

ENVIRONMENTAL- ECONOMIC ACCOUNTING

**Direct and indirect CO₂ emissions in Germany,
2005 – 2012**



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Abbreviations

bn	=	billion
EEA	=	Environmental-Economic Accounting
EUR	=	Euro
IPPC	=	Intergovernmental Panel on Climate Change
LULUCF	=	Land use, land use change, forestry
mn	=	million
UNFCCC	=	United Nations Framework Convention on Climate Change
%	=	percentage
% points	=	percentage points

Explanation of symbols

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Introduction

Carbon dioxide (CO₂) emissions can be outlined both in terms of origin and of consumption. As part of international reporting of greenhouse gases CO₂ emissions are reported – in terms of origin – for a certain territory based on emission sources¹. 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 various consumption categories. A distinction is drawn between consumption of private households, public consumption, gross fixed capital formation and exports. In doing so a fundamental distinction is made between domestic consumption and exports. The domestic consumption of goods 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, pp. 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

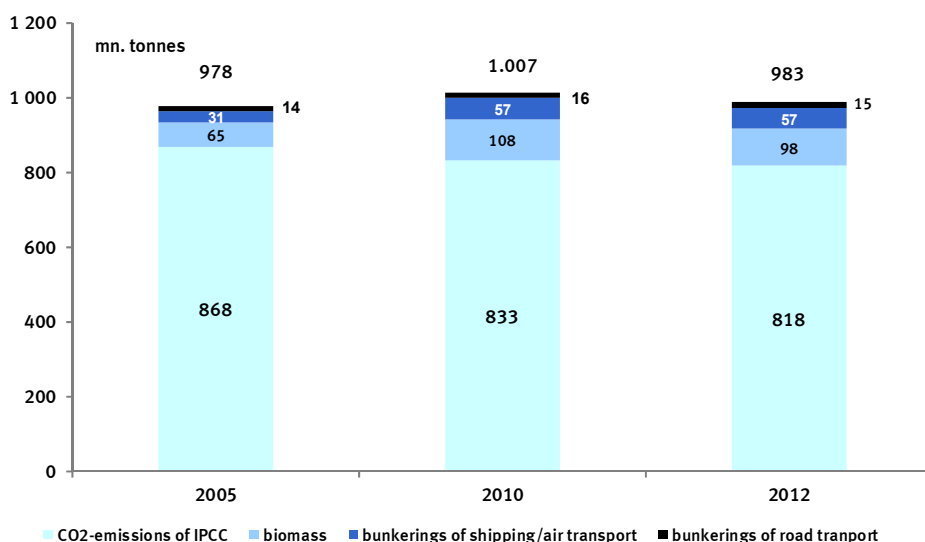
CO₂ emissions by different concepts

In 2012 CO₂ emissions in Germany – within the delimitation of the Environmental-Economic Accounting⁴ – amounted to 983 million tonnes. In 2005 the emissions were at 978 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 2005 and 2012 the emissions from the combustion of biomass increased substantially (2005: 65 million tonnes, 2012: 98 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 residential units⁶. This delimitation also includes CO₂ emissions arising from fuel purchases abroad in road traffic and sea transport by German residents (private households and companies).

CO₂ emissions according to the IPCC concept – have dropped by 5.7 % from 868 million tonnes (2005) to 818 million tonnes (2012) (see figure 1).

Figure 1 CO₂ emissions in Germany¹



¹ 2012 and 2010: data status IPCC 2015, 2005: 2013.

In 2012 domestic emissions have totalled 983 million tonnes. 768 million tonnes were caused by domestic industries, 214 million tonnes by private households. In 2012 CO₂ emissions at the production of imports amounted to 451 million tonnes. That is more than half – 58.7 % – of the emissions of domestic origin. Indirect emissions by industries and direct emissions of private households add up to 1,434 million tonnes in 2012. This total is based on measuring and allocating emissions from a production point of view.

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.

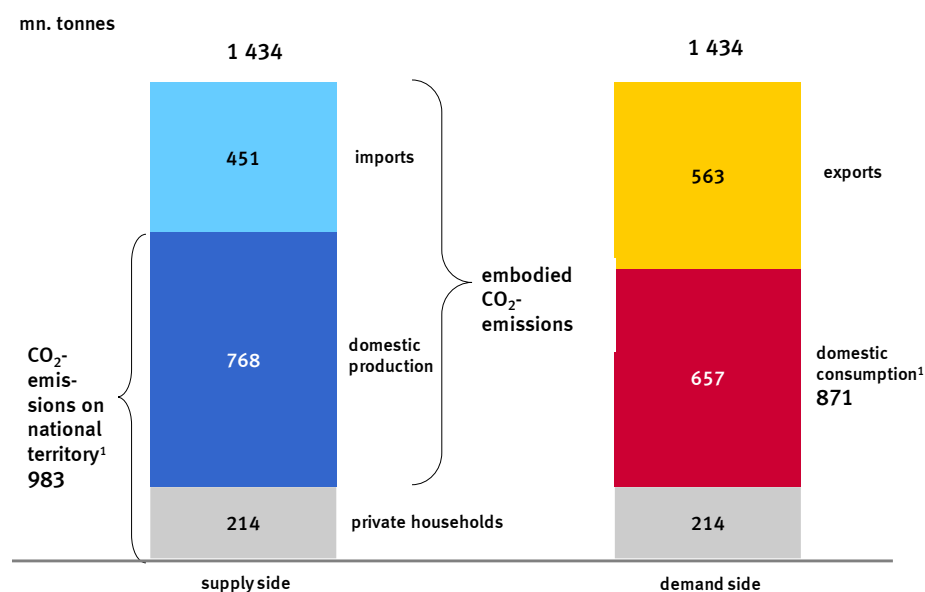
⁵ IPCC: Intergovernmental Panel on Climate Change. Emissions excluding the position “Land use, land use change, forestry” (LULUCF).

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

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

Figure 2 Direct and indirect CO₂ emissions in Germany 2012



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 exports (563 million tonnes) from total emissions these results in CO₂ emissions of 871 million tonnes for domestic consumption. This figure is 111 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.

Carbon dioxide emissions and other greenhouse gases

In terms of greenhouse gases in addition to CO₂ emissions, the methane (CH₄) – and nitrous oxide (N₂O) emissions are of great importance. By calculating the direct and indirect emissions of these gases, we get the cumulative emissions of the three most important greenhouse gases. In 2012 these amounted to 1 639 million tonnes of CO₂ equivalents. The CO₂ emissions had a share of 87.5 %, CH₄ emissions of 8.0 % and the N₂O emissions of 4.6 % (see table 1). For emissions emitted on the territory the share of CO₂ of total greenhouse gases (91.0 %) was higher than for the imports (80.6 %). In terms of imports, CH₄ emissions account for 12.7 %, the N₂O emissions of 6.7 %. Emission sources of CH₄ emissions are mainly the coal industry, the oil and gas extraction (especially pipeline transport), landfill gases in waste disposal and livestock in agriculture. For N₂O, specific processes in the chemical industry, in the generation of energy, during the combustion of fuels for transport and in fertilization in agriculture play a role.

CO₂ emissions by different concepts

Table 1 Direct and indirect greenhouse gas emissions 2012

Greenhouse gas	Total	Of which emissions	
		on the territory	abroad ¹
	mn t CO ₂ equivalent		
Total			
Carbon dioxide	1,434	983	451
Methane	130	59	71
Nitrous oxide	75	37	37
Total	1,639	1,080	559
share of total %			
Carbon dioxide	100	68.6	31.4
Methane	100	45.4	54.6
Nitrous oxide	100	50.0	50.0
Sum	100	65.9	34.1
share of sum %			
Carbon dioxide	87.5	91.0	80.6
Methane	8.0	5.5	12.7
Nitrous oxide	4.6	3.5	6.7
Sum	100	100	100

1 At the production of imported consumer goods and inputs for intermediate production of consumer goods.

Supply and use of CO₂ emissions

From 2005 to 2012 direct CO₂ emissions from the combustion of fuels increased in Germany by 0.5 % from 978 million tonnes to 983 million tonnes. In 2012 thereof 214 million tonnes were emitted by households – this was 21.8 % of total direct emissions in Germany – and 768 million tonnes by industries.

In addition to the direct emissions on the territory, emissions generated abroad at the production of German imports are to be considered when talking from a consumer's point of view. These (indirect) emissions have increased by 16.6 % from 387 million tonnes (2005) to 451 million tonnes (2012). The share of these emissions of total supply increased from 28.4 % (2005) to 31.5 % (2012).

Table 2 Direct and indirect CO₂ emissions in Germany

	2005	2010	2012	2012/2005
	mn t			%
Direct emissions on territory ¹	978	1,007	983	0.5
Private households	231	234	214	– 7.1
Industries	747	773	768	2.8
Imports	387	439	451	16.6
Domestic supply	1,365	1,446	1,434	5.1
Private households.....	231	234	214	– 7.1
Exports	488	529	563	15.4
Goods for domestic consumption	646	683	657	1.6
Consumer goods	413	439	438	6.1
Government purchases, capital formation	234	244	219	– 6.4
Total use	1,365	1,446	1,434	5.1
	in % of supply/use			% points
Direct emissions on territory	71.6	69.6	68.5	– 3.1
Private households	16.9	16.2	15.0	– 2.0
Industries	54.7	53.5	53.6	– 1.2
Imports	28.4	30.4	31.5	3.1
Total supply/use	100	100	100	X
Private households.....	16.9	16.2	15.0	– 2.0
Exports	35.7	36.6	39.3	3.5
Goods for domestic consumption	47.4	47.2	45.8	– 1.6
Consumer goods	30.3	30.4	30.6	0.3
Government purchases, capital formation	17.1	16.9	15.2	– 1.9

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

At the use side exports have the highest emissions and its share in total emissions has risen sharply – from 35.7 % (2005) to 39.3 % (2012). In 2012 the share of consumer goods was 30.6 %. However, direct emissions of households and those of consumer goods together still form the largest source of emissions with 45.6 % of all emissions (2012).

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 231 million tonnes (2005) to 214 million tonnes (2012). The emissions from the consumption of fuels for transportations have decreased by 3.9 %. Due to the temperature-affected decreases in consumption of fuels for heating, a decrease in emissions resulted for the fuels in 2012⁷ compared to 2005.

Table 3 Direct CO₂ emissions of private households and CO₂ content of consumer goods

	2005	2010	2012	2012/2005
	mn t			%
Direct emissions	231	234	214	- 7.1
Fuels (transport)	102	99	99	- 3.9
Fuels (housing)	128	135	116	- 9.6
CO₂ content of consumer goods	413	439	438	6.1
of which :				
Energy products	119	122	132	10.7
Goods	152	138	159	4.6
Services ¹	153	153	152	- 1.2
Total emissions	644	673	653	1.4
share of total emissions in %				
Direct emissions	35.8	34.8	32.9	X
CO₂ content of consumer goods	64.2	65.2	67.1	X
Energy products	18.5	18.1	20.2	X
Goods	23.6	20.5	24.4	X
Services ¹	23.8	22.8	23.2	X
tonnes per capita				
Total emissions	7.91	8.38	8.12	2.5

1 Incl. trade and transport services.

In 2012 direct emissions accounted for 32.9 % of total direct and indirect emissions of households. Indirect emissions – 438 million tonnes in 2012 – are accumulated to more or less equal portions to the use of energy, products and services. The emissions of energy products arise mainly at the power plants generating electricity for households. Although the emission coefficients – CO₂ emissions per kWh produced – remained almost constant between 2005 and 2012, electricity consumption of households decreased by 6.3 % during that period. Nevertheless, between 2005 and 2012 the consumption of district heating increased very strong by 13.0 %. This has led to a corresponding increase in emissions of heating plants

⁷ The year 2012 was a relatively warm year regarding the demand for heating energy. Between 2005 and 2012 temperature adjusted a decline by 5.5 % 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 at the distribution of goods. The emissions of the service sector have fallen in total by 1.2 %. 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 21.4 % during this period.

Between 2005 and 2012 price-adjusted purchases of private households in Germany have increased by 5.2 % (see table 4). Purchases of imported consumer goods increased from 120 bn. EUR to 132 bn. EUR (+ 10.0 %). Their share in total purchases accounts for about 10.2 % (2012). Considering only the purchases of products, then the import share is much higher: in 2012 the import share of products (excluding energy) was 30.7 %.

Table 4 Purchases of private households

Year	Domestic pur- chases ¹	Purchases ²					CO ₂ total
		domestic production and imports	imports		on the territory		
			total	including: products ³	total	including: products	
	2000 = 100	EUR bn					mn t
2005	101,9	1,121	120	102	1,002	186	413
2010	105,0	1,220	115	94	1,105	213	439
2011	106,4	1,269	128	104	1,142	237	443
2012	107,2	1,288	132	105	1,156	237	439
change in %							
2012/2005	5.2	14.8	10.0	2.7	15.4	27.5	6.2
in % of total				in % of goods	in % of total	in % of goods	
2005	X	100	10.7	35.5	89.3	64.5	X
2010	X	100	9.4	30.5	90.6	69.5	X
2011	X	100	10.1	30.4	89.9	69.6	X
2012	X	100	10.2	30.7	89.8	89.8	X

1 Domestic purchases of private households, price-adjusted, chain-linked index.

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

3 Purchases of goods excluding energy.

In 2012 about 65 % of the emissions from consumer goods – 285 million tonnes – have been generated in Germany, 35 % or 153 million tonnes abroad (see table 5). 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 at the production of consumer goods.

Comparing the trend of emissions with the change of price-adjusted purchases shows that emissions – both domestically and abroad – have increased. The trends can be influenced either by changes in the composition of purchases by commodity or – when looking at the imports by origin – by changes in the supplying countries.

Table 5 CO₂ content of consumer goods

Year	CO ₂ content				
	total	on the territory	abroad	at the production of	
				intermediate consumption for domestic consumption	final goods
	mn tonnes				
2005	413	278	134	67	68
2010	439	292	147	80	68
2011	443	287	156	86	70
2012	438	285	153	84	69
	change in %				
2012/2005	6.1	2.5	13.6	25.5	2.1
	in % of total				
2005	100	67.4	32.6	16.1	16.4
2010	100	66.5	33.5	18.1	15.4
2011	100	64.9	35.1	19.4	15.7
2012	100	65.1	34.9	19.1	15.8

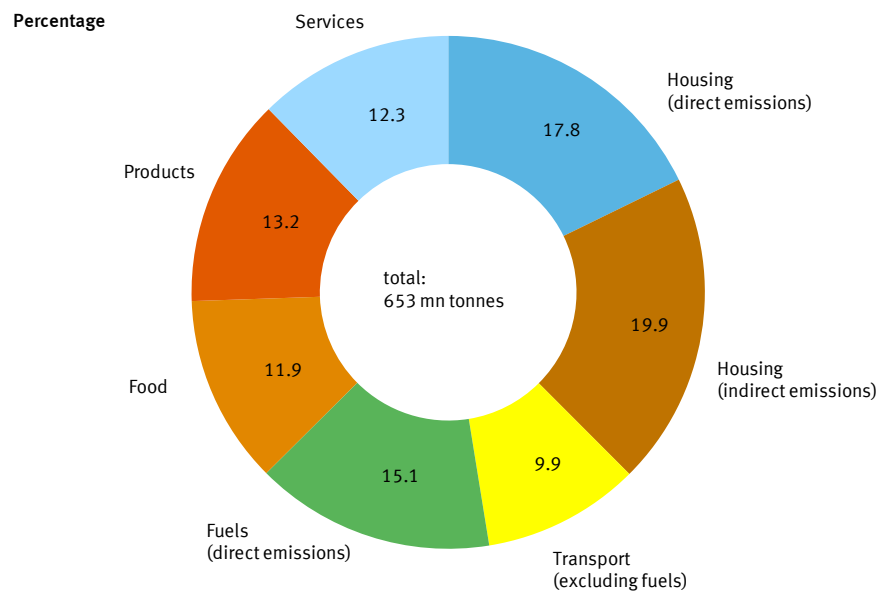
For example, price-adjusted purchases of services showed an increase of 7.2 %, much more than the increase of total purchases⁸. The purchases of everyday consumer goods, however, declined by 5.7 %. Since the production of goods usually requires a higher energy input and thus higher CO₂ emissions than average, a shift of purchases towards services contributes to a reduction in total emissions. However, certain service activities, such as transport activities, also have relatively high specific emissions. Also telecommunications services cause – when involving backward linkages – high emissions.

Direct and indirect emissions can be grouped according to “areas of demand”⁹. About 38 % of the emissions can be assigned to the area of “housing”, another 25 % are assigned to “transport”. These areas already account for more than two thirds of total emissions. Another important area is “food” with a share of 11.9 %. The remaining emissions can be attributed with 13.2 % to miscellaneous products and 12.3 % to the services.

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

⁹ Figures according to this grouping show emissions of trade industries at the corresponding product items.

Figure 3 Direct CO₂ emissions of private households and CO₂ emissions of consumer goods by areas of demand 2012



CO₂ emissions of imports by country of origin

In 2012 by far the highest emissions resulting from German imports occurred in China: 37.6 million tonnes, followed by the Netherlands (33.9 million tonnes) and Russia (26.4 million tonnes).

China is second in imports of commodities, but first at CO₂ emissions. This is mainly due to the energy- and CO₂-intensive production of commodities by using a high amount of coal at the generation of electricity. The high CO₂ content of imports from the Netherlands can be explained by the relatively high emission coefficients for the most important import commodities: The Netherlands has the highest shares of imports in the case of agricultural products, food products and basic chemicals. The industries producing these products have relatively high emission coefficients compared to other European countries. In the case of electricity generation – this is the industry that accounts for by far the most emissions – the Netherlands also has relatively high emission coefficients.

Tab 6 CO₂ emissions of imports 2012 by country of origin

Country	Co ₂ emissions					Total imports		
	total			of which:		products ¹		
	mn t	%	rank	final use	intermediate consumption	EUR mn	%	rank
				mn t				
Total	451.4	100		106.3	345.1	905,925	100	
Netherlands ...	33.9	7.5	2	7.9	26.0	85,738	9.5	1
China	37.6	8.3	1	13.7	23.9	78,529	8.7	2
France	25.2	5.6	4	5.8	19.4	64,039	7.1	3
United States ..	21.6	4.8	6	6.1	15.6	51,070	5.6	4
Italy	20.6	4.6	7	4.7	15.9	47,957	5.3	5
United Kingdom	19.1	4.2	9	4.4	14.7	42,820	4.7	6
Russia	26.4	5.8	3	4.7	21.6	42,765	4.7	7
Switzerland ...	8.5	1.9	13	2.0	6.5	37,775	4.2	8
Belgium	17.0	3.8	11	2.4	14.6	37,763	4.2	9
Austria	17.7	3.9	10	3.5	14.2	36,419	4.0	10
Poland	23.6	5.2	5	5.5	18.1	33,027	3.6	11
Czech Republic	20.3	4.5	8	5.1	15.2	32,493	3.6	12
Norway	4.6	1.0	17	0.7	3.9	26,324	2.9	13
Spain	8.3	1.8	14	2.0	6.3	23,207	2.6	14
Japan	8.9	2.0	12	2.6	6.4	21,910	2.4	15
Sweden	5.1	1.1	15	0.8	4.3	13,774	1.5	16
Brazil	4.9	1.1	16	0.9	4.0	10,615	1.2	17
Sum	303.3	67.2		72.8	230.6	686,226	75.7	
Rest	148.0	32.8		33.5	114.5	219,699	24.3	

1 Source: Foreign Trade Statistics.

CO₂ emissions of exports

Between 2005 and 2012 CO₂ emissions of exports as a whole rose by 15.4 % from 488 million tonnes to 563 million tonnes. In 2012 domestic production with 352 million tonnes contributes to somewhat more than half (62 %) of these emissions (see table 7). The remaining emissions – 211 million tonnes – are attributed to the production of imported raw materials and supplies used at the domestic production of exports. These emissions increased strongly both in absolute terms (+ 26.1 %) and pro rata. In 2005 these emissions accounted for 37.3 % of total emissions, in 2012 this share rose to 38.5 %.

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 2012 44 % of all CO₂ emissions from domestic industries arose in the production of exports. In 2005 the share was just under 38 %.

Table 7 CO₂ emissions of exports

	2005	2010	2012	2012/2005
	mn tonnes			%
Exports	487.8	529.2	563.0	15.4
Domestic production	320.3	336.0	351.8	9.8
Imported intermediate consumption ..	167.5	193.1	211.2	26.1
Imports	387.1	439.1	451.4	16.6
Exports less Imports	100.7	90.0	111.7	10.9
Domestic production	747.2	773.0	768.4	2.8
	in % of domestic production			% points
Exports from domestic production	37.6	42.9	44.1	6.5

The substantial rise in domestic and foreign CO₂ emissions for exports can be explained by a sharp increase of exports between 2005 and 2012 (see table 8). Exports at current prices (excluding re-exports) rose by 46.5 % from 2005 and 2012. Price-adjusted exports increased by 36.7 %.

Table 8 Exports

	2005	2010	2011	2012	2012/2005
	EUR bn				%
Total exports (fob)	847.9	1,066.5	1,185.5	1,242.1	46.5
cif/fob correction ¹	- 2.0	- 2.3	- 2.4	- 2.8	37.9
Final consumption expenditure of non-residents in the territory	22.4	25.4	26.3	27.6	23.1
Re-exports	140.5	162.3	180.1	190.8	35.8
Exports (adjusted)	868.4	1,090.1	1,211.5	1,266.9	45.9
Products	740.0	918.3	1,030.1	1,071.0	44.7
Services	144.3	171.7	181.4	196.0	35.8
	price-adjusted; chain index (2005 = 100)				
Exports	100	122.9	133.0	136.7	X
Products	100	121.3	132.0	135.1	X
Services	100	131.7	138.8	145.5	X

¹ Cif: cost, insurance and freight; fob: free on board.

Source: Federal Statistical Office; Input-Output Accounts

CO₂ emissions of exports

In parallel with the increase of exports domestic industries have increased the amount of imported materials and supplies as a proportion of their intermediate consumption. This share increased from 19.7 % to 20.7 % (see table 9). This increase is a main reason for the rise of embodied emissions of imported materials and supplies. Within the industries the manufacturing of chemicals showed a significant rise in the import share with an increase from 22.1 % (2005) to 25.4 % (2012).

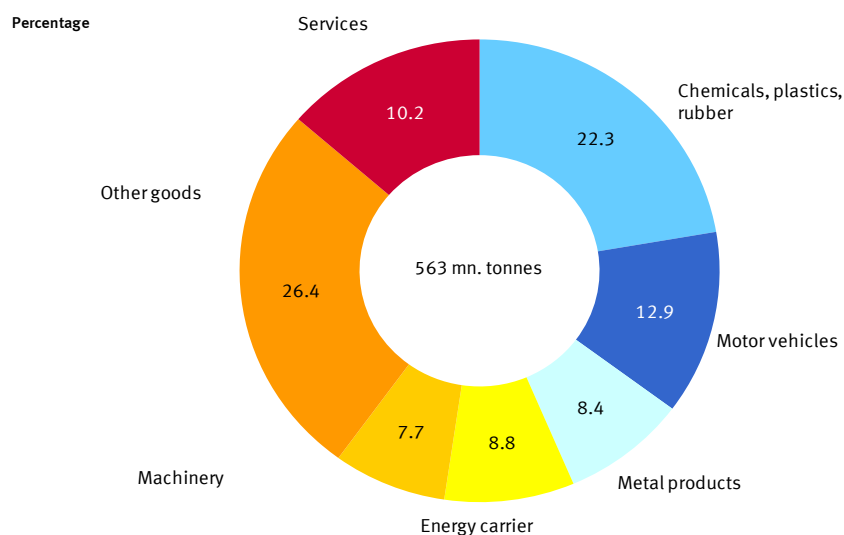
Table 9 Shares for imported intermediate goods by industries

	2005	2010	2011	2012	2012/2005
	%				% points
Total industries	19.7	19.2	20.2	20.7	0.9
Thereof:					
Manufacture of motor vehicles	24.3	26.7	26.2	26.2	2.0
Manufacture of machinery	25.2	26.8	27.3	27.4	2.1
Manufacture of chemicals	22.1	22.9	24.0	25.4	3.4

Source: Input-Output Accounts (several years of publications)

In the case of exports most emissions arise in the production of chemical and plastic products (22.3 %) and of motor vehicles (12.9 %). The export of metal products with a share of 8.4 % also causes high emissions.

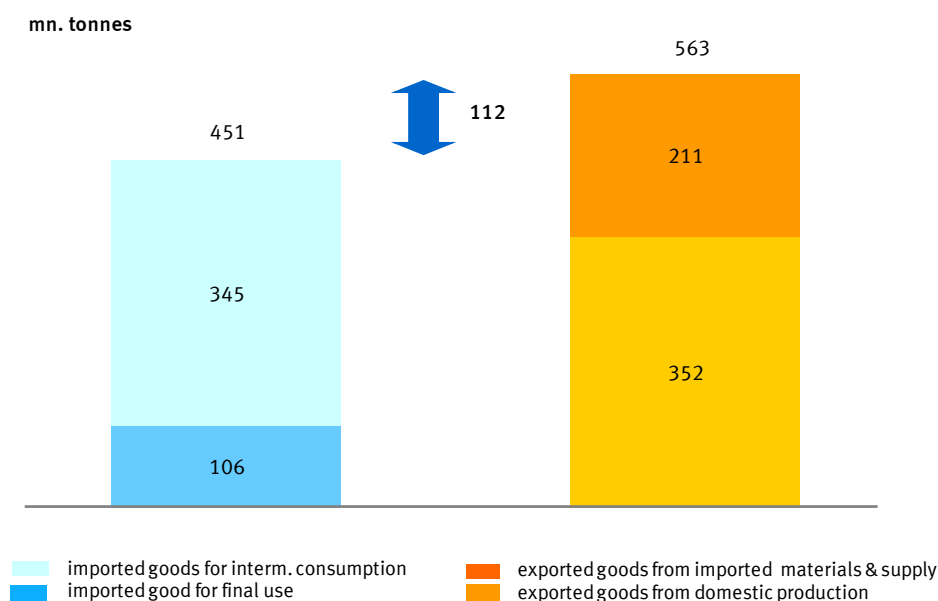
Figure 4 CO₂ emissions of exports by type of goods 2012



Foreign trade balance of CO₂ emissions

In 2012 CO₂ content of imports was 451 million tonnes (see figure 5), CO₂ content of exports was 563 million tonnes. This resulted in a CO₂-surplus of exports over imports of 112 million tonnes.

Figure 5 CO₂ emissions at the production of imports and exports 2012



By far the largest portion of CO₂ emissions for imports – 345 million tonnes or just under 76 % of total emissions of imports – applies to materials and supplies. The production of finished goods (consumer goods and capital goods) accounted only for 106 million tonnes of CO₂.

For imports too CO₂ emissions related to (German) exports were the most important driver. In 2012 211 million tonnes of CO₂ arose during the production of materials and supplies for German export production in the supplier countries. That is 38 % of all CO₂ emissions related to imports. These emissions are influenced by the dynamic growth of exports and the increase in the purchase of imported materials and supplies (see tables 8 and 9).