Energy Balance 2021

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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BEN BALANCE ENERGÉTICO NACIONAL URUGUAY

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Foreword

The National Energy Directorate (DNE) presents the National Energy Balance (BEN), which includes the main results of the energy sector at the national level for the year 2021. The BEN aims to provide information for the design and review of public policies, as well as issues related to the energy planning process. It is a very good tool that allows the government and the private sector to make decisions.

The year 2021 was a year of economic growth, but it still had the aftereffects of the pandemic, especially in the first quarter. This impacted some sectors, as did the drought, although this had less of an impact than in 2020.

In addition to this, the severe drought in southern Brazil led the country to import more electricity. Uruguay's role was to assist through exports. In 2022, to a lesser extent, the same occurred in Argentina. This challenge was timely to demonstrate the resilience of that system and the good functioning of the interconnection between our three countries.

In terms of supply, the conditions that characterized 2021 determined that the energy matrix was 5% higher than in 2020. This is largely explained by the increase in oil and oil products supply, mainly due to higher imports of gas oil for electricity generation. In turn, the supply matrix was 57% renewable, an excellent number by international standards, although it showed a decline from 2019 (63%).

The BEN 2021 showed that 71% of the consumption of oil products corresponded to the transport sector. However, for years, the sector with the highest energy consumption, taking into account all sources, was the industrial sector, which, in turn, generated almost half of the electrical energy it consumed. Its most demanded energy source was biomass, with 65%. The main industry in terms of consumption was the pulp and paper industry, which used biomass waste to a greater extent.

As for transport, in 2021, gasoline consumption increased 7% and gas oil consumption 12%. This demand had fallen in 2020, due to the decline in mobility caused by the pandemic. Meanwhile, even though it remained a minority, the demand for electric energy in transport almost doubled again, due to an increase in sales of electric and hybrid vehicles; demand went from just over 2,500 MWh to 4,600 MWh.

The country once again made a strong commitment to energy efficiency, a very important axis for Uruguay. It is also important to highlight the relevance of the diagnoses that are being developed in several sectors to learn more about energy issues and thus make the best decisions.

Finally, we would like to thank official agencies and private institutions for the valuable information they have provided, which made possible the preparation of this work.

Fitzgerald Cantero Piali, 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 the different energy flows. It comprises the supply, transformation, and sectoral consumption of energy (demand), expressed in a common unit and referred to as a calendar year. It is a necessary tool for energy planning since it shows the structure of energy production and consumption in the country. In turn, it is an input for the definition, monitoring, and evaluation of energy and environmental policies, as well as for the elaboration of other studies such as the National Greenhouse Gas Inventory (INGEI) of the energy sector. On the other hand, it must be related to other socioeconomic variables to obtain a sufficient instrument for decision-making in this area.

The National Energy Directorate (DNE) of the Ministry of Industry, Energy and Mining (MIEM) prepares and publishes the BEN annually through the area "Planning, Statistics and Balance" (PEB) and has information since 1965. Thus, with the BEN 2021, 57 years of the historical series are completed. Uruguay is one of the few countries in Latin America and the Caribbean to have such an extensive series of BENs published without interruption and available to the public. This publication continues a series that began in 1981 with the "National Energy Balance - Historical Series 1965-1980", carried out with the support and methodology of the Latin American Energy Organization (OLADE).

To make the figures for the different sources that make up the energy supply (which have different heating values) comparable, the values are expressed in ktoe (thousands of tonnes of oil equivalent), where one ton of oil equivalent (toe) corresponds to ten million kilocalories. The conversion of the corresponding magnitudes of each source to their expression in ktoe is done through their respective lower heating value (LHV).

The presentation of the information has varied significantly over the years. These are the modifications and improvements included in BEN 2021.

Sources:

- Biomass for biofuels: a change in criteria is incorporated, in which primary biomass is considered equal to bioethanol and biodiesel production. This change is in line with the IRES international recommendations that consider biofuels as primary energy sources. The entire 2010-2021 series is corrected.

- Biomass waste: the rumen consumed in the meat industry for energy purposes is beginning to be included. It has been considered since 2014; however, its value is very small compared to the rest of the waste.

- Solar thermal energy: a review is carried out for the entire historical series of the industrial sector.

Sectors:

- Agriculture sector: a revision and correction of the technical coefficients for the years from 2019 is made.

Other improvements:

- Global GDP series: a retropolated[1] Gross Domestic Product series by the Ministry of Economy and Finance (MEF) for the years 1965-2015 is being used. It should be noted that for the years after 2016, the official data published annually by the Central Bank of Uruguay (BCU) were already being used. This completes a GDP series for the entire historical series included in the BEN.

- Physicochemical properties: products that were not disaggregated or identified as such (fuels for electricity generation, industrial wastes, etc.) are added.

1- Retropolation is a technique that uses the variations in value, volume or price indexes of the series prepared with an older base year, to apply them to the values of the new base year. This mathematical procedure implies respecting the historical evolution of the variables.

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2. Uruguayan energy system infrastructure

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

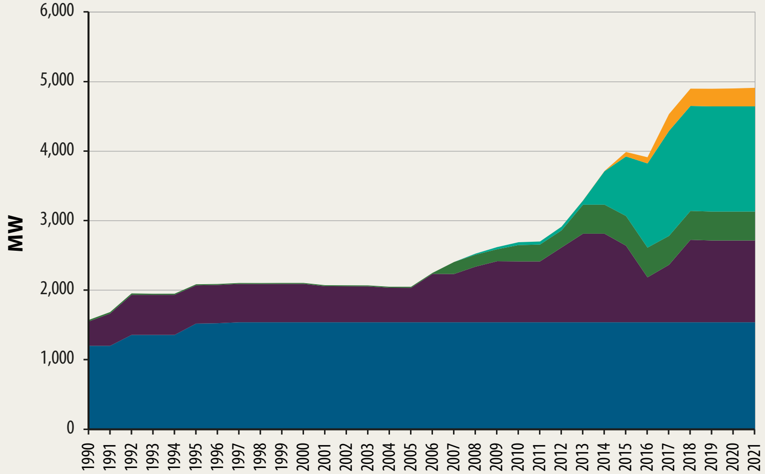
2.1. Power transformation sector

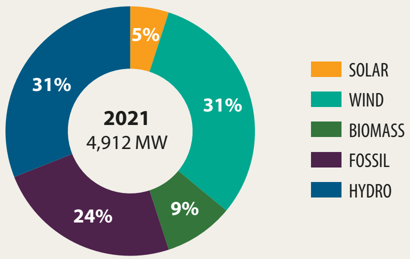
The country has four hydroelectric power plants; three are located on the Río Negro and one on the Río Uruguay (shared with Argentina). There are also thermal power plants operated by steam turbines, gas turbines, and engines run on fossil fuels and biomass. In addition, the power transformation sector 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).

By the end of 2021, Uruguay had a total installed capacity of 4,912 MW, including generators connected to the SIN and isolated generators. The capacity consisted of 1,538 MW from hydropower, 1,514 MW from wind, 1,177 MW from thermal fossil, 416 MW from thermal biomass, and 267 MW from photovoltaic solar generators. Considering installed capacity by source, 76% corresponded to renewable energy (hydropower, biomass, wind, and solar), while the remaining 24% was nonrenewable energy (gas oil, fuel oil, and natural gas).

2021
Installed capacity for power generation: 4,912 MW, 76% of which comes from renewable sources.

FIGURE 1. Installed capacity by source





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In the early 1990s, the total capacity of the generation park increased by 33%: from 1,571 MW (1990) to 2,085 MW (1995). This was mainly due to added capacity from fossil and hydropower sources (Uruguay began to use 50% of Salto Grande's installed capacity). Afterward, almost no new generators were included until 2005, when the total installed capacity had a net growth of 140%, reaching 4,925 MW towards the end of 2020. This growth was influenced by new local energy sources—which complemented traditional sources—and the diversification of the energy matrix. It is worth mentioning that, although the increase was net in the entire period, 2016 was the only year when the total installed capacity declined compared to the previous year, as fewer thermal plants operated, as detailed below.

In 2017, installed capacity grew again, reporting a new historical maximum in 2018 caused by the combined cycle plant's operational startup in Punta del Tigre and a series of wind farms and photovoltaic plants in recent years. Between 2019 and 2021, installed capacity has remained practically constant.

TABLE 1. Installed capacity by source

MW	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Fossil																
Steam turbines	256.5	256.5	256.5	255.0	255.0	255.0	255.0	255.0	255.0	205.0						
Gas turbines	54.7	249.7	249.7	235.7	535.7	535.7	635.7	835.7	835.7	815.7	565.7	745.7	1,105.7	1,105.7	1,105.7	**1,105.7**
Engines	38.8	44.4	46.0	5.5	85.0	85.0	185.0	184.2	184.2	81.0	81.0	81.0	81.0	71.0	71.0	**71.0**
Total Fossil	**350.0**	**550.6**	**552.2**	**496.2**	**875.7**	**875.7**	**1,075.7**	**1,274.9**	**1,274.9**	**1,101.7**	**646.7**	**826.7**	**1,186.7**	**1,176.7**	**1,176.7**	**1,176.7**
(%)	**22%**	**26%**	**26%**	**24%**	**33%**	**32%**	**37%**	**39%**	**34%**	**28%**	**17%**	**18%**	**24%**	**24%**	**24%**	**24%**
Biomass																
Steam turbines	21.6	14.9	13.7	13.5	234.6	242.1	246.1	416.1	416.1	426.1	426.1	414.6	414.6	414.6	414.6	**414.6**
Engines				1.0	1.0	1.0	1.0	1.0	1.6	1.6	1.6	1.6	1.6	1.7	1.7	**1.8**
Total Biomass	**21.6**	**14.9**	**13.7**	**14.5**	**235.6**	**243.1**	**247.1**	**417.1**	**417.7**	**427.7**	**427.7**	**416.2**	**416.2**	**416.3**	**416.3**	**416.4**
(%)	**1%**	**1%**	**1%**	**1%**	**9%**	**9%**	**8%**	**13%**	**11%**	**11%**	**11%**	**9%**	**8%**	**8%**	**8%**	**8%**
Hydro																
Total Hydro	**1,199.0**	**1,519.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**	**1,538.0**
(%)	**76%**	**73%**	**73%**	**75%**	**57%**	**57%**	**53%**	**47%**	**41%**	**39%**	**39%**	**34%**	**31%**	**31%**	**31%**	**31%**
Wind																
Total Wind					**40.6**	**43.6**	**52.6**	**59.4**	**481.3**	**856.8**	**1,211.5**	**1,510.7**	**1,510.7**	**1,514.0**	**1,514.0**	**1,514.0**
(%)					**2%**	**2%**	**2%**	**2%**	**13%**	**21%**	**31%**	**33%**	**31%**	**31%**	**31%**	**31%**
Solar																
Total Solar					**0.1**	**0.4**	**0.6**	**1.6**	**3.7**	**64.5**	**89.0**	**242.6**	**248.4**	**253.6**	**258.1**	**267.0**
(%)					**0%**	**0%**	**0%**	**0%**	**0%**	**2%**	**2%**	**5%**	**5%**	**5%**	**5%**	**5%**
TOTAL	**1,570.6**	**2,084.5**	**2,104.0**	**2,048.6**	**2,690.0**	**2,700.8**	**2,914.0**	**3,291.0**	**3,715.6**	**3,988.6**	**3,912.8**	**4,534.2**	**4,899.9**	**4,898.6**	**4,903.0**	**4,912.1**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

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The evolution of the installed capacity of **hydroelectric power plants** increased until the beginning of the 1990-2021 period, due to the gradual addition of power from the Salto Grande hydropower plant into Uruguay: 50% of 1,890 MW from 1995. Since that year, Uruguay completed its installed capacity in large-scale hydropower, which has remained constant. The share of hydropower plants in the total capacity went from 76% (in 1990) to 31% (in 2021).

The installed capacity of **thermal generators that run on fossil fuel** went from 350 MW (in 1990) to 551 MW (in 1995). This was mainly due to the installation of the La Tablada thermal power plant. Since that year, the installed capacity has remained relatively constant, increasing significantly between 2005 and 2014, when 600 MW corresponding to turbines and 179 MW corresponding to engines were incorporated (100 MW of which was rented). In 2013-2014, the maximum value of installed capacity from fossil fuels was reported. Then the trend changed, and the value decreased in the following two years. Between 2014 and 2015, the capacity of thermal fossil generators decreased 170 MW because Sala B at Central Batlle, the turbine in Maldonado, and the engines rented since 2012 ceased to operate. Between 2015 and 2016, there was a 455 MW reduction because the 5th and 6th units of Central Batlle and the leased equipment APR A and APR B ceased to operate. Between 2017 and 2018, the three combined cycle turbines started running in Punta del Tigre B (540 MW). This meant a new increase in the installed capacity of fossil fuels—which remained the same in 2021—and resulted in a 24% share compared to the total installed capacity for the previous year. 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 and is considered the thermal backup for the next 30 years.[2]

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> (30/ 07 /2022).

FIGURE 2. Installed capacity of hydropower plants

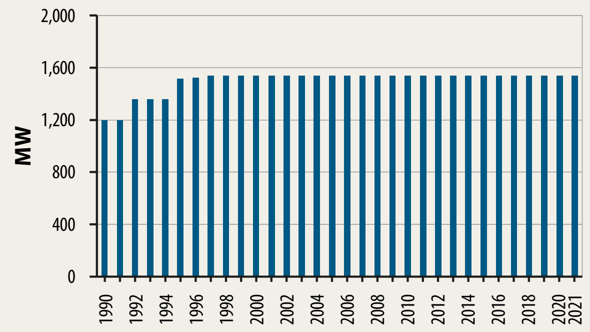
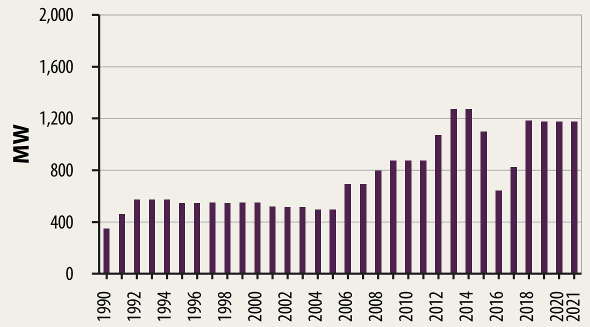


FIGURE 3. Installed capacity of thermal generators that run on fossil



Historically, the installed capacity of **thermal generators using biomass** did not exceed 22 MW until significant growth began in 2006. The electricity purchase contracts between UTE and private generators started to enter into force in 2007. As a result, there was a 410 MW growth in the installed capacity from biomass over the last twelve years. In particular, the increases recorded in 2007 and 2013 corresponded to the installation of cellulose plants which are currently operating in the country. Biomass share amounted to 1% of the total generation capacity until 2006, reaching a maximum value of 13% in 2013 and 9% in 2021.

In 2008, large-scale **wind energy** became part of the mix of energy generation, with the startup of the first wind farms in the country. Both private and public wind generators have been included since that year. This energy source has developed significantly, mainly between 2014 and 2017.

Until 2013, 59 MW of wind generators was installed, and as of 2014, between 300 and 400 MW came into operation each year. In this way, in December 2017, there were 43 large-scale wind farms connected to the network. Their total installed capacity was 1,511 MW considered jointly with microgenerators and autonomous plants. In 2018, there were no new installations, and in 2019, 2.2 MW were installed. This corresponded to off-grid autoproducers (not connected to the SIN), and a single park expanded its power by 1 MW. The share of wind generators in 2020 and 2021 was 31% of the total installed capacity. 2019's installed capacity stayed the same as there were no new installations.

As of December 2021, there are more than 40 large-scale wind farms and more than 20 photovoltaic plants.

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

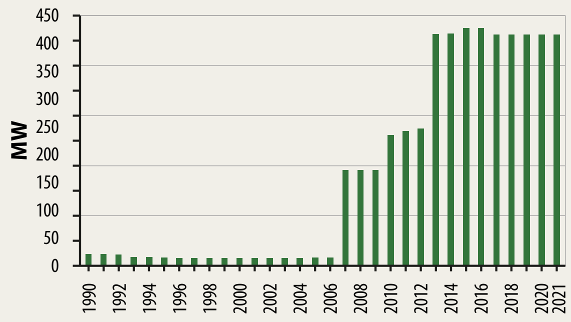
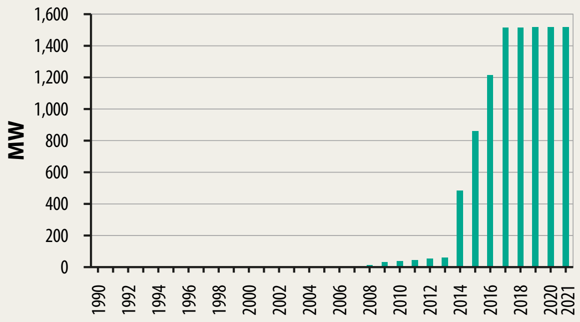


FIGURE 5. Installed capacity of wind generators



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Finally, **photovoltaic solar energy** is mentioned. Although it is a source that has been used in the country for many years, it still reports small values compared to other energy sources. Another highlight is the increased installed capacity recorded from 2015, from 4 MW (2014) to 267 MW (2021). In the last five years, 14 photovoltaic plants came into operation for a total of 150 MW, which allowed solar energy to have a 5% share of the country's total installed capacity.

Micro-scale solar PV generation also showed outstanding development in recent years; in 2021 there were 264 new installations connected to the grid for a total of 7.2 MW, double the capacity recorded in 2020. The sectoral distribution was as follows in order of importance: commercial/services (56%), industrial (22%), agriculture (14%), and residential (8%).

FIGURE 6. Installed capacity of photovoltaic solar generators

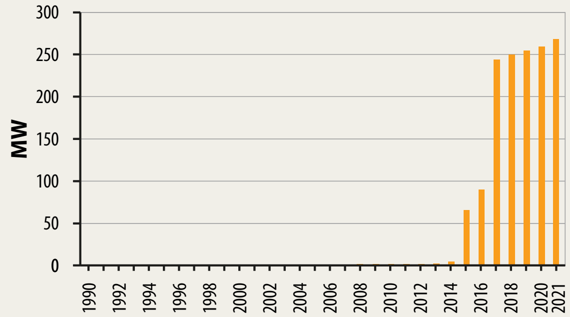

FIGURE 7. Installed capacity of solar microgeneration by sector

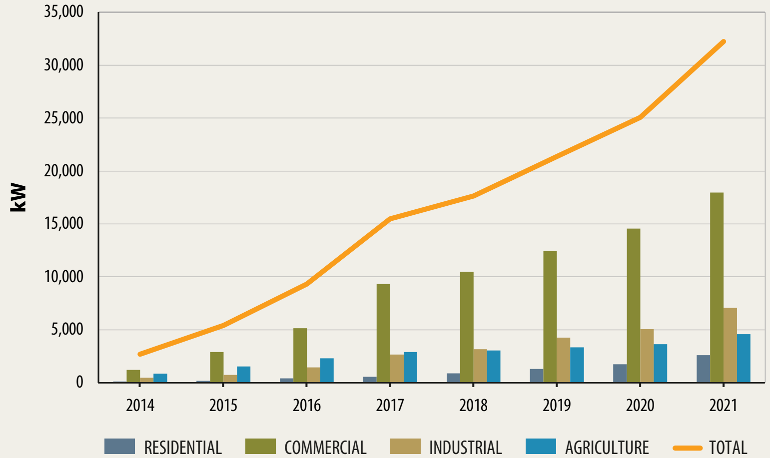

TABLE 2. Installed capacity of solar microgeneration by sector

kW	2014	2015	2016	2017	2018	2019	2020	2021
Residential	133	179	413	576	895	1,319	1,764	**2,601**
(%)	5%	3%	4%	4%	5%	6%	7%	**8%**
Commercial	1,206	2,914	5,137	9,312	10,481	12,412	14,542	**17,945**
(%)	45%	54%	55%	60%	60%	58%	58%	**56%**
Industrial	473	756	1,469	2,667	3,181	4,271	5,066	**7,072**
(%)	18%	14%	16%	17%	18%	20%	20%	**22%**
Agriculture	875	1,558	2,313	2,895	3,053	3,343	3,656	**4,578**
(%)	33%	29%	25%	19%	17%	16%	15%	**14%**
TOTAL	**2,687**	**5,408**	**9,331**	**15,450**	**17,610**	**21,344**	**25,028**	**32,196**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

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2.2. Hydrocarbon sector

Regarding the hydrocarbon sector, Uruguay has only one refinery that belongs to ANCAP, the state oil company located in Montevideo. Currently, its refining capacity is 50,000 barrels per day (8,000 m^3 /day) and, among other products, it produces mainly gas oil, gasoline, fuel oil, LPG (LP gas and propane), and jet fuels. 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 off the coast and transported through a 180 km oil pipeline to the refinery in Montevideo.[3] Fuels and other oil products are transported nationwide by road and sea, using the distribution plants in Montevideo, Colonia, Durazno, Paysandú, and Treinta y Tres.

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

According to data provided by ANCAP, the refinery started operating in 1937 and, over the years, its equipment and oil processing capacity was transformed. It should be noted that, due to the 1993-1995 remodeling, there was no production throughout 1994. At that time, a new catalytic cracking unit and a new visbreaking unit were installed. Additionally, changes were made around the plant to increase the energy efficiency of atmospheric distillation and vacuum units. This remodeling increased the refinery's processing capacity to 37,000 barrels/day (5,900 m^3/day).

In 1999, another significant remodeling period began, aiming to produce high-octane unleaded fuels. A gasoline hydrotreating unit, an isomerization unit, and a continuous catalytic reforming unit were thus installed, expanding the crude-processing capacity to 50,000 barrels a day. Between September 2002 and March 2003 and between September 2011 and January 2012, the refinery was shut down for scheduled maintenance.

3- National Administration of Fuels, Alcohol, and Portland (ANCAP), "Operación Terminales", <https://www.ancap.com.uy/2158/1/operacion-terminales.html> (07/30/2022).

In 2014, the first year of operation of the desulfurization plant was completed to produce gas oil and gasoline with low sulfur content, in line with international fuel specifications.

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

The refinery was shut down for unit maintenance activities between February and September 2017. As a result, there was a decrease in crude oil imports and an increase in the import of oil products to meet demand. Since 2018, the refinery has been operating as usual with a crude oil processing level similar to that of 2016.

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> (07/30/2022).

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Argentina supplies natural gas 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 of the country. It opened in October 1998, and its laying begins in Entre Ríos (Argentina) and ends in the city of Paysandú. The pipeline has 27,200 meters (including distribution branches in Uruguay and the section over the international bridge) and supplies the local distribution network.[6]

There are two gas pipelines with a total capacity of 6,000,000 m^3/day.

The second pipeline has been in operation since November 2002 in the southwestern part of the country and is operated by Gasoducto Cruz del Sur (GCDS). The system stretches from Punta Lara (Argentina) to Montevideo and its surroundings, going 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 trunk for the Río de la Plata crossing and a land trunk between Colonia and Montevideo, as well as several side pipelines that feed the different localities with a total extension of 400 kilometers.[7]

6- National Administration of Fuels, Alcohol, and Portland (ANCAP), “Gasoducto del Litoral”, <https://www.ancap.com.uy/1572/1/gasoducto-del-litoral.html> (07/30/2022).
7- *Gasoducto Cruz del Sur, Operaciones*, <https://www.gcds.com.uy/#operaciones> (12/15/2022).

2.3. Biofuels sector

As of 2010, the BEN has included the production and consumption of biofuels, mainly used in the transport sector blended with gasoline and gas oil. Law 18.195 (14/Nov/2007) and its Regulatory Decree 523/008 (27/Oct/2008) established the legal framework for producing, marketing, and using agrofuels in the country.

ALUR currently has two **bioethanol production** plants located in the north of the country. Since 2006, ALUR has been managing the CALNU cooperative's sugar factory in Bella Unión (Artigas), based on an energy and food project that involved an industrial investment plan to set up a distillery to produce ethanol, among other actions. This agroenergy food complex produces bioethanol, sugar, electricity, and animal feed, mainly from sugar cane juice and molasses and sweet sorghum juice to a lesser extent (although to a lesser extent).[8] According to data supplied directly by the company, the plant's capacity is 120 m^3/day of bioethanol and it operates from May to October. On many occasions, it has worked at higher than nominal capacity (140-190 m^3/day).

In October 2014, a new ethanol production plant was inaugurated in the department of Paysandú, with a 70,000 m^3/year installed capacity. The plant can process grain sorghum, maize, wheat, and barley, operating non-stop throughout the year to produce bioethanol and animal feed. The selected technology comes from the Katzen, a United States company. It stands out as it is energy-efficient, offers the possibility to use summer and winter crops, and has a low environmental impact.[9]

As for **biodiesel production**, ALUR features two industrial complexes located in the department of Montevideo. Plant N°1 is located in Paso de la Arena and has a biodiesel production capacity of 18,000 m^3/year from refined oil, used oil

8- Alcohols of Uruguay (ALUR), “Complejo Agroenergético” - Bella Unión, Artigas, <https://www.alur.com.uy/agroindustrias/bella-union> (07/30/2022).
9- Alcohols of Uruguay (ALUR), “Planta Bioetanol” – Paysandú, <https://www.alur.com.uy/agroindustrias/paysandu> (07/30/2022).

for frying, and beef fat. In addition, glycerin is produced as a byproduct, but this plant is not currently in operation. Plant N°2—which is in operation—is located in Capurro and has a biodiesel installed capacity of 62,000 m^3/year from vegetable oil, used frying oil, and beef fat. The products are biofuel, olein, and glycerin.

Installed production capacity (operational) to 2021:
bioethanol: 95,800 m^3/year
biodiesel: 50,000 tonnes/year

An agreement was signed with the company COUSA to ensure the efficient production of biodiesel, whereby its infrastructure is available for use. In turn, the private company provides grain milling and oil production services, supplying the raw material for both biodiesel plants. Soybeans and canola seeds are received to produce crude degummed oil and protein meal.

In 2015, the industrial process of plants N°1 and N°2 and the final product were certified according to the European standard *International Sustainability and Carbon Certification* (ISCC)[10] to produce biodiesel from frying oil and fat.

10- Alcohols of Uruguay (ALUR), "Planta 2 Biodiesel – Capurro", Montevideo, <https://www.alur.com.uy/agroindustrias/capurro> (07/30/2022).

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3. Energy supply

In 2021, the total gross energy supply in the country was 5,637 ktoe, 7% higher compared to the previous year and similar to that of 2019. Among the main sources that participated in the energy supply in 2021, it is worth mentioning:

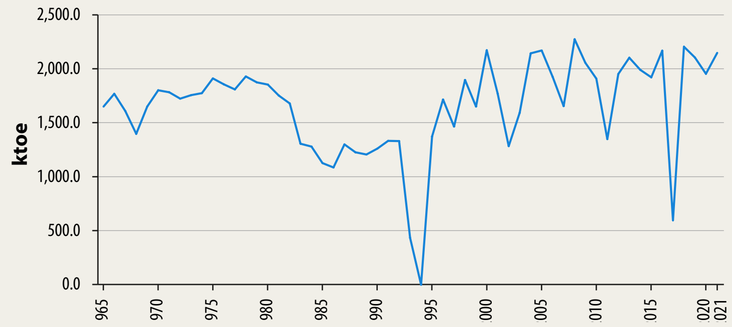
Oil and oil products:

In 2021, gross oil supply was 2,146 ktoe and registered a 10% growth compared to 2020. Refinery loadings showed similar behavior to that of the gross supply. During 2021, 2,050 ktoe of virgin crude oil (2,409 thousand m^3) were imported, 3% more than the previous year. It must be noted that, the years when the refinery was shut down for maintenance, where there were lower values of gross oil supply, such as 2002-2003, 2007, 2011 and 2017, or directly a null value for 1994, the year in which the refinery was shut down for remodeling.

Regarding oil products, in 2021 gross supply was 2,521 ktoe, 21% higher than in 2020. Within supply activities, the level of production was 2,135 ktoe and that of imports was 470 ktoe, which implied growth of 10% and 45%, respectively, compared to the previous year. It should be noted that in 2020 there had been a drop in the consumption of oil products partly due to measures adopted during the pandemic (reduction of mobility), which impacted the refinery's production.

Gas oil consumption for electricity generation was a consequence of low rainfall; its import increased in 2020 and 2021. The main oil products imported in 2021 were gas oil, followed by petcoke, and, to a lesser extent, non-energy products, and LPG. Fuel oil in 2021 was 100% supplied by the refinery, and there were no direct imports from free trade zones.

FIGURE 8. Gross oil supply



Exports of oil products in 2021 were three times higher than in the previous two years and corresponded to gasoline, propane, and non-energy products. The flow of international bunker dropped 6% in the last year, mainly due to a reduction in gas oil, which dropped from 86 ktoe to 77 ktoe, while bunker sales of jet fuels and fuel oil were similar between 2020 and 2021.

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Natural gas:

Natural gas imports in 2021 amounted to 68 ktoe, 14% more than in 2020. It is important to highlight that in 2019 there was an import higher than the average of recent years. The high value was associated with the consumption of natural gas recorded in the electricity sector, specifically in the tests conducted by UTE in the new combined cycle power plant.

Hydropower:

The gross supply of hydropower varies greatly from one year to another, as it depends on hydrological characteristics. In 2021 it was 511 ktoe and presented an increase of 28% concerning 2020, a year in which one of the lowest values of the last 30 years was recorded (400 ktoe). This was surpassed only by another minimum recorded in 2006 (343 ktoe). Water discharged (not used or not flowing through a turbine) is another variable monitored for this energy source. In the last two years, it corresponded to 1% of the hydropower produced, a practically negligible value compared to the situation that had been occurring until 2019, with 31% of water discharged concerning the hydropower produced (average value between 2016-2019).

Wind and solar energy:

In 2021, the gross wind power supply dropped 8% compared to 2020 and recorded a value similar to that of 2019. In the last two years, there was no increase in the installed capacity for electricity generation. On the other hand, the gross supply of solar energy presented a 7% increase. Both solar thermal and photovoltaic energy has been included in the matrix of results since 2014.

FIGURE 9. Gross natural gas supply

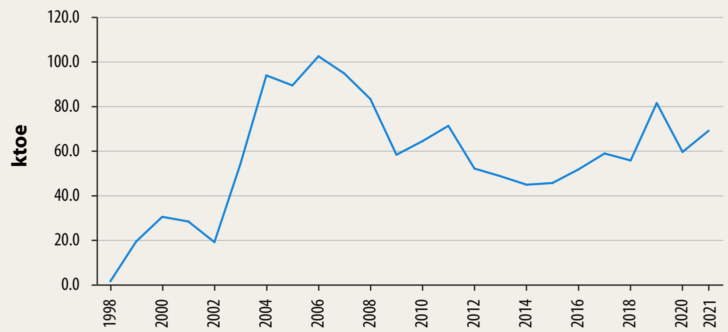


FIGURE 10. Gross hydropower supply

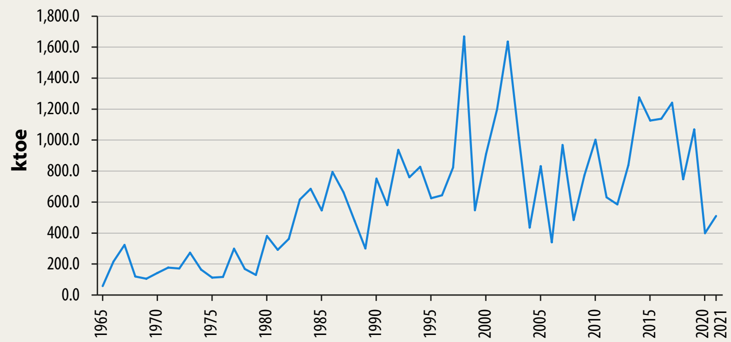
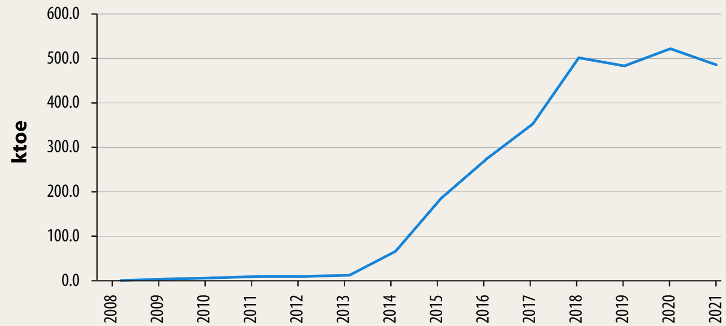


FIGURE 11. Gross wind and solar supply



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Biomass:

The gross biomass supply grew 2% compared to 2020 and reached a new record consumption of 2,266 ktoe. The gross biomass supply in 2021 accounted for 41% of the gross supply from primary sources; it surpassed oil whose share was 39%. To analyze the behavior of biomass, it is convenient to disaggregate it into the different sources that participate under this denomination: firewood, biomass waste (rice husk, sugarcane bagasse, black liquor, odorous gases, methanol, barley, husk, and rumen), and biomass for biofuel production.

The gross firewood supply for 2021 was 478 ktoe, 1% higher than that recorded in 2020 but somewhat lower than in previous years.

The gross supply of biomass waste increased 3% in 2021 (1,710 ktoe) compared to 2020 (1,663 ktoe). In the case of biomass for biofuel production, the gross supply for 2021 (78 ktoe) remained similar to the previous year.

Industrial waste:

This source includes waste such as end-of-life tires, used oils, glycerin, and alternative liquid fuels (CLA), mostly composed of hydrocarbons recovered from bilge water, as well as waste from the biodiesel industry. Although the gross supply in 2021 showed a 25% drop compared to the previous year, industrial waste had a much lower supply than the rest of the energy sources; for 2021 it was 7 ktoe.

Coal and coal coke:

In 2021, the gross supply from these sources was 3.5 ktoe, just below that recorded in 2020 (3.8 ktoe).

Imported/exported electricity:

In 2021, there was a total electricity import of 5 ktoe (55 GWh). This marginal value was of the order of that which had been occurring before 2020, the year in which the purchase of electricity had a one-off increase.

FIGURE 12. Gross firewood supply

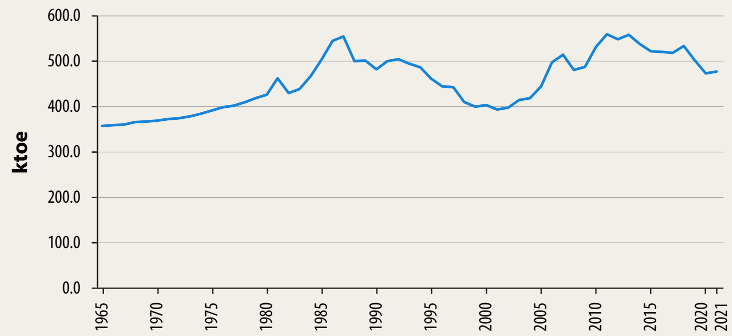
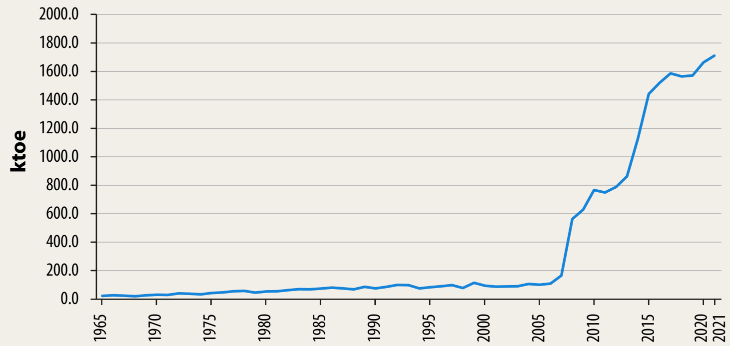


FIGURE 13. Gross biomass waste supply



For its part, electricity exports in 2021 were 245 ktoe (2,844 GWh), 148% higher than the previous year and similar to that of 2019, the year in which the historical maximum of electricity exports since 1965 (259 ktoe) was recorded. Electricity exported in 2021 corresponded to 18% of the generation.

In 2021, electricity exports corresponded to 18% of generation and were similar to that of 2019, the historical maximum of the series.

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3.1. Energy supply

The country's primary energy matrix also called "the matrix of energy supply", has had a net growth of 148% between 1990 and 2021. That year, after growing 5% compared to 2020, it registered a record 5,644 ktoe.

3.1.1. Primary matrix by source

In 2021, energy supply was as follows, in order of importance: oil and oil products (2,364 ktoe), biomass (2,266 ktoe), hydroelectricity (454 ktoe), wind electricity (429 ktoe), and, to a lesser extent, natural gas (68 ktoe), and solar energy (48 ktoe). The supply values of industrial waste, imported electricity, coal, and coal products were very small compared to the rest of the sources. Solar energy supply included both solar thermal energy and electricity from photovoltaic solar energy.

In 2021, once again, "oil and oil products" held the first place in the primary matrix, thus displacing biomass, which had held that position for the previous five consecutive years. It should be noted that oil and oil products have historically been the main sources of supply, surpassed by biomass only between 2016-2020. Hydropower held the second position up to and during 2007. However, biomass has displaced it to the third position since 2008. In 2020, hydropower held the fourth position as the third place was occupied by wind. Finally, in 2021, the supply of hydropower was slightly higher compared to wind power and, once again, held the third position in the primary matrix.

Another characteristic of Uruguay's primary matrix is that, over the last few years, there have been important changes in the diversification and a higher share of renewable energy sources. The supply of oil and oil products has remained practically constant in absolute value since 1965, but the supply matrix grew 148%. This growth was a direct consequence of the incorporation of new energy sources. For example, biomass accounted for 40% of the supply matrix in 2021, wind plus solar energy accounted for 9% and hydropower accounted for 8%.

An analysis of each energy source separately shows that **biomass** was one of the sources that presented the most significant changes, not only in percentage share but also in absolute value. This category includes the production of firewood, biomass waste, and biomass for biofuels, as well as the net import of charcoal.

Between 1990 and 2007, biomass was relatively constant; however, as of 2008 it began to play a more important role and was consolidated as the second most important source in Uruguay's energy supply. This growth slowed down between 2010 and 2011 and resumed in 2012, when it went from 1,366 ktoe (2012) to 2,187 ktoe (2017), reaching its highest share in the primary matrix (43%).

Between 2017 and 2021, biomass had small variations and registered a growth of 2.3% in 2021, reaching 2,266 ktoe. It should be noted that, although the maximum supply value for this source was achieved in 2021, as described above, oil and oil products displaced biomass to a second position in the supply matrix.

In the case of **oil and oil products**, supply includes the imports to produce oil products in the refinery and the net balance of foreign trade of oil products. The share of this category in the primary matrix has varied, mainly according to the needs of oil products for electricity generation. In 1965, practically the entire primary matrix was formed by oil and oil products (79%). Interestingly, although the share fell to 42% (2021), supply has remained relatively constant in absolute terms over these 57 years, at an average of 1,900 ktoe, as already mentioned. The last seven years recorded the lowest share levels for oil and oil products in the primary matrix; the historical minimum was recorded in 2019. In 2020 and 2021, they had growths of 11% and 9% respectively, associated with higher consumption of oil products for electricity generation. In 2020, the final consumption of oil products decreased due to the mobility reduction during the pandemic, whereas in 2021 there was an increase of 9%, as indicated below.

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Although in 2021 **hydroelectricity** grew almost one-third compared to 2020, it represented one of the lowest values of hydroelectricity recorded since 1990. This low rainfall condition affected the primary matrix and resulted in a lower share of renewable energy sources and, consequently, higher consumption of fossil fuels for generation.

It is important to highlight the evolution of **wind power** in the primary matrix. In 2008, the first year the country had large-scale wind energy, electricity generation amounted to 0.63 ktoe and increased to 471 ktoe in 2020, and then decreased 9% in 2021. The highest increase was recorded between 2014 and 2018, and the share of wind electricity increased from 1% to 8%. Although the figures remain small in the supply matrix, wind power surpassed hydroelectricity in 2020 and reached third place in the supply matrix (9%).

The remaining sources in the matrix of supply in 2021 had very small shares: natural gas (1%), solar (1%), industrial waste (< 1%), imported electricity (< 1%), and coal and coke (< 1%).

FIGURE 14. Energy supply by source

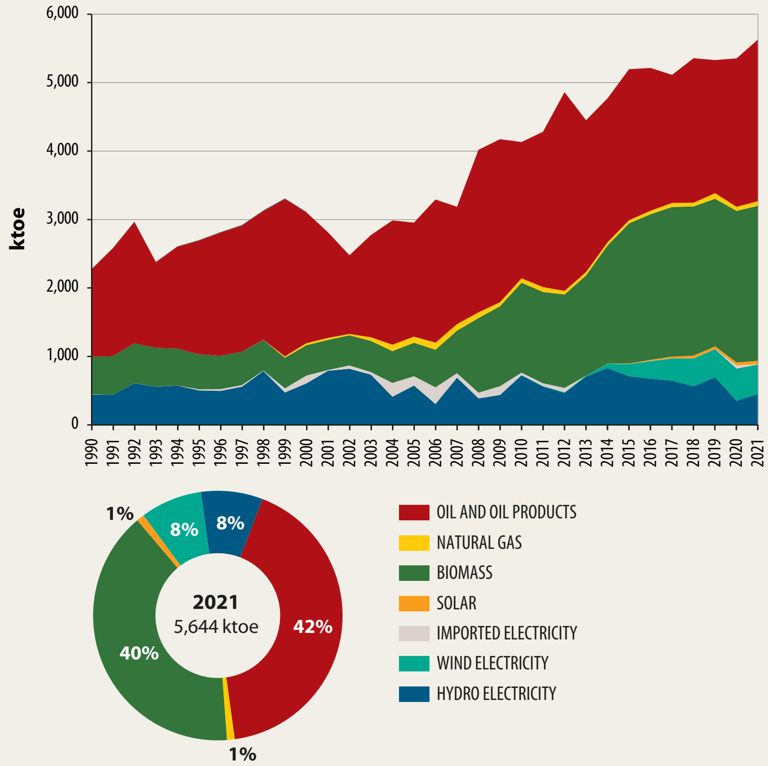

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TABLE 3. Energy supply by source

ktoe	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Imported electricity	4.4	16.2	114.2	136.3	33.3	41.0	63.8			0.2	2.1	0.3	1.2	0.0	44.2	**4.7**
(%)	0%	1%	4%	5%	1%	1%	1%			0%	0%	0%	0%	0%	1%	**0%**
Hydroelectricity	443.1	503.5	606.4	574.8	723.0	557.2	466.2	705.7	829.8	710.9	674.4	646.5	563.9	697.3	352.1	**453.5**
(%)	19%	19%	20%	19%	17%	13%	10%	16%	17%	14%	13%	13%	10%	13%	7%	**8%**
Wind electricity					6.0	9.6	9.7	12.4	63.0	177.6	257.5	324.6	407.0	408.7	470.9	**429.3**
(%)					0%	0%	0%	0%	1%	3%	5%	6%	8%	8%	9%	**8%**
Solar									3.0	7.2	16.5	27.0	40.0	41.4	45.4	**48.3**
(%)									0%	0%	0%	1%	1%	1%	1%	**1%**
Natural gas			30.6	89.3	64.4	71.5	52.2	48.8	45.0	45.8	51.8	58.5	55.2	80.8	59.8	**68.4**
(%)			1%	3%	2%	2%	1%	1%	1%	1%	1%	1%	1%	2%	1%	**1%**
Oil and oil products	1,275.4	1,661.0	1,910.8	1,666.9	1,991.7	2,270.6	2,905.1	2,218.9	2,105.4	2,207.8	2,086.3	1,871.8	2,111.8	1,945.9	2,168.8	**2,363.6**
(%)	56%	62%	62%	56%	48%	53%	60%	50%	44%	42%	40%	37%	39%	36%	40%	**42%**
Coal and coke	0.7	0.5	0.5	1.9	1.6	1.8	2.1	2.4	1.8	2.4	3.5	3.2	3.2	3.1	3.8	**3.5**
(%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Biomass	549.1	511.7	442.9	488.9	1,315.4	1,334.4	1,365.7	1,466.0	1,726.4	2,049.2	2,127.6	2,186.7	2,179.7	2,157.6	2,215.0	**2,266.1**
(%)	24%	19%	14%	17%	32%	31%	28%	33%	36%	39%	41%	43%	41%	40%	41%	**40%**
Industrial wastes						2.1	1.6	4.3	3.4	6.0	7.0	6.4	8.7	8.6	9.3	**7.0**
(%)						0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
TOTAL	**2,272.7**	**2,692.9**	**3,105.4**	**2,958.1**	**4,135.4**	**4,288.2**	**4,866.4**	**4,458.5**	**4,777.8**	**5,207.1**	**5,226.7**	**5,125.0**	**5,370.7**	**5,343.4**	**5,369.3**	**5,644.4**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) In 2013 and 2014, no electricity was imported. Since 2015, there has been an exchange with Argentina considered "return of energy", except for 2018, when a "contingent" mode was adopted at the corresponding cost. In turn, while electricity has been imported from Brazil since 2016, it has been used to test the new interconnection.
2) Solar energy supply includes solar thermal energy and photovoltaic solar electricity.

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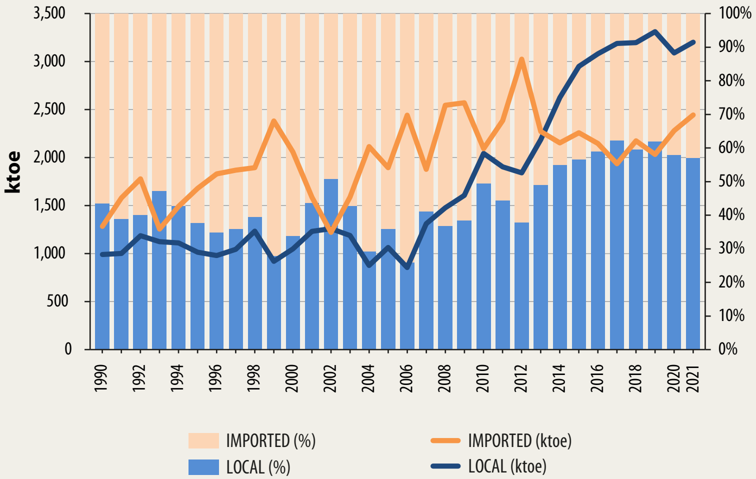
3.1.2. Primary matrix by origin

In 2021, the energy supply was 57% from local sources and 43% from imported sources. The last years of the entire series showed the most significant shares of local energy in the supply, with values higher than 57%. In absolute terms, it is important to note the net increase in local origin energy supply over the last few years. In the 1990-2006 period, local origin energy supply remained between 854 ktoe (2006) and 1,260 ktoe (2002). There has been a steady net growth since 2007, reaching a peak value of 3,311 ktoe in 2019, followed by a 7% drop in 2020, and a subsequent new growth of 4% in 2021.

Imported energy supply has varied throughout the period; registering a maximum value of 3,025 ktoe (2012) and a minimum of 1,220 ktoe (2002). In 2021, 7% more energy was imported than in 2020.

FIGURE 15. Energy supply by origin



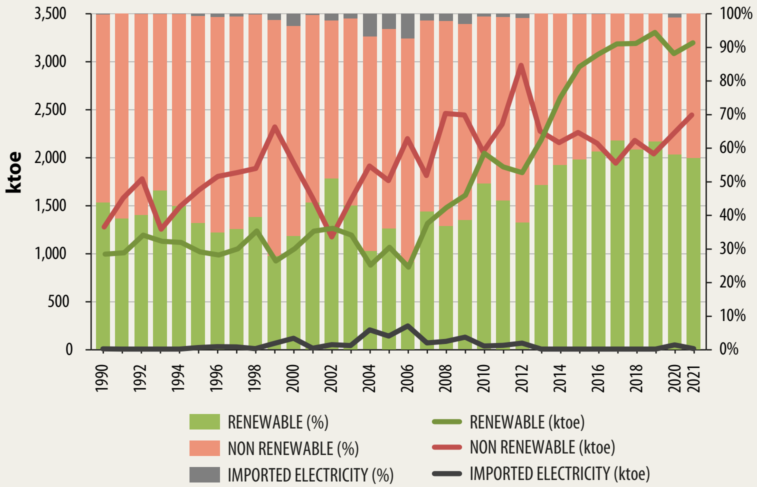
3.1.3. Primary matrix by type

Regarding energy supply, sources are also classified into renewable or nonrenewable origins. In 2021, renewable energy sources (biomass, solar thermal energy, hydroelectricity, wind electricity, and photovoltaic solar electricity) had a 57% share in the matrix of supply, while 43% corresponded to nonrenewable sources (oil and oil products, natural gas, coal and coke, and industrial waste). Imported electricity is reported separately as it cannot be classified as renewable or nonrenewable and was only 0.1% in 2021.

2021 Primary energy matrix: 57% renewable energy.

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

FIGURE 16. Energy supply by type



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Renewable energy supply grew significantly towards the end of the 1990-2021 period, increasing almost threefold the average recorded over the 15 years before 2005. In 2019, the maximum historical supply of renewable sources was recorded in absolute terms (3,305 ktoe) and share (62%). Even though this share fell to 57% in the 2020-2021 period, it falls within the values from 2015 onwards.

The share of renewable sources in the primary matrix has historically been strongly influenced by rainfall levels. However, with the diversification of energy sources and the major inclusion of local sources, the influence of hydropower variability on the supply matrix has decreased. For example, if we compare the structure of the primary matrix in 2006 with that recorded in 2021 (which have similar shares of rainfall levels), we observe that in 2006 renewable sources accounted for 26% of the supply, while in 2021 the share of renewables was 57%. This shows that diversifying the matrix also strengthens the national energy system.

3.2. Electricity generation

In 2021, electricity generation was 15,953 GWh (1,372 ktoe), which represented an 18% increase over the previous year. It should be noted that the capacity remained practically the same as in 2020, as mentioned in the chapter on infrastructure. The production comprised 89% from public service power plants (1,221 ktoe), while the remaining 11% was generated by autoproduction power plants (151 ktoe). Growth compared to 2020 was 20% and 2%, respectively.

Most electricity was provided through domestic production (99.5%), and there was no need to resort to high imports from neighboring countries. In 2020, after eight years of marginal imports, there were important purchases of electricity.

In 2021, electricity demand was supplied almost entirely by domestic production.

In 2021, Uruguay exported 2,844 GWh (245 ktoe) of electricity, 148% more than the previous year, and similar to 2019, the year that marked the country's highest electricity exports since 1965. Regarding export destinations, in 2020 78% of the electricity was exported to Brazil and 22% to Argentina. Between 2020 and 2021, exports to Argentina decreased 11%, while electricity sales to Brazil increased fivefold.

As per energy sources, in 2021 more than half of the electricity exported came from hydropower (54%), followed, to a lesser extent, by electricity generated from fossil fuels (34%). Between October 2017 and July 2020, Uruguay sold wind electricity to Argentina by generating agents other than UTE.

Final electricity consumption (calculated as generation plus imports minus exports, technical losses, and own use) grew 2% compared to 2020. It should be noted that the final energy consumption supplied from the SIN (excluding the electricity generated by autoproduction power plants) had similar behavior.

Historically, hydropower has played an important role in electricity generation 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 as per a convention with Argentina.

One of the characteristics of electricity generation in the country is the diversification of sources that have occurred in recent years. From 1965 to 2000 approximately, there were only three main energy sources were the main sources of electricity generation: 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 recent years, it remains marginal.

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FIGURE 17. Electricity balance

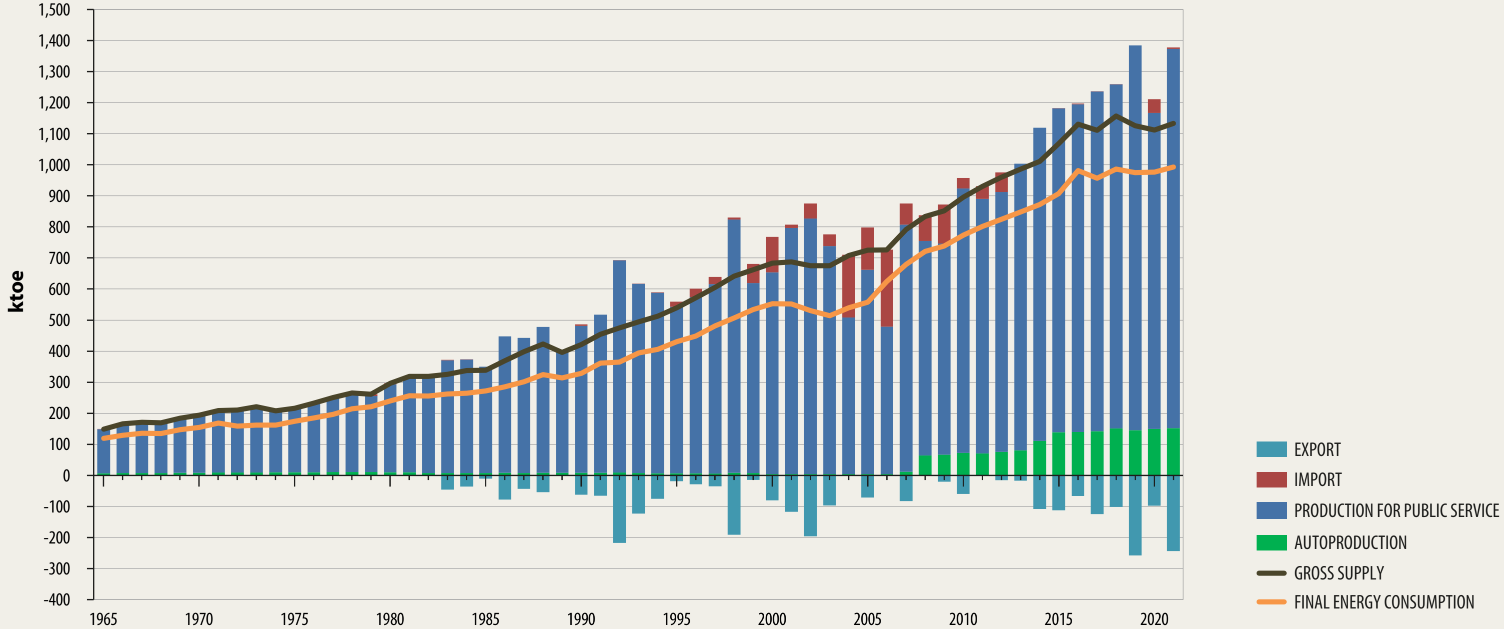
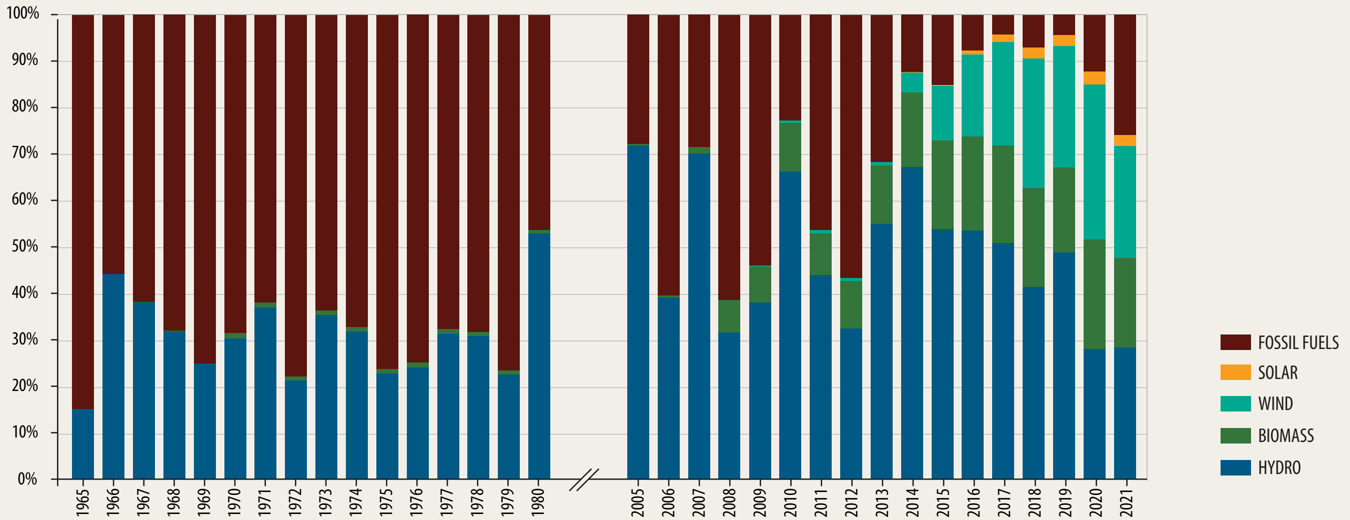


FIGURE 18. Share of inputs for electricity generation



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. On the other hand, in recent years, the diversification of sources in the generation matrix showed a lower consumption of fossil fuels compared to low availability of hydropower as input for generation.

In 2021, hydropower generation grew 29% over the previous year; however, it remained at low production levels and was similar to that registered in 2012. Electricity from biomass and solar energy was on the order of last year, while wind electricity decreased 9% between 2020 and 2021. As a result, electricity generation from fossil sources tripled. The main fuel used for generation was gas oil; its consumption increased 175% (398 ktoe) compared to 2020, followed, to a lesser extent, by fuel oil with a consumption of 61 ktoe (+129%).

Wind energy became part of the matrix of generation in 2008 and had a slow increase in the first years of its development. However, since 2013, there has been a significant increase in electricity generation: from 144 GWh to 5,476 GWh (2020). In 2016, in particular, wind electricity became the second source in the generation matrix. It continued to increase until 2020 when it reported its maximum share (40%). This has positioned it as the primary source of electricity generation in that year. In 2021, electricity generated from wind power dropped 9% and was once again surpassed by hydroelectricity. It should be noted that, in 2020 and 2021, there was no additional installed capacity from wind generators. The generation from this source grew 15% compared to 2019. This was achieved due to low levels of energy not used (1% of production). It should be noted that for 2019 energy not used was 7% of production.

In the case of biomass, it became more relevant in 2008 as an input for electricity production. This was caused by the fact that the contracts between UTE and private producers connected to the SIN—related to purchasing electricity from biomass—came into force. This included mainly biomass waste for electricity generation in the cellulose pulp industry. Over the last few years, electricity generation with biomass has increased significantly, tripling its value in ten years. Despite this steady growth, in 2016, biomass lost its 2014 second place in the energy matrix, and was displaced to the third position by wind energy.

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 2021, electricity generation from solar energy (483 GWh) grew 5% compared to 2020, reaching a new generation record since it was first introduced in the country in 2014. A highlight is that, during the years 2017, 2018, and 2019, there was more generation of electricity from photovoltaic energy than from fossil fuels.

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TABLE 4. Electricity balance

ktoe	1965	1980	1995	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Power plants for public service	141.8	283.2	536.3	657.1	851.7	820.0	836.7	922.7	1,008.6	1,043.0	1,055.6	1,094.4	1,107.3	1,238.9	1,017.6	**1,220.5**
Autoproduction power plants	5.7	9.4	6.0	3.6	71.3	69.6	74.5	79.8	110.1	137.9	138.5	140.9	150.4	144.9	148.3	**151.5**
TRANSFORMATION PLANTS	147.5	292.6	542.3	660.7	923.0	889.6	911.2	1,002.5	1,118.7	1,180.9	1,194.1	1,235.3	1,257.7	1,383.8	1,165.9	**1,372.0**
Production	147.5	292.6	542.3	660.7	923.0	889.6	911.2	1,002.5	1,118.7	1,180.9	1,194.1	1,235.3	1,257.7	1,383.8	1,165.9	**1,372.0**
Import	0.1	2.9	16.2	136.3	33.3	41.0	63.8			0.2	2.1	0.3	1.2	0.0	44.2	**4.7**
Export	-0.1	-0,0	-20.0	-72.3	-61.1	-1.6	-16.7	-17.8	-108.9	-113.6	-67.0	-125.7	-102.8	-258.9	-98.7	**-244.6**
International bunker																
Losses	-21.9	-47.3	-100.9	-154.1	-104.2	-110.7	-111.1	-110.2	-107.7	-128.1	-115.2	-123.6	-133.9	-113.7	-97.1	**-106.1**
Stock change																
Not used																
Adjustments			-0.1	-0.4	-0.1	0.1	0.9	0.6	0.3	-0.1	0.3	-0.1	0.1		-0.2	**0.2**
SUPPLY	125.6	248.2	437.5	570.2	790.9	818.4	848.1	875.1	902.4	939.3	1,014.3	986.2	1,022.3	1,011.2	1,014.1	**1,026.2**
GROSS SUPPLY	147.5	295.5	538.4	724.3	895.1	929.1	959.2	985.3	1,010.1	1,067.4	1,129.5	1,109.8	1,156.2	1,124.9	1,111.2	**1,132.3**
TOTAL NET CONSUMPTION	125.6	248.2	437.5	570.2	790.9	818.4	848.1	875.1	902.4	939.3	1,014.3	986.2	1,022.3	1,011.2	1,014.1	**1,026.2**
Own use	7.1	9.2	7.7	13.5	18.2	18.1	24.3	27.9	31.1	33.1	33.8	30.1	37.1	37.5	38.3	**34.5**
TOTAL FINAL CONSUMPTION	**118.5**	**239.0**	**429.8**	**556.7**	**772.7**	**800.3**	**823.8**	**847.2**	**871.3**	**906.2**	**980.5**	**956.1**	**985.2**	**973.7**	**975.8**	**991.7**

NOTE: "Losses" include technical and non-technical losses until and including 2005. Starting in 2006, non-technical losses are considered as final energy consumption. Social losses are included in the residential sector and the rest are distributed proportionally according to electricity consumption.

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In the case of on-grid photovoltaic microgeneration, a very significant increase was recorded during the last period: from 2,110 MWh (2014) to 39,219 MWh (2021). From a sectoral standpoint, the distribution in 2021 was as follows, in order of importance: commercial and services (57%), industrial (21%), agriculture (15%), and residential (7%). In the agricultural and residential sectors, most of the electricity generated from PV microgeneration was delivered to the grid (69% and 64%, respectively). As for the industrial sector, 57% of the electricity generated by photovoltaic microgeneration was for own use, while in the commercial and services sector, half of the generation was delivered to the grid and the other half was consumed by the establishments themselves.

Electricity generation can be analyzed from two points of view: the inputs for generation and 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. In 2021, a global transformation efficiency of 77% was recorded, with an efficiency loss of 5 points compared to 2020. This is explained by the fact that, in the last year, the share of fossil fuel generation was much bigger. These sources have lower transformation efficiencies than renewable sources.

On the other hand, the year 2012, which presented a rainfall level similar to that of 2021, recorded an overall transformation efficiency of 56%. This good performance of the generation sector in 2021 in the face of unfavorable environmental situations such as hydrologic conditions, was the result of including renewable sources such as wind energy, which was the second source of generation in 2021.

FIGURE 19. Microgeneration of electricity from solar energy by sector

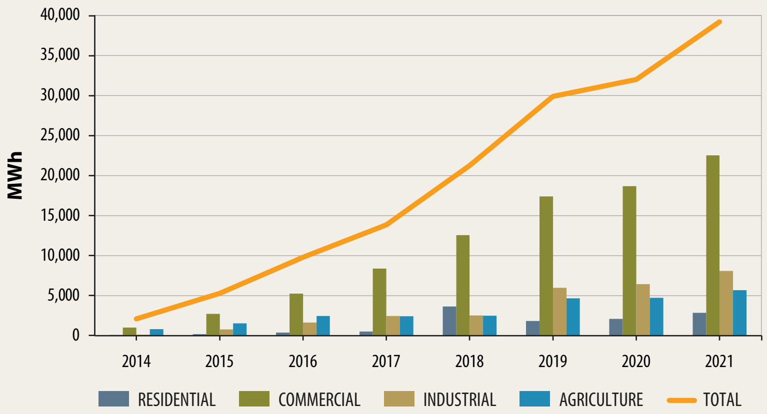

TABLE 5. Microgeneration of electricity from solar energy

MWh		2014	2015	2016	2017	2018	2019	2020	2021
Residential	EDG	94	151	352	437	2,203	1,221	1,536	**1,844**
	EOU	28	50	50	92	1,441	627	590	**1,033**
	TG	**122**	**202**	**402**	**528**	**3,644**	**1,848**	**2,126**	**2,877**
Commercial	EDG	393	1,386	3,051	4,834	9,213	8,719	10,012	**11,242**
	EOU	634	1,347	2,222	3,567	3,365	8,678	8,684	**11,288**
	TG	**1,027**	**2,734**	**5,274**	**8,401**	**12,578**	**17,396**	**18,696**	**22,530**
Industrial	EDG	122	321	708	1,070	1,664	2,493	2,844	**3,484**
	EOU	19	487	948	1,413	871	3,493	3,619	**4,618**
	TG	**141**	**808**	**1,656**	**2,483**	**2,536**	**5,986**	**6,464**	**8,102**
Agriculture	EDG	612	1,184	2,076	2,019	1,721	3,671	3,650	**3,926**
	EOU	207	373	414	433	787	1,015	1,085	**1,784**
	TG	**820**	**1,557**	**2,490**	**2,452**	**2,508**	**4,685**	**4,735**	**5,710**
TOTAL	EDG	1,222	3,043	6,187	8,359	14,802	16,103	18,043	**20,496**
	EOU	889	2,258	3,635	5,505	6,464	13,813	13,979	**18,723**
	TG	**2,110**	**5,300**	**9,821**	**13,864**	**21,266**	**29,916**	**32,021**	**39,219**

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

3.2.1. Matrix of inputs for electricity generation

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

The matrix of inputs for generation has varied significantly throughout the years and the diversification of energy sources towards the end of the period, as already mentioned. In 2021, the highest share in inputs for generation corresponded to hydropower (29%), followed by wind energy (24%), gas oil (23%), and biomass (19%). To a lesser extent, fuel oil (3%) and solar energy (2%) also participated.

FIGURE 20. Inputs for electricity generation

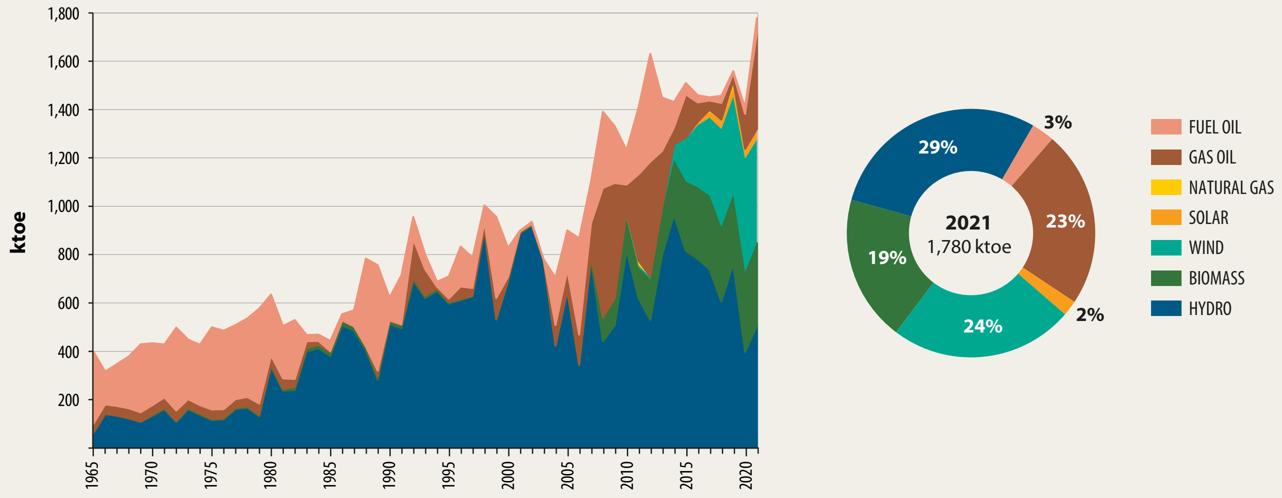

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TABLE 6. Inputs for electricity generation

ktoe	1965	1980	1995	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Hydropower	60.2	335.9	596.4	647.2	817.2	619.9	529.3	798.3	964.9	814.0	782.4	738.4	605.0	762.0	396.3	**504.5**
(%)	15%	53%	84%	72%	66%	44%	32%	55%	67%	54%	54%	50%	42%	49%	29%	**29%**
Wind					6.0	9.6	9.7	12.4	63.0	177.6	257.5	324.6	407.0	408.7	470.9	**429.2**
(%)					0%	1%	1%	1%	4%	12%	18%	22%	28%	26%	33%	**24%**
Solar									0.3	4.2	13.1	23.1	35.6	36.4	39.7	**41.6**
(%)									0%	0%	1%	2%	2%	2%	3%	**2%**
Firewood			5.0	0.8	8.6	1.8	7.0	9.9	2.0	4.8	4.2	1.3	2.4	1.8	1.6	**2.0**
(%)			1%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	**0%**
Biomass wastes	0.4	5.0	1.8	2.0	121.1	124.3	161.3	171.8	226.1	283.8	292.3	303.6	306.7	284.0	329.7	**341.7**
(%)	0%	1%	0%	0%	10%	9%	10%	12%	16%	19%	20%	21%	21%	18%	23%	**19%**
Gas oil	37.3	41.2	14.6	84.3	119.7	356.6	475.9	236.7	69.3	178.9	80.9	38.4	68.8	30.9	144.5	**397.6**
(%)	9%	6%	2%	9%	10%	25%	29%	16%	5%	12%	6%	3%	5%	2%	10%	**23%**
Gasoline														0.0	0.0	**0.1**
(%)														0%	0%	**0%**
Fuel oil	301.1	252.3	91.5	165.3	143.3	276.7	446.9	221.2	106.6	47.5	30.1	13.7	30.0	9.8	26.8	**61.3**
(%)	75%	40%	13%	18%	12%	20%	27%	15%	7%	3%	2%	1%	2%	1%	2%	**3%**
Natural gas				0.6	17.1	19.5	1.7	0.2	0.2	0.0		8.7	2.7	26.4		**1.6**
(%)				0%	1%	1%	0%	0%	0%	0%		1%	0%	2%		**0%**
TOTAL	**399.0**	**634.4**	**709.3**	**900.2**	**1,233.0**	**1,408.4**	**1,631.8**	**1,450.5**	**1,432.4**	**1,510.8**	**1,460.5**	**1,451.8**	**1,458.2**	**1,560.0**	**1,409.5**	**1,779.6**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

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

3.2.2. Electricity generation matrix by source

The electricity generated in 2021 came mainly from hydropower (5,273 ktoe), which reported a 29% increase compared to 2020 and returned to first place, after having been displaced by wind power in 2020. In turn, electricity production from wind decreased 9% and was 4,991 ktoe in 2021. Electricity from biomass grew 1%, but its share dropped from 20% to 17%.

The most remarkable change in 2021 was the growth of fossil thermal generation, which tripled from a 6% to a 15% share in the matrix of generation. As a result, the share of renewable sources in the electricity matrix of generation was 85% in 2021; it decreased nine percentage points compared to the previous year.

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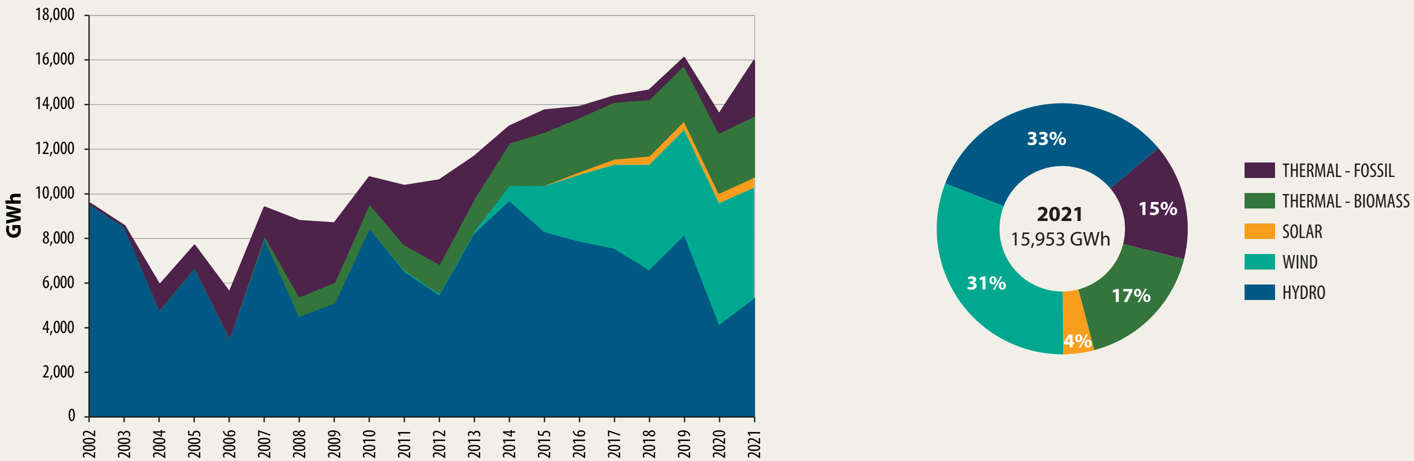
TABLE 7. Electricity generation by source

GWh	2002	2003	2004	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Thermal (fossil)	26.4	6.6	1,076.8	956.3	1,165.1	2,627.2	3,748.3	1,859.5	729.8	962.6	463.3	249.2	391.4	314.7	824.9	**2,469.2**
(%)	0%	0%	18%	12%	11%	25%	35%	16%	6%	7%	3%	2%	3%	2%	6%	**15%**
Thermal (biomass)	0.0	0.0	27.3	24.5	1,089.8	1,127.5	1,313.8	1,448.0	1,893.3	2,388.4	2,432.7	2,553.1	2,529.5	2,491.3	2,700.8	**2,736.7**
(%)	0%	0%	0%	0%	10%	11%	12%	12%	15%	17%	18%	18%	17%	15%	20%	**17%**
Hydropower	9,535.3	8,529.5	4,780.7	6,683.6	8,407.2	6,478.9	5,420.9	8,205.9	9,649.1	8,266.0	7,842.2	7,517.9	6,556.6	8,108.3	4,093.9	**5,272.8**
(%)	100%	100%	81%	87%	78%	63%	51%	70%	74%	60%	56%	52%	45%	50%	30%	**33%**
Wind					69.9	111.3	112.5	144.1	732.7	2,065.1	2,994.3	3,774.5	4,732.2	4,752.4	5,475.5	**4,991.3**
(%)					1%	1%	1%	1%	6%	15%	22%	26%	32%	30%	40%	**31%**
Solar									3.4	48.7	151.9	268.6	413.6	423.5	462.1	**483.4**
(%)									0%	0%	1%	2%	3%	3%	4%	**4%**
TOTAL	**9,561.7**	**8,536.2**	**5,884.8**	**7,664.4**	**10,732.0**	**10,344.9**	**10,595.4**	**11,657.5**	**13,008.3**	**13,730.8**	**13,884.5**	**14,363.2**	**14,623.2**	**16,090.1**	**13,557.1**	**15,953.4**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

FIGURE 21. Electricity generation by source



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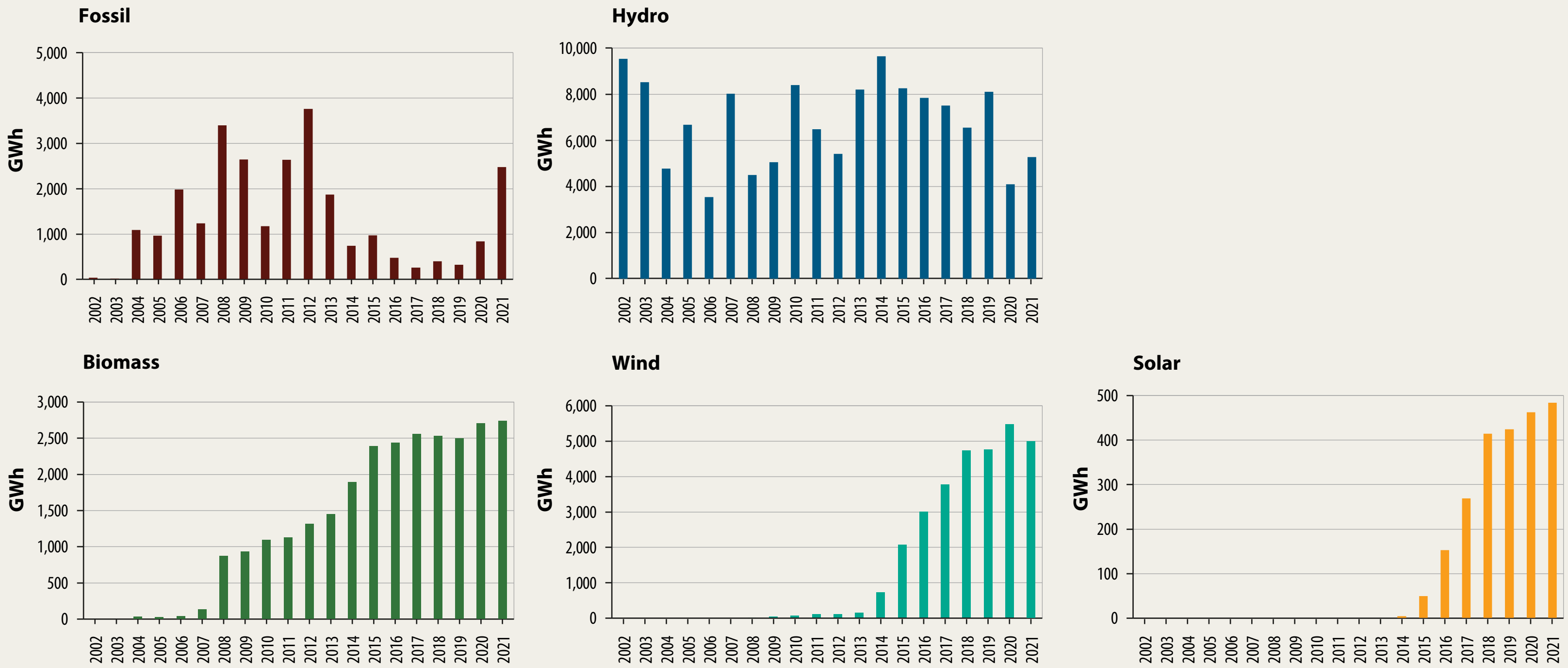
The evolution of the matrix of electricity generation by source also reflected the aforementioned characteristics in terms of variability, complementarity, and diversification. Until the 1980s, electricity generation came mainly from fossil fuels; since 1979, hydroelectricity has had a high share in the matrix of generation. In recent years, new energy sources have been incorporated.

A comparison between 2021 and 2012 shows that total electricity generation grew 51%. In terms of sources, hydropower generation decreased 3% and fossil fuel 34%. As a result, it is possible to observe the importance of the incorporation of local sources over the last 15 years, which provides clear advantages in the diversification of the matrix of generation.

In 2021, 85% of electricity generation came from renewable sources.

FIGURE 22. Electricity generation from each source



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3.3. Production of oil products

In 2021, the refinery operated as usual. Crude oil processing was 10% higher than the previous year and similar to 2019. It should be noted that 2020 was the first pandemic year in the country and the restrictions on mobility (mainly in the second two-month period of the year) had a direct impact on the consumption of oil products in the transport sector and, therefore, on fuel production.

In 2021, 2,135 ktoe of oil products were produced, with 11 ktoe of transformation losses. The main product was gas oil (983 ktoe), followed by motor gasoline (611 ktoe) and fuel oil (231 ktoe). To a lesser extent, there was production of LPG (LP gas and propane), kerosene, and jet fuel, among other products.

The refining process generates products that are consumed in the same process. In 2021, 70 ktoe of fuel gas and 33 ktoe of petcoke were produced. This consumption is recorded in the matrix of results under “own use of the energy sector”. In the case of fuel gas, there is an amount of energy reported as “not used” and another amount recorded as “losses.”

The refinery’s production structure has changed over these 56 years. Until the early 1980s, it mainly produced fuel oil (45% in 1965). However, as of 1983, the main product was gas oil (except for a few specific years), whose production has registered a net growth throughout the period, not only in absolute value but also in share. In 2021, it reached 46%. On the other hand, the production of fuel oil decreased throughout the period under study and recorded a share of only 11% during the last year.

Regarding motor gasoline, its share historically ranked in third place. However, it has surpassed fuel oil since 2011, moving to second place in the production structure. Crude oil processing and the production of oil products decreased in the years when the refinery had maintenance shutdowns.

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FIGURE 23. Refinery production structure

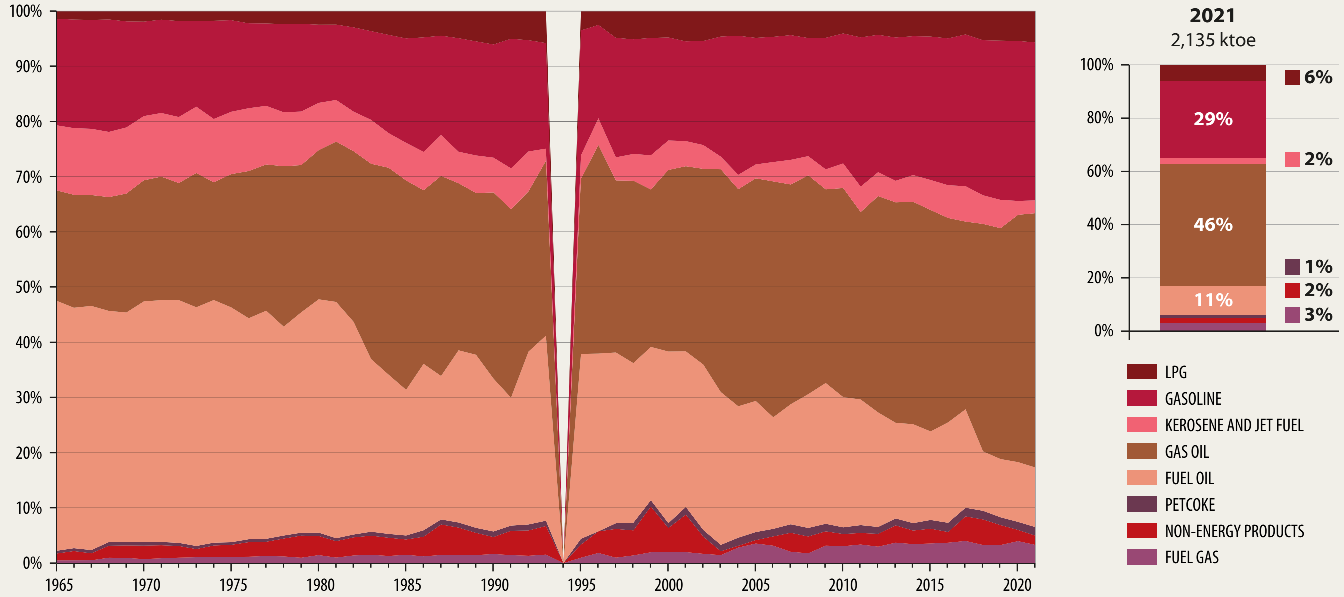

TABLE 8. Refinery production

ktoe	1965	1980	1995	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Liquefied petroleum gas	21.1	44.4	46.8	99.4	77.1	62.2	82.9	99.4	87.6	87.6	104.8	24.3	115.7	111.5	104.9	**121.3**
(%)	1%	2%	4%	5%	4%	5%	4%	5%	5%	5%	5%	4%	5%	5%	5%	**6%**
Gasoline	290.7	254.8	301.9	469.6	447.3	352.7	478.4	538.3	483.1	492.9	562.6	157.8	614.9	599.9	560.7	**610.7**
(%)	19%	14%	23%	23%	24%	27%	25%	26%	25%	26%	26%	28%	28%	29%	29%	**29%**
Kerosene and jet fuel	177.9	154.5	57.0	51.9	85.0	60.3	83.8	81.3	93.3	103.4	125.8	36.9	113.8	107.0	48.9	**49.9**
(%)	12%	9%	4%	3%	4%	5%	4%	4%	5%	5%	6%	6%	5%	5%	3%	**2%**
Gas oil	301.2	485.9	422.7	825.9	719.2	442.9	753.6	828.0	773.7	760.7	783.0	195.1	901.9	869.6	866.7	**983.4**
(%)	20%	27%	32%	40%	38%	34%	39%	40%	40%	40%	37%	34%	41%	42%	45%	**46%**
Fuel oil	683.2	760.9	446.8	486.8	448.7	297.2	399.4	360.0	344.5	304.6	385.3	102.5	236.0	219.8	209.9	**230.8**
(%)	45%	42%	33%	24%	24%	23%	21%	17%	18%	16%	18%	18%	11%	11%	11%	**11%**
Petcoke	7.5	10.8	14.1	29.7	22.8	18.6	23.9	26.0	25.9	29.9	35.2	9.0	34.3	29.3	28.1	**32.9**
(%)	0%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	1%	1%	**1%**
Non-energy products	18.6	62.2	31.5	12.6	41.9	27.1	44.6	64.7	47.0	50.8	40.9	25.5	101.1	74.9	39.2	**35.7**
(%)	1%	3%	2%	1%	2%	2%	2%	3%	2%	3%	2%	4%	5%	4%	2%	**2%**
Fuel gas	7.3	26.0	13.0	72.6	58.1	43.9	57.2	76.7	66.0	67.3	78.1	23.0	71.7	68.1	76.9	**70.2**
(%)	0%	1%	1%	4%	3%	3%	3%	4%	3%	4%	4%	4%	3%	3%	4%	**3%**
TOTAL	**1,507.5**	**1,799.5**	**1,333.8**	**2,048.5**	**1,900.1**	**1,304.9**	**1,923.8**	**2,074.4**	**1,921.1**	**1,897.2**	**2,115.7**	**574.1**	**2,189.4**	**2,080.1**	**1,935.3**	**2,134.9**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) The refinery was shut down because of scheduled maintenance of its units during the following periods: a- September 2011 - January 2012; b- February - September 2017. **2)** Although motor gasoline with bioethanol has been sold since 2010, the gasoline production data does not include biofuel. **3)** 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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4. Energy demand

"Total final consumption" is defined as the consumption of the following sectors: residential, commercial/services/public sector, transport, industry, and primary activities (agriculture, mining and fishing). It does not include the consumption of the energy sector used for the production or transformation of energy (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 grew from 1,715 ktoe in 1965 to 2,677 ktoe in 1999. After that year, total final consumption started to decrease 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 prevailing 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 reached a new consumption peak of 4,922 ktoe, 5% higher than in 2020.

The decrease in 2020 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 about 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 fell by 6.1% that year. If we consider the entire Energy Balance historical series from 1965 to 2021, there were only three years with such sharp drops in the economy: 1982, 1983 and, 2002.

FIGURE 24. Total final consumption

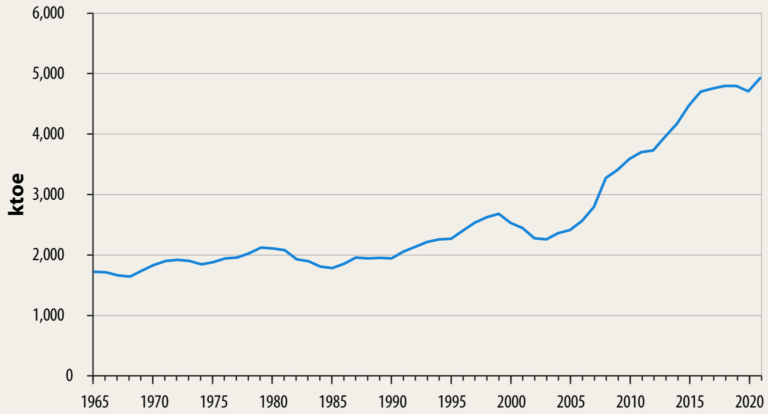


TABLE 9. Total final energy consumption

Year	ktoe	Year	ktoe	Year	ktoe
1965	1,715.0	1984	1,802.2	2003	2,251.0
1966	1,709.8	1985	1,778.4	2004	2,355.9
1967	1,656.2	1986	1,850.6	2005	2,407.7
1968	1,636.7	1987	1,950.4	2006	2,559.8
1969	1,734.2	1988	1,936.8	2007	2,788.6
1970	1,827.9	1989	1,947.4	2008	3,266.2
1971	1,895.1	1990	1,939.7	2009	3,405.2
1972	1,912.6	1991	2,048.9	2010	3,583.5
1973	1,898.1	1992	2,132.7	2011	3,696.1
1974	1,840.1	1993	2,211.5	2012	3,722.2
1975	1,875.0	1994	2,255.3	2013	3,948.0
1976	1,936.3	1995	2,263.0	2014	4,166.3
1977	1,953.3	1996	2,399.9	2015	4,467.3
1978	2,020.7	1997	2,528.7	2016	4,698.9
1979	2,116.0	1998	2,619.5	2017	4,749.2
1980	2,101.2	1999	2,676.8	2018	4,790.4
1981	2,075.6	2000	2,527.2	2019	4,790.6
1982	1,925.7	2001	2,438.9	2020	4,702.3
1983	1,889.1	2002	2,272.0	**2021**	**4,921.9**

As mentioned above, since 2004, the total final energy consumption has had a growing trend at an average annual rate of 5%. This value exceeded the historical trend, given that the previous decade of highest growth had been the 1990s when an average rate of 4% was recorded. In 2008, there was an increase in the total final consumption of 17%, which was mainly associated with the strong growth of the pulp industry.

In 2021, non-energy final consumption was 112 ktoe, 17% higher than the previous year. As final consumption for non-energy uses was only 2% of total final consumption, it was not worth analyzing by source. There follows the analysis of final energy consumption and its breakdown by source and by sector.

4.1. Final energy consumption by source

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

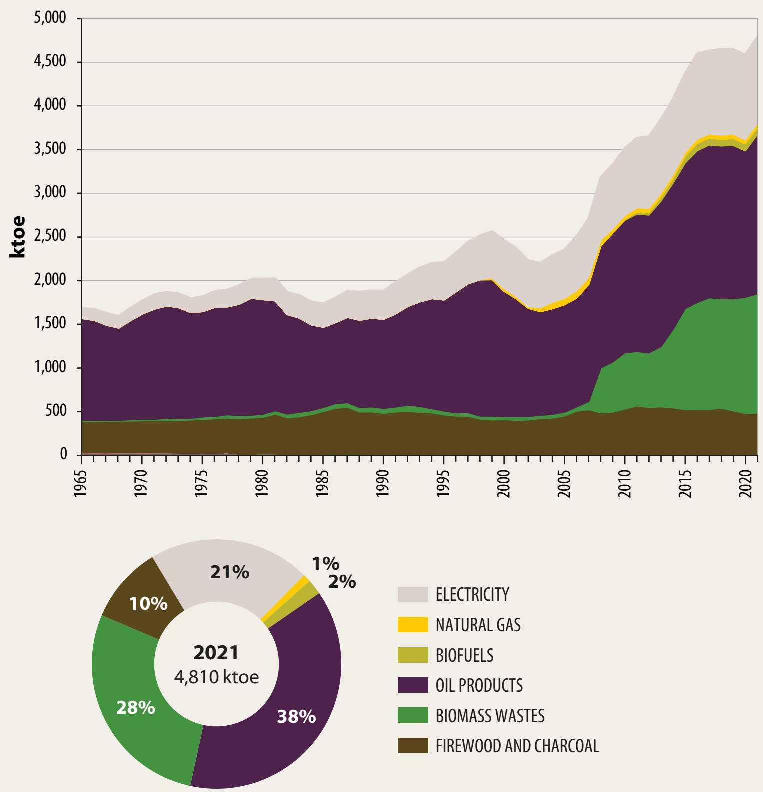
In 2021, final energy consumption was headed by biomass (firewood, charcoal, biomass waste, and biofuels) for the seventh consecutive year. It surpassed oil products (1,926 ktoe and 1,829 ktoe, respectively) with shares of 40% for biomass and 38% for oil products. Electricity consumption came in third (992 ktoe, 21%), while the share of natural gas was only 1%.

In the case of biomass, its consumption has been included in the entire historical series, with the particularity that it was relatively constant for over 40 years, with an average of 470 ktoe of final energy consumption. It was not until 2007 that it registered an increase that was maintained until 2021, this was influenced by biomass waste consumption.

Biomass waste refers to forestry and sawmill waste, black liquor, sugarcane bagasse, rice husks, sunflower husk, barley husk, and others. As of 2007, there has been a significant increase in waste consumption in the cellulose industry, mainly black liquor. For 2007 and 2008, the increase rates in biomass waste consumption were 91% and 447%, respectively. This happened again in 2014 and 2015, with increasing rates of 30% and 28%. Furthermore, in 2011, consumption fell (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.

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

FIGURE 25. Final energy consumption by source

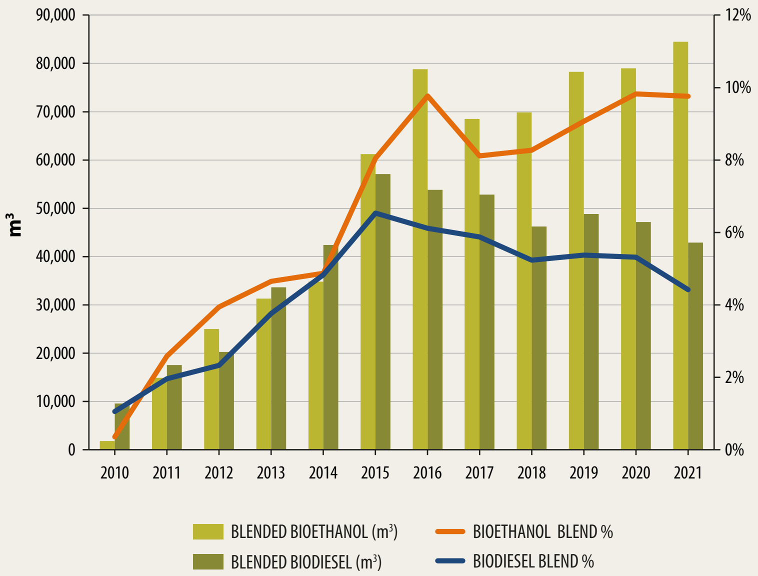


Since 2010, two new secondary energy sources, grouped under the term "biofuels", were incorporated: bioethanol and biodiesel.[11] After increasing consumption since their first year, in 2016, they recorded a maximum consumption (85 ktoe) and remained at an average of 78 ktoe in the last five years, with a 2% share in the final energy consumption matrix.

Biofuels are mainly consumed in blends with fossil fuels: gasoline-bioethanol and gas-oil-biodiesel. In 2021 and in terms of volume, the average mixture corresponded to 9.7% bioethanol in motor gasoline and 4.4% biodiesel in gas oil. The incorporation of biofuels made it possible to meet demand while reducing fossil fuel consumption and, therefore, helped reduce greenhouse gas emissions.

In 2021, the average blend (volume) was 9.7% bioethanol in motor gasoline and 4.4% biodiesel in gas oil.

FIGURE 26. Biofuel consumption and blending percentages



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

Historically, oil products have had the highest share in the matrix of final energy consumption. Over the last 20 years, they have behaved similarly to electricity, although their consumption was affected during the crisis at the beginning of the century, with negative rates until 2003. As of 2004, the consumption of oil products increased again, with annual growth rates of between 0.4% and 8%. In 2020, consumption decreased again (-5%), followed by subsequent growth of 9%. In the last year, final consumption of oil products was 1,829 ktoe.

As for electricity consumption, since 1965 it has presented a sustained net growth, except for some slight decreases recorded in the years 1972, 1982, 1989 and the fall at the beginning of the century for reasons already explained. The analysis of the last 10 years of the series shows that the growth rate was always positive, with an average of 3%, except for 2017 and 2019, when electricity consumption decreased. The historical maximum electricity consumption was recorded in the last year (992 ktoe). The increase in electricity consumption recorded in 2006 was associated with a change in methodology that evaluates nontechnical losses[12], which have been included in the final consumption sectors since that year. The social losses were included in the residential sector. The rest of the nontechnical losses were distributed according to the other sectors' share in electricity consumption.

12- Nontechnical losses are associated with consumption of electricity which is not billed.

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TABLE 10. Final energy consumption by source

ktoe	1965	1980	1995	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Firewood and charcoal	355.8	424.4	456.1	444.5	524.2	559.3	543.3	549.9	538.2	519.0	519.0	519.5	533.6	503.4	474.5	**478.4**
(%)	21%	21%	21%	19%	15%	15%	15%	14%	13%	12%	11%	11%	11%	11%	10%	**10%**
Biomass wastes	15.1	35.6	46.0	41.5	645.6	625.8	626.8	690.7	900.9	1,157.6	1,227.5	1,283.0	1,257.7	1,287.4	1,333.1	**1,368.7**
(%)	1%	2%	2%	2%	18%	17%	17%	18%	22%	26%	27%	27%	27%	27%	29%	**28%**
Coal	5.1	2.7	0.3	0.9												
(%)	0%	0%	0%	0%												
Oil products	1,164.1	1,312.8	1,274.5	1,234.5	1,520.5	1,578.0	1,582.0	1,671.4	1,679.4	1,672.4	1,742.1	1,753.4	1,754.2	1,761.4	1,681.8	**1,829.0**
(%)	69%	65%	58%	52%	43%	43%	43%	43%	41%	38%	38%	38%	38%	38%	37%	**38%**
Biofuels					8.8	22.0	29.4	43.8	52.8	78.8	85.2	79.1	74.0	80.3	79.1	**78.4**
(%)					0%	1%	1%	1%	1%	2%	2%	2%	2%	2%	2%	**2%**
Natural gas				73.5	45.7	50.0	46.9	46.6	42.8	43.7	47.7	47.0	50.8	49.7	47.2	**49.5**
(%)				3%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	**1%**
Coal products	22.6	4.7	0.2	0.9	0.3	0.3	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	**0.1**
(%)	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Electricity	118.5	239.0	429.8	556.7	772.7	800.3	823.8	847.2	871.3	906.2	980.5	956.1	985.2	973.7	975.8	**991.7**
(%)	7%	12%	19%	24%	22%	22%	23%	22%	21%	21%	21%	21%	21%	21%	21%	**21%**
Solar									2.6	3.0	3.3	3.9	4.4	5.0	5.6	**6.7**
(%)									0%	0%	0%	0%	0%	0%	0%	**0%**
Industrial wastes						2.1	1.6	4.3	3.4	6.0	7.0	6.4	8.7	8.6	9.3	**7.0**
(%)						0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
TOTAL	**1,681.2**	**2,019.2**	**2,206.9**	**2,352.5**	**3,517.8**	**3,637.8**	**3,654.0**	**3,854.1**	**4,091.5**	**4,386.8**	**4,612.5**	**4,648.5**	**4,668.7**	**4,669.6**	**4,606.5**	**4,809.5**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTE: Manufactured gas is included in coal products in 1965, and has been included in oil products in 1980 and 1995. As of 2005, it has been fully replaced by natural gas.

TABLE 11. Biofuel consumption

▸**DOWNLOAD spreadsheet GAS OIL AND BIODIESEL** ▸**DOWNLOAD spreadsheet GASOLINE AND BIOETHANOL**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Bioethanol production (m^3)	13,225	16,084	20,040	28,430	42,549	71,542	78,630	70,144	80,375	82,062	78,454	**85,647**
Blended bioethanol (m^3)	1,777	14,806	24,920	31,254	34,754	61,176	78,735	68,452	69,763	78,154	78,907	**84,408**
Commercialized gasoline with bioethanol (m^3)	503,919	574,399	633,804	673,787	714,442	760,950	806,944	844,712	844,886	862,722	804,077	**866,001**
Bioethanol blend percentage (%)	**0.4%**	**2.6%**	**3.9%**	**4.6%**	**4.9%**	**8.0%**	**9.8%**	**8.1%**	**8.3%**	**9.1%**	**9.8%**	**9.7%**
Biodiesel production (m^3)	11,068	18,202	20,585	35,241	45,234	57,554	53,482	52,848	47,923	49,976	46,112	**42,160**
Blended biodiesel (m^3)	9,549	17,489	20,227	33,569	42,319	57,002	53,749	52,745	46,189	48,769	47,070	**42,852**
Commercialized gas oil without biodiesel (m^3)	66,678	68,886	62,355	60,950	49,582	45,588	38,743	44,572	44,714	41,358	37,814	**37,690**
Commercialized gas oil with biodiesel (m^3)	908,827	895,196	871,954	894,564	877,096	873,711	880,317	899,373	883,402	908,659	886,730	**970,459**
Biodiesel blend percentage (%)	**1.1%**	**2.0%**	**2.3%**	**3.8%**	**4.8%**	**6.5%**	**6.1%**	**5.9%**	**5.2%**	**5.4%**	**5.3%**	**4.4%**

NOTES: 1) For years when the volume of blended biofuels exceeds production, the diference is mainly due to stock change. **2)** The global blend percentage is represented for the total gasoline and not by type of gasoline (super, premium). **3)** 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. **4)** 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.

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Although natural gas has been part of the energy matrix for more than 20 years, its penetration has been marginal since its appearance 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 of the main disadvantages of this energy source is that there is only one supplier—Argentina—so it is impossible to negotiate to obtain the minimum conditions that would enable the penetration of this energy source in the country.

Solar thermal energy has been included in the matrix of results since 2014. In 2021, final energy consumption grew 20% compared to the previous year, reaching 7 ktoe, associated with a surface of solar thermal collectors covering approximately 116,300 m^2.

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.

From 2007-2008, the consumption of the industrial sector recorded significant growth, almost doubling in just one year. Over the last fifteen years, the final energy consumption of the industrial sector went from 626 ktoe (2007) to 2,100 ktoe (2021), with two clear growth periods (2008-2010 and 2014-2015) due to the commissioning of new cellulose plants in the country.

It is noted that, although the new cellulose plants had a significant impact on the energy matrix, they are self-sufficient, as over 90% of their consumption comes from their energy sources. In turn, part of the electricity generated in these plants is delivered to the SIN.

As of 2013, final energy consumption has been reported with a broader breakdown of sectors. Sector consumptions lower than 1 ktoe are not reported, because they represent marginal values when they correspond only to one subsector. In other cases, there is no breakdown if the data correspond only to one company by sector (group consumption must then be reported) or if there is no adequate information for its classification.

FIGURE 27. Final energy consumption by sector

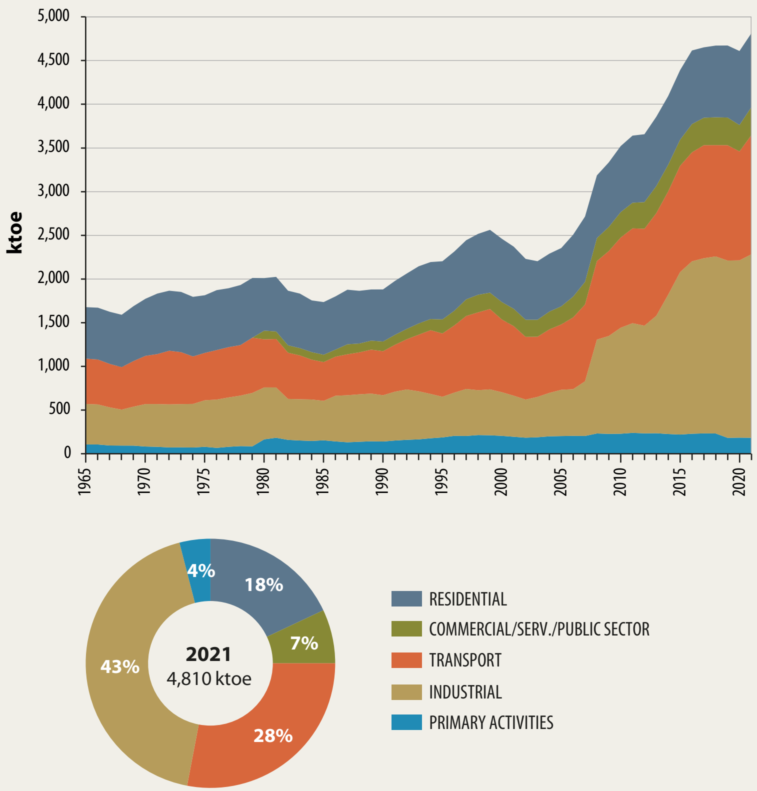

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TABLE 12. Final energy consumption by sector

ktoe	1965	1980	1995	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Residential	589.4	601.7	666.1	667.3	755.7	768.5	777.1	793.2	786.4	796.3	842.7	806.1	820.9	825.1	847.5	**845.5**
(%)	35%	30%	30%	28%	21%	21%	21%	21%	19%	18%	18%	17%	18%	18%	18%	**18%**
Commercial/services/ public sector	*	99.3	160.8	207.4	291.6	293.4	305.4	310.8	305.4	299.2	323.9	314.1	318.7	316.4	302.2	**320.8**
(%)		5%	7%	9%	8%	8%	8%	8%	7%	7%	7%	7%	7%	7%	7%	**7%**
Transport	518.8	550.9	724.7	748.2	1,032.3	1,085.7	1,109.3	1,174.7	1,182.3	1,216.4	1,247.4	1,294.2	1,274.4	1,320.7	1,247.0	**1,364.5**
(%)	31%	27%	33%	32%	29%	30%	30%	30%	29%	28%	27%	28%	27%	28%	27%	**28%**
Industrial	463.6	594.4	465.5	529.9	1,213.7	1,255.8	1,233.0	1,344.9	1,595.6	1,859.6	1,974.1	2,005.7	2,027.4	2,029.9	2,030.1	**2,100.2**
(%)	28%	29%	21%	23%	35%	35%	34%	35%	39%	42%	43%	43%	43%	43%	44%	**43%**
Primary activities	102.1	160.4	182.5	197.9	224.5	234.4	229.0	230.3	221.5	215.3	224.4	228.4	227.3	177.5	179.7	**178.5**
(%)	6%	8%	8%	8%	6%	6%	6%	6%	5%	5%	5%	5%	5%	4%	4%	**4%**
Non-specified	7.3	12.5	7.3	1.8	0.0	0.0	0.2	0.2	0.3							
(%)	0%	1%	0%	0%	0%	0%	0%	0%	0%							
TOTAL	**1,681.1**	**2,019.2**	**2,206.9**	**2,352.5**	**3,517.8**	**3,637.8**	**3,654.0**	**3,854.1**	**4,091.5**	**4,386.8**	**4,612.5**	**4,648.5**	**4,668.7**	**4,669.6**	**4,606.5**	**4,809.5**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTE: In 1965, the final energy consumption of the commercial/services/public sector is included in the residential sector.

4.2.1. Residential sector

Final energy consumption in the residential sector was 846 ktoe in 2021, similar to the previous year. Although the consumption of the residential sector includes a wide variety of sources, the main ones are three or four. 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, electricity and LPG consumption have increased throughout the years, compared to constant consumption of firewood and decreasing consumption of kerosene. In this way, as of 2010, the primary energy source consumed in the residential sector has been electricity, followed by biomass (firewood and biomass waste) and LPG.

Once again, it is worth noting that firewood and biomass waste consumption is evaluated through surveys. Therefore, the drop in biomass consumption reported since 2006 is not connected to changing consumption patterns but to a change in the evaluation methodology. In the case of firewood and until 2005, the value recorded in the 1988 survey (302 ktoe) remained the same. As of 2006, the results of the "Energy Use and Consumption Survey" (295 ktoe) were included. As of 2008, the consumption included in the updated version of the survey was also considered (284 ktoe). Biomass waste was included in 2006, assessing data from the survey mentioned above. In turn, a new residential survey was conducted in 2013, which reported firewood and biomass waste consumption results similar to previous years. In the 2021 balance, biomass (firewood, charcoal, and biomass waste) accounted for 35% of residential consumption.

Other sources used in the residential sector are gas oil and fuel oil, primarily for heating and water heating. Their joint share has been between 2% and 7% throughout the period surveyed (1965-2021). In 2021 they registered consumption of 5 ktoe and 8 ktoe, respectively. The use of natural gas in the residential sector began in 2000, with a share that has remained at 3% (22 ktoe, on average) over the last 10 years. In early 2005, manufactured gas used in Montevideo was replaced by natural gas.

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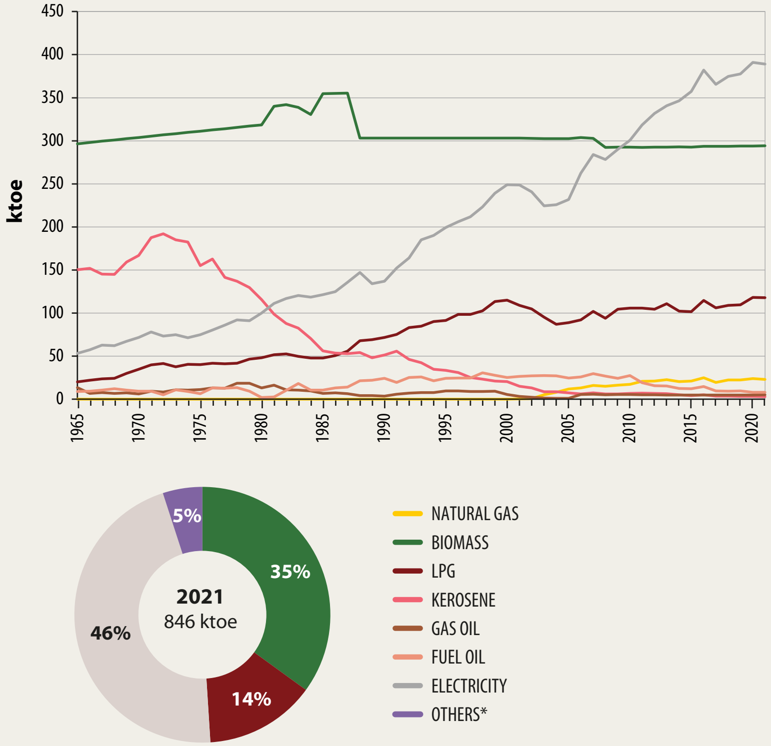
Residential consumption is reported for Montevideo and the rest of the country following the breakdown implemented in 2013. There is a certain correlation between consumption and population since about 40% of the country's total population lives in Montevideo[13] and approximately one-third of residential consumption corresponds to the capital.

FIGURE 28. Final energy consumption in the residential sector by source



NOTE: For the 2021 chart, the category "others" includes natural gas, solar, gasoline, kerosene, gas oil and fuel oil.

The main consumption difference was that over half of Montevideo's residential consumption was 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.

From the point of view of energy sources, electricity consumption was distributed between Montevideo and the rest of the country (40% and 60%, respectively). Something similar occurred with LPG consumption (LP gas and propane), which was 46% in Montevideo and 54% in the rest of the country. Most natural gases were consumed in the capital (91%) and the highest consumption of firewood and kerosene was outside the capital (80% and 76%).

In the case of solar, gas oil, fuel oil, and charcoal consumption of the residential sector, there was no breakdown for Montevideo and the rest of the country as data were insufficient for this classification. For other energy sources (such as gasoline and biodiesel), there was no breakdown because their consumption was lower than 1 ktoe.

Due to the mobility restriction measures taken by the government as of March 2020, we might think that this would lead to higher energy consumption as people had to stay at home for more extended periods. However, although consumption in the residential sector in 2020 grew by 3% compared to the previous year, it was in line with historical growth the same time, it should be kept in mind 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 behavior.

13- National Institute of Statistics (INE), "Poblaciones Estimadas y Proyectadas por Sexo y Edad según Departamentos", <https://www.ine.gub.uy/c/document_library/get_file?uuid=8b1b809e-e403-48d6-8128-99e8c9444182&groupId=10181> (07/21/2022).

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FIGURE 29. Breakdown of consumption in the residential sector in 2021

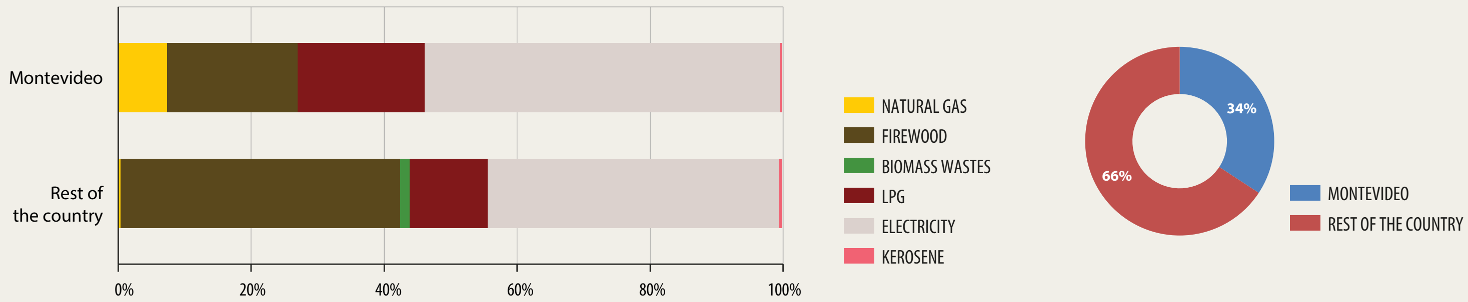

TABLE 13. Final energy consumption in the residential sector

ktoe	1965	1980	1995	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Natural gas				11.8	17.2	20.6	21.0	22.6	20.3	21.2	25.0	19.6	22.3	22.2	23.8	**22.9**
(%)				2%	2%	3%	3%	3%	3%	3%	3%	2%	3%	3%	3%	**3%**
Solar									2.2	2.5	2.7	3.2	3.7	4.2	4.6	**5.5**
(%)									0%	0%	0%	0%	0%	1%	1%	**1%**
Firewood and charcoal	296.5	318.3	303.0	302.3	285.0	284.5	284.9	284.9	285.1	285.0	285.8	285.8	285.8	286.2	286.1	**286.4**
(%)	54%	53%	45%	45%	38%	37%	37%	36%	36%	36%	34%	35%	35%	35%	34%	**34%**
Biomass wastes					7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	**7.6**
(%)					1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	**1%**
LPG	20.1	48.2	91.5	88.7	105.7	105.6	104.3	110.7	102.3	101.6	114.7	106.0	108.8	109.4	118.1	**117.8**
(%)	4%	8%	14%	13%	14%	14%	13%	14%	13%	13%	14%	13%	13%	13%	14%	**14%**
Gasoline					0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.3	**0.3**
(%)					0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Kerosene	150.2	115.7	33.4	7.4	6.7	7.1	6.6	6.3	5.1	4.3	5.2	3.5	3.7	3.2	3.3	**2.9**
(%)	27%	19%	5%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	**0%**
Gas oil	13.5	13.1	9.5	0.9	5.5	5.3	5.1	4.9	4.8	4.8	4.8	4.9	4.8	4.8	4.7	**5.1**
(%)	2%	2%	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	**1%**
Fuel oil	8.9	1.9	24.1	24.6	27.3	19.3	15.6	15.4	12.4	12.0	14.6	9.7	9.3	9.7	8.0	**8.1**
(%)	2%	0%	4%	4%	4%	3%	2%	2%	2%	2%	2%	1%	1%	1%	1%	**1%**
Manufactured gas	9.5	4.5	5.4	0.0												
(%)	2%	1%	1%	0%												
Electricity	53.1	100.1	199.2	231.6	300.5	318.2	331.7	340.5	346.3	357.0	381.9	365.4	374.6	377.4	391.0	**388.9**
(%)	10%	17%	30%	35%	40%	41%	43%	43%	44%	45%	45%	45%	46%	46%	46%	**46%**
TOTAL	**551.8**	**601.8**	**666.1**	**667.3**	**755.7**	**768.5**	**777.1**	**793.2**	**786.4**	**796.3**	**842.7**	**806.1**	**820.9**	**825.1**	**847.5**	**845.5**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) In 1965, 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)** As of 2010, gas oil includes biodiesel, and motor gasoline includes bioethanol. **3)** Until and including 2013, gas oil consumption includes diesel oil.

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4.2.2. Commercial/services/public sector

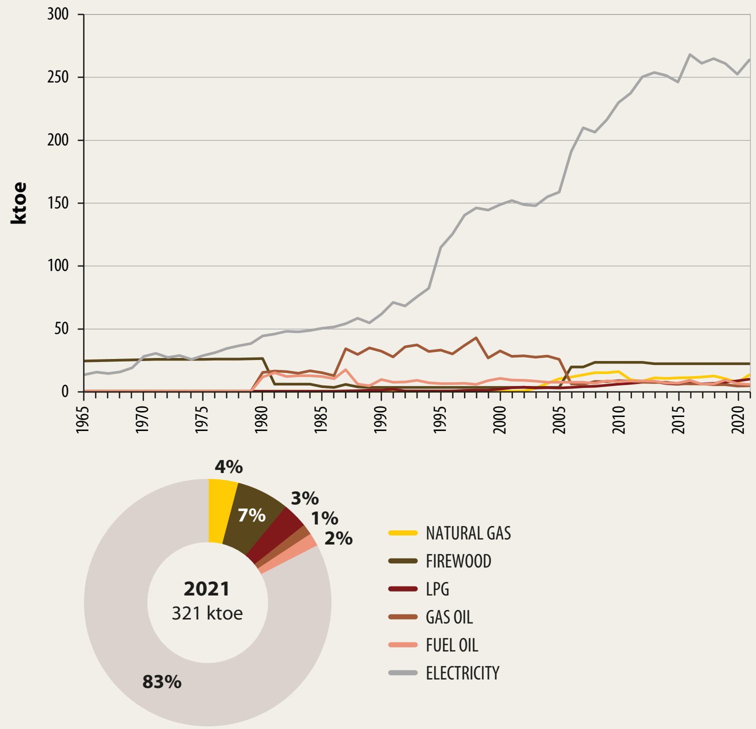
The final energy consumption in the commercial/services/public sector was 321 ktoe in 2021, 6% higher than the previous year.

Analyzing the overall consumption of the commercial/services/public sector, it is worth highlighting the importance of electricity, which has historically been the main energy source with a net and sustained growth throughout the series. After electricity consumption decreased 3% in 2020 compared to the previous year, in 2021 it increased again reaching 264 ktoe and a share of 83%. Since 2006, the share of electricity in the sector's final consumption has remained at values above 80%.

To a lesser extent, a firewood consumption of 22 ktoe was recorded for 2021 (7% of the sector). This value has remained constant over the last seven years and corresponds to the result 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 1965-2021 series are due to new survey results and not to changes in consumption patterns.

After a consumption increase of 27% compared to 2020, the other energy sources consumed in the sector (solar, gas oil, fuel oil, LPG, gasoline, kerosene, and natural gas) had, as a whole, a 10% share by 2021.

FIGURE 30. Final energy consumption in the commercial/services/public sector by source



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Consumption has been reported in four subsectors within the commercial/services/public sector as of 2013: "public lighting", "public administration and defense," "electricity, gas and water," and "others". The consumption of the "electricity, gas and water" subsector corresponded to 9% of the entire sector, while "public administration and defense" and "public lighting" recorded consumption of 7% and 6%, respectively. Meanwhile, the "others" subsector, which includes all energy consumption items that do not correspond to the previous categories, accounted for most consumption in the sector (78%).

The consumption structure shows that, in 2021, electricity was the main energy consumed in all subsectors. It was the only energy source used in "public lighting." For "public administration and defense", in addition to electricity (79%), there was consumption of firewood (9%), fuel oil (6%), LPG (6%), and gas oil (1%). In "electricity, gas and water", in addition to electricity consumption (95%), there was a very small consumption of LPG (4%) and practically negligible consumption of firewood and fuel oil. The "others" subsector had the following consumption matrix: electricity (80%), firewood (8%), natural gas (5%), LPG (3%), gas oil (2%,) and fuel oil (2%).

There is no breakdown for solar energy and kerosene due to their small values (less than 1 ktoe). Charcoal consumption in the commercial/services/public sector was negligible in recent years and was thus included in the "others" category.

FIGURE 31. Breakdown of consumption in the commercial/services/public sector in 2021

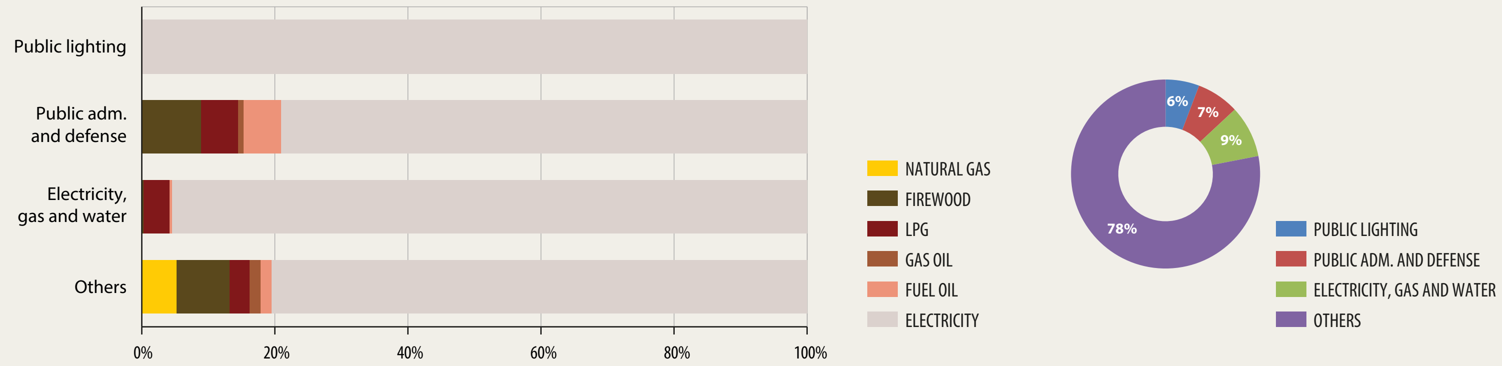

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TABLE 14. Final energy consumption in the commercial/services/public sector

ktoe	1965	1980	1995	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Natural gas				10.1	15.7	9.2	8.1	10.7	10.3	10.8	11.0	11.4	12.2	10.0	7.1	**13.1**
(%)				5%	5%	3%	3%	3%	3%	4%	3%	4%	4%	3%	2%	**4%**
Solar									0.4	0.4	0.5	0.6	0.6	0.7	0.8	**1.0**
(%)									0%	0%	0%	0%	0%	0%	0%	**0%**
Firewood and charcoal	24.2	26.1	3.1	3.1	23.1	23.1	23.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	**22.1**
(%)	64%	26%	2%	1%	8%	8%	8%	7%	7%	7%	7%	7%	7%	7%	7%	**7%**
LPG			0.3	2.8	5.7	6.4	7.3	7.9	6.2	5.8	6.3	6.0	6.4	7.2	8.3	**9.6**
(%)			0%	1%	2%	2%	2%	3%	2%	2%	2%	2%	2%	2%	3%	**3%**
Gasoline					0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.2	1.0	**1.1**
(%)					0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Kerosene	*	0.0	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	**0.0**
(%)		0.0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Gas oil	*	15.0	32.8	25.4	8.6	8.1	7.3	7.1	7.2	6.2	5.9	5.9	5.3	5.2	4.2	**4.5**
(%)		15%	20%	12%	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	1%	**1%**
Fuel oil	*	11.3	6.2	7.3	7.7	8.3	8.3	8.1	6.7	6.6	8.7	5.7	6.0	8.9	6.1	**5.5**
(%)		0.1	4%	4%	3%	3%	3%	3%	2%	2%	3%	2%	2%	3%	2%	**2%**
Manufactured gas	*	2.7	3.4	0.0												
(%)		3%	2%	0%												
Electricity	13.4	44.1	114.7	158.6	230.1	237.5	250.4	254.0	251.5	246.3	268.3	261.3	264.9	261.0	252.6	**263.9**
(%)	0.4	0.4	71%	76%	79%	81%	82%	82%	82%	82%	83%	83%	83%	83%	85%	**83%**
TOTAL	**37.6**	**99.2**	**160.8**	**207.4**	**291.6**	**293.4**	**305.4**	**310.8**	**305.4**	**299.2**	**323.9**	**314.1**	**318.7**	**316.4**	**302.2**	**320.8**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NOTES: 1) In 1965, 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, gas oil includes biodiesel, and motor gasoline includes bioethanol. **3)** Until 2013, gas oil consumption includes diesel oil.

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4.2.3. Transport sector

The final energy consumption in the transport sector was 1,365 ktoe in 2021, which represented an increase of 9% compared to the previous year. It corresponded entirely to secondary energy sources, mainly gas oil, and motor gasoline.

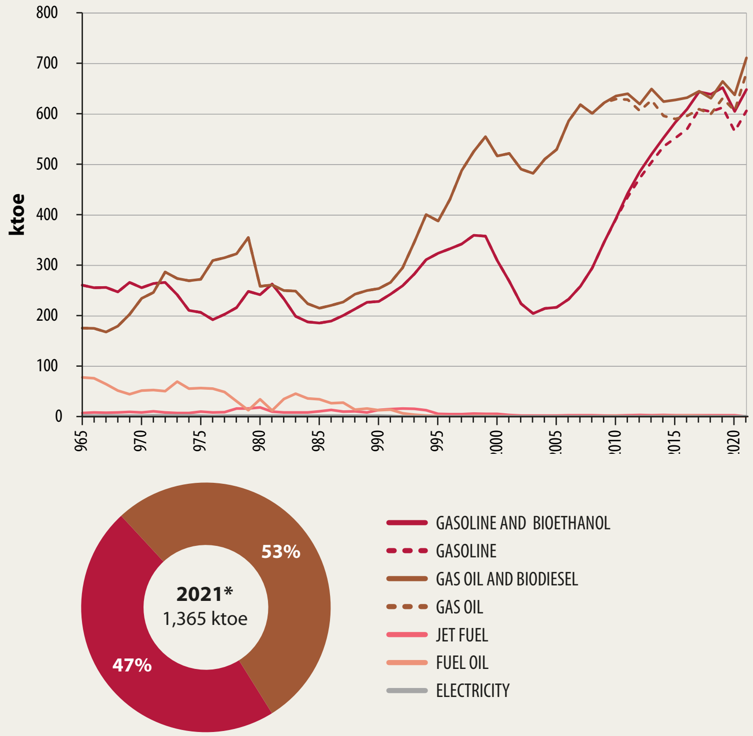
The share of the different energy sources has varied from 1965 to 2021. At the beginning of the period, motor gasoline was the source with the highest consumption. This situation remained constant until 1980-1981 when both consumptions were almost equal. However, this has changed since 1972, and gas oil has become the most consumed source in the sector. The gap increased in 1982, following an increase in gas oil consumption. With the 2002 crisis, the demand for both fuels dropped, more significantly in the case of gasoline. This situation set a more definite difference in the consumption of both sources. Even so, as of 2004, amid an upward trend for both sources, gasoline had the highest growth rates. This reduced the gap between gasoline and gas oil consumption once again.

Biofuels (bioethanol and biodiesel) have been included in the final consumption matrix since 2010. Their share in the transport sector increased from 1% (2010) to 6% (2015) and remained constant until 2020. In 2021, gas oil decreased one percentage point. For both biofuels, consumption went from 7 ktoe to 72 ktoe in these 11 years. As already mentioned, these sources were mainly consumed in blends with fossil fuels, gasoline-bioethanol, and gas oil-biodiesel, this made it possible to meet the demand and reduce fossil fuel consumption. The blending percentage recorded in 2021 was 9.7% for bioethanol in gasoline and 4.4% for biodiesel in gas oil.

The transport sector was one of the most affected by the mobility reduction measures applied at the beginning of the pandemic, mainly between March and May 2020. In that year, motor gasoline and gas oil consumption dropped 8% and 4%, respectively. By 2021 this situation was reversed and both fuels had higher consumption. Motor gasoline consumption was 606 ktoe and gas oil 683 ktoe; they had a share of 44% and 51%, respectively, for that year.

Gas oil consumption in recent years has had some variations. On the other hand, in 2018, and after 15 years of continuous growth, gasoline recorded its first drop. The trend of the last few years made the consumption of both fuels equal in 2017, but it was distanced again due to the sharp drop in gasoline consumption in 2020, and the large growth in gas oil consumption in 2021. The same behavior was verified when fossil fuels are considered blended with biofuels fossil fuels blended with biofuels (gasoline-bioethanol and gas oil-biodiesel).

FIGURE 32. Final energy consumption in the transport sector by source



***NOTE:** 44% gasoline; 3% bioethanol; 51% gas oil; 2% biodiesel.

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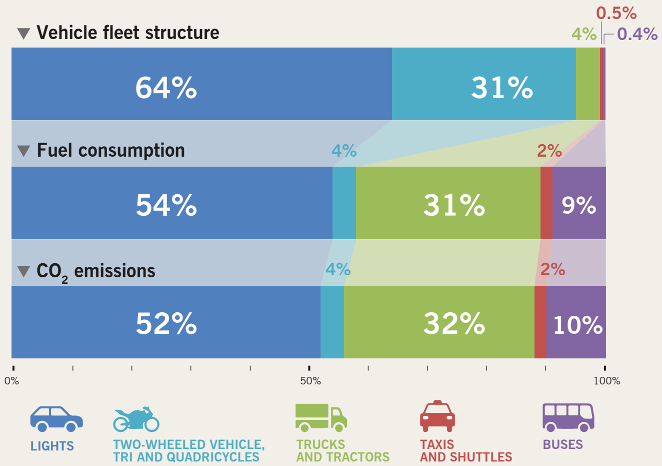
Other sources used in the transport sector are jet fuels and aviation gasoline. In the last few years, we have worked to improve the estimation of the consumption of fuels for agricultural aircraft through surveys conducted in the sector. Therefore, each new BEN includes the estimates for the new year and the reclassification and correction of consumption from the transport sector to the agricultural sector, if applicable. Over the last six years and considering both energy sources as a whole, the consumption of aviation fuels has remained constant (3 ktoe).

In 2021, electricity reached a value of 0.4 ktoe (4,500 MWh). In the historical series of the BEN there were records of electricity consumption in the transport sector from 1965 to 1992, the 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; but with values still small compared to other energy sources. In any case, year after year a higher consumption of electricity in transport was evidenced. Currently, there are electric vehicles in public transport, as well as in the fleet of UTE vehicles and private vehicles. Before 2016, these consumptions are included within the residential and commercial/services/public sector.

The behavior of fuel consumption in the transport sector is directly influenced by the fleet of vehicles, both in size and share according to the fuel used. Over the past 15 years, annual sales of new vehicles have tripled. Considering the type of fuel, in 2005, 75% of sales corresponded to gasoline vehicles, and this share grew to 99% in 2010. In 2021, this trend changed slightly: new gasoline vehicles sold accounted for 88% of total sales of light vehicles (cars, SUVs, utility vehicles, and pickups). Meanwhile, it is interesting to note the penetration of new technologies, such as electric and hybrid vehicles, which in 2021 accounted for 1% and 2% of sales, respectively.

When relating the structure of the vehicle fleet to fuel consumption in the transport sector, we can see that in 2021 the “light” category ranked first in terms of both the number of vehicles and consumption. However, two-wheeled (including tricycles and quadricycles) accounted for almost a third of the fleet, while they represented only 4% of fuel consumption. Conversely, the “trucks and tractors” category, with only 4% of the fleet, was responsible for nearly one-third of the transport sector’s energy consumption. Buses had similar behavior, accounting for less than 1% of the fleet in 2021, but consumed 9% of the sector’s fuel.

FIGURE 33. Vehicle fleet structure, fuel consumptions and CO_2 emissions, 2021



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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 river." Road transport consumption represented almost the total consumption of the sector (99%) of gas oil and gasoline mixed with biofuels. In turn, jet fuel and aviation gasoline consumption corresponded entirely to air transport. In the case of rail, air, and sea transport, consumption corresponded to gas oil. In 2019, no fuel oil was consumed in the transport sector, which was the case in previous years for sea and fluvial transportation. However, 0.1 ktoe of this source was consumed in 2020 and 2021.

It is important to keep in mind that, according to the energy balance methodology (IRES/OLADE), the consumption of air and fluvial transportation whose airport/port of departure is different from the airport/port of arrival is not considered as final consumption but as an international bunker.

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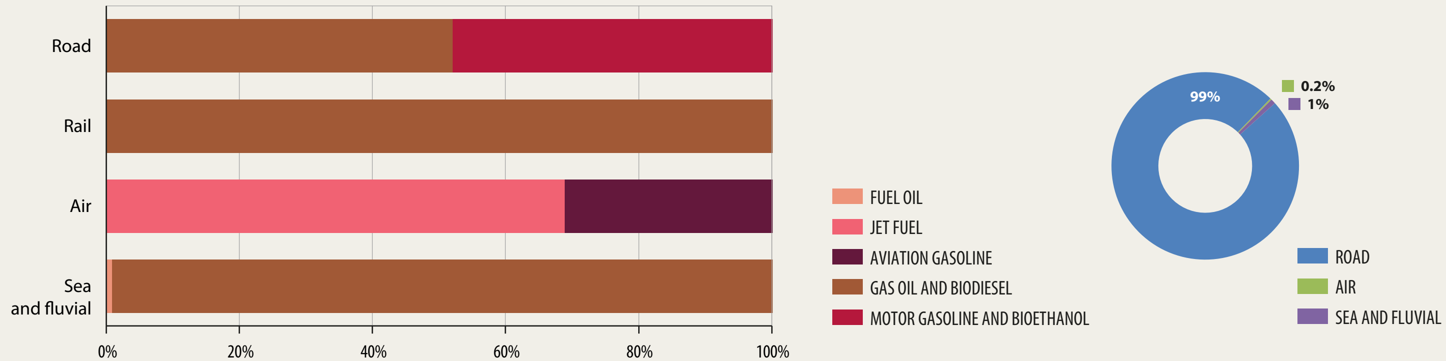
FIGURE 34. Breakdown of consumption in the transport sector in 2021



NOTE: Gas oil used in sea and fluvial transport does not include biodiesel.

TABLE 15. Final energy consumption of the transport sector

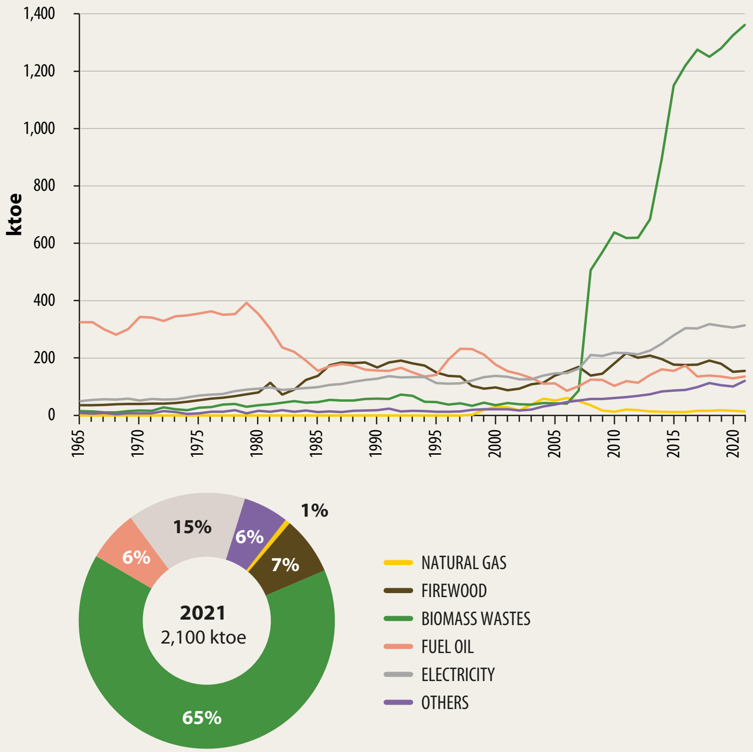
ktoe	1965	1980	1995	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Aviation gasoline		6.4	3.2	2.2	2.6	2.4	2.9	2.9	2.5	2.5	1.1	1.1	1.1	1.0	1.0	**1.0**
(%)		1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Motor gasoline	260.5	235.4	320.6	214.6	389.6	433.4	470.7	502.2	533.7	550.7	569.9	609.2	604.2	612.7	565.1	**605.9**
(%)	50%	43%	44%	29%	38%	40%	42%	43%	45%	45%	46%	47%	47%	46%	45%	**44%**
Bioethanol					0.9	7.5	12.5	15.6	17.5	30.8	39.6	34.3	34.8	39.4	39.6	**42.5**
(%)					0%	1%	1%	1%	1%	3%	3%	3%	3%	3%	3%	**3%**
Gas oil	175.3	258.1	388.1	530.0	630.3	629.2	607.2	628.1	597.1	590.8	596.8	610.5	601.1	631.8	606.9	**682.7**
(%)	34%	47%	54%	71%	61%	58%	55%	53%	51%	49%	48%	47%	47%	48%	49%	**51%**
Biodiesel					6.3	11.5	13.4	22.4	28.0	38.1	36.3	35.5	30.8	33.6	32.1	**29.7**
(%)					1%	1%	1%	2%	2%	3%	3%	3%	3%	3%	3%	**2%**
Queroseno	3.4	15.6														
(%)	1%	3%														
Jet fuel			12.0	1.4	1.7	1.7	2.4	2.9	2.2	2.7	2.2	2.3	2.0	2.1	2.0	**2.2**
(%)			2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Fuel oil	77.5	34.0	0.8		0.9	0.0	0.2	0.6	1.3	0.8	1.5	1.3	0.3		0.1	**0.1**
(%)	15%	6%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	**0%**
Electricity	2.1	1.5									0.0	0.0	0.1	0.1	0.2	**0.4**
(%)	0%	0%									0%	0%	0%	0%	0%	**0%**
TOTAL	**518.8**	**551.0**	**724.7**	**748.2**	**1,032.3**	**1,085.7**	**1,109.3**	**1,174.7**	**1,182.3**	**1,216.4**	**1,247.4**	**1,294.2**	**1,274.4**	**1,320.7**	**1,247.0**	**1,364.5**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**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 privates fleets. For previous years, it is very small and is included within the residential and commercial / services / public sector sectors.

4.2.4. Industrial sector

The final energy consumption of the industrial sector was 2,100 ktoe in 2021, 3% higher than that recorded in 2020. Please note that the industrial sector includes the manufacturing industry and the construction sector. The main source consumed in 2021 corresponded to biomass waste, representing 65% of the total industrial consumption. To a lesser extent, electricity consumption was recorded (15%), followed by firewood (7%) and fuel oil (6%).

FIGURE 35. Final energy consumption of the industrial sector by source



NOTE: "others" include gas oil, petcoke, LP gas, propane and industrial wastes.

In the 1965-2021 period, the industrial sector recorded a significant fluctuation in its energy consumption from various sources. In the first years of this period, fuel oil was the country's most widely used energy source, with a 70% share. It is essential to note the years when the consumption of firewood and electricity was higher than other sources (1986-1995 and 2003-2007) and the complementarity between fuel oil and firewood consumption throughout the years.

Biomass waste (rice and sunflower husks, sugarcane bagasse, black liquor, odorous gases, methanol, barley husks, and wood industry waste) has historically had a low consumption in the industry, with shares of less than 14% up to and including 2007. 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 as of 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. As already mentioned, this significant growth experienced by biomass waste since 2008 has transformed the industrial sector into the leading sector in energy consumption.

Electricity reported its maximum share in industrial consumption in 2002 (29%) and then decreased to 15-16% in the last eight years. Despite this percentage decrease, absolute electricity consumption experienced a net growth, with a maximum value in 2018 (318 ktoe). In 2021, it reported a 2% growth compared to 2020, reaching a value of 314 ktoe.

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 grid. Between 1965 and 1980, the share of electricity from autoproduction remained between 10% and 15% compared to industrial electricity consumption and then fell to shares lower than 10% for almost

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30 years. As of 2008, the share of electricity from autoproduction grew to between 30% and 35%, and from 2014 to values greater than 40% of the electricity consumption in the industry. Therefore, in the last eight years, industrial establishments generated almost half the electricity they consumed (47%-49%).

Firewood consumption increased and reached a 29% share in 2006, dropping to 7% in 2021. Although in the last year, the share fell by one percentage point, in absolute values the consumption of firewood in the industrial sector increased 2%.

Regarding fuel oil, its highest historical consumption has been in the industrial sector, with shares over 70%. As mentioned above, its consumption was especially significant in the first years of the series, with shares lower than 10% since 2010. In 2021, fuel oil consumption accounted for 6% of final energy consumption in the industrial sector.

Industrial consumption for 2021: 47% of electricity was self-produced and ANCAP supplied 100% of 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. This percentage remained the same until 2021. This reduction was partly explained by the decrease in consumption and the increase in the sector's total consumption. As already mentioned, we must consider the difficulties entailed by Argentina's natural gas supply (sole provider of this source).

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 eight years, going from 36 ktoe (2013) to 88 ktoe (2021). In turn, LPG consumption has increased in the last few years, but it remains marginal within the industrial sector's total consumption.

In the case of solar energy, in 2021, it was possible to estimate consumption at 0.2 ktoe, corresponding to an installed area of solar thermal collectors covering 2,858 m^2. This value was obtained from the annual surveys conducted on industrial facilities and information about the equipment imported by companies in the sector. This is a preliminary value, as solar energy information is difficult to collect in sector-specific surveys because the sample size fails to 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. In particular, in 2021 its share was 64%, followed by the "wood" (7%), "cement" (5%), and "chemical, rubber and plastic" (5%) sectors.

The industrial sectors presented differences not only in energy consumption levels but also in the types of energy used, which allows us to identify specific consumption patterns. In 2021, "paper and cellulose" and "wood" consumed mainly biomass waste (more than 80%), and to a lesser extent, electricity (less than 9%). In 2021, the "chemicals, rubber and plastic" sector had an electricity-based consumption (67%), followed by "firewood" (16%) and "biomass waste" (12%), while "cement" consumed mostly petcoke (80%) and electricity (7%). In the last year, the consumption matrix of "slaughterhouses" was formed by firewood (44%), electricity (38%), biomass waste (14%), and fuel oil (2%), while "mills" mainly consumed biomass waste (57%), electricity (25%), and firewood (16%).

In the "dairy" subsector, 2021 consumption was distributed among three sources: firewood (42%), electricity (26%), and fuel oil (23%). The "beverages and tobacco" and "other food" sectors recorded a similar consumption pattern: biomass waste (27% and 35%, respectively), firewood (31% and 24%), and electricity (31% and 25%). In the "textile" and "leather" sec-

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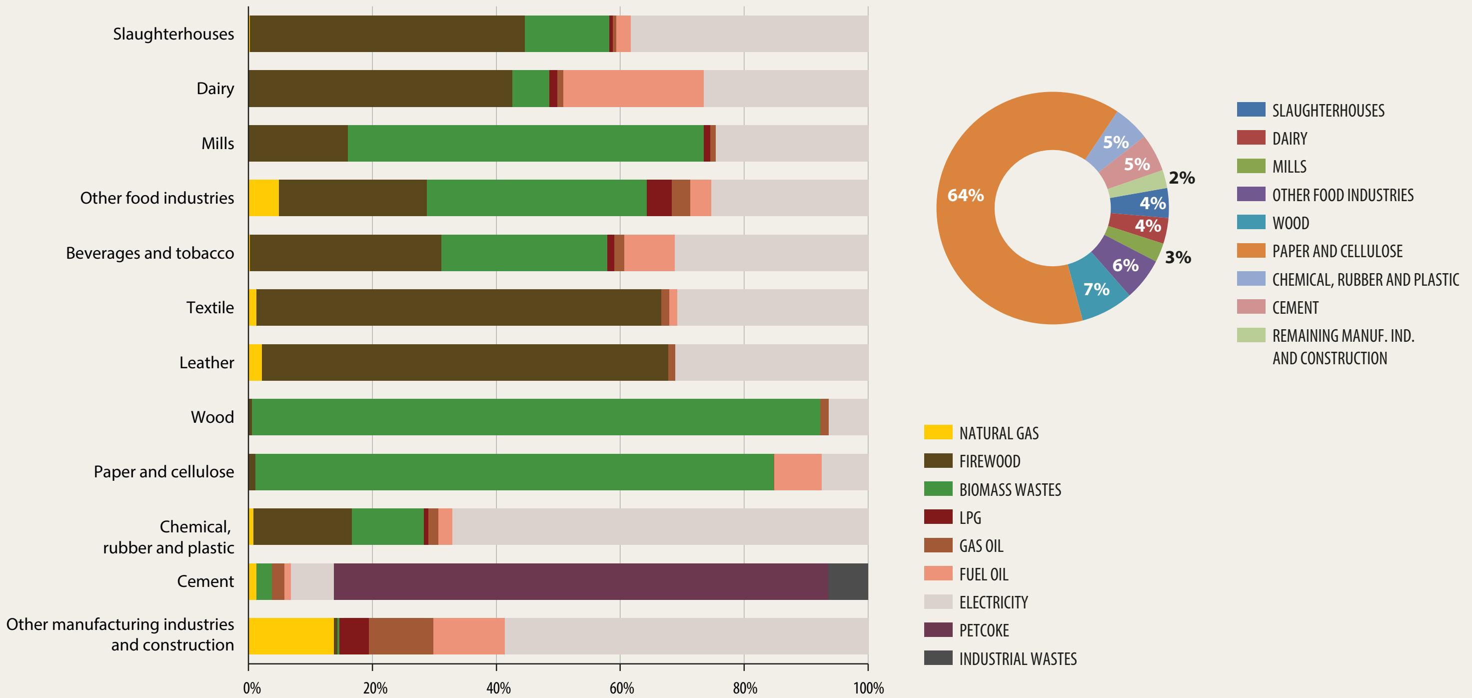
tors, energy consumption was led by firewood (65% and 64%, respectively) followed by electricity (31% and 30%). Finally, for the "other manufacturing and construction" sector, consumption in 2021 was distributed among more sources: electricity (58%), natural gas (14%), fuel oil (11%), gas oil (10%), 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 industry sector in 2021, mainly black liquor from the cellulose industry. In the case of electricity, its highest consumption was recorded in the "paper and cellulose industry" (32%), followed by the "chemical, rubber and plastic" sector (23%), and "slaughterhouses" (11%). Firewood represented the third energy source consumed by the industrial sector, and the following are the main consuming sectors: "slaughterhouses" (25%), "dairy products" (21%), "chemical, rubber and plastic" (11%), and "paper and cellulose" (9%). As for fuel oil, industrial consumption was mainly divided between the "paper and cellulose" industry (76%), followed to a lesser extent by "dairy products" (13%) and "chemicals, rubber, and plastic" (2%).

FIGURE 36. Breakdown of consumption in the industrial sector in 2021



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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 gasoline, solar energy, or biofuels, given their small values (lower than 1 ktoe).

TABLE 16. Final energy consumption in the industrial sector

ktoe	1965	1980	1995	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Coal	5.1	2.7	0.3	0.9												
(%)	1%	0%	0%	0%												
Natural gas				51.6	12.8	20.2	17.8	13.3	12.2	11.7	11.7	16.0	16.3	17.5	16.3	**13.5**
(%)				10%	1%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	**1%**
Solar									0.0	0.1	0.1	0.1	0.1	0.1	0.2	**0.2**
(%)									0%	0%	0%	0%	0%	0%	0%	**0%**
Firewood and charcoal	35.1	80.0	150.0	139.1	181.1	216.7	200.3	207.9	196.0	176.9	176.1	176.6	190.7	180.1	151.3	**154.8**
(%)	8%	13%	32%	26%	15%	17%	16%	15%	12%	10%	9%	9%	9%	9%	8%	**8%**
Biomass wastes	15.1	35.6	46.0	41.5	638.0	618.2	619.2	683.1	893.3	1,150.0	1,219.9	1,275.4	1,250.1	1,279.8	1,325.5	**1,361.1**
(%)	3%	6%	10%	8%	53%	49%	50%	51%	56%	62%	62%	64%	62%	63%	65%	**65%**
LPG	0.6	1.4	1.6	5.1	12.8	11.3	14.6	17.1	18.2	17.3	14.5	11.5	15.3	15.9	10.3	**8.9**
(%)	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	0%	1%	1%	1%	**0%**
Industrial wastes						2.1	1.6	4.3	3.4	6.0	7.0	6.4	8.7	8.6	9.3	**7.0**
(%)						0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Gasoline	5.6	4.7	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.3	0.5	0.5	0.9	**0.9**
(%)	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Kerosene	7.0	3.2	1.4	0.9												
(%)	2%	1%	0%	0%												
Gas oil	7.3	14.8	9.6	8.2	15.2	14.5	15.8	15.7	17.6	15.9	16.4	16.1	18.0	17.4	16.4	**16.5**
(%)	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	**1%**
Fuel oil	324.7	352.9	141.4	111.7	103.1	118.9	114.2	141.1	160.8	154.8	173.6	135.5	138.2	135.5	129.4	**135.5**
(%)	70%	59%	30%	21%	8%	9%	9%	10%	10%	8%	9%	7%	7%	7%	6%	**6%**
Petcoke	0.0	0.0	0.8	23.7	32.5	36.1	36.1	36.0	43.9	47.0	50.8	64.8	71.1	62.9	64.3	**88.0**
(%)	0%	0%	0%	4%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	**4%**
Manufactured gas	0.6	1.0	1.4	0.0												
(%)	0%	0%	0%	0%												
Coke of coal	12.5	4.7	0.2	0.9	0.3	0.3	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	**0.1**
(%)	3%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Electricity	49.9	93.3	112.6	146.1	217.6	217.2	213.0	226.0	249.9	279.5	303.6	302.9	318.3	311.5	306.1	**313.7**
(%)	11%	16%	24%	28%	18%	17%	17%	17%	16%	15%	15%	15%	16%	15%	15%	**15%**
TOTAL	**463.5**	**594.3**	**465.5**	**529.9**	**1,213.7**	**1,255.8**	**1,233.0**	**1,344.9**	**1,595.6**	**1,859.6**	**1,974.1**	**2,005.7**	**2,027.4**	**2,029.9**	**2,030.1**	**2,100.2**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**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.

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4.2.5. Primary activities sector

The primary activities sector[14] comprises the agriculture, mining, and fishing sectors. The final consumption of primary activities was 179 ktoe in 2021, 1% lower than the previous year. Gas oil was historically the most consumed energy source with a value of 127 ktoe and a share of 72% in 2021. Throughout the entire series, this source presented variations in consumption and recorded its maximum historical value in 1996 (184 ktoe). It must be noted that, since 2010, the gas oil reported in this sector has included blended biodiesel.

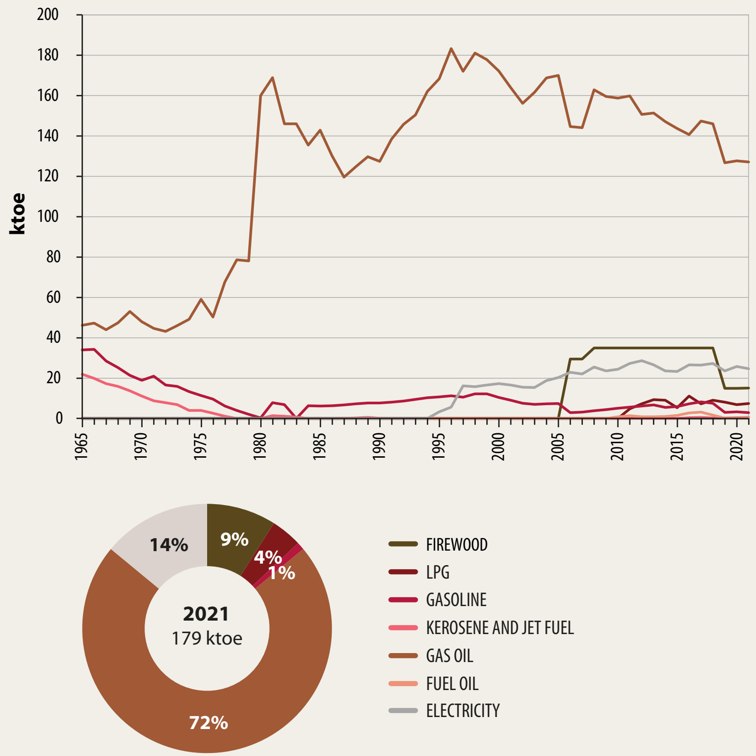
The second most important source within this sector has varied throughout the series: until 1996 it was gasoline, between 1997 and 2005 electricity, and then firewood. In 2019, electricity returned to second place in consumption. It should be noted that, in the last edition of the BEN, improvements were incorporated in the estimations of the primary sector, through surveys, particularly in the "poultry" sector. The results indicated that in recent years there has been a substitution of sources used in this subsector, specific firewood for LPG. For this reason, it is important to clarify that the 20 ktoe drop in firewood consumption associated with primary activities (35 ktoe in 2018 went to 15 ktoe in 2019) was established with a new survey (surely the drop has been more gradual, but the survey considered the 2019-2020 period).

Furthermore, electricity consumption increased until 2012 (29 ktoe), reaching a 13% share, and decreased again to 11% in 2015 (23 ktoe). In 2021, electricity consumption decreased 4% compared to the previous year, resulting in a 14% share.

LPG consumption in the primary activities sector has been recorded since 2011. In 2021, said consumption was 8 ktoe, entailing a 9% increase compared to 2020. Motor gasoline had a 1% share of the sector's own consumption in the last year, while fuel oil reported a meager figure (<1%). It should be noted that there has been no record of kerosene consumption in this sector since 1993.

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

FIGURE 37. 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, within the agricultural sector, the consumption of the poultry sector is disaggregated from the rest of agriculture, a breakdown that would be implemented as of 2019. These improvements have been possible thanks to the implementation of new statistical operations.

In 2021, the **agricultural sector** accounts for 85% (151 ktoe) of the consumption in the primary activities sector. Gas oil is the main source of agriculture, accounting for 69% of the sector's own consumption. It was followed by electricity, which reached 15% (23 ktoe) in 2021, while firewood is in the third position, with a 10% share (15 ktoe).

As for the **fishing sector**, its consumption was 17 ktoe in 2021, with a 9% share in the consumption of the primary activities sector. In the last year, a gas oil consumption of 14 ktoe was reported, associated with industrial fishing, and 2 ktoe of gasoline in non-industrial fishing. Marine gas oil used in ships does not include biodiesel.

Finally, the **mining sector** accounts for the remaining 6% (11 ktoe) within the primary activities sector. The main energy source consumed was gas oil, which accounts for 87% (9 ktoe) of the sector's own consumption. The remaining 13% corresponded to electricity. The other sources consumed in this sector have values lower than 0.1 ktoe and do not appear in the BEN matrix.

FIGURE 38.
Final energy consumption of the agriculture sector by source

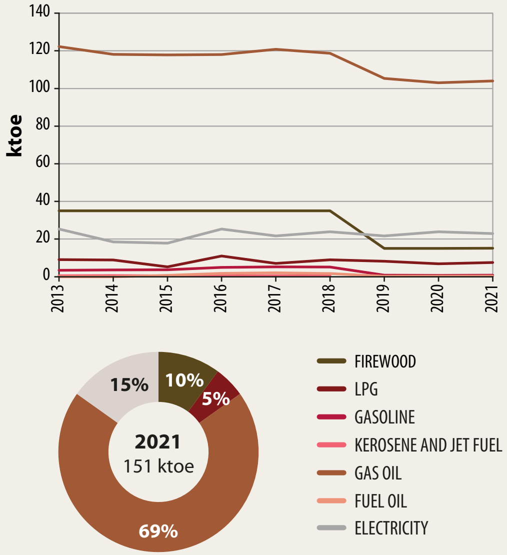

FIGURE 39.
Final energy consumption of the mining sector by source

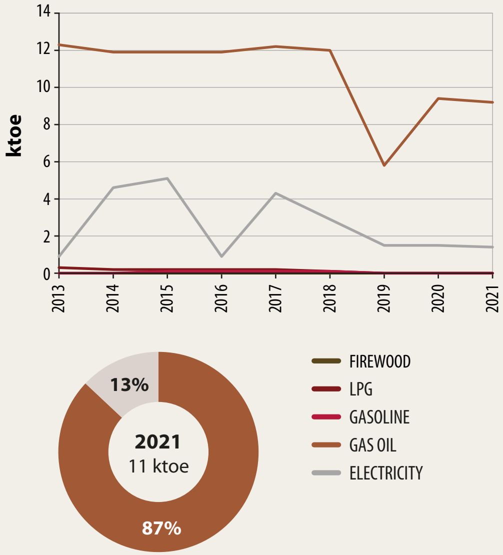

FIGURE 40.
Final energy consumption of the fishing sector by source

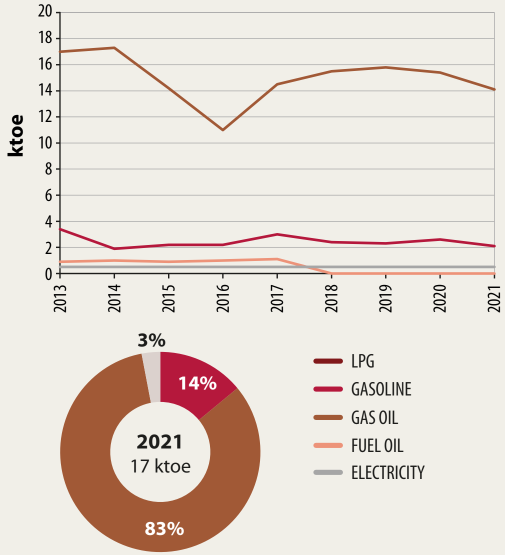

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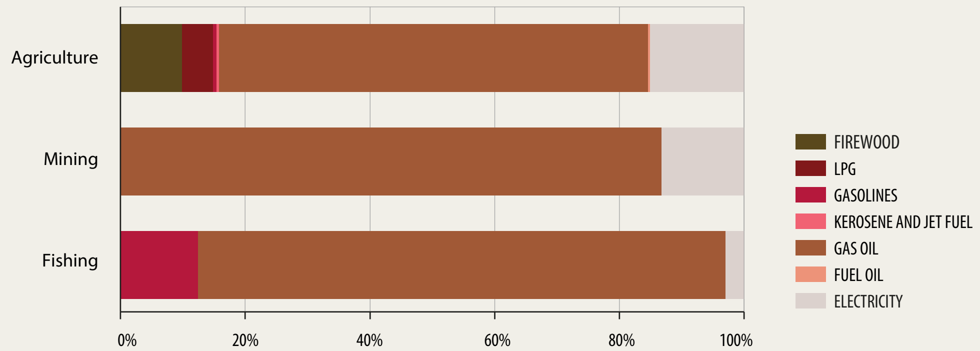
FIGURE 41. Breakdown of consumption in the primary activities sector in 2021



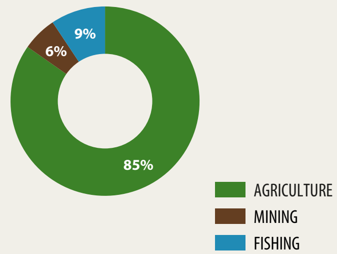


TABLE 17. Final energy consumption of the primary activities sector

ktoe	1965	1980	1995	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Firewood					35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	15.0	15.0	**15.1**
(%)					16%	15%	15%	15%	16%	16%	16%	15%	15%	9%	8%	**9%**
LPG						4.9	7.3	9.4	9.1	5.4	11.2	7.3	9.1	8.2	6.9	**7.5**
(%)						2%	3%	4%	4%	3%	5%	3%	4%	5%	4%	**4%**
Motor gasoline	34.0	0.3	10.7	7.4	5.2	5.7	6.3	6.8	5.5	6.0	6.2	7.3	6.8	2.3	2.6	**2.1**
(%)	33%	0%	6%	4%	2%	2%	3%	3%	2%	3%	3%	3%	3%	1%	1%	**1%**
Aviation gasoline											1.1	1.0	0.8	0.8	0.7	**0.8**
(%)											0%	0%	0%	0%	0%	**0%**
Kerosene and jet fuel	22.0										0.5	0.6	0.4	0.4	0.5	**0.6**
(%)	22%										0%	0%	0%	0%	0%	**0%**
Gas oil	46.2	160.1	168.5	170.1	158.9	160.0	150.8	151.5	147.3	143.9	140.9	147.5	146.2	126.9	127.8	**127.3**
(%)	45%	100%	92%	86%	71%	68%	66%	66%	67%	67%	63%	65%	65%	72%	72%	**72%**
Fuel oil					0.9	1.4	0.9	0.9	1.0	1.6	2.8	3.2	1.7	0.2	0.3	**0.3**
(%)					0%	1%	0%	0%	0%	1%	1%	1%	1%	0%	0%	**0%**
Electricity			3.3	20.4	24.5	27.4	28.7	26.7	23.6	23.4	26.7	26.5	27.3	23.7	25.9	**24.8**
(%)			2%	10%	11%	12%	13%	12%	11%	11%	12%	12%	12%	13%	15%	**14%**
TOTAL	**102.2**	**160.4**	**182.5**	**197.9**	**224.5**	**234.4**	**229.0**	**230.3**	**221.5**	**215.3**	**224.4**	**228.4**	**227.3**	**177.5**	**179.7**	**178.5**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**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.

5. Carbon dioxide emissions

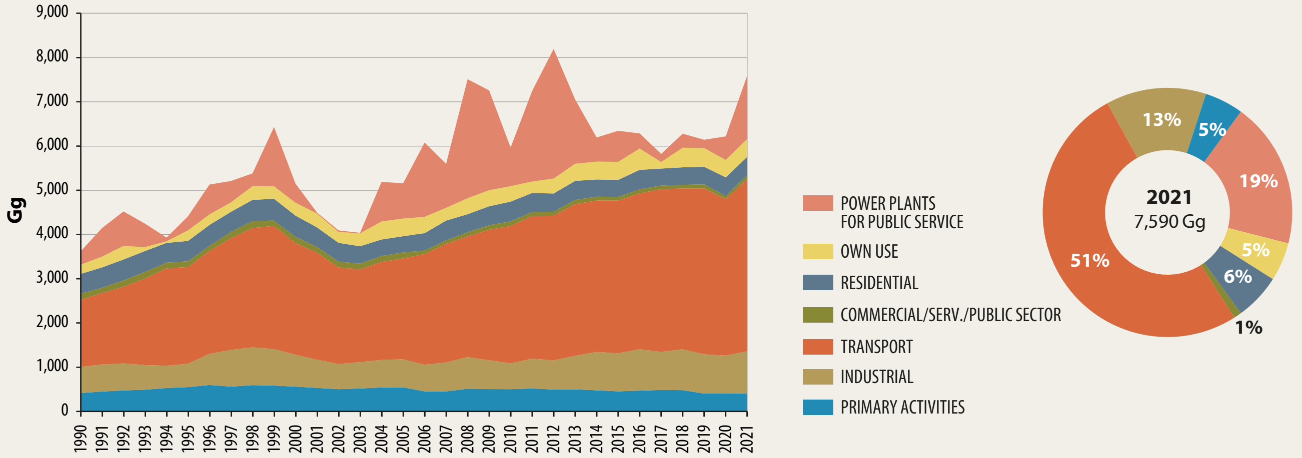
The BEN includes carbon dioxide (CO_2) emissions from fuel-burning activities in the energy industries (“power plants for public service” and “own use”) and the final consumption sectors (“residential,” “commercial/services/public sector,” “transport,” “industrial,” “primary activities”). The series begins in 1990 when Uruguay started to have data from the National Greenhouse Gas Inventories (INGEI).

CO_2 emissions are calculated according to the “2006 IPCC Guidelines for National Greenhouse Gas Inventories”. According to said 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 burned), there is an absorption process (through photosynthesis) in plant species during their growth. It is necessary to evaluate both things simultaneously to avoid drawing misleading conclusions from partial results. Therefore, the calculation of CO_2 emission and absorption from biomass is recorded in the “Agriculture, Forestry, and Other Land Use sector” (AFOLU) of the INGEI mentioned above. However, 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 adding them up in the totals, as explained above).

In 2021, CO_2 emissions from fuel combustion increased 22%; however, they were 7% lower than the historical maximum (2012).

Total CO_2 emissions in 2021 accounted for 7,590 Gg[15], 22% higher than the previous year. Considering the entire period under study, CO_2 emissions increased from 3,630 Gg in 1990 to 6,437 Gg in 1999. In 2003, they began to decrease to 4,043 Gg. This drop in emissions coincided with the decrease in energy demand caused by the crisis faced by the country at the beginning of the century, in addition to a few years of good rainfall. Since 2004, emissions showed a net upward trend, reaching the highest levels of the period in 2012 (8,191 Gg).

FIGURE 42. CO_2 emissions by sector



15- 1Gg (1 billion grams) equals to 1 ktonne (one thousand tonnes).

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The following years presented a net decrease in CO_2 emissions. And, in 2021, they reached a level of emissions 7% lower than the historical maximum and 109% higher than in 1990.

For the year 2021, CO_2 emissions were associated with the following categories in decreasing order: transport (3,886 Gg), public service power plants (1,432 Gg), industrial (951 Gg), residential (416 Gg), primary activities (411 Gg), own use (404 Gg) and finally commercial/services/public sector (90 Gg).

Thus, 24% of CO_2 emissions came from the energy industries (electricity generation and own use in the energy sector) and 76% corresponded to fuel-burning activities in the different final consumption sectors.

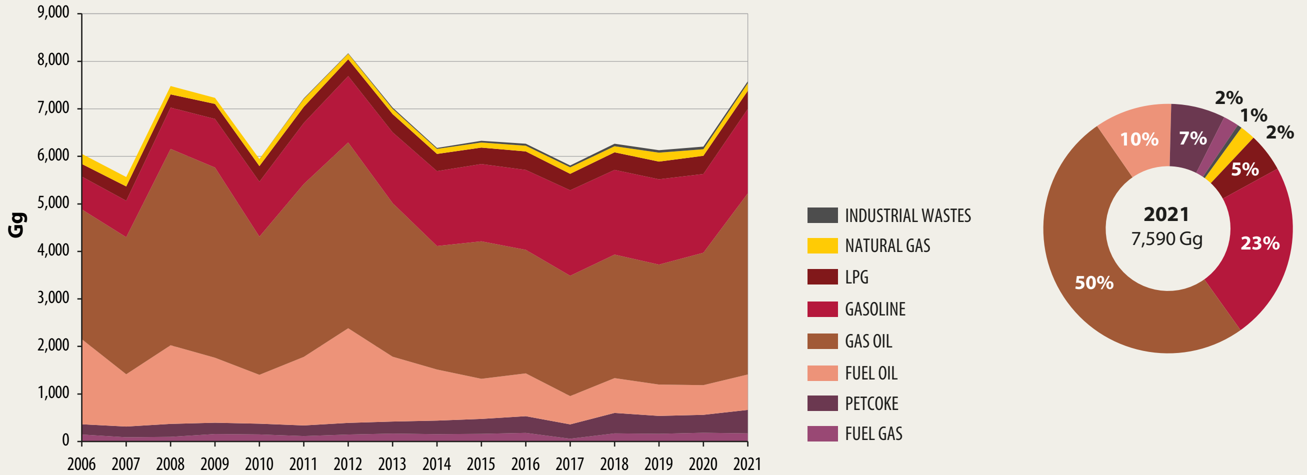
Regarding **energy industries**, the emissions from electricity generation power plants varied significantly as they are intricately linked to the country's rainfall conditions. For dry years with low hydroelectricity figures, the consumption of oil products in power plants is high, thus contributing to the total CO_2 emissions.

In the last 15 years, the greatest records corresponded to 2008, 2009, and 2012, with 36%, 31%, and 36% in total emissions, respectively. Similarly, in 2010 and as of 2013, there were good hydropower contributions for electricity generation, with the resulting 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 2021, there was a low level of hydroelectricity generation, similar to that of 2012, which caused emissions associated with the energy industry to grow by 170% compared to the previous year. This increase was not only associated with low hydropower, but also with the export of fossil fuel electricity in 2021, which had an impact on the emissions associated with this sector.

The consumption of hydrocarbon (gas oil, fuel oil, and natural gas) for electricity generation decreased between 2015 and 2017; therefore, associated CO_2 emissions also decreased. In 2018 there was a 73% increase in CO_2 emissions from

FIGURE 43. CO_2 emissions by source



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this category and, in 2019, they decreased again by 41%. In 2017 and 2019, the lowest CO_2 emissions from power plants in the last 18 years were recorded. Both in 2020 and 2021 increases were again recorded (184% and 170%, respectively). It is important to note the aforementioned, referring to the export of fossil-fuel electricity for these last two years.

Emissions from the energy sector's own use are mainly due to the operation of the refinery. They have remained relatively constant throughout the series, with shares between 5-8% of total CO_2 emissions. In particular, it is worth mentioning the decrease in emissions in this category in 2017, which was due to the shutdown of the refinery for maintenance, similar to what happened in 1994.

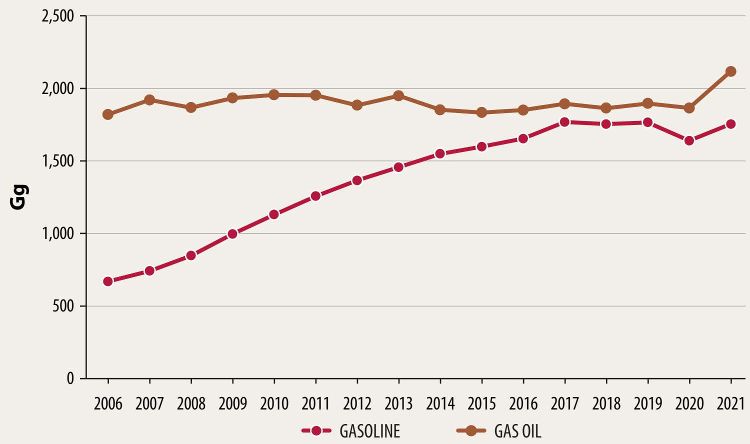
In 2018 and 2019, refinery operations were as usual and CO_2 emissions due to own use of the energy sector returned to those of previous years. In particular, in 2020 there was a decrease associated with lower refinery production, which, as indicated above, was due to the measures adopted by the country in response to the pandemic, which affected consumption in the transport sector. Finally, it is worth mentioning that in 2021, 10% more crude oil was processed than in the previous year, while emissions from own use were only 2% higher. This was due to a substitution of sources, as more natural gas was used and less fuel oil.

Regarding emissions from the **consumption sectors**, the main category has historically been the transport sector, with an average share (considering the series since 1990) of 60% of sectoral emissions and 49% of the total (including energy industries). The evolution of emissions followed the trend of energy consumption in this sector; it had sustained growth until 1999, a subsequent drop for four years, and finally a net increase until 2021, after the aforementioned decrease by 2020. Since 2006, the increase in CO_2 emissions in the transport sector was mainly marked by emissions associated with gasoline consumption, which increased 163% in these 15 years, while for gas oil they only grew 16%. It is mentioned that, in 2006, CO_2 emissions associated with gasoline consumption in transport were only 27%, while this share became almost half since 2014 (greater than 45%).

Transport was the main category responsible for CO_2 emissions in 2021.

CO_2 emissions in the other consumption sectors were similar to those from the transport sector in 1990. Emission trends in these sectors grew less than in the transport sector. For this reason, its 2021 share was 25% of total CO_2 emissions, and the share was 32% within the final energy consumption sectors. Although the industrial sector has remained relatively constant throughout the period, it is essential to note that, over the last eleven years, CO_2 emissions grew from 583 Gg (2010) to 951 Gg (2021). This was mainly due to increased fuel oil and petcoke consumption in the industry. CO_2 emissions from the residential, commercial/services/public sector, and primary activities sectors have been low compared to the other sectors. They have remained relatively constant throughout the years.

FIGURE 44. CO_2 emissions in the transport sector by source



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

In 2021, emissions from biomass combustion amounted to 9,388 Gg of CO_2, 2% higher than the previous year. As per fuels, biomass waste had the highest share (74%), followed by firewood and charcoal (24%) and, to a lesser extent, biofuels (3%).

The international bunkers category reported CO_2 emissions from sea and inland navigation, as well as aviation, inbound and outbound trips to other countries. In 2021, emissions from international bunkers were 415 Gg of CO_2, which represented a 6% decrease compared to 2020. In turn, between 2019 and 2020, there had already been a significant decrease of 45% as port and airport operations were severely affected by the pandemic.

In 2021, 70% of emissions in this category came from sea and fluvial transportation through marine gas oil (58%) and fuel oil (11%), while the remaining 31% corresponded to air transportation, mainly jet fuel.

FIGURE 45. Memo items of CO_2 emissions

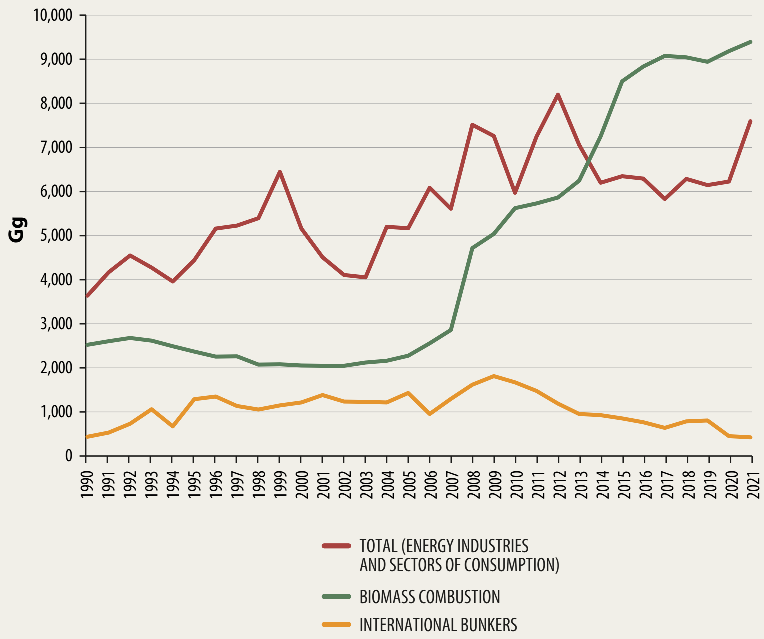

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FIGURE 46. CO_2 emissions by source and by sector

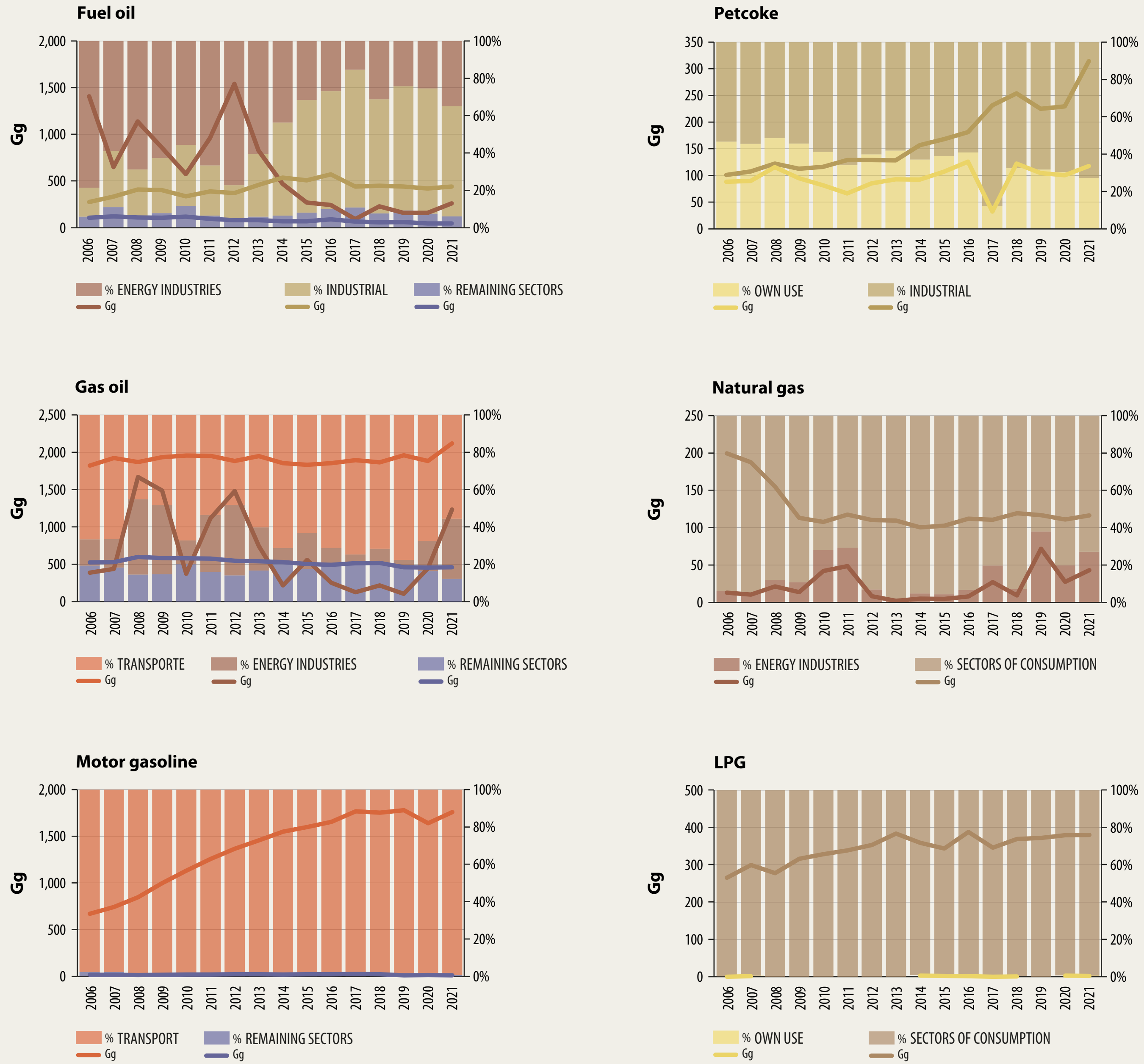

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TABLE 18. CO_2 emissions by sector

Gg	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Power plants for public service	298.8	318.2	429.4	795.3	872.6	2,044.7	2,926.5	1,449.1	544.8	700.3	340.8	183.3	316.7	187.1	531.1	**1,431.9**
(%)	8%	7%	8%	15%	15%	28%	36%	21%	9%	11%	5%	3%	5%	3%	9%	**19%**
Own use	208.8	239.4	292.0	398.9	349.1	258.8	338.0	387.7	403.9	408.3	482.2	147.9	443.1	423.6	394.6	**403.8**
(%)	6%	5%	6%	8%	6%	4%	4%	6%	7%	6%	8%	3%	7%	7%	6%	**5%**
Energy industries SUBTOTAL	*507.6*	*557.6*	*721.5*	*1,194.2*	*1,221.7*	*2,303.5*	*3,264.4*	*1,836.8*	*948.7*	*1,108.6*	*823.0*	*331.2*	*759.8*	*610.8*	*925.7*	***1,835.7***
(%)	*14%*	*13%*	*14%*	*23%*	*20%*	*32%*	*40%*	*26%*	*15%*	*17%*	*13%*	*6%*	*12%*	*10%*	*15%*	***24%***
Residential	444.6	459.9	476.1	366.8	445.9	428.3	411.7	429.9	388.6	384.9	439.8	383.5	396.2	397.7	418.6	**416.1**
(%)	12%	10%	9%	7%	7%	6%	5%	6%	6%	6%	7%	7%	6%	6%	7%	**6%**
Commercial/services/ public sector	139.7	129.9	145.4	133.9	105.3	92.6	89.9	96.3	86.6	83.0	91.3	81.7	83.7	90.0	73.4	**90.2**
(%)	4%	3%	3%	3%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	**1%**
Transport	1,513.9	2,182.1	2,519.4	2,277.5	3,101.4	3,221.6	3,265.7	3,424.8	3,419.0	3,448.7	3,519.7	3,675.9	3,628.1	3,747.0	3,531.7	**3,885.8**
(%)	42%	49%	49%	44%	52%	44%	40%	49%	55%	54%	56%	63%	58%	62%	56%	**51%**
Industrial	590.9	528.7	719.5	633.5	582.7	673.0	659.2	757.5	866.7	858.8	935.0	859.0	924.1	886.0	857.9	**951.3**
(%)	16%	12%	14%	12%	10%	9%	8%	11%	14%	14%	15%	15%	15%	15%	14%	**13%**
Primary activities	418.5	553.8	565.3	549.2	506.9	522.7	499.3	502.3	481.6	457.9	474.3	489.0	485.0	408.2	408.2	**410.8**
(%)	12%	12%	11%	11%	9%	7%	6%	7%	8%	7%	8%	8%	8%	7%	7%	**5%**
Non-specified	14.5	22.1	7.5	5.2	0.0	0.0	0.6	0.6	0.9						0.0	**0.0**
(%)	0%	0%	0%	0%	0%	0%	0%	0%	0%						0%	**0%**
Sectors of consumption SUBTOTAL	*3,122.1*	*3,876.5*	*4,433.2*	*3,966.1*	*4,742.3*	*4,938.0*	*4,926.4*	*5,211.4*	*5,243.4*	*5,233.2*	*5,460.1*	*5,489.1*	*5,517.2*	*5,529.0*	*5,289.7*	***5,754.1***
(%)	*86%*	*87%*	*86%*	*77%*	*80%*	*68%*	*60%*	*74%*	*85%*	*83%*	*87%*	*94%*	*88%*	*91%*	*85%*	***76%***
TOTAL	**3,629.7**	**4,434.1**	**5,154.7**	**5,160.3**	**5,964.0**	**7,241.5**	**8,190.8**	**7,048.1**	**6,192.1**	**6,341.9**	**6,283.1**	**5,820.3**	**6,277.0**	**6,139.8**	**6,215.5**	**7,589.8**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**101%**	**100%**	**100%**

NOTES: 1) CO_2 emissions are calculated according to the “2006 IPCC Guidelines for National Greenhouse Gas Inventories”.

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TABLE 19. CO_2 emissions by source

Gg	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Natural gas	212.6	197.8	175.9	127.1	149.9	166.1	118.4	111.6	105.5	107.3	120.0	137.4	128.5	188.4	138.3	**159.5**
(%)	3%	4%	2%	2%	3%	2%	1%	2%	2%	2%	2%	2%	2%	3%	2%	**2%**
LPG (Liquefied petroleum gas)	265.0	300.9	277.7	316.2	328.1	338.7	352.7	383.3	361.7	345.8	389.1	345.8	369.6	371.7	382.0	**382.0**
(%)	4%	5%	4%	4%	6%	5%	4%	5%	6%	5%	6%	6%	6%	6%	6%	**5%**
Motor gasoline	684.7	759.3	861.7	1,014.9	1,149.0	1,278.1	1,388.3	1,480.9	1,569.4	1,619.3	1,675.6	1,792.8	1,777.1	1,790.2	1,652.7	**1,770.5**
(%)	11%	14%	11%	14%	19%	18%	17%	21%	25%	26%	27%	31%	28%	29%	27%	**23%**
Aviation gasoline	6.4	7.8	7.8	7.5	7.5	7.0	8.4	8.4	7.3	7.3	6.4	6.1	5.5	5.2	4.9	**5.2**
(%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Kerosene	22.3	24.7	22.3	24.1	20.5	21.7	20.2	19.3	15.7	13.2	16.0	10.8	11.4	9.9	9.9	**8.7**
(%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Jet fuel	4.8	5.7	6.3	6.3	5.1	5.1	7.2	8.7	6.6	8.1	8.1	8.7	7.2	7.5	7.5	**8.4**
(%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Gas oil	2,731.7	2,885.2	4,132.4	4,003.1	2,907.9	3,638.8	3,910.3	3,233.0	2,598.9	2,893.6	2,599.8	2,532.8	2,599.8	2,525.1	2,786.6	**3,811.6**
(%)	45%	52%	55%	55%	49%	50%	48%	46%	42%	46%	42%	44%	41%	41%	45%	**50%**
Fuel oil	1,790.1	1,100.5	1,655.3	1,368.2	1,028.9	1,443.0	1,992.0	1,365.3	1,075.6	844.5	901.5	595.6	732.7	660.1	625.1	**745.7**
(%)	29%	20%	22%	19%	17%	20%	24%	19%	17%	13%	14%	10%	12%	11%	10%	**10%**
Petcoke	215.9	225.3	272.3	237.6	225.7	223.3	244.9	253.1	284.9	313.9	351.1	301.3	430.3	376.4	377.2	**493.5**
(%)	4%	4%	4%	3%	4%	3%	3%	4%	5%	5%	6%	5%	7%	6%	6%	**7%**
Fuel gas	137.9	80.5	89.5	148.6	140.1	105.9	137.9	158.0	145.9	152.4	172.7	50.2	162.3	153.4	175.1	**162.3**
(%)	2%	1%	1%	2%	2%	1%	2%	2%	2%	2%	3%	1%	3%	3%	3%	**2%**
Coal and coke of coal	9.4	11.6	6.7	0.9	1.3	1.3	0.9	0.9	0.4	0.4	0.9	0.4	0.4	0.4	0.4	**0.4**
(%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Industrial wastes						12.6	9.6	25.7	20.4	35.9	41.9	38.3	52.1	51.5	55.7	**41.9**
(%)						0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	**1%**
TOTAL	**6,080.8**	**5,599.4**	**7,507.8**	**7,254.4**	**5,964.0**	**7,241.5**	**8,190.8**	**7,048.1**	**6,192.1**	**6,341.9**	**6,283.1**	**5,820.3**	**6,277.0**	**6,139.8**	**6,215.5**	**7,589.8**
(%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**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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6. Indicators

This chapter presents a series of indicators that relate energy and CO_2 emissions variables, among others, to economic and demographic variables. It refers to the GDP[16] and population statistical series published by the Central Bank of Uruguay (BCU) and the National Institute of Statistics (INE), respectively.

It should be noted that for the years before 2015, we used the GDP series prepared by MEF applying retropolation. As a result, this BEN edition presents a global GDP series at constant 2016 prices since 1965, covering the entire period of study of energy variables.

In the case of population, the estimation and projection of its historical series were conducted according to the 2013 Revision[17] as of 1996. The 1965-1995 period was completed with the estimations corresponding to the 1998 Revision.[18]

16- 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> (07/21/2022).
17- National Statistics Institute (INE), *Uruguay: población estimada y proyectada por año, según sexo y edad simple*, <https://www.ine.gub.uy/c/document_library/get_file?uuid=2a5c1e6e-b02f-4a63-963f-925edea7c17e&groupId=10181> (07/21/2022).
18- National Statistics Institute (INE), *Uruguay: estimaciones y proyecciones de población por sexo y edad. Total del país, 1950-2050*, <https://www.ine.gub.uy/c/document_library/get_file?uuid=b5afeb58-1c4a-44fb-99d0-a99335fed9de&groupId=10181> (07/21/2022).

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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 showed a net decrease in the 1965-2021 period, reflecting considerable variability. In 1972, the historical maximum was recorded (3.44 toe/M$ 2016), and in 2005, the minimum (2.24 toe/M$ 2016). In 2021, energy intensity remained almost the same compared to the previous year, after growing 5% in 2020. This growth in intensity was related to the sharp drop in the economy (6%), while consumption recorded a 2% decrease in 2020. In 2021, both variables grew again and there was a very small increase (0.3%) in the final energy intensity.

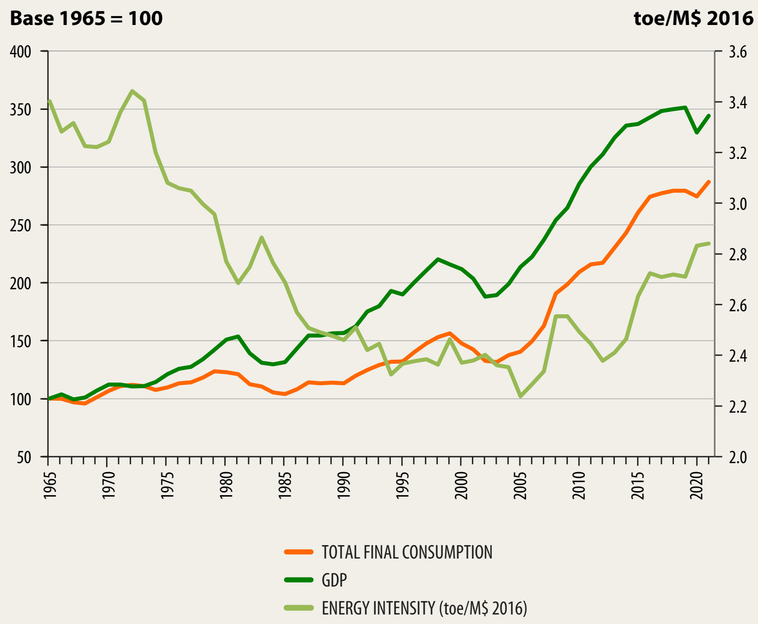
Final energy intensity in 2021:2.8 toe/M$ 2016.

GDP and the final energy consumption individual series are analyzed to understand this indicator's evolution better. This is done by taking the values of both variables for 1965 as a base equal to 100. Both series have behaved similarly in their evolution in the 1965-2021 period, alternating years of growth and others of decline where the variability recorded has made it possible to identify different periods.

The periods 1971-1972 and 1982-1983 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 fell, though GDP did so at a much higher rate. Although final energy consumption and GDP recorded a net growth between 1985 and 1999, it was higher for GDP. Therefore, energy intensity recorded a net fall (with some occasional years of growth). Energy demand declined between 2000 and 2003, after which it resumed an upward trend. Meanwhile, GDP registered negative growth rates between 1999 and 2002 inclusive. Thereafter, both series showed an upward trend.

During the 2005-2009 period, energy consumption grew at higher rates than GDP. It is worth noting that final consumption in the industrial sector grew significantly in 2008 (67% compared to 2007), which changed the country's consumption structure. For these years, energy intensity increased. In 2010, 2011, and 2012, there was the opposite trend. Although energy consumption and GDP increased, final energy consumption evolved at lower rates, leading to lower energy intensity.

FIGURE 47. Total final consumption and GDP (constant prices 2016)



Between 2013 and 2016, final energy consumption increased annually, mainly due to higher consumption in the industrial sector associated with the new pulp mill. However, GDP grew at favorable but lower rates year by year and reflected increasing energy intensity. The behavior was similar to that of the 2010-2012 period, with increases in final consumption and GDP, but at higher rates for the latter and downward energy intensity.

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For 2019, both variables grew at rates lower than 1% and resulted in an energy intensity 0.3% higher than in 2018. This behavior is typical of economic slowdowns in a pivotal year, which does not imply structural changes. In 2020 both series decreased, but GDP did so much more sharply than energy consumption, which determined an increase in energy intensity. Finally, by 2021 both variables grew again and the final energy intensity increased 0.3%.

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 equivalent oil per 1,000 inhabitants (toe/1,000 inhab.). This indicator has recorded a net growth throughout the period under study, rising from 637 toe/1,000 inhab. (1965) to 1,389 toe/1,000 inhabitants (2021), reaching an absolute maximum in the last year. The historical minimum occurred in 1968 and 1985 (591 toe/1,000 inhab.).

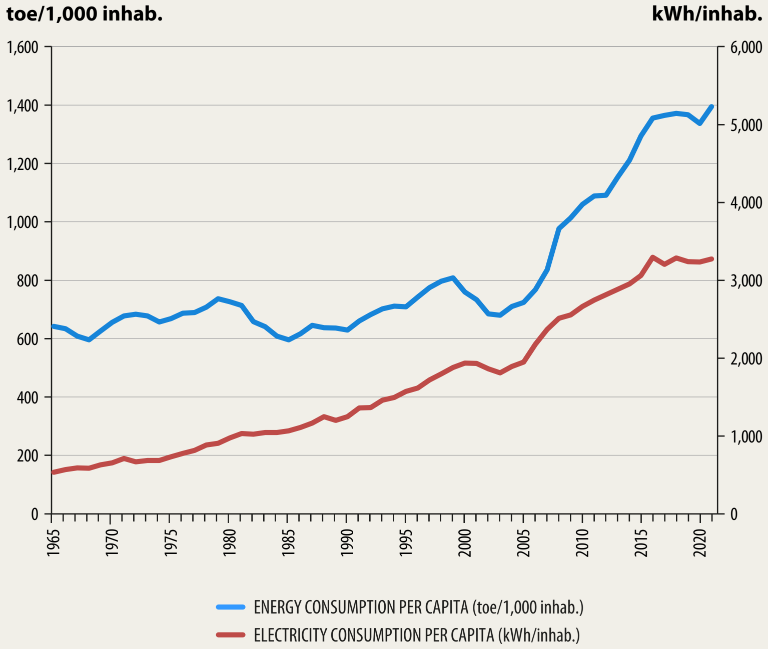
Starting in 1969, energy consumption per capita increased for eleven years, reaching a relative high in 1979, followed by six years of decline. From 1986, energy consumption per capita grew steadily; this growth was interrupted by the economic crisis at the beginning of the 21st century. However, this changed in 2004, when the upward trend began.

In 2007, the consumption peak of 1999 (pre-crisis) was surpassed, and energy consumption per capita kept growing until 2018 which was followed by two years of decline and then further growth in 2021.

Electricity consumption per capita is obtained as the ratio between electricity consumed and the number of inhabitants and expressed in kilowatt-hours per inhabitant (kWh/inhab.). Throughout the whole period, electricity consumption per capita had, in general, an upward trend, except for specific years when it decreased. The economic crisis affected electricity consumption per capita, as well as the remaining indicators.

2021:
Final consumption per capita:
1,389 toe/1,000 inhab.
Electricity consumption per capita:
3,255 kWh/inhab.

FIGURE 48. Energy and electricity consumption per capita



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Electricity consumption per capita increased from 512 kWh/ inhab. (1965) to a maximum of 1,917 kWh/inhab. (2000), and then it dropped to a minimum of 1,788 kWh/inhab. (2003). From that year onwards, the trend was reversed again and grew again reaching the historical maximum of 3,276 kWh/inhab. (2016). In 2017 and 2019, there were decreases of 3% and 2%, respectively, and in 2021 the electricity consumption per capita grew 1%.

TABLE 20. Total final consumption and GDP

	1965	1980	1995	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Total final consumption (ktoe)	1715	2101	2263	2,408	3,584	3,696	3,722	3,948	4,166	4,468	4,699	4,750	4,791	4,791	4,702	**4,922**
GDP (M$ 2016) *	504,206	759,055	956,917	1,076,527	1,438,031	1,512,264	1,565,770	1,638,384	1,691,447	1,697,718	1,726,406	1,754,508	1,762,893	1,769,071	1,660,778	**1,733,304**
Total final consumption/GDP (toe/M$ 2016)	**3.4**	**2.8**	**2.4**	**2.2**	**2.5**	**2.4**	**2.4**	**2.4**	**2.5**	**2.6**	**2.7**	**2.7**	**2.7**	**2.7**	**2.8**	**2.8**

NOTES: (*) Source: Years 1965-2015: Retropolated series by the Ministry of Economy and Finance (MEF) based on National Accounts statistics, bases 1961, 1983, 2005 and 2016, prepared and published by the Central Bank of Uruguay (BCU). Year 2016 and later: Central Bank of Uruguay (BCU): "GDP series by expenditure components in millions of constant 2016 pesos". www.bcu.gub.uy (07/21/2022). M$ 2016 corresponds to millions of pesos at constant 2016 prices.

TABLE 21. Energy and electricity consumption per capita

▸**DOWNLOAD spreadsheet ENERGY CONSUMPTION PER CAPITA**
▸**DOWNLOAD spreadsheet ELECTRICITY CONSUMPTION PER CAPITA**

	1965	1980	1995	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Population (thousands of inhabitants)[1]	2,693	2,914	3,218	3,352	3,397	3,413	3,426	3,440	3,454	3,467	3,480	3,493	3,506	3,519	3,531	**3,543**
Total final consumption (ktoe)	1,715	2,101	2,263	2,408	3,584	3,696	3,722	3,948	4,166	4,468	4,699	4,750	4,791	4,791	4,702	**4,922**
Consumption per capita (toe/1,000 inhab.)	**637**	**721**	**703**	**718**	**1,055**	**1,083**	**1,086**	**1,148**	**1,206**	**1,289**	**1,350**	**1,360**	**1,366**	**1,362**	**1,332**	**1,389**
Final electricity consumption (ktoe)	118.5	239.0	429.8	556.7	772.7	800.3	823.8	847.2	871.3	906.2	980.5	956.1	985.2	973.7	975.8	**991.7**
Electricity consumption per capita (toe/1,000 inhab.)	44	82	134	166	227	235	240	246	252	261	282	274	281	277	276	**280**
Electricity consumption per capita (kWh/inhab.)	**512**	**954**	**1,553**	**1,931**	**2,645**	**2,727**	**2,796**	**2,864**	**2,933**	**3,039**	**3,276**	**3,183**	**3,268**	**3,218**	**3,213**	**3,255**

NOTES: 1) Source: National Statistics Institute (INE). www.ine.gub.uy (07/21/2022). Years 1965, 1980, 1995: "Estimates and projections of the population of Uruguay, 1950-2050 (Revision 1998)". Year 2005 and later: "Total projected population (revision 2013)". The total population recorded according to the 2011 census was 3,286,314 inhabitants. This value is not used in the serial record in order not to create gaps.

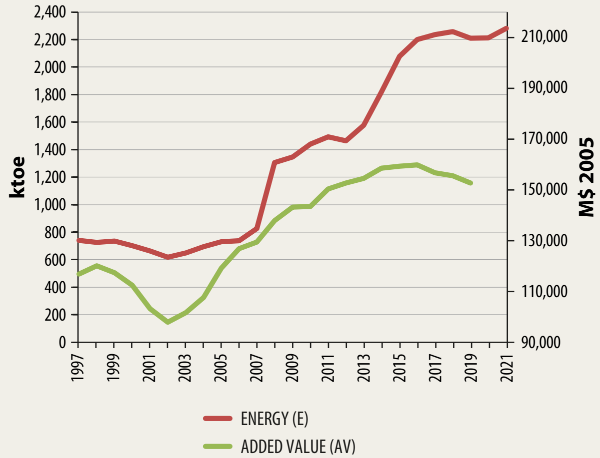
6.3. Energy intensity by sector

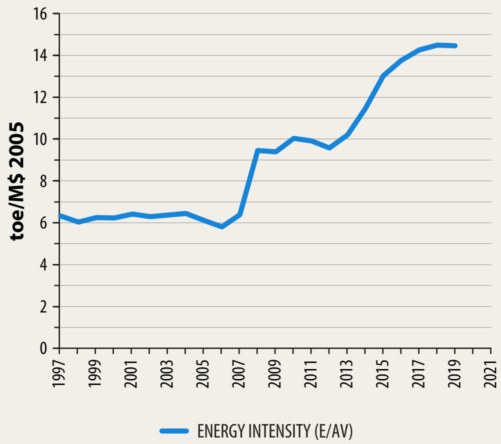
Energy intensity by sector is represented as the ratio between a sector's energy consumption and its added value. It is expressed in tonnes of oil equivalent per millions of Uruguayan pesos at constant 2005 prices (toe/M$ 2005). This represents the amount of energy required to generate a unit of added value. If instead of analyzing the energy consumption globally compared to GDP, we analyze energy consumption by sector concerning its added value, different behaviors depending on the sector are obtained. The following is the analysis of energy intensities for three sectors considering the 1997-2019 period (prepared by MIEM-DNE based on BCU data[19]). It is important to clarify that this analysis could not be conducted for 2020 and 2021, given the change of base implemented by the BCU (2016 base). This new base did not allow for sector-specific disaggregation at the time of this publication.

The series **industrial/primary activities** sector clearly shows the impact of the new cellulose industries in the market. This also caused a surge in energy intensity in 2008 and 2014. Until 2007, sectoral energy intensity remained between 5.8 and 6.4 toe/M$ 2005 and grew 48% in 2008. From that year, energy intensity has reported an upward trend, except in 2009, 2011, and 2012, which reported a slight reduction associated with the slower energy consumption growth in the industrial sector compared to economic growth.

In 2012, energy consumption decreased compared to the previous year. Between 2013 and 2016, both energy consumption and value-added increased, reflecting an increase in energy intensity. In the last three years, the significant growth in energy consumption has slowed down. Although the sector's added value decreased, the energy intensity of the industrial/primary activities sector increased.

FIGURE 49. Energy intensity of industrial/primary activities sector





NOTE: without 2020 and 2021 data, BCU did not publish the information to build this indicator.

19- Central Bank of Uruguay (BCU), Producto Interno Bruto por Industrias, Serie anual, precios constantes referencia 2005 por empalme, <https://www.bcu.gub.uy/Estadisticas-e-Indicadores/Cuentas%20Nacionales/cuadro_14a.xls> (07/01/2021).

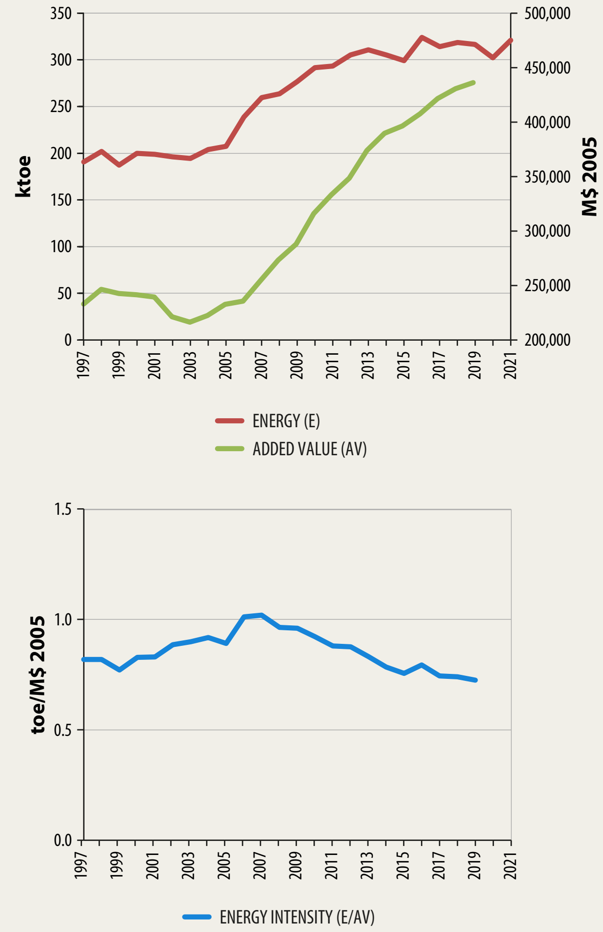
The series did not vary significantly regarding energy intensity in the **commercial/services/public sector** and remained relatively constant in the period studied (1997-2019), with a net decrease. The maximum value was reached in 2007 (1.02 toe /M$ 2005) and since 2008, there has been a downward trend, although both energy consumption and added value of the sector increased in said years. This explains why the sector's energy consumption has had a lower growth rate than the added value, which could result from implementing energy efficiency measures in the sector. The last five years have reported the lowest historical energy intensity values in the commercial/services/public sector (0.73 toe/M$ 2005 in 2019).

The energy intensity of the transport sector is analyzed in two different ways, using, on the one hand, the sector's added value and, on the other, the global GDP. The latter approach has become important because transport is a cross-cutting sector in the economy.

The energy intensity of transport per unit of value added in this sector reached historical lows in 2000 and 2008 (33.5 toe/M$ 2005) and showed variable behaviors over most of the period under study, with positive and negative growth rates. The growth (8%) recorded in energy intensity between 2008 and 2009 may have been caused by the international crisis because the value added generated in transport was barely higher than the previous year, while energy consumption maintained its historical growth.

The years 2015 and 2016 are noteworthy because the increase in energy consumption and the decrease in added value resulted in 14% and 11% growth in the energy intensity of the transport sector. In 2018 and 2019, energy intensity grew again (2%) after the fall recorded in 2017 (2%).

FIGURE 50. Energy intensity of the commercial/services/public sector



NOTE: without 2020 and 2021 data, BCU did not publish the information to build this indicator.

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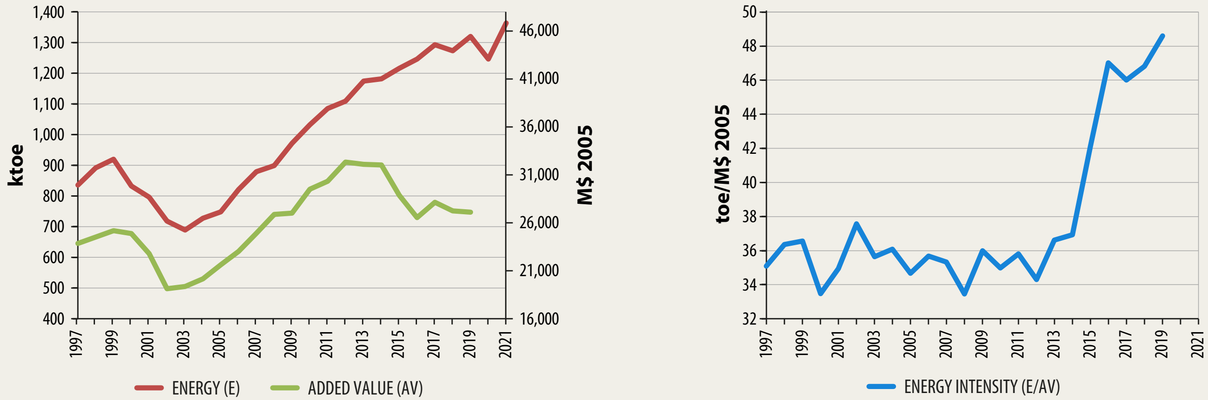
Finally, the energy intensity of transport per GDP unit behaved quite differently from the previous analysis, both in its trend and in the magnitude of values. Energy consumption in the transport sector and GDP developed similarly between 1997 and 2021, in terms of net growth over the whole period, with a sharp decline at the turn of the century caused by the crisis. Energy intensity peaked in 1999 (0.85 toe/M$ 2016), followed by a decrease until 2005 (0.70 toe/M$ 2016), as energy consumption declined at rates higher than GDP. From that year until 2020, energy intensity alternated annual increases and falls, a behavior that remained at values between 0.70 and 0.75 toe/M$ 2016. In 2021, energy consumption in the transport sector increased by 9% and GDP by 4%, resulting in a 5% increase in energy intensity.

FIGURE 51. Energy intensity of the transport sector



NOTE: without 2020 and 2021 data, BCU did not publish the information to build this indicator.

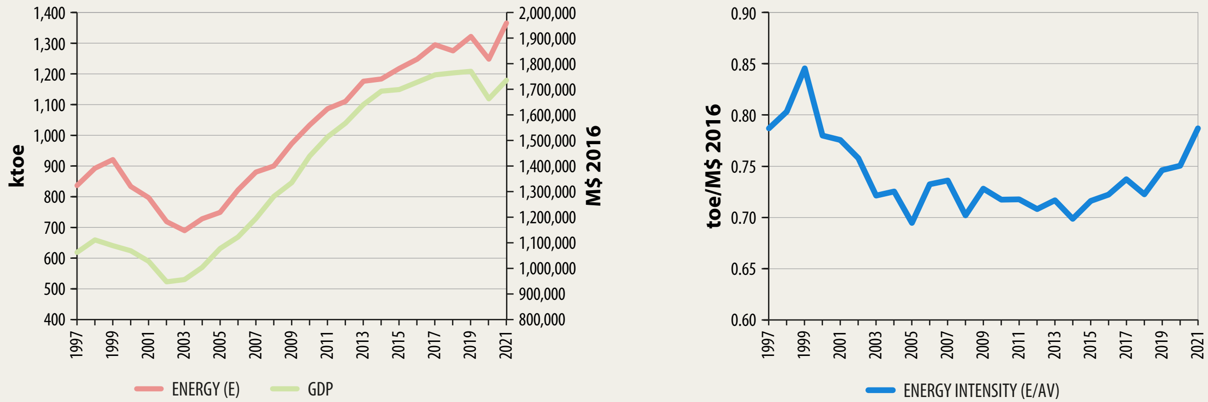


TABLE 22. Energy instensity by sector

		1997	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Industrial-primary activities	E	737.3	700.0	727.8	1,438.2	1,490.2	1,462.0	1,575.2	1,817.1	2,074.9	2,198.5	2,234.1	2,254.7	2,207.4	2,209.8	**2,278.7**
	AV[2] (M$ 2005)	116,714	112,268	119,057	143,386	150,267	152,530	154,319	158,327	159,176	159,721	156,513	155,426	152,540	N/D	**N/D**
	I[4]	**6.32**	**6.24**	**6.11**	**10.03**	**9.92**	**9.58**	**10.21**	**11.48**	**13.04**	**13.76**	**14.27**	**14.51**	**14.47**	**NE**	**NE**
Commercial-services-public sector	E	190.8	200.0	207.4	291.6	293.4	305.4	310.8	305.4	299.2	323.9	314.1	318.7	316.4	302.2	**320.8**
	AV[2] (M$ 2005)	232,969	241,637	232,787	316,082	333,314	348,525	373,860	389,676	396,366	407,551	421,556	430,757	436,366	N/D	**N/D**
	I[4]	**0.82**	**0.83**	**0.89**	**0.92**	**0.88**	**0.88**	**0.83**	**0.78**	**0.75**	**0.79**	**0.75**	**0.74**	**0.73**	**NE**	**NE**
Transport	E	835.5	832.3	748.2	1,032.3	1,085.7	1,109.3	1,174.7	1,182.3	1,216.4	1,247.4	1,294.2	1,274.4	1,320.7	1,247.0	**1,364.5**
	AV[2] (M$ 2005)	23,811	24,866	21,576	29,509	30,318	32,337	32,085	32,019	28,853	26,533	28,132	27,217	27,092	N/D	**N/D**
	I[4]	**35.09**	**33.47**	**34.68**	**34.98**	**35.81**	**34.30**	**36.61**	**36.92**	**42.16**	**47.01**	**46.00**	**46.82**	**48.75**	**NE**	**NE**
	GDP[3] (M$ 2016)	1,061,290	1,066,746	1,076,527	1,438,031	1,512,264	1,565,770	1,638,384	1,691,447	1,697,718	1,726,406	1,754,508	1,762,893	1,769,071	1,660,778	**1,733,304**
	I[4]	**0.79**	**0.78**	**0.70**	**0.72**	**0.72**	**0.71**	**0.72**	**0.70**	**0.72**	**0.72**	**0.74**	**0.72**	**0.75**	**0.75**	**0.79**

NOTES: 1) E: Energy; AV: Added value; I: Intensity (I=E/AV). **2)** Own elaboration MIEM-DNE based on data from the Central Bank of Uruguay (BCU): “Gross Domestic Product by Industries, Annual series, constant prices 2005 reference per joint”; www.bcu.gub.uy (07/01/2021). “M$ 2005 corresponds to millions of pesos at constant 2005 prices. For 2020 and later, BCU did not publish this information any more; N/D: no data. **3)** Source: Years 1997-2015: Retropolated series by the Ministry of Economy and Finance (MEF) based on National Accounts statistics, bases 1961, 1983, 2005 and 2016, prepared and published by the Central Bank of Uruguay (BCU). Year 2016 and later: Central Bank of Uruguay (BCU): “GDP series by expenditure components in millions of constant 2016 pesos”. www.bcu.gub.uy (07/21/2022). M$ 2016 corresponds to millions of pesos at constant 2016 prices. **4)** The energy intensity is calculated as the energy consumed (in toe) divides by the added value of the sector (in M$ 2005). For the transport sector, two energy intensities are presented, one based on the added value of the sector and another based on the global GDP (at constant 2016 prices). NE: not estimated.

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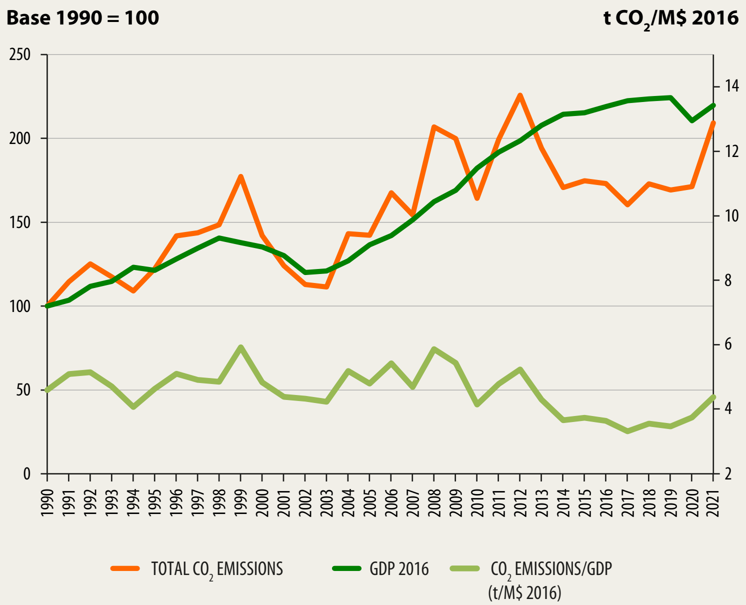
6.4. CO_2 emissions per GDP and per capita

CO_2 emissions intensity is represented as the ratio between CO_2 emissions and the GDP. It is expressed in tonnes of CO_2 per million of Uruguayan pesos at constant 2016 prices (tCO_2 /M$ 2016). In the 1990-2021 period, this indicator showed a net decrease from 4.6 to 4.4 tCO_2 /M$ 2016 and recorded an important variability throughout the series. The years with the highest intensity levels in emissions were 1999 and 2008 (5.9 tCO_2 /M$ 2016), while the lowest values reached since 1997 (on average 3.6 tCO_2 /M$ 2016) were recorded between 2014 and 2020. In 2021, CO_2 emissions increased 22% over the previous year and GDP grew 4%, resulting in a 17% increase in the intensity of CO_2 emissions.

In turn, to help understand the evolution of this indicator, individual series of GDP and CO_2 emissions from fuel combustion are analyzed. This is done by taking the values of both variables for 1990 as a base equal to 100.

FIGURE 52. Total CO_2 emissions and GDP



CO_2 emissions have presented some variability throughout the series and have accompanied GDP evolution. This behavior is also reflected in the intensity of CO_2 emissions. The large fluctuations in the total CO_2 emissions were strongly associated with the variation of emissions from thermal power plants for electricity generation due to the consumption of oil products for electricity generation to complement hydroelectricity. In 2020 there was a behavior similar to 2006 and in 2021 similar to 2012, in terms of poor availability of hydropower, resulting in higher CO_2 emissions compared to other years with better flow rates and their corresponding lower consumption of oil products for energy generation.

In particular, the last seven years recorded a significant increase in wind and photovoltaic electricity that offset the decrease in hydroelectricity. This resulted in lower consumption of oil products and the resulting decline in CO_2 emissions for electricity generation. The presence of these renewable energy sources in the matrix of electricity generation moderated the impact on CO_2 emissions in dry years such as 2020 and 2021.

Additionally, in 2020, GDP dropped significantly, so that the intensity of emissions increased. In the case of 2021, the increase in intensity was more influenced by the increase in emissions, due to the higher consumption of fossil fuels for electricity production.

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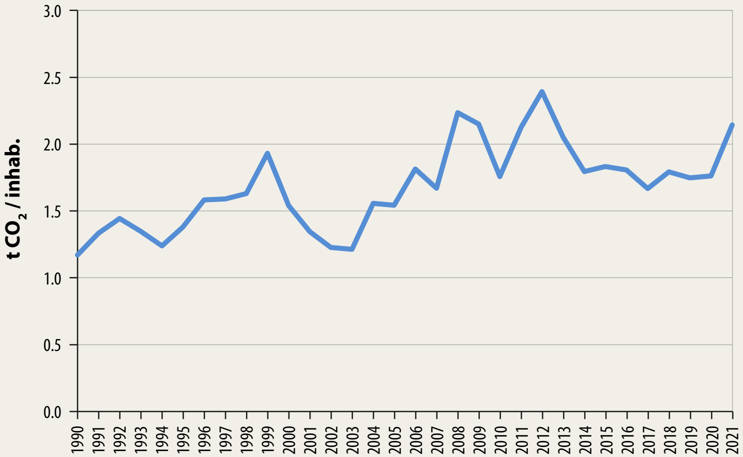
CO_2 emissions per capita are represented as the ratio between total CO_2 emissions and population and are expressed in tonnes of CO_2 per inhabitant (tCO_2/inhabitant). Net growth was recorded for the 1990-2021 period, which showed significant variability. This behavior, which alternates maximum and 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 1990 (1.2 tCO_2 /inhab.), while in 2012, emissions reached their maximum levels (2.4 tCO_2 /inhab.). Between 2014 and 2020, CO2 emissions per capita remained relatively constant (1.7 - 1.8 tCO_2 /inhab.) and increased again in 2021 by 22% (2.1 tCO_2 /inhab.).

FIGURE 53. CO_2 emissions per capita



2021:
CO_2 emissions intensity: 4.4 tCO_2/M$ 2016
CO_2 emissions per capita: 2.1 tCO_2/inhab.

TABLE 23. CO_2 emissions per GDP and per capita

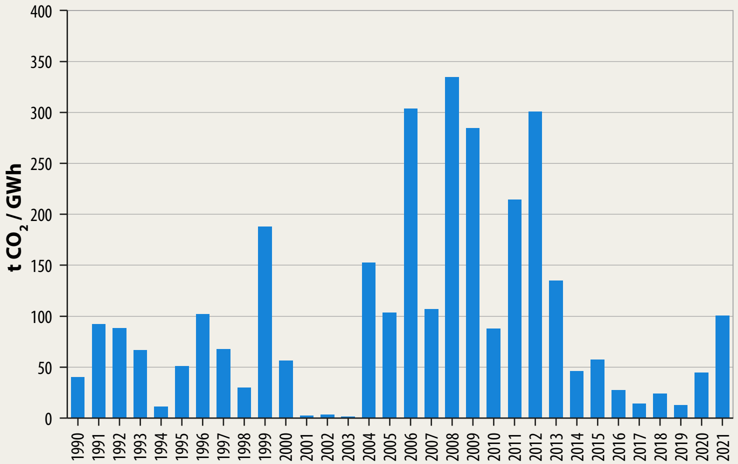
	1990	1995	2000	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
CO_2 total emissions (Gg)	3,630	4,434	5,155	5,160	5,964	7,242	8,191	7,048	6,192	6,342	6,283	5,820	6,277	6,140	6,215	**7,590**
GDP (M$ 2016) (1)	788,933	956,917	1,066,746	1,076,527	1,438,031	1,512,264	1,565,770	1,638,384	1,691,447	1,697,718	1,726,406	1,754,508	1,762,893	1,769,071	1,660,778	**1,733,304**
CO_2 emissions/GDP (t/M$ 2005)	4.6	4.6	4.8	4.8	**4.1**	**4.8**	**5.2**	**4.3**	**3.7**	**3.7**	**3.6**	**3.3**	**3.6**	**3.5**	**3.7**	**4.4**
Population (thousands of inhab.) (2)	3,106	3,218	3,349	3,352	3,397	3,413	3,426	3,440	3,454	3,467	3,480	3,493	3,506	3,519	3,531	**3,543**
CO_2 emissions per capita (t/inhab.)	**1.2**	**1.4**	**1.5**	**1.5**	**1.8**	**2.1**	**2.4**	**2.0**	**1.8**	**1.8**	**1.8**	**1.7**	**1.8**	**1.7**	**1.8**	**2.1**

NOTES: 1) Source: Years 1990-2015: Retropolated series by the Ministry of Economy and Finance (MEF) based on National Accounts statistics, bases 1961, 1983, 2005 and 2016, prepared and published by the Central Bank of Uruguay (BCU). Year 2016 and later: Central Bank of Uruguay (BCU): "GDP series by expenditure components in millions of constant 2016 pesos". www.bcu.gub.uy (21/07/2022). M$ 2016 corresponds to millions of pesos at constant 2016 prices. **2)** Source: National Statistics Institute (INE). www.ine.gub.uy (21/07/2022). Years 1990 and 1995: "Estimates and projections of the population of Uruguay, 1950-2050 (Revision 1998)". Year 2000 and later: "Total projected population (revision 2013)". The total population recorded according to the 2011 census was 3,286,314 inhabitants. This value is not used in the serial record in order not to create gaps.

6.5. The CO_2 emission factor of the SIN

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

FIGURE 54. CO_2 emission factor of the SIN



The emission factor has presented considerable variability throughout the whole series. This effect is associated with the considerable influence of rainfall levels on electricity generation in the country and the resulting amount of fossil fuels used, as mentioned above. In recent years, the generation of electricity from renewable sources has increased significantly, particularly wind energy and, to a lesser extent, photovoltaic solar energy. This seems to indicate that these sources and hydroelectricity have reduced the use of fossil fuels for such purposes.

The maximum emission factor of the SIN was recorded in 2008, with a 335 tCO_2 /GWh value, followed in importance by 2006 (304 tCO_2 /GWh) and 2012 (301 tCO_2 /GWh). On the other hand, the minimum figures were recorded between 2001-2003, with values lower than 3 tCO_2 /GWh, when almost 100% of the electricity was hydroelectricity. In 2020, a dry year (similar to 2006), where hydroelectricity accounted for only 30% of total generation, the emission factor of the SIN was 45 tCO_2 /GWh, three times higher than the previous year. In 2021, the emission factor had a new significant growth, reaching a 101 tCO_2 /GWh value.

In 2021, the emission factor of the SIN doubled to 101 tCO_2/GWh.

TABLE 24. CO_2 emission factor of the SIN

	1990	1995	2000	2005	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
CO_2 emissions from power plants for public service (Gg CO_2)	298.8	318.2	429.4	795.3	872.6	2,044.7	2,926.5	1,449.1	544.8	700.3	340.8	183.3	316.7	187.1	531.1	**1,431.9**
Electricity generated and supplied to the national grid (GWh)	7,358	6,236	7,547	7,641	9,903	9,535	9,729	10,729	11,728	12,128	12,274	12,726	12,876	14,406	11,833	**14,192**
Emission factor of the SIN (t CO_2/GWh)	**41**	**51**	**57**	**104**	**88**	**214**	**301**	**135**	**46**	**58**	**28**	**14**	**25**	**13**	**45**	**101**

NOTES: 1) CO_2 emissions are calculated according to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. **2)** SIN: National Interconnected System.

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6.6. Electrification rate

The **electrification rate** expresses the percentage of households with electricity compared to the total number of homes with dwellers. This indicator is developed for urban areas, rural areas, and the country total.

The total electrification rate went from 79.0% to 99.8% between 1975 and 2017 and remained constant until 2019. When analyzing the indicator separated by urban and rural areas, the most remarkable evolution is observed in the rural electrification rate, which has increased from 25.1% in 1975 to 98.9% in 2019. The urban electrification rate went from 89.0% to 99.9% in this period. It should be noted that this indicator could not be updated to 2020, as the Continuous Household Survey that—the statistical operator used to calculate this indicator—was not conducted because of the pandemic.

The total electrification rate went from 79.0% to 99.9% between 1975 and 2021.

In 2021, the total electrification rate increased to 99.9% and registered a record value of 99.8% for rural areas. That is to say, of the total number of occupied households in 2021, only 0.1% did not have electricity, either provided by UTE or its own (generator and/or battery charger via wind or solar generator), corresponding to 715 homes. The distribution was 605 housing units in urban areas and 110 in rural areas.

FIGURE 55. Electrification rate

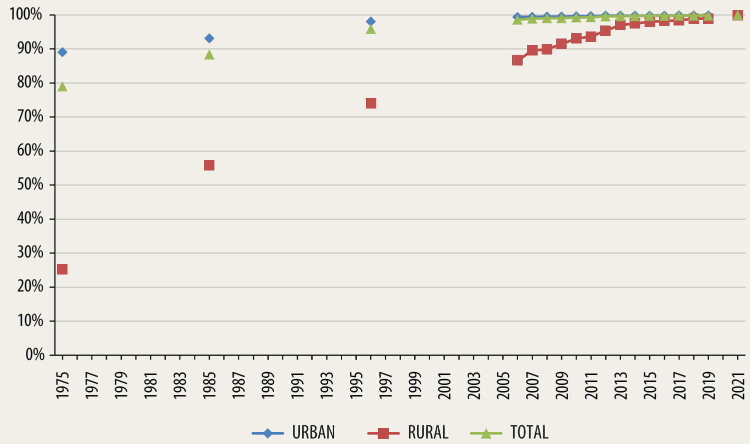

TABLE 25. Electrification rate

U: Urban / R: Rural / T: Total		1975	1985	1996	2006	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Occupied households (thousands)	U	632.4	719.0	855.2	1,050.2	1,098.6	1,100.6	1,099.2	1,121.7	1,149.3	1,155.3	1,161.6	1,166.6	1,173.0	1,175.0	N/D	**1,189.3**
	R	117.5	104.1	83.6	67.7	56.2	56.1	56.3	61.5	63.4	63.8	64.1	64.5	63.8	64.8	N/D	**63.0**
	T	**749.9**	**823.1**	**938.8**	**1,117.9**	**1,154.8**	**1,156.7**	**1,155.5**	**1,183.2**	**1,212.7**	**1,219.1**	**1,225.7**	**1,231.1**	**1,236.9**	**1,239.8**	**N/D**	**1,252.2**
Occupied households with electricity (thousands)	U	562.9	669.2	838.1	1,043.3	1,093.9	1,096.4	1,096.8	1,118.9	1,146.7	1,153.1	1,159.4	1,164.8	1,171.0	1,173.4	N/D	**1,188.7**
	R	29.5	58.0	61.9	58.6	52.3	52.5	53.7	59.7	61.8	62.5	62.9	63.5	63.1	64.0	N/D	**62.9**
	T	**592.4**	**727.2**	**900.0**	**1,101.9**	**1,146.2**	**1,148.9**	**1,150.5**	**1,178.6**	**1,208.5**	**1,215.5**	**1,222.3**	**1,228.3**	**1,234.1**	**1,237.5**	**N/D**	**1,251.5**
Electrification rate (%)	U	89.0%	93.1%	98.0%	99.3%	99.6%	99.6%	99.8%	99.8%	99.8%	99.8%	99.8%	99.8%	99.8%	99.9%	NE	**99.9%**
	R	25.1%	55.7%	74.0%	86.6%	93.1%	93.6%	95.4%	97.0%	97.5%	97.9%	98.2%	98.4%	98.9%	98.9%	NE	**99.8%**
	T	**79.0%**	**88.3%**	**95.9%**	**98.6%**	**99.3%**	**99.3%**	**99.6%**	**99.6%**	**99.7%**	**99.7%**	**99.7%**	**99.8%**	**99.8%**	**99.8%**	**NE**	**99.9%**

NOTES: 1) The information for 1975, 1985, 1996 and 2011 is taken from the national population and housing censuses. For the rest of the years, the information comes from the continuous hou-sehold surveys. (Source: INE and DNE's own estimates). **2)** The data for 1975 correspond only to UTE's electrification rate. **3)** From 1975 to 1996, these are housing units with dwellers present. **4)** From 2006 onwards, own generators and battery chargers (solar, wind) are included. **5)** N/D: no data: NE: not estimated. INE did not release information in the ECH 2020.

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.). Also, the energy path includes the constant final energy consumption per capita represented with isoquant curves and expressed in tonnes of oil equivalent per thousand inhabitants (toe/1,000 inhabitant).

Between 1965 and 2021, Uruguay's energy path had an overall evolution towards economic growth and decreased energy intensity. Throughout these 57 years, it is possible to identify different behaviors associated with specific stages the country has gone through.

In the 1965-1970 period, energy intensity fell, and GDP per capita increased. In 1971 and 1972, a particular behavior was recorded: energy demand grew. This, together with the GDP decrease, resulted in a significant increase in energy intensity that reached its historical maximum (3.44 toe/M$ 2016). After that and for nine consecutive years, energy intensity decreased at an average annual rate of 3%, while the economy recorded sustained growth.

1982 and 1983 recorded another particular feature: decreased GDP per capita and an increase in energy intensity which caused a downturn in the energy path. Over the 1983-1998 period, the evolution of indicators varied to some extent, but with a marked downward trend in energy intensity and the growth of 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 characterized by economic growth without significant structural changes. The construction sector does not show economic recovery in this post-crisis period. The production system's evolution did not involve investing in equipment and infrastructure as existing idle capacity was used. Additionally, energy demand declined until and including 2003, after which it resumed its upward trend. As GDP grew at a higher rate than energy consumption, energy intensity declined over this period.

In the 2005-2009 period, the share of the industrial sector in GDP grew by one point and, within the industry, the share of the paper and cellulose sectors increased from 9% to 19%. This robust industrial growth associated with the new cellulose plant and the development of the construction sector caused energy demand to soar. The industrial sector doubled its energy consumption; its final energy consumption, which had recorded annual growth rates of 3% and 4%, reached 17% in 2008. This notable change in the economic and energy structure led to considerable growth in energy intensity.

In turn, from 2009-2012, economic and energy consumption structures remained virtually constant. For this reason, the decrease in energy intensity could be linked to the implementation of energy efficiency projects and measures.

In the 2012-2016 period, energy demand underwent structural changes once again. The share of industrial consumption increased from 34% to 43% of total final energy consumption; this was strongly associated with the new cellulose plant. There is no significant change overall regarding the economic structure, given that the industrial sector continued to account 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.

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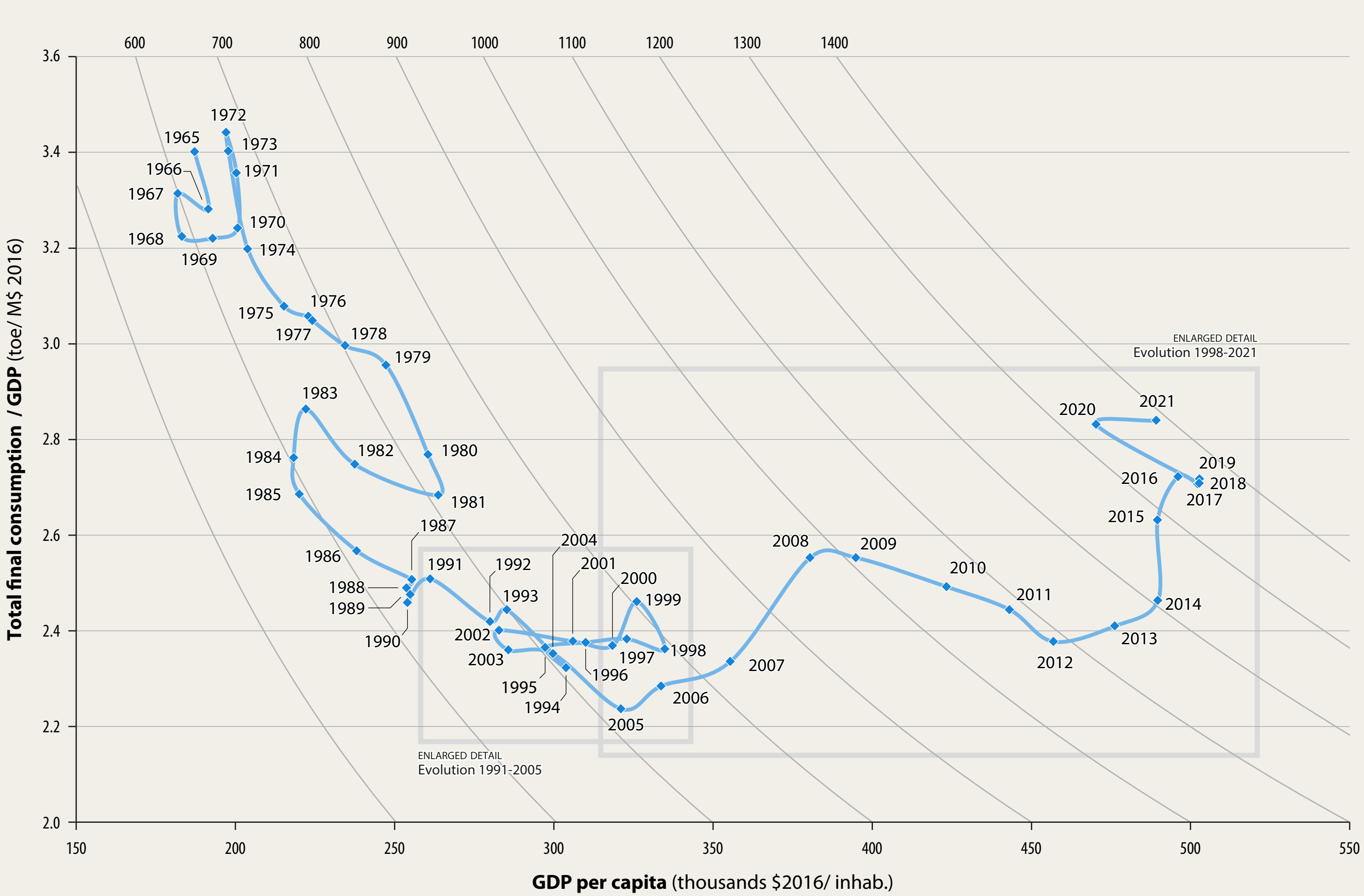
It is worth mentioning that the 2016-2019 period was similar to 2009-2012 in terms of energy intensity and GDP per capita but also showed an economic slowdown. In 2020, the situation changed again, and the pattern was similar to that described in 2002: the economy fell by almost 6%. In 2021, the country's economy resumed favorable development and the energy intensity remained similar to the previous year.

FIGURE 56. Energy path



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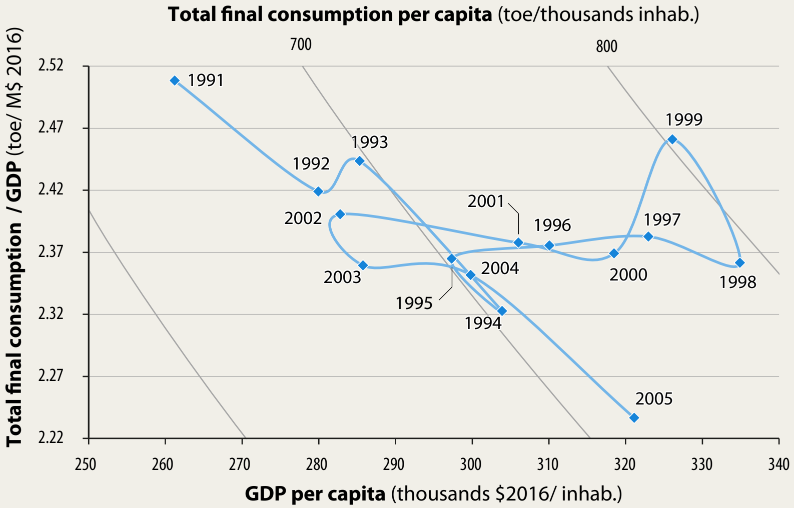
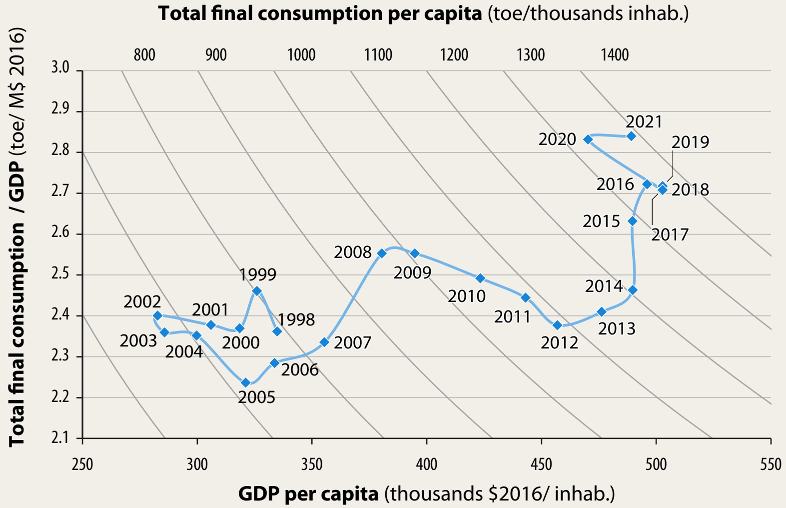
Finally, the third indicator represented in the energy path has already been mentioned in previous sections. It is interesting to observe its net growth evolution throughout the period, which alternates years of increases and decreases. Since 1965 and for 40 years, final consumption per capita has remained between 600 and 800 toe/1,000 inhab. However, since 2005 there has been sustained growth of 718 toe/1,000 inhab. (2005) to 1,389 toe/1,000 inhab. (2021), which practically doubled its value in the last sixteen years. The maximum consumption per capita was recorded precisely in the last year of the series.

FIGURE 57. Energy path / enlarged details

EVOLUTION 1991 - 2005



EVOLUTION 1998 - 2021



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7. Sustainable Development Goal 7 (SDG 7)

The Sustainable Development Goals (SDG) approved by the United Nations (UN) in 2015 contemplate, in an integrated manner, the challenges around 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 attainment of the SDGs to advance them towards 2030.[20]

In particular, SDG 7 aims to ensure access to affordable, safe, sustainable, and modern energy for all; the MIEM is the relevant body in this regard.

By 2015, the country already had an Energy Policy first developed in 2005, in permanent dialogue with all the public stakeholders involved in energy. Although this policy was adopted in 2008, it had already been partially implemented. Furthermore, in 2010, it was endorsed by a multi-party commission formed by representatives of the entire political sector, thus becoming state policy. Although the Energy Policy was conceived and designed based on the country's reality and institutional capacities, it matches the content and timeframe (2030) that the United Nations defined for attaining the SDGs. This explains why by 2015, Uruguay already had indicators that reflected a transformed energy landscape that aimed at achieving SDG 7.

In this way, while Uruguay implements the 2030 Energy Policy, it is on the path defined by the United Nations to ensure access to affordable, reliable, sustainable, and modern energy for all.

In 2018, Uruguay reaffirmed its commitment to fulfilling the 2030 Agenda by voluntarily submitting the second country report to the UN. On that occasion, five SDGs were reported, including SDG 7: "Affordable and clean energy".[21]

The SDG 7 indicators are as follows:

- 7.1.1.
  The proportion of the population with access to electricity
- 7.1.2.
  The proportion of the population with primary reliance on clean fuels and technology
- 7.2.1.
  Renewable energy share in the total final energy consumption
- 7.3.1.
  Energy intensity measured in terms of primary energy and GDP

For more information, please refer to "Uruguay's 2018 National Voluntary Review".

20- Sustainable Development Goals (SDGs), *Qué son los ODS*, <https://ods.gub.uy/index.php/quesonlosods> (07/21/2022).

21- Presidency - República Oriental del Uruguay, *"Informe Nacional Voluntario – Uruguay 2018"*, <https://ods.gub.uy/images/2018_Informe_Nacional_Voluntario_Uruguay_ODS.pdf> (21/07/2022).

FIGURE 58. Proportion of the population with access to electricity

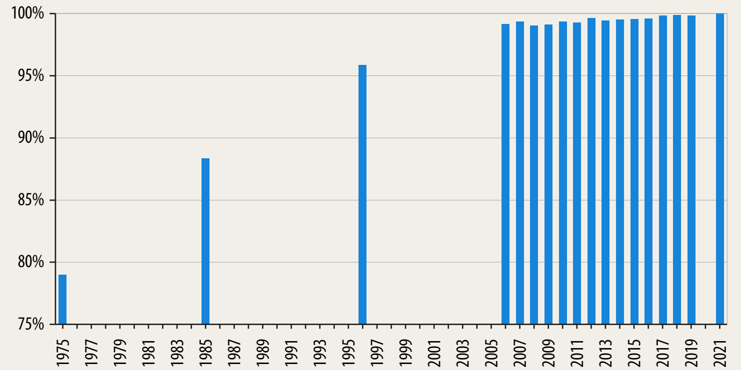

FIGURE 60. Renewable energy share in total final energy consumption

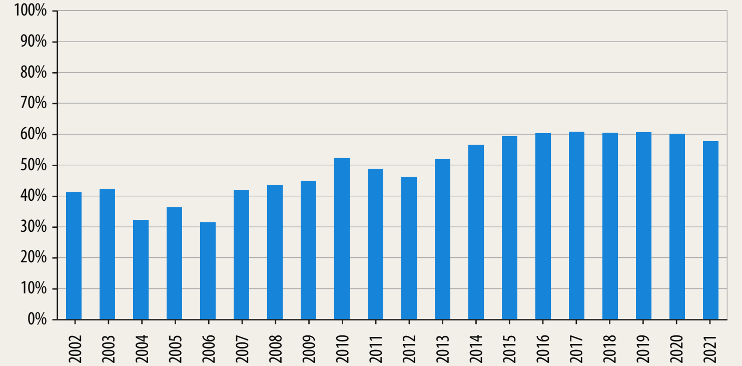

FIGURE 59. Proportion of population with primary reliance on clean fuels and technology

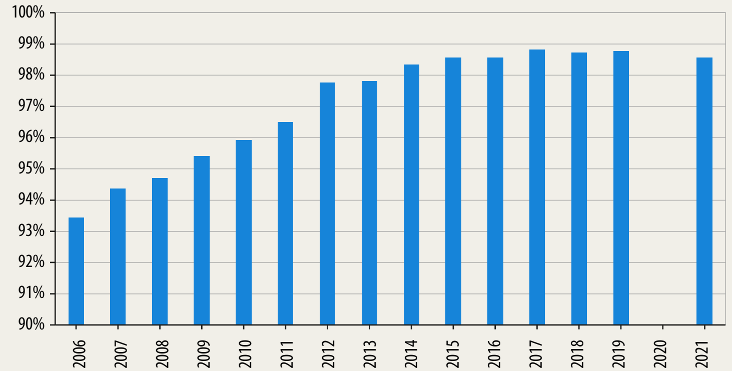

FIGURE 61. Energy intensity measured in terms of primary energy and GDP

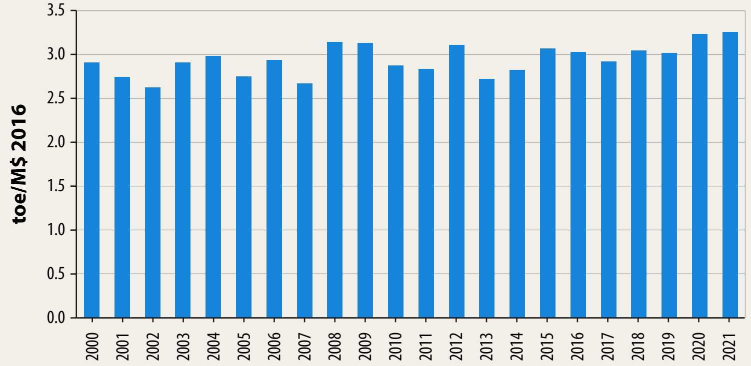

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TABLE 26. Proportion of population with access to electricity

	1975	1985	1996	2006	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Total population (thousands of inhabitants) (1)	2,829	3,009	3,258	3,358	3,397	3,413	3,426	3,405	3,415	3,467	3,479	3,493	3,507	3,518	N/D	**3,543**
Population with access to electricity (thousands of inhabitants) (1)	2,234	2,658	3,124	3,329	3,375	3,387	3,414	3,386	3,398	3,451	3,464	3,487	3,502	3,513	N/D	**3,543**
Indicator 7.1.1 (%)	**79.0%**	**88.3%**	**95.9%**	**99.1%**	**99.4%**	**99.3%**	**99.6%**	**99.4%**	**99.5%**	**99.5%**	**99.6%**	**99.8%**	**99.9%**	**99.9%**	**NE**	**100.0%**

NOTES: 1) Estimate made by DNE-MIEM based on data from the INE Continuous Household Survey (ECH). **2)** N/D: no data; NE: Not estimated. The INE did not collect the information for 2020 (due to the pandemic).

TABLE 27. Proportion of population with primary reliance on clean fuels and technology

	2006	2007	2008	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Total population (thousands of inhabitants) (1)	3,358	3,359	3,363	3,378	3,397	3,413	3,426	3,405	3,415	3,467	3,479	3,493	3,507	3,518	N/D	**3,543**
Population with firewood or kerosene as the main energy source for cooking and heating (thousands of inhabitants) (1)	220	190	178	155	139	120	77	75	57	50	50	42	45	43	N/D	**51**
Indicator 7.1.2 (%)	**93.4%**	**94.4%**	**94.7%**	**95.4%**	**95.9%**	**96.5%**	**97.8%**	**97.8%**	**98.3%**	**98.6%**	**98.6%**	**98.8%**	**98.7%**	**98.8%**	**NE**	**98.6%**

NOTES: 1) Estimate made by DNE-MIEM based on data from the INE Continuous Household Survey (ECH). Firewood and kerosene used as the main sources for cooking and heating are not considered clean fuels and technologies. **2)** N/D: no data; NE: Not estimated. The INE did not collect the information for 2020 (due to the pandemic).

TABLE 28. Renewable energy share in the total final energy consumption

	2002	2003	2004	2005	2006	2007	2008	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Final energy consumption (ktoe)	2,228	2,201	2,288	2,353	2,505	2,713	3,183	3,331	3,518	3,636	3,652	3,850	4,088	4,387	4,612	4,648	4,669	4,669	4,606	**4,810**
Final energy consumption of renewables sources (ktoe) (1)	918	928	736	854	791	1,141	1,386	1,490	1,838	1,774	1,691	1,996	2,317	2,601	2,781	2,822	2,824	2,830	2,768	**2,771**
Indicator 7.2.1 (%)	**41.2%**	**42.1%**	**32.2%**	**36.3%**	**31.6%**	**42.0%**	**43.5%**	**44.7%**	**52.2%**	**48.8%**	**46.3%**	**51.9%**	**56.7%**	**59.3%**	**60.3%**	**60.7%**	**60.5%**	**60.6%**	**60.1%**	**57.6%**

NOTE: 1) Electricity consumption is classified according to the matrix of electricity generation by source.

TABLE 29. Energy intensity measured in terms of primary energy and GDP

	2001	2002	2003	2004	2005	2006	2007	2008	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Primary energy (ktoe)	2,816	2,480	2,776	2,990	2,958	3,296	3,190	4,022	4,177	4,135	4,288	4,866	4,459	4,778	5,207	5,227	5,125	5,371	5,343	5,369	**5,644**
GDP (M$ 2016) (1)	1,025,739	946,428	954,050	1,001,792	1,076,527	1,120,649	1,193,957	1,279,637	1,333,938	1,438,031	1,512,264	1,565,770	1,638,384	1,691,447	1,697,718	1,726,406	1,754,508	1,762,893	1,769,071	1,660,778	**1,733,304**
Indicator 7.3.1 (toe/M$ 2016)(2)	**2.75**	**2.62**	**2.91**	**2.98**	**2.75**	**2.94**	**2.67**	**3.14**	**3.13**	**2.88**	**2.84**	**3.11**	**2.72**	**2.82**	**3.07**	**3.03**	**2.92**	**3.05**	**3.02**	**3.23**	**3.26**

NOTES: 1) Source: Years 2000-2015: Retropolated series by the Ministry of Economy and Finance (MEF) based on National Accounts statistics, bases 1961, 1983, 2005 and 2016, prepared and published by the Central Bank of Uruguay (BCU). Year 2016 and later: Central Bank of Uruguay (BCU): "GDP series by expenditure components in millions of constant 2016 pesos". www.bcu.gub.uy (07/21/2022). M$ 2016 corresponds to millions of pesos at constant 2016 prices.

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8. Methodology

8.1. General definitions

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

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

- **Gross energy:**
the primary or secondary energy to which the following deductions have not been applied: losses caused by transformation, transmission, transportation, distribution or storage, and amount of energy not used.

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

- **Final energy:**
the primary or secondary energy directly used by socioeconomic sectors. It is the energy that enters the consumption sector and is different from the previous one because of the energy sector's use. It includes energy and non-energy consumption.

- **Transformation center:**
facilities where primary or secondary energy undergoes processes that modify their properties or original nature through physical-chemical changes to transform it into energy 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 plant.

- **Consumption sector:**
part of the socioeconomic activity where final energy for its use converges. Own use is considered separately. It corresponds to the energy consumed by the energy sector for production, transformation, transportation, and distribution of energy (it does not include the energy used as input for transformation into other kinds of energy).

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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 matrix makes it possible to analyze all the processes and transformations of a specific source throughout the entire system and each category and the magnitude corresponding to each source. The "general summary matrix" includes the following five submatrices:

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

The following image shows how these submatrices are located in the summary matrix. These submatrices are analyzed below.

ENERGY BALANCE	Primary sources	Secondary sources	Losses	TOTAL
Primary energy	(1)			
Transformation plants	(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 plants
(3) Secondary energy balance
(4) Gross supply and net consumption
(5) Distribution of the final energy consumption by sector

The matrix summary has the same format for all the historical series; however, it is modified as new energy sources appear or when more detailed information is available, hiding or showing the relevant fields. It is essential to mention the greater disaggregation in the consumption sectors (available from 2013) and the breakdown by source for power plants for public service and autoproduction (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, coal, natural gas, hydropower, wind energy, solar energy, firewood, biomass waste, biomass for biofuels, and industrial waste.

The following are some clarifications for some of the primary sources:

- **Coal:**
it includes anthracite, peat, coal tars, and pitch.

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

- **Hydropower:**
the summary matrices include the theoretical equivalent. However, in the "supplementary information" section includes a hydropower chart considering the thermal equivalent.

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

- **Biomass waste:**
it includes rice and sunflower husks, sugarcane bagasse, black liquor, odorous gases, methanol, barley husks, wood industry waste, and rumen.

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- **Biomass for biofuel production:**
it considers the production of bioethanol and biodiesel.

- **Industrial waste:**
it includes end-of-life tires, used oils, glycerin, and alternative liquid fuels (CLA).

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

- **Import:**
the primary or secondary energy that comes from abroad.

- **Export:**
the primary or secondary energy that is sent abroad. Exports to the free trade zone are not considered exports; they are included in the final consumption as sales in the domestic market.

- **Losses:**
the energy losses caused by transportation, storage, transmission, and distribution (technical losses). Until 2005, nontechnical losses in the electricity sector were recorded as “losses”. Since 2006, they have been recorded in “final consumption”, considering the social losses within the residential sector. The remaining nontechnical losses have been distributed according to the share percentage in the other sectors’ electricity consumption.

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

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

- **Adjustments:**
statistical adjustment that makes supply and consumption data compatible, as well as the differences due to the rounding of figures.

- **Supply:**
the total energy available for consumption. It is obtained with the following equation:

Supply = Production + Import – Export – Losses + Stock change – Energy not used + Adjustments

Note:
in the summary matrices, the values of “export”, “losses” and “ energy not used” 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 plants

It reflects the activity of both primary and secondary transformation plants. Negative signs indicate income (inputs) and positive signs indicate expenditure. Because of the processes conducted in these plants, there are transformation losses obtained by algebraically adding the income to the spending.

Transformation plants include:

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

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

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

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

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

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

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

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

Cogeneration plants have a global efficiency of between 70% and 85%. Such efficiency depends on the type of technology used and how the energy is used in the process. “Global efficiency” is defined as the ratio of the total energy produced by the system (electricity and heat) versus the energy consumed.

8.2.3. Balance of secondary energy sources

It corresponds to the supply of secondary energy sources. The following secondary energy sources are included in this BEN edition: 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 are light naphtha, diesel oil, and manufactured gas, which, though not currently used in the country, are included in the years of the historical series when applicable.

There follows additional information about some of the secondary sources::

- **LPG:**
it should be noted that the 2020 edition improves the allocation of LPG consumption in the various activity sectors. For this reason, other classification criteria are implicit in the sectoral consumption of LPG until 2019. LPG consumption in the sector “other agricultural activities” in 2019 was estimated based on the total value of “agriculture” and the new consumption estimate in the “poultry farms”. Consequently, the 2020 decrease in consumption is partly due to a change in methodology.

- **Motor gasoline:**
does not include bioethanol, which is reported separately.

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

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- **Petcoke:**
it includes scorched and non-scorched petcoke and refinery coke. Until and including BEN 2012, it was referred to as "other energy products." Scorched petcoke is recorded as non-energy use.

- **Non-energy products:**
includes solvents, lubricants, and asphalts. Since 2013, with the startup of the desulfurization plant, "liquid sulfur" has been included as a new non-energy product.

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

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

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

The categories that correspond to the secondary energy balance are the same as the ones previously described for primary energy, except for an additional category:

- **International bunker:**
the energy sold to sea vessels and aircraft on international journeys, that is, journeys that leave one country and reach another. This activity is included under "exports " until 2012 and is represented independently from 2013 onwards.

8.2.4. Gross supply and consumption

This sub-matrix presents the gross energy supply and the total net consumption with the itemization of its components.

- **Gross supply:**
it is the supply of each energy source as found in the corresponding balance, plus the losses and amounts not used that are reported in the same balance.

Unlike other rows in the matrix, the 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:**
this is the total final consumption plus the energy sector's use.

- **Own use:**
the amount of primary and/or secondary energy that the energy sector uses for its operation, including production, transformation, transportation, and energy distribution. It does not include the energy used as input to transform it into another kind of power at transformation plants.

- **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 among the different socioeconomic activity sectors. Since the elaboration of the 2013 BEN, the collection of consumption data has been improved through new sector surveys. The traditional "Survey on firewood and biomass waste" became part of the "Survey on energy consumption in the industrial sector" (which covers other energy sources). It was conducted for the years 2011, 2013, 2014, 2015, 2016, 2017, 2018, 2020, and 2021. Energy consumption surveys were also conducted in the residential sector in 2013 and the commercial/services/public sector in 2013, 2014, and 2015. It is worth mentioning that the results of the latest will be included in future editions. As an improvement in the BEN 2020 edition, surveys conducted in the mining sector and the "poultry" area in the agricultural sector were included.

Additionally, final energy consumption was first reported in 2013, with a broader disaggregation of sectors. Sector consumptions lower than 1 ktoe are not reported since they represent marginal values, except when they correspond only to one subsector. Data are not disaggregated if they correspond only to one company by sector or if there is no available information for classification.

The classification adopted for sectors and subsectors is the following:

- **Residential sector:**
it includes the caloric, electric, and mechanic consumption of rural and urban families to meet the energy needs of households. It does not include personal transportation, which is reported within the transport sector.

Consumption was first reported in 2013 with the following criteria:

Residential sector
Montevideo
Rest of the country

In the case of firewood and LPG, the information is disaggregated according to the results of the "Survey on energy consumption and use in the residential sector 2013". In contrast, for electricity, kerosene, and natural gas, administrative data are used. As per biomass waste, total consumption is associated with the rest of the country. Regarding the other energy sources, the breakdown is not performed since 2013 due to a lack of information on their proper classification (solar, gas oil, fuel oil, fuel oil, charcoal).

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

Consumption was first reported in 2013 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 includes only consumption within the establishments.

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- **Transport sector:**
it includes public transportation of people and cargo carried by air, road, or water. It does not include internal transportation within the establishments that are included in the other sectors. International air and fluvial travel are not included. Their consumption is recorded under exports until 2012 and within international bunkers as of 2013.

Consumption was first reported in 2013 with the following breakdown:

Transport sector
Road
Rail
Air
Sea and river

Private vehicles are considered in the results obtained from the consumption surveys in the residential and industrial sectors in 2013, which collected this information.

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

This sector's consumption was first reported in 2013, with the breakdown::

Industrial sector	Associated ISIC Revision 4
Slaughterhouses	Group 101
Dairy	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 the ones corresponding to the "cement" section.

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- **Primary activities:**

these refer to agricultural production, livestock, and forestry extraction plus commercial fishing on the high seas, coast, coastal and estuarine fishing, including that carried out by factory ships and fleets engaged in fishing and its processing. It also includes mining. It was called "agriculture/fishing/mining sector" until BEN 2019.

This sector's consumption was first reported in 2013, with the following breakdown:

Primary activities
Agriculture
Mining
Fishing

Agriculture: it includes the consumption of energy sources within agricultural and forestry establishments. It also reports consumption of fuels by agricultural aircraft (jet fuel and aviation gasoline).

To report jet fuel consumption, annual company surveys are conducted on this sector; data has been available since 2016. This consumption was included in the transport sector until 2015. In 2020 and 2021, 100% of the respondents answered, so the data reflects the actual sector situation.

The consumption of the "poultry" sector has been reported since the edition of BEN 2020, separating it from the other agricultural subsectors.

Agriculture sector
Poultry
Other agricultural subsectors

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, the energy consumption of poultry farms is determined from the national production values for each year in question, using the developed technical coefficients.

In line with the implementation of improvements, in 2020, the estimated consumption of the rest of the energy sources for the other agricultural subsectors was revised and improved by considering other information sources—mainly data from the gas distribution companies. Other information sources analyzed were various publications, such as the "2006 Energy Use and Consumption Survey" and MGAP (Ministry of Livestock, Agriculture, and Fisheries) reports and studies, particularly those conducted by OPYPA regarding the intermediate consumption of agricultural activities. With the analysis of these reports, together with DIEA data publications, we developed technical coefficients. Depending on each activity, in some cases, these were liters/hectare, and in others, such as dairy, liters/liters of milk produced, or liters/head, in the case of cattle. This made it possible to obtain energy consumption for different years. This was further analyzed in terms of gas oil and gasoline consumption in the sector.

In 2021, we worked together with OPYPA to consolidate and adjust the methodology for calculating the technical coefficients mentioned above. To do so, we used the latest available information. This allowed us to obtain unique and common technical coefficients for both the BEN and the different reports prepared by OPYPA. It should be noted that for the agricultural sector the mobile year July/ "year *i-1*" - June/ "year *i*" is considered, that is to say, for the year 2021 of BEN the data for the period July/2020-June/2021 of the Agricultural Statistical Yearbook is considered.

Mining: in the BEN 2020 edition, we were able to disaggregate the mining sector statistics, which until BEN 2019 were reported with agriculture. A company survey was conducted, allowing us to interview 50% of the mines in Uruguay. The consumption of the different energy sources was obtained and technical coefficients of mineral consumption/production were calculated.

With the national mineral production data (provided by DINAMIGE), it is possible to obtain national energy consumption results for 2019 and 2020. For the year 2021 and from now on, 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, i.e., for the year 2021 of BEN the mining production data correspond to the period April/2021-March/2022. .

The data on electricity consumption is obtained from the UTE database and by cross-checking information with the surveys.

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

- **Not identified:** a sixth category that includes consumption coming from unidentified sectors. In the case of propane gas (LPG), it includes the consumption of companies whose main activity is classified as Section V of ISIC, Revision 4 (corresponding to the annex included by Uruguay on the exclusive use of local agencies).

8.3. Units and data formats

The unit adopted 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. Please note that the possible decimal differences in the values informed in tables, charts, and texts result from the rounding of figures. In turn, the addition of subtotals may not reproduce the exact total for the same reason.

Finally, when a value is represented as “0” (zero), it means it exists and is minimal (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.

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8.4. Special comments

8.4.1. Hydroelectric energy

Two approaches can be used to evaluate hydropower: the theoretical equivalent and the thermal equivalent. In the first case, turbined flow determines the energy that enters primary transformation plants (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: Ratio for the transformation of units
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);
the height of the daily water levels is considered
Q: Turbined flow (m^3/s)

The other approach (thermal-equivalent approach) evaluates hydropower production from the electricity generated at the hydroelectric power plants, considering the amount of hydrocarbons that would be needed to produce it at a conventional thermal power plant. This fictitious thermal power plant's performance is considered equal to the average performance of the existing thermal power plant, which operates in normal conditions.

The theoretical equivalent approach is used in the "general summary matrix."

8.4.2. Wind energy

In 2008, the country's first wind farms connected to the grid came into operation. This is why wind energy is included in the balance matrix from that year. No values are included for wind energy for previous years because current estimations about the number of windmills and wind turbines vary greatly depending on the information source.

The methodology applied by OLADE is used to determine wind energy. This is done from the generation of electricity of each farm/wind turbined, considering the same value as the electricity generated as "wind energy produced." Data on electricity generated from wind power, both large-scale and from micro-generation, which are connected to the grid, are supplied by UTE. An annual census is conducted for those who are autonomous and not connected to the grid.

The BEN 2020 introduces the concept of wind energy not used due to operational restrictions (OR). 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, they cannot deliver it to the grid.

Operational Restrictions (OR) are defined as those generation reductions imposed by the Electricity Market Administration (ADME) for the safe operation of the system. In particular, an Operational Restriction due to Excess Generation means limiting generation when the total generation, if not reduced, 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 the wind energy not used by each generator according to their OR, as described above.

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The 2018-2020 series for wind energy not used is completed.

Information on models for the calculation of OR can be found in the following documents[22]:

- "Procedure for operational restrictions applicable to wind and solar generators of the National Interconnected System (SIN)." [23]
- Wind power plant model.[24]

22- 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> (07/30/2022).
23- 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> (07/21/2022).
24- 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> (07/30/2022).

8.4.3. Solar energy

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

- **Solar thermal energy:**

the total aperture area of both imported and domestically manufactured equipment is obtained to make solar thermal energy estimations. The lack of stock for a few months is considered to estimate solar thermal energy. Therefore, what was imported/produced in one year is installed practically in the same year. The estimated shelf life is 15 years; this is considered to determine the cumulative equipment installed.

In 2017, local manufacturers were surveyed to determine the domestic production of solar thermal collectors. Therefore, the area of domestic production installed has been reported since that year. Up to and including 2016, the share of national producers is estimated to be 20% of the total.

The energy generated is calculated from the "average annual irradiance on a horizontal plane" and the installed area, considering a global efficiency of 40%:

$$\mathbf{E}_{\text{solar thermal}} = \text{Ef} \times \text{H}_0 \times \text{A} \times \frac{0.086\left(\frac{\text{toe}}{\text{MWh}}\right)}{1{,}000{,}000}$$

Where:

$\mathbf{E}_{\text{solar thermal}}$: Production of solar thermal energy (ktoe/year)
Ef: Global efficiency (0.40)
$\mathbf{H}_o$: Annual average irradiance on a horizontal plane (kWh/m2-year)[25]
A: Aperture area of solar thermal collectors/heaters (m^2)

25- *"Mapa solar del Uruguay"*. Second version, July 2007. 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.

The solar thermal energy generated corresponds to energy available for heating water. The balance standpoint can be interpreted as a potential since it is not the energy consumed but the energy captured by the equipment. In practice, not all this energy may be consumed.

Until and including 2016, the sector allocation of the final energy consumption is theoretical, as it considers the ordinary shares in the literature: 85% residential sector, 14.5% commercial/services/public sector, and 0.5% industrial sector. It should be noted that this information is difficult to collect in the sectoral surveys that are carried out periodically, since the sample size does not reflect the population using this technology.

Since 2017, an industrial consumption value associated with the area surveyed in the annual industrial survey is estimated; since 2019 it has been complemented with the imports of 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).

Furthermore, 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 and other surveys conducted in the sector made it possible to estimate 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:**

the methodology applied by OLADE and other international bodies is used to determine photovoltaic solar energy. This methodology considers the same value as the electricity generated as "photovoltaic energy produced." This methodology has been applied since BEN 2015 for the series since 2014.

Electricity generation with photovoltaic panels is determined in diverse ways depending on the installed capacity of the equipment. They can be regrouped into two types of producers:

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

– Solar connected to the grid; the annual data supplied by UTE is considered.

– Off-grid producers with an installed capacity greater than 150 kW and who do not deliver energy to the grid are surveyed.

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

– Small producers who deliver 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 off-grid producers, with installed capacities estimated to be lower than 150 kW, we use the same relation between energy generated and installed capacity of the producers who deliver to the grid and whose data is known. A census is conducted for the rest of the small off-grid producers whose information is known.

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The BEN 2020 introduces the concept of photovoltaic solar energy not used due to Operational Restrictions (OR). As previously mentioned for wind generators, it is established by decree that UTE must pay solar generators for all the electricity that they can generate, but due to OR set by the National Load Dispatcher they do not deliver it to the grid.

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

The 2018-2020 series for solar energy not used is completed.

Information on models for the calculation of OR[26] can be found in the following documents:

- "Procedure for operational restrictions applicable to wind and solar generators of the National Interconnected System (SIN)."[27]
- "Annex C): Model of a photovoltaic solar power plant."[28]

26- 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> (07/30/2022).
27- 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> (07/21/2022).
28- Pablo Soubes, Felipe Palacio and Ruben Chaer for the Electricity Market Administration (ADME), *Annex C): Modelo de central generadora solar fotovoltaica*, <https://adme.com.uy/db-docs/Docs_secciones/nid_324/ModeloSolarPV.pdf > (07/30/2022).

8.4.4. Firewood

In the case of firewood, production is considered to be the total energy consumption of firewood plus the firewood used in the following transformation plants: power plants for public service, autoproduction power plants, and coal plants.

For the industrial sector, firewood consumption is estimated based on surveys conducted annually by DNE-MIEM. If the industrial survey is not conducted in a given year, firewood use is calculated based on previous years' consumption. For the rest of the sectors, this survey is not annual. In years with no survey, the consumption value of the last survey is used.

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

Firewood entering power plants for public service and autoproduction power plants is estimated based on the surveys conducted by DNE-MIEM each year. On the other hand, firewood entering coal plants is calculated based on the non-imported charcoal, which has not happened again since 2004.

8.4.5. Biomass waste

Biomass waste production is recorded for as the addition of energy consumption and transformation center inputs, since there is no information available to estimate the unused production of other kinds of biomass waste, such as forestry waste. This criterion has been applied since 2008 and is widely used in other countries.

In previous years, the production of biomass waste was estimated considering the annual production of the crops that generate them (i.e., rice, sunflower, barley) and the proportion of their waste in the total weight, taking as the source of information the statistical yearbooks of DIEA (Agricultural Statistics Office) of the MGAP. Production was significantly higher

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than the consumption of these energy sources following these criteria.

As of 2008, consumption of forestry and sawmill waste (chips, sawdust, etc.) has been recorded, which was not the case in previous BEN editions.

In the case of the industrial sector and power plants for public service and autoproduction, consumption of biomass waste is estimated based on data collection, and surveys administered annually by the DNE-MIEM to companies that use this source as energy. 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.

8.4.6. Biomass for biofuels

The primary energy source called "biomass for biofuels" considers the production of bioethanol and biodiesel. This edition incorporates a change in the estimation criteria, in which primary biomass is considered equal to the production of each biofuel. The historical series since 2010 is corrected. This change is in line with the International Recommendations for Energy Statistics (IRES), which considers biofuels as primary energy sources.

The following are the considerations made in the estimations using the previous criterion, in which under the denomination "biomass for biofuels" the consumption of energy (grains, crude oils, sugarcane juice, etc.) associated with the production of biofuels was considered. It is worth mentioning that these biomass consumptions for biofuels are taken as estimations, for including biofuels in the energy matrix. These values will differ, to some extent, from those obtained from applying other types of methodology not described in this document.

- **Biomass for bioethanol production**: the production considered corresponds to the Bella Unión and Paysandú plants.

– **Bella Unión sugar factory:**

As there are no reliable values of sugar consumption in the sugarcane juice with a breakdown of the actual consumption of each process, the amount of primary source used for bioethanol is estimated using the production data of bioethanol/sugar, considering the average performance of the sugar-alcohol factory (fermentation + distillation), as well as other factors (stoichiometric factors, density, heating value, etc.).

Biomass estimation for the production of bioethanol from sugar cane is made using the equation below (Eq. 1):

$$\underset{(\text{ktoe})}{\textbf{Biomass for bioethanol}} = \frac{\text{Bioethanol Prod. } (m^3)}{(TP \times AFP \times EMP)} \times \frac{\text{LHV sugar (kcal/kg)}}{10{,}000{,}000}$$

Where:

TP: Theoretical Performance (m^3 bioethanol / t sugar)
AFP: Average performance of sugar-alcohol factory (fermentation + distillation)
EMP: Extraction-milling performance ratio
LHV sugar: Lower heating value of reducing sugars. Taking the value of 4,000 kcal/g (data from the literature)

Determination of the theoretical performance of ethanol production (TP):

The chemical reaction of ethanol production is considered from the reducing sugars and their stoichiometric ratio. Then, the TP is determined from ethanol density in the adequate units for its use in the equation above.

Chemical reaction		
$C_6H_{12}O_6$ -------	$2\ CH_3CH_2OH$ +	$2\ CO_2$
Stoichiometric ratio		
180 g	92 g	88 g
Theoretical performance (TP)		
92 g of produced ethanol every 180 g of consumed sugar		
Bioethanol density		
0.7915 kg/l		
Theoretical performance (TP)		
0.6457 m^3 bioethanol / sugar tonne		

Therefore, Eq. 1 results in the following simplified equation (Eq.2):

$$\text{Biomass for bioethanol (ktoe)} = \frac{[\,4 \times \text{Bioethanol Prod. } (m^3)\,]}{[\,TP \times EMP \times 6{,}457\,]}$$

It is worth noting that the sugar-alcohol sector reported the data corresponding to ethanol production, the average performance of the sugar factory, and the extraction-milling performance ratio. In addition to this, in recent years, the amounts of sweet sorghum used for bioethanol production were negligible compared to the total amount of sugarcane and are therefore considered to have similar characteristics to sugarcane.

– **Paysandú sugar factory:**

Primary source consumption for bioethanol production from grains is directly estimated using the actual number of grains processed, considering the average humidity and the heating value for this raw material. The sugar factory provides both grain consumption and average humidity, while a 4,000 kcal/kg heating value is considered for grains (data from the literature). The following grains are processed: sorghum, wheat, and maize.

- **Biomass for biodiesel production**: in the case of biodiesel, the type of grain used and the heating values from the literature are considered to estimate the primary sources. In recent years biodiesel production was mainly from soybean and rapeseed, and sunflower was not used. Fat is also considered a primary source for biodiesel production, as well as crude oil and cooking oil. These are the reference values used for the heating values:

– Soy: 2,050 kcal/kg

– Sunflower: 5,189 kcal/kg

– Fat: 9,200 kcal/kg

– Rapeseed: it is calculated considering a 44% oil content in the seed and an oil heating value of 8,811 kcal (data from the literature).

– Other oils: without specific composition data, the heating value of a mix with 80% sunflower oil and 20% soy oil was considered, thus resulting in a value of 8,527 kcal/kg.

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8.4.7. Biogas

The electricity generated with biogas produced from urban waste in the Las Rosas plant in Maldonado (since 2005) was not recorded in the value corresponding to the electricity supply until 2007. In 2008 it was first included in electricity production at "power plants for public service". In 2004, the second generator of electricity produced from biogas was included. It was produced by treating the effluents of a wool-washing plant. Between 2019 and 2021, generators of electricity produced from biogas were included. It was produced from the treatment of effluents from a dairy farm. The four generators are included within electricity production at "power plants for public service." Biogas (expressed as methane) is considered the primary source of this electricity. These values are minimal compared to the total (around 0.3 ktoe). This source is considered biomass waste.

8.4.8. CO_2

The BEN publication includes carbon dioxide emissions (CO_2) from fuel combustion activities in the energy industries and consumer sectors. Furthermore, CO_2 emissions from biomass combustion and international bunkers are included as memo items since they are not considered in the totals. The series began in 1990.

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

The following are the reported categories:

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

  – 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 whole period and biofuels as of 2010. This category's emissions correspond to biomass combustion in power plants for public service, autoproduction power plants, and in the different activity sectors.

  – International bunkers: it corresponds to the emissions from international bunkers, both sea, and air bunkers.

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

The BEN publication also includes the series of "CO_2 emissions by source" and "CO_2 emissions by source and sector", starting in 2006. For the last series of data mentioned, the breakdown is done considering the main categories associated with the emissions of each source.

8.4.9. Primary matrix (energy supply)

The "primary matrix", also called the "matrix of supply", represents the country's energy supply with the following breakdown: "electricity", "solar", "oil and oil products", "natural gas", "biomass" and "coal/coke". The supply activities for each energy source are considered for preparing the matrix (production, import, export, and international bunker).

In the case of electricity, the production of electricity of hydraulic, wind, and photovoltaic solar origin is considered, as well as the amount imported from neighboring countries. It is worth mentioning that, if there are imports for transit, they must be deducted from the total imports for that year. Since 2010, the matrix of results has included the electricity generated by power plants, disaggregated by source.

Regarding hydrocarbons, the imports of oil 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 biomass, the production of firewood, biomass waste, and biomass for biofuels is considered, as well as net charcoal imports. Finally, to quantify coal and coke supply, the import of mineral coal and coke of coal is recorded.

Solar thermal energy has been reported in the primary matrix since 2017, considering its production, along with photovoltaic solar electricity. Both sources are grouped under the term "solar."

The analysis of energy supply by source is presented, as well as two additional classifications:

By origin:

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

By type:

- Renewable: hydroelectricity, wind electricity, photovoltaic solar electricity, biomass, and solar thermal energy.
- Nonrenewable: natural gas, oil and oil products, coal, and coke.
- Imported electricity.

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ANNEX I.
Supplementary information

I.1. Conversion of units

TABLE 30. 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 31. 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

NOTE: The dot represents the thousands separator and the comma the decimal separator.

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

TABLE 32. Conversion factors constant in the historical series

toe	unidad	valor
Asphalts	toe/t	0.964
Sulphur	toe/m^3	0.393
Biodiesel	toe/m^3	0.831
	toe/t	0.950
Bioethanol	toe/m^3	0.507
	toe/t	0.640
Petcoke	toe/t	0.939
Imported petcoke	toe/t	0.800
Coal	toe/t	0.700
Charcoal	toe/t	0.750
Rice husk	toe/t	0.285
Sunflower husk	toe/t	0.380
Barley husk	toe/t	0.371
Coke of coal	toe/t	0.680
Electricity (theoretical equivalent)	toe/MWh	0.086
Fuel gas	toe/10^{3}m^3	1.100
Natural gas	toe/10^{3}m^3	0.830
Odorous gases	toe/m^3	0.240
Firewood	toe/t	0.270
Lubricants	toe/m^3	0.909
	toe/t	1.010
Methanol	toe/t	0.360

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

TABLE 33. Variable conversion factors in the historical series

tep	unidad	2016	2017	2018	2019	2020	2021
Sawdust, chips, forest wastes [1]	toe/t	0.222	0.230	0.235	0.276	0.271	**0.283**
Bagasse	toe/t	0.177	0.177	0.177	0.177	0.177	**0.177**
Deodorized butane	toe/m³	0.611	0.620	0.612	0.615	0.612	**0.613**
	toe/t	1.095	1.096	1.095	1.095	1.095	**1.094**
Electricity (thermal equivalent)	toe/MWh	0.248	0.224	0.264	0.143	0.209	**0.188**
Medium fuel oil	toe/m³	1.095	0.955	0.929	0.920	0.919	**0.929**
	toe/t	1.145	0.973	0.990	0.986	0.989	**0.986**
Intermediate fuel oil (IFO) [1]	toe/m³	1.082	0.950	0.943	0.938	0.927	**0.936**
	toe/t	1.124	0.976	0.976	0.982	0.988	**0.987**
Heavy fuel oil	toe/m³	1.147	0.960	0.958	0.951	0.940	**0.953**
	toe/t	1.168	0.966	0.969	0.972	0.978	**0.972**
Fuel oil [3] (for electricity generation)	toe/m³	1.040	0.946	0.945	0.945	0.937	**0.947**
	toe/t	1.055	0.975	0.973	0.973	0.980	**0.976**
Fuel oil (for cellulose plants)	toe/m³	1.094	0.956	0.958	0.950	0.943	**0.952**
	toe/t	1.120	0.972	0.969	0.975	0.977	**0.972**
Fuel oil [4] (free zone)	toe/m³		0.942	0.940	0.931		
	toe/t		0.986	0.984	0.988		
Gas oil [5] (SULPHUR CONT. < 10 PPM)	toe/m³	0.856	0.857	0.862	0.856	0.848	**0.854**
	toe/t	1.026	1.025	1.024	1.026	1.029	**1.026**
Gas oil [5] (SULPHUR CONT. < 50 PPM)	toe/m³	0.871	0.868	0.868	0.863	0.856	**0.858**
	toe/t	1.021	1.021	1.022	1.023	1.026	**1.025**
Marine gas oil [5]	toe/m³	0.887	0.882	0.880	0.880	0.872	**0.878**
	toe/t	1.025	1.016	1.016	1.016	1.019	**1.017**
Aviation gasoline (OCTANE NUMBER AVIATION METHOD: 100)	toe/m³	0.758	0.756	0.755	0.755	0.754	**0.752**
	toe/t	1.055	1.055	1.056	1.056	1.056	**1.056**
Gasoline [6] (OCTANE NUMBER RON: 97)	toe/m³	0.803	0.800	0.800	0.794	0.790	**0.786**
	toe/t	1.043	1.043	1.044	1.045	1.046	**1.047**
Gasoline [6] (OCTANE NUMBER RON: 95)	toe/m³	0.792	0.795	0.789	0.785	0.785	**0.780**
	toe/t	1.046	1.045	1.047	1.048	1.048	**1.049**
Black liquor [1]	toe/t	0.302	0.302	0.302	0.302	0.302	**0.302**
Crude oil	toe/m³	0.905	0.880	0.863	0.856	0.846	**0.851**
	toe/t	1.059	1.017	1.017	1.023	1.026	**1.024**
Propane	toe/m³	0.568	0.568	0.567	0.570	0.568	**0.571**
	toe/t	1.099	1.090	1.098	1.098	1.100	**1.097**
Kerosene	toe/m³	0.836	0.833	0.830	0.829	0.829	**0.828**
	toe/t	1.038	1.033	1.034	1.034	1.034	**1.035**
Industrial wastes [1]	toe/t	0.630	0.681	0.654	0.632	0.673	**0.693**
Solvents [1]	toe/m³	0.794	0.803	0.799	0.797	0.799	**0.801**
	toe/t	1.044	1.042	1.043	1.044	1.043	**1.043**
LP gas	toe/m³	0.601	0.589	0.609	0.615	0.607	**0.612**
	toe/t	1.093	1.091	1.092	1.092	1.092	**1.091**
Jet fuel	toe/m³	0.844	0.839	0.831	0.829	0.830	**0.833**
	toe/t	1.041	1.032	1.034	1.034	1.034	**1.033**

NOTES:
1) Weighted average. **2)** Data on gaseous products are estimated (ASTM D3588), under atmospheric pressure conditions and at 15.6°C. **3)** Corresponds to fuel oil used by UTE to generate electricity. Values up to 2010 are reported by ANCAP as “FUELOIL UTE” and after 2011 as “FUELOIL UTE MOTORES”. **4)** Fuel oil consumed in the free zone, acquired through a supplier other than ANCAP. Conversion factor estimated by MIEM. **5)** For gas oil with sulphur content lower than 50 ppm, the reported parameters correspond to the mixture of gas oil with biodiesel. The other types of gas oil are not sold with biodiesel. **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 34. CO_2 emission factors

Fuel by Energy Balance	Fuel by IPCC	CO_2 EF (kg/TJ)
Biodiesel	Biodiesel	70,800
Bioethanol	Biogasoline	70,800
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	73,300
Natural gas	Natural gas	56,100
Gas oil	Gas/diesel oil	74,100
Firewood	Wood	112,000
Motor gasoline	Motor gasoline	69,300
Aviation gasoline	Aviation gasoline	70,000
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	Industrial wastes	143,000
LP gas	Liquefied petroleum gases	63,100
Jet fuel	Jet kerosene	71,500

NOTE: Effective CO_2 emission factor (kg/TJ). **SOURCE:** 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chart 1.4: “Default CO_2 emission factors for combustion”.

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I.4. Acronyms

TABLE 35. 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
BEN	National Energy Balance
CALNU	Limited Agrarian Cooperative of Northern Uruguay
CBU	Central Bank of Uruguay
CO_2	Carbon dioxide
DIEA	Agricultural Statistics Office
DINAMIGE	National Directorate of Mining and Geology
DNE	National Energy Directorate
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$ 2005	Millions of Uruguayan pesos at constant 2005 prices
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 2021 is presented.

   The complete matrix series for the period 1965-2021 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 to 2020 can be downloaded from:
   https://ben.miem.gub.uy/anteriores.php

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

   1 ktop = 1,000 toe
   1 toe = 10,000,000 kcal

3. Below are some clarifications for certain primary and secondary source designations included in the matrix:

- **Coal:** Includes anthracite, peat, coal tars, and pitch.
- **Natural gas:** Data are considered at standard conditions (1 atm and 15°C).
- **Hydroenergy:** Theoretical equivalent is considered.
- **Solar:** Includes photovoltaic solar energy and solar thermal energy.
- **Biomass waste:** Includes rice and sunflower husks, sugarcane bagasse, black liquor, odorous gases, methanol, barley husks, wood industry waste, and rumen.
- **Biomass for biofuel production:** Considers the production of bioethanol and biodiesel.
- **Industrial waste:** Includes wastes such as end-of-life tires (ELTs), used oils, glycerin, and alternative liquid fuels (ALFs), mostly composed of hydrocarbons recovered from bilge water and waste from the biodiesel industry.
- **LPG:** Includes LP gas and propane.
- **Motor gasoline:** This does not include bioethanol, which is reported separately. Exports correspond to isomerates, reformed, and petrochemical naphtha.
- **Gas oil:** This does not include biodiesel, which is reported separately.
- **Petcoke:** Includes calcined petcoke, uncalcined petcoke, and refinery coke.
- **Non-energy:** Includes solvents, lubricants, asphalts, and liquid sulfur.
- **Coal coke:** Corresponds to hard coal coke.
- **Electricity:** Electricity consumption associated with transport includes captive and private fleets.

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CONSOLIDATED MATRIX 2021 (ktoe)

Energía primaria

CONSOLIDATED MATRIX 2021 (ktoe)	PETRÓLEO	CARBÓN MINERAL	GAS NATURAL	HIDROENERGÍA	EÓLICA	SOLAR	LEÑA	RESIDUOS BIOMASA	BIOCOMBUSTIBLES	RESIDUOS INDUSTRIALES	TOTAL
PRODUCCIÓN				510.6	435.6	48.6	477.5	1,707.3	78.4	7.0	**3,265.0**
IMPORTACIÓN	2,049.6	3.4	68.4					3.2			**2,124.6**
EXPORTACIÓN											
BÚNKER INTERNACIONAL											
PÉRDIDAS	-0.1		-1.2								**-1.3**
VARIACIÓN INVENTARIO	95.9										**95.9**
NO UTILIZADA				-6.1	-6.4	-0.3					**-12.8**
AJUSTES			0.7			0.1		-0.1			**0.7**
OFERTA	2,145.4	3.4	67.9	504.5	429.2	48.4	477.5	1,710.4	78.4	7.0	**5,472.1**
REFINERÍAS	-2,145.4										**-2,145.4**
CENTRALES ELÉCTRICAS SERV. PÚB.			-1.6	-504.5	-427.5	-39.4	-0.8	-147.5			**-1,121.3**
CENTRALES ELÉCTRICAS AUTOPROD.					-1.7	-2.2	-1.2	-194.2			**-199.3**
DESTILERÍAS DE BIOMASA									-43.4		**-43.4**
PLANTAS DE BIODIÉSEL									-35.0		**-35.0**
CENTROS DE TRANSFORMACIÓN	-2,145.4		-1.6	-504.5	-429.2	-41.6	-2.0	-341.7	-78.4		**-3,544.4**
OFERTA BRUTA	2,145.5	3.4	69.1	510.6	435.6	48.7	477.5	1,710.4	78.4	7.0	**5,486.2**
CONSUMO NETO TOTAL		3.4	66.3			6.8	475.5	1,368.7		7.0	**1,927.7**
CONSUMO PROPIO			16.8			0.1					**16.9**
CONSUMO FINAL TOTAL		3.4	49.5			6.7	475.5	1,368.7		7.0	**1,910.8**
CONSUMO FINAL NO ENERGÉTICO		3.4									**3.4**
CONSUMO FINAL ENERGÉTICO			49.5			6.7	475.5	1,368.7		7.0	**1,907.4**
APERTURA SECTORIAL – RESIDENCIAL			22.9			5.5	283.5	7.6			**319.5**
MONTEVIDEO			*20.8*				*55.5*				
INTERIOR			*2.1*				*228.0*	*7.6*			
COMERCIAL/SERVICIOS/SECTOR PÚB.			13.1			1.0	22.1				**36.2**
ALUMBRADO PÚBLICO											
ADM. PÚBLICA Y DEFENSA							*2.1*				
ELECTRICIDAD, GAS Y AGUA							*0.1*				
RESTO			*13.1*				*19.9*				
TRANSPORTE											
CARRETERO											
FERROVIARIO											
AÉREO											
MARÍTIMO Y FLUVIAL											
INDUSTRIAL			13.5			0.2	154.8	1,361.1		7.0	**1,536.6**
FRIGORÍFICOS			*0.2*				*38.6*	*11.9*			
LÁCTEOS			*0.0*				*32.0*	*4.5*			
MOLINOS			*0.0*				*8.9*	*31.8*			
OTRAS ALIMENTICIAS			*4.3*				*20.9*	*31.1*			
BEBIDAS Y TABACO			*0.1*				*11.3*	*9.8*			
TEXTILES			*0.1*				*5.1*				
CUERO			*0.2*				*5.9*				
MADERA			*0.0*				*0.8*	*141.0*			
PAPEL Y CELULOSA			*1.5*				*14.2*	*1,115.9*			
QUÍMICA, CAUCHO Y PLÁSTICO			*0.8*				*16.9*	*12.3*			
CEMENTO			*1.4*				*0.0*	*2.7*		*7.0*	
OTRAS MANUFACTURERAS Y CONSTRUC.			*4.9*				*0.2*	*0.1*			
ACTIVIDADES PRIMARIAS							15.1				**15.1**
AGRO							*15.1*				*15.1*
AVÍCOLAS							*1.4*				*1.4*
RESTO AGRO							*13.7*				*13.7*
MINERÍA							*0.0*				*0.0*
PESCA											
NO IDENTIFICADO											

Energía secundaria

CONSOLIDATED MATRIX 2021 (ktoe)	GLP	GASOLINA AUTOMOTORA	GASOLINA AVIACIÓN	QUEROSENO	TURBOCOMBUSTIBLE	GASOIL	FUELOIL	COQUE DE PETRÓLEO	NO ENERGÉTICO	GAS FUEL	BIOETANOL	BIODIÉSEL	COQUE DE CARBÓN	CARBÓN VEGETAL	ELECTRICIDAD	TOTAL	PÉRDIDAS TRANSFORMACIÓN	TOTAL
PRODUCCIÓN	121.3	610.7		3.8	46.1	983.4	230.8	32.9	35.7	70.2	43.4	35.0			1,372.0	**3,585.3**		
IMPORTACIÓN	25.3		3.1			295.9		76.9	69.2				0.1	2.9	4.7	**478.1**		
EXPORTACIÓN	-3.2	-18.2						0.0	-0.2						-244.6	**-266.2**		
BÚNKER INTERNACIONAL			0.0		-43.6	-77.2	-14.0									**-134.8**		
PÉRDIDAS	-0.7		-0.1		0.0	0.0	0.0		-0.2		-0.4	-0.2			-106.1	**-107.7**		
VARIACIÓN INVENTARIO	1.9	17.6	-1.2	0.7	0.3	26.4	13.3	12.2	0.9		0.4	0.8				**73.3**		
NO UTILIZADA										-2.8						**-2.8**		
AJUSTES		0.1				0.1		0.1	0.1	-0.1		0.1			0.2	**0.6**		
OFERTA	144.6	610.2	1.8	4.5	2.8	1,228.6	230.1	122.1	105.5	67.3	43.4	35.7	0.1	2.9	1,026.2	**3,625.8**		
REFINERÍAS	121.3	610.7		3.8	46.1	983.4	230.8	32.9	35.7	70.2						**2,134.9**	-10.5	
CENTRALES ELÉCTRICAS SERV. PÚB.						-396.3	-61.3								1,220.5	**762.9**	-358.4	
CENTRALES ELÉCTRICAS AUTOPROD.		-0.1				-1.2					0.0	-0.1			151.5	**150.1**	-49.2	
DESTILERÍAS DE BIOMASA											43.4					**43.4**		
PLANTAS DE BIODIÉSEL												35.0				**35.0**		
CENTROS DE TRANSFORMACIÓN	121.3	610.6		3.8	46.1	585.9	169.5	32.9	35.7	70.2	43.4	34.9			1,372.0	**3,126.3**	-418.1	
OFERTA BRUTA	145.3	610.2	1.9	4.5	2.8	1,228.6	230.1	122.1	105.7	70.1	43.8	35.9	0.1	2.9	1,132.3	**3,736.3**		**5,637.2**
CONSUMO NETO TOTAL	144.6	610.2	1.8	4.5	2.8	831.1	168.8	122.1	105.5	67.3	43.4	35.6	0.1	2.9	1,026.2	**3,166.9**		**5,094.6**
CONSUMO PROPIO	0.8	0.1		0.0		0.9	19.3	32.9	0.0	67.3	0.0				34.5	**155.8**		**172.7**
CONSUMO FINAL TOTAL	143.8	610.1	1.8	4.5	2.8	830.2	149.5	89.2	105.5		43.4	35.6	0.1	2.9	991.7	**3,011.1**		**4,921.9**
CONSUMO FINAL NO ENERGÉTICO		0.1		1.6				1.2	105.5		0.6	0.0				**109.0**		**112.4**
CONSUMO FINAL ENERGÉTICO	143.8	610.0	1.8	2.9	2.8	830.2	149.5	88.0			42.8	35.6	0.1	2.9	991.7	**2,902.1**		**4,809.5**
APERTURA SECTORIAL – RESIDENCIAL	117.8	0.3		2.9		4.9	8.1				0.0	0.2		2.9	388.9	**526.0**		**845.5**
MONTEVIDEO	*54.0*			*0.7*											*150.9*			
INTERIOR	*63.8*			*2.2*											*238.0*			
COMERCIAL/SERVICIOS/SECTOR PÚB.	9.6	1.0		0.0		4.3	5.5				0.1	0.2		0.0	263.9	**284.6**		**320.8**
ALUMBRADO PÚBLICO															*18.5*			
ADM. PÚBLICA Y DEFENSA	*1.3*					*0.2*	*1.3*								*18.5*			
ELECTRICIDAD, GAS Y AGUA	*1.1*					*0.0*	*0.1*								*27.2*			
RESTO	*7.2*					*4.1*	*4.1*							*0.0*	*199.7*			
TRANSPORTE		605.9	1.0		2.2	682.7	0.1				42.5	29.7			0.4	**1,364.5**		**1,364.5**
CARRETERO		*605.9*				*671.2*					*42.5*	*29.7*			*0.4*	***1,349.7***		***1,349.7***
FERROVIARIO						*0.2*						*0.0*				***0.2***		***0.2***
AÉREO			*1.0*		*2.2*											***3.2***		***3.2***
MARÍTIMO Y FLUVIAL						*11.3*	*0.1*									***11.4***		***11.4***
INDUSTRIAL	8.9	0.8				15.8	135.5	88.0			0.1	0.7	0.1		313.7	**563.6**		**2,100.2**
FRIGORÍFICOS	*0.5*					*0.5*	*2.0*								*33.3*			
LÁCTEOS	*1.0*					*0.7*	*17.1*								*19.9*			
MOLINOS	*0.6*					*0.5*	*0.0*								*13.6*			
OTRAS ALIMENTICIAS	*3.5*					*2.5*	*3.0*								*22.1*			
BEBIDAS Y TABACO	*0.4*					*0.6*	*3.0*								*11.4*			
TEXTILES	*0.0*					*0.1*	*0.1*								*2.4*			
CUERO	*0.0*					*0.1*	*0.0*								*2.8*			
MADERA	*0.0*					*2.1*									*9.7*			
PAPEL Y CELULOSA	*0.3*					*1.5*	*102.6*								*99.0*			
QUÍMICA, CAUCHO Y PLÁSTICO	*0.8*					*1.6*	*2.4*								*71.1*			
CEMENTO	*0.1*					*2.1*	*1.2*	*88.0*							*7.60*			
OTRAS MANUFACTURERAS Y CONSTRUC.	*1.7*					*3.5*	*4.1*						*0.1*		*20.8*			
ACTIVIDADES PRIMARIAS	7.5	2.0	0.8	0.0	0.6	122.5	0.3				0.1	4.8			24.8	**163.4**		**178.5**
AGRO	*7.5*		*0.8*		*0.6*	*99.6*	*0.3*					*4.4*			*22.9*	***136.1***		***151.2***
AVÍCOLAS	*4.6*														*2.8*	***7.4***		***8.8***
RESTO AGRO	*2.9*		*0.8*		*0.6*	*99.6*	*0.3*					*4.4*			*20.1*	***128.7***		***142.4***
MINERÍA	*0.0*	*0.0*		*0.0*		*8.8*					*0.0*	*0.4*			*1.4*	***10.6***		***10.6***
PESCA	*0.0*	*2.0*				*14.1*					*0.1*				*0.5*	***16.7***		***16.7***
NO IDENTIFICADO	0.0																	

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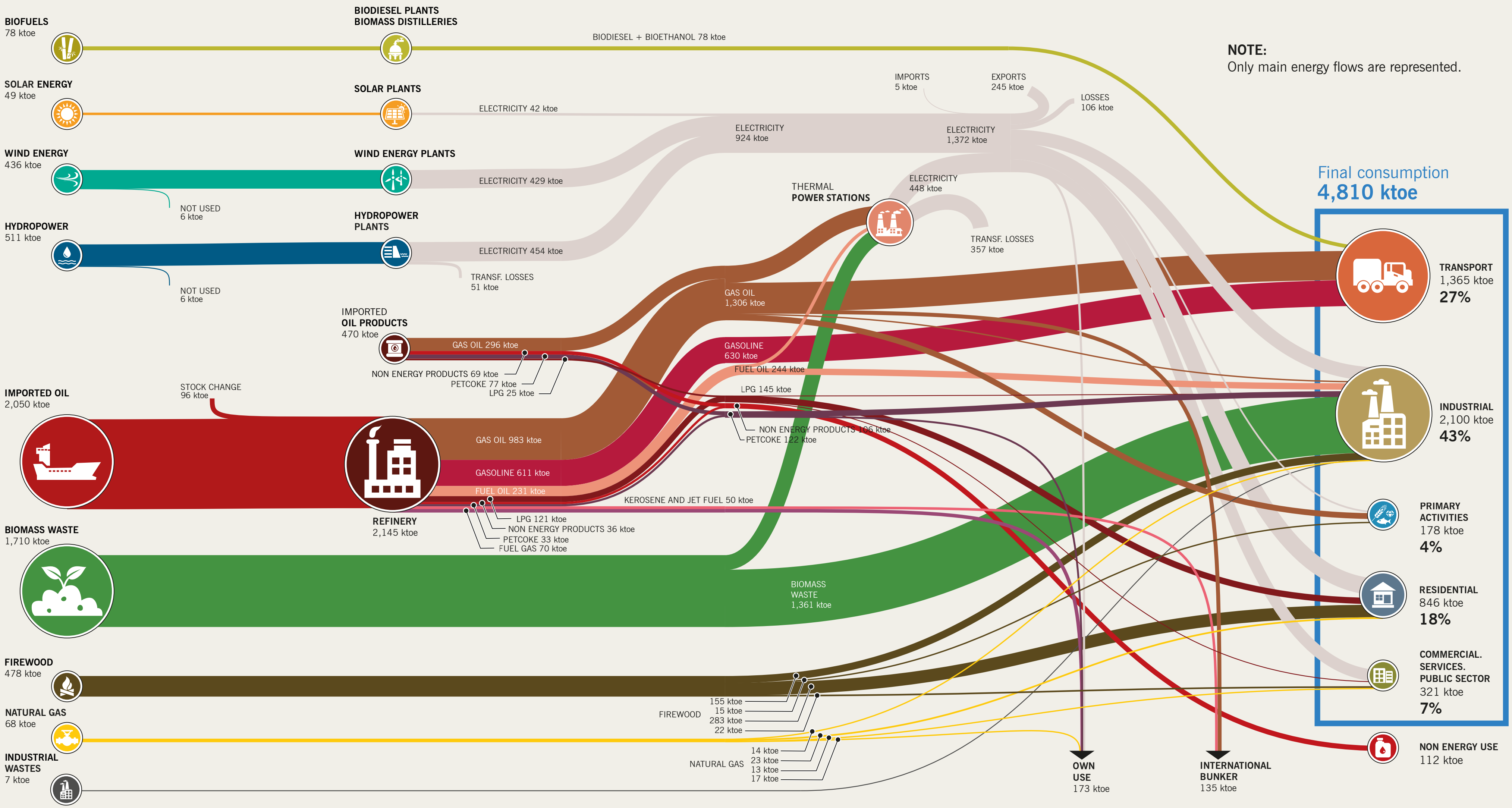
FLOW CHART 2021

(ktoe)



Energy Balance 2021

Ministerio de Industria, Energía y Minería

BEN Balance Energético Nacional Uruguay

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