UMWELTÖKONOMISCHE GESAMTRECHNUNGEN

CO_2 content of German import and export goods, 2000 – 2010

2014

Federal Statistical Office of Germany

Contents

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 used and the calculation methods is given in the methodological description.

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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 93. 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, 12/2007, p. 1261-1269.

Methodological describtion

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.

Methodological description

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 from a survey by the European Statistical Office[4]. 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[5] and for the metal producing industries on basis of process chain data.

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4 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
5 International energy balance sheets are published by the International Energy Agency (IEA).
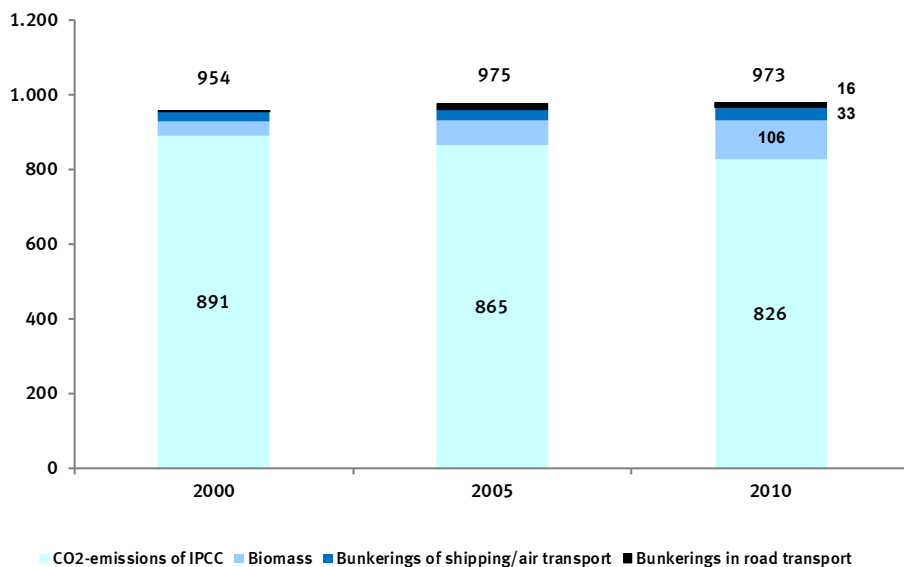
CO$_2$ emissions by different concepts

In 2010 CO$_2$ emissions in Germany – within the delimitation of the Environmental-Economic Accounting[6] – amounted to 973 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 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 delimitation[7] the emissions from international shipping and aviation – but only those of the resident units[8]. 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 7.3 % from 891 million tonnes (2000) to 826 million tonnes (2010) (Figure 1).

Figure 1 **CO$_2$ emissions in Germany**
mn tonnes

■ CO2-emissions of IPCC ■ Biomass ■ Bunkerings of shipping/air transport ■ Bunkerings in road transport

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

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

8 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.

Of the total domestic emissions of 973 million tonnes in 2010, 742 million tonnes are related to the domestic industries, 231 million tonnes to private households. In 2010 CO$_2$ emissions from the production of imports amounted to 411 million tonnes. That is more than half (55.4 %) of emissions of domestic origin. Indirect emissions for industries and the 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 CO$_2$ 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 CO$_2$ emissions in Germany 2010**
mn tonnes
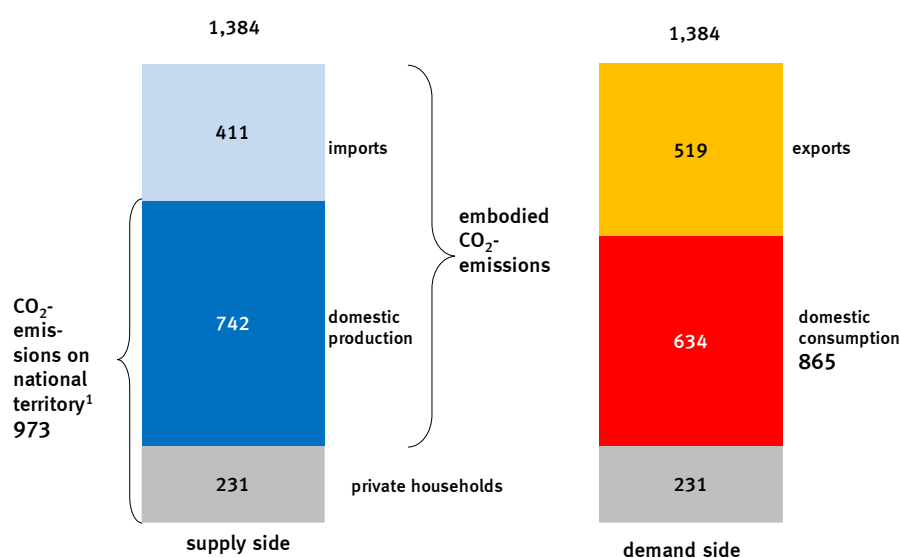
[1] Residents concept, incl. biomass and bunkering.

The emissions related to domestic consumption can be compared with domestic emissions derived from the production point of view. After deducting the CO$_2$ content of the exports (519 million tonnes) from total emissions this results in CO$_2$ emissions of 865 million tonnes for domestic consumption. This figure is 108 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

Between 2000 and 2010 CO$_2$ emissions of exports as a whole rose by 25.9 % from 412 million tonnes to 519 million tonnes. Domestic production with 326 million tonnes makes up somewhat more than half (63 %) of these emissions (Table 1). 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 CO$_2$ emissions in Germany. In 2010 44 % of all CO$_2$ 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 CO$_2$ emissions of consumer goods in the total emissions of the industries dropped to 36 %.

Table 1 **CO$_2$ emissions of exports**

	2000	2005	2010	2010 / 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**	*17.6*
Domestic production.....................................	721.6	747.2	741.9	*4.8*
	in % of production			%-pts.
Exports from domestic production................	*37.6*	*42.9*	**44.0**	*6.4*

The substantial rise in domestic and foreign CO$_2$ emissions for exports can be explained in high monetary terms in exports between 2000 and 2010 (see Table 2). 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 2 **Exports and import shares for intermediate consumption**

	2000	2005	2010	2010 / 2000
	EUR bn			%
Total exports (fob[1], territorial concept)............................	**667.3**	**898.7**	**1 165,5**	*74.7*
Re-exports...	94.0	140.4	230.5	*145.2*
Exports excl. 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*
	%			%-pts.
Imported intermediate goods in % of total				
intermediate consumption...	*18.6*	*19.7*	*19.8*	*1.3*
including:				
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

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 %.

The proportion of materials and supplies in intermediate consumption as a whole rose from 18.6 % to 19.8 %. 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).

CO$_2$ emissions of imports

Total CO$_2$ emissions of imports rose by 9.3 % from 379 million tonnes in 2000 to 411 million tonnes in 2010 (Figure 3). Even more than the CO$_2$ emissions of imports, the CO$_2$ emissions of exports have increased – from 412 million tonnes to 519 million tonnes. This resulted in a CO$_2$-surplus of imports over exports of 108 million tonnes in 2010 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**
mn tonnes
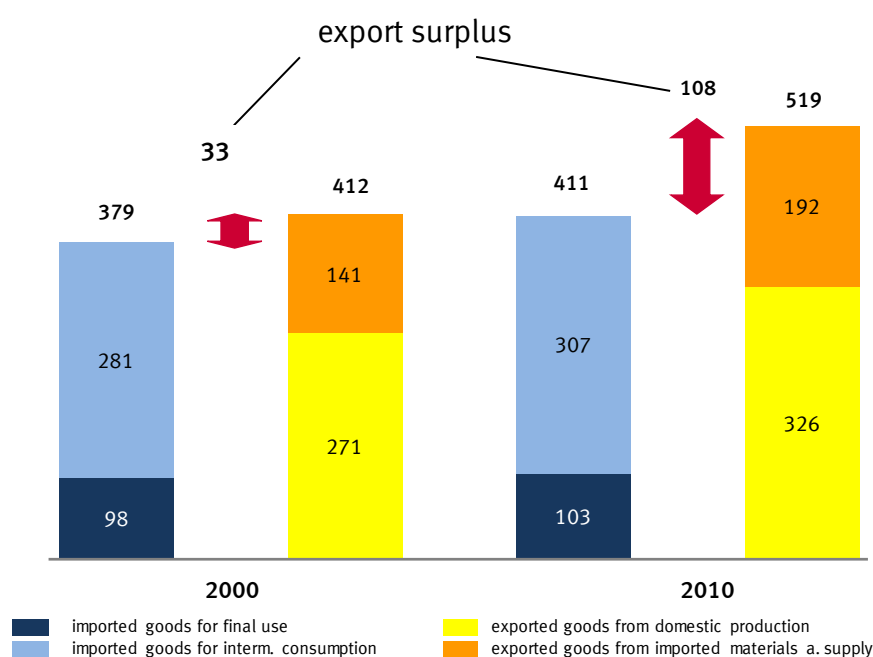
By far the largest portion of CO$_2$ emissions for imports – 307 million tonnes (2010) or just under 75 % of the total emissions of imports – applies to materials and supplies. The production of finished goods (consumer goods and capital goods) accounted for 103 million tonnes of CO$_2$.

For imports too CO$_2$ emissions related to (German) exports were the most important driver. In 2010 192 million tonnes of CO$_2$ arose during the production of materials and supplies for German export goods in the supplier countries. That is 47 % of all CO$_2$ 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 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 2010: 134 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 2010 occurred in the Netherlands: 38.3 million tonnes of CO_2, followed by China (34.4 million tonnes) and France (27.4 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 2010, 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. China is first in imports of goods, at the CO_2 emissions the second. This is mainly due to the energy-and CO_2-intensive production of goods by the use of coal in the production of electricity.

Table 3 **CO_2 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 of America...	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
Together............................	**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

CO$_2$ emissions of imports and exports in terms of goods

Most of the CO$_2$ emissions of imported final goods are caused by imported vehicles (16 %) and in connection with emissions of food products and imported energy (each 11 %). In terms of the industries which generate CO$_2$ emissions, in the case of imports, electricity generation (40 %) and steel and non-ferrous metal production (13 %) are the industries with the highest emissions (Table 4).

Table 4 **CO$_2$ emissions of imports by industries**

Industries	2000	2005	2010	2010 / 2000
	mn tonnes			%
Total...	379	387	411	8.3
	in % of total			%-pts.
including:				
Generation of electricity and steam........................	37.8	40.0	39.7	2.0
Manufacture of steel and non-ferrous metals.........	15.1	16.3	13.0	−2,1
Manufacture of chemicals......................................	8.9	7.8	10.3	1.4
Transport services..	8.4	8.9	7.6	−0.8

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 **CO$_2$ emissions of exports in terms of goods 2010**
       in %