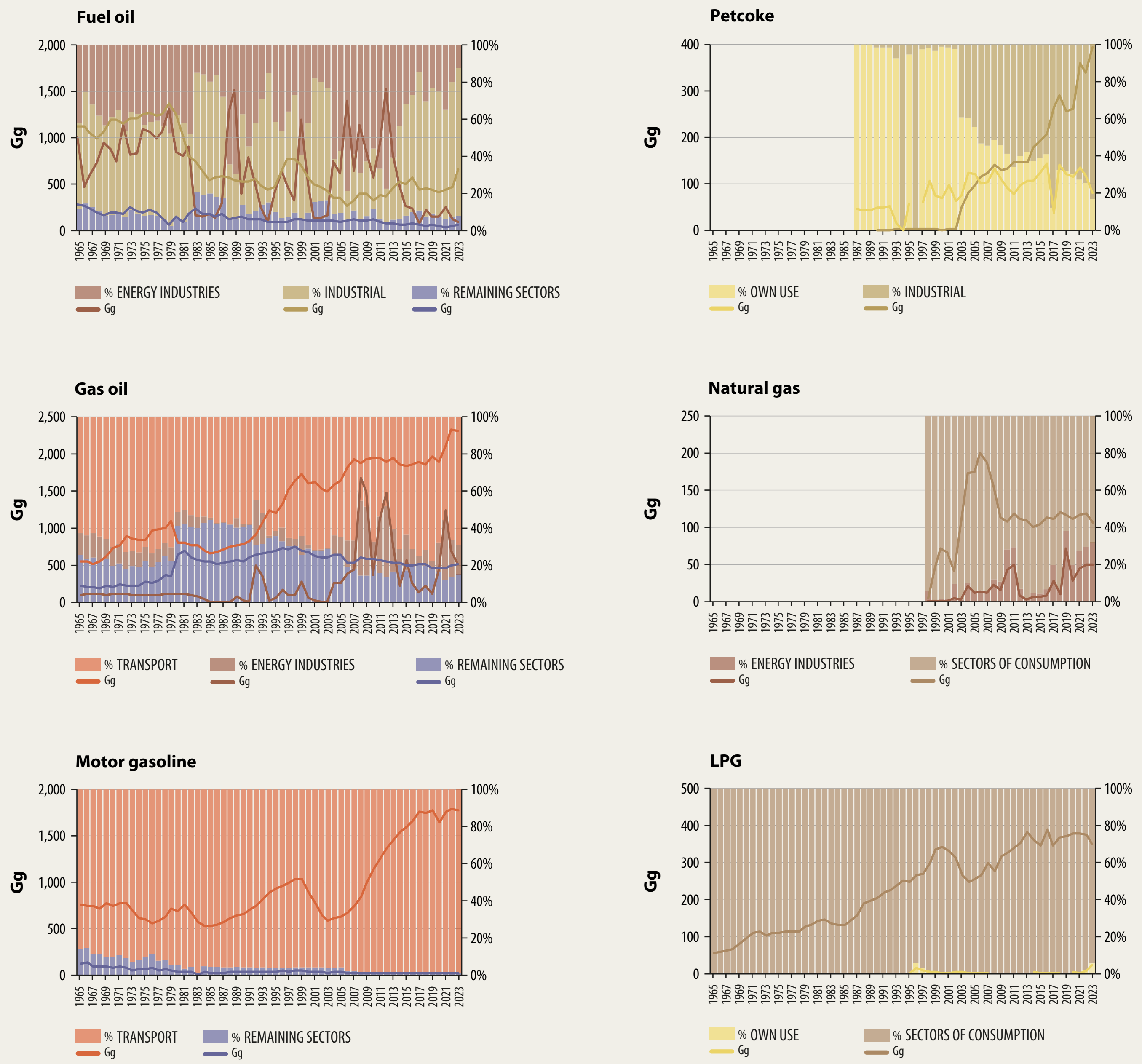

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TABLE 16. CO_2 emissions by sector

Gg	1965	1975	1985	1995	2005	2015	2023
Power plants for public service	1,009.1	1,093.5	101.8	318.2	795.3	700.3	**604.8**
(%)	21%	21%	3%	7%	15%	11%	**8%**
Own use	118.1	136.5	121.8	239.4	398.9	408.3	**257.6**
(%)	2%	3%	4%	5%	8%	6%	**4%**
Energy industries SUBTOTAL	*1,127.3*	*1,230.0*	*223.6*	*557.6*	*1,194.2*	*1,108.6*	***862.4***
(%)	*23%*	*24%*	*7%*	*13%*	*23%*	*18%*	***12%***
Residential	593.6	642.1	360.8	459.9	366.8	378.9	**343.6**
(%)	12%	12%	12%	10%	7%	6%	**5%**
Commercial/services/ public sector			92.2	129.9	133.9	83.0	**121.5**
(%)			3%	3%	3%	1%	**2%**
Transport	1561.1	1644.1	1338.0	2,182.1	2,277.6	3,448.7	**4,091.5**
(%)	32%	32%	43%	49%	44%	55%	**58%**
Industrial	1275.8	1384.9	601.8	528.7	633.5	833.6	**1,218.7**
(%)	26%	27%	19%	12%	12%	13%	**17%**
Primary activities	308.2	229.4	461.9	553.8	549.2	457.9	**446.7**
(%)	6%	4%	15%	12%	11%	7%	**6%**
Non-specified	21.6	20.6	8.1	22.1	5.2	6.0	**15.0**
(%)	0%	0%	0%	0%	0%	0%	**0%**
Sectors of consumption SUBTOTAL	*3,760.3*	*3,921.1*	*2,862.8*	*3,876.5*	*3,966.2*	*5,208.1*	***6,236.9***
(%)	*77%*	*76%*	*93%*	*87%*	*77%*	*82%*	***88%***
TOTAL	**4,887.6**	**5,151.0**	**3,086.4**	**4,434.2**	**5,160.4**	**6,316.8**	**7,099.3**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) CO_2 emissions are calculated according to the "2006 IPCC Guidelines for National Greenhouse Gas Inventories". **2)** In 1965 and 1975, the CO_2 emissions of the commercial/ services/public sector is included in the residential sector.

TABLE 17. CO_2 emissions by source

Gg	1965	1975	1985	1995	2005	2015	2023
Natural gas					184.1	107.3	**153.6**
(%)					4%	2%	**2%**
LPG	54.7	109.4	131.6	248.1	255.2	345.8	**370.9**
(%)	1%	2%	4%	6%	5%	5%	**5%**
Motor gasoline	881.8	665.9	553.3	969.7	649.9	1,619.3	**1,793.4**
(%)	18%	13%	18%	22%	13%	26%	**25%**
Aviation gasoline			10.3	9.4	6.4	7.3	**5.6**
(%)			0%	0%	0%	0%	**0%**
Kerosene	560.2	516.6	171.9	105.7	25.3	13.2	**9.3**
(%)	11%	10%	6%	2%	0%	0%	**0%**
Jet fuel			22.5	35.9	4.2	8.1	**6.9**
(%)			1%	1%	0%	0%	**0%**
Gas oil	867.4	1,205.3	1,227.9	1,958.6	2,544.6	2,893.6	**3,328.0**
(%)	18%	23%	40%	44%	49%	46%	**47%**
Fuel oil	2,404.8	2,553.3	916.1	993.6	1,089.5	844.5	**820.5**
(%)	49%	50%	30%	22%	21%	13%	**12%**
Petcoke				60.8	218.0	313.9	**475.2**
(%)				1%	4%	5%	**7%**
Fuel gas	33.7	55.9	47.5	50.3	175.1	152.4	**97.9**
(%)	1%	1%	2%	1%	3%	2%	**2%**
Coal and coke of coal	84.9	44.7	5.4	2.2	8.0	0.4	**8.9**
(%)	2%	1%	0%	0%	0%	0%	**0%**
Industrial wastes						10.7	**29.2**
(%)						0%	**0%**
TOTAL	**4,887.6**	**5,151.0**	**3,086.4**	**4,434.2**	**5,160.4**	**6,316.8**	**7,099.3**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) CO_2 emissions are calculated according to the "2006 IPCC Guidelines for National Greenhouse Gas Inventories". **2)** Gas oil includes diesel oil until and including 2012.

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SUMMARY OF CHAPTER 6

Indicators

This chapter presents a series of indicators that relate energy and CO_2 emissions variables (among others) to economic and demographic variables.

Final energy intensity in 2023 was 3 tonnes of oil equivalent per million pesos at constant 2016 prices (toe/M$ 2016), 10% higher than the previous year. While both variables grew between 2022 and 2023, total final consumption grew by a greater magnitude than GDP. This indicator presented a net decrease since 1965 and was accompanied by high variability.

Per capita energy consumption peaked in 2023 at 1,534 toe per 1,000 inhabitants, after showing a net growth over the entire period under study from 637 toe/1,000 inhabitants in 1965.

For its part, **per capita electricity consumption** recorded a value of 3,467 kWh per inhabitant in 2023, up 5% compared to 2022 and maintaining its upward trend throughout the series.

In the case of **CO_2 emissions intensity**, it experienced a 2% drop in 2023 and resulted in a value of 3.9 tCO_2/M$ 2016. This indicator has been characterized by a net decrease in the period 1965-2023 and a strong variability.

Per capita CO_2 emissions were 2.0 tCO_2/inhabitant in the last year and showed a slight net growth with respect to 1965. As with the previous indicator, there is significant variability from year to year.

In 2023, the **emission factor of the National Interconnected System** (SIN) was 56 tCO_2/GWh, 7% lower than in 2022. It varies from one year to another according to the mix used for electricity generation delivered to the grid. The great influence that the level of hydraulicity has on the country's electricity generation and the consequent amount of fossil fuels used for generation, resulted in this indicator presenting great variability throughout the series.

In recent years, Uruguay has recorded large increases in the generation of electricity from renewable sources, mainly wind energy and, to a lesser extent, solar photovoltaic energy: together with hydroelectricity, these have had an impact on the use of smaller quantities of fossil fuels. During the period 1965-1979, the SIN emission factor was at the highest levels of the entire historical series, with an average of 400 tCO_2/GWh, while the minimum values were between 2001-2003 (1-3 tCO_2/GWh).

In 2023, the **electrification rate** was 99.9%, meaning that only 0.1% of the total number of occupied dwellings lacked an electricity supply, either from UTE or from their own sources (such as generators and/or battery chargers powered by wind or solar energy).

The **energy pathway** shows the different behaviors that the country has gone through, related to structural changes and economic evolution, and their impact on energy intensity. It shows the large increase in energy intensity (10%) and the low growth of GDP per capita recorded in 2023.

6. Indicators

This chapter presents a series of indicators that relate energy and CO_2 emissions variables, among others, to economic and demographic variables. Both GDP[21] and population statistical series published by the Central Bank of Uruguay (BCU) and the National Institute of Statistics (INE), respectively, were employed.

It should be noted that for the years before 2015, the GDP series prepared by MEF was utilized with the application of extrapolation. Thus, in this edition of BEN, a global GDP series at constant 2016 prices have been compiled since 1965, encompassing the entire study period of energy variables.

In the case of population, the estimation and projection of its historical series were conducted according to the 2013 Revision[22] for years after 1996. The 1965-1995 period was completed with the estimations corresponding to the 1998 Revision.[23]

21- Central Bank of Uruguay (BCU), *Series del PIB por componentes del gasto en millones de pesos constantes de 2016*, <https://www.bcu.gub.uy/Estadisticas-e-Indicadores/Cuentas%20Nacionales/1.%20Gasto_K.xlsx> (06/01/2024).
22- National Statistics Institute (INE), *Uruguay: población estimada y proyectada por año, según sexo y edad simple*, <https://www5.ine.gub.uy/documents/Demograf%C3%ADayEESS/SERIES Y OTROS/Estimaciones y proyecciones/Revisi%C3%B3n 2013/Total_pais_poblacion_por_sexo_y_edad_1996-2050.xls> (06/01/2024).
23- National Statistics Institute (INE), *Uruguay: estimaciones y proyecciones de población por sexo y edad. Total del país, 1950-2050*, <https://www5.ine.gub.uy/documents/Demograf%C3%ADayEESS/SERIES%20Y%20OTROS/Estimaciones%20y%20proyecciones/Revisiones%20anteriores/proyecciones_revision_1998.rar> (06/01/2024).

6.1. Final energy intensity

Final energy intensity is represented as the ratio between final energy consumption and GDP. It is expressed in tonnes of oil equivalent per millions of Uruguayan pesos at constant 2016 prices (toe/M$ 2016).

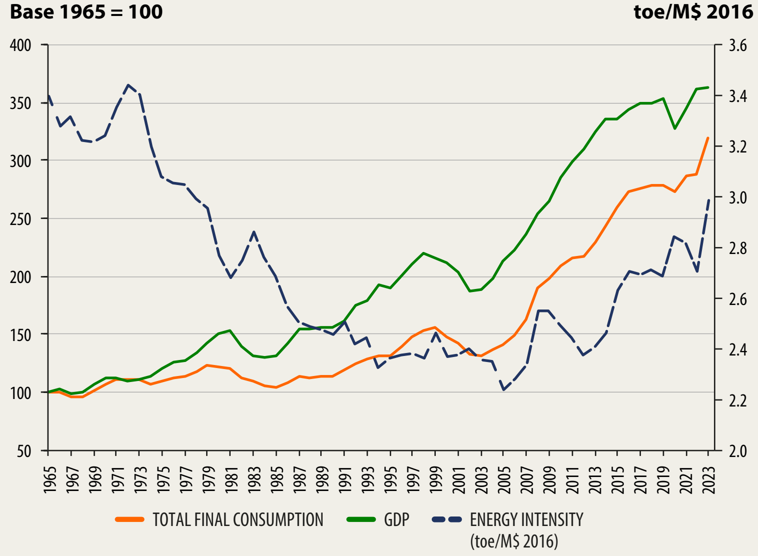
The final energy intensity presented a net decrease throughout the 1965-2023, period, along with a great variability. The historical maximum was recorded in 1972 (3.44 toe/M$ 2016) while the minimum was recorded in 2005 (2.24 toe/M$ 2016). In 2023, energy intensity increased by 10%, after decreasing by 4% in 2022. This growth in energy intensity resulted from the fact that, although both variables grew, GDP grew at a higher rate than total final consumption.

Final energy intensity in 2023: 3 toe/M$ 2016.

GDP and individual series for final energy consumption are analyzed to enhance the understanding of this indicator. This is achieved by setting the values of both variables for 1965 as a base equal to 100. Both series have behaved similarly in their evolution in the 1965-2023, alternating years of growth and others of decline where the variability recorded has made it possible to identify different periods.

The 1971-1972 and 1982-1983 periods are noteworthy as they recorded sharp increases in energy intensity compared to previous years. In the first case, final energy consumption grew while GDP decreased; in the second, both variables dropped yet GDP did so at a higher rate. Although final energy consumption and GDP recorded a net growth between 1985 and 1999, it was higher for GDP. Consequently, energy intensity recorded a net decline (with some occasional years of growth). Energy demand declined between 2000 and 2003, and afterwards, it returned to an upward trend. In turn, GDP recorded negative growth rates between 1999 and 2002 included. Thereafter, both series showed an upward trend.

FIGURE 58. Total final consumption and GDP



During the 2005-2009 period, energy consumption grew at higher rates than GDP. Notably, there was a significant growth in final consumption within the industrial sector in 2008, marking a 67% increase compared to 2007. This shift had a considerable impact on the country's consumption structure. For these years, energy intensity exhibited an increasing trend. However, in 2010, 2011, and 2012, the opposite pattern emerged. Despite energy consumption and GDP increased, final energy consumption evolved at lower rates, leading to a decrease in energy intensity.

Between 2013 and 2016, final energy consumption increased annually. This was mainly due to higher consumption in the industrial sector associated with the addition of a new cellulose plant. Nevertheless, GDP grew at positive albeit lower rates each year, leading to a rising energy intensity. Similar patterns to the 2010-2012 period reappeared in 2017 and 2018, depicting growth in both final consumption and GDP, albeit at higher rates for the latter. Meanwhile, there was a declining trend in energy intensity.

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In 2019, both variables experienced growth rates below 1%, resulting in an energy intensity 0.3% higher than that of 2018. This pattern is typical during economic slowdowns in a pivotal year, which does not imply structural changes. In 2020, both series declined, with GDP experiencing a more significant decrease than energy consumption, leading to an increase in energy intensity. By 2021 and 2022, both variables resumed their upward trend, but GDP did so to a greater extent, resulting in final energy intensity decreasing by 0.5% and 4.2%, respectively.

Finally, it should be noted that the start-up of the third cellulose plant in the country in 2023 was also a key factor behind the significant increase in final consumption relative to GDP.

6.2. Energy and electricity consumption per capita

Energy consumption per capita is obtained as the ratio between total final energy consumption and the number of inhabitants, expressed in tonnes of oil equivalent per 1,000 inhabitants (toe/1,000 inhab.) This indicator had a net growth throughout the period under study and increased from 637 toe/1,000 inhab. (1965) to 1,534 toe/1,000 inhab. (2023), reaching an absolute maximum in the last year. The historical minimum was recorded in 1968 and 1985 (591 toe/1,000 inhab.).

Starting in 1969, energy consumption per capita increased for 11 years, reaching a relative peak in 1979, followed by six years of decline. Since 1986, energy consumption per capita has grown steadily. While this growth was interrupted during the economic crisis at the beginning of the 21st century, from 2004 onwards, the upward trend resumed.

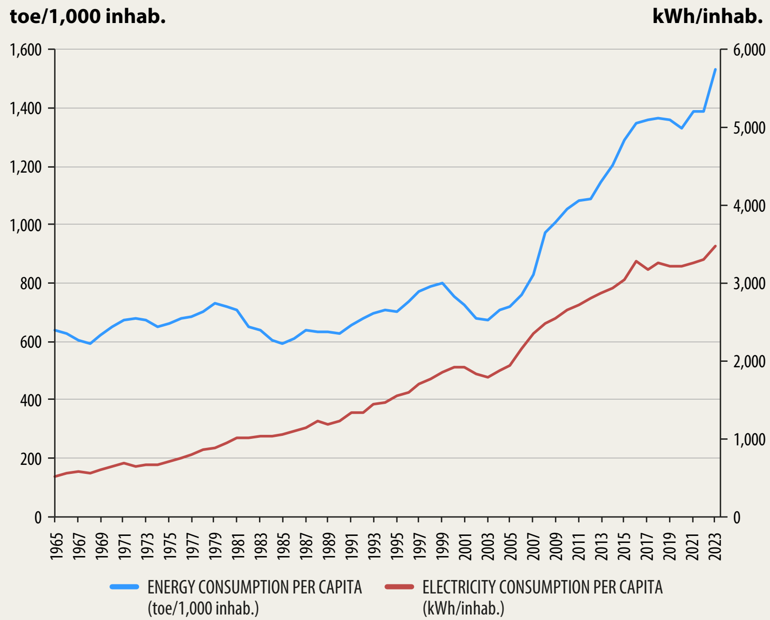
In 2007, the previous consumption peak from 1999 (before the crisis) was surpassed, and energy consumption per capita continued to rise until 2018. This was followed by two years of decline and another two years of new growth.

Electricity consumption per capita is obtained as the ratio between electricity consumed and the number of inhabitants. It is expressed in kilowatt-hour per inhabitant (kWh/inhab.). Throughout the entire series, electricity consumption per capita generally had an upward trend, except for certain years when there was a decrease. The economic crisis had an impact on electricity consumption per capita, as it did on the rest of the indicators.

2023:
Final consumption per capita:
1,534 toe/1,000 inhab.
Electricity consumption per capita:
3,467 kWh/inhab.

Electricity consumption per capita increased from 512 kWh/inhab. (1965) to a maximum of 1,917 kWh/inhab. (2000). Then, it dropped to a minimum of 1,788 kWh/inhab. From

FIGURE 59. Energy and electricity consumption per capita



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that year onwards, the trend reversed once again and continued to grow, reaching the historical maximum of 3,276 kWh per inhabitant in 2016. Over the following five years, per capita electricity consumption remained relatively constant, with slight fluctuations. In 2022, this indicator continued to increase and was surpassed again in 2023, growing by 5% (3,467 kWh/inhab).

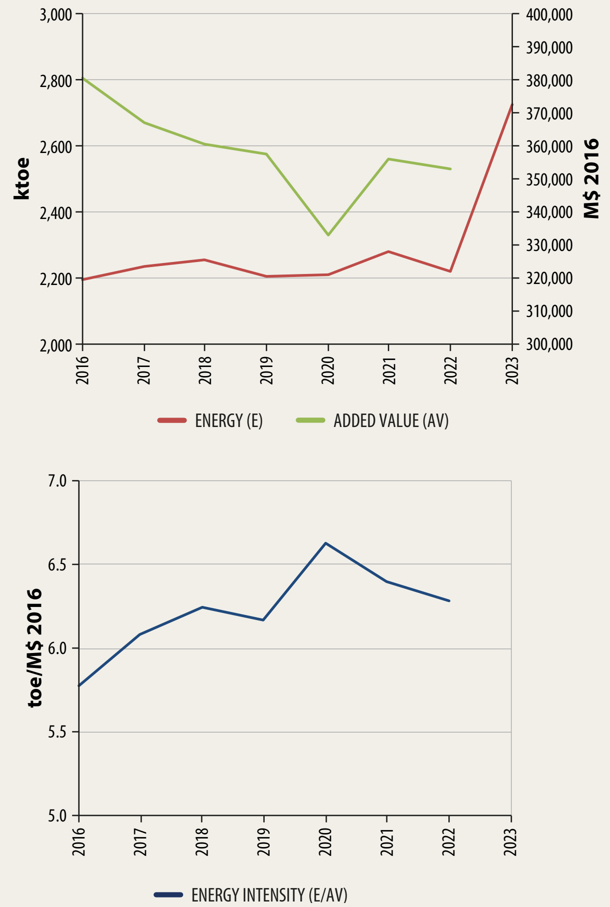
6.3. Energy intensity by sector

The **energy intensity by sector** is defined as the ratio between a sector's energy consumption and its added value, expressed in tonnes of oil equivalent per million of Uruguayan pesos at constant 2016 (toe/M$ 2016). This represents the amount of energy needed to generate one unit of added value. If, instead of analyzing energy consumption globally in comparison to GDP, the analysis focuses on energy consumption per sector relative to its added value, distinct patterns emerge based on the sectors. Below is the analysis of energy intensities for three sectors considering the 2016-2022 period (prepared by MIEM-DNE based on BCU data[24]). Note that this analysis could not be conducted for 2023, since, at the time of going to press, BCU information did not include data for that year.

In the **industry/primary activities** series, energy intensity has shown a net increasing trend, with some interannual variability. Between 2016 and 2022 final consumption has remained relatively constant, so the decrease in value added in 2020 resulted in an increase in energy intensity for that year. In 2022 both variables decreased and resulted in a decreasing intensity. In particular, in 2023 there was an increase of 23% in the consumption of industry and primary activities, led mainly by the entry into operation of the pulp mill in the country. In the absence of value-added information for that year, it was not possible to determine the energy intensity.

24- Central Bank of Uruguay (CBU), *Cuenta de Producción Industrias a precios constantes, Series en valores constantes de 2016*, <https://www.bcu.gub.uy/Estadisticas-e-Indicadores/Cuentas%20Nacionales/12_2016_2022_Cuenta%20Produccion%20Industrias_K.xlsx> (05/20/2024).

FIGURE 60. Energy intensity of industrial/primary activities sector



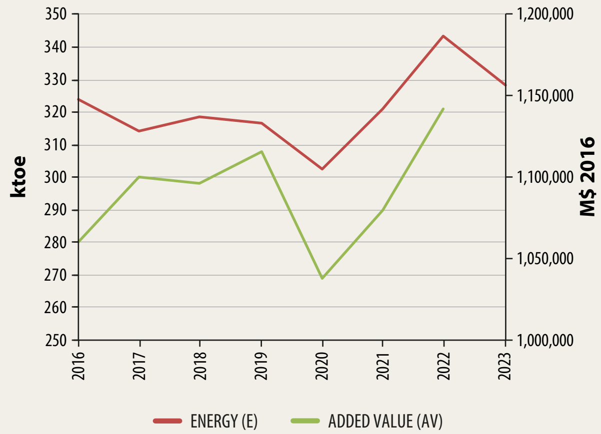
The series did not vary significantly regarding energy intensity in the **commercial/services/public sector** and remained relatively constant in the period under study 2016-2022, showing a net decrease of 2%. However, in the last three years evaluated (2020, 2021 and 2022) there has been an upward trend, with growth of 3%, 2% and 1%, respectively.

The energy intensity of the **transport sector** is analyzed in two different ways: using the sector's added value and the global GDP. This last approach is important because transport is a cross-cutting sector for the economy and data are available for the complete historical series.

The energy intensity of transport per unit of value added in that sector remained constant between 2016 and 2019 (14 toe/M$ 2016) and recorded a prominent growth in 2020 (14%), followed by two years of decreases.

Finally, the energy intensity of transport per GDP unit had a quite different behavior from the previous analysis, not only in its trend but also in the magnitude of values. Between 1965 and 2023, energy consumption in the transport sector and GDP showed a similar evolution; there was a net growth in the whole period, with a sharp decline at the beginning of the century resulting from the above-mentioned crisis. Energy intensity peaked in 1972 (1.11 toe/M$ 2016) followed by a decline until 1987 (0.60 toe/M$ 2016), since energy consumption declined at lower rates than GDP. From that year until 1999 energy intensity grew again and reached a new relative maximum (0.85 toe/M$ 2016). In the present century, the energy intensity of transport per unit of GDP has fluctuated between 0.70 and 0.78 toe/M$ 2016). By 2023 it stood at 0.77 after a 1% drop compared to the previous year.

FIGURE 61. Energy intensity of the commercial/services/public sector



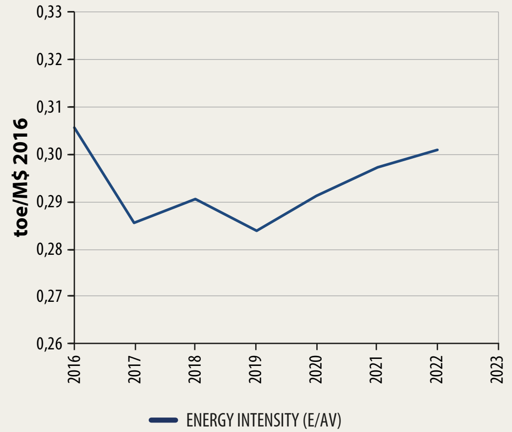


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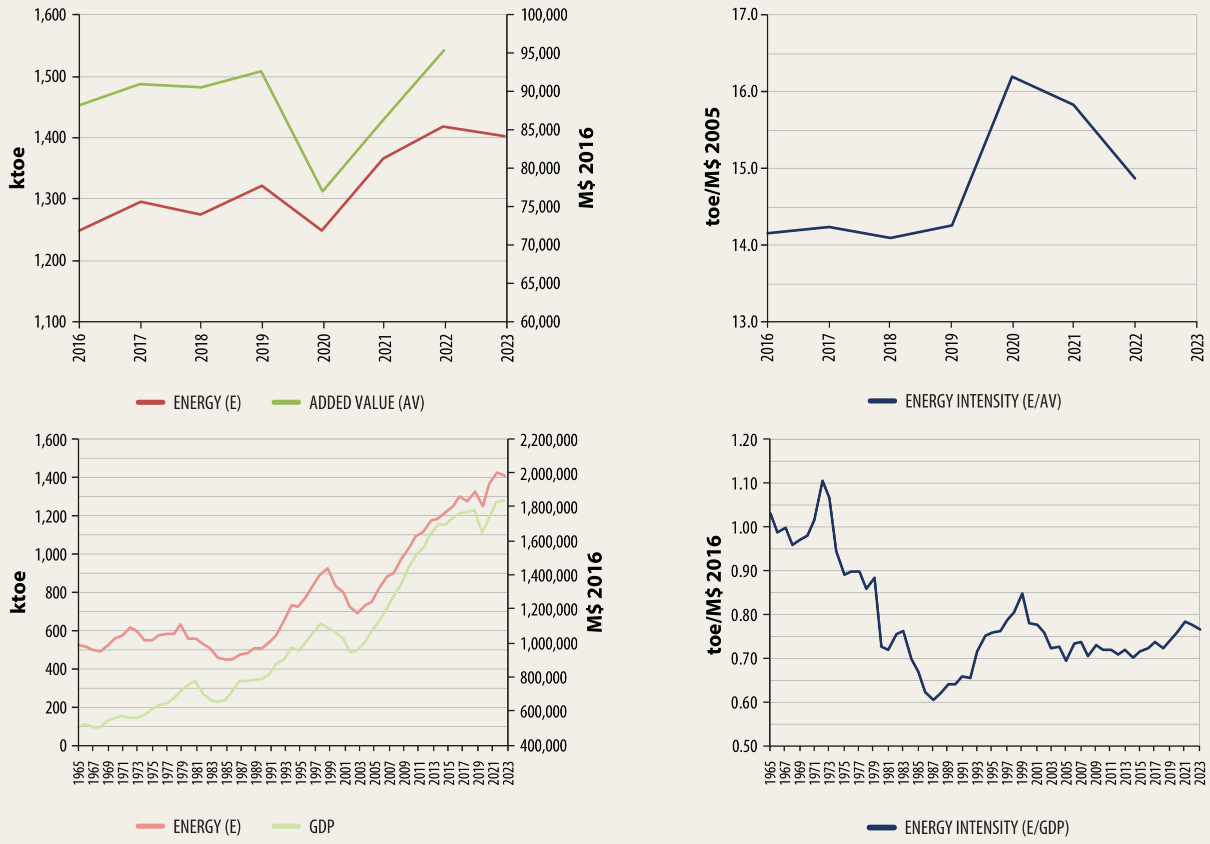
FIGURE 62. Energy intensity in the transport sector



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6.4. CO_2 emissions per GDP and per capita

CO_2 emissions intensity is represented as the ratio between CO_2 emissions and GDP. It is expressed in tonnes of CO_2 per million of Uruguayan pesos at constant 2016 prices (tCO_2/M$ 2016). In the 1965-2023 period, this indicator had a net decrease from 9.7 to 3.9 tCO_2/M$ 2016, displaying high variability throughout the series. The years with the highest emission intensity levels were 1965 and 1972 (9.7 tCO_2/M$ 2016). Meanwhile, the lowest values were recorded between 2014 and 2020 (at an average of 3.6 tCO_2/M$ 2016). In 2023, CO_2 emissions fell by 2 % compared to the previous year while GDP grew 0.4 %, resulting in a 2% drop in CO_2 emissions intensity.

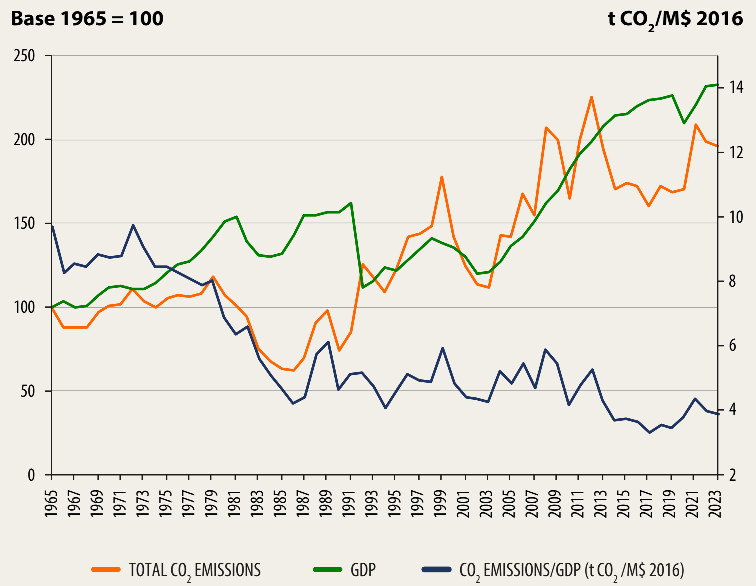
In turn, to better understand the evolution of this indicator, individual series of CO_2 emissions from fuel combustion activities and GDP are analyzed; to this end, the values of both variables for the year 1965 are taken as a base equal to 100.

CO_2 emissions have varied throughout the entire series and have accompanied the evolution of GDP. This behavior is also reflected in the intensity of CO_2 emissions. The large fluctuations in total CO_2 emissions were strongly associated with the changes in emissions from thermal power plants for electricity generation, caused by the consumption of oil products for electricity generation as a hydroelectricity complement. Regarding low hydropower availability, 2020 was similar to 2006, and 2021 was similar to 2012. This was reflected in higher CO_2 emissions compared to other years with better flow rates and their corresponding lower consumption of oil products for electricity generation.

Particularly the period after 2015 featured a large increase in wind and photovoltaic electricity. This offset the decrease in hydroelectricity and resulted in a lower consumption of oil products, with the subsequent decline in CO_2 emissions for electricity generation. The presence of these renewable energy sources in the electricity generation matrix resulted in a more moderate impact on CO_2 emissions during dry years such as 2020-2023.

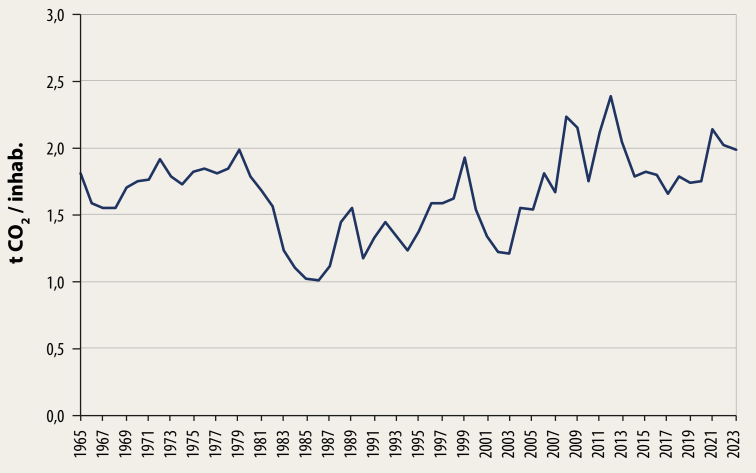
In 2020, this situation was paralleled by a sharp GDP drop, thus increasing the intensity of emissions. In 2021, the rise in intensity was more influenced by the increase in emissions, due to the higher consumption of fossil fuels for electricity production. It is emphasized once again that in 2021, a significant portion of these emissions was associated with electricity generation ultimately destined for export.

FIGURE 63. Total CO_2 emissions and GDP



CO_2 emissions per capita are represented as the ratio between total CO_2 emissions and population. They are expressed in tonnes of CO_2 per inhabitant (tCO_2/inhab.). The 1965-2023 period recorded a slight net growth, showing considerable variability. This behavior, which alternates maximum and minimum records, is correlated with a variation in fossil fuel consumption in thermal power plants. The minimum CO_2 emissions per capita were recorded in 1986 (1.0 tCO_2/inhab.), while maximum emissions were recorded in 2012 (2.4 tCO_2/inhab.). CO_2 emissions per capita decreased by 2 % in 2023 to 2 tCO_2/inhab.

FIGURE 64. CO_2 emissions per capita



2023:

CO_2 emissions intensity: 3.9 tCO_2/M$ 2016

CO_2 emissions per capita: 2.0 tCO_2/inhab.

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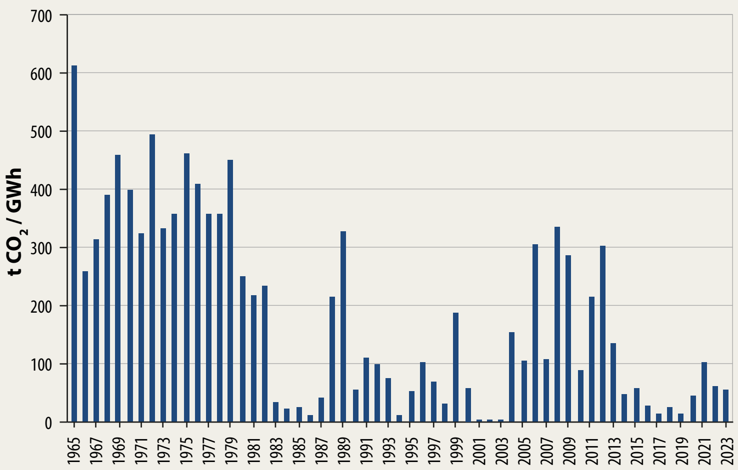
6.5. CO_2 emission factor of the SIN

The **emission factor of the SIN** represents the amount of CO_2 generated per GWh of produced electricity delivered to the grid. It is determined as the ratio of CO_2 emissions from power plants for public service and the electricity generated by such generators and delivered to the SIN. The emission factor varies from one year to another according to the mix of fuels used for electricity generation delivered to the grid.

The emission factor has varied considerably throughout the whole series. Such an effect is related to the great influence of rainfall levels on the country's electricity generation and the consequent amount of fossil fuels used, as mentioned above. In recent years, Uruguay has recorded significant growth in the generation of electricity from renewable sources, especially wind energy and, to a lesser extent, photovoltaic solar energy. This seems to suggest that, together with hydroelectricity, these sources have led to a reduction in the use of fossil fuels.

FIGURE 65. CO_2 emission factor of the SIN



The emission factor of the SIN recorded its highest levels in the entire historical series during the 1965-1979 period, with an average of 400 tCO_2/GWh. Maximum values were recorded in 1965 (612 tCO_2/GWh), 1972 (494 tCO_2/GWh), and 1975 (461 tCO_2/GWh). As of 1980, the emission factor of the SIN decreased and has remained at an average of 103 tCO_2/GWh to date. The minimum values were recorded between 2001-2003 (ranging from 1 to 3 tCO_2/GWh) and in 1984-1986 (approximately 20 tCO_2/GWh). Practically 100% of electricity was generated from hydropower during those years. In 2020, a dry year (similar to 2006), when hydroelectricity accounted for only 30% of total generation, the SIN emission factor was 45 tCO_2/GWh; three times higher than the previous year.

In 2021, the emission factor recorded significant growth again, amounting to 101 tCO_2/GWh. It should be noted that this year was atypical in terms of large exports of fossil fuel electricity. In 2022 and 2023, the emission factor was 60 and 56 tCO_2/GWh, respectively.

In 2023,
the emission factor of the SIN was 56 tCO_2/GWh.

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6.6. Electrification rate

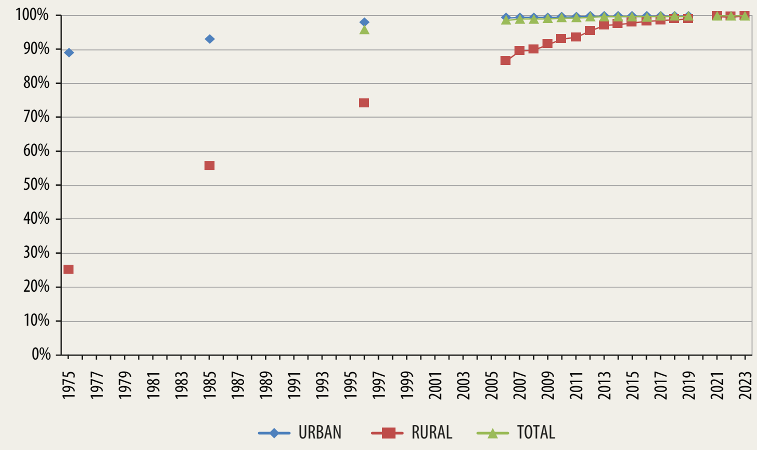
The **electrification rate** expresses the percentage of houses that have electricity in relation to the total number of occupied dwellings. This indicator is developed for urban areas, rural areas, and the country total.

Between 1975 and 2017, the total electrification rate increased from 79.0% to 99.9% and remained constant until 2023. When analyzing the indicator separated by urban and rural areas, a more accentuated evolution can be observed for the rural electrification rate, which increased from 25.1% in 1975 to 99,9% in 2023. In turn, the urban electrification rate increased from 89.0% to 99.9% in such period. Note that this indicator could not be updated for 2020, as the base information from the Continuous Household Survey, the statistical operator used for the calculation, was not collected due to the pandemic.

Analyzing this indicator in a different way, in 2023, only 0.1% of the total number of occupied dwellings did not have electricity supply, either supplied by UTE or their own (engine-generator and/or battery charger through a wind or solar generator); the figure corresponded to 757 dwellings. The distribution was 712 dwellings in urban areas and 46 in rural areas.

The total electrification rate rose from 79.0% to 99.9% between 1975 and 2023.

FIGURE 66. Electrification rate



6.7. Energy path

The **energy path** is a graphic representation of two indicators: final energy intensity and GDP per capita. Final energy intensity is expressed in tonnes of oil equivalent per millions of Uruguayan pesos at constant 2016 prices (toe/ M$ 2016), while GDP per capita is expressed in thousands of Uruguayan pesos at constant 2016 prices per inhabitant (thousands $ 2016/inhab.). The energy path also includes the total final consumption per capita through isoquant curves and expressed in tonnes of oil equivalent per thousand inhabitants (toe/1,000 inhab.).

Between 1965 and 2023, Uruguay's energy path had an overall evolution towards economic growth and decreased energy intensity. Throughout these 59 years, different behaviors associated with particular stages that the country went through can be identified.

In the 1965-1970 period, energy intensity fell, and GDP per capita increased. 1971 and 1972 had a particular behavior, as energy demand grew together with the decrease in GDP. This resulted in a significant increase in energy intensity, which reached its historical maximum (3.44 toe/M$ 2016). From that moment on and for nine consecutive years, energy intensity decreased at an average rate of 3% per year, whereas the economy grew steadily.

Meanwhile, 1982 and 1983 saw another particular behavior marked by a decrease in GDP per capita and an increase in energy intensity, which caused a setback in the energy path. In the 1983-1998 period, the evolution of the indicators varied to a certain extent, but the trend was towards a decrease in energy intensity and a growth in GDP per capita.

The following years reflect the country's economic crisis at the beginning of the century through a further downturn of the energy path, marked by a decrease in GDP per capita and an almost constant energy consumption per GDP unit.

The 2002-2005 period was marked by economic growth without significant structural changes. The construction sector did not show economic recovery in this post-crisis period and the production system's evolution did not involve investing in equipment and infrastructure as existing idle capacity was used. In turn, energy demand declined until and including 2003. After this year, it resumed its upward trend. As GDP grew at a higher rate than energy consumption, energy intensity declined.

In the 2005-2009 period, the industrial sector's share in GDP grew by one percentage point and, within the industry, the share of the paper and cellulose sectors rose from 9% to 19%. This sharp industrial growth coupled with the addition of one cellulose plant and the growth of the construction sector caused energy demand to skyrocket. The industrial sector doubled its energy consumption, while final energy consumption —which had previously recorded 3% and 4% annual growth rates— rose to 17% in 2008. This major change in the economic and energy structure led to a significant increase in energy intensity.

In turn, from 2009-2012, economic and energy consumption structures remained practically constant. Thus, the drop in energy intensity could be linked to the implementation of energy efficiency projects and measures.

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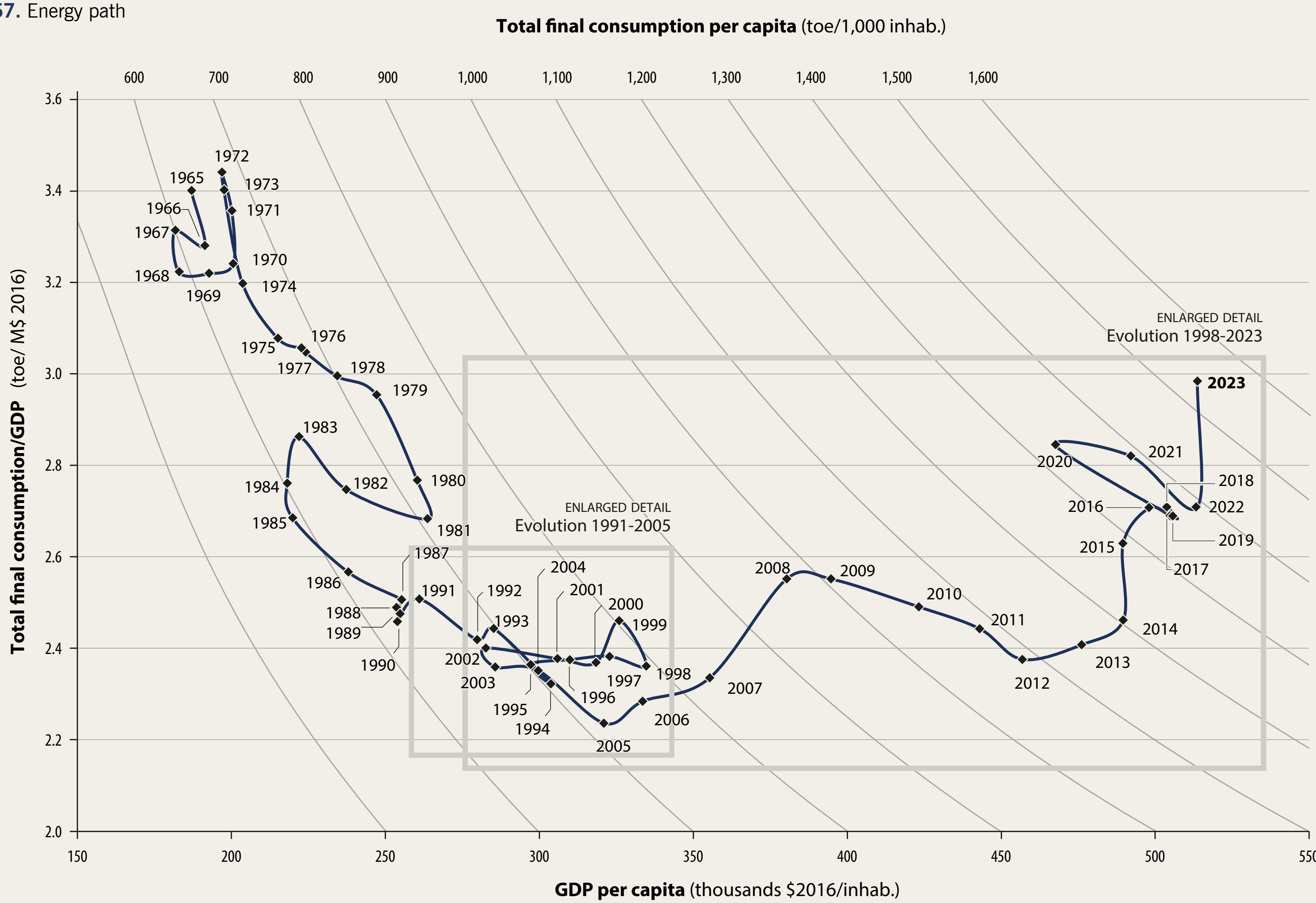
In the 2012-2016 period, energy demand underwent structural changes again. The share of industrial consumption increased from 34% to 43% of total final energy consumption, which was strongly associated with the new cellulose plant. In terms of economic structure, there was no significant overall change as the industrial sector still accounted for 15% of GDP. However, the analysis of industrial subsectors shows structural changes, as the paper and cellulose sector's added value grew from 19% to 28% compared to the whole industry. This behavior was similar to that recorded in the 2005-2009 period.

It is worth noting that the 2016-2019 period was similar to 2009-2012 in terms of energy intensity and GDP per capita but it was also coupled with an economic slowdown. In 2020, the situation shifted again, and the pattern was similar to that described in 2002: the economy fell by 6% and determined a setback in the energy path. In 2021, the country's economy resumed a favorable development and the energy intensity remained similar to the previous year. By 2022, GDP per capita continued to increase (4%) and a drop in energy intensity (4%) was recorded. In 2023, GDP growth was very low, however, the energy intensity had a large increase (10%).

FIGURE 67. Energy path



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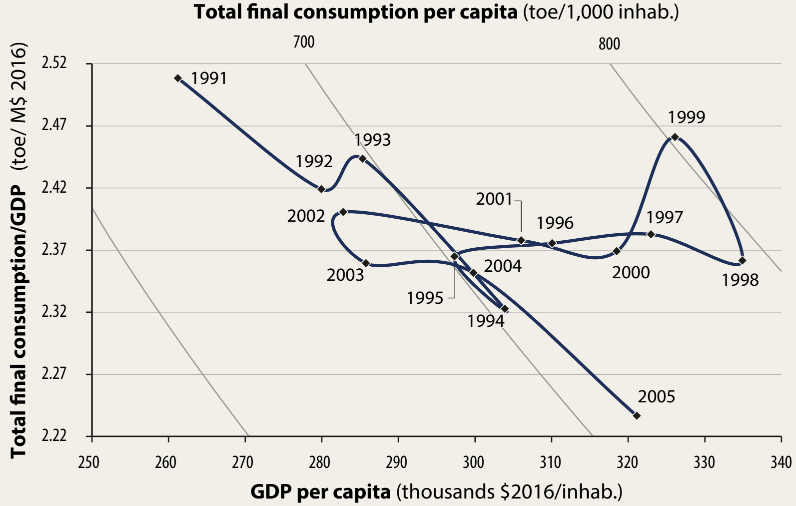
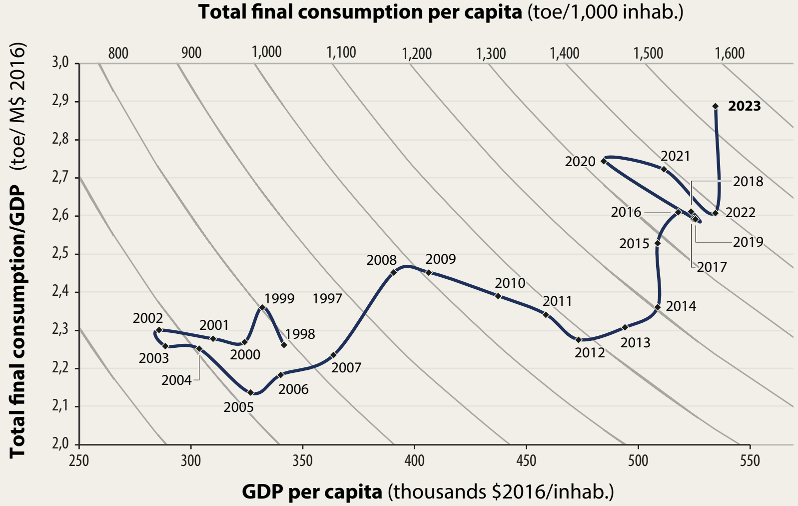
Finally, final consumption per capita, the third indicator represented in the energy path, has already been mentioned in previous sections. It is interesting to observe its net growth evolution throughout the period, which alternates years of increases and decreases. Since 1965 and for 40 years, final consumption per capita remained at values between 600 and 800 toe/1,000 inhab. However, since 2005 there has been a sustained growth from 718 toe/1,000 inhab. (2005) to 1,534 toe/1,000 inhab. (2023) practically doubling its value in the last 18 years. The maximum consumption per capita was recorded precisely in the last year of the series.

FIGURE 68. Energy path/enlarged details

EVOLUTION 1991-2005



EVOLUTION 1998-2023



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7. Sustainable development goal 7 (SDG 7)

SUSTAINABLE DEVELOPMENT GOALS

7 AFFORDABLE AND CLEAN ENERGY

The Sustainable Development Goals (SDGs) approved by the United Nations (UN) in 2015 address, in an integrated manner, the challenges surrounding the three dimensions of sustainable development that are key to the future of the planet: economic, social, and environmental. The Government of Uruguay, working transversally at all the ministries, autonomous bodies, and decentralized services, has assumed the responsibility of guiding its public policies regarding the fulfillment of the SDGs to make progress in each of them towards the year 2030.[25]

Governance in the elaboration of SDGs:

The coordination of the Uruguayan state for the development and monitoring of the SDGs is based on Presidential Resolution N°862 of December 5, 2016.

This resolution mandates the Presidency of the Republic, through its Office of Planning and Budget (OPP), to manage, develop, and monitor the SDGs. To this end, the Management and Evaluation Directorate (AGEV) is designated as responsible for overseeing and coordinating public policies related to the SDGs, as well as preparing follow-up reports on them. This office works in conjunction with the National Institute of Statistics (INE), which, through the National Statistical System (SEN), compiles the SDG indicators for which it is the primary source of information. It also relies on the SDG indicators collected by other agencies. The Uruguayan Association for International Cooperation (AUCI) is responsible for monitoring international cooperation activities related to the SDGs.

In particular, **SDG 7** aims to ensure access to affordable, safe, sustainable, and modern energy for all. The MIEM, through the DNE, is the reference body for this goal.

By 2015, the country already had an Energy Policy first developed in 2005, in permanent dialogue with all the public stakeholders involved in the matter. While it was approved in 2008, its implementation had already begun. In 2010, it was endorsed by a multi-party commission composed by representatives of the entire political sector, thus becoming state policy. Although the Energy Policy was devised and designed based on the country's reality and institutional capacities, it matches the content and timeframe (2030) set by the United Nations to fulfill the SDGs. This explains why, by 2015, Uruguay already had indicators reflecting a transformed energy reality and was moving towards the achievement of SDG 7.

As Uruguay implements the 2030 Energy Policy, it aligns with the path outlined by the United Nations to ensure universal access to affordable, reliable, sustainable, and modern energy.

In 2018, Uruguay reaffirmed its commitment to fulfilling the 2030 Agenda by voluntarily submitting the second country report to the UN. At that time, five SDGs were reported, including SDG 7 "Affordable and clean energy."[26]

25- Sustainable Development Goals (SDGs), *Qué son los ODS*, <https://ods.gub.uy/index.php/quesonlosods> (08/16/2024).

26- Presidency - República Oriental del Uruguay, *"Informe Nacional Voluntario – Uruguay 2018"*, <https://ods.gub.uy/images/2018_Informe_Nacional_Voluntario_Uruguay_ODS.pdf> (08/16/2024).

FIGURE 69. Proportion of the population with access to electricity

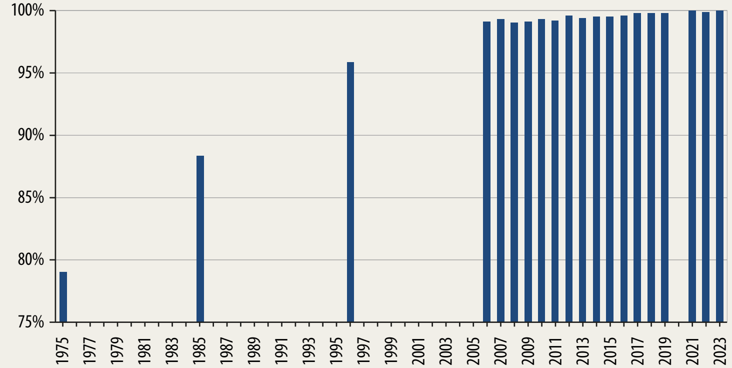


FIGURE 71. Renewable energy share in total final energy consumption

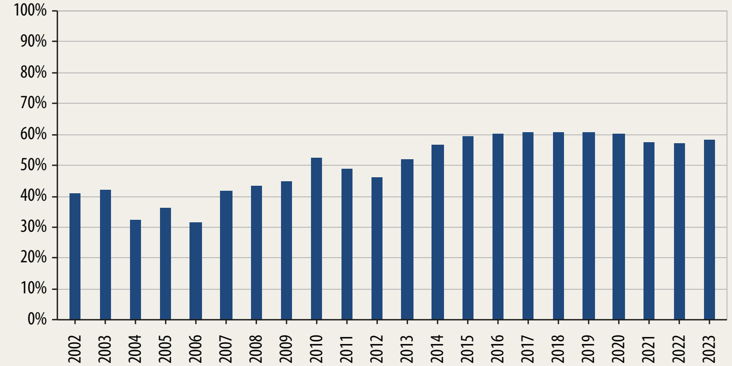


FIGURE 70. Proportion of population with primary reliance on clean fuels and technology

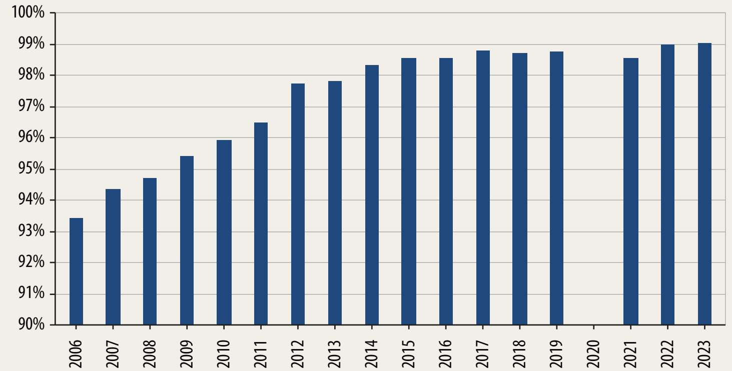
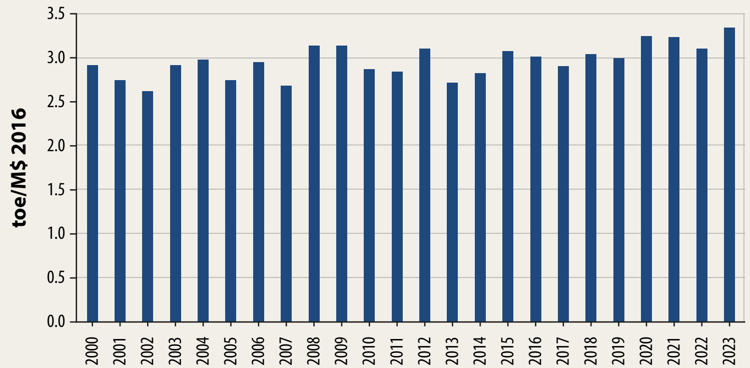


FIGURE 72. Energy intensity measured in terms of primary energy and GDP



The indicators for SDG 7 are the following:

- **Target 7.1.** By 2030, ensure universal access to affordable, reliable, and modern energy services.

  INDICATOR 7.1.1. Proportion of population with access to electricity.

  INDICATOR 7.1.2. Proportion of population with primary reliance on clean fuels and technology.

- **Target 7.2.** By 2030, increase substantially the share of renewable energy in the global energy mix.

  INDICATOR 7.2.1. Renewable energy share in the total final energy consumption.

- **Target 7.3.** By 2030, double the global rate of improvement in energy efficiency.

  INDICATOR 7.3.1. Energy intensity measured in terms of primary energy and GDP.

For further information, please refer to “Uruguay’s 2018 Voluntary National Review.”

7.1. Evolution of indicators 7.1.1 y 7.1.2

Indicator 7.1.1
Proportion of the population with access to electricity

Uruguay has an electrification rate [27] of over 99.97%, which means that the methodology used to monitor the indicator (Continuous Household Survey) is no longer a viable tool, given that the error of the statistical operation is greater than the percentage to be determined. In 2023, a national population census was conducted in Uruguay and the official results have not been published at the time of writing. The value of this indicator is expected to be adjusted with this statistical operation.

From a statistical point of view, Uruguay has achieved the goal of 100% of the population electrified. Therefore, in order to continue advancing towards this goal, new and more complex indicators must be generated to measure the quality and affordability of the electricity service provided.

Indicator 7.1.2
Proportion of population with primary reliance on clean fuels and technology

For this indicator, it is important to clarify that only the home environment is considered as the universe of application and not the environment in general. For this reason, the use of LPG as a cooking source is considered a clean source.

The slight drop in 2021 (0.1%) is partly explained by the pandemic and the use of less clean sources for cooking.

As of 2022, the indicator remained at 99% and reached a limit in which, as is the case with indicator 7.1.1, the statistical operation (ECH) used as a reference to determine this indicator presents a methodological error greater than what remains to reach 100% of the indicator.

It is worth noting that Uruguay has one of the highest percentages in the region in terms of access to clean sources and technologies.

27- Under SDG 7 the electrification rate is determined on a population basis, unlike the indicator presented in Chapter 6 which is based on dwellings

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7.2. Evolution of indicator 7.2.1

Indicator 7.2.1
Renewable energy share in the total final energy consumption

Uruguay has been working on the decarbonization of the energy matrix for more than a decade (Energy Policy 2005-2030), with policies and multiparty agreements that have led to extremely significant achievements, such as the almost total decarbonization of the electricity generation matrix.

As for final consumption, there is still a long way to go, and it is undoubtedly more complex and costly. However, having an electricity matrix with a very low GHG emissions content allows us to move towards the electrification of end uses, as the electricity generation matrix is already clean.

In 2023, Uruguay reached 58% renewable sources in the final consumption matrix. An analysis of the evolution of this indicator demonstrates the impact of the energy policy, which began to show results in 2013, when the share of renewable sources in the final consumption matrix exceeded 50%. This reference value was not only maintained but continued to grow, averaging 59% over the last decade.

7.3. Evolution of indicator 7.3.1

Indicator 7.3.1
Energy intensity measured as a function of primary energy and GDP

Although this indicator is monitored and reported by Uruguay, it is not related to energy efficiency for developing countries.

It is a suitable indicator for mature and stable economies, but for countries still in the development stage, where their economic structure is changing, the indicator actually measures changes in the economic structure rather than improvements in efficiency.

For example, the growth of the industrial sector in an emerging economy leads to an increase in its energy intensity, which does not necessarily indicate a decrease in energy efficiency. This situation was clearly observed in 2023, when the entry of a single industry, accompanied by marginal economic growth, caused Uruguay's energy intensity to increase by 8%. This does not reflect a loss of energy efficiency in the country, but rather the incorporation of an energy-intensive industry, which had a greater impact on energy consumption than on GDP.

In any case, Uruguay reports that this indicator does not show significant changes, except when an energy-intensive industry is introduced, which leads to an increase in intensity.

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8. Methodology

8.1. General definitions

- **Primary energy source:**
it is the energy source provided directly by nature, like hydropower and wind energy; after going through a mining process like hydrocarbons, natural gas, and coal; or through photosynthesis like firewood and biomass waste (from urban, agriculture and livestock, and agro-industrial activities).

- **Secondary energy source:**
it is the energy obtained from a primary source (or another secondary source) after undergoing a physical-chemical process that modifies its original characteristics.

- **Gross energy:**
it is the primary or secondary energy, from which losses in transformation, transmission, transport, distribution, and storage have not been deducted, including the remaining amount of energy not used.

- **Net energy:**
it is the primary or secondary energy for consumption purposes, from which the losses mentioned above, and the energy not used have been deducted.

- **Final energy:**
it is the primary or secondary energy directly used by socioeconomic sectors. It is the energy that enters the consumption sector and differs from the previous one due to its own use in the energy sector. It includes energy and non-energy consumption.

- **Transformation center:**
it is the facility where primary or secondary energy undergoes processes that modify its properties or original nature through physical-chemical changes, aiming to transform it into another form of energy that is more suitable for consumption. They are classified into “primary” if they only process primary sources, and “secondary,” if primary and/or secondary sources enter the transformation center.

- **Consumption sector:**
it is the part of the socioeconomic activity that receives final energy for its utilization. Own use is considered separately; it corresponds to the energy consumed by the energy sector for production, transformation, transportation, and distribution of energy (not including the energy used as input for transformation into other energy types).

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8.2. Structure

The National Energy Balance (BEN) provides a representation of the energy system's structure and operation. This is done in an organized and systematic manner, summarizing the information in a "general summary matrix" also known as "consolidated matrix." This enables the analysis of all the processes and transformations that a given source undergoes throughout the entire system, as well as for each category (the magnitudes corresponding to each source). The "general summary matrix" is comprised of the following five submatrices:

- Primary energy balance
- Balance of transformation centers (primary and secondary)
- Secondary energy balance
- Gross supply and net consumption
- Distribution of final energy consumption by sector

This figure shows a schematic representation of how these submatrices are located in the "summary matrix." Subsequently, an analysis of each of these submatrices is presented.

ENERGY BALANCE	Primary sources	Secondary sources	Losses	TOTAL
Primary energy	(1)			
Transformation centers	(2)			
Secondary energy		(3)		
Gross supply and net consumption	(4)			(4)
Final energy consumption	(5)			(5)

NOTES:
(1) Primary energy balance
(2) Balance of transformation centers
(3) Secondary energy balance
(4) Gross supply and net consumption
(5) Distribution of the final energy consumption by sector

The summary matrix has a standard format for all years in the historical series. However, it is modified as new energy sources emerge, or as more detailed information becomes available, either hiding or revealing the relevant fields. It is worth mentioning the greater disaggregation in the consumption sectors (available from 2013 onwards), and the breakdown by source for public service and autoproduction power plants (available from 2010).

8.2.1. Balance of primary energy sources

It corresponds to the supply of primary energy sources. This BEN edition includes: crude oil, mineral coal, natural gas, hydropower, wind energy, solar energy, firewood, biomass waste, biomass for biofuels, and industrial waste.

Below are a few clarifications for some of the primary sources:

- **Mineral coal:**
includes anthracite, peat, coal tars, pitch and other types of coal. Non-energy peat is not considered, as per IRES methodology.

- **Natural gas:**
data are considered for standard conditions (1 atm and 15°C).

- **Hydropower:**
the summary matrices include the theoretical equivalent.

- **Solar energy:**
includes photovoltaic solar energy and solar thermal energy.

- **Biomass waste:**
includes rice and sunflower husks, sugarcane bagasse, black liquor, odorous gases, methanol, barley husks, forestry and sawmill waste (chips, sawdust, pellets, etc.), glycerin, and rumen sludge effluent treatment blend.

- **Biomass for biofuel production:**
includes bioethanol and biodiesel production.

- **Industrial waste:**
includes non-renewable industrial waste such as: end-of-life tires (ELT), alternate liquid fuels (ALF), used oils, and solid recovered fuels (SRF). Note that this waste contains a blend of products that cannot be disaggregated and may thus contain a small fraction of some renewable waste.

The primary energy balance includes eight categories: production, import, export, losses, stock change, not used, adjustments, and supply. Since the categories also apply to the secondary energy balance, the definitions for both cases are listed below:

- **Production:**
it is the amount of primary energy extracted from nature or the amount of secondary energy originated in a transformation center.

- **Import:**
it is the primary or secondary energy that comes from outside the country.

- **Export:**
it is the primary or secondary energy that is sent outside the country. Exports to the free trade zone are not considered exports per se. Instead, they are included in the final consumption as sales in the domestic market.

- **Losses:**
these are energy losses incurred during transportation, storage, transmission and distribution (technical losses). Until 2005, non-technical losses in the electricity sector were recorded as "losses." From 2006 onwards, these losses are recorded under "final consumption," considering social losses in the residential sector. Social losses are included in the residential sector, and the remaining non-technical losses are distributed proportionally to consumption. Since 2023, these remaining losses have been allocated to the "not identified" sector.

- **Stock change:**
it is the difference between the stock of an energy source by December 31 of year $i-1$ and December 31 of year i.

- **Energy not used:**
it is the amount of energy that, either for the technical and/or economic nature of its exploitation, is not currently being used.

- **Adjustments:**
it is the statistical adjustment that makes supply and consumption data compatible, as well as differences arising from the rounding of figures.

- **Supply:**
it is the total energy effectively available for consumption. It is obtained using the equation below:

$$\text{Supply} = \text{Production} + \text{Import} - \text{Export} - \text{Losses} + \text{Stock change} - \text{Energy not used} + \text{Adjustments}$$

Note:
in the summary matrices, "export," "losses," and "energy not used" values appear with a negative sign, so the "supply" value is obtained algebraically by adding these values to those corresponding to "production," "import," "stock change," and "adjustments."

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8.2.2. Balance of transformation centers

It reflects the activity of both primary and secondary transformation centers. The negative signs represent incomes (inputs), while the positive ones represent outgoings (outputs). The processes carried out in these centers result in transformation losses, calculated by adding the inputs and outputs algebraically.

Transformation centers include:

- **Refinery:**
an industrial facility where crude oil is subjected to physical and chemical transformation processes to obtain compounds and oil products of greater market value.

- **Power plants for public service:**
include plants that deliver the electricity generated to the grid, such as hydroelectric, wind, solar photovoltaic, and thermoelectric plants.

- **Autoproduction power plants:**
include power plants where the electricity produced is to be consumed by autoproducers themselves, excluding delivery to the grid.

- **Biomass distilleries:**
industrial bioethanol production plants.

- **Biodiesel plants:**
industrial biodiesel production plants.

- **Coal plants:**
transformation center where charcoal is produced from firewood.

- **Gas plants:**
transformation center where gas is manufactured from light naphtha.

- **Coke plants:**
transformation center where coke of coal is produced.

Cogeneration plants have an overall efficiency of 70-85%. Such efficiency depends on the type of technology used and how the energy is used in the process. “Overall efficiency” is defined as the ratio of the total energy produced by the system (electricity and heat) to the energy consumed.

8.2.3. Balance of secondary energy sources

It corresponds to the supply of secondary energy sources. This BEN edition includes the following secondary energy sources: LPG, motor gasoline, aviation gasoline, kerosene, jet fuel, gas oil, fuel oil, petcoke, non-energy products, fuel gas, bioethanol, biodiesel, coke of coal, charcoal, and electricity. Other secondary sources include light naphtha, diesel oil, and manufactured gas, which, although not currently used in the country, are included in the applicable years of the historical series.

Below are certain clarifications for some of the secondary sources:

- **LPG:**
includes LP gas and propane. It is worth noting that the 2020 edition improved the allocation of LPG consumption across various activity sectors. For this reason, other classification criteria are implicit in the sectoral consumption of LPG until 2019. LPG consumption in the “remaining agriculture” sector was estimated in 2019 based on the total “agriculture” value and the new consumption estimate for the “poultry” subsector. For this reason, the drop in consumption towards 2020 is partly due to a change in methodology.

- **Motor gasoline:**
it does not include bioethanol, which is reported separately. Exports consist of isomerates, reformates, and petrochemical naphtha.

- **Gas oil:**
it does not include biodiesel, which is reported separately.

- **Petcoke:**
it includes non-calcined petcoke, calcined petcoke, and refinery coke. Up to and including BEN 2012, it was referred to as "other energy products." Calcined petcoke is recorded as non-energy consumption.

- **Non-energy products:**
these include solvents, lubricants, and asphalts. As of 2013, with the startup of the desulfurization plant, "liquid sulfur" has been included as a new non-energy product. As of 2023, and in accordance with the IRES methodology, imports and exports of lubricants are no longer considered, as they are not linked to the refinery's production flow.

- **Fuel gas:**
its production was considered equal to own use until and including 2012. Since 2013, volume "not used" and "losses" have been included. Consequently, production is greater than the refinery's own use. This change in methodology has been applied since 2013.

- **Coke of coal:**
it corresponds to coke of hard coal. Until the 2012 BEN, it was referred to as "coke."

- **Electricity:**
In recent years, electricity consumption associated with transport includes captive and private fleets.

The categories for the secondary energy balance are the same as the ones described above for primary energy, except for one additional category:

- **International bunker:**
it is the energy sold to sea vessels and aircrafts on international voyages; that is, voyages departing from one country and arriving in another. This activity was included under "exports" until 2012. From 2013 onwards, it is represented independently.

8.2.4. Gross supply and consumption

This submatrix displays the gross energy supply and total net consumption, along with a breakdown of the items contributing to the latter.

- **Gross supply:**
it is the supply of each energy source as shown in the corresponding balance. It includes additions of losses and the quantity not used indicated in such balance.

Unlike other rows in the matrix, total gross supply is not obtained by adding the primary and the secondary energy sources. Such an addition would result in duplicates as the production of secondary sources would be added to the primary sources from which they were obtained. Therefore, the correct way to calculate it is by deducting the production of secondary sources from the addition.

- **Total net consumption:**
is the total final consumption plus the energy sector's own use.

- **Own use:**
the amount of primary and/or secondary energy that the energy sector uses for its operation, including production, transformation, transport, and energy distribution. It does not include the energy used as input for transformation into another energy type in the transformation centers.

- **Total final consumption:**
the addition of the final energy consumption and the non-energy consumption.

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8.2.5. Distribution of final energy consumption by sector

This last part of the consolidated matrix shows how final energy consumption is distributed across the various socio-economic activity sectors. Since the elaboration of the 2013 BEN, consumption data collection has been improved through new sectoral surveys. The traditional "Survey on firewood and biomass waste" became part of the "Survey on energy consumption in the industrial sector," which includes other energy sources and was conducted for the years 2011, 2013 to 2018 and 2020 to 2023. Likewise, there were energy consumption surveys in the residential sector in 2013 and in the commercial/services/public sector in 2013, 2014, and 2015. Note that the results of this last survey will be included in future publications. As an improvement in the 2020 BEN, surveys were conducted in the mining sector and the "poultry" subsector within the agriculture sector.

As of 2013, final energy consumption is included with a broader disaggregation by sector. Sector consumptions lower than 1 ktoe are not reported, as they involve very small values. Exceptions are made in cases where they correspond to only one subsector. Neither is the breakdown made if there is only one company per sector—grouped consumption must be reported— or if there is no available information for classification.

The disaggregation by sector and subsector is the following:

- **Residential sector:**
includes the caloric, electric, and mechanical consumption of rural and urban families to meet household energy needs. Personal transport is not included; it is reported within the transport sector.

As of 2013, consumptions are reported with the following breakdown:

Residential sector
Montevideo
Rest of the country

For firewood and LPG, the breakdown is based on the results of the "Survey on energy consumption and use in the residential sector 2013." Meanwhile, administrative data are used for electricity and natural gas. As for biomass waste, all consumption is associated with the rest of the country. Since 2013, there has been no breakdown for the remaining energy sources due to insufficient information for proper classification (solar, kerosene, gas oil, fuel oil, charcoal).

- **Commercial/services/public sector:**
includes tertiary sector activities such as schools, hospitals, stores, hotels, restaurants, public lighting, public administration, among others. It encompasses sections D to U according to the "International Standard Industrial Classification" (ISIC) revision 4 and public lighting.

As of 2013, consumptions are reported with the following breakdown:

Commercial/services/public sector	Associated ISIC Revision 4
Public lighting	-
Public administration and defense	Section O
Electricity, gas, and water	Sections D and E
Others	Sections G, H*, I, J, K, L, M, N, P, Q, R, S, T and U

NOTE: (*) This only includes consumption within the establishments.

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- **Transport sector:**

includes the individual and collective movement of people and cargo by air, land, and water. It excludes internal transportation within the establishments comprised in the remaining sectors. International air and fluvial travel are not included either. Their consumption is recorded under exports until 2012, and, starting from 2013, it is recorded under international bunker.

As of 2013, consumptions are reported with the following breakdown:

Transporte sector
Road
Rail
Air
Sea and fluvial

For private vehicles, results from consumption surveys conducted in the residential and industrial sectors in 2013 were considered, providing valuable information.

As of 2016, aviation fuels (aviation gasoline and jet fuel) have been surveyed by means of an annual company survey. According to IRES methodology, these consumptions associated with aero-agriculture activities are reported in the transportation sector.

- **Industrial sector:**

it includes the manufacturing industry and construction, corresponding to sections C and F of the ISIC Rev.4 industrial classification, respectively. It is essential to mention that agro-industries and the fishing industry are considered within this sector.

As of 2013, consumptions are reported with the following breakdown:

Industrial sector	Associated ISIC Revision 4
Slaughterhouses	Group 101
Diary	Group 105
Mills	Class 1061
Other food industries	Groups 102, 103, 104, 107 and 108
Beverages and tobacco	Divisions 11 and 12
Textile	Divisions 13 and 14
Leather	Division 15
Wood	Division 16
Paper and cellulose	Divisions 17 and 18
Chemical, rubber, and plastic	Divisions 19*, 20, 21 and 22
Cement	Classes 2394 and 2395
Other manufacturing industries and construction	Division 23** / Divisions 24 to 33 / Section F

NOTES: (*) excluding the refinery (19201); its consumption is considered under “own use.”
(**) Including all the classes of division 23 except for those corresponding to the “cement” subsector.

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- **Primary activities:**

they refer to agriculture, livestock, and forest extraction production, plus commercial fishing on the high seas, coast, coastal and estuarine fishing. It includes activities carried out by factory ships and fleets involved in fishing and its processing. It also includes mining. Until BEN 2019, it was referred to as "agriculture/fishing/mining."

As of 2013, consumptions are reported with the following breakdown:

Primary activities
Agriculture
Mining
Fishing

Agriculture: it includes the consumption of energy sources within agricultural and forestry establishments. The consumption of the "poultry" subsector has been reported since BEN 2020, separating it from the other agricultural subsectors.

Agriculture sector
Poultry
Remaining agriculture subsectors

To this end, an energy consumption survey was conducted among Uruguayan poultry farms in 2020, with a response rate of 50%, but representing 81% of national production. Technical coefficients of energy consumption per head of poultry were calculated, and the results were scaled up to obtain nationwide figures (INAC data). This survey was also used to obtain information for 2019. For 2021 and from now on, poultry energy consumption is determined based on the national production values for each year under consideration, using the technical coefficients developed.

In line with the implementation of improvements, a review and refinement were conducted in 2020 to estimate the consumption of other energy sources for the remaining subsectors within agriculture. Other information sources were considered, mainly data from gas distributors. Publications were also analyzed, such as the 2006 "Energy Use and Consumption Survey," and MGAP (Ministry of Livestock, Agriculture, and Fisheries) reports and studies, particularly studies carried out by OPYPA regarding intermediate consumption of agricultural activities. Technical coefficients were elaborated with the analysis of these reports, together with DIEA data publications; depending on the activity, in some cases, they were liters/hectare, and in others, such as dairy, they were liters/liters of milk produced, or liters/head for cattle. This made it possible to obtain energy consumption for different years. Further analysis was conducted on the sector's consumption of gas oil and gasoline.

In 2021, joint work was carried out with OPYPA to consolidate and adjust the methodology for calculating the technical coefficients mentioned above; to this end, the latest available information was employed. This allowed for the obtention of unique and common technical coefficients for both the BEN and the different reports prepared by OPYPA. In 2022, the adjustment of the technical coefficients with OPYPA was completed. This entailed adjusting the gas oil consumption for agriculture in the 2019-2021 series.

It should be noted that for the agriculture sector, the mobile year July/"year *i-1*" - June/"year *i*" is considered; that is, for the 2023 BEN year, the data for the period July/2022-June/2023 of the Agricultural Statistical Yearbook is considered.

Mining: in the 2020 BEN edition, the separation of mining sector statistics was achieved, which until BEN 2019 had been reported with agriculture. A company survey was conducted, enabling 50% of the mines in Uruguay to be interviewed. Consumption of the different energy sources was obtained, and technical coefficients of mineral consumption/production were calculated.

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With the national mineral production data (provided by DINAMIGE), it was possible to obtain national energy consumption results for 2019 and 2020. For 2021 and onwards, energy consumption is determined based on the mining production data provided by DINAMIGE, using the technical coefficients developed. It should be noted that the moving year April/ "year *i*" - March/ "year *i+1*" is considered, that is, for the year 2023 of BEN, the mining production data refers to the period April/2023-March/2024.

Data on electricity consumption are obtained from the UTE database and by cross-checking information with the surveys.

Fishing: the estimates of energy consumption for industrial fishing are based on administrative data on fuel sales and volumes declared in the records of the National Directorate of Aquatic Resources (DINARA) of the Ministry of Livestock, Agriculture and Fisheries (MGAP). As of 2014, the administrative data on non-industrial fishing comes from the General Registry of Fishing and the current tax exemption agreement on purchased fuel.

- **Not identified:** a sixth category that includes consumption coming from sectors not identified. In the case of propane gas (LPG), it includes consumption by companies whose main activity is classified as Section V of ISIC, Revision 4 (corresponding to the annex included by Uruguay for exclusive use by local agencies). For electricity, starting in 2023, non-technical losses are included in this category, except for social losses, which are allocated to the residential sector.

8.3. Units and data formats

The unit used to express the energy flows comprising the National Energy Balance is the ktoe (thousands of tonnes of oil equivalent).

1 ktoe = 1,000 toe
1 toe = 10,000,000 kcal

The conversion of the magnitudes corresponding to each source to its expression in toe is done through its respective Lower Heating Value (LHV). The 0.086 toe/MWh technical criterion is applied in the case of electricity. Note that any decimal place differences in the values reported in tables, charts, and texts are due to rounding of the figures. In turn, for the same reason, the addition of subtotals may not reproduce the exact total.

Finally, when a value is represented as "0" (zero), it means that it exists and is very small (less than 0.1). When the cell appears empty, it means that the flow does not correspond to Uruguay or that the information necessary to quantify the magnitude is not available.

8.4. Special comments

8.4.1. Hydroelectric energy

Hydropower is evaluated using the theoretical equivalent criterion; the turbined flow is used to determine the energy that enters the primary transformation centers (hydroelectric power plants).

Hydropower production is calculated as follows:

$$E_{hydro} = k \times ß \times g \times t \times h \times Q$$

Where:

- E_{hydro}: Hydropower production (kWh/year)
- **k:** Coefficient for unit conversion
- **ß:** Water density (kg/m^3)
- **g:** Gravity acceleration (m/s^2)
- **t:** Operational time of the plant (hours/year)
- **h:** Average fall height (m); daily water levels are considered
- **Q:** Turbined flow (m^3/s)

8.4.2. Wind energy

In 2008, the country's first wind farms connected to the grid came into operation. Thus, since that year, wind energy has been included in the balance matrix. For previous years, no data on wind energy were included since the current estimates of the number of windmills and wind turbines vary significantly depending on the information source.

The methodology applied by OLADE is used to determine wind energy; it is done using the electricity generated by each wind farm/wind turbine and considering as "wind energy produced" the same value as the electricity generated. UTE provides information on electricity generated from wind energy, encompassing both large-scale and microgeneration units connected to the grid. An annual census is conducted for those that operate autonomously and are not connected to the grid.

As of BEN 2020, the concept of wind energy not used due to Operational Restrictions (OR) is introduced, and data from 2018 onwards are considered. This concept arises from a decree, where UTE is urged to pay for energy to wind energy generators that can generate energy but, due to an operational restriction established by the National Load Dispatcher, cannot deliver it to the grid.

Operational Restrictions (OR) are defined as those generation reductions imposed by ADME (Electricity Market Administration) for the safe operation of the system. In particular, Operational Restrictions due to Excess Generation refer to limitations on generation in situations where, without the reduction, the total generation would exceed the value of energy demand (Uruguayan demand plus export) minus the reserve margin and forcings defined by ADME for the safe operation of the National Interconnected System (SIN).

ADME provides data on wind energy not used by each generator according to their OR, as described above.

Information on models for OR calculation can be found in the following documents[28]:

- "Procedure for operational restrictions applicable to wind and solar generators of the National Interconnected System (SIN)."[29]
- Wind power plant model.[30]

8.4.3. Solar energy

As of 2014, the BEN included solar energy estimations, as well as solar thermal and photovoltaic energy.

28- Electricity Market Administration (ADME), *Documentos sobre los modelos para el cálculo de las R.O.*,<https://adme.com.uy/imasd/simsee_principal/adme_windsim.php> (07/23/2024).
29- Electricity Market Administration (ADME), *Procedimiento para restricciones operativas aplicable a generadores de fuente eólica y solar del Sistema Interconectado Nacional (SIN)*, <https://adme.com.uy/db-docs/Docs_secciones/nid_78/ProcedimientoParaGestiondeRestriccionesOperativas_v201512091831.pdf> (07/23/2024).
30- Chaer Ruben, Palacio Felipe, Soubes Pablo for Electricity Market Administration (ADME), *Modelo de central de generación eólica*, <https://adme.com.uy/db-docs/Docs_secciones/nid_324/ModeloCentralGeneradoraEolica.pdf> (07/23/2024).

- **Solar thermal energy:**

to estimate solar thermal energy, the total aperture area of both imported and domestically manufactured equipment is calculated. The assumption that there is no stock for more than a few months is made, asserting that what is imported or produced in a given year is practically installed in the same year. Additionally, a lifespan of 15 years is considered to determine the cumulative installed equipment.

In 2017, local manufacturers were surveyed to determine the domestic production of solar thermal collectors. As of that year, the actual area of installed domestic production is reported. Up to and including 2016, the share of national producers is estimated to be 20% of the total. It is noted that as of the year 2020 there are no records of domestic production.

The energy generated is calculated from the "average annual irradiance on a horizontal plane" and the installed area; with an overall efficiency of 44%:

$$E_{solar\ thermal} = Ef \times H_0 \times A \times \frac{0.086\,(\frac{toe}{MWh})}{1{,}000{,}000}$$

Siendo:

- $E_{solar\ thermal}$: Production of solar thermal energy (ktoe/year)
- **Ef:** Overall efficiency[31]
- H_o: Annual average irradiance on a horizontal plane (kWh/m^2-year)[32]
- **A:** Aperture area of solar thermal collectors/heaters (m^2)

The solar thermal energy generated corresponds to energy available for heating water. From a balance perspective, it can be interpreted as a potential, as it represents the energy captured by the equipment and not the energy consumed. In practice, not all of that energy may be consumed.

31- International Energy Agency - Solar Heating and Cooling Programme (IEA-SHC), *Simple method for Converting Installed Solar Collector Area to Annual Collector Output*, <https://www.iea-shc.org/common-calculation-method> (07/23/2024).
32- *"Mapa solar del Uruguay"*. Second version, June 2017. Source: Alonso-Suárez, R., Abal, G., Siri, R.,Muse, P., (2014). Satellite-derived solar irradiation map for Uruguay. Energy Procedia 57:1237-1246, 10.1016/j.egypro.2014.10.072.

Until and including 2016, the sectoral allocation of final energy consumption is theoretical, considering typical shares from literature: 85% residential sector, 14.5% commercial/services/public sector, and 0.5% industrial sector. It is important to note that this information is challenging to gather in the sectoral surveys conducted periodically due to the sample size not adequately reflecting the population using this technology.

As of 2017, an industrial consumption value associated with the area surveyed in the annual industrial survey is estimated. Since 2019, it has been complemented with imports from companies with an industrial line of business. The theoretical share is maintained for the commercial/services/public sector, and the balance is closed with the residential sector (by difference).

Additionally, reference is made to the solar technology census conducted in 2018 among companies and institutions in the commercial and services areas. Only the subsectors most likely to own solar equipment under the Solar Thermal Energy Law (Law 18,585 of September 2009) were surveyed. The census, along with other surveys in the sector, allowed the estimation of an installed area of 5,783 m^2 of solar thermal collectors, equivalent to 0.3 ktoe. A higher value was verified for the theoretical estimate applied to the commercial/services/public sector. For this reason, the data collected in these statistical studies are correctly included in the calculation since the total number of companies in the industry using this technology is unknown.

- **Photovoltaic solar energy:**

to determine photovoltaic solar energy, the methodology applied by OLADE and other international organizations is considered. This methodology regards the "produced photovoltaic energy" as the same value as the electricity generated by photovoltaic panels. This methodology has been applied since BEN 2015 for the series since 2014.

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Electricity generation from photovoltaic panels is determined in several ways, depending on the installed capacity of the equipment. Producers can be grouped into the following two types:

01. Producers with an installed capacity greater than 150 kW.

– On-grid solar plants; for which the annual data supplied by UTE is considered.

– Autonomous producers with installed capacities higher than 150 kW, who do not supply energy to the grid, are surveyed.

02. Producers with an installed capacity lower than 150 kW (microgenerators).

– Small producers who supply energy to the grid; the annual microgeneration data provided by UTE is used. As of 2019, UTE has not provided annual generation data, so a theoretical annual generation is estimated from the installed capacity data. UTE's information on energy delivered to the grid is available, and the difference is used to obtain data on self-consumed energy.

– For small autonomous producers with estimated installed capacities below 150 kW, who do not supply to the grid, the same ratio of energy generated to installed capacity is applied as that of producers who contribute to the grid and have known data. A survey is conducted for the remaining small autonomous producers for whom information is available.

Starting from BEN 2020, the concept of photovoltaic solar energy not used due to Operational Restrictions (OR) is introduced and is considered from 2018 onwards. As previously mentioned for wind generators, it is decreed that UTE must compensate solar generators for all the electricity they are capable of generating but, due to OR set by the National Load Dispatcher, is not delivered to the grid.

ADME provides data on the solar energy not used in each photovoltaic plant according to their OR, as described above.

Information on models for OR calculation can be found in the following documents[33]:

- "Procedure for operational restrictions applicable to wind and solar generators of the National Interconnected System (SIN)."[34]
- "Annex C): Model of a photovoltaic solar power plant."[35]

33- Electricity Market Administration (ADME), *Documentos sobre los modelos para el cálculo de las R.O.*, <https://adme.com.uy/imasd/simsee_principal/adme_windsim.php> (07/23/2024).
34- Electricity Market Administration (ADME), *Procedimiento para restricciones operativas aplicable a generadores de fuente eólica y solar del Sistema Interconectado Nacional (SIN)*,<https://adme.com.uy/db-docs/Docs_secciones/nid_78/ProcedimientoParaGestiondeRestriccionesOperativas_v201512091831.pdf> (07/23/2024).
35- Pablo Soubes, Felipe Palacio y Ruben Chaer for Electricity Market Administration (ADME), *Anexo C): Modelo de central generadora solar fotovoltaica*, <https://adme.com.uy/db-docs/Docs_secciones/nid_324/ModeloSolarPV.pdf > (07/23/2024).

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8.4.4. Firewood

The production of firewood is calculated by adding the total energy consumption of firewood to the firewood used in the following transformation centers: public service power plants, autoproduction power plants, and coal plants. It is noted that coal plants were in operation until 2004 inclusive.

For the industrial sector, firewood consumption is estimated through annual surveys conducted by DNE-MIEM. In the absence of an industrial survey for a particular year, firewood consumption is extrapolated from the data of preceding years. This survey is not conducted annually for the remaining sectors, and in survey-absent years, the consumption value from the last survey is retained.

In BEN 2020, firewood consumption in the "primary activities" sector was adjusted based on the 2015 OPYPA report for the sector and the 2020 poultry subsector survey.

The quantity of firewood entering public service power plants and autoproduction power plants is estimated from the annual census conducted by DNE-MIEM. Conversely, the amount of firewood entering coal plants is calculated based on domestically produced charcoal.

8.4.5. Biomass waste

Biomass waste production is accounted for by adding energy consumption and transformation center inputs. This approach is adopted due to the lack of information to estimate the production not used of other types of biomass waste, such as forestry waste.

This criterion has been applied since 2008 and is widely employed in other countries. In previous years, biomass waste production was calculated based on the annual output of crops generating them (such as rice, sunflower, barley) and the proportion of their waste relative to the total weight. This information was sourced from the statistical yearbooks of DIEA (Agricultural Statistics Office) of the MGAP. Under this criterion, production was significantly higher than the consumption of these energy sources.

Also, trade data (import and export) is taken into account for applicable waste, such as pellets and briquettes.

For the industrial sector and power plants for autoproduction and public service, the consumption of biomass waste is estimated based on data collection surveys conducted annually by DNE-MIEM among companies using this energy source. As for the residential sector, the 2006 "Energy Use and Consumption Survey" results and the "2013 Residential Survey" have been used in the last few years.

Biogas:

Biomass waste also includes biogas used for electricity production, expressed as methane. The values are very small in relation to the total (around 0.3 ktoe).

Since 2008, "Las Rosas" plant (Maldonado) has been accounted for in the electricity production of "power plants for public service" as the first electricity generator using biogas produced from urban waste. In 2014, a second electricity generator fueled by biogas was introduced, produced by treating effluents from a wool-washing plant. Between 2019 and 2021, two electricity generators running on biogas came into operation, produced from the treatment of effluents from a dairy farm.

In 2022, a fifth generator was introduced. However, unlike previous ones, it is categorized under "autoproduction power plants" for electricity production since it does not deliver energy to the grid. This generator has a unique feature: a portion of the generated biogas is utilized for electricity generation, while the remaining biogas serves as thermal energy. In 2022, only 5% of the total utilized biogas was allocated to electricity generation.

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8.4.6. Biomass for biofuels

The primary energy source called “biomass for biofuels” considers the production of bioethanol and biodiesel. In accordance with the IRES methodology, primary biomass is considered equivalent to the production of each biofuel. This criterion has been applied since BEN 2021 and retroactively for the entire historical series.

Since BEN 2022 it adopts a different criterion in line with the IRES methodology, focusing solely on the production of bioethanol and biodiesel for energy purposes. It is noted that, while this was accompanied by a correction of the historical series, the impact was very small in terms of magnitude.

8.4.7. Kerosene

In the BEN 2022 edition, enhancements have been implemented in the methodology for calculating kerosene consumption. This involves using information gathered from surveys conducted by DNE-MIEM (Industrial and Mining Survey; Useful Energy Balances (BNEU)) as well as data from the Expenditure and Income Survey (ENGIH) and the Continuous Household Survey (ECH) conducted by the INE.

As for the residential sector, an average consumption per household was calculated for those using kerosene as the main cooking source and an average consumption for the remaining households. This calculation was based on the 2006 residential BNEU and the 2005-2006 ENGIH. Then, a projection for residential consumption for the 2006-2015 series was made based on the total number of households and those with kerosene as the main source for cooking as reported in the ECHs.

For years after 2016, an average consumption per household was computed based on the 2016-2017 ENGIH for those utilizing kerosene as the primary heating source, along with an average consumption for the remaining households. Then, a projection for 2016-2022 residential consumption was made based on the total number of households and those using kerosene as the main heating source as reported in the ECHs.

According to the above methodology, applicable to years before 2005, kerosene consumption of the residential sector was allocated as the difference between the total final energy consumption and the consumption of the remaining sectors. Using this new methodology, a more precise estimation of residential consumption is imputed, and the difference from the final energy consumption is attributed as “not identified.” This categorization is made due to the absence of sufficient information to classify it within any other sector

For the mining sector, the values collected through surveys since 2019 are imputed. In turn, non-energy consumption of kerosene obtained in the industrial survey is considered. This information is used for the years 2016 and onwards. For years where no new information is available, the same values as the last available survey are maintained. It should be noted that both consumptions are very small, being represented in the results matrix with 0.0 ktoe values.

Finally, it is noted that for the commercial/service/public sector kerosene consumption is based on administrative sales data and it is considered that it may be underestimated. Provided that reliable information is available from the statistical surveys, improvements can be incorporated into future BEN editions.

8.4.8. CO_2 emissions

The BEN publication includes carbon dioxide (CO_2) emissions corresponding to fuel combustion activities in the energy industries and sectors of consumption. CO_2 emissions from biomass combustion and international bunkers are also included. These are presented as memo items since they are not considered in the totals. The series began in 1965.

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CO_2 emissions are calculated according to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The reported categories are detailed below:

- **Energy industries:** The emissions from the following transformation centers are considered, as well as the energy sector's own use. It should be noted that CO_2 emissions from autoproduction power plants are included in the industrial sector, according to the employed methodology.

– Power plants for public service

– Own use

- **Consumption sectors:** The same sectors included in the BEN and detailed in the "structure" section of this methodology description are considered.

– Residential

– Commercial/services/public sector

– Transport

– Industrial

– Primary activities

– Not identified

- **Memo items:** they are presented separately and are not included in the total CO_2 emissions of the following categories:

– Biomass combustion: it includes firewood, biomass waste, and charcoal for the entire series and, as of 2010, biofuels are included too. Emissions in this category correspond to biomass combustion in public service and autoproduction power plants, as well as in the different activity sectors.

– International bunkers: refer to emissions from international marine and aviation bunkers.

The default CO_2 emission factors (EFs) for combustion, shown in Table 1.4 of the Volume 2: Energy of the 2006 IPCC Guidelines, are used to estimate emissions.

The BEN publication also includes the "CO_2 emissions by source" and "CO_2 emissions by source and sector" series. For the latter, the breakdown is done considering the main categories associated with the emissions of each source.

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8.4.9. Primary matrix (energy supply)

The "primary matrix", also called the "supply matrix," represents the country's energy supply with the following breakdown: "electricity," "solar," "oil and oil products", "natural gas," "biomass," and "coal/coke." For its preparation, as a general methodology, the supply activities for each energy source are considered (production, import, export, and international bunker). Production is not considered for secondary sources because such contribution is already included in the primary source from which it originates.

As for **hydrocarbons**, the imports of crude and natural gas are reported, and the net balance of foreign trade of oil products is calculated as the difference between imports and exports (including international bunker).

For **hydropower**, hydroelectricity is considered. As an exception for this primary source, hydropower production is not considered for determining supply.

In the case of **wind energy**, electricity generated from wind power (both public service and autoproduction) is considered. As in the previous case, wind energy production is not considered.

Solar energy includes solar photovoltaic energy and solar thermal energy. The supply of **solar photovoltaic energy** is determined by considering the electricity generated from photovoltaic sources (both public service and autoproduction). As in the case of hydropower, production data is not considered.

Regarding **thermal solar energy**, supply is determined based on production. It is noted that both types of solar energy are presented together in the BEN results matrix, thus solar energy production includes both thermal and photovoltaic. For this reason, the data on solar thermal energy production should be calculated as follows: solar production minus solar energy "not used", minus transformation center inputs.

For **biomass**, the production of firewood, biomass waste, and biomass for biofuels is considered, as well as the net foreign trade balance of biomass waste, bioethanol, biodiesel and charcoal, calculated as the difference between imports and exports.

To quantify **coal and coke** supply, imports of mineral coal and coke of coal are recorded. In the case of **industrial waste**, supply takes production into account.

Finally, for electricity, imports from neighboring countries must be considered. It is worth noting that, as an exception to the general rule, electricity exports are not considered because their deduction as such is not possible.

Additionally, two classifications are added to the analysis of energy supply by source:

By origin:

- Local: national production.
- Imported: net imports.

By type:

- Renewable: hydroelectricity, wind, photovoltaic and solar electricity/biomass/solar thermal.
- Non-renewable: natural gas/oil and oil products/coal and coke.
- Imported intensity.

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ANNEX I.
Supplementary information

I.1. Conversion of units

TABLE 18. Most common prefixes for multiple and submultiple units

Multiple	Submultiple
10^3 kilo (k)	10^{-3} milli (m)
10^6 mega (M)	10^{-6} micro (μ)
10^9 giga (G)	10^{-9} nano (n)
10^{12} tera (T)	10^{-12} pico (p)

TABLE 19. Conversion ratios between energy units

1) TO convert from:	2) Into:			
	TJ	kcal	ktoe	MWh
	3) Multiply by:			
Terajoule **(TJ)**	1	238,845,897	2.4E-02	277.8
Kilocalorie **(kcal)**	4.1868E-09	1	1E-10	1.16E-06
ktoe	41.868	1E+10	1	11,630
Megawatt-hour **(MWh)**	3.6E-03	859.845	8.6E-05	1

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I.2. Conversion factors (based on the LHV)

TABLE 20. Constant conversion factors in the historical series

	unit	value
Asphalts	toe/m³	0.9640
	toe/t	0.9640
Sulphur	toe/m³	0.3928
Biodiesel	toe/m³	0.8312
	toe/t	0.9500
Bioethanol	toe/m³	0.5066
	toe/t	0.6400
Charcoal	toe/t	0.7500
Rice husk	toe/t	0.2850
Sunflower husk	toe/t	0.3800
Barley husk	toe/t	0.3712
Coke of coal	toe/t	0.6800
Petcoke	toe/t	0.9386
Imported petcoke	toe/t	0.8000
Fuel gas	toe/10³m³	1.1000
Natural gas	toe/10³m³	0.8300
Odorous gases	toe/10³m³	0.2400
Firewood	toe/t	0.2700
Lubricants	toe/m³	0.9090
	toe/t	1.0100
Methanol	toe/t	0.3600

NOTE: Natural gas: the data are considered under standard conditions (1 atm and 15ºC).

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TABLE 21. Variable conversion factors in the historical series

	unit	2023
Sawdust, chips, forest wastes [(1)]	toe/t	**0,2794**
Bagasse	toe/t	**0,1769**
Deodorized butane	toe/m³	**0,6118**
	toe/t	**1,0946**
Coal	toe/t	**0,2740**
Medium fuel oil [(3)]	toe/m³	**0,9239**
	toe/t	**0,9911**
Intermediate fuel oil (IFO) [(1)]	toe/m³	**0,9288**
	toe/t	**0,9854**
Heavy fuel oil	toe/m³	**0,9439**
	toe/t	**0,9787**
Fuel oil [(4)] (FOR ELECTRICITY GENERATION)	toe/m³	**0,9299**
	toe/t	**0,9872**
Fuel oil (FOR CELLULOSE PLANTS)	toe/m³	**0,9346**
	toe/t	**0,9825**
Gas oil [(5)] (SULPHUR CONTENT < 10 PPM)	toe/m³	**0,8521**
	toe/t	**1,0271**
Gas oil [(5)] (SULPHUR CONTENT < 50 PPM)	toe/m³	**0,8551**
	toe/t	**1,0260**
Marine gas oil [(5)]	toe/m³	**0,8690**
	toe/t	**1,0207**
Aviation gasoline (OCTANE NUMBER - AVIATION METHOD: 100)	toe/m³	**0,7580**
	toe/t	**1,0548**
Gasoline [(6)] (OCTANE NUMBER RON: 97)	toe/m³	**0,7849**
	toe/t	**1,0476**
Gasoline [(6)] (OCTANE NUMBER RON: 95)	toe/m³	**0,7774**
	toe/t	**1,0497**
Black liquor [(1)]	toe/t	**0,3162**

	unit	2023
Crude oil	toe/m³	**0,8466**
	toe/t	**1,0270**
Propane	toe/m³	**0,5692**
	toe/t	**1,1004**
Kerosene	toe/m³	**0,8313**
	toe/t	**1,0337**
Industrial wastes [(1)]	toe/t	**0,7482**
Solvents [(1)]	toe/m³	**0,7971**
	toe/t	**1,0438**
LP gas	toe/m³	**0,6095**
	toe/t	**1,0927**
Jet fuel	toe/m³	**0,8296**
	toe/t	**1,0341**

NOTES:
1) Weighted average. **2)** Data on gaseous products are estimated (ASTM D3588), under atmospheric pressure conditions and at 15.6°C. **3)** Medium fuel oil corresponds to heating fuel oil. **4)** Corresponds to fuel oil used by UTE to generate electricity. Values up to 2010 are reported by ANCAP as "FUEL-OIL UTE" and after 2011 as "FUELOIL UTE MOTORES". **5)** Gas oil with sulphur content lower than 10 ppm and marine gas oil are not sold with biodiesel. In 2023 there was no blended biodiesel in gas oil with sulphur content lower than 50 ppm. **6)** For motor gasoline, the reported parameters correspond to the fuel before the addition of bioethanol.

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I.3. CO_2 emission factors

TABLE 22. CO_2 emission factors

Fuel by Energy Balance	Fuel by IPCC	CO_2 EF (kg/TJ)
Biodiesel	Biodiesel	70,800
Bioethanol	Biogasoline	70,800
Coal (2)	Lignite	101,000
Charcoal	Charcoal	112,000
Coke of coal	Coke oven coke	107,000
Petcoke	Petroleum coke	97,500
Diesel oil	Gas/diésel oil	74,100
Fuel oil	Residual fuel oil	77,400
Fuel gas	Refinery gas	57,600
Manufactured gas	Other petroleum products	44,400
Natural gas	Natural gas	56,100
Gas oil	Gas/diésel oil	74,100
Firewood	Wood	112,000
Motor gasoline	Motor gasoline	69,300
Aviation gasoline	Aviation gasoline	70,000
Black liquor	Black liquor	95,300
Naphtha	Naphtha	73,300
Propane	Liquefied petroleum gases	63,100
Kerosene	Other kerosene	71,900
Biomass wastes	Other primary solid biomass	100,000
Industrial wastes (3)	Industrial wastes	81,062
LP gas	Liquefied petroleum gases	63,100
Jet fuel	Jet kerosene	71,500

1) IPCC, *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chart 1.4: Default CO_2 emission factors for combustion*, <https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf> (08/01/2024). **2)** Heating value of coal used in 2023 was similar to lignite. **3)** Weighted average.

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I.4. Acronyms

TABLE 23. Acronyms

ADME	Electricity Market Administration
AGESIC	National Agency for the Development of e-Government and the Information Society
ALUR	Alcohols of Uruguay
ANCAP	National Administration of Fuels, Alcohol, and Portland
BCU	Central Bank of Uruguay
BEN	National Energy Balance
CALNU	Limited Agrarian Cooperative of Northern Uruguay
CO_2	Carbon dioxide
DIEA	Agricultural Statistics Office
DINAMIGE	National Directorate of Mining and Geology
DNE	National Directorate of Energy
EF	CO_2 emission factor
GDP	Gross Domestic Product
Gg	Gigagram
HHV	Higher Heating Value
INAC	National Meat Institute
INE	National Statistics Institute
INGEI	National greenhouse gas inventories
inhab.	Inhabitants
IPCC	Intergovernmental Panel on Climate Change
IRES	International Recommendations for Energy Statistics
ISIC	International Standard Industrial Classification
kcal	Kilocalorie
ktoe	Kilotonnes of oil equivalent
kWh	Kilowatt-hour
kWp	Kilowatt peak
LHV	Lower Heating Value
LPG	Liquefied petroleum gas
M$ 2016	Millions of Uruguayan pesos at constant 2016 prices
m^3	Cubic meter
MGAP	Ministry of Livestock, Agriculture and Fisheries
MIEM	Ministry of Industry, Energy and Mining
MW	Megawatt
MWh	Megawatt-hour
NCM	Mercosur Common Nomenclature
OLADE	Latin American Energy Organization
OPYPA	Office of Programming and Agricultural Policy
PEB	Planning, Statistics and Balance Area (at DNE)
ppm	Parts per million
SIN	National Interconnected System
t	Tonne
toe	Tonne of oil equivalent
UTE	National Administration of Power Plants and Electrical Transmissions

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ANNEX II.
Consolidated matrix and flow chart

General remarks

1. The consolidated matrix and flow chart for the year 2023 is presented.

   The complete matrix series for the 1965-2023 period is available at:
   https://ben.miem.gub.uy/matrices.php

   Flow charts for the years 1965, 1980, 1996, 1996, 2001, 2005, 2010 and from 2015 onwards can be downloaded from:
   https://ben.miem.gub.uy/anteriores.php

2. Energy flows are expressed in ktoe (thousand tonnes of oil equivalent)

   1 ktoe = 1,000 toe
   1 toe = 10,000,000 kcal

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CONSOLIDATED MATRIX 2023 (ktoe)	▼ Primary energy source											▼ Secondary energy source																	
	CRUDE OIL	MINERAL COAL	NATURAL GAS	HYDROPOWER	WIND ENERGY	SOLAR ENERGY	FIREWOOD	BIOMASS WASTE	BIOMASS FOR BIOFUELS	INDUSTRIAL WASTE	TOTAL	LPG	MOTOR GASOLINE	AVIATION GASOLINE	KEROSENE	JET FUEL	GAS OIL	FUEL OIL	PETCOKE	NON-ENERGY PRODUCTS	FUEL GAS	BIOETHANOL	BIODIESEL	COKE OF COAL	CHARCOAL	ELECTRICITY	TOTAL	TRANSFORMATION LOSSES	TOTAL
PRODUCTION				700.9	440.8	52.1	472.4	2,278.9	56.2	8.6	**4,009.9**	78.3	439.1		3.5	66.1	696.8	117.3	19.8	5.6	42.2	48.9	7.3			1,107.4	**2,632.3**		
IMPORT	1,354.3	1.6	65.7					1.6			**1,423.2**	58.8	193.7	1.5		26.0	548.9	123.5	120.8	128.7				0.1	4.0	120.2	**1,326.2**		
EXPORT								-1.4			**-1.4**	-0.6								-0.1		-0.1	-6.9			-21.0	**-28.7**		
INTERNATIONAL BUNKER														-0,0		-94.2	-88.6	-9.7									**-192.5**		
LOSSES	-0.5		-0.2					-198.7			**-199.4**	-0.9		-0.1	-0.1	-0.2	-0.7	-0.2		-0.2		-0.4	-0,0			-107.9	**-110.7**		
STOCK CHANGE	121.0	0.5									**121.5**	4.8	-14.7	0.6	-0.3	4.6	-83.5	22.4	-23.3	0.5		-4.9	-0.3				**-94.1**		
ENERGY NOT USED			-0,0	-355.2	-31.0	-1.8					**-388.0**										-1.6						**-1.6**		
ADJUSTMENTS		-0.1	-0.1			0.1					**-0.1**			-0.1			-0.1	-0.1		0.1		0.1				-0.2	**-0.3**		
SUPPLY	1,474.8	2.0	65.4	345.7	409.8	50.4	472.4	2,080.4	56.2	8.6	**4,965.7**	140.4	618.1	1.9	3.1	2.3	1,072.8	253.2	117.3	134.6	40.6	43.6	0.1	0.1	4.0	1,098.5	**3,530.6**		
REFINERY	-1,474.8										**-1,474.8**	78.3	439.1		3.5	66.1	696.8	117.3	19.8	5.6	42.2						**1,468.7**	-6.1	
POWER PLANTS FOR PUBLIC SERVICE				-345.7	-407.9	-37.8	-0.8	-145.6			**-937.8**						-165.4	-28.3								928.9	**735.2**	-202.6	
AUTOPRODUCTION POWER PLANTS					-1.9	-4.5	-1.8	-221.5			**-229.7**		-0,0				-1.0	-3.7				-0,0				178.5	**173.8**	-55.9	
BIOMASS DISTILLERIES									-48.9		**-48.9**											48.9					**48.9**		
BIODIESEL PLANTS									-7.3		**-7.3**												7.3				**7.3**		
TRANSFORMATION CENTERS	-1,474.8			-345.7	-409.8	-42.3	-2.6	-367.1	-56.2		**-2,698.5**	78.3	439.1		3.5	66.1	530.4	85.3	19.8	5.6	42.2	48.9	7.3			1,107.4	**2,433.9**	-264.6	
GROSS SUPPLY	1,475.3	2.0	65.6	700.9	440.8	52.2	472.4	2,279.1	56.2	8.6	**5,553.1**	141.3	618.1	2.0	3.2	2.5	1,073.5	253.4	117.3	134.8	42.2	44.0	0.1	0.1	4.0	1,206.4	**3,642.9**		**6,563.7**
TOTAL NET CONSUMPTION		2.0	65.4			8.1	469.8	1,713.3		8.6	**2,267.2**	140.4	618.1	1.9	3.1	2.3	906.4	221.2	117.3	134.6	40.6	43.6	0.1	0.1	4.0	1,098.5	**3,332.2**		**5,599.4**
OWN USE			20.6			0.1					**20.7**	7.9	0.1		0.0		0.7	2.2	19.8	0.0	40.6	0.0				35.1	**106.4**		**127.1**
TOTAL FINAL CONSUMPTION		2.0	44.8			8.0	469.8	1,713.3		8.6	**2,246.5**	132.5	618.0	1.9	3.1	2.3	905.7	219.0	97.5	134.6		43.6	0.1	0.1	4.0	1,063.4	**3,225.8**		**5,472.3**
NON-ENERGY CONSUMPTION		0.0									**0.0**		0.0		0.0		0.1		0.9	134.6		0.0					**135.6**		**135.6**
FINAL ENERGY CONSUMPTION		2.0	44.8			8.0	469.8	1,713.3		8.6	**2,246.5**	132.5	618.0	1.9	3.1	2.3	905.6	219.0	96.6			43.6	0.1	0.1	4.0	1,063.4	**3,090.2**		**5,336.7**
BREAKDOWN BY SECTOR ▸ **RESIDENTIAL**			18.9			6.6	283.5	7.6			**316.6**	104.6	0.4		0.9		5.4	0.7				0.0			4.0	409.4	**525.4**		**842.0**
MONTEVIDEO			17.2				55.5					47.9														153.2			
REST OF THE COUNTRY			1.7				228.0	7.6				56.7														256.2			
COMMERCIAL/SERVICES/PUBLIC SECTOR			12.8			1.2	22.1				**36.1**	9.8	1.0		0.0		4.3	15.2				0.1			0.0	261.8	**292.2**		**328.3**
PUBLIC LIGHTING																										15.000			
PUBLIC ADMINISTRATION AND DEFENSE							2.1					1.3					0.2	1.3								18.3			
ELECTRICITY, GAS AND WATER							0.1					0.8					0.0	0.1								27.1			
OTHERS			12.8				19.9					7.7					4.1	13.8							0.0	201.4			
TRANSPORT													611.7	1.9		2.3	742.6	0.1				43.2				1.0	**1,402.8**		**1,402.8**
ROAD													611.7				731.8					43.2				1.0	***1,387.7***		***1,387.7***
RAIL																	0.1										***0.1***		***0.1***
AIR														1.9		2.3											***4.2***		***4.2***
SEA AND FLUVIAL																	10.7	0.1									***10.8***		***10.8***
INDUSTRIAL		2.0	13.1			0.2	149.1	1,705.7		8.6	**1,878.7**	10.7	1.9				20.1	198.8	96.6			0.1	0.1	0.1		336.6	**665.0**		**2,543.7**
SLAUGHTERHOUSES			0.1				27.8	5.7		1.4		0.7	0.1				0.6	2.4								29.6			
DIARY			0.3				22.3	23.4		0.0		1.2	0.2				0.8	12.9								21.1			
MILLS			0.0				8.6	42.5		0.0		0.6	0.1				0.4	0.0								9.7			
OTHER FOOD INDUSTRIES			4.0				29.2	30.2		0.0		4.8	0.4				0.7	2.9					0.1			19.3			
BEVERAGES AND TOBACCO			0.7				17.4	17.0		0.0		0.2	0.2				0.3	2.1								12.7			
TEXTILE			0.1				4.1			0.0		0.0	0.0				0.1	0.3								2.4			
LEATHER			0.2				8.2			0.0		0.1	0.0				0.2	0.3								2.3			
WOOD			0.0				0.0	150.0		0.0		0.0	0.0				2.9									13.1			
PAPER AND CELLULOSE			1.5				16.1	1,415.3		0.0		0.1	0.0				3.2	163.0								142.9			
CHEMICAL, RUBBER AND PLASTIC			1.4				15.2	16.0		0.3		1.0	0.3				2.6	3.0								57.6			
CEMENT		2.0	1.0					3.9		6.8		0.0	0.0				2.6	1.2	96.6							9.100			
OTHER MFG. IND. AND CONSTRUCTION			3.8				0.2	1.7		0.1		2.0	0.6				5.7	10.7						0.1		16.8			
PRIMARY ACTIVITIES							15.1				**15.1**	7.4	3.0		0.0		133.2	1.6				0.2				22.0	**167.4**		**182.5**
AGRICULTURE							15.1				*15.1*	7.4					109.7	1.6								20.0	***138.7***		***153.8***
POULTRY							1.4				*1.4*	4.7														2.4	***7.1***		***8.5***
REMAINING AGRIC. SUBSECTORS							13.7				*13.7*	2.7					109.7	1.6								17.6	***131.6***		***145.3***
MINING							0.0				*0.0*	0.0	0.0		0.0		8.0					0.0				1.6	***9.6***		***9.6***
FISHING												0.0	3.0				15.5					0.2				0.4	***19.1***		***19.1***
NOT IDENTIFIED												0.0			2.2			2.6								32.6	37.4		**37.4**

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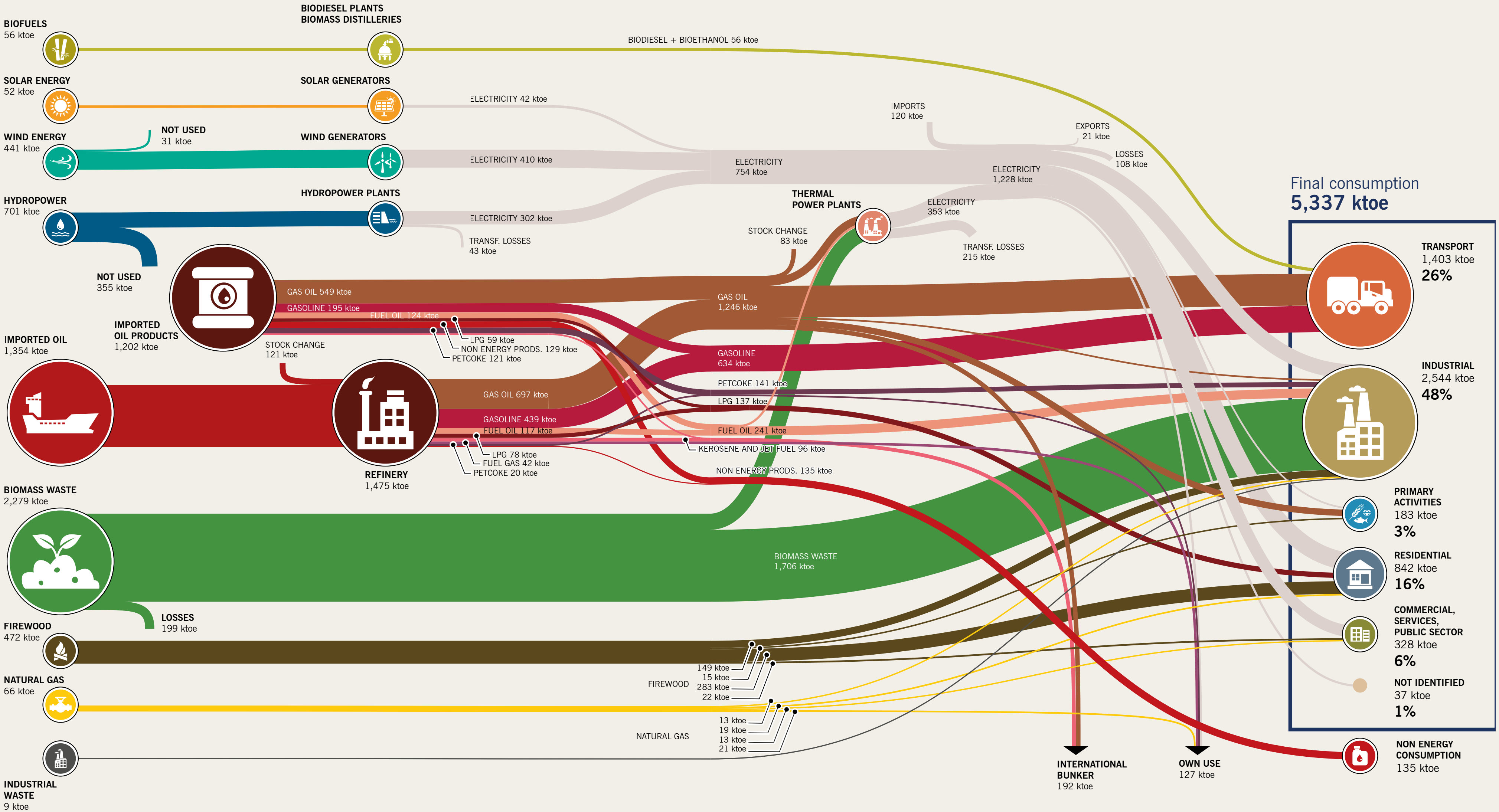
FLOW CHART
2023
(ktoe)

NOTE:
Only main energy flows are represented.



Energy Balance 2023

República Oriental del Uruguay
Ministry of Industry, Energy and Mining
National Energy Directorate