

2nd October 2024

ECONOMIC AND ENVIRONMENTAL INDICATORS – CARBON FOOTPRINT
2010-2021

**IN 2021, THE NATIONAL CARBON FOOTPRINT
(51.9 KILOTONS OF CO₂, CORRESPONDING TO 1.5% OF THE EU'S CARBON FOOTPRINT),
DECREASED BY 25.3% COMPARED TO 2010, A SHARPER REDUCTION THAN IN THE EU (-18.7%)**

In 2021, Portugal's carbon footprint was 51.9 kilotons of carbon dioxide emissions, equivalent to 5.0 tons *per capita*, 25.3% less than in 2010.

Half of the emissions were emitted in Portugal (15.2% from households and 34.8% from production activities due to domestic demand), while the other half were emitted abroad (19.3% in EU Member States and 30.7% in other countries).

The EU's carbon footprint is higher than that estimated for Portugal (on average 1.5 times higher, or 2.8 tons more *per capita*), although the reduction since 2010 is less marked than in Portugal (-18.7%).

Outside the EU, China was the country that contributed the most to the national carbon footprint (7.4% of the total).

Statistics Portugal publishes for the first time, in an integrated manner and in the context of developing statistics – Statslab, Carbon Footprint estimates for Portugal, i.e. quantifying the emissions generated by the consumption of goods and services in the national territory. These statistics aim to take advantage of the methodological approach developed by Eurostat, with this emphasis focusing on its implementation at national level.

Background information

Carbon dioxide (CO₂) emissions can be calculated from two perspectives: production-based, resulting from the emissions of economic activities, or consumption-based, considering the emissions related to the final demand/consumption of goods and services, including global emissions generated along the whole production chain. This latter perspective is known as the carbon footprint.

There are three dimensions of analysis, considering the methodological approaches used and the purposes of the information collected, under which CO₂ emissions statistics are currently produced (Table 1).

Table 1. CO₂ and greenhouse gas emissions, perspectives for analysis

Methodological approach	Information framework	Purpose
1. CO ₂ and GHG emissions classified by technical processes	UN GHG emissions inventories	Official international reporting framework for international climate policies: United Nations Framework Convention on Climate Change (UNFCCC) and the European Union Regulation on the Greenhouse Gas Monitoring Mechanism (EU MMR)
2. CO ₂ and GHG emissions classified by economic activities	Eurostat Air Emissions Accounts (AEA)	Adapted for integrated environmental-economic analyzes
3. Footprints = CO ₂ and GHG emissions from a consumption perspective	Eurostat modeling results	Analytical application of AEA

Source: Eurostat

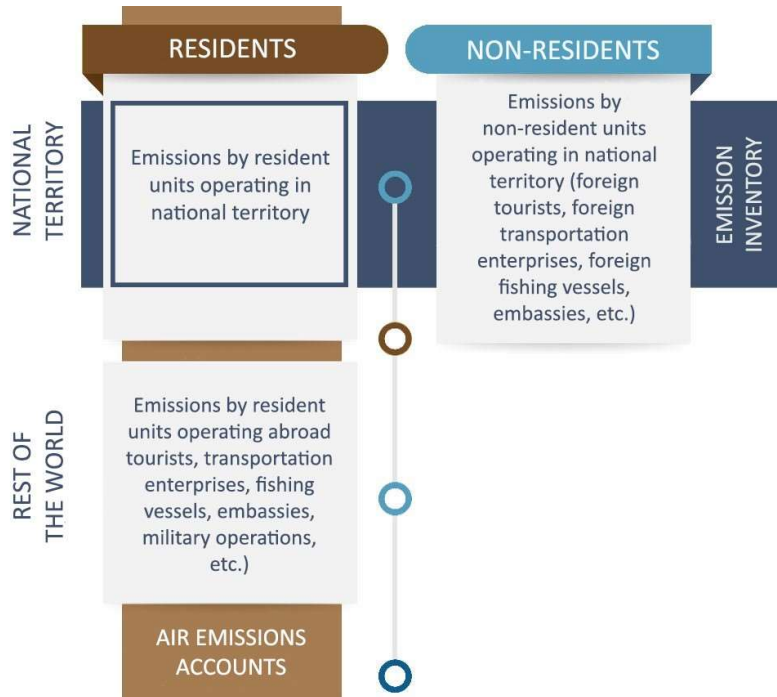
The inventories account for emissions from a production perspective and classify them by different categories of polluting activities. The data is the official information used to inform international climate policies.

The Air Emissions Accounts (AEA) employ the System of National Accounts (SNA) methodology to calculate production emissions data, disaggregated by economic activity in accordance with the NACE classification. These accounts are utilized to ascertain emission intensities and to conduct integrated environmental-economic analyses.

These two analytical tools record anthropogenic emissions, excluding those from natural sources (e.g. volcanoes, forest fires, etc.). The distinction lies in the geographical scope of the emission sources considered: national emission inventories account for emissions from the national territory (territory principle), whereas the AEA calculates emissions resulting from human activities within the national economy. This is defined as the total economic activities of resident units, regardless of the origin of the emissions, with some resident units being able to emit abroad (residence principle). Considering the divergent contexts of these two analytical frameworks, it is not uncommon for the total emissions reported in inventory databases to diverge significantly from the emissions calculated in the AEA.

Figure 1 shows the differences between the economic residence principle used in the AEA and the Footprint (vertical ellipse), and the territory-oriented principle of geographical residence used in national emissions inventories (horizontal ellipse). The economic residence principle requires recording all emissions per unit resident in the territory, as well as outside, i.e. in the rest of the world.

Figure 1. Definition of geographical and economic residence



Source: Statistics Portugal

The difference in scope is why there are differences in the results for CO₂ emissions (see Table 2).

Table 2. The main differences between the AEA and emissions inventories

Emission inventories (territory principle)	Air emissions accounts (residence principle)
Emissions are attributed to the country where the emission occurs.	Emissions are attributed to the country where the economic operator causing the emission inhabits.
Emissions are attributed to processes classified according to their technical nature (e.g. combustion in power plants, use of solvents).	Emissions are classified by economic activity, following the NACE classification of the system of national accounts.
Emissions from international shipping, aviation and road transport are attributed to the countries where the associated fuel is stored, regardless of the operator's place of residence.	Emissions from international shipping, aviation and road transport are attributed to the countries where the ship/aircraft operator is resident, regardless of where the emission occurs.

Source: Statistics Portugal

The Carbon Footprint is an estimate which, although resulting from the analytical application of the AEA, also includes emissions attributed to consumption, covering the amount of emissions generated globally throughout all the supply chains of goods and services used. Specifically, the calculation of a country's Carbon Footprint considers CO₂ emissions from the consumption of goods and services within its territory, as well as CO₂ emissions generated outside the country in the production of goods and services for its consumption. On the other hand, CO₂ emitted in the production of goods and services intended for export is not counted.

To calculate the Carbon Footprint, Eurostat provides two models that differ in their approach to calculating the estimated emissions generated in the production of imported goods and services:

- Through the [Consumption-Based Accounting tool \(CBA\)](#). There is no geographical breakdown for the origin of imports, so the associated emissions reflect the application of the Domestic Technology Assumption (DTA), i.e. the model 'assumes' that production technologies outside the EU are 'the same' as those in the EU.
- Through the environmental extension of the [FIGARO Multi-Regional Input-Output \(MRIO\)](#) project, a multi-regional, 'closed' model, i.e. one that encompasses the entire world economy. Much more detailed in geographical terms, it comprises 46 regions, each broken down by economic activity. Given its level of disaggregation, it makes it possible to estimate CO₂ emissions produced in the countries where imports originate.

Since INE has the basic information needed to implement it and because in theory multi-regional models produce better results, the FIGARO approach was preferred for the footprint estimation carried out in this press release.

Carbon footprint reaches 51.9 kilotons of CO₂ in 2021, with 50% of emissions occurring outside national territory

In 2021, a year still marked by the effects of the COVID-19 pandemic, Portugal emitted 42.1 kt¹ of CO₂ and its Carbon Footprint was 51.9 kt. of CO₂. This discrepancy in results is due to the difference between the two concepts. The CO₂ emitted in Portugal covers all CO₂, whether used for national consumption or associated with exported products. Portugal's Carbon Footprint includes CO₂ emissions associated with products used for national consumption, whether produced in Portugal or abroad. To calculate Portugal's Carbon Footprint, it was estimated that as result of national consumption, 10.0 kt of CO₂ will have been emitted in the EU and 15.9 kt outside the EU, to which 25.9 kt emitted by the national production system to meet domestic consumption were associated.

¹ Kiloton, corresponds to 1000 tons (t)

Table 3. CO₂ emissions Portugal, the EU and the rest of the world, 2021

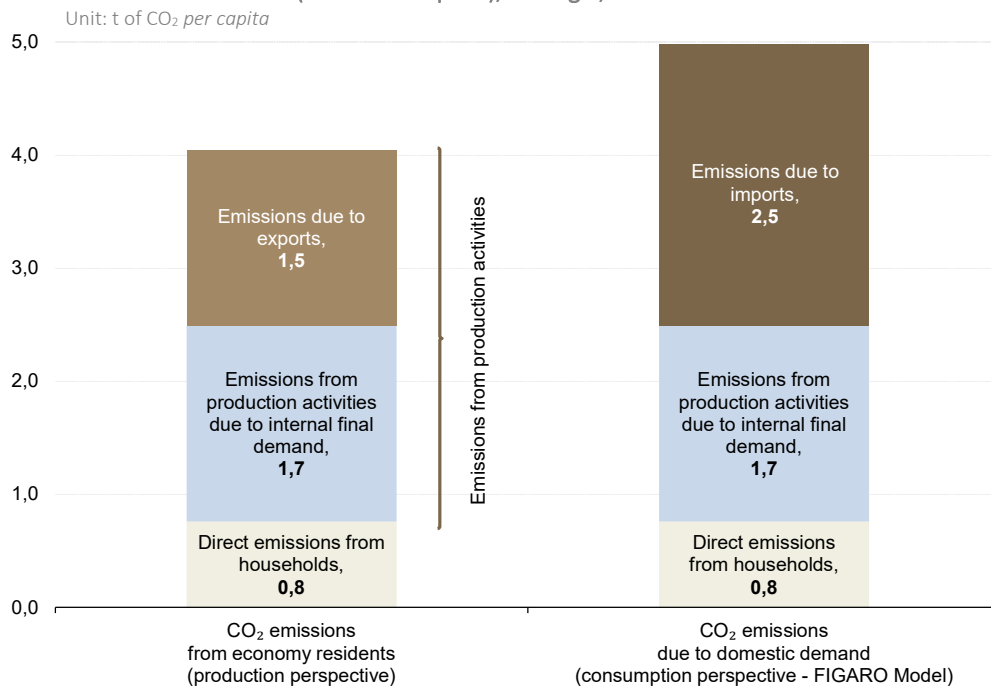
kt de CO ₂	"At the service of Portuguese consumption (domestic demand)"	"At the service of EU consumption (domestic demand)"	"Serving consumption outside the EU (domestic demand)"	TOTAL	% of Total
produced in Portugal	25.9	7.7	8.4	42.1	0.1%
produced in the EU	10.0	2 406.3	602.7	3 009.0	7.9%
produced in the rest of the world	15.9	1 062.1	33 831.8	34 893.9	92.1%
Total consumed	51.8 (0.1 % of total)	3 468,4 (9.2 % of total)	34 434.5 (90,8 % of total)	37 902.9	100.0%
Carbon Footprint (t of CO₂ per capita)	5.0	7.8	4.6	4.8	

Source: Statistics Portugal

In 2021, the emissions embodied in imported goods and services (25.9 kt of CO₂) were higher than those generated by Portuguese exports (16.1 kt of CO₂), meaning that Portugal was a net importer of CO₂ emissions.

In Figure 2, CO₂ emissions *per capita* are represented, from the perspective of production and consumption (Carbon Footprint).

Figure 2. CO₂ emissions - production and consumption perspective (Carbon Footprint), Portugal, 2021



Source: [Statistics Portugal](https://inec.pt)

These emissions comprise two common components: direct emissions from households (0.8 tons of CO₂ *per capita*) and production-based emissions resulting from domestic demand (2.1 tons of CO₂ *per capita*). In addition, there is a component that varies according to the perspective used to calculate it.

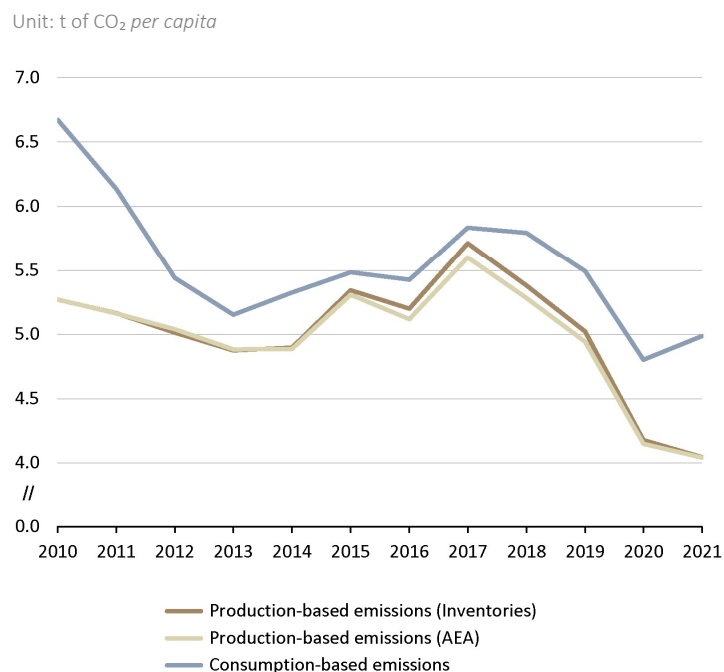
The production perspective, the left column of Figure 2, includes all CO₂ production-based emissions taking place in Portugal, whether or not they are consumed in Portugal, including CO₂ emitted in Portugal in the production of goods and services destined for foreign countries (exports - 1.5 tons of CO₂ *per capita*). The latter emissions are excluded from the Carbon Footprint (right-hand column).

From a consumption perspective, the Carbon Footprint shown in the right-hand column of Figure 2 includes CO₂ emissions from a consumption perspective, i.e. due to the end use of goods and services by the Portuguese economy.

Its end use covers public and private consumption, as well as the use of products for gross fixed capital formation, i.e. investment, such as buildings, plants and machinery, motor vehicles, etc. The estimate includes CO₂ emissions that occur globally along all supply chains to produce goods and services, reflecting the expenditure made by all residents in relation to production carried out on national territory. It includes CO₂ emissions due to imports, i.e. the amount of CO₂ that, although emitted abroad, was generated to produce the goods and services imported to meet domestic demand (2.5 tons of CO₂ *per capita*).

Between 2010 and 2021, emissions generated by domestic demand were systematically higher than those attributed to production activities; the carbon footprint fell by 25.4%, a steeper decrease than that which occurred with emissions calculated from a production perspective.

Figure 3. Evolution of CO₂ Emissions - Production (Inventories and AEA) and Consumption (Carbon Footprint) Perspective, Portugal, 2010-2021



Source: [Statistics Portugal](https://inec.pt)

The evolutionary analysis for the 2010-2021 period (Figure 3) shows that, despite the methodological differences (Chapter 2 of the [AEA Methodological Notes](#)), the two projects that assess CO₂ emissions from the production perspective show close results.

It should also be noted that over the period under analysis, CO₂ emissions from the consumption perspective were systematically higher (on average around 0.5 tons of CO₂ *per capita* for the inventories and 0.6 tons of CO₂ *per capita* for the AEA). However, although with different orders of magnitude and except for 2021, the behavior of the Carbon Footprint in the period under analysis shows an evolutionary pattern like the behavior of CO₂ emissions calculated from the production perspective. In 2021, contrary to the decrease in CO₂ emissions from the production perspective compared to the previous year, the Carbon Footprint increased from 4.8 tons of CO₂ *per capita* in 2020 to 5.0 tons of CO₂ *per capita* in 2021. This result was due to the worsening of the net balance of trade in CO₂ emissions.

Between 2010 and 2021, the Carbon Footprint fell by 25.3%, a sharper decrease than that seen from the production perspective (-23.3% for inventories and -23.4% for AEA). During this period, it is possible to identify three distinct phases in the evolution of Portugal's Carbon Footprint. Up until 2013, there was a sharp drop in the Carbon Footprint (-23.4%), while the reduction in production-based emissions was significantly lower (-7.4%). Between 2013 and 2017, there was some irregularity in evolution, but the Carbon Footprint grew by 11.8% and production-based emissions by 14.7%. Finally, between 2017 and 2021, the Carbon Footprint resumed its downward trend (an average of 14.2%), an evolution accompanied by production-based emissions which showed a more intense average reduction (-27.8%).

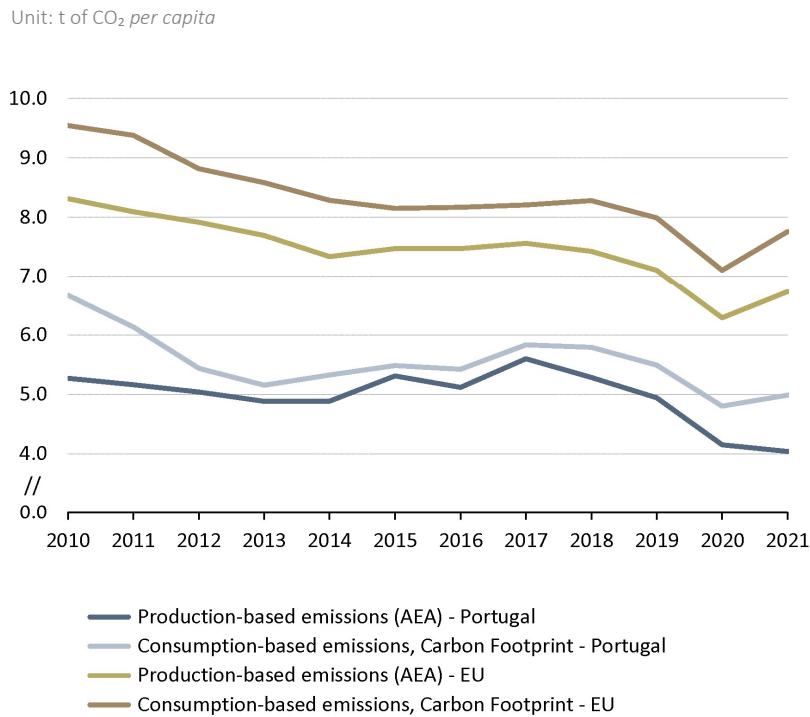
Between 2020 and 2021, emissions from production and consumption activities showed opposite trends. While production-based emissions fell by 2.6% (in the AEA), emissions from consumption increased by 3.8%, driven by the 16.2% growth in emissions attributable to imports.

Portugal's carbon footprint was on average 1.5 times lower than the EU's, in the period 2010-2021

Despite showing a similar evolution to the EU in the 2010-2021 period, the national Carbon Footprint shows lower values, on average 2.8 tons of CO₂ *per capita* (Figure 4).

Unlike the EU, Portugal's Carbon Footprint has been consecutively higher than the CO₂ emissions measured from the perspective of production activities. This is due to the net balance of emissions resulting from international trade transactions, where Portugal showed a deficit (Figure 4), unlike the EU.

Figure 4. CO₂ Emissions Evolution - Production and Consumption Perspective (Carbon Footprint), Portugal and the EU, 2010-2021



Source: [Statistics Portugal](#)

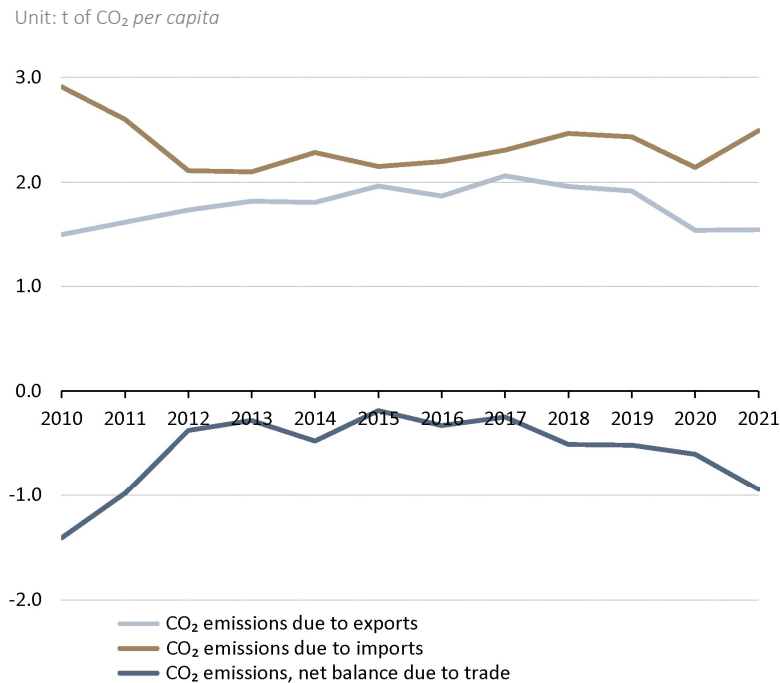
Between 2010 and 2021, the decrease in Portugal's Carbon Footprint (-25.3%) was greater than that observed in the EU (-18.7%). As a result of the differences in trade balances, between 2010 and 2021, the average difference between the EU's Carbon Footprint in relation to CO₂ production-based emissions (0.9 tons of CO₂ per capita) was greater than in the case of Portugal (0.6 tons of CO₂ per capita).

Portugal's CO₂ emissions trade balance is in deficit but a surplus in the EU

Figure 5 gives a more detailed view of the evolution between 2010 and 2021 of CO₂ emissions related to trade flows, showing the evolutionary behavior of emissions associated with international trade flows and the resulting net balance of CO₂ emissions.

During the period from 2010 to 2021, emissions related to imports were always higher than emissions due to the production of exports, i.e. emissions due to consumption were systematically higher than emissions related to production.

Figure 5. CO₂ emissions - Net balance due to trade (exports versus imports), Portugal, 2010-2021



Source: [Statistics Portugal](#)

If international trade transactions were not accounted for, in 2021 Portugal would no longer emit the CO₂ emissions needed to produce exports (1.5 tons of CO₂ per capita) but would have to produce imported goods and services locally to meet its consumption needs, which would result in extra emissions of 2.5 tons of CO₂ per capita. This would result in a negative balance of 0.9 tons of CO₂ per capita.

In 2021, 18.4% of the CO₂ emissions generated by domestic production went to the USA. In contrast, China was the country that contributed most to the national carbon footprint (7.4%)

Figure 6 shows Portugal's production-based CO₂ emissions in 2021 by destination, i.e. the countries or regions where the end use of the products that caused CO₂ emissions in the Portuguese economy occurred that year.

In 2021, CO₂ emissions based on national production totaled 42.1 kt. Of these, 25.9 kt, 61.6% were consumed in Portugal. Outside Portugal, national emissions consumed in EU member states totaled 18.4%, corresponding to 7.7 kt of emissions. In the G20 countries, an international economic cooperation forum which brings together the world's main economies, including industrialized and developing countries, and which represents around 80% of gross world product and 75% of international trade, 9.2 kt of Portuguese production emissions were consumed, 21.8% of the total.

The United States, with 1.8 kt (4.3%), was the country with the largest share of CO₂ emissions based on Portuguese production, followed by China with 1.1 kt, around 2.7%.

Figure 6. Destination of CO₂ emissions based on Portugal's production, 2021

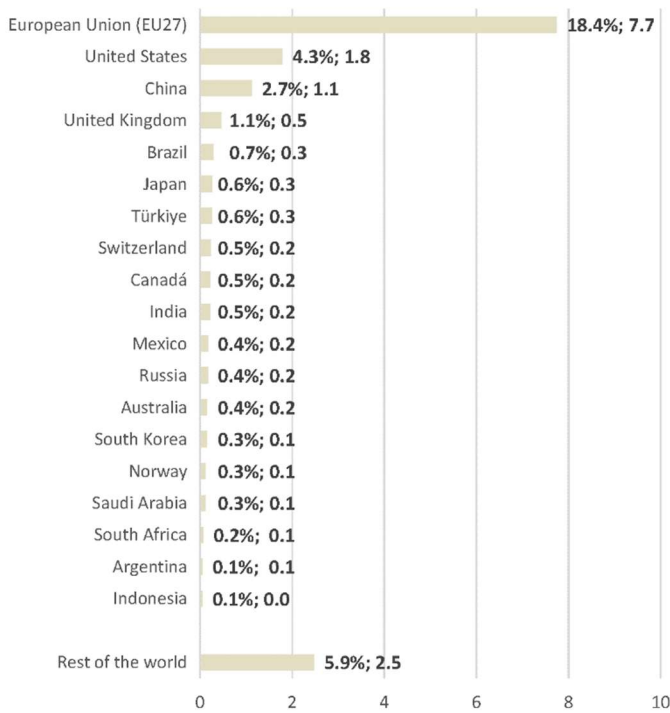
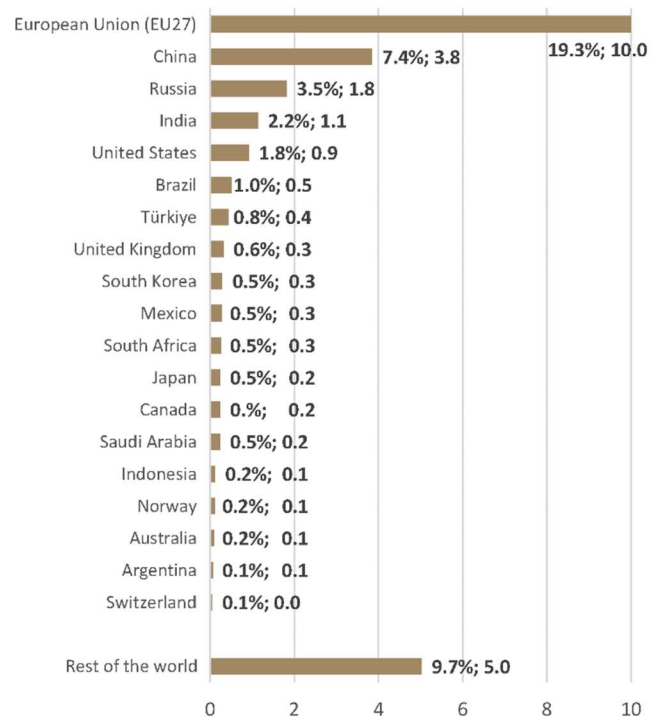


Figure 7. Origin of CO₂ emissions based on Portugal's consumption, 2021



Unit: %, kilotons (kt)

Source: [Statistics Portugal](https://inec.pt)

Source: [Statistics Portugal](https://inec.pt)

Figure 7 shows CO₂ emissions based on consumption in Portugal in 2021, by origin. That is, the country or region where CO₂ emissions were originally emitted during the production of end-use products in the Portuguese economy that year. CO₂ emissions based on consumption in Portugal were estimated at 51.9 kt. Around half were emitted by the Portuguese economy itself (25.9 kt) and 19.3% were produced in EU member states (9.9 kt).

It should be noted that the group of countries that make up the G20 was responsible for 13.6 kt of CO₂ emissions based on national consumption (26.2%). With 3.9 kt (7.4%), China was the country with the largest share of these emissions, followed by Russia 1.8 kt (3.5%) and India 1.1 kt (2.2%).

Figure 8. Carbon footprint, by categories and groups of CPA products, Portugal, 2021

Unit: kg of CO₂ per capita



Source: [Statistics Portugal](https://inec.pt)

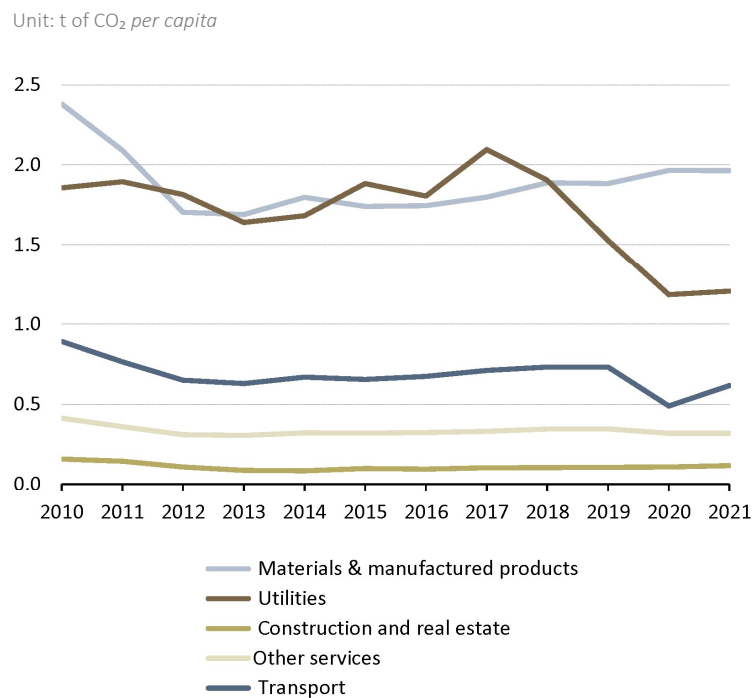
Figure 8 shows the Carbon Footprint by categories and groups of CPA products (Classification of Products by Activity). In the [Annex](#) you can also see the Carbon Footprint for all CPA products, by type of end use and origin, as well as their correspondence with the category and product group used in Figure 8.

The product category classified as 'Materials and manufactured products' contributed 46.5% of the total CO₂ production-based emissions in 2021 due to domestic demand. The product categories 'Utilities', 'Transport', 'Other services' and 'Construction and real estate' accounted for 24.2%, 12.4%, 6.4% and 2.4% respectively.

CO₂ emissions generated by domestic demand for these products account for 84.8% of the total carbon footprint and 4,225 kg of CO₂ emissions *per capita*. The remaining 15.2% consists of direct household emissions, equivalent to 758 kg of CO₂ emissions per capita.

Analyzing the evolution from 2010 to 2021 (Figure 9), emissions from all product categories fell sharply until 2013, justified by the crisis of 2010-2013, the deepest recession since 1980, with an impact on GDP *per capita*, which fell by 6.9% in this period.

Figure 9. Evolution of the Carbon Footprint by categories of CPA products, Portugal, 2010-2021



Source: [Statistics Portugal](#)



Figure 9 also shows the effect that the COVID-19 pandemic has had on the evolution of emissions from all product categories. Emissions fell in 2020 for most categories, especially 'Transport' (-33.1%) and 'Utilities' (-22.5%), with the exceptions of the increases seen in 'Materials and manufactured products' (4.3%) and 'Construction and real estate' (1.8%). In 2021, except for the slight drop in 'Materials and manufactured products' (-0.1%), emissions from all product categories show increases that seem to indicate the beginning of a return to production at pre-COVID 19 levels.

Figure 9 also shows a clear drop in the Carbon Footprint of the 'Utility' category from 2017 onwards. This decrease (-44.4%) was essentially due to the reduction in energy uses relevant to emissions (those which, as a result of production and consumption, mainly in combustion processes, give rise to emissions of polluting gases and particles into the atmosphere) attributed to the product 'D35 Electricity, gas, steam and air conditioning supply', which always represents over 91% of the total of products in the 'Utilities' category.

From 2017 to 2021, the most relevant energy uses for emissions associated with product D35 decreased by 43.7%. This decrease shows, firstly, less use of fossil fuels and, consequently, an increase in the use of renewable sources (21.5%), in addition to the use of less polluting energy sources (94.0% decrease in the use of coal).



METHODOLOGICAL NOTE

The Carbon Footprint measures the CO₂ emissions associated with the consumption of goods and services by residents, regardless of where the emissions occur along the supply chain. In addition, emissions directly generated by households, mainly through transport and the burning of heating fuel, are also accounted for. These emissions are often called ‘consumption emissions’ to distinguish them from estimates related to emissions produced in the economy.

The difference between the Carbon Footprint (consumption perspective) and the amount of carbon dioxide emitted directly by the economy (production perspective) lies in international trade. To assess the impact of consumption on CO₂ emissions, it is necessary to consider the origin of imported goods and their supply chains. The Carbon Footprint includes the amount of CO₂ emissions that occur globally throughout the supply chain to produce goods and services used in domestic demand, including consumption and investment.

CO₂ emissions resulting from the consumption of these goods and services are accounted for in the Carbon Footprint, as are emissions abroad resulting from the production of goods and services for domestic demand. CO₂ emissions resulting from the production of goods and services for export are excluded from the Carbon Footprint.

Due to the increasing globalization and complexity of supply chains, emissions associated with international trade are becoming increasingly important. In recent decades, much production capacity has been transferred from developed to developing countries. Developed countries increasingly import products instead of producing them, which reduces emissions from the production perspective. However, emissions from the consumption perspective will not change until these countries change their consumption patterns.

The consumption perspective, as it reflects the impact of consumption needs on global CO₂ emissions, is important for monitoring sustainable development. Hence the importance of assessing the Carbon Footprint, which reflects the extent to which a country's consumption needs contribute to global CO₂ emissions and consequently allows for a more accurate assessment of national contributions to climate change.

Two approaches implemented by Eurostat were used to calculate CO₂ emissions emitted abroad during the production of goods and services for domestic demand. In addition to the FIGARO Multi-Regional Input-Output (MRIO) project, the Consumption-based accounting tool - the CBA model - was also used.

1. FIGARO (Full International and Global Accounts for Research in input-Output analysis)

The FIGARO model is the result of a cooperation project between Eurostat and the European Commission's Joint Research Centre. The project is also known as EU inter-country Supply, Use and Input-Output tables (EU - IC-SUIOT), i.e. resource, use and input-output tables between EU countries.

The FIGARO model requires a combination of different statistical domains, specifically it uses data from national accounts, business statistics, international trade statistics and employment statistics. This information is collected for the EU and for the EU's 18 main trading partners (Argentina, Australia, Brazil, Canada, China, India, Indonesia, Japan, Mexico, Norway, Russia, Saudi Arabia, South Africa, South Korea, Switzerland, Turkey, United Kingdom, United States). The 'rest of the world' region has been created to complete the 45+1 FIGARO framework.

It's a multi-regional model, in which each of the 45+1 regions presents detailed information by 64 NACE plus the 'households' aggregate. It is a 'closed' model, i.e. it encompasses the entire world economy. Given its level of detail, it makes it possible to estimate 'real' emissions, i.e. each country's emissions from a production perspective (AEA) are allocated to the final consumption categories of each of those same countries - which corresponds to the consumption perspective (i.e. 'footprint').

FIGARO tables provide a comprehensive description of the EU economy by identifying the products supplied in the EU by both domestic production and imports (by country of origin), as well as the use of products by companies and households for intermediate or final purposes (by country of destination). They are a frequently used tool for different types of economic analyses, such as the study of global value chains, trade and employment analyses and environmental footprints, as well as providing a framework consistent with the balance of national accounts, balance of payments and international trade statistics.

In May 2021, Eurostat published the EU-IC-SUIOT tables for the first time. These tables are updated annually in line with the latest macroeconomic aggregates. The FIGARO tables are compared with the most recent macroeconomic aggregates and respect the same quality standards as official statistics.

Also in 2021, Eurostat started a pilot project to estimate CO₂ emissions accounts for the 45+1 geographical entities, which serves as an environmental extension to the FIGARO dataset.

The current version of FIGARO, namely the FIGARO 2023 edition, covers the entire time series from 2010 to 2021. In terms of environmental dimensions, for the time being the FIGARO model only includes CO₂.

There are two main sources of data that feed the FIGARO Carbon Footprint modelling, the FIGARO tables of trade inputs-outputs between countries (ICIOT), as the main input, and the CO₂ emissions of the AEA, as the environmental dimension.

For more information on FIGARO application data: carbon footprints, see the following references:

- [Carbon footprints \(FIGARO application\) - Reference Metadata](#)
- [FIGARO - CO₂ estimates - Methodological Note](#)

The [modelling results for the EU](#) are published annually by Eurostat and made available in a [database](#). To produce the information provided here, the data obtained from the 2023 edition of the AEA and the data from the National Accounts 2010-2021 Resource-Use Balance Tables (UERF) were used.

2. CBA (Consumption-based accounting tool)



This is a consumption-based accounting application that makes it possible to estimate atmospheric emissions footprints or any other type of footprint for which it is possible to provide data at NACE*64 level.

CBA results are calculated using a [tool](#), which can be found on [Eurostat's methodology page](#). In this model, there is only one region (EU, in the case of the data we publish), and no geographical detail is available on the origin of imports. For this reason, emissions associated with imports follow the Domestic Technology Assumption (DTA) approach, i.e. the model 'assumes' that production technologies outside the EU are 'the same' as those used in the EU, so imported products are considered as if they were produced with production technologies like those used in the EU. This implies that the results should be interpreted with caution and that the reported 'imported emissions' actually represent emissions avoided in the EU.

To calculate the Carbon Footprint, Eurostat's Excel application uses two data sources to feed the modelling:

1. Resource Use Balance Tables (RUSQ), which depict the production and consumption activities of national economies in detail. They form the basis of so-called input-output models and analyses. Both tables and models are very useful tools for tackling a range of issues. By adding environmental information (e.g. atmospheric emissions or energy use) to these input-output models, it is possible to broaden their analytical scope. Environmentally extended input-output analyses are of relevance to topics such as sustainable production and consumption, the sustainable use of natural resources and resource productivity.
2. CO₂ emissions from a production perspective come from the AEA, which is part of Eurostat's environmental accounts program. The AEA record emissions of greenhouse gases and atmospheric pollutants through a detailed breakdown of economic activities, namely 64 branches of activity and various activities of private households. The data obtained from the 2023 edition of the AEA was used to produce the information provided here.

For more information on the methodology used by the CBA, please consult the following references:

- [Creating consolidated and aggregated EU27 Supply, Use and Input- Output Tables, adding environmental extensions \(air emissions\), and conducting Leontief- type modelling to approximate carbon and other 'footprints' of EU27 consumption for 2000 to 2006](#)
- [Eurostat Manual of Supply, Use and Input-Output Tables \(2008\)](#)
- [Reference metadata 'Emissions of greenhouse gases and air pollutants induced by final use of CPA products \(input-output analysis\)'](#)

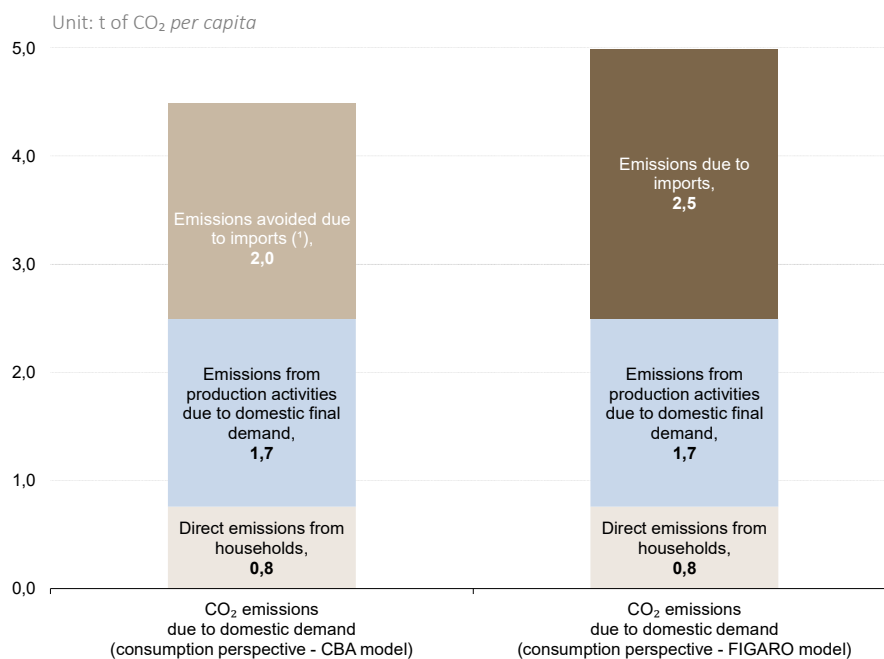
The modelling results for the EU are available from Eurostat in a [database](#). In this model it is possible to obtain results for all the pollutants that are available in the AEA (i.e. in addition to GHGs, also NO_x, SO_x, etc.).

3. FIGARO vs. CBA

Figure 10 shows both approaches to calculating CO₂ emissions from the consumption perspective - Carbon Footprint, i.e. due to the end use of products in the Portuguese economy.

The end use of goods and services covers public and private consumption, as well as the use of products for gross fixed capital formation, i.e. investment, such as buildings, plant and machinery, motor vehicles, etc. The estimate includes CO₂ emissions that occur globally throughout the supply chain to produce goods and services that are used in domestic demand.

Figure 10. CO₂ emissions - CBA and FIGARO models from the consumption perspective (Carbon Footprint), Portugal, 2021



(*) "Emissions avoided due to imports" is based on the amount of carbon dioxide that would have been emitted if the imported products had been produced in the EU-27 using EU-27 production technologies.

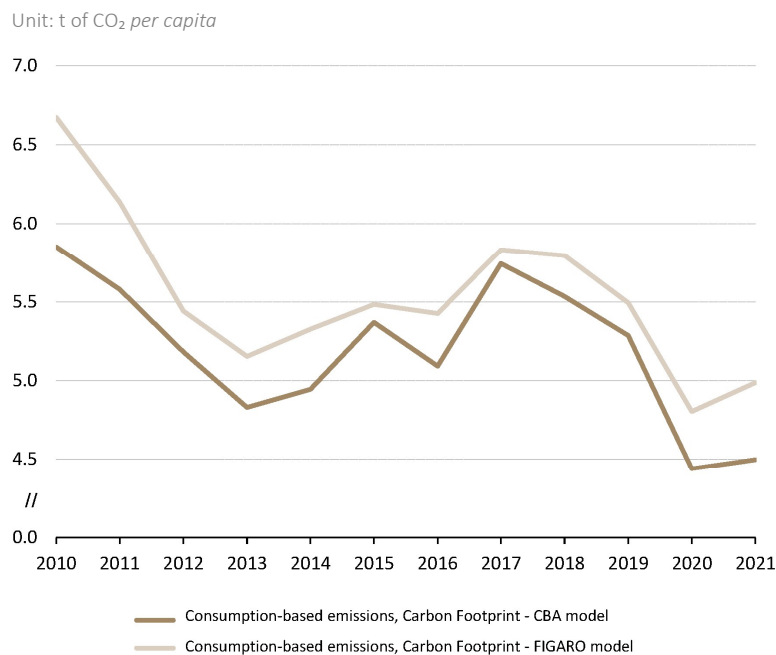
Source: [Statistics Portugal](#)

In the CBA model approach, shown in the left-hand column of Figure 10, the estimate of 2.0 tons of CO₂ per capita corresponds to the amount of CO₂ that would have been emitted due to domestic demand for goods and services if all imported goods and services were produced using average EU-27 production technology.

In the FIGARO model approach, shown in the right-hand column of Figure 8, the estimate of CO₂ emissions points to 2.5 tons of CO₂ per capita, including emissions due to imports, i.e. it measures the amount of CO₂ emitted abroad to produce the goods and services imported by Portugal to meet domestic demand.

About the 2010-2021 evolution (Figure 11), the approaches show similar behavior, although with different orders of magnitude. It should be noted that the FIGARO model systematically records higher values than those obtained in the CBA model. This is because the production technologies of products imported by Portugal from outside the EU are more CO₂ emitting than those from the EU assumed by the DTA assumption in the CBA model.

Figure 11. Evolution of CO₂ emissions - CBA and FIGARO models from the consumption perspective (Carbon Footprint), Portugal, 2010-2021



Source: [Statistics Portugal](https://inec.pt)

INFORMATION EXPERIMENTAL STATUS

Due to modelling assumptions, Eurostat's estimation of the Carbon Footprint is more uncertain than the production-based emissions reported in the AEA. Emissions related to the production of imports, often referred to as emissions 'embedded' in imports, are not as easily measurable as emissions generated within Portuguese borders. There are general conventions on how to carry out these estimates, however, the results cannot be considered as robust as estimates of domestically generated carbon emissions.

The use of two methodological models, which are not yet sufficiently robust, and the possibility of future developments being incorporated, make the results presented classified as experimental statistics, and are therefore subject to future revisions. In addition, it is important to emphasize that the Carbon Footprint estimate obtained through the CBA model assumes the 'domestic technology', i.e. imported goods and services are assigned production technologies like those used in the EU. In most cases, this approach leads to an underestimation of the real impacts.



To better estimate the emissions embodied in EU imports, it is important to consider that the production technologies used outside the EU may not correspond to the average production technologies used within the EU. To realize this estimate, it will be necessary to develop a global-scale model fed by a dataset that includes all inter-industry trade flows. Although there are several research projects that have produced global datasets, a standardized dataset that is produced on a regular basis is not yet available. Eurostat is currently developing this dataset as part of the FIGARO project, but due to its length and complexity, it is estimated that it will take several years before it is reliably usable for modelling Carbon Footprints.

ACRONYMS AND ABBREVIATIONS

CBA: Consumption-based Accounting tool

AEA: Atmospheric Emissions Accounts

CO₂: Carbon dioxide

COVID-19: Coronavirus disease, (year in which the disease was first identified - 2019)

CPA: Classification of Products by Activity

DTA: Domestic Technology Assumption

FIGARO: Full International and Global Accounts for Research in input-Output analysis

GHG: Greenhouse gases

MRIO: Multi-Regional Input-Output

SNA: System of National Accounts

ANNEX – DATA

1. Data from Figure 2: CO₂ emissions - production and consumption perspective (Carbon Footprint), Portugal, 2021

 (tons of CO₂ per person)

	CO ₂ emissions from economy residents (production perspective)	CO ₂ emissions due to internal demand (consumption perspective - FIGARO Model)
Direct emissions from households	0,7580	0,7580
Emissions from production activities due to internal final demand	1,7347	1,7347
Emissions due to exports	1,5490	-
Emissions avoided due to imports	-	-
Emissions due to imports	-	2,4902
Total	4,0418	4,9829

2. Data from Figure 3: Evolution of CO₂ Emissions - Perspective of production (Inventories and CEA) and consumption (Carbon Footprint), Portugal, 2010-2021

 (tons of CO₂ per person)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Production-based emissions (Inventories)	5,2715	5,1660	5,0150	4,8763	4,8971	5,3448	5,2014	5,7140	5,3816	5,0225	4,1777	4,0449
Production-based emissions (AEA)	5,2731	5,1632	5,0408	4,8845	4,8867	5,3089	5,1188	5,6013	5,2852	4,9431	4,1493	4,0418
Consumption-based emissions	6,6826	6,1452	5,4165	5,1641	5,3615	5,4950	5,4467	5,8466	5,7936	5,4574	4,8172	4,9829

3. Data from Figure 4: Evolution of CO₂ Emissions - Production and consumption perspective (Carbon Footprint), Portugal and EU, 2010-2021

 (tons of CO₂ per person)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Production-based emissions (AEA) - Portugal	5,2731	5,1632	5,0408	4,8845	4,8866	5,3090	5,1188	5,6014	5,2852	4,9431	4,1493	4,0418
Consumption-based emissions, Carbon Footprint - Portugal	6,6826	6,1452	5,4165	5,1641	5,3615	5,4950	5,4467	5,8466	5,7936	5,4574	4,8172	4,9829
Production-based emissions (AEA) - EU	8,3144	8,0915	7,9154	7,6930	7,3350	7,4697	7,4721	7,5603	7,4247	7,1053	6,2923	6,7330
Consumption-based emissions, Carbon Footprint - EU	9,5446	9,3795	8,8172	8,5815	8,2844	8,1507	8,1656	8,2059	8,2806	7,9901	7,1051	7,7609

4. Data from Figure 5: CO₂ emissions – Net balance due to trade (exports versus imports), Portugal, 2010-2021

 (tons of CO₂ per person)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CO ₂ emissions due to exports	1,5016	1,6193	1,7352	1,8209	1,8090	1,9646	1,8698	2,0615	1,9594	1,9190	1,5415	1,5490
CO ₂ emissions due to imports	2,9112	2,6013	2,1109	2,1005	2,2839	2,1506	2,1978	2,3069	2,4679	2,4334	2,1428	2,4902
CO ₂ emissions, net balance due to trade	-1,4095	-0,9820	-0,3757	-0,2796	-0,4749	-0,1860	-0,3280	-0,2454	-0,5084	-0,5144	-0,6013	-0,9412

5. Data from Figure 6 and 7: Destination of CO₂ emissions based on Portugal's production, 2021
 Origin of CO₂ emissions based on Portugal's consumption, 2021

Destination country	Kilotons (kt)	Percentage of total
Portugal	25,9435	61,6742
European Union (EU27)	7,7389	18,3973
United States	1,7879	4,2502
China	1,1226	2,6686
United Kingdom	0,4627	1,1001
Brazil	0,2866	0,6813
Japan	0,2633	0,6260
Türkiye	0,2569	0,6106
Switzerland	0,2273	0,5404
Canada	0,2236	0,5316
India	0,2183	0,5190
Mexico	0,1764	0,4194
Russia	0,1762	0,4188
Australia	0,1557	0,3701
South Korea	0,1468	0,3490
Norway	0,1207	0,2869
Saudi Arabia	0,1140	0,2709
South Africa	0,0705	0,1675
Argentina	0,0536	0,1274
Indonesia	0,0468	0,1112
Rest of the world	2,4732	5,8795
Total	42,0654	100,0000

Country of origin	Kilotons (kt)	Percentage of total
Portugal	25,9435	50,0252
European Union (EU27)	9,9940	19,2709
China	3,8450	7,4141
Russia	1,8154	3,5006
India	1,1283	2,1756
United States	0,9166	1,7675
Brazil	0,5052	0,9741
Türkiye	0,4257	0,8209
United Kingdom	0,3141	0,6057
South Korea	0,2838	0,5472
Mexico	0,2737	0,5278
South Africa	0,2685	0,5176
Japan	0,2374	0,4577
Canada	0,2364	0,4559
Saudi Arabia	0,2345	0,4522
Indonesia	0,1189	0,2292
Norway	0,1183	0,2280
Australia	0,0845	0,1630
Argentina	0,0585	0,1128
Switzerland	0,0404	0,0780
Rest of the world	5,0179	9,6758
Total	51,8608	100,0000

6. Data from Figure 8: Carbon Footprint, by categories and product groups CPA, Portugal, 2021

CPA Products					Final consumption expenditure		Gross capital formation		Final use, Total	
Products		Groups	Categories	national emissions	imported emissions	national emissions	imported emissions	global emissions		
Code	Designation			kg per capita				%		
CPA_D35	Electricidade, gás, vapor água quente e fria e ar frio	Energia	Utilitários	394,74	465,04	43,58	199,84	1 103,19	22,14	
CPA_C23	Outros produtos minerais não metálicos	Metais e minerais	Materiais e produtos	74,32	109,45	176,93	97,74	458,45	9,20	
CPA_H49	Serviços de transportes terrestres e por condutas (pipelines)	Terrestres	Transportes	22,44	223,68	8,36	64,25	318,73	6,40	
CPA_C20	Produtos químicos	Combustível fóssil e produtos químicos	Materiais e produtos	150,36	112,97	19,24	30,18	312,74	6,28	
CPA_C19	Coque e produtos petrolíferos refinados	Combustível fóssil e produtos químicos	Materiais e produtos	1,19	134,25	2,35	151,71	289,50	5,81	
CPA_C24	Metais de base	Metais e minerais	Materiais e produtos	78,51	102,00	10,76	22,36	213,63	4,29	
CPA_B	Indústrias extractivas	Produtos da agricultura, silvicultura	Materiais e produtos	73,39	109,21	13,60	6,02	202,23	4,06	
CPA_A01	Produtos da agricultura, da produção animal, da caça e dos serviços	Produtos da agricultura, silvicultura	Materiais e produtos	8,88	115,44	0,85	34,21	159,38	3,20	
CPA_C10-12	Produtos alimentares, bebidas e produtos da indústria do tabaco	Alimentos, bebidas e tabaco	Materiais e produtos	2,96	111,91	7,58	23,22	145,67	2,92	
CPA_F	Construções e trabalhos de construção	Construção	Construção e bens imobiliários	27,46	77,87	5,00	19,34	129,67	2,60	
CPA_H50	Serviços de transporte por água	Marítimos	Transportes	13,02	2,43	98,98	1,31	115,74	2,32	
CPA_E37-39	Serviços de saneamento básico; Serviços de resíduos	Outros utilitários	Utilitários	60,00	45,07	1,75	1,84	108,65	2,18	
CPA_G46	Venda por grosso, excepto de veículos automóveis e motocicletas	Serviços comerciais	Outros serviços	73,06	9,95	9,44	6,60	99,05	1,99	
CPA_H51	Serviços de transporte aéreo	Aéreos	Transportes	50,43	17,25	11,46	6,27	85,41	1,71	
CPA_C17	Papel e cartão e seus artigos	Madeira e papel	Materiais e produtos	24,48	28,79	2,72	6,23	62,22	1,25	
CPA_G47	Venda a retalho, excepto de veículos automóveis e motocicletas	Serviços comerciais	Outros serviços	35,99	5,05	1,63	1,72	44,40	0,89	
CPA_P85	Serviços de educação	Educação e serviços culturais	Outros serviços	21,78	17,71	0,42	0,58	40,49	0,81	
CPA_A03	Produtos da pesca e da aquicultura e serviços relacionados	Produtos da agricultura, silvicultura	Materiais e produtos	35,81	1,85	0,86	0,63	39,15	0,79	
CPA_C13-15	Produtos têxteis; Artigos de vestuário; Couro e produtos afins	Vestuário e mobiliário	Materiais e produtos	17,43	15,54	0,91	1,10	34,98	0,70	
CPA_R90-92	Serviços culturais; Serviços de lotarias e outros jogos de aposta	Educação e serviços culturais	Outros serviços	21,19	0,09	0,06	0,03	21,37	0,43	
CPA_I	Serviços de alojamento, restauração e similares	Alojamento e serviços alimentares	Outros serviços	13,30	4,01	0,21	0,46	17,98	0,36	
CPA_H52	Serviços de armazenagem e auxiliares dos transportes	Serviços auxiliares	Transportes	3,47	3,99	5,61	3,92	16,98	0,34	
CPA_C25	Produtos metálicos transformados, excepto máquinas e equipamento	Metais e minerais	Materiais e produtos	4,42	8,51	0,35	2,68	15,96	0,32	
CPA_C28	Máquinas e equipamentos, n.e.	Equipamento	Materiais e produtos	8,79	3,56	1,33	1,35	15,03	0,30	
CPA_Q87-88	Serviços de apoio social com alojamento	Serviços sociais e de saúde	Outros serviços	1,43	2,04	4,20	7,36	15,02	0,30	
CPA_G45	Vendas por grosso e a retalho e de reparação de veículos automóveis	Serviços comerciais	Outros serviços	13,58	0,29	0,15	0,11	14,13	0,28	
CPA_O84	Serviços da administração pública, defesa e segurança social obrigatória	Administração pública	Outros serviços	4,95	4,86	0,87	1,79	12,48	0,25	
CPA_N78	Serviços de emprego	Outros serviços	Outros serviços	7,07	2,54	1,42	0,93	11,96	0,24	
CPA_C22	Artigos de borracha e de matérias plásticas	Combustível fóssil e produtos químicos	Materiais e produtos	1,95	3,04	2,47	2,59	10,04	0,20	
CPA_C16	Madeira e cortiça e suas obras, excepto mobiliário; espartaria e cestaria	Madeira e papel	Materiais e produtos	1,14	5,19	0,67	2,91	9,90	0,20	
CPA_Q86	Serviços de saúde humana	Serviços sociais e de saúde	Outros serviços	5,37	1,81	0,39	0,30	7,88	0,16	
CPA_M71	Serviços de arquitectura e de engenharia; serviços de ensaios e análises técnicas	Outros serviços	Outros serviços	3,36	2,11	0,89	0,83	7,20	0,14	
CPA_C29	Veículos automóveis, reboques e semi-reboques	Equipamento	Materiais e produtos	0,13	4,58	0,04	2,43	7,19	0,14	
CPA_C21	Produtos farmacêuticos e preparações farmacêuticas de base	Combustível fóssil e produtos químicos	Materiais e produtos	1,10	2,25	1,13	1,13	5,62	0,11	
CPA_H53	Serviços postais e de courier	Outros serviços	Outros serviços	2,19	1,52	0,86	0,83	5,41	0,11	
CPA_A02	Produtos da silvicultura, da exploração florestal e serviços relacionados	Produtos da agricultura, silvicultura	Materiais e produtos	0,83	3,27	0,25	0,44	4,79	0,10	
CPA_S94	Serviços prestados por organizações associativas	Administração pública	Outros serviços	1,65	1,93	0,23	0,69	4,50	0,09	
CPA_K64	Serviços financeiros, excepto seguros e fundos de pensões	Serviços financeiros	Outros serviços	3,74	0,32	0,14	0,10	4,30	0,09	
CPA_C31-32	Mobiliário e produtos diversos das indústrias transformadoras	Vestuário e mobiliário	Materiais e produtos	2,27	0,86	0,63	0,37	4,13	0,08	
CPA_E36	Água captada e tratada (incluindo serviços de distribuição de água)	Outros utilitários	Utilitários	3,44	0,28	0,20	0,10	4,03	0,08	
CPA_M72	Serviços de investigação e desenvolvimento científicos	I&D	Outros serviços	1,44	1,54	0,22	0,41	3,62	0,07	
CPA_C18	Trabalhos de impressão e gravação	Madeira e papel	Materiais e produtos	1,39	0,81	0,84	0,54	3,57	0,07	
CPA_N80-82	Serviços de segurança; Serviços para edifícios, jardins e de apoio a empresas	Outros serviços	Outros serviços	0,10	1,71	0,15	1,41	3,37	0,07	
CPA_S95	Serviços de reparação de computadores e de bens pessoais e domésticos	Outros serviços	Outros serviços	0,62	0,58	1,23	0,64	3,06	0,06	
CPA_C27	Equipamento eléctrico	Equipamento	Materiais e produtos	1,17	1,00	0,27	0,41	2,85	0,06	
CPA_C33	Serviços de reparação e instalação de máquinas e equipamento	Equipamento	Materiais e produtos	1,54	0,75	0,17	0,30	2,75	0,06	
CPA_T	Serviços das famílias para uso próprio	Outros serviços	Outros serviços	2,04	0,44	0,01	0,12	2,61	0,05	
CPA_C26	Produtos informáticos, electrónicos e ópticos	Equipamento	Materiais e produtos	0,08	1,08	0,04	1,36	2,56	0,05	
CPA_J62-63	Informática e serviços relacionados; Serviços de informação	TIC	Outros serviços	1,44	0,42	0,28	0,16	2,29	0,05	
CPA_J61	Serviços de telecomunicações	TIC	Outros serviços	1,42	0,33	0,11	0,11	1,96	0,04	
CPA_L68	Serviços imobiliários	Imobiliário	Construção e bens imobiliários	1,67	0,13	0,09	0,04	1,93	0,04	
CPA_N93	Serviços desportivos, de diversão e recreativos	Educação e serviços culturais	Outros serviços	0,86	0,63	0,16	0,22	1,87	0,04	
CPA_N77	Serviços de aluguer	Serviços financeiros	Outros serviços	0,06	0,66	0,03	1,11	1,86	0,04	
CPA_M74-75	Outros serviços de consultoria, científicos, técnicos e veterinários	Outros serviços	Outros serviços	1,41	0,09	0,15	0,06	1,71	0,03	
CPA_K65	Serviços de seguros e fundos pensões, excepto da segurança social obrigatória	Serviços financeiros	Outros serviços	1,27	0,19	0,08	0,06	1,60	0,03	
CPA_N79	Serviços de agências viagens, operadores turísticos e outros serviços de reservas	Outros serviços	Outros serviços	0,52	0,69	0,08	0,21	1,51	0,03	
CPA_J59-60	Serviços de filmes, televisão, gravação de som e música e de radiodifusão	TIC	Outros serviços	0,31	0,75	0,06	0,33	1,46	0,03	
CPA_C30	Outro equipamento de transporte	Equipamento	Materiais e produtos	0,50	0,30	0,26	0,11	1,16	0,02	
CPA_K66	Serviços auxiliares de serviços financeiros e de seguros	Serviços financeiros	Outros serviços	0,11	0,12	0,72	0,11	1,07	0,02	
CPA_J58	Serviços de edição	TIC	Outros serviços	0,35	0,53	0,03	0,14	1,05	0,02	
CPA_S96	Outros serviços pessoais	Outros serviços	Outros serviços	0,42	0,15	0,26	0,14	0,97	0,02	
CPA_M73	Serviços de publicidade e estudos de mercado	Outros serviços	Outros serviços	0,58	0,18	0,04	0,09	0,89	0,02	
CPA_U	Serviços dos organismos internacionais e outras instituições extraterritoriais	Outros serviços	Outros serviços	0,00	0,01	0,00	0,00	0,01	0,00	
CPA_M69-70	Serviços jurídicos e contabilísticos, de sedes sociais e de consultoria de gestão	Outros serviços	Outros serviços	0,00	0,00	0,00	0,00	0,00	0,00	
Total CPA Products				1 290,88	1 775,62	443,82	714,59	4 224,91	84,79	
Direct emissions from households				758,02	0,00	0,00	0,00	758,02	15,21	
Total CPA products and direct household emissions				2 048,90	1 775,62	443,82	714,59	4 982,93	100,00	

 7. Data from Figure 9: Evolution of CO₂ emissions by product categories CPA, Portugal, 2010-2021

 (tons of CO₂ per person)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Materials & manufactured products	2,3800	2,0907	1,7047	1,6901	1,7979	1,7410	1,7456	1,7993	1,8890	1,8848	1,9662	1,9637
Utilities	1,8579	1,8959	1,8151	1,6397	1,6828	1,8838	1,8053	2,0965	1,9043	1,5278	1,1843	1,2063
Construction and real estate	0,1578	0,1438	0,1079	0,0871	0,0849	0,0985	0,0952	0,1025	0,1042	0,1061	0,1080	0,1180
Other services	0,4131	0,3601	0,3104	0,3051	0,3211	0,3209	0,3237	0,3314	0,3459	0,3466	0,3187	0,3191
Transport	0,8927	0,7657	0,6507	0,6301	0,6689	0,6548	0,6734	0,7121	0,7312	0,7321	0,4898	0,6177
Total	5,7015	5,2562	4,5889	4,3521	4,5555	4,6989	4,6432	5,0418	4,9746	4,5974	4,0669	4,2249

8. Data from Figure 10: CO₂ Emissions – CBA and FIGARO Models from a consumption perspective (Carbon Footprint), Portugal, 2021

(tons of CO₂ per person)

	CO ₂ emissions due to domestic demand (consumption perspective - CBA model)	CO ₂ emissions due to domestic demand (consumption perspective - FIGARO model)
Direct emissions from households	0,7580	0,7580
Emissions from production activities due to internal final demand	1,7347	1,7347
Emissions due to exports	-	-
Emissions avoided due to imports	1,9953	-
Emissions due to imports	-	2,4902
Total	4,4880	4,9829

9. Data from Figure 11: CO₂ Emissions – Evolution of CO₂ emissions - CBA and FIGARO models from a consumption perspective (Carbon Footprint), Portugal, 2010-2021

(toneladas de CO₂ por pessoa)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Emissões das atividades de consumo - Modelo CBA	5,8530	5,5795	5,1835	4,8299	4,9452	5,3713	5,0929	5,7462	5,5359	5,2857	4,4381	4,4955
Emissões das atividades de consumo - Modelo Figaro	6,6826	6,1452	5,4165	5,1641	5,3615	5,4950	5,4467	5,8466	5,7936	5,4574	4,8172	4,9829