Environmental-Economic Accounting

CO_2-content of German imports and exports

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Carbon dioxide (CO_2) emissions can be outlined both in terms of origin and consumption. As part of international reporting for 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 in terms of consumption the emissions are determined in connection with the consumption of goods and assigned to the originator. 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, which 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. The basis of the calculation and the methods are described in the appendix.

CO_2 emissions in Germany in 2007 – within the delimitation of the Environmental-Economic Accounting[4] – amounted to 959 million tonnes. In 2000 the emissions were still 948 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 2007 the emissions arising from the combustion of biomass more than doubled (2000: 33 million tonnes, 2007: 76 million tonnes).

The emissions within the delimitation of the Environmental-Economic Accounting also 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)[7].

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 6 % from 887 million tonnes (2000) to 834 million tonnes (2007) (see Diagram 1).

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* The calculations were achieved as part of a project "Extended Input-Output Model for Energy and Greenhouse Gases", which was promoted by the Statistical Office of the European Communities. A final report with a detailed description of method and full results will be published in the Spring of 2011.

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

2 Initial results on the energy and CO2 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.

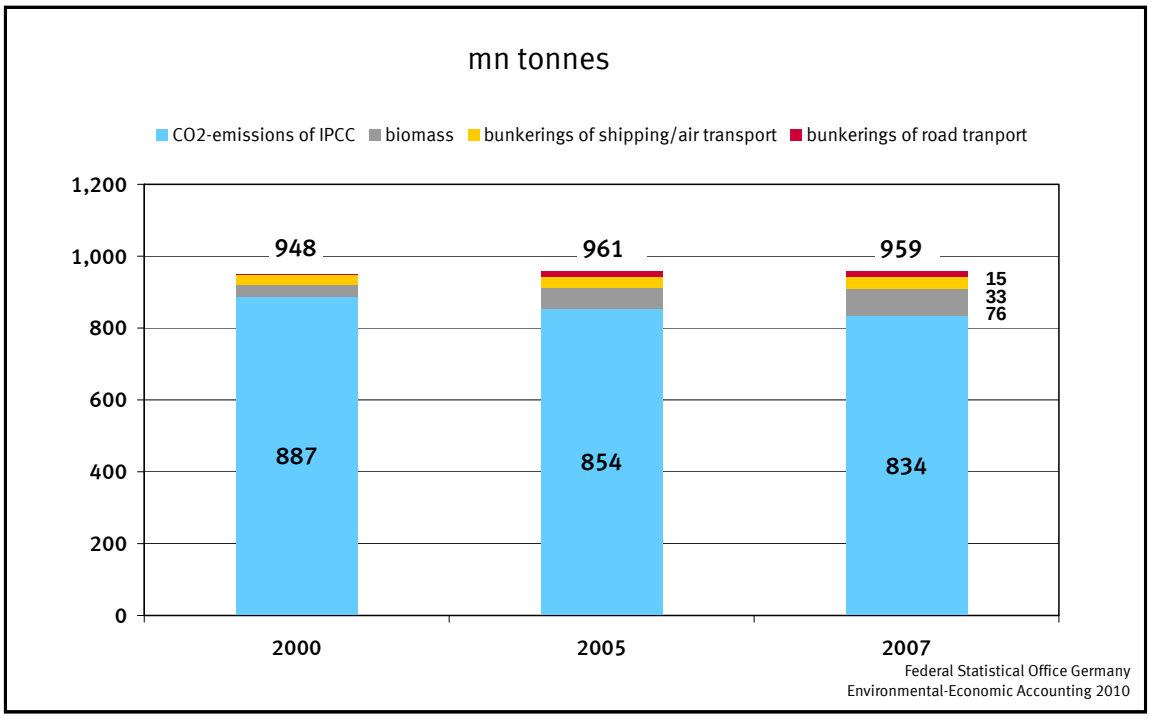
4 Including emissions from biomass, from bunkering by residents in international shipping and aviation and from fuel purchased abroad by residents.

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.

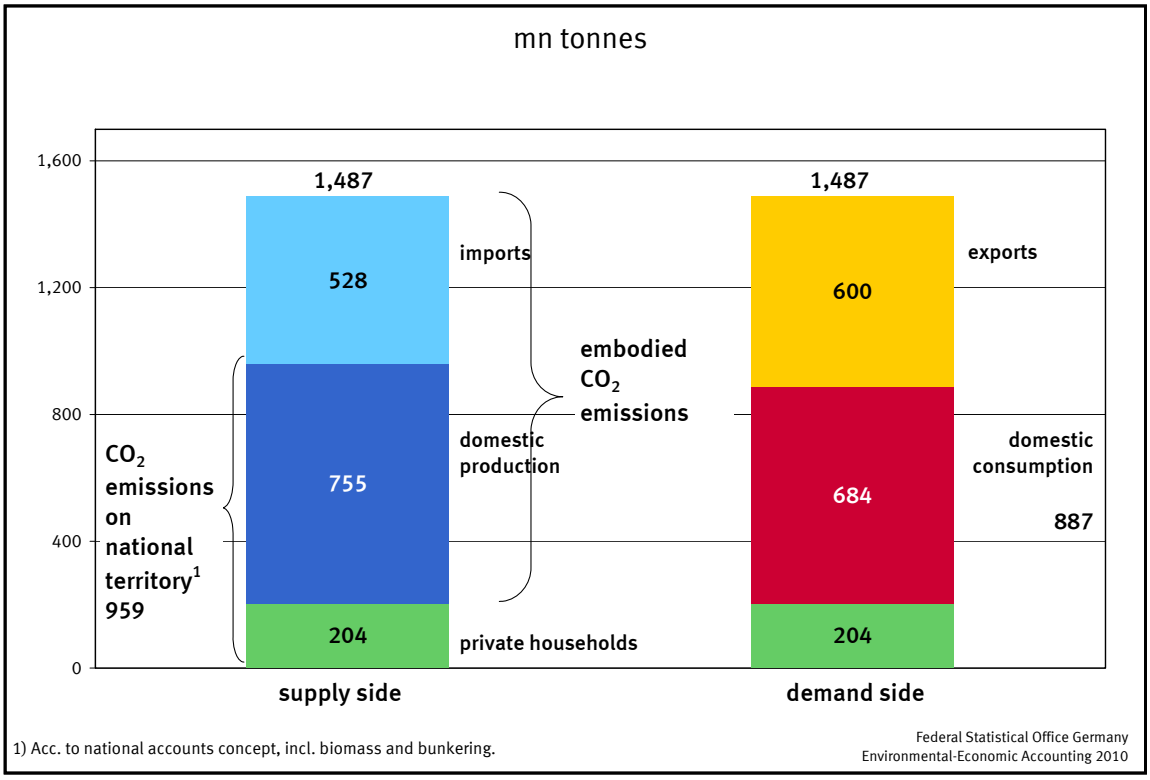
7 The emissions are offset against the emissions arising from fuel purchases in Germany by non-residents.

Diagram 1: CO_2 emissions in Germany 2000 – 2007



Of the domestic emissions in 2007, 755 million tonnes related to the (domestic) industries, 204 million tonnes to private households. In 2007 CO_2 emissions for the production of imports amounted to 528 million tonnes. That is more than half – 55.1 % – of domestic emissions. Together with the direct emissions cumulative emissions for 2007 come to 1,487 million tonnes. This output is based on measuring and allocating emissions from a production point of view.

Diagram 2: Direct and indirect CO_2 emissions in Germany



Based on the results of the model calculations CO_2 emissions can also be outlined in terms of consumption (see Diagram 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 of exports (CO_2 content of exports) are assigned to the rest of the world.

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 (600 million tonnes) from the total output this results in CO_2 content of 887 million tonnes for domestic consumption. This figure is 72 million tonnes below the CO_2 emissions arising on the territory. The reason for the smaller CO_2 figure for domestic consumption by comparison with the domestic emissions delimited territorially is the higher emission content of the exports compared with the imports.

Exports

The CO_2 content of the exports was 600 million tonnes in 2007. Of this the domestic production of 348 million tonnes makes up somewhat more than half (58 %) of the emissions. The remaining emissions – 252 million tonnes – have arisen in the production of imported raw materials and supplies used for the domestic production of exports. These emissions have risen very strongly both in absolute terms (+76 %) 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. 46 % of all CO_2 emissions from domestic industries arose in 2007 in the production of exports. In 2000 the proportion 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 2007 the proportion of CO_2 emissions of consumer goods in the total emissions of the industries dropped to 35 %.

CO_2 emissions of exports as a whole rose by 44.2 % from 416 million tonnes to 600 million tonnes between 2000 and 2007. The substantial rise in domestic and foreign CO_2 emissions for exports can be explained by the high monetary growth in exports between 2000 and 2007. In addition to this the domestic industries have increased imported materials and supplies as a proportion of total intermediate consumption over this period, which explains the particularly high growth in the embodied emissions of imported materials and supplies:

Table 1: Export of goods and import proportions for intermediate consumption 2000 – 2007

Commodities	Exports	Exports			Imported materials and supplies / intermediate consumption		
	2007	2000	2007	07/00	2000	2007	change in
	Rank	EUR bn		%	%	%	%-pts.
Motor vehicles, vehiclest equipment	1	101.3	157.3	55.3	21.9	25.2	3.3
Machinery	2	75.2	123.6	64.3	25.1	25.7	0.6
Chemicals (excl. pharmaceuticals)	3	51.2	73.2	43.0	24.5	24.9	0.4
Wholesale trade	4	34.2	52.6	53.7	8.7	9.5	0.8
Electrical machinery	5	24.7	37.2	50.5	20.7	23.8	3.0
Non-ferrous metal products	10	12.6	28.6	127.1	45.9	57.9	12.0
Office machinery	24	6.7	8.7	30.2	42.6	54.4	11.8
Total		576.6	940.1	63.1	18.6	21.3	2.7

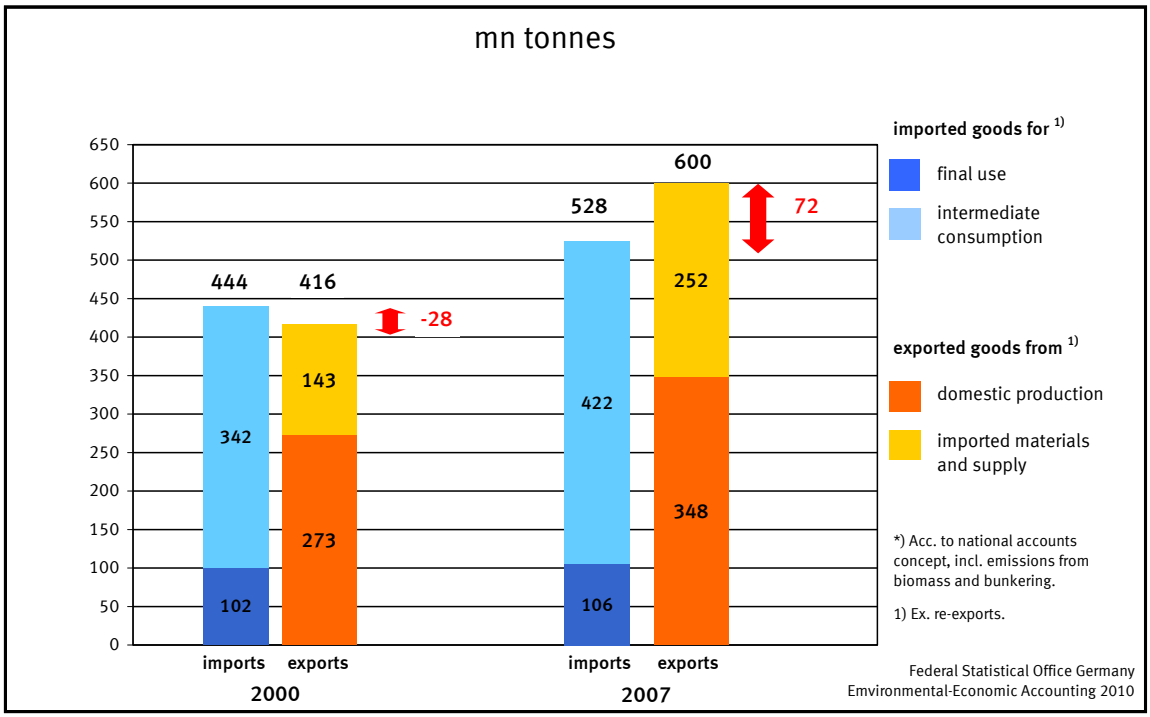
Source: Federal Statistical Office, Input-Output Accounts.

Exports (excluding re-exports) rose nominally by 63.1 % between 2000 and 2007. Price-adjusted the growth came to 65.8 % (fob, including re-exports). The five most significant industries increased their exports nominally between 43 % and 64 %. In these sectors a rise in import quotas for intermediate consumption can be observed on an ongoing basis. The proportion of materials and supplies in intermediate consumption as a whole rose from 18.6 % to 21.3 %. For products (excluding energy products) alone the import share is already 35.4 %. The non-ferrous metals sector, and the production of office machines and EDP equipment have enjoyed a particularly strong increase in terms of the import quota.

Imports

Total CO_2 emissions of imports rose by 19.0 % from 444 million tonnes in 2000 to 528 million tonnes in 2007.

Diagram 3: CO_2 emissions at the production of imports and exports



By far the largest portion of CO_2 emissions for imports – 422 million tonnes (2007) or just under 80 % of the total emissions of imports – applies to materials and supplies. The production of finished goods (consumer goods and capital goods) accounted for 106 million tonnes of CO_2.

For imports too CO_2 emissions connected with (German) exports were the most important source. 252 million tonnes of CO_2 arose during the production of materials and supplies for export goods production in the supplier countries in 2007. That is 47 % of all CO_2 emissions relating to imports. The substantial increase in these emissions of 76 % can be explained by the dynamic growth of exports and the increase in the purchase of imported materials and supplies (see Table 1). Comparatively speaking, much lower CO_2 emissions arose during the production of imported consumer goods and upstream goods for the manufacture of consumer goods in Germany in 2007: 139 million tonnes, i.e. 26 % 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 2007 occurred in the Netherlands: 53.0 million tonnes of CO_2, followed by France (37.0 million tonnes) and China (33.9 million tonnes).

The high CO_2 content of imports 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 and food. In these industries it has the highest direct emission coefficients of European countries. In the case of electricity generation also – this is the industry that accounts for by far the most emissions – the Netherlands has comparatively high emission coefficients by comparison with other European countries. Although France, the country with the highest proportion of imported goods for 2007, 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 ninth as far as goods imports are concerned, for CO_2 emissions however it is the fourth 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 by country of origin

Country	CO_2					Total imports		
	Total			Of which				
				Final use	Interm. cons.	Products 1)		
	mn t	%	Rank	mn t		EUR mn	%	Rank
Total	**528.2**	**100.0**		**106.2**	**422.0**	**769,206**	**100.0**	
FR	37.0	7.0	2	7.2	29.8	62,873	8.2	1
NL	53.0	10.0	1	9.6	43.4	61,951	8.1	2
CH	33.9	6.4	3	11.0	22.9	56,417	7.3	3
US	24.1	4.6	10	6.7	17.4	45,993	6.0	4
IT	30.4	5.8	6	7.3	23.2	44,694	5.8	5
UK	29.4	5.6	7	6.2	23.3	41,966	5.5	6
BE	28.8	5.5	8	3.8	25.0	36,250	4.7	7
AT	28.3	5.4	9	4.7	23.6	32,091	4.2	8
RS	32.3	6.1	4	2.9	29.4	28,891	3.8	9
JP	10.3	2.0	12	3.3	7.0	24,381	3.2	10
PO	31.4	5.9	5	6.2	25.2	24,055	3.1	11
ES	11.3	2.1	11	2.9	8.5	20,687	2.7	12
NO	6.2	1.2	14	0.6	5.6	17,736	2.3	13
SE	7.6	1.4	13	1.0	6.6	13,981	1.8	14
Sum	**364.3**	**69.0**		**73**	**291.0**	**511,965**	**66.6**	
Rest	164.0	31.0		32.9	131.1	257,241	33.4	

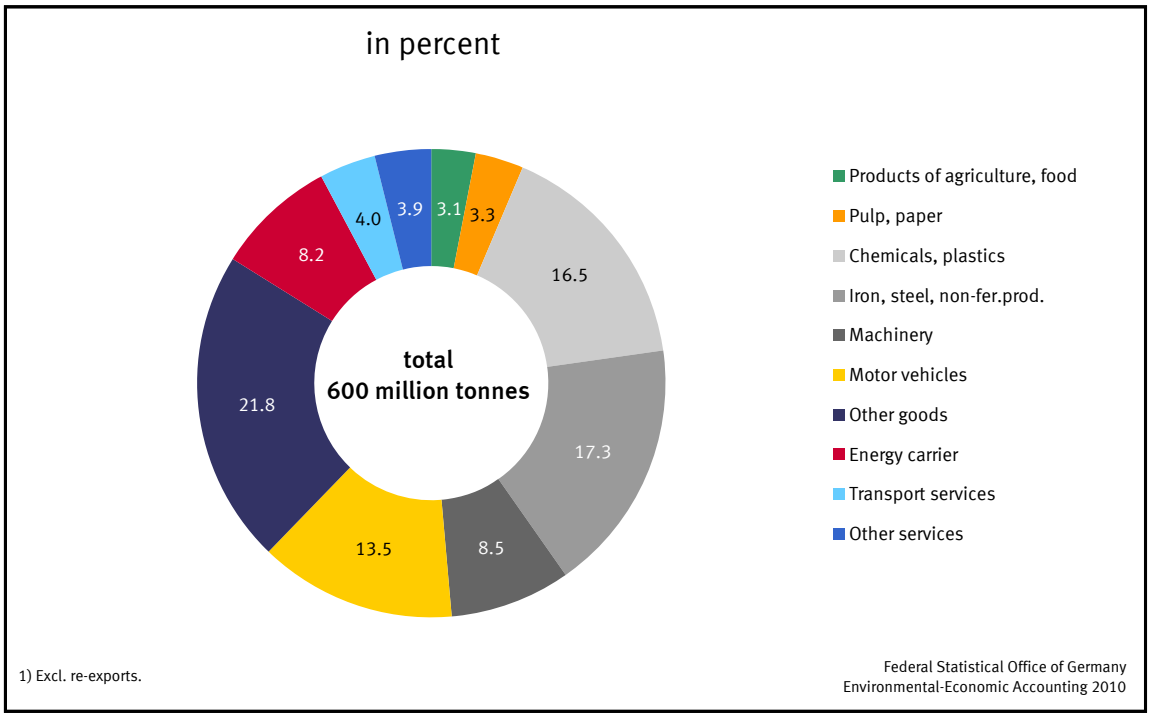
1) Source: Foreign Trade Statistics. Environmental-Economic Accounting 2010.

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 (17 %). This is followed by emissions connected with imported services (14 %) and emissions relating to the production of imported machinery and equipment (6 %).
In terms of the industries which generate CO_2 emissions, in the case of imports, electricity generation (35 %) and steel and non-ferrous metal production (28 %) are the sectors with the highest emissions.

In the case of exports most emissions arise in the production of vehicles (14 %) and chemical products (14 %). The export of steel and steel products with a share of 12 % also causes high emissions.

Diagram 4: CO_2 emissions of exports in terms of goods 2007



CO_2 content of imports with regionalised calculation and with a calculation based on domestic emission coefficients

Within regionalised calculation of the CO_2 content of imports country-specific emission coefficients are used (see notes in the appendix). A comparative calculation for the imports, taking account of the domestic emission coefficients, can also answer the questions as to whether the imports in the countries of origin – on average – are linked to higher or lower emissions of CO_2 than in Germany.

It appears that in 2007, with regionalised calculation, 70 million tonnes (13.2 %) higher CO_2 emissions arise than if the imports are produced domestically.
If one compares emission coefficients for significant emitters it is evident for example that the emission coefficient for electricity generation[8] in the countries of origin on a – weighted – average is somewhat lower than domestically: Countries of origin: 0.129 t/MJ – Germany

[8] The emission coefficient for electricity generation gives the CO2 emissions in terms of the volumes of electricity generated.

0.150 t/MJ[9]. The reason for the higher emission coefficient for Germany is due to the high consumption of coal and lignite in electricity generation. Burning them gives rise to particularly high CO_2 emissions. On the other hand, in the case of aluminium production, the emission coefficient in Germany is very much more favourable than that of the countries of origin. This is related to the high proportion of secondary aluminium in aluminium production. Very much less energy is required to produce secondary aluminium than in the production of primary aluminium. In the production of agricultural products and food the domestic emission coefficients are also lower than those of the countries of origin.

Appendix

The model for calculating the energy and CO_2 content of goods is based on an extended input-output analysis. Here the production is calculated – either for 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 for the CO_2 emissions.

The calculation model is based on a hybrid input-output table (IOT). In this IOT the monetary details of production, import and the use of energy for the energy sectors is replaced by the physical details 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 be established with the actual physical energy consumption of the industries.

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

The energy flow account is carried out as standard in a similar fashion as classifying the branches in the national input-output calculations for 71 – 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 a distinction is made between 9 energy sectors in the calculation model. Apart from this, important energy-intensive industries, such as chemicals and the non-ferrous metal industries, are further subdivided. As a result of the apportionments – and aggregations for less important sectors – a level of disaggregation of 73 sectors is achieved.

The import calculations are made separately in line with the 14 most important countries of origin for German imports and a residual figure, which covers the remaining imports. The details of import figures – for goods – 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 do not therefore constitute environmental use in connection with domestic demand.

In the case of import calculations it was generally assumed that the imports were produced 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 for the countries of origin is taken into account. As a result, in terms of energy consumption this aims to achieve a far-reaching approximation to actual production conditions in the countries of origin.

[9] MJ: megajoule = 10^6 joules.

Domestic CO_2 emissions are determined directly based on the energy input of the industries with the help of emission factors for the individual energy sources. For the European countries of origin there were details of CO_2 emissions based for industries available from a survey by the European Statistical Office[10]. 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 the details of the energy balance sheets of these countries[11] and on basis of process chain data.

[10] 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

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