

ENVIRONMENTAL- ECONOMIC ACCOUNTING

**Direct and indirect CO₂ emissions in Germany,
2000 – 2010**



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Introduction

Carbon dioxide (CO₂) emissions can be outlined both in terms of origin and consumption. As part of international reporting of greenhouse gases the CO₂ emissions are reported – in terms of origin – for a certain territory based on groups of emitters¹. When they are considered from a consumer's point of view the emissions are determined in connection with the consumption of goods and are assigned to the consumers. In doing so a fundamental distinction is made between domestic consumption and exports. The domestic consumption of goods (consumption, capital formation) causes emissions domestically and abroad. These emissions can be assigned to domestic consumers. The exports likewise cause emissions in Germany and abroad and are assigned to the rest of the world².

The calculations are based on an extended hybrid input-output model with a regionalisation of the import flows³.

1 Greenhouse inventories as part of Kyoto Reporting in accordance with the UN Climate Convention (UNFCCC).

2 See also: Mayer, H.: "Umweltökonomische Aspekte der Globalisierung" in: Wirtschaft und Statistik, No. 12/2007, p. 1261 – 1269.

3 A comprehensive description of the extended Input-Output model is available at DESTATIS:

www.destatis.de/ExtendedInputOutputModel.pdf

A short overview on the methods used is included in the paper "CO₂-content of German import and export goods 2000 – 2010" (Wiesbaden, February 2014) available in the Internet:

www.destatis.de/ImExResultsPDF

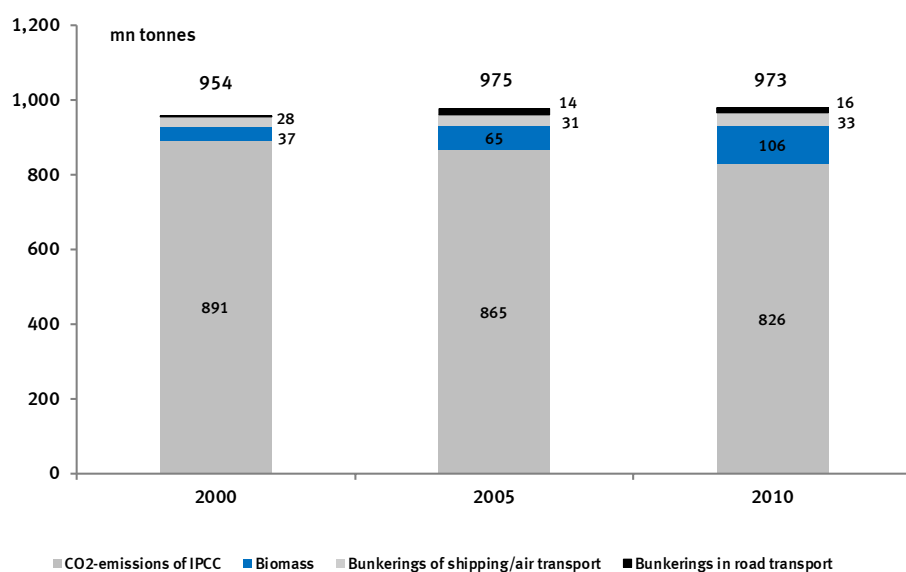
CO₂ emissions by different concepts

In 2010 CO₂ emissions in Germany – within the delimitation of the Environmental-Economic Accounting⁴ – amounted to 973 million tonnes. In 2000 the emissions were at 954 million tonnes. The reason for the slight rise in CO₂ emissions in Germany was an increased energy consumption of biomass with associated CO₂ emissions. Between 2000 and 2010 the emissions arising from the combustion of biomass more than tripled (2000: 37 million tonnes, 2010: 106 million tonnes).

The emissions within the delimitation of the Environmental-Economic Accounting include in addition to the emissions in the IPCC delimitation⁵ also emissions from international shipping and aviation – but only those of the resident units⁶. This delimitation also includes the CO₂ emissions arising from fuel purchases abroad in road traffic by German residents (private households and companies).

Excluding the emissions from biomass and those arising from fuel purchased abroad and excluding emissions from international shipping and aviation, domestic emissions – in line with the delimitation employed by the IPCC – have dropped by 7.3 % from 891 million tonnes (2000) to 826 million tonnes (2010) (Figure 1).

Figure 1 CO₂ emissions in Germany



4 Including emissions from biomass, from bunkering by residents in international shipping and aviation and from fuel purchased abroad by residents but excluding bunkering of non-residents on the territory.

5 IPCC: Intergovernmental Panel on Climate Change. Emissions excluding the position "Land use, land use change, forestry" (LULUCF).

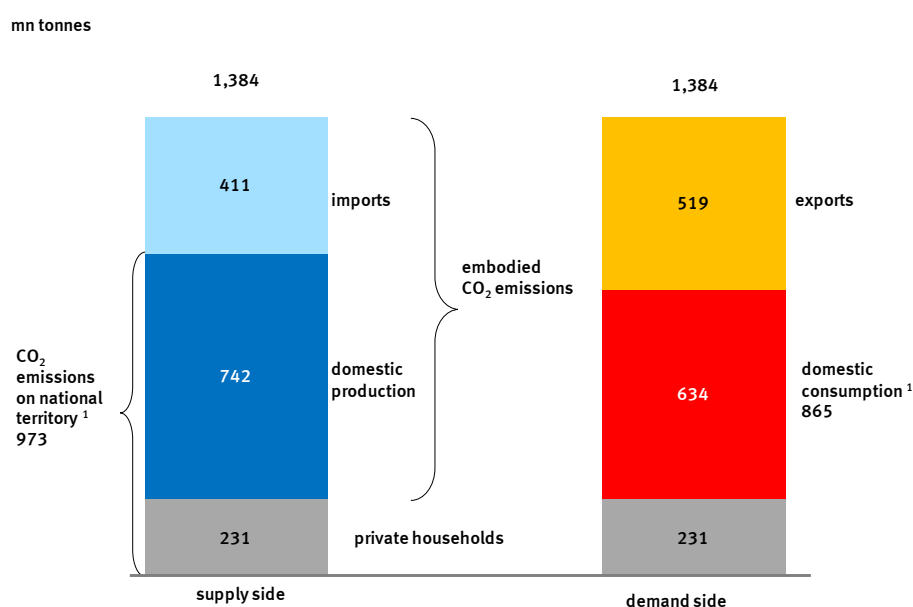
6 In international reporting of greenhouse gases all emissions from bunkering by international shipping and aviation in Germany are shown as "figures for information purposes". The level of these emissions is not included in the standardised final record.

CO₂ emissions by different concepts

Of the total domestic emissions of 973 million tonnes in 2010, 742 million tonnes are caused by domestic industries, 231 million tonnes by private households. In 2010 CO₂ emissions from the production of imports amounted to 411 million tonnes. That is more than half – 55.4 % – of the emissions of domestic origin. Indirect emissions by industries and direct emissions of private households add up to 1,384 million tonnes in 2010. This total is based on measuring and allocating emissions from a production point of view.

Based on the results of the model calculations CO₂ emissions can also be outlined from a consumption point of view (Figure 2). Here a distinction is made between the emissions to be assigned to domestic consumption and the emissions resulting from the production of exports.

Figure 2 Direct and indirect CO₂ emissions in Germany 2010



¹ Residents concept, incl. biomass and bunkering.

The emissions related to domestic consumption can be compared with domestic emissions derived from the production point of view. After deducting the CO₂ content of the exports (519 million tonnes) from total emissions these results in CO₂ emissions of 865 million tonnes for domestic consumption. This figure is 108 million tonnes below the CO₂ emissions arising on the territory. The reason for the lower CO₂ figure for domestic consumption is the higher emission content of exports compared with imports.

Supply of CO₂ emissions by demand areas

Between 2000 and 2010 direct CO₂ emissions from the combustion of fuels increased in Germany by 1.9 % from 954 million tonnes to 973 million tonnes. Thereof in 2010 were 231 million tonnes emitted by households – those were 23.7 % of total direct emissions in Germany – and 742 million tonnes by industries.

In addition to the direct emissions on the territory, the emissions generated abroad in the production of German import goods are to be considered when talking from a consumer's point of view. This (indirect) emissions have increased by 8.3 % from 379 million tonnes (2000) to 411 million tonnes (2010). The share of these emissions compared to the total supply increased from 28.4 % (2000) to 29.7 % (2010).

Table 1 Direct and indirect CO₂ emissions in Germany

	2000	2005	2010	2010 to 2000
	mn tonnes			%
Direct emissions on territory ¹	954	975	973	1.9
Private households.....	232	228	231	– 0.7
Industries	722	747	742	2.8
Imports	379	387	411	8.3
Domestic supply ²	1,333	1,362	1,383	3.7
Private households.....	232	228	231	– 0.7
Exports	412	488	519	25.9
Goods for domestic consumption	689	646	634	– 8.0
Consumer goods	424	413	416	– 1.9
Government purchases, capital formation	265	234	218	– 17.7
Total use	1,333	1,362	1,383	3.7
	in % of supply / use			percentage points
Direct emissions on territory	71.6	71.6	70.3	– 1.2
Private households.....	17.4	16.7	16.7	– 0.8
Industries	54.1	54.9	53.6	– 0.5
Imports.....	28.4	28.4	29.7	1.2
Total supply/use	100	100	100	
Private households.....	17.4	16.7	16.7	– 0.8
Exports	30.9	35.8	37.5	6.6
Goods for domestic consumption	51.7	47.5	45.8	– 5.8
Consumer goods	31.8	30.3	30.1	– 1.7
Government purchases, capital formation	19.8	17.1	15.7	– 4.1

1 As defined in Environmental-Economic Accounting (residents concept, incl. emissions from the combustion of biomass).

2 Domestic supply = Direct emissions on territory + Imports.

At the consumption side export goods have the highest emissions and their share in total direct and indirect emissions have risen sharply – from 30.9 % (2000) to 37.5 % (2010). In 2000 consumer goods caused with 31.8 % still the highest emissions. These emissions decreased in the period 2000 to 2010 absolutely and proportionally. However, direct emissions of households and those of consumer goods together form the largest source of emissions with 46.8 % of all emissions (2010).

Direct CO₂ emissions of private households and CO₂ content of consumer goods

Direct CO₂ emissions of households arise through the combustion of fuels in road transport and in the area of “housing”. These direct emissions have decreased from 232 million tonnes (2000) to 231 million tonnes (2010). The emissions from the consumption of fuels for transportations have decreased by 6.3 %. Due to the temperature-related increases in consumption of fuels for heating, a slight increase in emissions resulted for the fuels in 2010⁷ compared to 2005.

Table 2 Direct CO₂ emissions of private households and CO₂ content of consumer goods

	2000	2005	2010	2010 to 2000
	mn tonnes			%
Direct emissions	232	228	231	– 0.7
Fuels (transport)	101	100	95	– 6.3
Fuels (housing)	131	127	136	3.6
CO₂ content of consumer goods	424	413	416	– 1.9
of which:				
Energy products.....	119	122	126	5.6
Goods.....	152	138	141	– 7.2
Services ¹	153	153	149	– 2.6
Total emissions	657	641	647	– 1.5
	share of total emissions in %			
Direct emissions	35.4	35.6	35.7	
CO₂ content of consumer goods	64.6	64.4	64.3	
Energy products.....	18.1	19.0	19.4	
Goods.....	23.2	21.5	21.8	
Services ¹	23.4	23.9	23.1	
	tonnes per capita			
Total emissions	7.991	7.771	7.913	– 1.0

1 Incl. trade and transport services.

Direct emissions accounted for 35.7 % (2010) of total emissions that can be attributed to households. Indirect emissions – 416 million tonnes in 2010 – are accumulated to more or less equal portions to the demand of energy, goods and services. The emissions of energy products arise mainly from the power plants, generating electricity for households. While there, the emission coefficients (CO₂ emissions per kWh produced) decreased by 6 % between 2000 and 2010. During the same period the consumption of electricity by households has increased by 8.6 %. Since 2000 the consumption of district heating increased also due to relatively “cold” temperatures in the reference year 2010 – very strong by 44 %. This has led to a corresponding increase in emissions of heating plants.

⁷ The year 2010 was a relatively cold year with an above average demand for heating energy. Between 2000 and 2010 temperature adjusted a decline by 15.8 % of the emissions can be reported. See tables of Environmental-Economic Accounting, Part 3 Energy, table 3.3.6.5 “Total CO₂ emissions of private households – direct and indirect”.
https://www.destatis.de/DE/Publikationen/Thematisch/UmweltoekonomischeGesamtrechnungen/Querschnitt/UmweltnutzungundWirtschaftTabelle5850007137006Teil_2.pdf?__blob=publicationFile

Direct CO₂ emissions of private households and CO₂ content ...

The emissions of the service sector also include emissions of the trade and transport industries, which provide services to households through the distribution of goods. The emissions of the service sector have fallen in total by 2.6% (Table 2). Emissions, however, have changed differently within the service sector. For example, the emissions from the transport industry, in particular because of the sharp rise in emissions from aviation, increased by 6.3% during this period.

Between 2000 and 2010 the purchases of private households in Germany have increased price-adjusted by 5.1% (Table 3). Purchases of imported consumer goods compared to the total purchases of households (domestically) have increased more (30.1 %) than the purchases of domestically produced goods (16.9 %). The percentage of total purchases has increased from 10.3 % to 11.4 %. Considering only the purchases of products, then the import share is much higher: in 2010, the import share of products (excluding energy) was 35.5 %, in 2000 the share was still at 31.8%.

Table 3 Purchases of private households

Year	domestic purchases ¹	purchases ²				
		domestic production and imports	imports		on the territory	
			total	including: goods ³	total	including: goods ³
	2000 = 100	EUR bn				
2000.....	100	1,024	106	92	919	198
2005.....	101.4	1,121	120	102	1,002	186
2010.....	105.1	1,212	138	117	1,074	213
change in %						
2010 to 2000....	5.1	18.3	30.1	27.0	16.9	7.7
2000.....		100	10.3	31.8	89.7	68.2
2005.....		100	10.7	35.5	89.3	64.5
2010.....		100	11.4	35.5	88.6	64.5

1 Purchases of private households in Germany, price-adjusted, chain-linked index.

2 At basic prices without net taxes, data from input-output tables.

3 Purchases of goods excluding energy.

In 2010 about 68 % of the emissions from consumer goods – 282 million tonnes – have been generated in Germany, 32 % or 134 million tonnes abroad (Table 4). The emissions abroad can be separated in roughly equal parts on emissions for intermediate goods and of finished consumer goods. The emissions of intermediate goods are a portion of total emissions of imported intermediate goods. This portion is linked to intermediate goods that are used domestically in the production of consumer goods.

Comparing the trend of emissions with the change of price-adjusted purchases shows that despite increased purchases emissions – both domestically and abroad – have fallen (in total by 1.9 %). This change is affected by several factors. On one side reduced emission coefficients in production domestically and abroad could have resulted in a decline. On the other hand, also changes in the composition of purchases by groups of goods and also by imports from changing countries of origin effect the change in emissions.

Table 4 CO₂ content of consumer goods

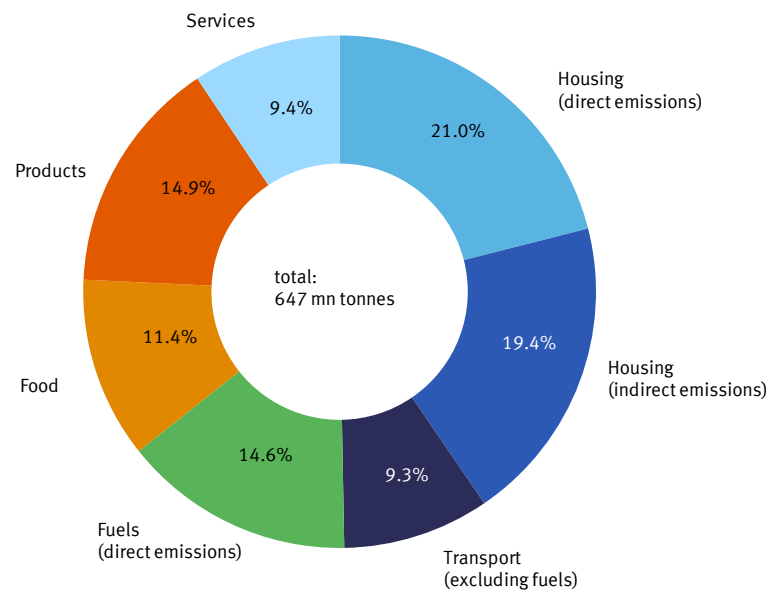
Year	CO ₂ content				
	total	on the territory	abroad	for the production of	
				intermediate consumption for domestic consumption	final goods
	mn tonnes				
2000.....	424	284	140	73	67
2005.....	413	278	134	68	67
2010.....	416	282	134	69	66
	change in %				
2010 to 2000....	– 1.9	– 0.8	– 4.2	– 5.6	– 2.6
	% of total				
2000.....	100	67.0	33.0	17.1	15.9
2005.....	100	67.4	32.6	16.4	16.1
2010.....	100	67.7	32.3	16.5	15.8

For example, purchases of services (price-adjusted) had an increase of 11.6 %, more than twice the increase of total purchases⁸. The purchases of everyday consumer goods, however, declined by 4.3 %. Since the production of goods usually requires a higher energy input and thus higher CO₂ emissions occur, a shift of purchases towards services can contribute to a reduction in total emissions. However, certain service activities, such as transport activities, also have high specific emissions. Also telecommunications services cause – when involving the backward linkages (here the generation of electricity) – high emissions.

Direct and indirect emissions can be grouped according to “areas of demand”. About 40 % of the emissions can be assigned to the area of “housing”; another 24 % are assigned to “transport”. These areas already account for more than two thirds of the total emissions. Another important area is “food” with a share of 11.4 %. The other emissions can be attributed with 14.9 % to miscellaneous products and 9.4 % to the remaining services.

⁸ See Volkswirtschaftliche Gesamtrechnungen (National Accounts), Fachserie 18 Reihe 1.4, 2012, Tabelle 3.3.4.

Figure 3 Direct CO₂ emissions of private households and CO₂ emissions of consumer goods by areas of demand 2010



CO₂ emissions of imported consumer goods by country of origin

In 2010 most imports of goods came from China (EUR 77.3 billion). This is followed by the Netherlands and France with imports of EUR 67 billion and EUR 60.1 billion. The three main reference countries are also responsible for the three most important countries for imported consumer goods. With purchases of EUR 12.9 billion China is also here in the first place of importing countries.

For CO₂ emissions of consumer goods the Netherlands with emissions of 14.2 million tonnes is the country with the highest emissions. This corresponds to a share of 10.6 % of total CO₂ emissions from imports of consumer goods (including imported intermediate goods). This is followed by China and France with shares of 8.3 % and 6.1 % respectively. For the Netherlands, the emissions of imported intermediate goods are the highest of all countries. The reason for this is that particular agricultural and chemical products are imported, which cause relatively high CO₂ emissions in their production. China and France, however, export much less intermediate goods with high CO₂ emissions to Germany. In Russia, high CO₂ emissions occur during the transport of natural gas and oil to Germany, which are used in Germany directly or as intermediate goods.

CO₂ emissions of imported consumer goods by country of origin

Table 5 Imports by country of origin and CO₂ emissions 2010

Country	Imports					
	products ¹			consumer goods ²		
	EUR mn	%	rank	EUR mn	%	rank
Total	795,091	100		126,609	100	
China	77,270	9.7	1	12,936	10.2	1
Netherlands	67,049	8.4	2	10,544	8.3	2
France	60,055	7.6	3	10,520	8.3	3
United States	45,241	5.7	4	7,950	6.3	5
Italy	41,977	5.3	5	9,291	7.3	4
United Kingdom...	37,923	4.8	6	6,425	5.1	8
Belgium	33,304	4.2	7	5,382	4.3	9
Austria	32,646	4.1	8	6,830	5.4	7
Russia	31,840	4.0	9	541	0.4	15
Poland	27,627	3.5	10	7,039	5.6	6
Japan	22,475	2.8	11	2,620	2.1	11
Spain	21,955	2.8	12	4,917	3.9	10
Norway	17,167	2.2	13	682	0.5	14
Sweden	12,776	1.6	14	1,784	1.4	13
Brazil	9,445	1.2	15	1,995	1.6	12
Sum	538,750	67.8		89,455	70.7	
Rest	256,341	32.2		37,154	29.3	

Country	CO ₂ emissions				
	total			of which:	
	mn tonnes	%	rank	final use	intermediate consumption
				mn tonnes	
Total	134.3	100		65.7	68.6
China	11.2	8.3	2	7.1	4.1
Netherlands	14.2	10.6	1	7.1	7.1
France	8.2	6.1	3	3.9	4.3
United States	7.6	5.6	4	3.7	3.8
Italy	6.9	5.1	6	3.6	3.3
United Kingdom...	6.7	5.0	7	3.2	3.5
Belgium	5.8	4.3	10	2.6	3.2
Austria	5.8	4.3	9	2.8	3.0
Russia	6.6	4.9	8	1.1	5.5
Poland	7.4	5.5	5	4.0	3.4
Japan	2.5	1.8	12	1.2	1.3
Spain	3.8	2.8	11	2.0	1.8
Norway	1.7	1.3	13	0.5	1.2
Sweden	1.6	1.2	15	0.6	1.0
Brazil	1.7	1.3	14	0.8	0.9
Sum	91.6	68.2		44.4	47.2
Rest	42.7	31.8		21.3	21.4

1 Source: Foreign Trade Statistics.

2 Products (excluding energy) and services – finished goods without intermediate consumption. Imports (cif) for private consumption including energy amounted in total to EUR 137.6 billion.

CO₂ emissions of exports

Between 2000 and 2010 CO₂ emissions of exports as a whole rose by 25.9 % from 412 million tonnes to 519 million tonnes. In 2010 domestic production with 326 million tonnes makes up somewhat more than half (63 %) of these emissions (Table 6). The remaining emissions – 192 million tonnes – are attributed to the production of imported raw materials and supplies used in the domestic production of exports. These emissions increased strongly both in absolute terms (+ 37 %) and pro rata. In 2000 these emissions accounted for 34.1 % of total emissions, in 2010 this share rose to 37.1 %.

In spite of the rise in the import portion, the domestic manufacture of exports is the most significant source for CO₂ emissions in Germany. In 2010 44 % of all CO₂ emissions from domestic industries arose in the production of exports. In 2000 the share was just under 38 %. In 2000 there were still slightly higher emissions for the domestic production of consumer goods than was the case for exports. In 2010 the share of CO₂ emissions dropped to 36 %.

Table 6 CO₂ emissions of exports

	2000	2005	2010	2010 to 2000
	mn tonnes			%
Exports	412.0	487.8	518.5	25.9
Domestic production	271.4	320.3	326.4	20.2
Imported intermediate consumption	140.6	167.5	192.2	36.7
Imports.....	379.3	387.1	410.6	8.3
Exports – Imports	32.7	100.7	107.9	
Domestic production	721.6	747.2	741.9	2.8
	in % of domestic production			percentage points
Exports form domestic production.....	37.6	42.9	44.0	6.4

The substantial rise in domestic and foreign CO₂ emissions for exports can be explained by a large rise of exports between 2000 and 2010 (see Table 7). Exports (excluding re-exports) rose nominally by 63.1 % between 2000 and 2010. Price-adjusted exports came to 71.9 %. The five most significant export goods in current prices increased by 28 % to 88 %.

In addition to this increase the domestic industries have increased the amount of imported materials and supplies as a proportion of total intermediate consumption from 18.6 % to 19.8 % within this period. This is probably a main reason for the high increase in the embodied emissions of imported materials and supplies. Within the industries the car manufacturing industry showed a significant rise in the import share of intermediate consumption – from 21.9 % (2000) to 24.5 % (2010).

CO₂ emissions of exports

Table 7 Exports and import shares for intermediate consumption

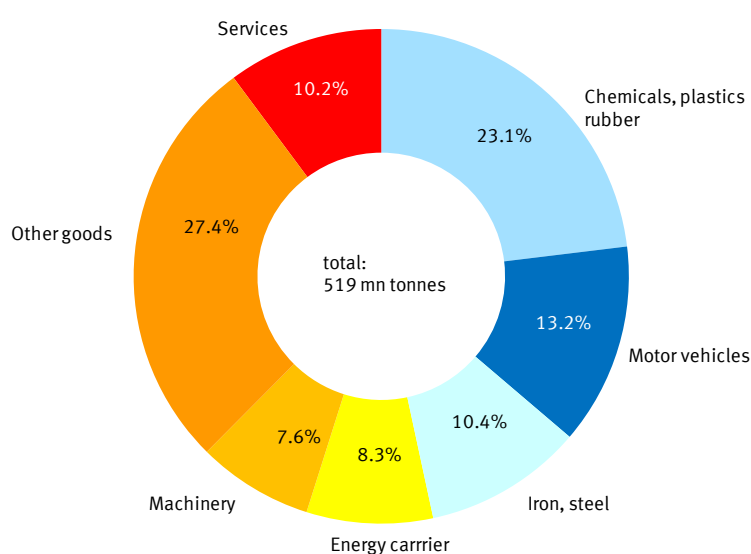
	2000	2005	2010	2010 to 2000
	EUR bn			%
Total exports (fob¹, territorial concept)	667.3	898.7	1,165.5	74.7
Re-exports	94.0	140.4	230.5	145.2
Exports excluding Re-exports	573.3	758.2	935.0	63.1
including:				
Motor vehicles	107.9	145.6	162.7	50.7
Machinery	92.6	126.6	147.0	58.8
Chemicals	58.6	73.0	94.6	61.5
Electrical and office machinery	67.0	83.6	85.6	27.9
Metals	29.4	40.9	55.2	87.7
	%			percentage points
Imported intermediate goods of total intermediate consumption	18.6	19.7	19.8	1.3
Including (industries):				
Manufacture of motor vehicles	21.9	24.3	24.5	2.5
Manufacture of machinery	25.1	25.2	27.1	2.0
Manufacture of chemicals	24.5	22.1	24.5	– 0.1

1 fob: free on board.

Source: Federal Statistical Office, Input-Output Accounts.

In the case of exports most emissions arise in the production of chemical and plastic products (23.1 %) and of motor vehicles (13.2 %). The export of steel and steel products with a share of 10.4 % also causes high emissions.

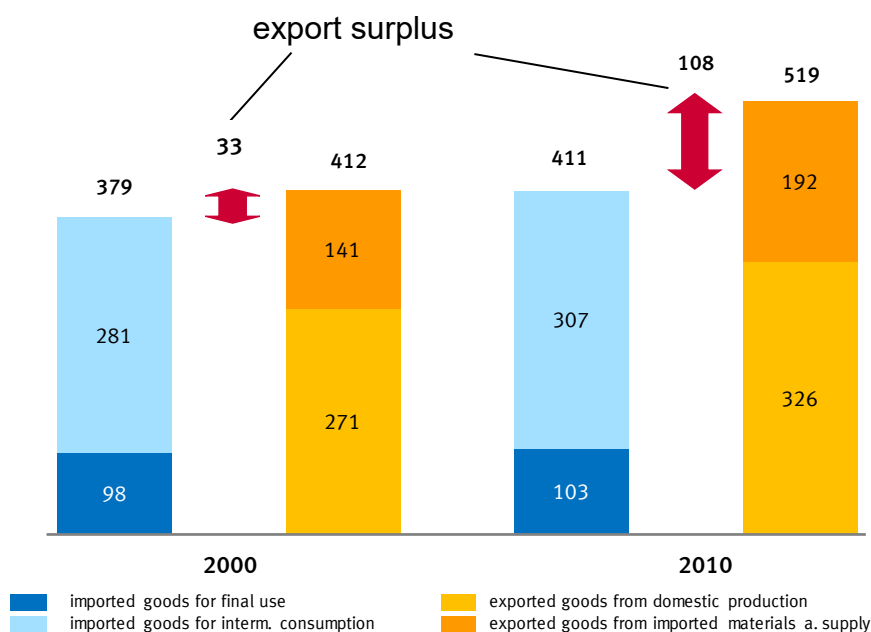
Figure 4 CO₂ emissions of exports in terms of goods 2010



CO₂ emissions of imports and foreign trade balance

Total CO₂ emissions of imports rose by 8.3 % from 379 million tonnes in 2000 to 411 million tonnes in 2010 (Figure 5). Even more than the CO₂ emissions of imports, the CO₂ emissions of exports have increased – from 412 million tonnes to 519 million tonnes. This resulted in a CO₂-surplus of imports over exports of 108 million tonnes in 2010 compared to a surplus of 33 million tonnes in 2000.

Figure 5 CO₂ emissions at the production of imports and exports to and from Germany



By far the largest portion of CO₂ emissions for imports – 307 million tonnes (2010) or just under 75 % of the total emissions of imports – applies to materials and supplies. The production of finished goods (consumer goods and capital goods) accounted for 103 million tonnes of CO₂.

For imports too CO₂ emissions related to (German) exports were the most important driver. In 2010 192 million tonnes of CO₂ arose during the production of materials and supplies for German export production in the supplier countries. That is 47 % of all CO₂ emissions related to imports. The substantial increase in these emissions of 36 % can be explained by the dynamic growth of exports and the increase in the purchase of imported materials and supplies (see Table 2). In comparison, much lower CO₂ emissions arose during the production of imported consumer goods and imported materials and supplies for the manufacture of consumer goods in Germany in 2010: 134 million tonnes, i.e. 30 % of the entire CO₂ emissions of imports. These emissions have even dropped slightly since 2000.

CO₂ emissions of imports by country of origin

By far the highest emissions resulting from German imports in 2010 occurred in the Netherlands: 38.3 million tonnes of CO₂, followed by China (34.4 million tonnes) and France (27.4 million tonnes).

The high CO₂ content of imports from the Netherlands can be explained by the comparatively high emission coefficients for the most important imports: The Netherlands has the highest shares of imports in the case of imported agricultural products, food products and basic chemicals. In the industries producing these products it has the highest direct emission coefficients of the European countries. In the case of electricity generation – this is the industry that accounts for by far the most emissions – also the Netherlands has comparatively high emission coefficients in comparison with other European countries. Although France, the country with the highest proportion of imported goods for 2010, is top of the league as far as energy content is concerned, it has lower CO₂ emissions than the Netherlands because of its largely CO₂-free electricity generation. China is first in imports of goods, at the CO₂ emissions the second. This is mainly due to the energy- and CO₂-intensive production of goods by the use of coal in the production of electricity.

Table 8 CO₂ emissions of imports 2010 by country of origin

	CO ₂ emissions			of which:		total imports		
	total			final use	intermediate consumption	products		
	mn tonnes	%	rank	mn tonnes		EUR mn	%	rank
Total.....	410.6	100		103.2	307.5	795,091	100	
China.....	34.4	8.4	2	14.8	19.6	77,270	9.7	1
Netherlands.....	38.3	9.3	1	9.0	29.3	67,049	8.4	2
France.....	27.4	6.7	3	6.8	20.6	60,055	7.6	3
United States	25.2	6.1	4	8.1	17.1	45,241	5.7	4
Italy.....	21.4	5.2	7	5.7	15.7	41,977	5.3	5
United Kingdom.....	21.3	5.2	8	5.4	15.9	37,923	4.8	6
Belgium.....	19.9	4.8	10	3.5	16.4	33,304	4.2	7
Austria.....	20.0	4.9	9	4.6	15.4	32,646	4.1	8
Russia.....	22.9	5.6	5	2.1	20.9	31,840	4.0	9
Poland.....	22.4	5.4	6	6.2	16.2	27,627	3.5	10
Japan.....	9.8	2.4	12	3.3	6.5	22,475	2.8	11
Spain.....	10.1	2.5	11	3.1	7.0	21,955	2.8	12
Norway.....	5.3	1.3	14	1.4	3.9	17,167	2.2	13
Sweden.....	5.9	1.4	13	1.2	4.7	12,776	1.6	14
Brazil.....	4.0	1.0	15	1.0	3.1	9,445	1.2	15
Sum.....	288.3	70.2		76.1	212.1	538,750	67.8	
Rest.....	122.4	29.8		27.0	95.3	256,341	32.2	

Source: Foreign Trade Statistics