Environmental-Economic Accounting

CO_2 content of German imports and exports 2000 - 2008

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Ihr Kontakt zu uns:
www.destatis.de/Contact
Telephone: +49 (0) 611 / 75 4585

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by Helmut Mayer

Introduction

Carbon dioxide (CO_2) emissions can be outlined both in terms of origin and consumption. As part of international reporting of greenhouse gases the CO_2 emissions are reported – in terms of origin – for a certain territory based on groups of emitters[1]. When they are considered from a consumer's point of view the emissions are determined in connection with the consumption of goods and assigned to the consumer. 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 that must be assigned to the rest of the world[2,3].

The calculations are based on an extended hybrid input-output model with a regionalisation of the import flows. A description of the base data and the calculation methods is given in the appendix.

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

[2] Initial results on the energy and CO_2 content of imports and exports were presented at the 93rd DGINS Conference in Budapest in 2007: "Environmental pressures from German imports and exports", Schoer, K; Buyny, S.; Flachmann, Chr.; Klink, St.; Mayer, H.; Federal Statistical Office, Wiesbaden 2007.

[3] See also: Mayer, H.: "Umweltökonomische ‚Aspekte der Globalisierung" in: Wirtschaft und Statistik, No. 12/2007, p. 1261-1269.

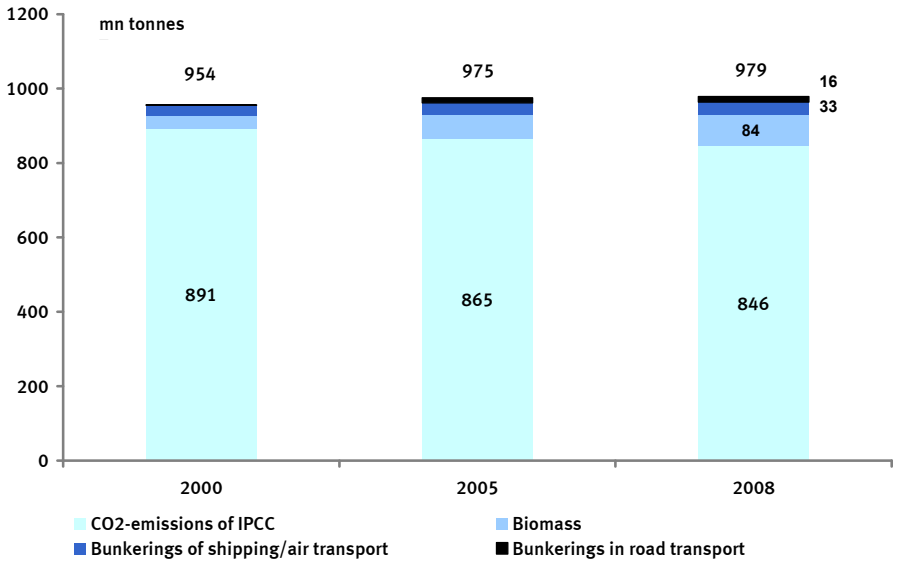
CO_2 emissions by different concepts

In 2008 CO_2 emissions in Germany – within the delimitation of the Environmental-Economic Accounting[4] – amounted to 979 million tonnes. In 2000 the emissions were at 954 million tonnes. The reason for the slight rise in CO_2 (gross-) emissions in Germany was an increased energy consumption of biomass with associated CO_2 emissions. Between 2000 and 2008 the emissions arising from the combustion of biomass more than doubled (2000: 37 million tonnes, 2008: 84 million tonnes).

The emissions within the delimitation of the Environmental-Economic Accounting include in addition to the emissions in the IPCC delimitation[5] the emissions from international shipping and aviation – but only those of the resident units[6]. This delimitation also includes the CO_2 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 5.1 % from 891 million tonnes (2000) to 846 million tonnes (2008) (see Figure 1).

Figure 1: CO_2 emissions in Germany 2000 – 2008



[4] Including emissions from biomass, from bunkering by residents in international shipping and aviation and from fuel purchased abroad by residents.

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

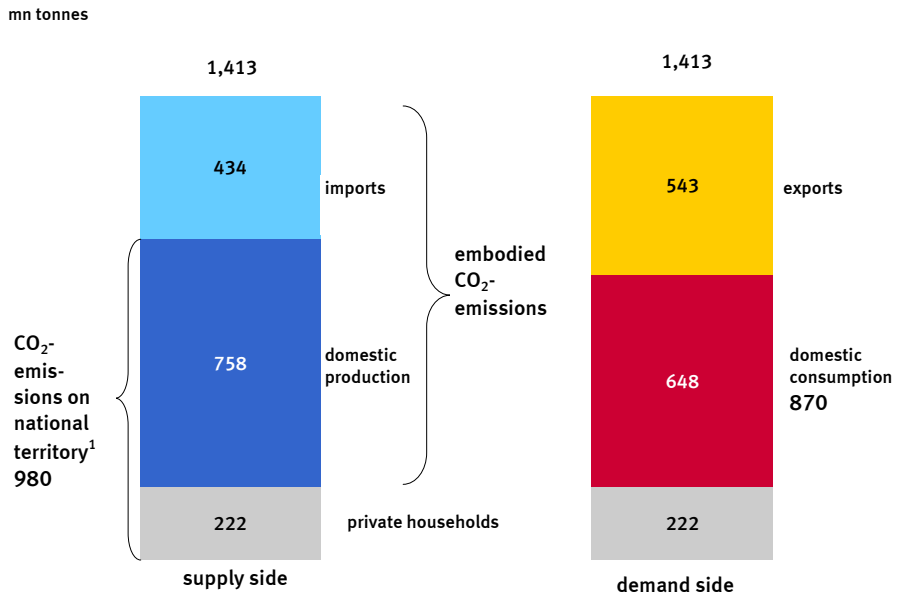
[6] In international reporting of greenhouse gases all the emissions from bunkering by international shipping and aviation in Germany are shown as "figures for information purposes". The level of these emissions is not included in the standardised final record.

CO_2 emissions by different concepts

Of the total domestic emissions of 979 million tonnes in 2008, 758 million tonnes are related to the (domestic) industries, 222 million tonnes to private households. In 2008 CO_2 emissions from the production of imports amounted to 434 million tonnes. That is more than half – 57.2 % – of emissions of domestic origin. Cumulative emissions for 2008 for industries and the direct emissions of private households add up to 1,413 million tonnes. This total is based on measuring and allocating emissions from a production point of view.

Based on the results of the model calculations CO_2 emissions can also be outlined from a consumption point of view (see 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. When considered from a consumption point of view the emissions related to exports (CO_2 content of exports) are assigned to the rest of the world.

Figure 2: Direct and indirect CO_2 emissions in Germany



[1] Residents concept, incl. biomass and bunkering.

The emissions related to domestic consumption can be compared with domestic emissions considered from the production point of view. After deducting the CO_2 content of the exports (543 million tonnes) from total emissions this results in CO_2 emissions of 870 million tonnes for domestic consumption. This figure is 110 million tonnes below the CO_2 emissions arising on the territory. The reason for the lower CO_2 figure for domestic consumption is the higher emission content of exports compared with imports.

CO_2 emissions of exports

The CO_2 content of exports was 543 million tonnes in 2008. Domestic production with 336 million tonnes makes up somewhat more than half (62 %) of these emissions (see Figure 3). The remaining emissions – 207 million tonnes – have arisen in the production of imported raw materials and supplies used in the domestic production of exports. These emissions increased strongly both in absolute terms (+47 %) and pro rata.

In spite of the rise in the import portion, the domestic manufacture of exports is the most significant source for CO_2 emissions in Germany. In 2008 44 % of all CO_2 emissions from domestic industries arose in the production of exports. In 2000 the share was only 38 %. In 2000 there were still slightly higher emissions for the domestic production of consumer goods than was the case for exports. In 2008 the share of CO_2 emissions of consumer goods in the total emissions of the industries dropped to 34 %.

Between 2000 and 2008 CO_2 emissions of exports as a whole rose by 31.6 % from 412 million tonnes to 543 million tonnes. The substantial rise in domestic and foreign CO_2 emissions for exports can be explained in high monetary terms in exports between 2000 and 2008 (see Table 1). In addition to this increase the domestic industries have increased imported materials and supplies as a proportion of total intermediate consumption within this period. This could be a main reason for the high increase in the embodied emissions of imported materials and supplies:

Table 1: Export of goods and import shares for intermediate consumption 2000 – 2008

Goods / industries	Exports			Imported materials and supplies / intermediate consumption		
	2000	2008	08/00	2000	2008	08/00
	EUR bn		%	%	%	%-pts.
Total exports (fob, territorial concept)	**667,3**	**1168,8**	**75,2**			
Re-exports	94,0	193,3	105,7			
Exports excl. re-exports / industries	**573,3**	**975,5**	**70,2**	**18,6**	**21,3**	**2,7**
thereof:						
Motor vehicles, vehiclest equipment	107,9	172,6	59,9	21,9	25,2	3,3
Maschinery	92,6	166,9	80,2	25,1	25,7	0,6
Chemicals	58,6	95,2	62,4	24,5	24,9	0,4
Electrical and office maschinery[1]	67,0	86,1	28,6	-	-	-
Metals[1]	29,4	61,8	110,2	-	-	-

[1] Due to the change of classification of industries it is not possible to compare intermediate consumption in 2000 and 2008 for these industries.

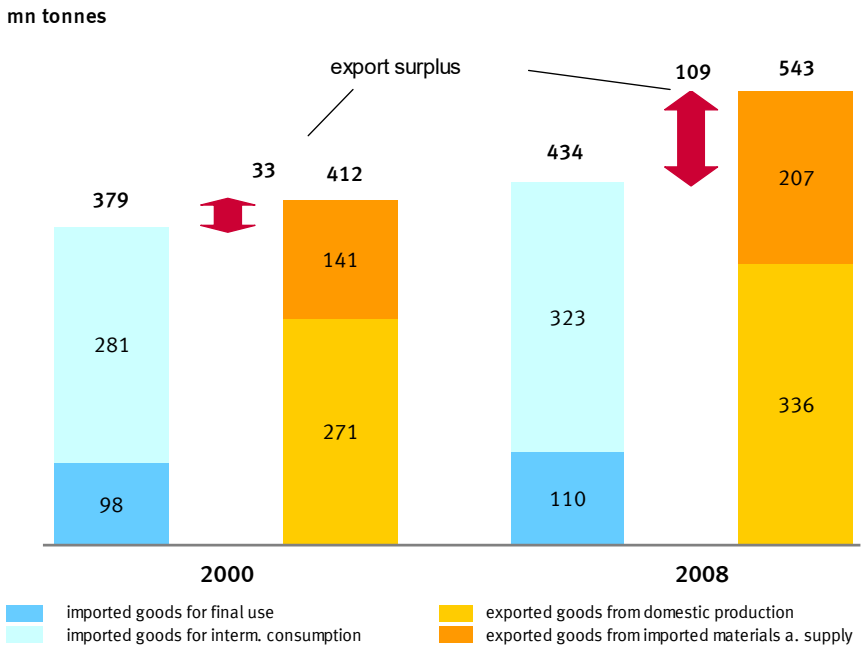
Source: Federal Statistical Office, Input-Output Accounts.

Exports (excluding re-exports) rose nominally by 75.2 % between 2000 and 2008. Price-adjusted the growth came to 68.7 % (fob, including re-exports). The five most significant industries increased their exports in current prices between 29 % and 110 %. The proportion of materials and supplies in intermediate consumption as a whole rose from 18.6 % to 21.3 %. In the branch of automobiles and automotive parts, the share of intermediate consumption has risen particularly sharply – from 21.9 % (2000) to 25.2 % (2008).

CO_2 emissions of imports

Total CO_2 emissions of imports rose by 14.0 % from 379 million tonnes in 2000 to 434 million tonnes in 2008 (see Figure 3). Even more than the CO_2 emissions of imports, the CO_2 emissions of exports have increased – from 412 million tonnes to 543 million tonnes. This resulted in a CO_2-surplus of imports over exports of 109 million tonnes in 2008 compared to a surplus of 33 million tonnes in 2000.

Figure 3: CO_2 emissions at the production of imports and exports to and from Germany



By far the largest portion of CO_2 emissions for imports – 323 million tonnes (2008) 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 110 million tonnes of CO_2.

For imports too CO_2 emissions related to (German) exports were the most important driver. In 2008 207 million tonnes of CO_2 arose during the production of materials and supplies for German export goods in the supplier countries. That is 48 % of all CO_2 emissions related to imports. The substantial increase in these emissions of 47 % can be explained by the dynamic growth of exports and the increase in the purchase of imported materials and supplies (see Table 1). In comparison, much lower CO_2 emissions arose during the production of imported consumer goods and imported materials and supplies for the manufacture of consumer goods in Germany in 2008: 130 million tonnes, i.e. 30 % of the entire CO_2 emissions of imports. These emissions have even dropped slightly since 2000.

CO_2 emissions of imports by country of origin

By far the highest emissions resulting from German imports in 2008 occurred in the Netherlands: 39.3 million tonnes of CO_2, followed by China (32.0 million tonnes) and France (30.7 million tonnes).

The high CO_2 content of imports coming from the Netherlands can be explained by the comparatively high emission coefficients for the significant imports: The Netherlands has the highest shares of imports in the case of imported agricultural products, food products and basic chemical materials. In these industries 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 2008, is top of the league as far as energy content is concerned, it has lower CO_2 emissions than the Netherlands because of its largely CO_2-free electricity generation. Russia is only seventh as far as goods imports are concerned, for CO_2 emissions however it is the sixth greatest emitter. This is mainly due to the energy-intensive and CO_2-intensive transport of energy sources (natural gas and crude oil) to Germany.

Table 2: CO_2 emissions of imports 2008 by country of origin

Country	CO_2					Total imports		
	Total			of which		Products[1]		
				Final use	Iterm. Cons.			
	mn t	%	Rank	mn tonnes		EUR mn	%	Rank
Total	**433,6**	**100,0**		**110,1**	**323,5**	**803.785**	**100,0**	
NL	39,3	9,1	1	9,3	30,1	67.920	8,4	1
FR	30,7	7,1	3	7,2	23,5	62.939	7,8	2
CN	32,0	7,4	2	13,2	18,9	60.825	7,6	3
IT	21,7	5,0	9	6,4	15,3	46.842	5,8	4
US	25,8	5,9	4	8,7	17,1	46.464	5,8	5
UK	25,2	5,8	5	5,8	19,4	41.646	5,2	6
RU	25,2	5,8	6	2,4	22,8	37.087	4,6	7
BE	21,4	4,9	10	3,5	17,9	36.623	4,6	8
AT	22,8	5,3	8	5,6	17,2	32.874	4,1	9
PO	24,5	5,6	7	7,0	17,5	25.869	3,2	10
JP	10,2	2,3	12	3,8	6,3	23.130	2,9	11
NO	5,6	1,3	14	0,6	4,3	22.323	2,8	12
ES	10,3	2,4	11	2,9	7,3	20.701	2,6	13
SE	6,6	1,5	13	1,3	5,3	13.569	1,7	14
BR	4,3	1,0	15	1,1	3,2	9.497	1,2	15
Sum	**305,4**	**70,4**		**79**	**225,9**	**548.307**	**68,2**	
Rest	128,2	29,6		30,6	97,5	255.477	31,8	

[1] Source: Federal Statistical Office, Foreign Trade Statistics

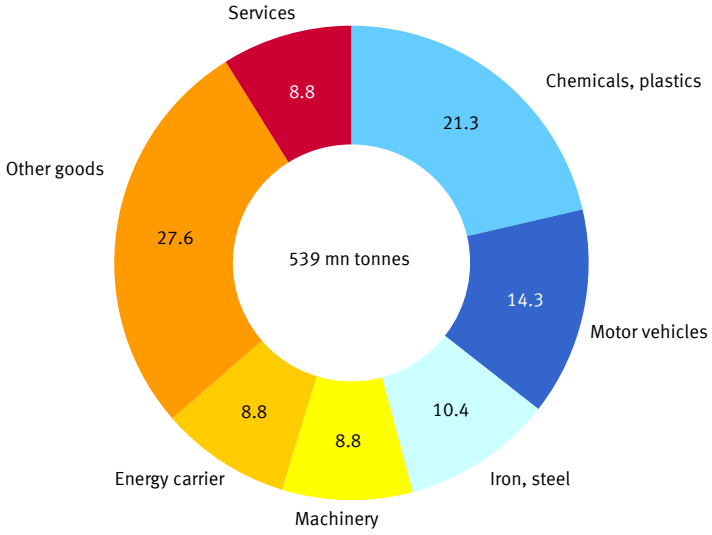
CO_2 emissions of imports and exports in terms of goods

For imports most CO_2 emissions are caused by the demand for imported vehicles (16 %). This is followed by emissions connected with imported services (13 %) and emissions relating to the production of imported machinery and equipment (10 %).

In terms of the industries which generate CO_2 emissions, in the case of imports, electricity generation (38 %) and steel and non-ferrous metal production (16 %) are the industries with the highest emissions.

In the case of exports most emissions arise in the production of chemical and plastic products (21.3 %) and of motor vehicles (14.3). The export of steel and steel products with a share of 14.4 % also causes high emissions.

Figure 4: CO_2 emissions of exports in terms of goods 2008



Appendix[7]

The model for calculating the energy and CO_2 content of goods is based on an extended input-output analysis. In that model is calculated first the output for the production of – either the entire final demand or for certain demand categories, such as exports. Then the emission content of the (final demand) goods is determined with the help of emission coefficients.

The calculation model is based on a hybrid input-output table (IOT). In that IOT the monetary figures for production, import and the use of energy are replaced by the physical figures from the energy flow account – in calorific values (joules). The use of physical units facilitates greater precision for the calculations. In the case of the emission calculation it enables a direct link to the actual energy consumption of the industries.

The energy flow accounts by energy sources and industries supplies important output parameters for the calculation of domestic emissions: firstly, it forms the basis for calculating the energy and emission coefficients for CO_2 for the individual domestic industries. Secondly it provides the details for the specific energy inputs of the industries. These details are of primary significance for calculating the effects on upstream production.

The energy flow account is carried out in a similar fashion as classifying the branches in the national input-output calculations for 72 – functionally separated – homogeneous branches. In addition, subdivisions of the energy generation and conversion sectors are applied – in accordance with the subdivision of the energy sectors in the national energy balance sheets. A separate presentation of electricity generation is of great significance for the calculations. Consequently, in the calculation model, a distinction is made between 8 energy sectors. Apart from this, important energy-intensive industries, such as chemicals and the non-ferrous metal industries, are further subdivided. As a result of the disaggregation – and aggregations for less important sectors – a level of disaggregation of 66 sectors is applied.

The import calculations are made separately in line with the 15 most important countries of origin for German imports and a residual figure, which covers the remaining imports. The details of import figures – for products – are taken from the foreign trade statistics. Information from balance of payments statistics is evaluated regarding imports of services. Imports – and exports – were adjusted by the figures for re-exports, as these goods do not remain in Germany and therefore do not constitute use of environmental resources in connection with domestic demand.

In the case of import calculations it was generally assumed that the imports were produced by using domestic technology. However, for the energy sectors and other important energy-intensive industries (steel and aluminium production and paper manufacture) the actual energy consumption of those countries of origin is taken into account. As a result, in terms of energy consumption this aims to achieve an approximation to the actual production conditions in the countries of origin.

Domestic CO_2 emissions are determined directly based on the energy input of the industries and with the help of emission factors for the individual energy sources. For the European countries detailed figures of CO_2 emissions of industries were available

7 A comprehensive description of the extended Input-Output model is available at DESTATIS: https://www.destatis.de/EN/Publications/Specialized/EnvironmentalEconomicAccounting/ExtendedInputOutputModel.pdf?__blob=publicationFile

from a survey by the European Statistical Office[8]. For the non-European countries of origin (USA, Japan, China, Russia) the emissions for the energy sectors and the energy-intensive industries referred to were calculated on basis of the energy balance sheets of these countries[9] and for the metal producing industries on basis of process chain data.

[8] Eurostat Web page: Sector "Environment", database: physical and hybrid flow accounts (env_ac_ainacehh) http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/database

[9] International energy balance sheets are published by the International Energy Agency (IEA).