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Extended Input-Output Model for Energy and Greenhouse Gases

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Extended Input-Output Model for Energy and Greenhouse Gases

Final Report

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Abbreviations

DE or D	= Germany
FR	= France
NL	= Netherlands
IT	= Italy
UK	= United Kingdom
ES	= Spain
AT	= Austria
SE	= Sweden
BE	= Belgium
PO	= Poland
NO	= Norway
RS	= Russia
CH	= China
US	= United Staates
JP	= Japan
IOT	= Input-Output Table
IOA	= Input-Output Analysis
CO_2	= Carbon dioxide
NAMEA	= National Accounting Matrix including Environmental Accounts
Branch	= Homogeneous branches
IEA	= International Energy Agency
EEA	= Environmental Economic Accounting
NE	= Non-Ferrous
TJ	= Terajoule
WZ	= Industry
Mf.	= Manufacturing
CRF	= Common Reporting Format
UNFCCC	= United Nations Framework Convention on Climate Change
Eurostat	= Statistical Office of the European Union
LCA	= Life Cycle Analysis

1 Introduction

1.1 Objective and compilation strategy

The compilation strategy is based on the use of the input-output table (IOT) and the application of input-output analysis[1]. Special attention is devoted to a separate calculation of the energy and CO_2 content of domestic goods and goods imported into Germany. Calculating the imports does not involve taking full account of the technology of the supplier countries (i.e. of the national IOT). Account is only taken of the national energy input conditions for the supplier countries most important as far as German imports are concerned, in the case of important energy-intensive sectors, such as the energy generation and conversion sectors, and the production of steel and aluminium. Doing so, while bearing in mind the industry-specific energy and emission coefficients of the supplier countries, should provide a far-reaching approximation to the actual energy input and emissions of CO_2 in the supplier countries in the production of (German) imports.

In the case of imports a distinction has been made between 14 supplier countries (see Chapter 4.2.1), which together make up 67.5 % of German goods imports in 2006.

The chosen hybrid compilation strategy with mixed monetary and physical units (for the energy sectors) in the IOT facilitates a relatively disaggregated calculation involving 73 industries. Here the details of energy input of the most important energy-intensive segments in the energy sector area and the metal production industry in the supplier countries can be derived from the energy balance sheets of these countries (published by Eurostat and IEA). (See for example the details of fuel input in electricity production in Appendix Table 4). Account of this information has been taken both in terms of the upstream link and for calculating the specific energy coefficients. Nevertheless substantial gaps still remain as far as the energy input of the other sectors are concerned, as there are no disaggregated details available on energy input by industries (so-called NAMEA tables).

It has proved possible to determine sector-specific coefficients for all industries for the European countries based on the NAMEA-Air data. For the non-European countries however this only applies to the selected energy-intensive industries.

The calculation segments (see Overview 2 in Chapter 1.5) provide for a separate calculation of energy input for domestic use and abroad for the utilisation categories of "Export" and "Private consumption". At the same time a calculation is made of the "Total figure", i.e. of the entire energy and CO_2 content of the final demand (goods). In the case of the import calculations a further distinction is made in terms of upstream goods – as far as their relevant energy content is concerned – and final use goods (consumer goods). This distinction facilitates an explicit analysis of the consequences of an increase in international production links (globalisation of production). For example it is possible to investigate whether in the course of time an "off-shoring" of energy-intensive (emission-intensive) production processes has occurred.

1 The input-output-tables of Germany are published at www.destatis.de.

1.2 CO_2 emissions based on Environmental-Economic Accounting and IPCC concept

CO_2 emissions will be calculated and presented in accordance with the concept of Environmental-Economic Accounting (see Chapter 2.1). This concept differs from that of the Intergovernmental Panel on Climate Change (IPCC), which is binding for international reporting on greenhouse gases. The Environmental-Economic Accounting concept is more comprehensive than the IPCC concept: In addition to the emissions according to the IPCC it includes the emissions arising from the combustion of biomass – in Germany predominantly wood – and emissions arising from international aviation and shipping. In international reporting these emissions only appear as "memo item". But they are ignored as far as total figures are concerned. Apart from this, according to the Environmental-Economic Accounting concept, the emissions in road traffic from fuel purchased abroad is included (minus emissions arising from fuel purchased by non-residents). The delimitations made in the Environmental-Economic Accounting are geared to the definitions and delimitations of the economic performance parameters used in the national accounts. According to the international system of national accounts (SNA 2008), the measurement of activities refers to the economic units (residents) in an economic area. This means that the calculation of energy consumption and CO_2 emissions in Environmental-Economic Accounting is also based on the residence concept. Here, both in the case of the domestic industries and that of the private households, road transport performance and fuel purchases outside the economic area are included, while those relating to foreign units in Germany are excluded. Mind you, the consumer expenditure of German residents abroad (travel expenditure) is not taken into consideration in the calculations. The delimitation of consumer expenditure follows that of the national input-output tables.

1.3 Producing energy input-output tables for 2000 and 2007 and calculating (primary) energy and CO_2 coefficients

To implement the energy and CO_2 analysis model a first step was to carry out work on producing a sufficiently disaggregated (energy) IOT for reporting years 2000, 2005, 2006 and 2007. Based on the national IOT in a breakdown into 71 branches further subdivisions were made for the energy sectors and other important energy-intensive sectors such as the chemical and nonferrous metal industries (see Chapter 4.3.1). In subdividing the energy sectors the breakdown largely used was that into energy generation and conversion sectors customary in the energy balance sheets. The basic chemical industry and the aluminium production and processing industries were disembedded from the chemical industry and the nonferrous metal industries respectively (the aggregated hybrid energy IOT for 2000 and 2006 appear in the Appendix, see Tables 1 and 2).

For the sake of computational accuracy a hybrid compilation strategy was chosen when drawing up the IOT and the input-output analysis. With this approach the IOT includes details in both monetary and physical units in the evidence of upstream links and of the end use of goods. Methodological notes on this compilation approach can be found in Chapter 4.1. Details in physical units are provided in the IOT for the energy sectors and for the steel production and processing sector (here however only in the case of calculations for the countries supplying Germany with imported goods). The hybrid compilation approach facilitates – in domestic calculations – the complete integration of quantitative information on the use of energy from the energy flow account of Environmental-Economic Accounting. In calculating imports, details from the energy balance sheets (see Chapter 4.3.2) and from the special calculations for the steel and aluminium sector (Chapter 4.3.3 and 4.3.4) can be used directly for the supplier countries.

For calculating the sector-specific CO_2 coefficients – unlike energy input – recourse was made to the NAMEA-Air tables for European supplier countries. This information was fully integrated in the calculations. For the non-European supplier countries specific coefficients were deduced and incorporated for the energy sectors and for the steel and aluminium industries. The intention is to calculate and use further sector-specific coefficients for a later calculation point – based on energy balance sheets and details arising from the national emission inventories on greenhouse gases.

1.4 Determining the final demand – calculating imports by country of origin

In the case of imports a special evaluation of foreign trade statistics subdivided into 14 supplier countries was carried out (see Chapter 4.2.1). As far as imports were concerned, re-exports were estimated on a country-by-country basis and eliminated from the imports. Imports of services were estimated country by country using information from balance of payments statistics. Total imports, based on supplier country, were broken down in the subsequent computational sequence into final use goods and upstream goods (see Chapter 1.5).

1.5 Calculation segments for the IO analysis/ production- and consumption-orientated approach

According to the calculation segments (see Overview 2) separate computational sequences were defined and drawn up for the use categories "export", "private consumption" and "final use as a whole".

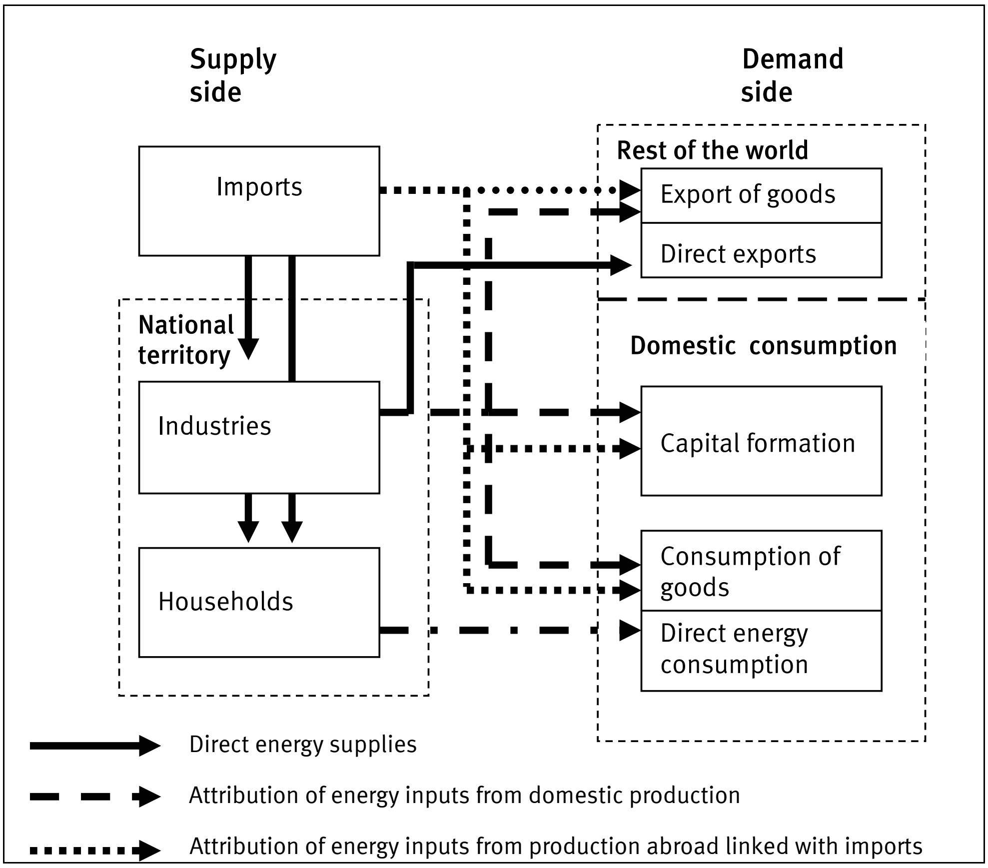
For imports a separate calculation is carried out for upstream goods. In this case a distinction is made first of all for every supplier country between imports of goods for final use and upstream goods. For the upstream goods this is followed by an assignment to the final use categories (the domestic final demand). And so for example this calculation facilitates a calculation of the entire energy used in connection with the production of export goods. In addition to the domestic production cost the imported materials and supplies, with their energy and CO_2 content, which are used in the domestic production of exports, are included.

The calculations have been so structured that an evaluation of the results on energy content and CO_2 emissions is possible, both in terms of goods for final demand (categories) and industies. This facilitates both a production-orientated and a consumption-orientated analysis.

The energy consumption of an economy is generally shown by reference to the territory of the country and comprises the energy consumption in the territory of a country (territorial principle). The most important energy parameter for comparisons based on time and space – primary energy consumption in that country – relates to the domestic consumption of primary energy. This is determined by deducting energy exports and the increase in energy stocks from the domestic output of primary energy. The primary energy consumption of an economy includes, along with the entire consumption of final energy, the losses involved in converting energy sources and the energy consumption of the energy sectors plus non-energetic consumption of energy sources.

As an alternative to the territorially related recording of energy consumption – and of greenhouse gases – energy consumption, and the emission of greenhouse gases, can be determined on a consumption-orientated basis. With this approach the link is the domestic consumption of goods (consumer goods and consumption for capital formation). To this is assigned the entire energy consumption that is necessary to produce those goods (products and services) – domestically and abroad – (see Diagram 1).

Diagram 1: Production-orientated and consumption-orientated approach



Along with this assignment of energy consumption by branches the consumption-orientated approach – as does the production-orientated approach (or territorial approach) – includes direct energy consumption by private households. In the consumption-orientated approach the energy used that arises domestically in the production of export goods is not assigned to domestic consumption but to consumption by the rest of the world.

Overview 1: Calculation of energy consumption and CO_2 emissions from the supply and demand side

	What is calculated?	Where is it calculated?
Supply side (national territory)	Direct energy consumption on the national territory (domestic supply) Emissions on the national territory	National territory: Consumption sectors, emission groups: – power plants, other transformation units – Industry – Private households – Small businesses – Transport
Demand side	Direct energy consumption/ emissions from private households	Private households
	Incl. energy consumption/ emissions at the production of goods on the national territory (consumer goods, investment)	Domestic industries
	Excl. energy cons./emissions at the production of export goods	
	Incl. energy cons./emissions at the production of imports	Industries from the rest of the world

The project has as an objective the development of a calculation model that facilitates a calculation of energy consumption and carbon dioxide (CO_2) emissions in line with the consumption-orientated approach. Here, on the consumption side, exports and the consumption of private households are considered separately. Energy consumption and emissions connected with the production of export goods are "loaded" from the consumption point of view not onto domestic but onto foreign consumption. From the production point of view a distinction is made between energy consumption by domestic branches to produce goods for export and for domestic demand and energy consumption by branches of abroad in order to produce (German) imports (Overview 2).

Overview 2: Calculation segments for the energy I/O model

Energy consumption of industries/branches	Categories of goods	Allocation to …	Origin
on the national territory	Mf. of export goods (incl. intermediate products)	Export	National territory
	Mf. of consumption goods	Consumption	National territory
	Mf. of other goods	No explicit analysis!	National territory
in the rest of the world	Mf. of intermediate goods for exports to Germany	Export	Imports
	Mf. of intermediate goods for consumption goods	Consumption	Imports
	Mf. of consumption goods	Consumption	Imports
	Mf. of other imported goods	Imports	Imports

The individual calculation segments are aimed at enabling a more precise analysis of goods categories:

Analysis of consumption:

- What demand for goods is associated with a high specific energy input?
  - How has energy input changed over time in terms of monetary demand (energy intensity)?
  - What proportion of energy content have foreign consumer goods compared with domestic?
  - How much energy is used in the manufacture of exports as a whole?
  - What is the importance of the imported materials and supply used in the production of export goods in Germany? Have the proportions of domestic production and imports shifted over time (offshoring)?
- An**alysis of imports:**
  - How much energy is used for the production of imported goods overall?
  - Which countries of origin have what proportions of the total energy used?
  - Is the energy used for producing goods abroad higher than is the case with domestic production?

- Is the total energy used in producing imported goods higher than is the case with the domestic production of export goods (extended foreign-trade balance sheet: see Diagram 3)?
- What demand factors – demand for finished products, raw materials and intermediate products – contribute to the energy used abroad?

2 Results

2.1 The most important results

Direct CO_2 emissions in Germany

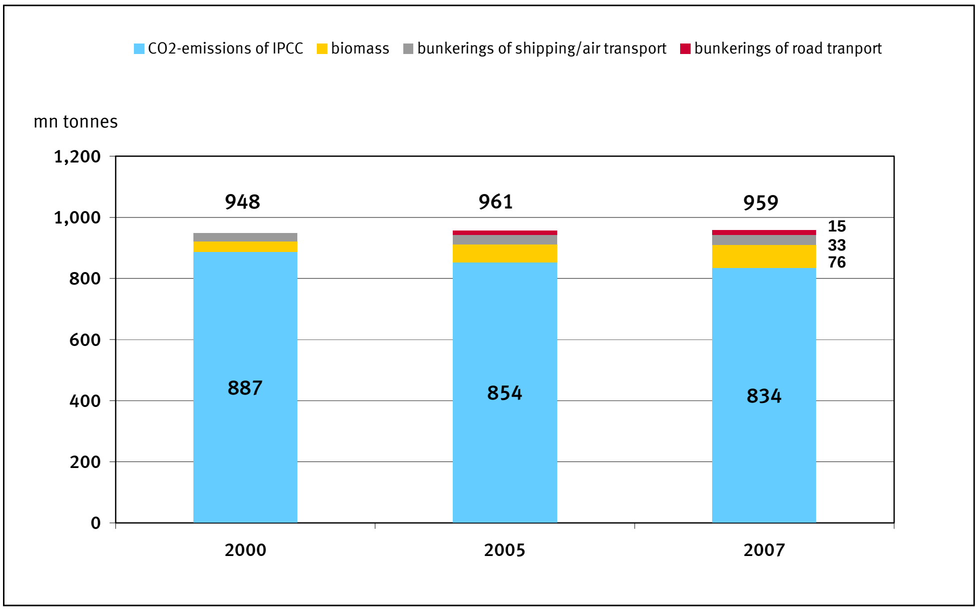
As far as direct CO_2 emissions are concerned, in 2007 these amounted domestically – within the delimitation of the Environmental-Economic Accounting – to 959 million tonnes*. Of these 755 million tonnes related to the (domestic) branches, 204 million tonnes to private households. In 2000 CO_2 emissions amounted to 948 million tonnes.

CO_2 emissions from biomass

Delimitation according to the Kyoto protocol

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 these emissions more than doubled (2000: 33 million tonnes, 2007: 76 million tonnes). Excluding the emissions from biomass, 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).

Diagram 2: CO_2 emissions of Germany according the concepts EEA and IPCC



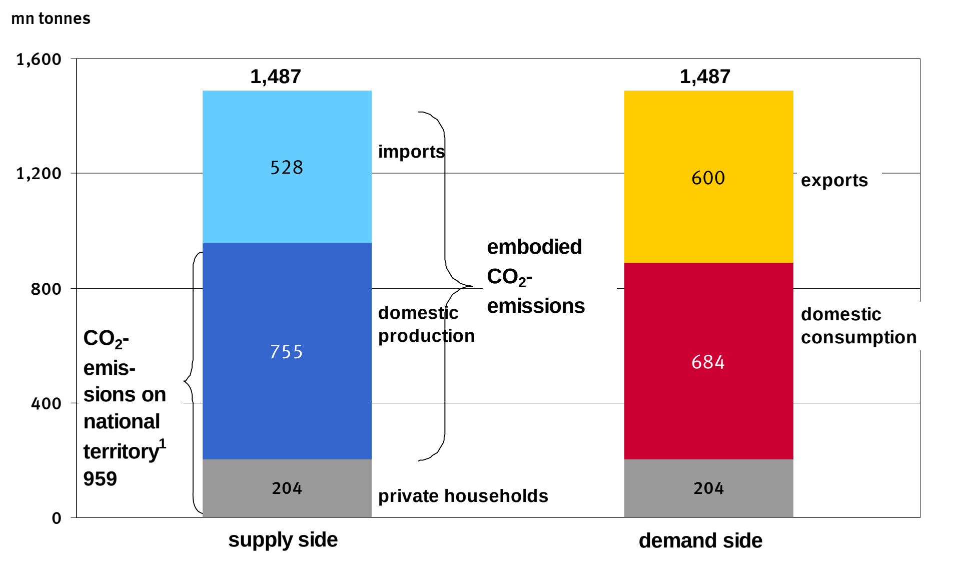
*) Including emissions from biomass, from bunkering by residents in international shipping and aviation and from fuel purchased abroad in road traffic.

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

Emissions abroad

Further CO_2 emissions arise from the production of imported goods. These amounted to 528 million tonnes in 2007. That is more than half (55.1 %) of all domestic emissions (2007: 959 million tonnes). In 2000 it was still 444 million tonnes (46.8 %).

Diagram 3: CO_2 emissions and embodied CO_2 in Germany 2007



1) Acc. to national accounts concept, incl. biomass and bunkering.

Emission changes between 2000 and 2007

The entire volume of CO_2 emissions rose 6.9 % from 1,392 million tonnes to 1,487 million tonnes between 2000 and 2007, which was much more than the domestic volume (+1.2 % from 948 million tonnes to 959 million tonnes). The reason for this rise is on the one hand the sharp rise in the emission content of imported goods and on the other a very sharp rise in exports (+44.2 % from 416 million tonnes in 2000 to 600 million tonnes in 2007).

Emissions of imported goods

The CO_2 emissions of imported goods rose by 19.0 % from 444 million tonnes to 528 million tonnes between 2000 and 2007. The domestic emissions of the branches and private households have only risen by 1.2 % from 948 to 959 million tonnes. This means that domestic CO_2 emissions have been shifted abroad. A primary reason for this shift lies in the well above-average growth in emissions from imported goods required for producing export goods.

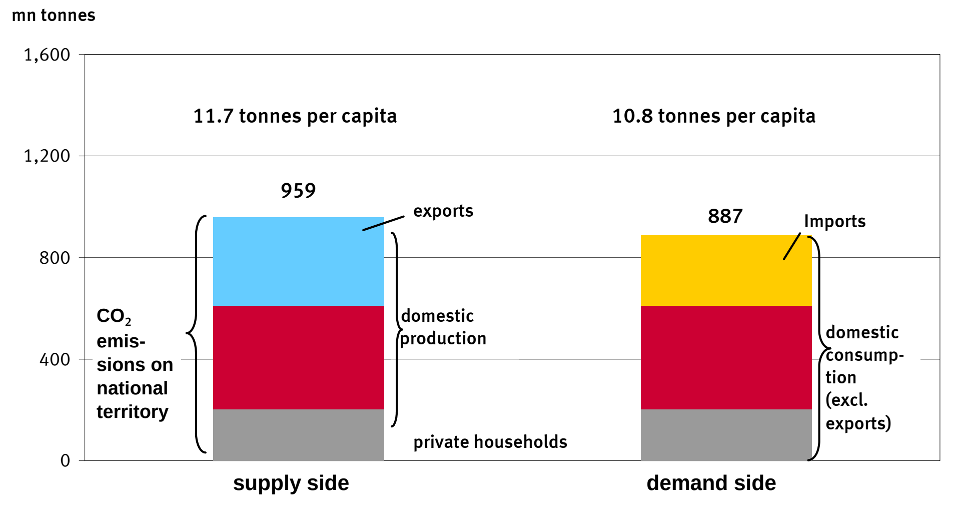
Emissions per capita based on source

Based on source every inhabitant was responsible for 11.7 tonnes of CO_2 emissions in 2007. These emissions comprise all the emissions arising domestically. Based on consumption per-capita emissions amounted to 10.8 tonnes. Emissions based on consumption were less than emissions based on source, because overall more emissions arose in the course of producing exports than imports.

Emissions per capita based on consumption

Emissions based on consumption only include the emissions arising from the domestic consumption of goods and from the direct consumption of fuels by private households. They also include the CO_2 emissions arising from the production of imports for domestic consumption. They do not however include the emissions arising from the production of exports which in terms of consumption are assigned to the countries for which the exports are intended.

Diagram 4: CO_2 emissions in Germany 2007 – per capita



1) Incl. emissions from biomass and bunkering.

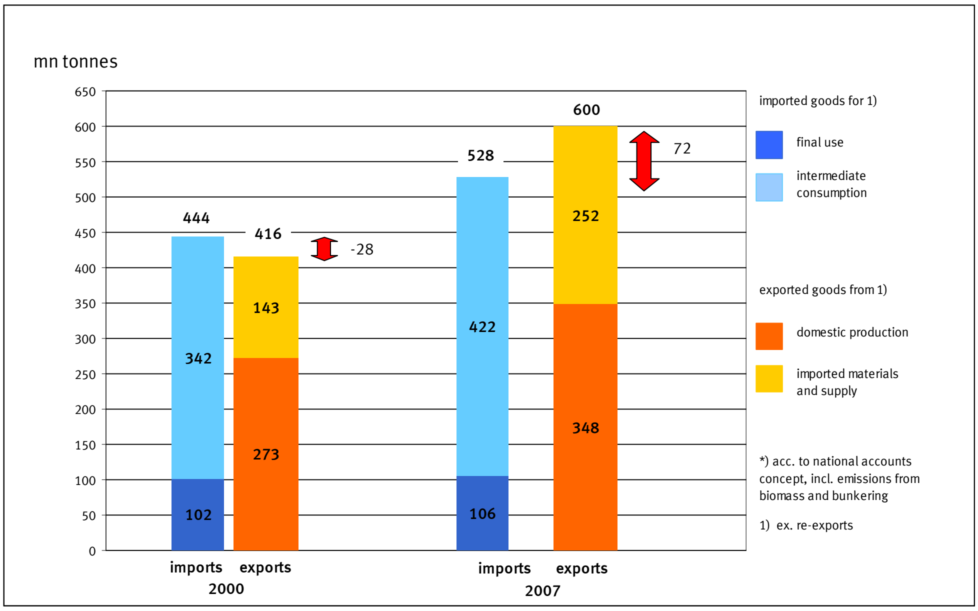
Emission content of the exports

The emissions connected with exports have grown even more strongly than those related to imports. They have grown by 44.2% from 416 million tonnes to 600 million tonnes.

Foreign trade balance for the CO_2 emissions

The emission content of exports in 2007 rose by 72 million tonnes more than that of imports. In 2000 the emission content of imports was still 28 million tonnes higher than that of exports.

Diagram 5: Embodied CO_2 emissions of imports and exports



CO_2 emissions of exports and domestic production

Of all domestic emissions of the branches in 2007 just under half (46.1 %) is connected with the production of exports. In 2000 the proportion was only 38.1 %.

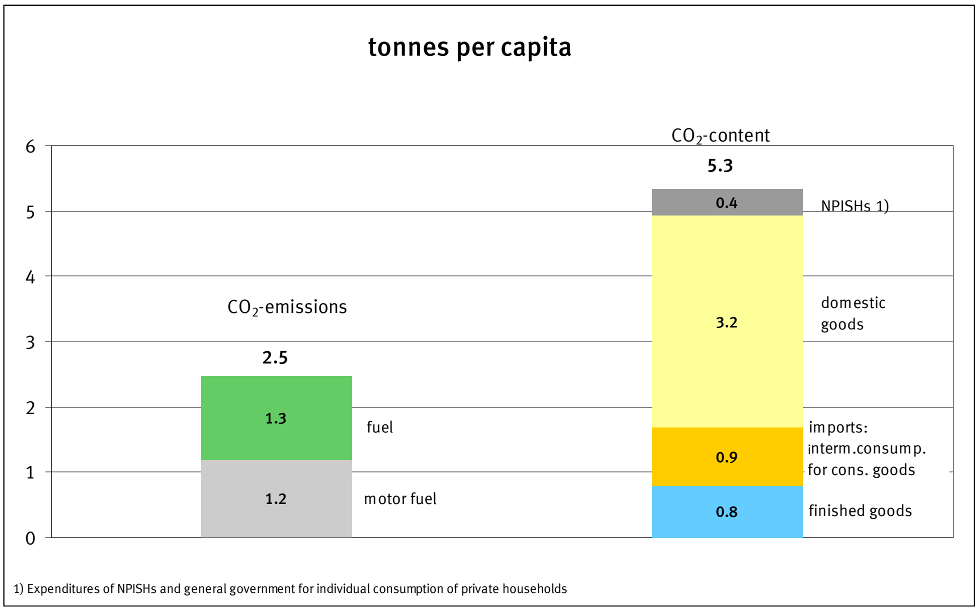
Emissions related to imported intermediate products

A high proportion of the total emissions for exports relates to intermediate products and materials from abroad. Emissions related to the production of these intermediate products in 2007 was 42 % of the emission content of the exports, in 2000 it was only 34 %.

CO_2 emissions of private households (carbon footprint)

The total CO_2 emissions assignable to private households (carbon footprint) averaged 7.8 tonnes in 2007. The CO_2 emissions connected with consumer goods (5.3 tonnes) came to more than twice that of the direct CO_2 emissions (2.5 tonnes) of private households.

Diagram 6: CO_2 emissions of private households and CO_2 content of private consumption goods 2007



Direct CO_2 emissions of households

The direct CO_2 emissions of private households were split more or less equally between heating fuels (1.3 tonnes) and petrol/diesel etc (1.2 tonnes).

CO_2 content of consumer goods

Of the total CO_2 content of consumer goods (2007: 4.9 tonnes, excluding emissions by private organisations and the state) 1.7 tonnes or 35 % related to emissions associated with the production of imported consumer goods (including imported materials and supplies linked to the production of consumer goods in Germany). In the case of purchases the import share is 24.9 %. This means that the production of imports, by comparison with that of domestic goods, entails a higher expenditure of energy and CO_2 emissions per euro value. 3.2 tonnes CO_2 per capita – that is 65% of all indirect emissions – relate to the domestic production of consumer goods.

In Germany most emissions are concerned with the provision of electricity: in 2007 this amounted to 36 % of all domestic emissions. The second-highest proportion relates to trade services connected with the purchase of consumer goods.

These came to 13.1 %. These are followed by emissions from (third-party) traffic performance with a proportion of 9.3 %.

Emission content of imports – food, motor vehicles

In the case of imports most CO_2 emissions relate to the production of food: In 2007 this was 13.9 % of all emissions related to imported finished products. The second highest emissions were caused by vehicle imports (13.4 %).

Public services for individual consumption

Further emissions arise from the provision of services by private organisations and the state for individual consumption (excluding services provided by public administration). These can also – like expenditure – be assigned to private households. The CO_2 emissions arising from services in the area of education, health (GP and hospital services), culture and sport amount to 0.4 tonnes per capita.

2.2 Output and use of energy and CO_2

The direct output of energy (= total use of energy sources) in Germany in 2007 was 25.5 EJ. Adjusted by double countings of energy arising from the domestic conversion of energy sources, an output of (direct) primary energy (= primary energy consumption) of 16.7 EJ and domestic primary energy consumption of 14.3 EJ (= 16.7 – 2.4 EJ exports) results.

Table 1: Supply and use of energy 2000 – 2007

Category			2000	2007	2000	2007	2000	2007
			Direct		Indirect 1)		Cumulated	
			petajoule					
1		Domestic production	12,099	13,163			12,099	13,163
2	+	Imports	12,279	12,472	7,488	8,826	19,767	21,297
3	=	**Supply**	24,378	25,635	7,488	8,826	31,866	34,460
4	-	Transformation output	8,307	8,912			8,307	8,912
5	=	**Supply of primary energy**	**16,071**	**16,723**	**7,488**	**8,826**	**23,560**	**25,549**
6	-	Homogeneous branches	10,381	10,580	-10,381	-10,580	0	0
7	=	**Final uses**	**5,690**	**6,143**	**17,869**	**19,405**	**23,560**	**25,549**
8	-	Export	1,792	2,428	6,963	9,576	8,755	12,004
9	=	Final domestic uses	3,898	3,715	10,907	9,830	14,805	13,545
		of which:						
10		private hhs / consumption of private hhs	3,914	3,570	6,218	5,745	10,132	9,315
			share as a % of					
1		Domestic production					38.0	38.2
2		Imports	**76.4**	**74.6**	**41.9**	**45.5**	**62.0**	**61.8**
3		**Supply**					100.0	100.0
4		Transformation output	**23.6**	**25.4**				
5		**Supply of primary energy**	100.0	100.0			100.0	100.0
6		Homogeneous branches	64.6	63.3	58.1	54.5		
7		**Final uses**			**100.0**	**100.0**		
8		of which: export	11.1	14.5	39.0	49.3	37.2	47.0
10		private hhhs / consumption of private hhs	24.4	21.3	34.8	29.6	43.0	36.5

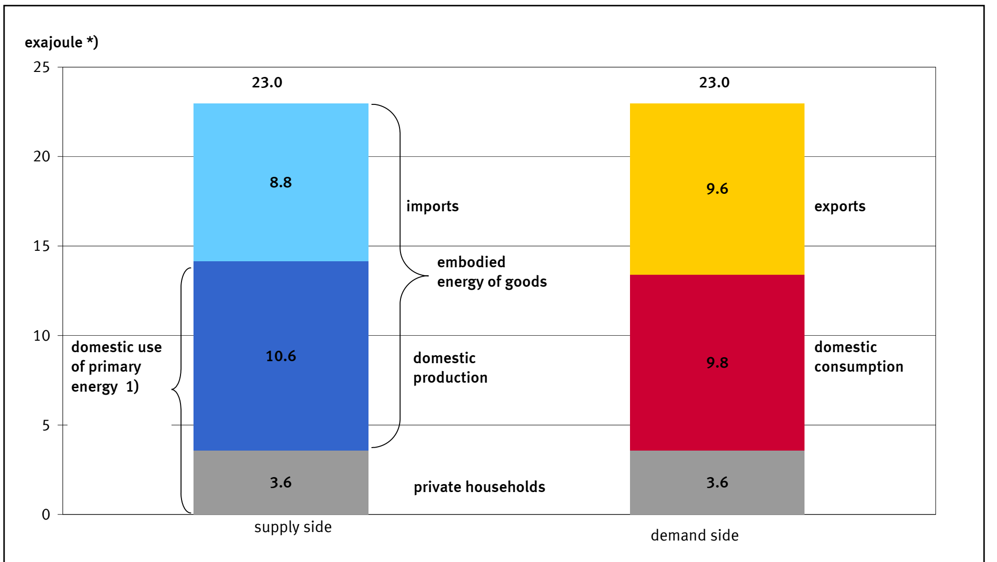
1) Embodied energy of goods for final uses.

A further 8.8 EJ of energy arise – abroad – in the production of imports. This amounts to 52.7 % (= 8.8 / 16.7 EJ) of the domestic output of primary energy. Together with domestic primary energy this produces a cumulative output of primary energy of 25.5 EJ. Deduction of the direct exports of energy sources and the energy content of export goods produces a (cumulative) domestic energy output of 13.5 EJ. This is the entire energy consumption assignable to domestic consumption.

Domestic energy consumption	16.7 EJ (supply side)
+ Energy content of imports	8.8 EJ
= Cumulated energy	**25.5 EJ**
- Energy content of exports	12.0 EJ
= Final domestic uses	**13.5 EJ (demand side)**
Of which:	
Energy consumption of private households	3.6 EJ
Energy content domestic consumption	9.8 EJ

The energy used in producing imports rose by 17.9 % between 2000 and 2007, much more sharply therefore than the output of primary energy (4.1 %). The energy used in producing exports has risen even more sharply than the energy content of the imports – by 37.5 %. After deduction of the cumulative energy content of the exports there is a reduction from 14.8 EJ (2000) to 13.5 EJ (2007) for the cumulative primary energy consumption in Germany (domestic consumption). This corresponds to a percentage reduction in 2007 of just under 9 % compared with 2000.

Diagram 7: Energy consumption and embodied energy of goods 2007



*) 1 Exajoule = 1 EJ = 10^{18} Joule - 1) acc. to national accounts concept.

Table 2: Domestic generation of CO_2 emissions and embodied CO_2 of imports

		Category	2000	2007	2000	2007	2000	2007
			Direct		Indirect 1)		Cumulated	
			mn tonnes					
1		Domestic production 2)	948	959			948	959
2	+	Imports			444	528	444	528
3	=	**Supply**	**948**	**959**	**444**	**528**	**1,392**	**1,487**
4	-	Homogeneous branches	716	755	-716	-755	0	0
5	=	**Supply corrected**	**232**	**204**	**1,159**	**1,284**	**1,392**	**1,487**
6	-	Export			416	600	416	600
7	=	**Domestic consumption** of which:	232	204	743	684	976	887
8		private hhs / consumption of private hhs	232	204	422	405	654	609
			share as a % of					
1		Domestic production 2)	100.0	100.0			68.1	64.5
2		Imports			38.3	41.2	31.9	35.5
3		**Supply**	**100.0**	**100.0**	38.3	41.2	100.0	100.0
4		Homogeneous branches	75.5	78.8	61.7	58.8		
5		**Supply corrected**			**100.0**	**100.0**	**100.0**	**100.0**
6		Export			35.9	46.7	29.9	40.3
7		**Domestic consumption** of which:			64.1	53.3	70.1	59.7
8		private hhs / consumption of private hhs	24.5	21.2	36.4	31.6	47.0	40.9

1) CO_2 emissions generated at the production of goods.
2) Incl. emissions from international bunkering and biomass.

As far as direct CO_2 emissions are concerned in 2007 these amounted domestically – within the delimitation of the national accounting[2] – to 959 million tonnes. Of these emissions 755 million tonnes related to the (domestic) branches, 204 million tonnes to private households. In 2007 CO_2 emissions related to the production of imports amounted to 528 million tonnes. That is more than half – 55.1 % – of domestic emissions.

The CO_2 content of final demand goods (indirect emissions) rose by 10.7% from 1,159 million to 1,284 million tonnes between 2000 and 2007. This means that the CO_2 emissions rose more strongly than the energy content of the goods (2007/2000: + 8.6%).

Together with the direct emissions cumulative emissions for 2007 come to 1,487 million tonnes. After deducting the CO_2 content of the exports from the whole output this produces a CO_2 content of 887 million tonnes for domestic consumption.

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

	CO_2 emissions on the territory	959 mn tonnes (supply side)
–	CO_2 emissions of imports	528 mn tonnes
=	**Cumulated CO_2 emissions**	**1,487 mn tonnes**
–	CO_2 emissions of exports	600 mn tonnes
=	**CO_2 emissions of domestic consumption**	**887 mn tonnes**
	Of which:	
	Direct CO_2 emissions of private households	**204 mn tonnes**
	Embodied CO_2 emissions of private consumption	405 mn tonnes

The consumption-orientated total figure for the CO_2 emissions at 887 million tonnes is 72 million tonnes – i.e. 7.5 % – below the emissions arising in the territory.

The (cumulative) volume of CO_2 emissions rose 6.9 % from 1,392 million tonnes to 1,487 million tonnes between 2000 and 2007, which was much more than domestic output (+1.2 % from 948 mill. tonnes to 959 mill. tonnes). The reason for this rise is the sharp increase in the energy content of imports which rose by 19.0 % (from 444 million tonnes to 528 million tonnes).

Even sharper than the rise in emissions for imports is the rise in CO_2 emissions of exports – by 44.2 % (from 416 million tonnes to 600 million tonnes).

In the case of goods for domestic consumption there is a 3.9 % drop in CO_2 emissions. The CO_2 content of consumer goods dropped from 422 million tonnes (2000) to 405 million tonnes (for further details see Section 2.6.).

2.3 Energy and CO_2 content of goods (indirect energy consumption or indirect emissions)

Energy

The energy content of the total final demand of goods (domestic consumption and exports) rose by 8.6 % from 17.9 EJ to 19.4 EJ between 2000 and 2007. This is in particular due to the rise in the final demand for goods requiring an increased energy input.

Table 3: Final use of goods 2000 – 2007 and embodied energy of goods

	Final use categories	2000	2005	2007	2007/2000
			Euro bn		in %
	Final use from ...				
1	Domestic production	2,261	2,504	2,768	22.4
2	Imports (final use 1)	180	182	210	16.9
3	Total (1+2)	2,441	2,686	2,978	22.0
4	Imported materials and supply	358	426	526	46.8
5	Total imports (2+4) 1)	538	608	736	36.8
6	**Total uses (3+4)**	**2,799**	**3,112**	**3,504**	**25.2**
			% of total use		%-points
	Final use from ...				
1	Domestic production	80.8	80.5	79.0	-1.8
2	Imports (final use 1)	6.4	5.8	6.0	-0.4
3	Total (1+2)	87.2	86.3	85.0	-2.2
4	Imported materials and supply	12.8	13.7	15.0	2.2
5	Total imports (2+4) 1)	19.2	19.5	21.0	1.8
6	**Total uses (3+4)**	100.0	100.0	100.0	
			petajoule		in %
	Embodied energy of goods for final uses				
1	Domestic production	10,381	10,617	10,580	1.9
2	Imports	1,677	1,601	1,714	2.2
3	Total (1+2)	12,059	12,219	12,294	2.0
4	Imported materials and supplies	5,811	6,257	7,112	22.4
5	Total imports (2+4)	7,488	7,859	8,826	17.9
6	**Total embodied energy (3+4)**	**17,869**	**18,476**	**19,405**	**8.6**
			% of total energy		%-points
	Embodied energy of goods for final uses				
1	Domestic production	58.1	57.5	54.5	-3.6
2	Imports	9.4	8.7	8.8	-0.6
3	Total (1+2)	67.5	66.1	63.4	-4.1
4	Imported materials and supplies	32.5	33.9	36.6	4.1
5	Total imports (2+4)	41.9	42.5	45.5	3.6
6	**Total embodied energy (3+4)**	100.0	100.0	100.0	

1) Excl. re-exports.

Other factors also influence the results for the entire energy content, such as the composition of energy consumption in terms of energy source, the efficiency of energy generation and the origin of the imports as far as the supplier country is concerned.

The total final demand rose – in relevant prices – by 25.2 % in this period. This means that imports had much stronger growth than domestic production. They rose nominally by 36.8 %, while the final demand from domestic production only increased by 22.4 %. There was a particularly high level of growth in the imports of upstream goods with a rise of just under 47 % between 2000 and 2007.

As a consequence of this increase in demand for imports the rise in the energy content of the imports between 2000 and 2007 was above average at 17.9 %. On the other hand the energy content of products from domestic production rose only slightly by 1.9 %.

The reason for the high level of growth in imports in particular was the rise in imported materials and supplies. The sharp rise in demand for these goods led to a rise in the energy content by 22.4 % (from 5.8 EJ in 2000 to 7.1 EJ in 2007). The energy content of all imports rose from 7.5 EJ (2000) to 8.8 EJ (2007), i.e. by 17.9 %. This means that about 80 % of the entire energy used abroad for producing imports relates to the production of imported upstream goods.

The sharp growth in imported materials and supplies is closely connected with the sharp growth in exports. An increased relocation of (partial) production processes abroad and an increase in the purchase of intermediate products from abroad – based on a change in international work-sharing – has meant that imported materials and supplies have been used to a greater extent in the production of exports (see Section 2.4., Table 5).

Table 4: CO_2 emissions at the production of goods by use categories

Use categories	2000	2007	07/00	2000	2007
	mn tonnes		%	% of total	
	Goods from domestic production and imports				
Total final use	1,159	1,284	10.7	100.0	100.0
Exports	416	600	44.2	35.9	46.7
Final domestic use	743	684	-8.0	64.1	53.3
Of which:					
Consumption of private households	422	405	-3.9	36.4	31.6
	Goods from domestic production				
Total final uses	716	755	5.6	100.0	100.0
Exports	273	348	27.7	38.1	46.1
Final domesticl uses	443	407	-8.0	61.9	53.9
Of these:					
Private consumption expenditure	279	266	-4.5	38.9	35.2
Final consumption of NPISHs	5	4	-7.2	0.7	0.6
Government final cons. expenditure	52	47	-8.1	7.2	6.3
Fixed capital formation	89	72	-19.0	12.4	9.5
Inventories	19	18	x	2.7	2.3
	Imports				
Total final use	444	528	19.0	100.0	100.0
Export	143	252	75.7	32.3	47.7
Final domestic use	300	276	-8.0	67.7	52.3
Of which:					
Consumption of private households	143	139	-2.8	32.3	26.4

A total of 1,284 million tonnes of CO_2 were released in the production of goods for domestic consumption and exports in 2007. Of this 46.7 % related to the production of exports and just under 31.6 % to the production of consumer goods. The remaining emissions have been assigned to capital goods and goods for government consumption. The CO_2 content of exports increased by a good 44 % to 600 million tonnes between 2000 and 2007. On the other hand the CO_2 content of consumer goods dropped by 3.9 % from 422 to 405 million tonnes.

This means that the production of exports is the most significant source for CO_2 emissions. This applies both to domestic production (proportion of exports: 46.1 %) as to imports. In the case of imports the upstream imports for producing exports in Germany in particular enjoyed a substantial rise of 75.7 %. 47 % of the CO_2 emissions related to imports are connected with exports.

2.4 CO_2 emissions of imports and exports

Imports

528 million tonnes, i.e. 41 % of all CO_2 emissions connected with the production of goods in 2007 were assigned to the production of imports. In 2000 it was still 444 million tonnes or 38.3 %. This means that the emissions of imports in 2007 rose 19.0 % compared with 2000.

The emissions of imports connected with exports had a particularly high increase of a good 75 %. These are the emissions involved with the production of imported upstream goods which are required for the domestic production of exports. 42 % of the emissions relating to exports as a whole must be assigned to these imports.

The emissions connected with imported materials and supplies for exports are closely related to the domestic production of exports.

Table 5: Exports of goods and imported materials and supplies

Commodities	Exports				Imported materials and supplies / intermediate consumption		
	2007	2000	2007	07/00	2000	2007	change in
	Rank	Euro 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.

Table 5 shows the high nominal growth of exports (domestic production excluding re-exports) between 2000 and 2007 of 63.1 %. The five most significant branches in terms of value increased their exports between 43 % and 64 %.

The proportion of imported materials and supplies in intermediate consumption as a whole rose from 18.6 % to 21.3 %. The non-ferrous metals sector, and the production of office machines and EDP equipment enjoyed a particularly strong increase.

If one only takes account of the goods and ignores the – less CO_2-intensive – provision of services, the proportion of goods imports in the utilisation of goods as a whole rose from 28.3 % (2000) to 30.3 % (2007).

These factors – the dynamic growth in exports and the increase in the purchase of imported materials and supplies – have made a significant contribution to the rise in CO_2 emissions of imports.

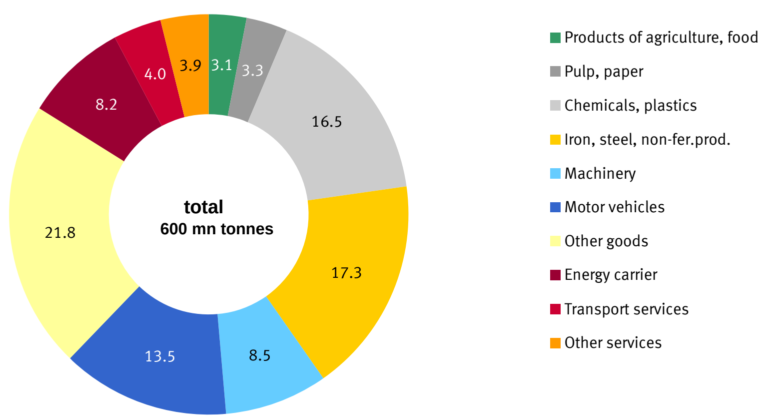
The branch "generation of electricity" has the highest share (35.2 %) of the CO_2 emissions of imported goods, followed by the production of steel with a share of 28.3 %.

Exports

600 million tonnes of CO_2 emissions were related to exports in 2007. In 2000 it was 416 million tonnes. This means that the CO_2 emissions related to exports rose by 44.2 % between 2000 and 2007.

In the case of exports the highest proportions of CO_2 emissions related to iron and steel products and non-ferrous metals (17.3 %), followed by chemical products and plastics (16.5 %). Motor vehicles account for 13.5 % of CO_2 emissions by exports and the energy sources 8.2 %.

Diagram 8: CO_2 emissions of exports by type of goods 2007 (percentage)



1) Excl. re-exports.

2.5 Foreign trade balance for energy and CO_2

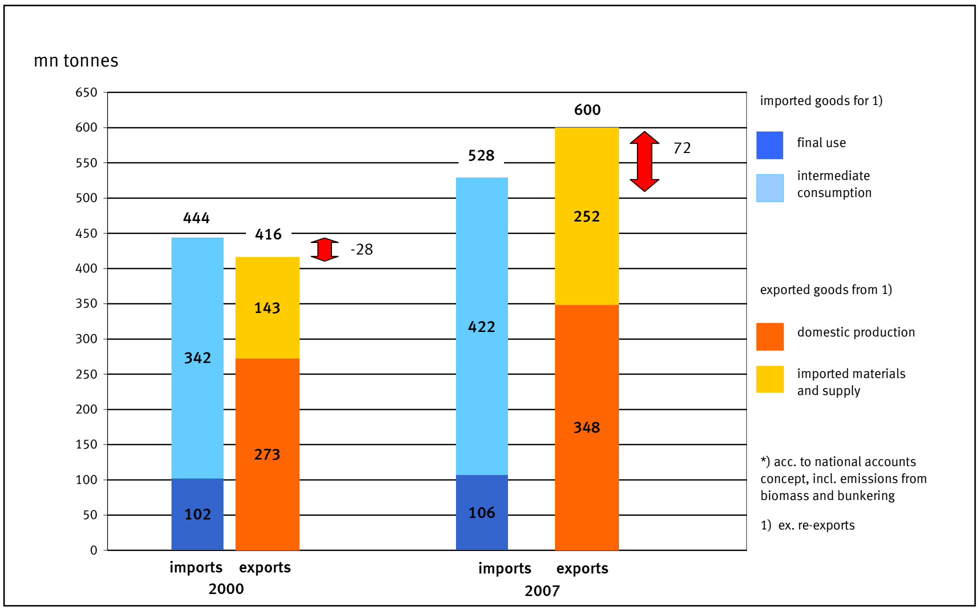
CO_2 emissions

Table 6: CO_2 emissions of imports and exports

	Use categories	2000	2005	2007	2007/2000
			Euro bn		ch. in %
1	**Imports**	538	608	736	36.8
2	for final use	180	182	210	16.9
3	materials and supplies	358	426	526	46.8
4	Exports	670	900	1,116	66.6
5	Re-exports	93	140	176	88.8
6	**Net-exports (domestic production) (4 - 5)**	577	760	940	63.1
7	Total domestic production	3,786	4,187	4,651	22.8
8	of which: for final use	2,261	2,504	2,768	22.4
9	**Net-exports - imports (6 - 1)**	**39**	**152**	**204**	
			share %		ch. in %-pts.
10	Net-exports	25.5	30.4	34.5	9.0
11	Domestic production for final uses	100.0	100.0	100.0	
			embodied CO_2		
	CO_2 for the production of ...		mn tonnes		ch. in %
12	**Imports**	444	452	528	19.0
13	for final use	102	95	106	4.5
14	materials and supplies	342	357	422	23.4
15	**Net-exports**	416	504	600	44.2
16	from domestic production	273	316	348	27.7
17	imported materials and supplies	143	188	252	75.7
18	Total domestic production	716	733	755	5.6
19	Indirect CO_2 total (12 + 18)	1,159	1,185	1,284	10.7
20	**Net-exports - imports (15- 12)**	**-28**	**52**	**72**	
			share %		ch. in %-pts.
22	Net-exports (domestic production)	38.1	43.1	46.1	8.9
23	Domestic production	100.0	100.0	100.0	

*) Excl. re-exports.

Diagram 9: Embodied CO_2 emissions of imports and exports



In 2005 and 2007 as a whole more CO_2 emissions arose in the production of exports than in the production of imports. The export surplus came to 72 million tonnes of CO_2 in 2007.

CO_2 emissions 2007

Exports	600 mn tonnes
Of which:	
Domestic production	348 mn tonnes
Imported materials and supply	252 mn tonnes
Imports	528 mn tonnes
Balance exports minus imports	72 mn tonnes

The CO_2 emissions from the domestic production of exports rose from 273 million tonnes (2000) to 348 million tonnes (2007) (+ 27.7 %). The reason for this high level of growth was the rise in the production of exports which rose – nominally – by 63.1 %. The emissions of the domestic branches in the production of exports amount to almost half the total emissions emitted by the branches (2007: 46.1 %).

The emissions from the imported upstream goods have risen even more strongly than the emissions from the domestic production of exports – by 75.7 %. These emissions have risen proportionately to a good 40 % of the total emissions of exports. In 2000 the proportion was just 34 %.

2.6 Private consumption

2.6.1 CO_2 content of goods by demand area (per capita)

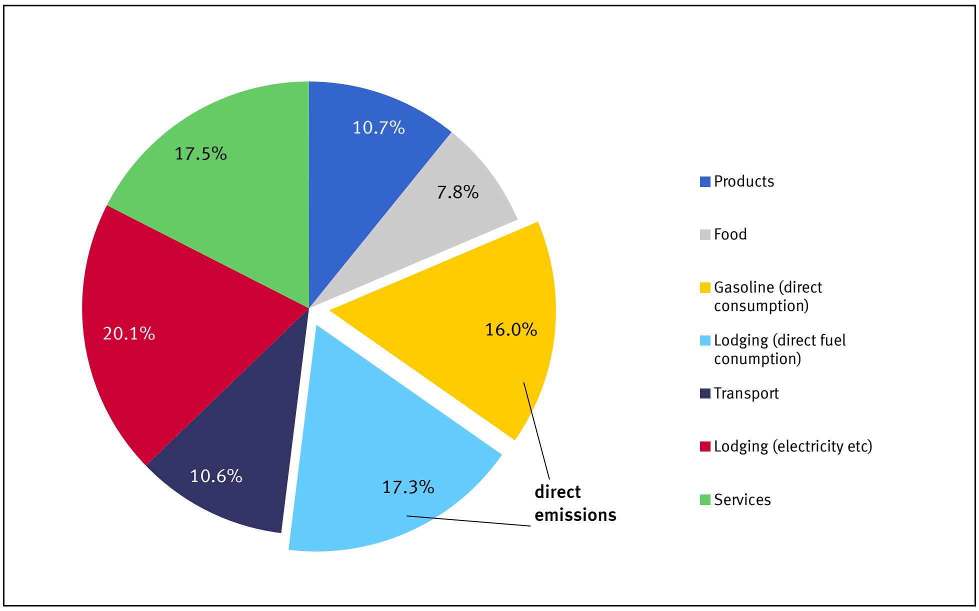
In 2007 the total direct and indirect CO_2 emissions by private households came to 609 million tonnes or 7.4 tonnes per capita.

Direct CO_2 emissions and CO_2 content of consumer goods in 2000 and 2007:

	2000	2007	2000	2007
	mn tonnes		tonnes per capita	
Direct emissions	233	204	2.8	2.5
Of which: dwelling	131	106	1.6	1.3
Gasoline	101	98	1.2	1.2
Embodied CO_2 of consumer goods	422	405	5.1	4.9
Total emissions	654	609	**7.9**	**7.4**

Table 7 shows the consumption expenditure (at production prices), the energy and CO_2 content of goods for private consumption including the direct energy consumption of private households in the "dwelling" area and for motorised individual transport and the associated CO_2 emissions by demand area.

Diagram 10: CO_2 emissions of private households and embodied CO_2 of consumer goods 2007 (percentage)



With a proportion of 37.1 % most emissions come into the "dwelling" area: the emissions of utilised fuels make up 17.4 % of total emissions. Somewhat higher emissions – 19.8 % – arise in the generation of the fuels and especially in generating the electricity used in the household. The CO_2 emissions involved in generating electricity and district heating make up the highest proportion of emissions of all positions (16.9 %).

26.8 % of all emissions must be assigned to the area of “transport” (mobility). Along with (direct) emissions from fuel consumption these are the assignable emissions arising from the production of motor vehicles and emissions by the motor vehicle trade and from motor vehicle repairs.

17.5 % of the CO_2 emissions occur in the area of “services”. The largest individual sectors are trade with 6.4 % and hotel and restaurant services with 2.9 % of total emissions.

Food accounts for 7.8 % of all emissions. The remaining products make up 10.8 %.

Alongside direct emissions from households and assignable emissions of consumer goods further services with their emissions can be assigned to private consumption: the expenditure of private organisations and the government expenditure for individual consumption. These comprise expenditure for educational provisions, health services (GP and hospital services) and services in the area of culture and sport. In providing these services CO_2 emissions amounted to 34 million tonnes or 0.4 tonnes per capita.

Table 7: Household final consumption expenditure, embodied energy and embodied CO_2 2007 – per capita

CPA	Areas of demand	Household expenditure 1)	Embodied energy	Embodied CO_2	
		1,000 Euro	1,000 KWh	tonnes	in %
	Households final consumption expenditure	**14.120**	**31.457**	**7.404**	**100**
	Products	**1.806**	**3.782**	**0.797**	**10.8**
17.18	Textiles, furs	0.319	0.653	0.133	1.8
21.22	Paper, publishing	0.267	0.412	0.089	1.2
24-25	Chem. prod, rubber, plastic	0.267	1.020	0.204	2.8
30-33	Office and elect. machinery	0.175	0.245	0.052	0.7
36-37	Furniture, jewelery, music. Instruments etc.	0.244	0.453	0.096	1.3
	Other products	0.534	0.999	0.223	3.0
	Food	**1.156**	**2.514**	**0.579**	**7.8**
01	Agricultural products.	0.187	0.446	0.107	1.4
15	Food., tobacco	0.969	2.068	0.472	6.4
	Transport	**1.780**	**7.932**	**1.982**	**26.8**
34	Motor vehicles and eqipment	0.621	1.364	0.310	4.2
50	Trade, repair services of vehicles	0.390	0.319	0.062	0.8
	Fuel (direct)	0.279	4.562	1.192	16.1
60.1	Transport via railways	0.105	0.379	0.087	1.2
60.2	Other land transport	0.142	0.238	0.059	0.8
61	Water transport	0.023	0.036	0.013	0.2
62	Air transport	0.139	0.903	0.226	3.1
63	Auxiliary transport services	0.081	0.130	0.032	0.4
	Habitation	**3.147**	**11.639**	**2.749**	**37.1**
70	Real estate services	2.709			
	Energy direct	0.438	7.493	1.285	17.4
10	Coke	0.005	0.133	0.046	0.6
11	Natural gas	0.079	3.031	0.611	8.3
23	Heavy fuel, light fuel, liquid gas	0.000	1.429	0.377	5.1
40.1-3	Electricity, district heating	0.353	2.229	0.000	0.0
	Biomass, other renewable energies		0.671	0.251	3.4
	Energy indirect		4.146	1.464	19.8
10	Coal		0.007	0.001	0.0
11	Natural gas		0.133	0.028	0.4
23	Coke, mineral oil products		0.891	0.187	2.5
40.1/3	Electricity, district heating		3.116	1.248	16.9
	Services	**6.232**	**5.590**	**1.296**	**17.5**
51-52	Retail and wholesale trade	2.054	2.048	0.473	6.4
55	Hotel, restaurant services.	0.768	0.936	0.214	2.9
85	Health services and social work.	0.678	0.404	0.089	1.2
65-95	Other services	2.732	2.202	0.520	7.0
	Direct		**12.055**	**2.478**	**33.5**
	Indirect		**19.402**	**4.926**	**66.5**
	of which imports 2)	1.515	7.884	1.693	22.9
	Total	**14.120**	**31.457**	**7.404**	**100.0**
	NPISHs and general government services for individual consumption				
80	Education services	1.075	0.545	0.127	1.7
85	Health services	1.900	1.106	0.252	3.4
92	Cultural and sport services	0.146	0.129	0.031	0.4
	Total	**3.122**	**1.779**	**0.410**	**5.5**
	HH consumption and individual cons.	**17.242**	**33.236**	**7.814**	**105.5**

1) On the territory, at basic prices excl. net-taxes on products.

2) Incl. imported materials and supply for domestic production for household consumption.

2.6.2 Energy and CO_2 content by groups of goods

Table 8 shows the expenditure by private households domestically and the energy and CO_2 content of consumer goods based on selected groups of goods. For the selection the six goods with the highest energy content in 2007 were chosen.

Table 8: Household final consumption expenditure, embodied energy and CO_2 of selected consumer goods 2000 – 2007

Commodities	Expenditures[1]			Energy content			CO_2 content		
	2000	2007	07/00	2000	2007	07/00	2000	2007	07/00
	Euro bn		%	petajoule		%	mn tonnes		%
Total hh consumption	**1,150**	**1,306**	**13.6**	**6,218**	**5,745**	**-7.6**	**421.8**	**405.2**	**-3.9**
Of these:									
Electricity, district heating	19.7	30.4	54.5	914	923	1.0	95.6	102.7	7.4
Food	118.3	129.0	9.1	905	846	-6.5	57.4	53.8	-6.2
Motor vehicles etc.	59.6	68.8	15.5	460	446	-3.0	27.8	27.7	-0.1
Coke, mineral oil products	49.4	54.4	10.1	290	264	-9.1	17.6	15.4	-12.9
Hotel, restaurant services	62.0	70.4	13.5	286	277	-3.2	17.9	17.6	-1.3
Services of air transport	8.5	12.5	46.8	206	267	30.0	14.4	18.6	29.0
Subtotal	317.5	365.5	15.1	3,061	3,023	-1.2	230.7	235.8	2.2
				percentage					
Total hh consumption	**100**	**100**	**%-pts**	**100**	**100**	**%-pts**	**100**	**100**	**%-pts**
Of these:									
Electricity, district heating	1.7	2.3	0.6	14.7	16.1	1.4	22.7	25.3	2.7
Food	10.3	9.9	-0.4	14.5	14.7	0.2	13.6	13.3	-0.3
Motor vehicles etc.	5.2	5.3	0.1	7.4	7.8	0.4	6.6	6.8	0.3
Coke, mineral oil products	4.3	4.2	-0.1	4.7	4.6	-0.1	4.2	3.8	-0.4
Hotel, restaurant services	5.4	5.4	0.0	4.6	4.8	0.2	4.2	4.4	0.1
Services of air transport	0.7	1.0	0.2	3.3	4.7	1.3	3.4	4.6	1.2
Subtotal	27.6	28.0	0.4	49.2	52.6	3.4	54.7	58.2	3.5

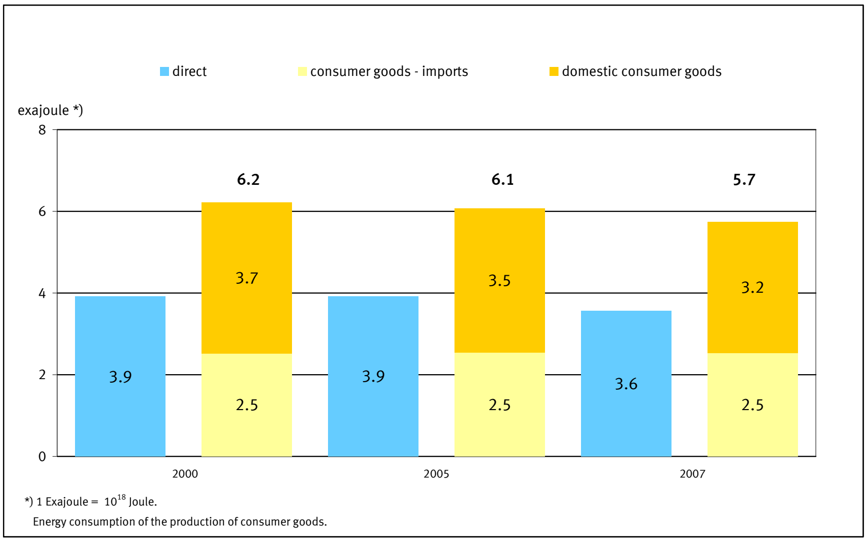
1) At purchasers`s prices (Input-Output-Accounts).

“Electricity, district heating” is the group of goods with the highest energy and CO_2 content. Although the expenditure only makes up 2.3 % of total consumer expenditure, the proportion of total energy content in 2007 was around 16.1 % and 25.3 % in terms of CO_2 content. The disproportionate CO_2 content by comparison with the energy content indicates that, when electricity and district heating are generated – very high, above-average emissions ensue by comparison with other energy sources.

Food also has a very high energy and CO_2 content. It is responsible for 13.3 % of total CO_2 emissions connected with consumer goods. For example, this also includes the emissions that arise directly or indirectly in trade. Direct emissions arise from firing fuels for heating purposes. Indirect emissions are caused in particular by obtaining electricity from the electricity generation industry. Electricity is used in the food trade for cooling purposes or for baking and causes above-average electricity consumption by comparison with other trade activities. Emissions connected with trade activity make up about 40 % of the emissions that arise in food production.

It is worth noting the substantial rise in the energy and CO_2 content of transport performance by the air transport industry. Emissions went up by 29 % to 186 million tonnes between 2000 and 2007. This rise results from a very sharp increase in the demand for transport performance with a corresponding rise in expenditure by households (+46.8 % from 2000 to 2007).

Diagram 11: Energy consumption of private households and embodied energy of consumer goods 2000 – 2007



2.6.3 Energy and CO_2 content by branch

Table 9 shows the emissions of the branches in Germany and abroad in connection with private consumption for selected branches.

Table 9: Origin of embodied CO_2 emissions of consumer goods by branches 2007

NACE	Homogeneous branches	Total	Inland	Imports [1]
			mn tonnes	
	Total	**405.2**	**266.0**	**139.3**
	Of which:			
40.1-3	Generation of electricity, district heating	220.0	166.5	53.5
60-63	Transport services	41.9	27.1	14.8
50-52	Retail and wholesale trade	12.2	11.3	0.8
24	Mf. of chemical products	11.5	2.4	9.0
25	Mf. of rubber and plastic	9.2	5.3	3.8
15	Mf. of food and tobacco	7.6	4.9	2.8
			percentage of total	
40.1-3	Generation of electricity, district heating	54.3	62.6	38.4
60-63	Transport services	10.3	10.2	10.6
50-52	Retail and wholesale trade	3.0	4.3	0.6
24	Mf. of chemical products	2.8	0.9	6.5
25	Mf. of rubber and plastic	2.3	2.0	2.7
15	Mf. of food and tobacco	1.9	1.8	2.0

1) Incl. emissions at the production of materials and supplies bound for domestic production of consumer goods.

More than half of all CO_2 emissions – 54.3 % – arise in the electricity and district heating sectors. As far as the domestic production of consumer goods is concerned it is as high as 62.6 %. The branch with the second highest importance is – a long way

More than half of all CO_2 emissions – 54.3 % – arise in the electricity and district heating sectors. As far as the domestic production of consumer goods is concerned it is as high as 62.6 %. The branch with the second highest importance is – a long way behind – the traffic sector with a share of just over 10 %. These are followed – even further behind – by trade and the production of other chemical products (excluding pharmaceutical products).

2.6.4 Energy intensity of consumer demand

Table 10: Energy and CO_2 content of consumer goods – intensities

	Unit	Year				2000=100			Energy intensity kJ/Euro / CO_2-intensity t/Euro		
		2000	2005	2006	2007	2005	2006	2007	2005	2006	2007
Household expenditures 1)	Euro bn	1,149.7	1,168.9	1,186.9	1,180.7	101.7	103.2	102.7			
Energy content	petajoule	6,218	6,072	6,018	5,745	97.6	96.8	92.4	96.0	93.8	90.0
CO_2 content	mn tonnes	422	412	412	405	97.6	97.6	96.1	96.0	94.5	93.6

1) Domestic household expenditure at purchaser`s prices (price-adjusted, chained).

The energy and CO_2 content of consumer goods dropped by 7.6 % and 3.9 % respectively between 2000 and 2007. Price-adjusted, domestic expenditure rose by 2.7 % in this period. This indicates that consumer expenditure on average was less energy-intensive over time and relatively fewer CO_2 emissions ensued. Energy intensity dropped on average by 10.0 % and CO_2 intensity by 6.4 %.

The energy intensity and CO_2 intensity of consumer demand are influenced by a number of factors. These include from the demand point of view the composition of consumption according to types of goods and to the origin of the consumer goods (see Table 11). The energy intensity and CO_2 intensities in domestic production differ from those of imports. From the producer's point of view the energy and CO_2 intensity are determined by the composition of the energy sources employed and the efficiency with which they are used in the production processes.

2.6.5 Consumer expenditure, energy and CO_2 content of goods based on the origin of the goods

Consumer expenditure rose nominally by 13.4 % between 2000 and 2007. Purchases of domestic products rose by 12.9 % and those of imports by 17.8 %. The higher growth of imports has meant that the proportion of imports in purchases as a whole has risen by a total of 10.7 % (see Table 11).

If one looks at the particularly environmentally relevant purchases of goods more closely, it is evident that the proportions of imports are much higher and there is a significant shift from domestic purchases to purchases of imported goods. The import share for imported goods was 35.4 % in 2007. This share has risen by 3.6 percentage points compared with 2000. There has been a corresponding drop in the proportion of domestic goods.

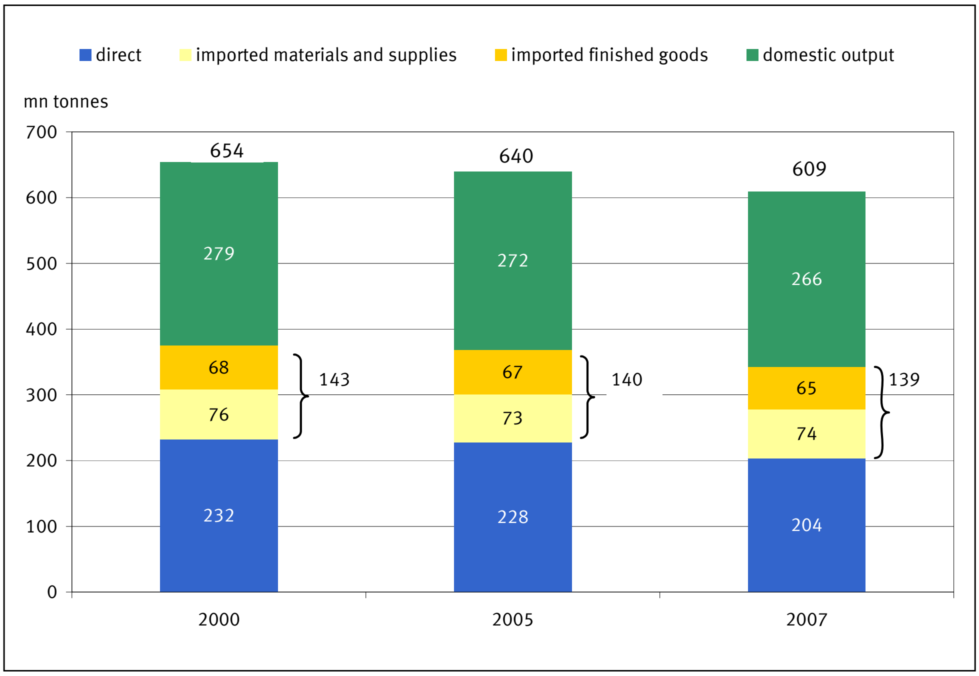
Table 11: Final Consumption expenditure of households by origin 2000 – 2007

Year	Total 2)	Total 1)					
		Domestic production and imports	Imports		Domestic production		
			Total	of which: products (excl. en)	Total	of which: products (excl. en)	
	2000=100	Euro bn					
2000	100.0	1,024	106	92	919	198	
2007	102.7	1,162	125	104	1,037	190	
		change in %					
2007 / 2000	2.7	13.4	17.8	13.0	12.9	-3.9	
		% of total purchases		% of prod. 3)	% of total purch.	% of prod. 3)	
2000		100.0	10.3	31.8	89.7	68.2	
2007		100.0	10.7	35.4	89.3	64.6	
		change in %-points					
2007 / 2000			0.4	3.6	-0.4	-3.6	

1) At basic prices.
2) Price-adjusted, chained, at purchaser's prices.
3) Percentage of imported products of total products (excl. energy sources).
Source: Federal Statistical Office, Input-Output-Accounts.

The energy used and in particular the CO_2 output for consumer goods have shifted pro rata from domestic to foreign in line with the trend in consumer expenditure. As far as energy use is concerned the proportion of imports in the energy content of consumer goods as a whole rose from 39.5 % (2000) to 40.6 % (2007). This proportion includes imported materials and supplies that are required domestically for the production of consumer goods.

Diagram 12: CO_2 emissions of private households and embodied CO_2 of domestic and imported goods



In the case of CO_2 emissions the import share of the emissions in the CO_2 content as a whole was 34.4 % in 2007. Here the emissions connected with imported preliminary products for the domestic production of consumer goods are higher at 74 million tonnes (2007), than the emissions involved in the production of imported consumer goods (65 million tonnes in 2007).

The lower proportion of foreign goods in CO_2 emissions by comparison with the energy content indicates a use of energy sources that differs from that of domestic sources – with on average lower CO_2 emissions in the production of goods. The use of fuels in electricity generation plays a crucial part here.

2.6.6 CO_2 emissions of imports (private consumption) by country of origin

The three most significant importing countries as far as the importation of goods in terms of value are concerned in 2007, were France, the Netherlands and China. As a result of the demand for consumer goods the highest emissions abroad arose in the Netherlands. For 2007 the estimated figure was 15.5 million tonnes of CO_2. The second-highest emitter is already China with 10.4 million tonnes. By comparison with imports in terms of value, and because of the very much lower emissions in electricity generation, France has much lower CO_2 emissions as a whole and occupies third place in the emitter ranking.

Table 12: Embodied energy and CO_2 of imported consumer goods by country of origin 2007

Country	Energy					CO_2					Total imports		
	Total			of which:		Total			of which:		Products 1)		
				Final use	Interm. cons.*)				Final use	Interm. cons.*)			
	Peta-joule	%	Rank	Petajoule		mn t	%	Rank	mn t		Euro mn	%	Rank
Total	**2,335**	**100.0**		**1,071**	**1,263**	**139.3**	**100.0**		**65.4**	**73.9**	**769,206**	**100.0**	
FR	261	11.2	1	122	139	8.9	6.4	3	4.0	4.9	62,873	8.2	1
NL	257	11.0	2	115	141	15.5	11.2	1	7.2	8.3	61,951	8.1	2
CH	143	6.1	4	91	52	10.4	7.5	2	6.5	3.9	56,417	7.3	3
US	110	4.7	8	53	56	6.8	4.9	8	3.4	3.4	45,993	6.0	4
IT	131	5.6	5	70	61	8.6	6.2	4	4.6	4.0	44,694	5.8	5
UK	124	5.3	7	53	71	8.0	5.8	6	3.6	4.4	41,966	5.5	6
BE	129	5.5	6	54	75	5.7	4.1	10	2.3	3.4	36,250	4.7	7
AT	87	3.7	10	38	49	5.9	4.2	9	2.4	3.5	32,091	4.2	8
RS	144	6.2	3	38	106	8.0	5.8	5	2.1	6.0	28,891	3.8	9
JP	48	2.0	13	26	22	2.7	1.9	12	1.5	1.2	24,381	3.2	10
PO	88	3.8	9	42	45	7.7	5.5	7	3.7	4.0	24,055	3.1	11
ES	63	2.7	11	33	30	3.6	2.6	11	1.9	1.7	20,687	2.7	12
NO	47	2.0	14	12	36	2.2	1.6	13	0.6	1.7	17,736	2.3	13
SE	58	2.5	12	13	45	1.8	1.3	14	0.5	1.2	13,981	1.8	14
Sum	**1,688**	**72.3**		**761**	**927**	**96.0**	**68.9**		**44.3**	**51.6**	**511,965**	**66.6**	
Rest	647	27.7		310	336	43.3	31.1		21.1	22.2	257,241	33.4	

*) Incl. emissions at the production of materials and supplies bound for domestic production of consumer goods
1) Foreign trade statistics: total: goods 769 Euro (967.79 Euro incl. services).
Value National Accounting: Fachserie 18, Tabelle 3.4.5.1, Reihe 14, Goods in nominal prices 781.95 Euro bn.

2.6.7 Emission intensity of domestic branches

Table 13: CO_2 emissions and output of domestic branches (CO_2 intensities)

CPA	Homogeneous branches	CO_2 emissions			Output			CO_2 coefficient				
		2000	2005	2007	2000	2005	2007	2000	2005	2007	chge % 07/00	chge % 05/00
		mn tonnes			Euro bn / petajoule			tonnes / thousand Euro			%	
	Total	**716**	**733**	**755**	**3,786**	**4,202**	**4,651**	**189.0**	**174.5**	**162.4**	**-14.1**	**-7.7**
	Energy branches 1)	**380**	**404**	**426**	***11,614***	***12,006***	***11,726***	**32.7**	**33.7**	**36.4**	**11.1**	**2.8**
10	Coal	1	1	1	*2,689*	*2,507*	*2,413*	0.4	0.5	0.5	35.2	15.7
11	Natural gas	1	1	0	*769*	*751*	*687*	1.6	1.1	0.7	-55.7	-30.6
23	Coke, mineral oil products	21	22	21	*5,502*	*5,757*	*5,570*	3.9	3.8	3.8	-1.6	-1.8
40.1-3	Electricity, district heating, other gas	357	380	403	*2,654*	*2,990*	*3,056*	134.4	127.2	132.0	-1.7	-5.4
	Manufacturing (excl. energy)	**192**	**187**	**187**	**1,352**	**1,504**	**1,765**	**141.7**	**124.1**	**106.0**	**-25.2**	**-12.4**
01	Agriculture	13	12	10	46	44	51	274.9	262.8	202.2	-26.4	-4.4
15	Food, tobacco	9	8	8	108	118	132	80.5	67.3	58.7	-27.1	-16.5
17.18	Textilies, furs	3	2	1	27	22	23	116.4	81.8	47.9	-58.8	-29.7
21.22	Paper, printed matter	10	19	12	87	83	90	117.6	224.4	131.0	11.3	90.7
24	Chemicals	34	31	33	151	173	194	222.0	176.2	169.7	-23.5	-20.6
25	Rubber, plastic	45	40	44	89	90	103	509.6	449.1	427.1	-16.2	-11.9
30-33	Office, electrical machinery	2	3	2	169	170	202	13.0	17.9	11.8	-9.6	37.1
34	Motor vehicle and equipment	3	3	3	214	273	320	14.4	12.3	9.2	-36.2	-14.2
36-37	Furniture, jewelery, etc.	1	1	1	35	33	38	18.8	27.1	36.4	93.9	44.3
	Other goods	72	68	72	426	497	612	168.8	137.7	118.4	-29.9	-18.4
	Total services	**144**	**142**	**142**	**2,337**	**2,543**	**2,722**	**61.5**	**55.9**	**52.1**	**-15.3**	**-9.1**
50-52	Retail and wholesate trade	23	20	17	369	382	410	61.6	51.4	42.1	-31.6	-16.6
55	Hotel, restaurant services	3	3	3	66	64	68	48.6	48.5	47.8	-1.5	-0.2
60-63	Transport services	57	61	64	162	188	216	354.3	325.1	297.9	-15.9	-8.2
85	Health services etc.	6	6	5	183	208	218	31.3	28.2	24.8	-20.8	-9.9
65-95	Other services	55	53	52	1,557	1,702	1,810	35.2	30.9	28.5	-18.8	-12.0

1) Output of energy branches in petajoule (in cursive letters).

CO_2 emissions in the domestic branches per output fell by 14.1 % on average between 2000 and 2007.

The CO_2 intensity of the goods producing branches fell on average by just over 25 %, while that of the service sectors fell by 15.3 %. The CO_2 intensity of the energy sectors in terms of their physical output (petajoules) rose on average, because of the increase in coal mining. The CO_2 intensity of the greatest emitter – electricity generation and district heating generation – dropped slightly between 2000 and 2007 (-1.7 %).

2.7 Emission intensity of imports

CO_2 emissions of imports increased by 19 % from 444 million tonnes to 528 million tonnes between 2000 and 2007. Imports rose, price-adjusted, by 40 % in this period. This gives rise to a drop in emission intensity from an average of just under 15 %.

Table 14: Imports – CO_2 intensities

Commodities	CO_2-emissions		Imports 1)		Intensities		CO_2	Imports 1)	CO_2 intensity
	mn t		Euro bn		1,000 t/ Euro mn				
	2000	2007	2000	2007	2000	2007	Change 2007/2000 in %		
Agriculture	6.6	7.5	17.8	19.3	0.37	0.39	14.2	8.2	5.6
Goods (excl. energy sources)	318.9	403.7	436.8	627.8	0.73	0.64	26.6	43.7	-11.9
Food and beverages	26.4	30.2	27.8	35.1	0.95	0.86	14.4	26.2	-9.3
Pulp, paper	9.2	11.0	13.4	15.6	0.69	0.71	19.2	16.4	2.4
Chemicals. (excl. pharm.)	28.1	35.1	37.6	51.8	0.75	0.68	24.9	37.8	-9.4
Plastics	6.1	8.8	8.8	11.6	0.70	0.76	43.5	31.7	8.9
Metals	26.6	50.6	31.8	44.9	0.84	1.13	90.1	41.4	34.4
Machinery	40.2	53.2	31.9	43.8	1.26	1.21	32.1	37.2	-3.7
Vehicles	69.2	91.0	45.2	58.9	1.53	1.55	31.5	30.3	0.9
Energy sources	24.0	24.8	51.8	63.9	0.46	0.39	3.2	23.4	-16.4
Construction	28.9	24.1	3.6	3.1	8.07	7.72	-16.7	-13.0	-4.3
Transport	10.1	14.3	11.4	19.0	0.89	0.75	41.6	66.9	-15.1
Services (excl. transport)	55.2	53.7	68.3	84.0	0.81	0.64	-2.7	23.1	-20.9
Total	**443.7**	**528.2**	**537.9**	**753.3**	**0.82**	**0.70**	**19.0**	**40.0**	**-15.0**

There was a particularly high, above-average, drop in emission intensity in the production of chemical products. These dropped by 9.4 %. Most emissions were caused by the demand for the metal products. In this case the emission intensity rose by 34.4 %.

2.8 Energy content and CO_2 emissions by importing country in 2007 (Comparative calculation)

A comparative calculation was carried out on the energy and CO_2 content of the final demand with the aim of comparing the differences in the high energy input and CO_2 emissions in goods production in the importing countries with Germany. This comparative calculation was based on the entire final demand for 2007 and the energy and CO_2 content arising in the individual countries, when the country-specific energy input and emission conditions are considered, were determined.

Table 15: Energy consumption and CO_2 emissions by country using German expenditure level of final use 2007

Country	Energy cons.	CO_2	Country	Energy cons.	CO_2
	D=100			D=100	
FR	118.6	67.0	AT	81.6	81.9
NL	88.6	93.2	BE	99.7	68.5
NO	71.4	38.5	PO	100.5	130.6
IT	86.1	85.9	CH	120.0	139.3
UK	99.7	99.5	RS	110.7	96.0
ES	95.8	82.8	US	104.1	102.7
SE	89.6	54.5	JP	110.2	99.0

As far as energy content and CO_2 emissions are concerned, some countries occasionally present very substantial differences by comparison with Germany. France and China have very much higher figures than Germany as far as energy input is concerned, as do China and Poland when CO_2 emissions are considered. Norway and Sweden have comparatively lower emissions than Germany for CO_2 emissions. Firstly the differences for energy input and CO_2 emissions from the German level can be explained by differences in the efficiency of the energy used for the energy sectors and the energy-intensive industries, and secondly by a different kind of energy mix (nature of the energy sources used). For example, the low level of CO_2 emissions in France can be explained by the high proportion of – emission-free – nuclear power stations; in Norway and Sweden a higher input of renewable energies such as hydroelectric power leads to lower CO_2 emissions than in Germany. Countries such as China, Poland and Russia have a comparatively high proportion of fossil energy sources – such as coal and natural gas – among the total energy inputs, especially as far as electricity generation is concerned. They therefore discharge higher CO_2 emissions than Germany.

3 Analytical instruments

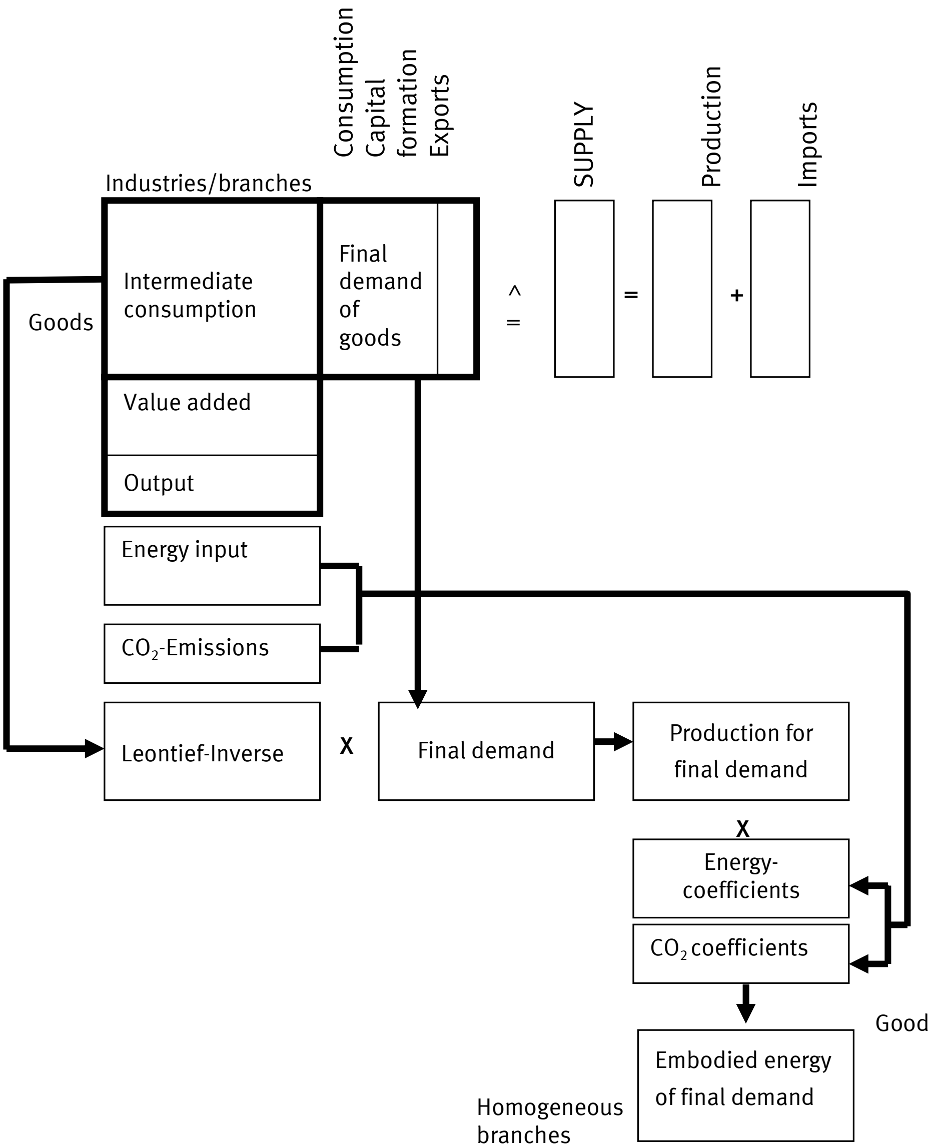
3.1 The input-output analysis model

Input-output analysis (IOA) is an outstandingly suitable analytical instrument for calculating energy consumption and greenhouse gases in accordance with the consumption-orientated approach. It facilitates in particular an assignment of energy consumption of industries to the goods of final demand or to the final use categories (consumption, capital formation, export) (Diagram 13):

A primary application of the IOA is assigning production factors to the final demand of goods. For example an I-O analysis model is used to calculate how many employees in an economy overall are employed in the production of motor vehicles. In this model those directly employed in automobile construction and those employed by suppliers – and at all upstream stages – are assigned to the demand for motor vehicles. This assignment is made based on the input-output table (IOT), which pictures the production and the final demand in terms of goods and activities.

The assignment of production factors to final demand – as for example to employees or energy input – is carried out with the help of the Leontief inverse, and gives the total production output involved in producing a final demand unit. Multiplying the Leontief inverse with the (diagonal) matrix of the final demand shows the entire production necessary for producing the final demand for a particular good – at all stages of production. Then, linking the energy or CO_2 emission coefficients to these output values enables the calculation of energy content (or the CO_2 content) of the final demand category to be determined.

Diagram 13: Calculation scheme on embodied energy and CO_2 of goods



The Leontief inverse is derived as follows based on the identity of output and use of goods:

$x = A * x + y$ (1) x: vector of output
y: vector of final demand for goods
A: Matrix of input-coefficients (intermediate consumption)

In matrix format:

$X - AX = Y$ (1a)

This produces the basic equation for the input-output analysis (open quantity model):

$X = (I - A)^{-1} * Y$ (2) L: Leontief inverse $(I - A)^{-1}$

The X-matrix contains the output for the individual branches that arise in the production of the individual final demand goods as a whole or in certain final use categories (consumption, capital formation, exports).

The use of production factors in producing final demand is determined by linking a coefficient vector with the output:

$B = b * L * Y$	(3)	b: specific input of the production factor = b/x B: total input of the production factor in producing final demand goods

The calculation model can also be used for applying the production factor “energy” and for calculating CO_2 emissions. The vector “b” then contains the specific energy input or the specific CO_2 emissions of the branches. The specific energy input is the (primary) energy input of the branches in terms of their output:

$e = E / x$	(4)	E: use of primary energy in the branches.

When using energy a “net amount” (= primary energy) is assumed. Converting primary energy sources into secondary energy sources gives rise to double counting of energy volumes when the entire use of energy is calculated. This double counting must be eliminated when calculating the energy content of goods. And so the energy use assigned to the conversion sectors is only losses from the conversion of energy and their own energy consumption. Together with the energy use of the remaining branches (= final energy consumption and non-energy use of energy sources) there is a total amount of energy, which is largely equivalent to the key indicator – primary energy consumption – when energy consumption is analysed.

Only losses from flaring and distribution and statistical differences are ignored for direct energy input, so they are not assigned to the energy content of the goods.

4 The compilation concept

4.1 The hybrid input-output model

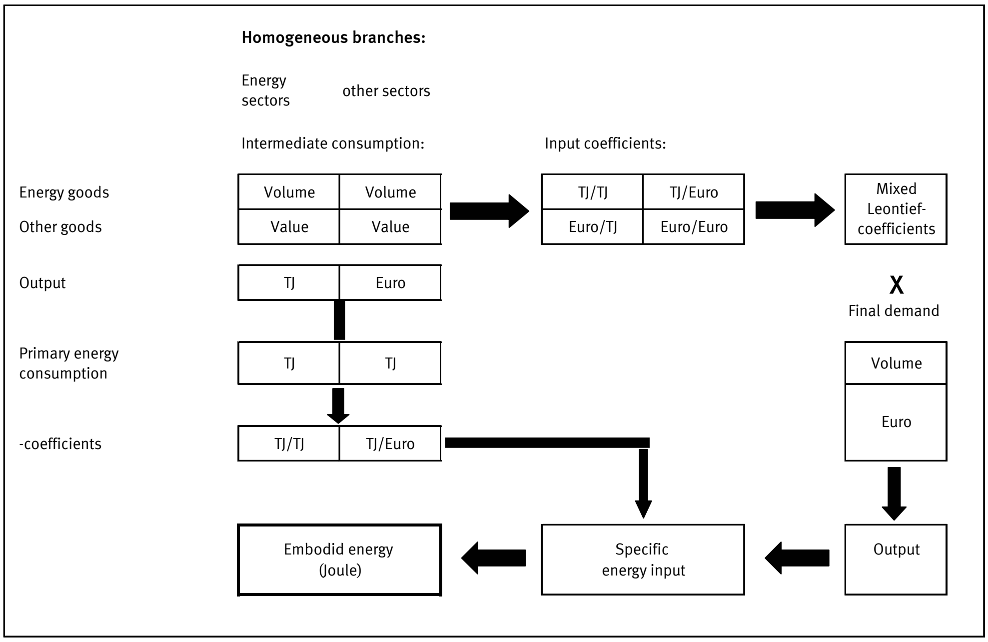
The input-output analysis model can also be developed on the basis of an IOT that includes both value flows and physical flows ("hybrid IO-model"). In a hybrid IO model the values of certain lines – in this case the lines that show the use of energy – are replaced by the relevant volume details. The final demand also is made up partly of values and partly of volumes. The outputs of the branches are also given in volume units.

Calculation of the "mixed Leontief inverses" is based on these "mixed" figures on intermediate consumption. The calculations in the extended energy IO analysis model are then made in just the same way as in the model with pure value details. In determining the energy content of the products a coefficient vector with mixed coefficients is used. With the energy sectors the energy coefficients are related to the physical output (energy output in joules), with the remaining sectors to the value-related output (in euros).

The compilation sequence takes place in five steps (see Diagram 13):

1. Drawing up the mixed IOT
2. Determining the input coefficients and the mixed Leontief inverse
3. Calculating the (indirect) output to produce the final demand goods
4. Calculating the specific energy input of the branches (primary energy coefficients) based on the energy flow account
5. Calculating the energy content by final demand goods and categories

Diagram 14: Hybrid approach for I/O-analysis on energy



The hybrid model has the following advantages compared with the pure values approach:

a) non-homogeneous flows of goods with significant variations in average prices among the different purchasers are replaced by the volumes required in the IOA,

b) exchanging the quoted values for the energy sectors (IOT rows) facilitates further disaggregation of the energy sectors,

c) using volumes (heating figures) for the production and consumption of energy enables a direct link to be made between the carbon dioxide emissions and the energy consumption figures.

All three factors contribute to an improvement in the quality of results compared with the simple model.

The traditional IO analysis model presupposes the homogeneity of the branches in terms of the production processes and the manufactured products. This means that the IOT used in the model should be broken down in such a way that the branches presented are as homogeneous as possible in terms of the manufactured goods and production processes. The assumption regarding the homogeneity of output implies that the goods – in the rows of the IOT – should be homogeneous, i.e. should show identical prices for all purchasing branches. This is not the case in many sectors for the harmonised IOT – drawn up for European purposes – with a relatively rough breakdown of rows and columns of 60 sectors. And so energy commodities, such as electricity for example, often display a substantial price differentiation between the various purchasers. Other groups of commodities such as “coke, refined petroleum products and nuclear fuel” (CPA 23) are very heterogeneous in terms of their price and production process.

In the simple Leontief quantity model this lack of homogeneity leads to a distorted assignment of energy inputs to final demand goods (see simplified example in the Appendix, Overview 1): branches with an above average purchase price for energy, i.e. with a relatively smaller energy input in terms of volume units show a very much higher energy output in the model with pure values compared with the hybrid model. This means that the energy content of these goods in the model with pure values appear too high (in the simplified example these are the products of the branch with the abbreviation “AG”).

The use of physical data in physical units for the energy sectors also facilitates a disaggregation of the IOT for the energy sectors and so brings about a further, significant improvement in the quality of the results. For the energy lines of the IOT from the energy flow accounts there are highly differentiated details on the output and use of energy sources in calorific units (joules) available. These data can be used, together with the details from the energy balance sheet on energy sectors, to extend the energy IOT in the lines and columns (see Chapters 4.3.1 und 4.3.2).

The use of details in physical units also facilitates direct linking of the emission factors for carbon dioxide with energy production and with the production of other energy-intensive branches. Normally, the energy input and emission coefficients are defined in relation to the monetary output of the branches. These coefficients can alternatively be defined for the energy sectors with reference to their physical output – in calorific units (joules). The output of the energy sectors is known from the energy statistics and the energy balance sheet.

This alternative calculation of the coefficients is particularly advantageous for determining the coefficients for the foreign energy sectors: these coefficients can be determined directly from the details coming from the countries' energy balance sheets. These contain both the details required on the individual energy inputs and on energy production. Doing so there is no – possibly difficult – determination of the monetary outputs of these sectors necessary.

For the area of steel production and steel processing, standardisation of the energy and emission coefficients was also carried out with reference to the physical production of steel – in tonnes. German iron and steel statistics[3] include comprehensive details of the production and processing of steel abroad. Consequently, together with the calculations on the energy inputs of this sector, a direct determination of the energy and emission coefficients can be carried out for steel production. As with the energy sectors this makes it unnecessary to assess monetary details on the output of the steel sector in the individual countries of origin. This avoids uncertainties when converting these details – available in national currency units – into euros.

4.2 Domestic calculations and those for imports

Separate calculations are carried out for domestic production and for imports. The imports are characterised by country-specific commodity structures of import values, production techniques and energy input or CO_2 emission coefficients. Substantial account is taken of these differences in a regionalised calculation.

First of all the imports are processed in terms of commodities by supplier country (see Chapter 4.2.1). The respective production techniques in the supplier countries is not in general but only considered for important energy-intensive branches, such as the energy sectors and the steel industry (see Chapter 4.2.2.). Likewise the specific energy input and the CO_2 coefficients for the energy sectors and steel industry are recorded on a country-specific basis. On top of this, in the case of the European supplier countries, country-specific CO_2 coefficients are used for all branches. The coefficients are calculated according to economic activities based on a survey by EUROSTAT on air emissions in the European Union (EU)[4].

3 Federal Statistical Office, Fachserie 4, Reihe 8.1, Produzierendes Gewerbe – Eisen und Stahl, various editions.
4 Eurostat: Bereich „Umwelt", Datenbank: physische und hybride Flussrechnungen (env_ac_ainacehh) http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/database

4.2.1 Regionalisation of imports

Imports are distinguished by 14 countries of origin which – with the exception of Sweden – are of the greatest importance for imports according to foreign trade statistics (see Table 16).

Table 16: Imports of products by country of origin 2006

Country of origin	Euro mn	% of total	Country of origin	Euro mn	% of total
France	62,102	8.5	Russia	30,020	4.1
Netherlands	60,750	8.3	Japan	24,016	3.3
China	49,958	6.8	Poland	21,226	2.9
USA	49,197	6.7	Spain	19,832	2.7
Italy	41,470	5.6	Norway	19,646	2.7
United Kingdom	40,832	5.6	Sweden	12,900	1.8
Belgium	33,388	4.5	Sum	495,637	67.5
Austria	30,301	4.1	Total	733,994	100.0

Source: Federal Statistical Office, Foreign Trade Statistics

Sweden was included because of its importance in the importation of cellulose and paper – an energy-intensive production process, which differs sharply from Germany with regard to its energy input.

The import values are determined country-by-country in a breakdown in line with the Product Classification for Production Statistics (GP)[5] based on a special evaluation of foreign trade statistics. In this special evaluation both volume details (in kilograms) and values (in euros) were evaluated for two and three digit entries – in some cases even four digit entries.

The import details for energy sources are given in calorific values (terajoules). These details are taken from various official and association statistics.[6]

In the case of the imports re-exports are excluded first – by deduction. Re-exports are imported goods that are re-exported without being changed in the 'transfer' country. As they do not remain in the country the energy used in producing them and the associated CO_2 emissions need not be assigned to domestic statistics. The level of re-exports appears by commodity group in the import-IOT. The ratio of re-exports to imports as a whole determined on this level is used for the country-by-country assessment of re-exports.

Next, the total values of imports by commodity groups – in line with the calculation segments (see Overview 2) – are broken down into categories of use. The following categories are distinguished: consumer goods, goods for intermediate consumption, other imports (capital formation, government final consumption expenditure). In the

5 Federal Statistical Office: Product Classification for Production Statistics, 1995 edition.

6 Imported natural gas: Federal Office of Economics and Export Control (BAFA) and Federal Ministry of Economics and Technology (ed.): Developments in the importation of natural gas into the Federal Republic of Germany (in terajoules).
Imported crude oil: Federal Office of Economics and Export Control (BAFA): Official Mineral Oil Statistics, Table 2. Imported Mineral Oil: Association of the German Petroleum Industry (MWV): Mineral oil figures, (File "mzxls.zip", File MINVERS, Table p.26). Imported hard coal: Statistik der Kohlenwirtschaft e.V.: Coal imports by supplier countries.

calculations for the imported goods for intermediate consumption an assignment must be made of production to the final use categories.

Categorising imports as consumer goods and intermediate consumption is carried out using the monetary details of the total import IOT on a commodity level – in a similar fashion for all countries.

4.2.2 Taking account of country-specific production conditions

In the analysis model, country-specific production conditions are only taken into account for important energy intensive branches – such as for the energy transformation sectors and the steel sector. The aim is to approximate the modelled emissions to the actual emissions in the supplier countries. No general consideration is given to country-specific technologies and upstream links, i.e. integrating the IOT of the supplier countries, for conceptual reasons. With the exception of the branches mentioned the calculations are therefore based on domestic technology of Germany.

With this method only the energy inputs of the energy sectors, the aluminium industry and the steel industry are shown on a country-specific basis. The other inputs of those branches – included on a monetary basis – are taken from the IOT for Germany. This approach requires the energy inputs for the branches shown on a country-specific basis to be standardised to match the German production level.

A primary reason for not completely including the production conditions of the supplier countries is that the chosen disaggregated calculation approach has no adequately disaggregated international IOT available[7]. Apart from this the hybrid calculation approach facilitates more detailed consideration of important energy consuming branches in this country and in the supplier countries (see next section for the breakdown of branches in the IO analysis model).

With this calculation approach the energy and CO_2 content of the goods supplied by the supplier countries is in the foreground from a conceptional point of view. The backward linkages triggered in the direct supplier countries by the German imports and the resultant energy input is assigned completely to the direct supplier country with this approach[8]. The comprehensive, detailed linking of regions or countries is reserved for multi-regional IO analysis.

Country-specific characteristics are included as follows in the energy input and CO_2 emission coefficients irrespective of how the production links of supplier countries are shown. In the energy sectors (7 sectors), in steel production (NACE Rev. 1: 27.1-3), the aluminium industry (27.42) and cellulose and paper production (21.1) special coefficients are calculated for all supplier countries with the help of special calculations (see Chapter 4.3.2-4, CO_2 coefficients in the steel sector: see Table 5 in the Appendix). For pipeline transportation (60.3) special energy and emission coefficients were calculated for Norway and Russia – the main supplier countries for natural gas and crude oil imports. These calculations which take account of the special input of energy sources in terms of transport and transport length. For the other sectors CO_2 emission coefficients could only be calculated for the European supplier countries. Here the data collected and published by Eurostat on emitted air pollutants based on

7 The OECD provides detailed IOTs for a large number of countries (42 countries) in its "Structural Analysis (STAN) Database": see OECD (2006): The OECD Input-Output Database: 2006 Edition, STI Working Paper 2006/8 N. Yamano, N. Ahmad, Oct. 2006. However, the detailed tables (broken down into 48 sectors) with a range of subdivisions important for IO analysis for a large number of countries – for the European countries for example – are not available (see Table 4 in OECD 2006).
Link with OECD-STAN Database: Input-Output Tables (http:/www.oecd.org/sti/inputoutput/).

8 One exception is aluminium imports, where the imports of raw or secondary aluminium of the direct supplier countries are additionally analysed in greater detail.

economic sectors was used[9]. As no comparable data on energy consumption are available for European – and non-European countries – the domestic coefficients were assumed when calculating the energy coefficients for these sectors. It may be possible to calculate further country-specific energy coefficients by evaluating the national energy balance sheets for sectors of the manufacturing industry.

Overview 3: Availability of energy and CO_2 emission coefficients by industries/branches and supplying countries

Region /Industries	Energy branches		Steel, aluminium, pulp and paper production		Other branches	
	Energy	CO_2	Energy		Energy	CO_2
European countries	X	X	X	European countries	X	X
Other countries	X	X	X	Other countries	X	X

Impact of the regionalised calculation for imports (comparative calculation)

The energy and CO_2 content of goods is higher for regionalised calculation of imports while taking into account country-specific energy input conditions and the CO_2 emission coefficients, than for a non-regionalised calculation and assumption of domestic production conditions.

The energy content of imports would be just under 21 % lower and the CO_2 content 13.2 % lower when calculating domestic production conditions, than the results would be based on a detailed, regionalised calculation. This has different impacts on the level of the energy and CO_2 content of the entire demand with 9.4 % for energy content and 5.4 % for CO_2 content.

Table 17: Energy and CO_2 content of goods using a regionalised and non-regionalised approach for imports

Category	Regionalised		Non-regionalised		Difference: regionalised / non-regionalised			
	2000	2007	2000	2007	2000	2007	2000	2007
	CO_2 content in mn tonnes						%	
Production of								
domestic goods	716	755	716	755	0	0	0.0	0.0
imported goods	444	528	408	458	36	70	8.1	13.2
Total	**1,159**	**1,284**	**1,123**	**1,214**	**36**	**70**	**3.1**	**5.4**
	Energy content in petajoule						%	
Production of								
domestic goods	10,381	10,580	10,381	10,580	0	0	0.0	0.0
imported goods	7,488	8,826	6,481	7,000	1,007	1,825	13.4	20.7
Total	**17,869**	**19,405**	**16,862**	**17,580**	**1,007**	**1,825**	**5.6**	**9.4**

9 Eurostat: Sector "Environment", database: Physical flow and hybrid accounts (env_ac_ainacehh) http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/database

The reason for the higher level of energy and CO_2 content in the regionalised calculation is that on average more energy is used for producing imports in the supplier countries than applies to domestic production. And so of the four greatest supplier countries (for imports) in 2007 – France, Netherlands, China, USA – all apart from the Netherlands had a higher specific energy input than Germany (see Table 17). For CO_2 emissions the gap between Germany and other countries is significantly less. This is due to the comparatively high CO_2 output in Germany for electricity generation, the branch that has a strong impact on the result.

Between 2000 and 2007 the differences in energy and CO_2 content of imported goods have increased in the regionalised and non-regionalised approach. The reason is the higher than average growth of the imports from countries with a higher than average input of energy and CO_2-emissions, e.g. China and Russia.

4.3 Drawing up the hybrid input-output table

4.3.1 Domestic

Breakdown of the branches in the energy IO analysis model

The hybrid energy IOT is based on the monetary IOT of the Federal Statistical Office[10]. The national publication is broken down into 71 branches (see Overview 2 in the Appendix). Compared with the IOT that forms part of the European Transfer programme in A60 breakdown (two digits in the NACE Rev. 1 and the CPA) the national IOT already contains important subdivisions for the following energy-intensive branches:

Overview 4: Breakdown of branches in the national IOT

No	Monetary IOT (national publication)	CPA 2003
16	Pulp, paper and paper products	21.1
17	Paper and paperboard	21.2
21	Pharmaceuticals	24.4
22	Chemicals (not incl. pharmaceuticals)	24 (ex. 24.4)
23	Rubber products	25.1
24	Plastic products	25.2
25	Glass and glassware	26.1
26	Non-refractory ceramic goods, treated stone and earth	26.2 – 26.8
27	Basic iron, steel and tubes and semi-finished products	27.1 – 27.3
28	Non-ferrous metals and semi-finished products	27.4
29	Foundry work services	27.5
40	Electricity, steam and hot water supply	40.1, 40.3
41	Gas, distribution of gaseous fuels through mains	40.2
49	Transport via railways	60.1
50	Other land transport, transport via pipelines	60.2 – 60.3

10 The input-output tables are published in Fachserie 18 Volkswirtschaftliche Gesamtrechnungen, Reihe 2 Input-Output Rechnung. Classification of the national IOT into 71 branches (R71) see Appendix 2.

Further subdivisions have been made in the analysis model for the energy sectors and for further, selected energy-intensive branches to improve the quality of the results and the informational value of the model (Overview 5).

In the subdivisions the details of the energy input can be taken directly from the energy balance sheet or the energy flow account. The other – monetary – inputs have to be supplemented by further calculations. To limit the extent of the compilation model summaries of sectors with a relatively low energy input are made in the services sector. Accordingly, the analysis model comprises 73 branches (see Overview 2 in the Appendix).

Overview 5: Breakdown of branches in the energy IOT

Breakdown in the monetary IOT	Breakdown in the energy IOT	NACE Rev. 1
Coal mining	Hard coal Lignite	10.1 10.2
Coke, refined petroleum products and nuclear fuel	Coke oven products Refined petroleum products Nuclear fuel	23.1 23.2 23.3
Electricity, steam and hot water supply	Electricity Steam and hot water supply	40.1 40.3
Chemicals (excl. pharmaceuticals)	Basic chemicals Chemicals (excl. pharmaceuticals)	24.1 24 (ex. 24.1/4)
Non-ferrous metals and semi-finished products	Aluminium and aluminium products Other non-ferrous metal products	27.42 27.41/43-45

Calculating the consumption of energy branches and integration into the IOT

Energy consumption in the environmental-economic accounts is calculated for 34 energy sources and 71 branches[11]. The breakdown into energy sources matches the breakdown in the national energy balance sheet[12]. In addition to these energy sources further subdivisions are made in the area of renewable energies. A distinction is made between 7 energy sources (the energy balance sheet contains a subdivision of the "renewables" according to three energy sources "water power, wind, photovoltaics", "biomass and renewable waste", "other renewable energy sources"). The detailed calculations in the area of renewable energies are mainly based on the satellite balance sheet "Renewable energies", which is also published by the

11 See breakdown of energy sources in the energy flow account of the environmental-economic account in Overview 3 in the Appendix.

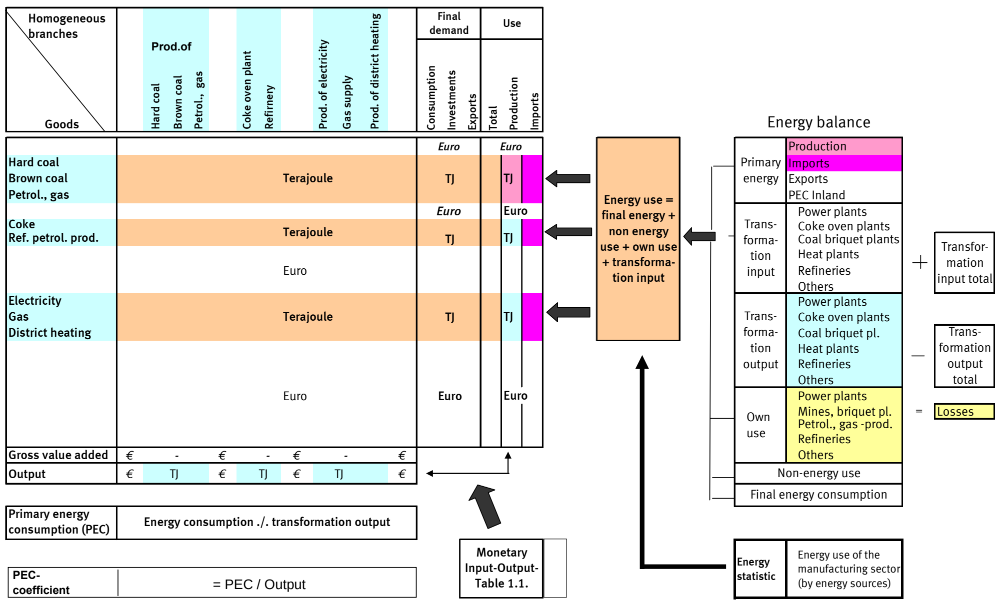
12 The energy balance sheets are issued by the Arbeitsgemeinschaft Energiebilanzen (AGEB – the Working Group on Energy Balances). They comprise tables in natural units, in hard coal units and in calorific units (terajoules). In addition to the detailed energy balance sheets, timed sequences of primary energy consumption and final energy consumption of the consumption sectors with current details are published in the "Auswertungstabellen" ("Evaluation tables"). http://www.ag-energiebilanzen.de/viewpage.php?idpage=6
Methodological notes on the energy balance sheets are provided in the Internet under "Erläuterungen" as PDF text. See "Vorwort zu den Energiebilanzen für die Bundesrepublik Deutschland" ("Foreword to the energy balance sheets for the Federal Republic of Germany").

Arbeitsgemeinschaft Energiebilanzen (AGEB – the Working Group on Energy Balances)[13].

The calculations of the output and consumption of energy are based on the details of the energy balance sheet, (official) energy and refined petroleum statistics and other statistics from research institutes on energy consumption of households and "small consumers" (industry, trade, services) (see Diagram 4). In the area of road transport we carried out our own, detailed calculations on fuel consumption according to individual types of vehicles and keepers. The results of the calculation are regularly published in "Economy and Use of Environmental Resources" – Tables on Environmental-Economic Accounting [14].

Details of the use of energy sources – in terajoules – are summarised for 9 groups of energy sources (see energy sectors in Diagram 15 plus "Nuclear energy"). These details replace line by line the monetary details of the IOT. The renewable energies provided by nature (wind, water, photovoltaics, solar thermal) have no monetary equivalent in the IOT and are therefore excluded from the IOT. In calculating the energy coefficients however they are fully included like "economic" energy sources. Their energy content is determined by the effective level method and amounts to 100% of the secondary energy generated (electricity and heat)[15].

Diagram 15: Hybrid energy IOT and energy balance



13 Available on the home page of the AG-EB under Daten/Bilanzen (data/balance sheets) as satellite balance sheets in Excel format. Statistics of renewable energies are prepared by the working group "Renewable Energies - Statistics" (AG-EE-Stat). http://www.erneuerbare-energien.de/inhalt/5468/

14 Umweltnutzung und Wirtschaft – Tabellen zu den Umweltökonomischen Gesamtrechnungen, Teil 2: Energie und Rohstoffe, Kapitel 3: Energie. Table 3 in the Appendix includes details on the use of energy by branch and private households for reporting year 2006. http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Navigation/Publikationen/Fachveroeffentlichungen/UGR,templateId=renderPrint.psml__nnn=true

15 See "Vorwort zu den Energiebilanzen", p. 9.

4.3.2 Calculations for the foreign energy sectors

Detailed calculations on the input structures in the supplier countries are of great importance in view of the significance of the upstream chains for determining total energy use. Direct energy consumption in the manufacture of final demand goods (consumer goods, capital goods and export goods) in the supplier countries can still be determined in a comparatively simple manner with the help of suitable energy coefficients. On the other hand calculating energy expended in upstream production stages is difficult and time-consuming: ideally this calculation should be based on a complete reproduction of production processes and supplier links in the individual supplier countries and between the supplier countries, i.e. on multi-regional IOTs. This comprehensive approach has not been selected in the project – as stated above – for conceptual reasons.

In the approach chosen here emphasis is given on an as close as possible reproduction of the most important upstream chains in the supplier countries. By far the most important upstream chain as far as energy use and CO_2 emissions are concerned is the production of electricity. There are substantial conversion losses when electricity is generated using primary energy sources, which – together with own use of energy – are assigned to the sector as energy consumption. High CO_2 emissions arise when fossil fuels are used in the power stations.

According to provisional calculations for 2006 energy use in producing electricity domestically amounts to 33.5 % of the entire domestic energy consumption of the branches. Although the proportion of electricity production in the manufacture of imports in the supplier countries is somewhat lower at 27.3 %, there too electricity generation is by far the most important consumer of energy. As far as the CO_2 emissions of the branches are concerned the proportion of electricity generation is even higher, as the branches outside energy generation to a large extent use the – with direct use – CO_2-free electricity. Among imports the proportion of electricity generation of the total CO_2 emissions of the branches was 37.3 % (2006).

The second most important energy consumer in the production of German imports is the steel and non-ferrous metal sector (NACE 27). In the case of energy input this sector had a proportion of 19.3 % of the entire energy consumption of the branches in 2006, and 24.3 % of the CO_2 emissions. Because of its great significance this branch has been analysed in detail for the individual countries. Along with the high direct energy consumption the sector is partly characterised also by a high indirect energy consumption and high indirect CO_2 emissions. These arise from the use of electricity in steel production – for example in manufacturing secondary steel in electric furnaces and in the generation of non-ferrous metals, such as for example aluminium, which also involve very high electricity consumption. Consequently it is also of great importance to record the production processes and energy inputs of the sectors as precisely as possible (see Chapter 4.3.3).

In calculating the energy consumption of the energy sectors for the most important import countries (10 European, 4 non-European countries) the energy balance sheets of these countries and other statistics were evaluated. The energy balance sheets of EUROSTAT were drawn upon for the 10 European countries[16]. For the 4 non-European countries – China, Japan, Russia and the USA – the energy balance sheets published

16 The details on energy are not published by Eurostat in the form of energy balance sheets, but in a database in the form of time sequences for the individual features of the energy balance sheet: http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/database
For the calculations in this project Eurostat has provided details in natural units and in oil units in the form of an energy balance sheet.

by the International Energy Agency (IEA) are evaluated[17]. In addition further details – subdivided more precisely by energy sources – on the individual energy sectors were taken from the United Nations database (Statistical Division)[18]. This for example enabled the energy sectors' own consumption, which is only published in total in the energy balance sheets, to be further subdivided into subsectors. The database contains details on the use of energy (in natural units) fully subdivided in terms of energy sources. This detailed information is particularly necessary for calculating the CO_2 emission coefficients. Overview 6 contains the recorded sectors and features in the energy sector.

Overview 6: Characteristics of input and output data of energy branches

1	Generation of electricity	Production and fuel provided by 8 energy sources, own use of power plants
2	Heat power stations	Production, fuel provided by 4 energy sources
3	Refineries	Output, transformation input, own use by 4 energy sources
4	Extraction of crude oil and natural gas	Extraction, own use by 4 energy sources
5	Coal mining	Extraction, own use by 5 energy sources
6	Cokeries	Production, transformation input and own use by 4 energy sources

Table 18 compares electricity generation in China and Germany (in GWh and PJ), fuel input in electricity generation, efficiency and CO_2 emissions for electricity production in 2006 (Table 4 in the Appendix compares the fuel input in electricity generation for Germany and all supplier countries included). China has 9 % higher energy coefficients compared with Germany. Because of its high coal input in electricity production China has a very high CO_2 coefficient: this is 58 % higher than that of Germany.

17 International Energy Agency: Energy Statistics, Energy Balances of OECD and Non-OECD Countries, various years.
18 United Nations Statistics Division: Energy Statistics Database. http://data.un.org/Explorer.aspx?d=EDATA

Table 18: Generation of electricity, fuel input and CO_2 emissions of power plants in Germany and China

Energy source	Generation of electricity			Fuel input			Effiiciency factor		CO2-emissions		
	China		Germany	China		Germany	China	Germany	specif.	China	Germany
	GWh	PJ	PJ	1,000 t oil	PJ	PJ	%		t /TJ	1,000 t	1,000 t
Hard coal	2,328,195	8,382	496	613,980	25,690	1,234	32.6	40.2	94.1	2417	116
Lignite (brown coal)			544			1,433			110.6		158
Crude oil	0	0		230	10		0.0		78.0	42	
Mineral oil products	51,589	186	38	12,760	534	89	34.8	42.4			
Natural gas	26,104	94	264	5,450	228	521	41.2	50.7	56.0	13	7
Nuclear energy	54,843	197	602	14,290	598	1,826	33.0	33.0			
Water-, windpower	435,786	1,569	251	37,480	1,568	381	100.0	66.0			
Geotherm., solar etc.	3,973	14		340	14		100.5				
Other energy sources	2,331	8	96	800	33	256	25.1	37.6	72.1	3	63
Electricity	0	0		0	0						
Sum	**2,902,821**	**10,450**	**2,292**	**685,330**	**28,675**	**5,739**	**36.4**	**39.9**		**2,476**	**345**
Own use					669	142					
Total energy					**29,344**	**5,881**					
Energy-, CO2-coefficients					***2.81***	***2.57***				***0.237***	**0.150**
- Germany = 100					**109**	**100**				**158**	**100**

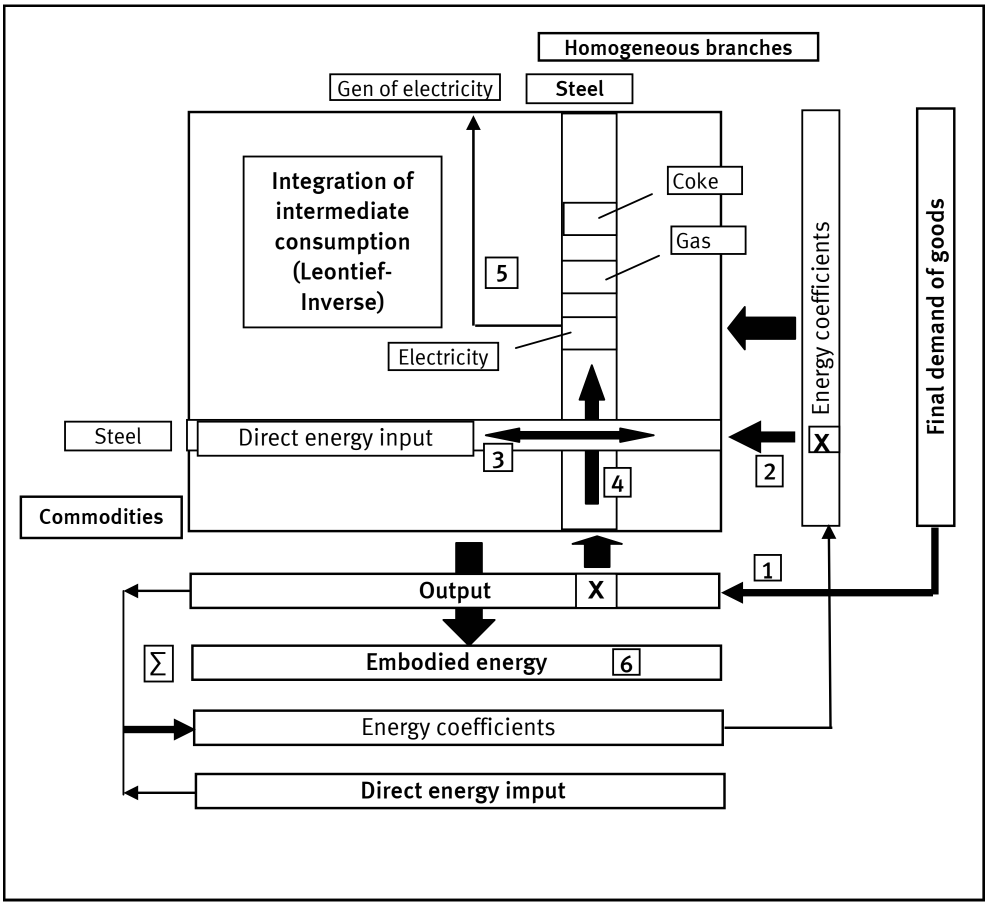
Source: China: IEA-energy balances; Germany: Energy balance (Arbeitsgemeinschaft Energiebilanzen),Environmental-Economic Accounting.

4.3.3 Special calculation for the steel sector (WZ 27.1-3)

In view of the great importance of the iron and steel sector (WZ 27.1-3) in terms of energy input and as a major source of CO_2 emissions a special calculation has been made for this sector. The importance of the steel sector is due to the high specific energy input in steel production and its role as an important supplier for many sectors of capital goods and consumer goods production. Consequently, in the case of imports the overwhelming proportion of energy use for steel production is not due to the imported steel products themselves but to the imported finished products with a high proportion of steel. It is therefore of great importance to consider as closely as possible the production process in countries that do not export steel directly to Germany in large quantities, such as for example China, USA and Japan – but do export finished products with a high steel content.

Diagram 16 presents schematically the sequence for calculating energy consumption in connection with steel production. This can be subdivided into 6 steps.

Diagram 16: Calculation of direct and indirect energy input for the production of steel



1: Determination of the production level for the production of steel (based on total final demand))
2: Determination of the direct energy input for the production of steel
3: Distribution of energy for branches receiving steel
4: Determination of intermediate inputs
5: Energy input of suppliers
6: Attribution of embodied energy to goods for final use

First of all the IO analysis model determines the level of steel production that is necessary for producing German imports (Step 1). Then direct energy consumption in steel production is calculated with the help of the – country-specific – energy coefficients (Step 2). A third step is to assign this energy consumption to the branches that produce final demand goods using steel as an intermediate product. Based on the calculations for energy input in the steel sector the energy purchases by the steel sector (Step 4) and the energy input necessary for this from the energy producers are determined (Step 5). The last step (Step 6) is to assign this (indirect) energy input in return to the goods that contain steel as an intermediate product.

The special calculation first records the production of iron and steel and their processing in Germany and the selected supplier countries in terms of quantities (see Table 19).

Table 19: Production of steel in Germany and selected supplying countries 2006

	DE	FR	AU	IT	NL	BE	CH	RS	US	JP	Imports total
	in 1,000 tonnes										
Total	47,224	19,852	7,130	31,625	6,373	11,630	420,917	56,500	98,556	116,196	
Oxygen steel	32,550	12,242	6,487	11,823	6,223	8,172	377,460	43,500	42,458	85,965	
Electric steel	14,674	7,610	643	19,802	150	3,458	43,457	13,000	56,098	30,231	
	% of total										
Oxygen steel	68.9	61.7	91.0	37.4	97.6	70.3	89.7	77.0	43.1	74.0	
Electric steel	31.1	38.3	9.0	62.6	2.4	29.7	10.3	23.0	56.9	26.0	
	in 1,000 tonnes										
memo item:											
Imports to Germany	-	3,988	2,750	2,693	4,045	3,567	338	1,500	55	52	34,316

Source: Federal Statistical Office, Iron and Steel Statistics, Foreign Trade Statistics.

For steel production the energy input and CO_2 emissions for the supplier countries are calculated using two approaches. The first approach for estimating energy inputs and CO_2 emissions is based on details from process chain analysis. With the second approach the national and international energy balance sheets are evaluated in terms of the energy consumption of the steel sector.

Both calculation approaches are initially aimed at obtaining findings on the extent and nature of steel production in the individual countries. A further intention was to determine the differences in the results of the two calculation methods – process chain analysis on the one hand and energy balance sheet method on the other. Apart from these aims process chain analysis has made it possible to determine and correct any lack of plausibility in the energy balance sheets of individual countries for individual years.

It was possible to get details on the CO_2 emissions of the steel sector – with the exception of the USA and China – from the publications of the UNFCCC on greenhouse gases. The greenhouse gas inventory[19] for the steel sector includes both energy-related and process-related emissions. The process-related CO_2 emissions include in particular the entire carbon content of the reducing agent (coke, hard coal).

19 United Nation Framework Convention for Climate Change (UNFCCC), Data interface http://unfccc.int/di/DetailedByCategory.do

Structural elements in the greenhouse gas inventories *) in the area of steel production:

CRF Code	Description	Content
1.A.2.a	Iron and steel producing industry	Burning fuels
2.C.	Industrial processes	Process-related emissions
2.C.1	Iron and steel production	Emissions from steel works including emissions from blast furnaces and CO_2 emissions from electrode burn-off in electric furnace steel manufacture
2.C.1.1	Iron, steel and malleable cast iron production	
2.C.1.2	Basic iron production	
2.C.1.3	Sinter production	
2.C.1.4	Coke	
2.C.1.5	Other	

*) CRF: Common Reporting Format.

For the USA and China recourse was made to the calculation results based on process chain analysis, as there were no details (China) or only insufficiently disaggregated details (USA) available from UNFCCC.

An initial estimate of energy use was made using process chain analysis. Explicit attention was given to the very different energy input in the production of oxygen steel on the one hand and the production of electric furnace steel on the other. During the production of oxygen steel predominantly carbon-rich primary and secondary energy sources are used such as hard coal, coke and natural gas, whereas in the production of electric furnace steel only electricity is used – to melt scrap. Consequently the two processes have very different values in terms of (direct) CO_2 emission coefficients.

Nevertheless process chain analysis still produces incomplete estimates initially as far as energy input by the sector is concerned. In particular, not all supplier countries provide sufficiently reliable details of their specific energy input in steel production. Details are also lacking on energy input in the processing of steel (drawing and rolling of steel). By modifying specific input coefficients an attempt has been made to improve the estimate and to agree the key values from these energy balance sheets. In the last resort however the international energy balance sheets on energy consumption in the steel sector were used as a basis when calculating energy input and energy coefficients.

Table 20 shows energy consumption and CO_2 emissions in steel production for Germany, Italy, Austria, France and China in 2006 (Table 3 in the Appendix shows details of steel production and CO_2 emissions for all countries included with the exception of Norway). In the case of the CO_2 emissions, alongside the direct emissions arising from steel production, there are also records of emissions including the upstream chain of “electricity production”. Here the input of electricity is “loaded” with the national emission coefficients for electricity production. The emission coefficient based on these calculations facilitates a better evaluation of the CO_2 emissions associated with steel production as a whole and is more suitable for international comparisons of specific emissions. Alongside the efficiency of the applied techniques and the different processes for generating steel this comparison also takes account of the different nature and efficiency of electricity generation in the individual countries.

Table 20: Energy consumption and CO_2 emissions from the production of steel in Germany, Italy, Austria, France and China 2006

	Unit	DE	IT	AU	FR	CH
Energy consumption:						
Final energy use (EB):						
Coal	TJ	121,782	48,304	116	83,614	1,486,673
Coal oke	TJ	156,527	99,315	47,675	70,720	6,719,008
Coke gas	TJ	33,026	0	1,239	16,352	0
Blast furnace gas	TJ	78,293	180	20,693	24,911	0
Mineral oil products	TJ	31,544	5,092	651	1,944	116,946
Natural gas	TJ	89,760	78,932	16,679	35,019	43,013
Electricity	TJ	79,092	78,026	12,611	57,289	1,182,406
Others	TJ	4,062	0	0	0	162,050
Total	TJ	594,086	309,850	99,664	289,849	9,548,045
CO_2 emissions						
Total (LCA[1)])	1,000 t	49,737	21,568	9,531	22,326	883,678
Total (UNFCCC)	1,000 t	53,182	18,296	11,542	20,665	-
Coefficients (per t steel):						
Energy	TJ / t	12.7	10.1	15.0	14.5	22.5
CO_2	t / t	1.1	0.6	1.6	1.0	2.1
Energy	D=100	100	79.9	118.1	114.0	177.4
CO_2	D=100	100	51.4	143.7	92.4	186.4
Upstream chain: for generation of electricity						
CO_2 coefficient	t / TJ	0.150	0.145	0.081	0.025	0.237
CO_2 emissions	1,000 t	11,897	11,282	1,027	1,424	280,151
CO_2 emissions incl. upstream chain	1,000 t	65,079	29,578	12,569	22,089	1,163,829
coefficient	t / t	1.38	0.94	1.76	1.11	2.75
coefficient	D=100	100	68	128	81	200
Production of steel	1,000 t	47,224	31,624	7,129	19,852	422,989
Share of furnace steel	%	31.1	62.6	9.0	38.3	10.3

1) LCA: Life cycle analysis

Source: Eurostat (Energy balances), IEA-Energy balances, UNFCCC (Data Interface 2009), Federal Statistical Office of Germany: Iron and Steel Statistics, Environmental-Economic Accounting.

By comparison with Germany, Italy for example has 20 % lower energy and 49 % lower (direct) CO_2 coefficients. These lower coefficients for Italy result from a comparatively high proportion of electric furnace steel in steel production as a whole. In 2006 the proportion was 62.6 %, whereas the proportion in Germany was approximately half of this, at 31.1 %. In producing electric furnace steel – as already mentioned – the direct energy input and direct CO_2 emissions are substantially lower in terms of the volume of steel produced than in the production of oxygen steel. The higher proportion of electric furnace steel in Italy leads to comparatively low (direct) CO_2 coefficients (2006: 0.58 tonnes CO_2 per tonne of steel).

If one considers the upstream chain of “electricity production” then CO_2 emissions increase in particular in those countries with a high electricity input in steel production and with high CO_2 emissions in electricity production. For example the gap between Italy and Germany is reduced because of the greater use of electricity in Italy. Nevertheless, the emission coefficient of Italy is still 32 % lower than the German coefficient.

For countries with relatively low emission coefficients in electricity production – such as France – this gives rise to comparatively low coefficients. And so the emission coefficient (including electricity production) for France is only 81 % of the German coefficient. For China with a very high emission coefficient in electricity production the emission coefficient (including electricity production) is twice as high as in Germany, i.e. – bearing in mind emissions arising from the production of the electricity used – twice as many CO_2 emissions are released per tonne of steel produced in China compared with Germany.

4.3.4 Special calculation for the aluminium industry (WZ 27.42)

The production of aluminium is a very energy-intensive process. The production of raw aluminium takes place either by the fused-salt electrolysis of aluminium oxide (production of primary aluminium) or by processing aluminium scrap (production of secondary aluminium) (see Diagram 1 in the Appendix). Unlike the production of primary aluminium the production of secondary aluminium is less energy- intensive. This only requires about an eighth of the energy used to produce primary aluminium. A high energy use arises in the production of aluminium oxide (alumina) from the aluminium oxide/hydroxide mixture contained in bauxite. This mixture is then incinerated in fluidised bed furnaces or in rotary kilns. This uses mainly natural gas. Then the raw aluminium is obtained by fused-salt electrolysis, using the Hall–Héroult process[20]. This requires large amounts of electricity.

The energy content of aluminium and the CO_2 emissions associated with production depend both on the nature of the aluminium production in the direct countries of origin and on the kind of production of imported raw aluminium and semifinished material among other intermediate suppliers (see Diagram 1 in the Appendix). Many countries do not produce raw aluminium themselves or only in small quantities – such as Belgium for example (see Table 11) – and import primary aluminium instead in order to produce finished products or semifinished products. This must be borne in mind when calculating the energy used in producing aluminium products. The supplier countries have the entire energy used in producing aluminium, i.e. including the energy input in the production of (raw) aluminium by its suppliers from other countries “added on”.

Table 21 shows the original data for calculating the energy input for the production of raw aluminium (including aluminium oxide – alumina) and the results for the energy input and CO_2 emissions for Germany and selected trade partners.

First of all the production of aluminium oxide (alumina) was estimated using a given process-related ratio[21].

20 See de.wikipedia.org; Aluminium and Schmelzflusselektrolyse.
21 See European Commission (2000): integrated pollution Prevention and Control (IPPC), p. 283.

Table 21: Production of raw aluminium, energy input and CO_2 emissions of aluminium production in Germany and selected supplier countries in 2006

	DE	NO	IT	BE	US	CH
Production	in 1,000 tonnes					
Aluoxide (red clay)	973	2,566	574	0	4,304	17,640
Raw aluminium	1,311	1,709	1,582	110	5,281	11,699
-Primary	516	1,360	304	0	2,281	9,349
-Secondary	796	349	1,278	110	3,000	2,350
	as a percentage of raw aluminium					
-Primary	39.3	79.6	19.2	0.0	43.2	79.9
-Secondary	60.7	20.4	80.8	100.0	56.8	20.1
Imports	in 1,000 tonnes					
Aluoxide (red clay)	2,943	755	1,603	1,374	9,774	6,910
Raw aluminium	2,073	400	849	728	5,180	1,198
-Primary	1,560	400	849	728	5,180	1,198
-Secondary	513	0	0	0	0	0
Total supply						
Aluoxide (red clay)	3,916	3,321	2,176	1,374	14,077	24,550
Raw aluminium	3,384	2,109	2,431	838	10,461	12,897
-Primary	2,076	1,760	1,153	728	7,461	10,547
-Secondary	1,309	349	1,278	110	3,000	2,350
	as a percentage of raw aluminium					
-Primary	61.3	83.5	47.4	86.9	71.3	81.8
-Secondary	38.7	16.5	52.6	13.1	28.7	18.2
Energy consumption	in terajoule					
Production	45,212	105,171	33,961	958	192,596	808,709
Aluoxide (red clay)	9,227	31,411	7,021	0	47,854	238,579
Raw aluminium	35,985	73,760	26,939	958	144,742	570,130
-Primary	29,054	70,720	15,808	0	118,612	549,661
-Secondary	6,931	3,040	11,131	958	26,130	20,469
of which:						
Electricity	28,272	66,069	16,544	163	114,384	517,613
Fuel	1,959	5,168	1,155	0	8,668	35,526
Natural gas	14,981	33,935	16,261	795	69,544	255,570
Imports	121,619	30,039	63,786	54,670	378,033	163,894
Aluoxide	36,031	9,239	19,618	16,814	108,673	93,459
Raw aluminium	85,588	20,800	44,168	37,856	269,360	70,435
-Primary	81,120	20,800	44,168	37,856	269,360	70,435
-Secondary	4,468	0	0	0	0	0
Total supply	166,831	135,210	97,746	55,628	570,629	972,603
Aluoxide	45,258	40,650	26,639	16,814	156,527	332,039
Raw aluminium	121,573	94,560	71,107	38,814	414,102	640,565
-Primary	110,174	91,520	59,976	37,856	387,972	620,096
-Secondary	11,400	3,040	11,131	958	26,130	20,469
Specif. energy consumption	terajoule per tonnes raw aluminium					
Production						
Raw aluminium	34.5	61.5	21.5	8.7	36.5	69.1
Germany=100	100	178	62	25	106	200
Supply						
Al. incl. semi-finished goods(D=10	100	178	115	184	153	195
CO_2 emissions (production)	1,000 tonnes					
direct	923	2,303	1,001	45	4,571	17,083
	tonnes CO_2 per tonne raw aluminium					
specific	0.7	1.3	0.6	0.4	0.9	1.5
D=100	100	191	90	58	123	207
Upstream chain generation of electricity						
speciifc (kg CO_2 /TJ Output)	0.150	0.002	0.145	0.078	0.165	0.237
	1,000 tonnes					
absolut	4,253	117	2,392	13	18,836	122,640
upstream chain to direct	4.6	0.1	2.4	0.3	4.1	7.2

Source: US. Geological Survey Minerals Yearbook; International Aluminium Institute: Statistical Report (Energy used in metallurgical Alumina Production);
Wirtschaftsvereinigung Metalle: Metallstatistik; Umweltbundesamt: PROBAS (Prozessorientierte Basisdaten für UmweltmanagementInstrument). Environmental-Economic Accounting.

The production of alumina in connection with imported primary aluminium is estimated with a similar method.

Energy input in the domestic production of primary and secondary aluminium and in the production of imported aluminium has been estimated with the help of process-orientated details. For Germany there are details available from the PROBAS database on the production of primary aluminium (electrolysis) and secondary aluminium (recycling)[22]. For the supplier countries the energy input used in producing alumina was calculated based on region-specific details[23]. For the production of primary aluminium from alumina (fused-salt analysis) the process-specific details for Germany were used as a basis and further details on the technical lower and upper limits of energy input by electricity were taken into account[24]. In determining the input coefficients for China and Russia in particular a lower consumption of electricity in the course of time, i.e. technical progress, was assumed.

China is by far the largest producer of raw aluminium (see Table 21). An overwhelming proportion of primary aluminium – about 80 % of all raw aluminium – is produced there. This leads to a very high specific energy use (energy input per tonne of raw aluminium). Compared with Germany, China requires twice as much energy per tonne of raw aluminium. Italy and Belgium for example have a lower specific energy input than Germany in production. Both countries have a comparatively higher proportion of secondary aluminium in production. Nevertheless, both countries import substantial quantities of primary aluminium – with a correspondingly high energy content. Consequently for total supply both countries show a higher specific energy content compared with Germany.

Direct CO_2 emissions arise from the – overwhelming – use of gas in the rotatory kilns and in the use of fossil energy sources for the remelting of secondary aluminium. Very much higher emissions arise in connection with the production of electricity, where fossil energy sources are used. For each tonne of raw aluminium the selected countries have direct CO_2 emissions between 0.4 (Belgium) and 1.5 tonnes (China) in production. Bearing in mind the upstream chain of “electricity production”, CO_2 emissions increase many times – between 2.4 times (Italy) to 7.2 times (China). Only in the case of Norway and Belgium indirect emissions are relatively low, as only low CO_2 emissions arise in electricity production. On the other hand China, because of the high proportion of coal used in electricity production, has by far the highest emission coefficients for electricity generation (0.237 kg of CO_2 per terajoule electricity output) and very high indirect CO_2 emissions – more than 120 million tonnes of CO_2 – in the upstream chain of “electricity production".

22 PROBAS: Prozessorientierte Basisdaten für Umweltmanagement Instrumente, published by the Federal Environment Agency (Berlin) and the Institute for Applied Ecology (Freiburg) http://www.probas.umweltbundesamt.de/php/sektoren.php?&PHPSESSID=08f0732b3084c496d402088af39100de

23 See information provided by the International Aluminium Institute (Statistical Report) on specific energy consumption for alumina production for five regions (Africa and South Asia, North America, Latin America, East Asia and Oceania, Europe) http://stats.world-aluminium.org/iai/stats_new/formServer.asp?form=8

24 European Commission (2000), p. 284 Information on specific electricity consumption for electrolysis using the pre-bake process.

4.3.5 Special calculation for the production of pulp, paper and paperboard (WZ 21.1)

For the branch "Manufacture of pulp, paper and paperboard" (WZ 21.1) a special calculation was carried out in which, for the most important supplier country – Sweden –, the embodied energy and CO_2 emissions in the manufacture of pulp and paper were analysed and determined in greater detail.

The production of pulp and paper are relatively energy-intensive processes. The production of pulp in particular requires a high energy use. Nevertheless, a significant portion of the energy can be generated by generating one's own energy, i.e. by using the energy content of the raw material used: "wood". The energy used in producing paper can in particular be reduced by using recycled material (waste paper). And so the energy used in producing pulp and paper depends on the nature of the energy sources used, the way in which energy is generated by the factory, especially by process heat, e.g. in coupled processes (cogeneration) and on the amount of recycled material used.

In the case of imports account should ideally be taken of both the special composition of the imports – pulp (CPA 21.11) on the one hand, and on paper and paperboard (CPA 21.12) on the other – as well as circumstances specific to the country in question. In the project the special calculation had to be restricted – for reasons that include data availability – to the most important supplier country for pulp and paper: Sweden. Sweden has a share of 17.4 % of the entire imports of pulp and paper (2006: Euro 13.7 billion). As far as the import of pulp is concerned, this proportion is even higher (2006: 22.9 %).

In the special calculation the energy consumption of Sweden from the energy balance sheet was initially broken down into the subsectors of pulp production and paper production. To facilitate this, details were accessed from a large Swedish pulp factory[25]. For both subsectors the specific energy input was then determined with reference to the volume of production. A further step was to calculate the energy input coefficient for the production of German imports from Sweden. In doing so the proportions of pulp and paper in terms of volume in imports from Sweden were taken into account and a weighted coefficient was determined. Finally the coefficient was converted to the output in euros.

The imports from Sweden give rise to an energy coefficient that is very much higher – about 80 % – than the German figure, as the imports have a high proportion of pulp, with a relatively high energy content.

The CO_2 emission coefficient for the production of German imports was determined based on details of the use of energy sources for the subsectors of pulp and paper production in Sweden. In view of the higher input of biomass (wood) compared to Germany there is a lower emission coefficient for Sweden.

25 Norrsundet Pulp Mill.

5 The influence of technological assumptions on the results

Determining the energy and CO_2 content of goods necessitates taking account of the production conditions and emission conditions in the manufacture of those goods. This means not only taking account of the production conditions in the domestic manufacture of goods but also includes the production conditions abroad.

Foreign countries supply goods either directly for final demand – for private or public consumption – or as upstream goods for producing goods for domestic consumption and export goods.

The energy used for producing these goods and the resultant CO_2 emissions must be included when calculating the energy and CO_2 content of the final demand goods.

The production conditions of all or at least the most important countries of origin for the German imports should be taken into account when the calculations are made. This would not be sufficient however as the supplier countries obtain large proportions of their materials and supplies from other countries. These purchases from upstream production stages should ideally be taken account of on a regionalised basis. This would only be possible if a multiregional calculation approach were used.

Table 22: Import shares for selected upstream goods with a high energy content 2007 (as a percentage of all imported materials and supplies)

Products	France	Netherlands 1)	Germany
Chemical products	61.8	54.6	58.0
Metals	54.7	80.1	61.6
Pulp and paper	39.7	58.1	58.1
Products	37.5	47.0	23.3
Imported materials and supplies	18.8	30.1	23.3

1) Data of 2006.

Source: Eurostat I/O data base.

Such a calculation approach is however extremely demanding and time-consuming in terms of data collection. Firstly, this approach requires access to comparable and sufficiently detailed input-output tables for all countries (regions). Secondly, the supply streams between the countries (regions) would have to be completely regionalised, i.e. the countries from which the imports originate – and possibly the countries for which the exports are to be made – would have to be fully determined.

The multiregional compilation approach requires a high degree of effort in terms of data collection and processing. Furthermore, not all countries of origin (regions) have sufficiently detailed and up-to-date input-output tables available. For the European supplier countries there are symmetrical IOTs available for a large number of countries, broken down into 60 branches (A60). It is however questionable whether sufficiently precise results on energy content and CO_2 content for individual countries can be calculated with this degree of computational detail. The restricted data availability for non-European countries leads, with multiregional I/O models, to the computational detail often having to be further restricted by comparison with the European IOTs[26].

In view of the calculation approach on which this is based another route has been taken because of the data available and in order to achieve the desired computational accuracy. Based on the existing national IOTs divided into 71 branches further disaggregations were carried out for energy-intensive industries and the energy input conditions in the most important countries of origin for German imports taken into account. This took place based on a hybrid compilation approach, which facilitated the use of data for quantity energy input from the International energy balance sheets and from details taken from process chain analysis. This has made it possible – compared with the monetary model – to achieve very much more precise results on the energy content and CO_2 content of the goods produced in Germany (see Chapter 4.1). It can also be assumed for the explicitly noted, most important countries of origin that the results achieved regarding the energy and CO_2 content of the imports are very much more accurate based on the disaggregated calculations than the results based on an aggregated, purely monetary IOT.

The most important factors influencing the computational results for imports are analysed in greater detail below.

5.1 Aggregation effect: CO_2 content of imported goods exemplified by metal imports

Table 23 shows the import figures for metals in 2007 for the four most significant supplier countries, subdivided into three groups of goods[27]. There are substantial differences as far as the shares in terms of value of the individual groups of goods in total imports of metals are concerned. France has a high proportion of steel and steel products (59 % of the total imports of metals), Russia, on the other hand, has 60 % for non-ferrous metals (excluding aluminium).

The incidence of CO_2 emissions in the production of metals is very varied. As far as direct production is concerned (without upstream chains) by far the highest CO_2 emissions are emitted in this sector during steel production (0.567 t CO_2 per thousand Euro Output) because of the high input of reducing agents[28]. On the other hand, in the case of aluminium production and that of other non-ferrous metals the – direct – emissions per output are very much less. The emissions that occur in the upstream chains, especially in connection with purchases of electricity are ignored here.

With an aggregated calculation of emissions for metal production the differences in the use of upstream activities, such as energy input and the emission of greenhouse gases are ignored in the subsectors. The (direct) emissions are calculated using the average coefficients for all metal production. When country-specific coefficients are used this average coefficient reflects the relevant production conditions in the country of origin, not however the special composition of German imports from these countries.

26 The OECD database for the I-O tables (STAN Industry Database) contains IOTs for 44 countries broken down into 48 economic sectors. For a number of countries, such as for the EU countries however, the IOTs are only available in a restricted sectoral breakdown. http://www.oecd.org/sti/inputoutput/
27 The import figures for foundry products are assigned to iron and non-ferrous metal products.
28 Emission coefficient for Germany.

Table 23: Imports of steel and non-ferrous metals and CO_2 emissions 2007

CPA	Products / branches	Unit	FR	NL	BE	RS	Total
			imports to Germany				
27.1-3	Basic iron and steel	Euro mn	3,746	2,756	3,157	994	31,850
27.42	Aluminium, alu products	Euro mn	989	1,505	989	749	11,431
27.4R	Other non-ferrous metals	Euro mn	1,584	1,768	2,422	2,657	24,183
	Total	Euro mn	**6,319**	**6,029**	**6,567**	**4,399**	**67,465**
27.1-3	Basic iron and steel	%	59	46	48	23	47
27.42	Aluminium, alu products	%	16	25	15	17	17
27.4R	Other non-ferrous metals	%	25	29	37	60	36
	Total	%	**100**	**100**	**100**	**100**	**100**
27.1-3	Basic iron and steel	mn tonnes	4,382	4,791	4,060	1,660	38,924
27.1-3	Basic iron and steel	Euro/tonnes	0.855	0.575	0.778	0.599	0.818
		Inverse 1)	production of imports - Euro mn -				
27.1-3	Mf. of iron and steel	2.44	9,140	6,725	7,702	2,425	77,714
27.42	Mf. of aluminium	2.64	2,611	3,973	2,611	1,977	30,179
27.4R	Mf. of other non-ferrous m	2.64	4,182	4,668	6,393	7,013	63,844
	Total		**15,932**	**15,366**	**16,706**	**11,416**	**171,737**
27	Metal production	**2.37**	14,977	14,291	15,566	10,428	159,912
			direct CO_2-emissions				
		coeff. 2)	1,000 tonnes				
		t/Euro 1,000	- detailed calculation (A) -				
27.1-3	Basic iron and steel	0.567	5,180	3,811	4,365	1,374	44,041
27.42	Aluminium, alu products	0.076	199	303	199	151	2,301
27.4R	Other non-ferrous metals	0.034	143	159	218	240	2,181
	Total		**5,522**	**4,274**	**4,782**	**1,765**	**48,524**
		t/Euro 1,000	*0.347*	*0.278*	*0.286*	*0.155*	*0.283*
			- aggregated calculation (B) -				
27	Basic iron and steel	0.384	5,745	5,482	5,971	4,000	61,343
			A-B				
27	Basic iron and steel		-224	-1,208	-1,189	-2,236	-12,819
27	Basic iron and steel	% of A	*-4.1*	*-28.3*	*-24.9*	*-126.7*	*-26.4*

1) Inverse coefficients (diagonal element) from German IOT (incl. further processing).
2) CO_2 emission coefficient for Germany (Refering to: production incl. further processing).

Comparing a detailed calculation of CO_2 emissions with an aggregated calculation – based on inverse coefficients and CO_2 emission coefficients for Germany - shows substantial absolute and percentage differences in results: the CO_2 emissions for an aggregated calculation are consistently lower than with a detailed calculation. The differences lie between –4.1 % (for the imports from France) and –126.7 % (for the Russian imports). The reason for the lower emission figures in the detailed calculation is the higher proportion of imported non-ferrous metals in metal imports – by comparison with (German) production. With the production of non-ferrous metals comparatively less CO_2 is emitted than is the case with metal production as a whole.

5.2 Effects of a quantity-based calculation (hybrid I/O model)

With the hybrid calculation approach the CO_2 emissions are calculated using the quantity information on the production of goods and demand for them. In Table 24 the result of a quantity-based calculation is compared with the result of a value-based calculation. With the quantity-based calculation, on the one hand for this comparison emission coefficients for Germany (A1) are used, and on the other hand national coefficients (A2) are used for the countries of origin for the imports. This also facilitates an assessment of the impact of using different CO_2 emission coefficients.

Table 24: Imports of steel, steel products and CO_2 emissions 2007

Products	Unit	FR	NL	BE	RS	INSG
		German imports				
Basic iron and steel, steel produc	mn tonnes	4,382	4,791	4,060	1,660	38,924
	Euro mn	3,746	2,756	3,157	994	31,850
	Euro/tonnes	0.855	0.575	0.778	0.599	0.818
		direct CO_2-emissions 1)				
		1,000 tonnes				
Quantity calculation (A1) 1)	1.14	4,996	5,462	4,628	1,892	44,373
Quantity calculation (A2)		4,420	4,013	3,795	3,083	
domestic emisssion coefficient	tonnes/tonnes steel	1.01	0.84	0.93	1.86	
		A1-A2				
		576	1,449	833	-1,191	
	in % of A1	*11.5*	*26.5*	*18.0*	*-63.0*	
Monetary calculation (B)						
Output (Euro mn)	*2.44* 2)	*9,140*	*6,725*	*7,702*	*2,425*	*77,714*
CO_2 emissions 1)	0.567	5,180	3,811	4,365	1,374	44,041
		A1-B				
		-184	1,651	263	518	332
	in % of A1	*-3.7*	*30.2*	*5.7*	*27.4*	*0.7*

1) With emission coefficient, (tonnes CO_2 / tonnes steel respectively tonnes CO_2 / Euro 1,000) for Germany.
2) Inverse coefficient (IOT Germany 2007).

Comparing the results of the quantity account (A1) with the value account (B) for the CO_2 emissions based on the emission coefficients for Germany shows in part substantial absolute and relative differences. The countries of origin, whose imports have below-average prices show higher emissions for the quantity account than for the value account. And vice versa. For iron and steel imports the percentage differences for the Netherlands and Russia with differences of 30.2 % and 27.4 % are particularly high.

In this example the use of different emission coefficients has a considerable influence on the results. The national emission coefficients show great differences here – with a corresponding impact on the emission content of goods (see differences account A1-A2).

The influence of a quantity-based and value-based calculation will be demonstrated by a further example – imports of electricity from France.

Table 25: Imports of electricity from France and CO_2 emissions 2007

NACE	Output	Primary energy consum-ption	CO_2	CO_2 coeffi-cients	Imports from France							
					final use				intermediate consumption		total	
					electricity			other goods				
					direct	prod. 2)	coeff. 3)	prod. 2)	direct	prod. 2)	direct	prod. 2)
	Euro mn		1,000 t	t/Euro 1,000								
1. Regionalised calculation with disaggregation for branch 40 (quantities)												
	petajoule				terajoule							
40.1	2,030	3,705	52,179	0.026	**16,194**	17,816	*1.10*	46,069	**42,846**	159,365	**59,040**	205,435
40.2				0.000	0	409		5,082	0	33,118	0	38,199
40.3	5	9	819	0.155	0	13		3,499	0	11,739	0	15,238
					CO_2 in 1,000 tonnes							
40.1					416	458	*1.10*	1,184	*1,101*	4,095		5,279
40.2					0	0		1		7		8
40.3					0	2		542		1,819		2,361
Insg.						460		**1,727**		**5,921**		**7,648**
2. Calculation with monetary IOT of France (without disaggregation) 1												
					Euro mn							
40	69,516		38,672	0.56	**164**	216	*1.32*	900	**434**	2287	**597**	3,187
					CO_2 in 1,000 tonnes							
						120		**501**		**1,272**		**1,773**
3. Calculation with monetary IOT of Germany												
					Euro mn							
40				0.56	**164**	220	*1.3*	952	**434**	2400	**597**	3,353
					CO_2 in 1,000 tonnes							
								530		**1,335**		**1,865**

1) Data for 2006.
2) Production of imported goods in country of origin.
3) Inverse coefficients for France (Total-IOT), for calculation 3 coefficients for Germany.

Table 25 shows the results of calculating CO_2 emissions in the implemented calculation model based on quantity information (first part of the table) and a comparative calculation based on the monetary IOT from France (second part of the table) in the breakdown into 60 branches. Apart from this the attempt is made in a further comparative calculation (third part of table) to determine the influence of the differences in technology between France and Germany. Here the IOT for Germany is used in the monetary account instead of the IOT for France.

It is evident that with a quantity-based account with a subdivision of energy supply (NACE 40) into three subsectors the CO_2 emissions of the entire energy supply are more than four times as high as in the case of a calculation based on a purely monetary, aggregated IOT broken down into 60 sectors (7.6 million tonnes CO_2 compared to 1.8 million tonnes).

These large differences are already evident when considering solely CO_2 emissions, which are to be allocated to the imports of electricity. In the quantity-based calculation, emissions amounting to 460 thousand tonnes of CO_2 are assigned to imports of 16.2 petajoules (the portion that is assigned to final demand). With this calculation the relatively low CO_2 emission coefficients of French electricity production are used.

With a value-based calculation based on the monetary IOT for France (IOT for domestic production and imports) only 120,000 tonnes of CO_2 are assigned to the relevant electricity imports of 164 million Euros. Here too the results for the quantity-based account are almost four times as high as those for the value-based account.

The reason for the large discrepancies can be found in the definition and coverage of the emission coefficient for the energy supply in the monetary account. The emissions, which arise almost exclusively in the subsector of "Electricity generation", are assigned to energy supply as a whole. The sector as a whole also includes the gas supply sector (40.2) with very low direct CO_2 emissions along with electricity generation and district heating supplies. Gas supplies as a proportion of the sector as a whole cannot be determined for France based on available details. In Germany the proportion of output in 2007 was 15.3 %. From a definitive point of view the output of the gas supply also includes the output of the gases produced alongside the distribution performance for distributing gases. The emission coefficient for the entire energy supply calculated on this basis is therefore untypical and unsuitable for estimating the CO_2 emissions linked to electricity demand.

Table 25 also shows the results of a further comparative calculation. Here the IOT for France was exchanged by the IOT for Germany in the value-based account. The results may provide information on the influence of technology on the incidence of CO_2 emissions. Using German technology but with emission coefficients for France would mean that 5.2 % higher CO_2 emissions would arise in the production of imports from France in the area of energy supply. This percentage difference arises for the entire emission content of imports from France using the IOT of France instead of the modified IOT from Germany actually used.

In our view these differences cannot lead one to conclude that the technology-related emission conditions – in France – are more favourable. It can be assumed that at the aggregation level of the IOT (60 sectors) used here the composition of the industries in Germany and France are very different, especially in the energy-intensive and emission-intensive industries such as those of metal production and chemicals. The differences for the input coefficients of the industries are therefore due both to a difference in the composition of subsectors and to the technology-related differences in the subsectors.

6 Comparative calculations between hybrid and monetary models with different levels of disaggregation

6.1 Comparison of the energy content of goods with different levels of computational detail (hybrid model)

To calculate the energy content of goods from domestic production the hybrid (energy-) IOT disaggregated into 73 sectors (R73) was used as a basis for the domestic figures (domestic table) for reporting year 2006. For purposes of comparison this table was aggregated for 67 sectors (R67). This breakdown largely corresponds to the breakdown of the national IOT (R71)[29]. The following table shows the differences in the breakdown of the two analysis models. The analysis model with 73 branches has further subdivisions in three energy sectors and in two – energy-intensive – industrial sectors.

Overview 7: Breakdown of homogeneous branches of the hybrid I/O model by 73 respectively 67 branches

NACE[1)]	Branch	R73	R67
10.1	Hard coal	X	}
10.2/3	Lignite	X	}
23.1	Coke oven products	X	}
23.2	Refined petroleum products	X	}
23.3	Nuclear fuel	X	
24.1	Basic chemicals	X	}
24R (ex. 24.4)	Other chemicals	X	}
27.42	Aluminium	X	}
27.4R	Other non-ferrous metal products	X	}
40.1	Electricity	X	}
40.3	District heating	X	}

1) NACE Rev.1.

To calculate the energy and CO_2 content new energy and CO_2 emission coefficients were determined for the integrated IOT broken down into 67 sectors (R67).

For a number of sectors there are significant differences between the two calculations for the energy and CO_2 content of the goods. For 18 of the 67 sectors there are deviations of more than 5% in the energy content (for the CO_2 content: 12 sectors). For 5 sectors there are deviations of more than 10% in the energy content (for the CO_2 content: 2 sectors):

Error statistics for the results of the energy and CO_2 content of goods for different levels of computational detail for the I/O analysis model (67 and 73 sectors respectively):

29 From a computational point of view the IOT broken down into 67 sectors has aggregations in three areas (in mining, insurance and personal services.).

Number of sectors (groups of goods) with percentage deviations

More than 5 %		Less than 10 %	
energy	CO_2	energy	CO_2
18	12	5	2

The following table contains – for the energy content – results for selected sectors with significant deviations.

Table 26: Energy content of goods 2006 according model with different breakdown

CPA	Commodities	Energy content 1)				of which: electricity and district heating				Share electricity 2)
		R67 3)	R73 3)	R67-R73		R67	R73	R67-R73		
		petajoule			%	PJ			%	%
24 R	Other chemicals	1,341.6	1,304.6	37.0	2.8	260.1	225.8	34.2	15.2	68.2
85	Health services	385.4	349.0	36.4	10.4	131.6	95.4	36.1	37.9	52.4
80	Education services	206.2	174.0	32.2	18.5	68.0	37.6	30.4	81.0	36.4
92	Cultural a. sport services	123.6	112.1	11.5	10.3	38.1	26.6	11.5	43.3	52.5
27.1-3	Basic iron, steel	508.1	546.2	-38.1	-7.0	81.9	102.4	-20.6	-20.1	99.5
29	Machinery	390.8	404.7	-13.9	-3.4	109.1	121.8	-12.7	-10.4	88.5
34	Motor vehicles	589.6	600.1	-10.5	-1.8	185.5	195.3	-9.9	-5.1	80.7
60.1	Railway services	117.5	124.9	-7.4	-5.9	45.1	54.0	-8.9	-16.5	98.2

1) Of domestic production.
2) Electricity in a percentage of direct purchases of electricity and district heat.
3) 73 calculation breakdown energy (IOT) respectively 67 branches

In addition to the total energy content the table includes the energy content from the use of electricity and district heating in goods production. It is clear that a major portion of the total difference for energy content can be explained by the difference in the sub-quantity "Electricity and district heating".

The results show that goods requiring a relatively high proportion of electricity for their manufacture (proportion of total electricity and district heating taken up, see last column of the table) have a smaller energy content in the aggregated calculation than in the disaggregated calculation and vice versa. This is due to the very much higher energy coefficients in electricity generation by comparison with district heating generation. With electricity generation very much higher energy losses arise (a reduced efficiency with energy conversion), than with heat generation. With the disaggregated calculation these losses are precisely assigned to the relevant purchasers, whereas in the case of the aggregated calculation an average energy coefficient (weighted with domestic production) is used for the electricity and district heating generation sector.

Subdividing the "Electricity and district heating generation" sector into the two subsectors – as in the R73 analysis model – leads therefore to a substantial improvement in the assignment of energy used for producing goods to final demand goods.

6.2 Comparison of the energy and CO_2 content of goods in the monetary and in the hybrid model

Comparison of the energy and CO_2 content of goods from domestic production is based on the hybrid model divided into 67 branches and the aggregated monetary model likewise broken down into 67 sectors. This breakdown largely matches the breakdown in the national IOT (R71).

Table 27: Energy and CO_2 content of goods in the monetary and hybrid calculation model 2006 (R67) – selected branches

CPA [1]	Commodities	Energy content (petajoule)				CO_2 content (mn tonnes)			
		monetary	hybrid	mon. - hybrid	of %	monetary	hybrid	mon. - hybrid	of %
	a) selected branches with high absolute deviations:								
40.1/3	Elektricity, district heating	1,893	1,401	492	35.1	198.3	146.6	51.7	35.3
24 (ex. 24.4)	Chemicals (excl. pharmceuticals	1,166	1,342	-175	-13.1	36.7	54.4	-17.7	-32.6
27.1-3	Basic iron , steel	473	508	-35	-6.8	41.3	44.3	-3.0	-6.8
27.4	Non-ferrous metal products	127	156	-29	-18.5	5.8	8.9	-3.0	-34.2
85	Health and social services	357	385	-28	-7.3	20.5	23.6	-3.0	-12.9
21.1	Pulp, paper	162	188	-27	-14.1	8.9	11.7	-2.8	-23.9
	b) selected branches with high percentage of deviations								
10	Coal and peat	10	2	8	317.7	0.6	0.2	0.4	252.0
40.2	Distribution of gas	26	3	23	798.9	2.3	0.2	2.1	1,066.9
	total	10,804	10,772	32	0.3	729.3	727.1	2.2	0.0

1) Classification of production activities.

The deviations between the results of the monetary and hybrid model can be traced back to 3 auses.

1. Monetary transactions (upstream activities) without a physical equivalent
2. Inconsistent figures for the monetary and physical details in the IOT
3. Lack of homogeneity in the monetary transactions in a sector in the IOT (price differentiation)

Re 1.:

For the supply streams (output) for the goods the monetary table also includes service transactions without a relevant physical equivalent: for example the electricity generation and distribution sector also includes pure distribution services, which are posted in the same sector as the purchase of electricity generation and distribution services. These purchases have no physical equivalent to match the energy source "electricity". The domestic IOT includes an entry of 9.5 billion euros for electricity generation and distribution services to its own sector ("Diagonal element") for 2006. This figure overwhelmingly consists of distribution services (for the distribution of electricity), which companies in this sector provide for other companies in the sector.

In the hybrid IO model in the diagonal element a company's own consumption of electricity in the electricity sector appears in physical values (terajoules). In 2006 the proportion of this input was 5.8 % of total electricity generation. The proportion of the monetary dimension in domestic production at 13.2 % was more than twice the physical dimension. In the monetary model based on this high monetary dimension a correspondingly high – implausible – energy content and CO_2 output was generated (see in Table 23 the details for 40.1/3 Electricity and district heating).

Re 2.:

Differing computational results can also result from inconsistent computation. This means that the monetary details – in the monetary IOT – are not in conformity with the physical dimensions (and vice versa). Ideally the details for the monetary inputs for energy consumption are derived on the basis of existing physical details. If the calculations are carried out independently of one another the consistency of the calculations is not ensured and this gives rise to results that differ from one another. The advantage of the hybrid model consists in being able to link up directly to existing information arising from the energy flow accounts, independently of the monetary details for the energy input.

In Table 27 under b) two sectors are listed as an example, for which there are inconsistent output data on electricity consumption for these sectors, giving rise to high percentage deviations for the results of the analysis.

This gives rise to a significant deviation even in absolute terms for the gas distribution sector (CPA 40.2). Clearly, here in the monetary and hybrid tables the distribution services and the relevant energy expenditure (energy costs) are assigned differently. One reason for this could be the necessary separation according to NACE of distribution services for pipeline transport (Pipelines, NACE 60.30) and distribution in the supply network (40.2).

Re 3.:

Of greater significance are the deviations that are due to a "lack of homogeneity" of branches (in the lines) of the IOT. One reason for a lack of homogeneity in the branch is if there are differences in (average) prices for the purchasers of the good (group of goods).

This lack of homogeneity of has been presumed for the branch of “Electricity generation” and investigated in greater detail. In particular it has been assumed that industrial sectors with a high electricity consumption and high purchases of electricity from the national network (so-called special contract customers) pay lower prices than customers with lower consumption. The energy content (and the CO_2 content) of the "major customers" would then be underestimated in a monetary model, since there the energy content is calculated on the basis of the comparatively "more favourable" monetary energy costs on a Euro basis.

Table 28: Energy content of goods and energy costs of selected homogeneous branches 2006

CPA	Homogeneous branches/commodities	Energy content [1]			nput electricity, district heating [1]		
		monetary	hybride IO	mon-hybr.	costs [2]	quantity	price
		petajoule			Euro mn	mn kWh	Ct/kWh
24 R	Other chemicals	1,166	1,342	-175	1,931	65,540	2.9
27.1-3	Basic iron, steel	473	508	-35	1,395	22,418	6.2
27.4	Non-ferrous metals	127	156	-29	612	13,548	4.5
41	Water distribution	22	16	6	556	3,607	15.4
15.1-8	Food	469	465	5	1,542	16,971	9.1
	Total	10,804	10,772	32	40,305	504,853	8.0

1) Of domestic production.
2) At basic prices, Input-Output Accounts.

Table 28 shows that major customers such as other chemicals (excluding pharmaceutical products) the non-ferrous metal industry and iron and steel production enjoy well below-average prices for the purchase of electricity and district heating (last column). These sectors show in the hybrid model very much higher values than in the monetary model for the energy content of goods. On the other hand in the case of water supply – with very much above-average prices for electricity – there is a much higher figure in the monetary model for energy content than in the hybrid model. In this sector we cannot however rule out the monetary output data for energy costs being shown as too high by comparison with the actual energy consumption.

6.3 Comparison of the energy and CO_2 content of goods in the monetary model with different levels of disaggregation

The I/O analysis was first carried out based on 55 (R55), then based on 67 (R67) sectors. The level of disaggregation of 67 sectors arises from using the national IOT in R71 breakdown and from the aggregation of some sectors – that are insignificant from the computational results[30].

The following overview shows in which branches there are different levels of disaggregation.

Overview 8: Subdivision of IOT into 67 and 55 branches

67 branches (A67)		55 branches (A55)		67 branches (A67)		55 branches (A55)	
NO	CPA	CPA	NO	NO	CPA	CPA	NO
1	15.1 – 15.8	15	1	13	27.1 – 27.3	27	7
2	15.9			14	27.4		
3	21.1	21	2	15	27.5		
4	21.2			16	40.1/3	40	8
5	22.1	22	3	17	40.2		
6	22.2 – 22.3			18	45.1 – 45.2	45	9
7	24.4	24	4	19	45.3 – 45.5		
8	24 (ex. 24.4)			20	60.1	60	10
9	25.1	25	5	21	60.2 – 60.3		
10	25.2			22	75.1 – 75.2	75	11
11	26.1	26	6	23	75.3		
12	26.2 – 26.8						

Table 29 shows for selected groups of goods (with high absolute differences) the differing results for energy and CO_2 content of goods in the R55 and R67 breakdowns respectively. Overall, in the case of the energy content for three groups of goods there are differences of more than 10 % (range: +10 to –13 %), in the case of CO_2 content there are five groups of goods whose results deviate from one another by more than 10 % (range: +11 to –14 %).

30 Aggregations were carried out in the area of mining and quarrying (CPA 12-14), insurance and financial aid services (CPA 66-67), miscellaneous personal services and household services (CPA 93-95). The discontinuation leads, using the A60 breakdown, to a comparative classification based on 55 sectors (= 60 – 4- CPA99).

Table 29: Energy content and CO_2 emissions of goods of different breakdown of branches

CPA	Commodities	Energy content (PJ)				CO_2 emissions			
		R55 [1)]	R67 [1)]	Diff. (R55-R67)		R55 [1)]	R67 [1)]	Diff. (R55-R67)	
		petajoule			%	mn tonnes			%
	Total	10,804	10,804	0		729	729	0	
	of which:								
24	Chemicals	1,315	1,267	48	4	43	41	2	4
27	Basic iron and steel	658	636	22	3	52	49	3	5
45	Construction	545	561	-16	-3	36	40	-3	-9
60	Transport services	161	186	-24	-13	9	10	-1	-13

1) I/O-analysis with 55 respectively 67 brakdown of branches.

In the following example (see Table 30) for the land transport sector the causes of the deviations in CO_2 content are examined in greater detail.

Table 30: Comparison of CO_2 emissions of land transport 2006 for the I/O calculation model with different breakdown of branches

	R67 [1)]			R55 [1)]	R55/R67
	60.1	60.2	Sum	60 (agg.)	
Energy-input branches (Euro mn):					
Electricity, district heating, etc.	639	332	971	971	
Electricity, district heating, other gas: as a % of output	*4.4*	*0.6*	*1.4*	*1.4*	
Output (Euro mn)	14,582	53,602	68,184	68,184	
Output as a % of total	*21.4*	*78.6*	*100.0*		
Final use (Euro mn)	10,439	16,299	26,738	26,738	
Final use as a % of total	*39.0*	*61.0*	*100.0*		
Production (Euro mn)					
Electricity, district heating, gas (40)	609	188	797	576	-221
of which direct:					
Electricity, district heating, gas (40)	457	101	558	381	-178
Emission-coefficient (t/Euro):					
Electricity. district heating (40.1/3)	5.33	5.33			
Produced gas (40.2)	0.004	0.004			
Total	4.48	4.48		4.48	
CO_2 emissions (1,000 t):					
Withdrawal of ...					
Electricity, district heating, gas (40)	3,242	1,000	4,242	2,579	-1,663
Total	5,496	4,993	10,489	9,088	-1,401

1) Breakdown of I/O-analysis by 55 respectively 67 homogeneous branches.

The rail transport sector (WZ 60.1) had a output of 14.6 billion Euros in 2006, other land transport 53.6 billion Euros. By comparison with other land transport, rail transport is characterised by a higher relative use of electricity (including district heating and generated gases) regarding its output – 4.4 % and 0.6 % respectively.

By comparison with output the final demand is characterised by a higher proportion of rail services in the total services of land transport. In the case of other land transport on the other hand services – such as road goods transport – are predominantly rendered as an upstream activity for other branches.

This greater demand for railway services leads – by comparison with the aggregated calculation (R55) with average figures – to a higher demand for supplies (production figures) of electricity (797 million Euros compared to 576 million Euros).

A major part of this difference is already due to the variations in the level of direct demand for electricity: with a disaggregated calculation more electricity is used directly for producing the service as with the aggregated calculation (558 million Euros compared to 381 million Euros).

Relatively speaking, very much higher emissions arise in producing electricity and district heating (CPA 40.1/3) than in producing generated gases (CPA 40.2). That is why the subsector also presents much higher emission coefficients than the sector as a whole (CPA 40).

The higher demand for electricity also leads therefore in the case of the disaggregated calculation to higher upstream (indirect) CO_2 emissions than is the case with the aggregated calculation.

There are therefore two factors that are responsible for the differences between the disaggregated and the aggregated calculation: firstly the variations in demand for upstream activities based on differences in input coefficients and secondly the differences in the emission coefficients for the subsectors (in this case between electricity production and the production of generated gases).

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Table 1: Hybrid (Energy-) Input-Output-Table for Germany 2000

Branches	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	A,B	EN1	EN2	EN3	EN4	ex C,D	41,F	G+H	I	J-O	Total	Pha	NPISHs	G	INV	CI	EX	FD	FU
A,B	4,760	7	5	0	0	35,346	0	1,068	61	2,199	43,446	16,590	0	0	3,769	-92	5,390	25,657	69,103
EN1	3	121	0	352	2,815	223	1	6	1	7	3,528	40	0	0	0	-126	59	-27	3,501
EN2	7	0	22	4,594	565	935	17	134	7	235	6,517	948	0	0	0	-34	444	1,358	7,875
EN3	154	3	1	971	1,949	1,557	224	269	877	414	6,418	2,151	0	0	0	-6	1,137	3,283	9,700
EN4	20	35	2	64	245	1,001	28	176	96	246	1,913	601	0	0	0	150	153	903	2,816
ex C,D	9,237	1,483	136	595	4,128	581,652	70,323	28,872	11,244	47,654	755,325	269,065	0	12,865	172,067	5,466	555,806	1,015,269	1,770,594
41,F	556	193	6	109	830	5,608	10,457	2,384	1,975	32,087	54,205	8,737	0	0	175,748	0	109	184,594	238,799
G+H	2,819	324	31	107	1,862	65,605	11,867	24,897	8,253	17,994	133,759	240,274	0	10,597	19,566	0	40,978	311,415	445,174
I	322	51	128	606	1,228	36,403	1,980	39,945	65,922	19,366	165,951	59,064	0	2,728	0	0	26,696	88,488	254,439
J-O	6,829	1,048	299	1,774	10,038	144,360	33,228	71,852	29,458	331,905	630,791	391,421	33,830	361,454	40,010	83	33,002	859,800	1,490,591
Total (exl. taxe	26,193	4,188	702	33,356	28,353	898,965	130,475	175,156	125,682	460,395	1,883,465	1,024,435	33,830	387,920	411,190	6,750	670,570	2,534,695	4,418,160
D21-D31	1,100	51	11	616	753	5,692	1,633	3,293	5,561	27,875	46,585	125,255	0	3,990	31,240	0	-770	159,715	206,300
Total (incl. taxe	27,293	4,239	713	33,972	29,106	904,657	132,108	178,449	131,243	488,270	1,930,050	1,149,690	33,830	391,910	442,430	6,750	669,800	2,694,410	4,624,460
Value added	22,835	248	1,365	3,390	24,393	388,708	103,106	256,433	97,937	957,785	1,856,200								
Output	50,128	2,689	769	7,353	2,654	1,293,365	235,214	434,882	229,180	1,446,055	3,786,250								
Imports	18,975	813	7,106	2,347	162	477,229	3,585	10,292	25,259	44,536	631,910								
Total	69,103	3,501	7,875	9,700	2,816	1,770,594	238,799	445,174	254,439	1,490,591	4,418,160								
for info:																			
PEV (PJ)	*184*	*48*	*24*	*362*	*3,447*	*3,550*	*270*	*589*	*987*	*919*	*10,381*	*3,914*							*14,295*
CO2 (Mill. t)	*13*	*1*	*1*	*21*	*357*	*179*	*8*	*26*	*65*	*45*	*716*	*232*							*948*

Data for energy branches (EN1-4) in Petajoule
Other branches in EURO

Legend for homogeneous branches:

NACE Rev. 1

A,B	Agriculture, forestry and fishery
EN1	Coal mining (10)
EN2	Extraction of crude petroleum, natural gas (11)
EN3	Cokeries, refinery of petroleum products (23)
EN4	Electricity (40)
ex C,D	Manufacturing (D ex 10,11,23), other mining sctors
41,F	Water supply, construction
G+H	Wholesale and retail sale
I	Transport and communication
J-O	Other service sectors

Categories of final demand:

Pha	Private consumption
NPISHs	Non-profit institutions serving households
G	Government consumption
Inv	Fixed capital formation
CI	Changes in inventories
EX	Exports
FD	Final demand
FU	Final use
Total (ex. taxes)	Total intermediate consumption ex taxes
D21-D31	Taxes on goods minus subsidies on products
Total (incl. taxes)	Total intermediate consumption incl. taxes
VA	Gross value added
Output	Output
PEC	Primary energy consumption
CO_2	Carbon dioxid emissions

Table 2: Hybrid (Energy-) Input-Output-Table for Germany 2006

Branches	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	A,B	EN1	EN2	EN3	EN4	ex C,D	41,F	G+H	I	J-O	Total	Pha	NPISHs	G	INV	CI	EX	FD	FU
A,B	8,167	14	9	0	0	32,597	0	844	87	2,669	44,387	15,915	0	0	3,317	1,103	6,436	26,771	71,158
EN1	0	128	0	318	2,834	235	2	5	0	5	3,528	39	0	0	0	-25	73	87	3,615
EN2	16	1	9	4,810	779	945	13	101	10	215	6,897	965	0	0	0	291	569	1,825	8,722
EN3	132	1	1	972	1,930	1,395	177	238	893	445	6,182	2,052	0	0	0	67	1,504	3,624	9,806
EN4	21	33	2	50	268	1,137	28	196	100	322	2,157	661	0	0	0	169	238	1,067	3,224
ex C,D	9,805	1,681	234	743	5,236	756,536	62,638	29,086	12,892	49,463	928,314	272,814	0	14,280	172,000	-7,933	832,684	1,283,845	2,212,159
41,F	599	169	6	96	966	6,545	9,085	2,515	1,928	28,481	50,390	8,281	0	0	158,595	0	99	166,975	217,365
G+H	2,969	257	35	135	1,407	65,177	11,620	20,449	8,611	18,066	128,726	265,282	0	12,512	19,620	-4,500	62,832	355,746	484,472
I	326	34	197	1,525	2,927	41,541	1,567	46,810	83,579	19,421	197,927	72,232	0	2,691	0	0	43,300	118,223	316,150
J-O	8,057	805	496	2,235	12,579	173,504	34,464	86,216	36,921	406,172	761,449	457,933	36,010	391,104	40,068	359	53,070	978,544	1,739,993
Total (excl. tax)	31,922	3,854	1,265	55,786	52,190	1,119,923	122,272	194,044	158,589	536,702	2,276,547	1,153,787	36,010	420,870	393,740	-13,680	1,030,240	3,020,967	5,297,514
D21-D31	1,086	58	10	64	1,346	10,612	1,645	4,511	6,016	34,069	59,417	135,093	0	4,560	29,350	0	-220	168,783	228,200
Total (inxcl. tax)	33,008	3,912	1,275	55,850	53,536	1,130,535	123,917	198,555	164,605	570,771	2,335,964	1,288,880	36,010	425,430	423,090	-13,680	1,030,020	3,189,750	5,525,714
Value added	17,190	647	1,943	4,779	32,132	439,284	90,498	276,074	116,744	1,114,009	2,093,300								
Output	50,198	2,374	741	7,478	3,058	1,569,819	214,415	474,629	281,349	1,684,780	4,429,264								
Imports	20,960	1,241	7,981	2,328	166	642,340	2,950	9,843	34,801	55,213	868,250								
Total	71,158	3,615	8,722	9,806	3,224	2,212,159	217,365	484,472	316,150	1,739,993	5,297,514								
for. info.																			
PEV (PJ)	*172*	*53*	*11*	*420*	*3,613*	*3,649*	*225*	*559*	*1,095*	*1,007*	*10,805*	*3,932*							*14,736*
CO2 (Mill. t)	*12*	*2*	*1*	*22*	*391*	*172*	*7*	*23*	*73*	*47*	*748*	*230*							*978*

Data for energy branches (EN1-4) in Petajoule
Other branches in EURO

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Total (ex. taxes)	Total intermediate consumption ex taxes
D21-D31	Taxes on goods minus subsidies
Total (incl. taxes)	Total intermediate consumption incl. taxes
VA	Gross value added
Output	Output
PEC	Primary energy consumption
CO_2	Carbon dioxid emissions

Table 3: Energy consumption of homogeneous branches and households by type of energy sources 2006 *)
(National Accounts Concept)
terajoule

No.	CPA 1)	Homogeneous branches	Total	Hard coal and hard coal products	Lignite and lignite products	Mineral oil	
						Together	Crude oil
1	01	Products of agriculture, hunting and related services	168,778	0	0	129,766	0
2	02	Products of forestry, logging and related services	3,067	0	0	2,428	0
3	05	Fish and other fishing products, services incidental to fishing	628	0	0	56	0
4	10	Coal and lignite, peat	170,531	4,443	123,804	1,170	0
5	10.1	Hard coal and hard coal products	19,241	4,443	0	747	0
6	10.2/10.3	Lignite (brown coal) and lignite products, peat	151,291	0	123,804	423	0
7	11	Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying	11,228	0	0	575	0
8	12/13	Metal ores (including uranium and thorium ores)	27	0	27	0	0
9	14	Mining and quarrying products	19,276	443	1,716	4,331	0
10	15	Food products and beverages	222,899	3,249	6,399	37,780	0
11	16	Tobacco products	3,254	94	21	377	0
12	17	Textiles	32,887	903	49	3,036	0
13	18	Wearing apparel; furs	4,788	0	4	1,097	0
14	19	Leather and leather products	2,777	0	3	672	0
15	20	Wood and products of wood and cork (except fumiture), articles of straw and plaiting materials	58,528	9	39	4,357	0
16	21	Paper and paperboard	226,038	13,139	2,329	6,521	0
17	21.1	Pulp, paper and paper products	177,586	13,139	2,329	3,931	0
18	22	Publishing, printed matter and record media	67,997	29	36	8,332	0
19	23	Coke, refined petroleum products and nuclear fuel	6,299,303	312,351	6,016	5,770,708	4,798,952
20	23.1	Coke	356,626	303,455	6,016	21,873	0
21	23.2	Refined petroleum products	5,942,353	8,896	0	5,748,835	4,798,952
22	24	Chemicals	1,382,910	17,639	15,145	807,866	0
23	25	Rubber and plastic products	89,851	30	353	8,030	0
24	25.2	Plastic products	67,437	0	278	6,461	0
25	26	Glass, non-refractory ceramic goods, treated stone and earths	303,489	17,632	39,531	39,565	0
26	26.1	Glass and glassware	78,184	0	472	12,329	0
27	26.2 - 26.8	Non-refractory ceramic goods, treated stone and earths	225,305	17,632	39,060	27,236	0
28	27	Basic metals	925,123	461,466	967	39,505	0
29	27.1	Basic iron, steel and tubes	768,425	451,093	649	32,968	0
30	27.2/27.3	Semi-finished products made from basic iron, steel and tubes	21,944	504	0	1,005	0
31	27.4	Basic precious and non-ferrous metals and semi-finished products made from basic precious and non-ferrous metals	84,421	1,065	183	3,728	0
32	27.5	Casting of metals	50,332	8,804	136	1,804	0
33	28	Fabricated metal products	106,030	434	0	16,205	0
34	29	Machinery	94,656	115	89	19,676	0
35	30	Office machinery and computers	2,842	0	7	1,056	0
36	31	Electrical machinery and apparatus n.e.c.	57,265	452	64	7,982	0
37	32	Communication equipment and apparatus, radio, television, other electronic components	21,326	0	28	2,892	0
38	33	Medical, precision and optical instruments, watches and clocks	25,404	0	19	4,790	0
39	34	Motor vehicles, trailers and semi-trailers	129,473	1,144	0	19,731	0
40	35	Other transport equipment	26,951	0	0	4,158	0
41	36	Furniture, other manufactured goods n.e.c.	27,117	1,467	27	5,358	0
42	37	Secondary raw material	5,840	144	2	577	0
43	40	Electricity	6,413,498	1,359,969	1,474,370	103,830	0
44	40.1	Electricity, services of production and distribution of electricity	5,886,784	1,233,749	1,432,909	92,457	0
45	40.2	Gas, services of manufacture of gas, distribution of gaseous fuels	4,116	0	0	689	0
46	40.3	Steam and hot water supply, services of production and distribution of steam and hot water	522,598	126,219	41,461	10,684	0
47	41	Water and services of collection, purification and distribution of water	13,491	0	0	545	0
48	45	Construction work	211,972	1,987	41	176,023	0
49	45.1/45.2	Site preparation, building of complete constructions or parts thereof, civil engineering	153,913	942	19	136,987	0
50	45.3 - 45.5	Building installation and other building work	58,059	1,045	22	39,036	0
51	50	Trade, maintenance and repair services of motor vehicles; retail trade services of automotive fuel	66,076	0	0	41,753	0
52	51	Wholesale trade and commission trade	119,643	870	18	60,475	0
53	52	Retail trade services, except of motor vehicles, repair services of personal and household goods	264,910	3,104	64	105,440	0
54	55	Hotel and restaurant services	108,082	1,174	24	30,502	0
55	60	Land transport, transport via pipelines	251,513	0	0	160,168	0
56	60.1	Transport via railways	69,589	0	0	22,858	0
57	60.2/60.3	Other land transport, transport via pipelines	181,924	0	0	137,310	0
58	61	Water transport services	68,536	0	0	68,276	0
59	62	Air transport services	451,237	0	0	450,945	0
60	63	Supporting and auxiliary transport services	204,786	0	0	144,328	0
61	64	Post and telecommunications	119,182	0	0	68,891	0
62	J (65-67)	Services of the monetary institutions, insurance and pension funding services	57,306	0	0	23,783	0
63	K (70-74)	Real estate services, renting of machinery and equipment without operator and of personal and household goods	275,438	0	0	168,741	0
64	L (75)	Public administration and defence services, compulsory social security services	170,763	0	2,550	88,819	0
65	M (80)	Education services	118,431	709	15	22,287	0
66	N (85)	Health and social work services	166,065	1,736	36	30,767	0
67	O (90-99)	Other public and personal services	218,993	355	7	110,602	0
68	90	Sewage and refuse disposal services, sanitation and similar services	44,278	0	0	31,120	0
69	92	Recreational, cultural and sporting services	86,371	71	1	38,964	0
70		**All homogeneous branches**	**19,790,205**	**2,205,084**	**1,673,800**	**8,804,772**	**4,798,952**
71		Domestic final consumption of private households	3,931,573	19,679	19,842	2,051,416	0
72		**All homogeneous branches and domestic consumption of private households**	**23,721,778**	**2,224,763**	**1,693,642**	**10,856,188**	**4,798,952**
73	+	Changes in inventories	197,511	0	0	0	0
74	+	Losses due to flaring and distributions	131,739	-13,121	-159	88,270	35,913
75	+	Exports and bunkering of non-residents on the territory	2,383,824	56,064	19,716	1,525,189	23,517
76	+	Statistical discrepancies	174,699	1,144	2,311	0	0
77	=	Total use (national accounts concept)	**26,609,551**	**2,268,849**	**1,715,509**	**12,469,648**	**4,858,382**
78		Domestic production	13,067,993	902,841	1,711,041	5,563,717	150,887
79	+	Imports and bunkering of residents abroad	13,541,559	1,366,008	4,468	6,905,931	4,707,495
80	=	Total supply (national accounts concept)	**26,609,552**	**2,268,849**	**1,715,509**	**12,469,648**	**4,858,382**

*) Including final energy consumption as well as transformation input, consumption of the energy sectors and final non-energy consumption and balance of bunkering (national account concept).
1) Classification of products by activity (CPA) in the European Economic Community (1993 edition).
2) Including biogas and generation plants for other energy producers.

Table 3: Energy consumption of homogeneous branches and households by type of energy sources 2006 *)

(National Accounts Concept)
terajoule

Mineral oil: Motor gasoline	Mineral oil: Gas-diesel oil	Mineral oil: Air fuel	Mineral oil: Light fuel oil	Mineral oil: Heavy fuel oil	Mineral oil: Other mineral oil products	Gases	Renewable energy and other non-renewable energy sources: Together	Renewable energy and other non-renewable energy sources: Water and wind power, solar energy plant and other 2)	Renewable energy and other non-renewable energy sources: Biomass	Renewable energy and other non-renewable energy sources: Renewable energies	Renewable energy and other non-renewable energy sources: Non-renewable waste, waste heat etc.	Electricity	Nuclear energy	Remote heating	No.
10,858	92,638	0	24,781	0	1,489	15,844	3,332	0	1,648	1,684	0	19,836	0	0	1
127	2,292	0	8	0	1	7	69	0	69	0	0	563	0	0	2
7	47	0	1	0	0	1	9	0	9	0	0	563	0	0	3
55	601	0	393	12	109	916	7,736	0	39	0	7,697	30,213	0	2,250	4
22	355	0	297	12	61	872	6	0	6	0	7,697	12,665	0	508	5
33	246	0	96	0	48	44	7,730	0	32	0	0	17,548	0	1,742	6
55	517	0	2	0	0	8,872	99	0	99	0	0	1,657	0	25	7
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
98	1,634	0	1,525	364	709	4,477	504	0	500	0	4	7,730	0	76	9
1,211	5,047	0	20,493	9,772	1,258	96,073	3,875	0	2,727	0	1,148	69,373	0	6,151	10
31	132	0	214	0	0	1,451	35	0	35	0	0	1,256	0	19	11
111	471	0	1,895	467	93	15,172	108	0	107	1	0	11,477	0	2,142	12
72	304	0	676	0	46	1,773	30	0	30	0	0	988	0	896	13
24	102	0	545	0	0	948	23	0	23	0	0	795	0	336	14
191	827	0	1,947	1,087	305	11,345	21,888	0	21,887	0	0	18,994	0	1,896	15
259	1,131	0	2,626	2,166	338	76,594	35,733	0	30,872	119	4,742	77,612	0	14,109	16
119	537	0	1,162	2,005	107	49,372	35,191	0	30,330	119	4,742	61,455	0	12,168	17
408	1,728	0	6,056	0	140	36,480	192	0	184	7	0	19,855	0	3,074	18
125,716	2,474	220	57,654	125,124	660,568	34,735	149,687	0	147,298	0	2,389	25,762	0	44	19
3	13	0	2	0	21,855	24,085	1	0	1	0	0	1,166	0	29	20
125,713	2,461	220	57,652	125,124	638,713	10,621	149,686	0	147,297	0	2,389	24,314	0	0	21
1,129	4,931	0	41,177	167,628	593,001	261,970	15,498	0	4,180	0	11,318	185,493	0	79,299	22
502	2,122	0	4,906	347	153	21,736	821	0	441	0	380	54,494	0	4,387	23
375	1,585	0	4,025	323	153	12,419	388	0	388	0	0	45,437	0	2,454	24
306	1,450	0	7,837	13,906	16,067	117,985	35,206	0	22,082	0	13,124	53,007	0	563	25
72	304	0	429	8,481	3,042	47,441	31	0	31	0	0	17,783	0	129	26
234	1,145	0	7,408	5,425	13,025	70,544	35,175	0	22,052	0	13,124	35,224	0	434	27
764	3,237	0	3,152	25,520	6,831	257,270	2,236	0	420	0	1,815	162,560	0	1,119	28
287	1,220	0	574	24,478	6,409	202,612	1,691	0	119	0	1,571	79,147	0	265	29
115	490	0	353	0	47	13,277	48	0	48	0	0	6,949	0	162	30
268	1,128	0	1,139	1,002	191	26,708	458	0	214	0	244	51,887	0	393	31
94	398	0	1,087	40	185	14,673	39	0	39	0	0	24,578	0	299	32
884	4,092	0	8,277	48	2,904	42,194	589	0	554	0	34	45,184	0	1,424	33
1,648	7,378	0	8,555	153	1,942	30,312	869	0	868	0	1	38,898	0	4,697	34
188	719	0	148	0	1	614	74	0	74	0	0	1,034	0	56	35
764	3,394	0	2,263	24	1,537	26,923	344	0	343	1	0	19,489	0	2,011	36
306	1,355	0	700	0	532	2,959	155	0	154	0	0	12,995	0	2,296	37
402	1,761	0	1,828	46	753	9,527	546	0	546	0	0	9,207	0	1,315	38
2,186	9,302	0	2,959	124	5,159	29,091	1,219	0	1,208	0	11	63,991	0	14,297	39
270	1,179	0	2,708	0	1	11,771	115	0	115	0	0	8,804	0	2,103	40
270	1,158	0	1,893	57	1,980	3,436	4,957	0	4,956	0	0	11,445	0	426	41
52	241	0	237	0	46	793	1,402	0	498	0	904	2,911	0	12	42
729	3,715	0	18,325	31,582	49,479	869,075	602,243	190,699	297,569	578	113,397	178,323	1,825,689	0	43
562	2,864	0	10,513	31,396	47,122	610,381	517,157	190,699	249,891	1	76,566	174,442	1,825,689	0	44
118	567	0	3	0	1	3	12	0	12	0	0	3,413	0	0	45
49	284	0	7,809	186	2,356	258,691	85,074	0	47,666	577	36,831	468	0	0	46
92	445	0	8	0	0	6	9	0	9	0	0	12,930	0	0	47
5,570	50,318	0	17,826	0	102,308	12,846	5,590	0	4,490	2	0	13,922	0	1,563	48
3,027	24,694	0	8,450	0	100,817	6,091	2,533	0	2,101	2	0	6,599	0	741	49
2,543	25,625	0	9,377	0	1,491	6,755	3,057	0	2,389	320	0	7,323	0	822	50
1,097	8,415	0	6,537	0	25,704	3,880	1,839	0	1,839	0	0	17,068	0	1,536	51
4,910	43,346	0	11,984	0	234	16,412	13,399	0	13,193	206	0	27,368	0	1,102	52
13,121	46,136	0	42,777	0	3,407	58,558	2,204	0	1,892	288	0	79,875	0	15,666	53
1,371	2,053	0	24,102	0	2,975	22,028	1,001	0	393	608	0	41,771	0	11,583	54
2,549	146,257	0	2,820	0	8,542	2,097	28,516	0	28,491	25	0	59,969	0	763	55
30	17,958	0	2,737	0	2,133	2,022	178	0	153	25	0	43,768	0	763	56
2,519	128,299	0	83	0	6,409	76	28,338	0	28,338	0	0	16,201	0	0	57
77	35,893	0	0	30,103	2,203	0	259	0	259	0	0	0	0	0	58
758	2,241	447,928	17	0	0	13	268	0	268	0	0	11	0	0	59
1,329	140,232	0	629	0	2,138	1,519	39,113	0	39,113	0	0	15,295	0	4,532	60
1,853	58,835	0	8,195	0	8	6,062	24,532	0	24,517	9	0	17,412	0	2,284	61
1,054	2,284	0	20,440	0	5	15,103	491	0	234	101	0	12,234	0	5,696	62
23,532	94,437	0	49,501	2	1,269	36,680	6,636	0	6,180	456	0	49,597	0	13,784	63
4,670	28,352	1,543	51,692	3	2,559	33,595	671	0	356	219	0	32,460	0	12,669	64
265	1,016	0	20,256	7	743	47,663	18	0	18	0	0	18,309	0	29,429	65
2,491	4,172	0	22,818	4	1,283	54,086	669	0	304	365	0	42,161	0	36,610	66
16,472	75,662	0	14,540	3,354	574	27,966	11,071	0	10,999	73	0	33,212	0	35,780	67
3,639	22,789	0	992	3,352	348	67	7,707	0	7,707	0	0	2,317	0	3,068	68
6,629	27,437	0	4,761	1	135	12,114	1,808	0	1,760	48	0	17,927	0	15,486	69
230,834	**896,073**	**449,691**	**517,926**	**411,899**	**1,499,397**	**2,328,861**	**1,025,877**	**190,699**	**672,093**	**4,743**	**156,963**	**1,608,102**	**1,825,689**	**318,019**	70
963,145	385,084	0	671,432	0	31,755	964,572	215,408	0	202,665	12,743	0	509,400	0	151,256	71
1,193,979	**1,281,157**	**449,691**	**1,189,358**	**411,899**	**1,531,152**	**3,293,433**	**1,241,285**	**190,699**	**874,758**	**18,865**	**156,963**	**2,117,502**	**1,825,689**	**469,275**	72
0	0	0	0	0	0	53,503	1,347	0	1,347	0	0	103,694	0	38,966	73
39,390	6,315	-2,586	2,884	1,371	4,983	56,750	0	0	0	0	0	0	0	0	74
258,631	513,652	159,696	75,966	314,495	179,232	545,336	0	0	0	0	0	237,280	0	239	75
0	0	0	0	0	0	171,245	-0	0	-0	0	0	-0	0	0	76
1,492,000	**1,801,125**	**606,801**	**1,268,208**	**727,765**	**1,715,367**	**4,120,267**	**1,242,633**	**190,699**	**876,106**	**18,865**	**156,963**	**2,458,476**	**1,825,689**	**508,480**	77
1,331,511	1,436,164	188,837	754,964	565,932	1,135,422	846,909	1,242,633	190,699	876,106	18,865	156,963	2,292,372	0	508,480	78
160,489	364,961	417,964	513,244	161,833	579,945	3,273,358	0	0	0	0	0	166,104	1,825,689	0	79
1,492,000	**1,801,125**	**606,801**	**1,268,208**	**727,765**	**1,715,367**	**4,120,267**	**1,242,633**	**190,699**	**876,106**	**18,865**	**156,963**	**2,458,476**	**1,825,689**	**508,480**	80

Table 4: Transformation input for the generation of electricity 2006 in Germany and selected countries

CPA	Energy sources	DE	FR	NL	IT	UK	ES	AT	SE	BE	PO	NO	RS	CH	US	JP
		in petajoule														
10.1	Hard coal	1,234	224	210	423	1,361	595	56	16	68	1,028	1	1,393	25,690	13,659	2,563
10.2/3	Brown coal (lignite)	1,433	0	0	0	0	57	6	7	0	526	0	421	0	6,908	0
11	Natural gas	521	231	451	1,151	1,005	577	93	8	169	40	2	3,948	228	6,147	2,034
23.2	Mineral oil products	92	70	24	388	25	188	12	15	14	7	0	215	544	754	951
23.3	Nuclear fuel	1,826	4,859	37	0	814	649	0	723	503	0	0	1,703	598	8,900	3,308
40.1	Electricity 1)	174	100	14	55	71	47	17	11	15	52	4	259	669	731	153
40.2	Produced gas	90	37	22	58	40	14	13	11	27	25	0				
	Sum	5,370	5,521	759	2,074	3,316	2,127	197	791	795	1,679	7	7,939	27,728	37,099	9,010
	Biomass, non-renewable waste	325	82	85	102	116	48	43	130	41	21	5	34	48	1,066	300
	Renewable energies	187	212	10	345	44	177	135	228	5	24	435	624	1,568	1,050	315
	Total	**5,881**	**5,815**	**854**	**2,521**	**3,476**	**2,352**	**375**	**1,149**	**841**	**1,725**	**447**	**8,597**	**29,344**	**39,215**	**9,625**
	Generation of electricity 2)	**2,292**	**2,048**	**481**	**1,316**	**1,418**	**1,064**	**264**	**627**	**332**	**799**	**441**	**3,578**	**10,450**	**15,388**	**3,935**
	of which: Generation of heat	**0**	**0**	**127**	**209**	**0**	**0**	**45**	**111**	**29**	**221**	**5**	**0**	**0**	**0**	**0**
		as % of total														
10.1	Hard coal	21.0	3.8	24.7	16.8	39.2	25.3	14.8	1.4	8.0	59.6	0.2	16.2	87.5	34.8	26.6
10.2/3	Brown coal (lignite)	24.4	0.0	0.0	0.0	0.0	2.4	1.7	0.7	0.0	30.5	0.0	4.9	0.0	17.6	0.0
11	Natural gas	8.9	4.0	52.8	45.6	28.9	24.5	24.8	0.7	20.0	2.3	0.5	45.9	0.8	15.7	21.1
23.2	Mineral oil products	1.6	1.2	2.8	15.4	0.7	8.0	3.3	1.3	1.6	0.4	0.0	2.5	1.9	1.9	9.9
23.3	Nuclear fuel	31.0	83.6	4.4	0.0	23.4	27.6	0.0	62.9	59.8	0.0	0.0	19.8	2.0	22.7	34.4
40.1	Electricity	3.0	1.7	1.7	2.2	2.0	2.0	4.4	0.9	1.7	3.0	0.9	3.0	2.3	1.9	1.6
40.2	Produced gas	1.5	0.6	2.5	2.3	1.1	0.6	3.5	0.9	3.2	1.5	0.0	0.0	0.0	0.0	0.0
40.3	Fernwärme	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sum	91.3	95.0	88.9	82.3	95.4	90.4	52.5	68.8	94.5	97.4	1.6	92.3	94.5	94.6	93.6
	Biomass, non-renewable waste	5.5	1.4	9.9	4.0	3.3	2.0	11.6	11.3	4.8	1.2	1.2	0.4	0.2	2.7	3.1
	Renewable energies	3.2	3.6	1.2	13.7	1.3	7.5	35.9	19.9	0.6	1.4	97.2	7.3	5.3	2.7	3.3
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
		as % of generation of electricity														
	Transformation input	257	284	177	192	245	221	142	183	253	216	101	240	281	255	245
	D=100	100	111	69	75	96	86	55	71	99	84	40	94	109	99	95

1) Incl. own use of power stations.

2) Incl. heat generation of CHP; for Germany incl. generation of electricity; Russia and USA: transformation of fuel input from CHP to generation of district heating

Table 5: Production of steel, CO_2 emissions and CO_2 coefficients at the production of steel

Country	Unit	2000	2005	2006
			Manufacture of steel	
Germany	1,000 t	46,376	44,524	47,224
Belgium	1,000 t	11,636	10,420	11,630
France	1,000 t	20,956	19,480	19,852
Italy	1,000 t	26,759	29,349	31,625
Netherlands	1,000 t	5,666	6,919	6,373
Austria	1,000 t	5,723	7,031	7,130
Poland	1,000 t	10,498	8,336	10,007
Sweden	1,000 t	5,227	5,723	5,466
Spain	1,000 t	15,874	17,826	18,391
United Kingdom	1,000 t	15,155	13,237	13,869
China	1,000 t	127,143	355,285	420,917
Japan	1,000 t	106,444	112,471	116,226
Russia	1,000 t	59,136	66,146	70,830
USA	1,000 t	101,803	94,897	98,556
			CO_2-emissions	
Germany	1,000 t	55,530	50,788	54,029
Belgium	1,000 t	14,313	10,950	10,903
France	1,000 t	21,873	21,271	20,665
Italy	1,000 t	19,201	17,126	18,296
Netherlands	1,000 t	5,246	5,738	5,996
Austria	1,000 t	9,418	11,445	11,542
Poland	1,000 t	18,336	10,247	15,148
Sweden	1,000 t	2,848	3,349	3,318
Spain	1,000 t	8,158	10,390	9,368
United Kingdom	1,000 t	21,678	19,701	20,435
China	1,000 t	370,256	753,174	883,678
Japan	1,000 t	151,023	152,998	154,800
Russia	1,000 t	114,204	131,417	133,978
USA	1,000 t	109,583	86,052	87,764
			CO_2-coefficients 1)	
Germany	t/t	1.20	1.14	1.14
Belgium	t/t	1.23	1.05	0.94
France	t/t	1.04	1.09	1.04
Italy	t/t	0.72	0.58	0.58
Netherlands	t/t	0.93	0.83	0.94
Austria	t/t	1.65	1.63	1.62
Poland	t/t	1.75	1.23	1.51
Sweden	t/t	0.54	0.59	0.61
Spain	t/t	0.51	0.58	0.51
United Kingdom	t/t	1.43	1.49	1.47
China	t/t	2.91	2.12	2.10
Japan	t/t	1.42	1.36	1.33
Russia	t/t	1.93	1.99	1.89
USA	t/t	1.08	0.91	0.89
Germany	D=100	100	100	100
Belgium	D=100	103	92	82
France	D=100	87	96	91
Italy	D=100	60	51	51
Netherlands	D=100	77	73	82
Austria	D=100	137	143	141
Poland	D=100	146	108	132
Sweden	D=100	46	51	53
Spain	D=100	43	51	45
United Kingdom	D=100	119	130	129
China	D=100	243	186	183
Japan	D=100	118	119	116
Russia	D=100	161	174	165
USA	D=100	90	79	78

1) CO_2 emissions in tonnes per tonnes of steel.

Source: Federal Statistical Office Germany - Iron- and Steel Statistics,
UNFCCC - Greenhouse Gas Data (Comparison by category)
Federal Statistical Office of Germany - Environmental-Economic Accounting 2010.

Table 6: CO_2 emissions by industries 2006 in 1,000 tonnes*

NACE (Rev.1)	DE	AT	BE	ES	FR	IT	NL	NO	PL	SE	UK
A	7,604	2,520	2,291	9,060	10,630	7,549	9,340	545	11,126	2,769	5,285
A01	7,501	1,853	2,018	8,944	9,707	7,537	8,272	494	9,847	1,756	5,219
A02	103	667	273	116	922	12	1,068	52	1,280	1,013	66
B	4	3	323	2,715	1,819	749	731	1,293	261	232	568
C	5,055	1,168	1,281	2,027	2,147	1,445	2,483	13,282	1,794	524	21,578
CA	4,099	786	517	1,236	1,000	357	2,074	13,082	1,489	5	20,410
CA10	2,337	0	56	906	72	0	0	7	838	3	169
CA11	1,762	785	78	330	499	357	2,074	13,075	651	2	20,242
CA12	0	0	383	0	430	0	0	0	0	0	0
CB	956	382	764	791	1,147	1,087	409	200	305	519	1,168
CB13	3	0	381	210	429	9	0	26	152	259	18
CB14	953	382	383	581	718	1,079	409	175	153	261	1,150
D	186,425	27,933	38,826	114,669	126,441	146,213	46,618	12,317	61,495	16,794	107,649
DA	11,424	1,125	2,265	5,913	15,682	7,635	4,168	631	4,596	682	9,307
DA15	11,288	1,112	2,263	5,889	15,650	7,605	4,160	628	4,575	680	9,270
DA16	136	12	2	24	31	31	8	3	20	1	37
DB	1,298	146	701	1,947	1,441	8,625	220	18	1,419	54	2,362
DB17	1,125	95	352	1,787	1,311	7,723	111	17	720	49	2,189
DB18	173	51	349	160	131	902	109	2	699	4	173
DC	84	27	347	144	160	916	0	3	709	3	44
DD	1,421	365	352	539	893	1,111	172	78	743	137	1,547
DE	8,172	2,471	1,048	3,235	5,441	6,470	1,770	552	1,406	1,955	6,109
DE21	6,831	923	691	3,007	4,950	5,085	1,523	518	994	1,906	4,171
DE22	1,341	1,548	357	229	491	1,385	247	34	412	49	1,938
DF	19,750	2,833	1,239	21,320	22,460	20,963	12,213	2,144	9,362	2,772	17,044
DG	31,614	2,115	10,497	8,540	16,928	2,634	16,606	2,557	10,852	1,744	13,619
DH	2,114	72	365	156	2,086	14,610	268	35	760	106	4,787
DI	39,102	5,390	6,167	53,754	25,671	50,406	2,305	1,833	9,147	3,727	14,527
DJ	58,494	12,585	11,872	17,419	23,488	22,571	7,591	4,293	16,219	4,887	28,720
DJ27	54,097	12,325	11,495	16,943	20,129	21,017	7,123	4,244	14,405	4,619	26,408
DJ28	4,397	260	378	475	3,359	1,555	469	49	1,814	268	2,312
DK	4,194	279	380	579	2,300	3,892	333	50	982	194	1,864
DL	2,752	245	1,445	145	1,739	1,976	420	11	2,628	63	1,741
DL30	161	4	357	8	216	43	96	0	605	2	105
DL31	1,362	111	364	119	771	1,170	126	10	770	29	846
DL32	437	85	362	10	277	426	99	0	637	11	429
DL33	792	45	363	8	475	338	99	1	616	21	362
DM	4,808	141	780	341	3,072	3,172	186	66	460	309	3,018
DM34	3,948	107	410	256	1,978	2,569	102	15	240	269	1,838
DM35	715	34	370	86	1,093	603	85	51	219	40	1,180
DN	1,199	140	1,369	636	5,081	1,232	366	44	2,212	162	2,959
DN36	953	137	969	256	4,285	1,137	307	15	1,555	51	2,244
DN37	246	3	400	380	796	96	59	29	657	112	715
E	367,705	12,301	29,318	102,403	38,988	141,329	50,310	440	176,579	7,553	187,492
E40	367,642	12,197	29,294	101,662	38,672	141,283	50,287	435	176,374	7,552	186,325
E41	63	104	24	742	316	47	23	5	205	1	1,167
F	7,580	2,062	603	3,137	4,956	3,906	2,304	734	453	2,122	11,611
G	18,430	2,353	830	6,307	10,073	18,877	3,132	464	1,898	1,790	14,187
G50	3,405	318	427	1,637	3,202	1,918	823	394	1,011	1,156	2,859
G51	7,154	1,016	225	3,143	4,805	8,463	1,504	42	495	391	5,875
G52	7,871	1,019	179	1,527	2,067	8,496	805	29	392	242	5,453
H	3,259	643	138	3,253	3,015	2,777	1,546	69	759	93	2,535
I	62,311	7,777	7,535	40,162	40,183	42,202	27,701	17,820	37,382	13,903	94,559
I60	18,434	6,219	6,498	23,805	32,080	26,444	7,800	4,596	37,294	3,229	29,008
I61	9,585	53	575	4,125	2,920	4,705	5,843	11,185	14	7,557	19,234
I62	16,992	1,139	138	10,020	4,309	7,957	13,177	1,648	75	2,665	43,172
I63	14,153	236	208	1,954	874	2,016	474	172	0	301	1,022
I64	3,148	129	116	258	0	1,081	406	219	0	151	2,123
J	3,267	249	401	235	1,667	1,034	791	121	152	56	979
J65	1,126	139	139	64	559	451	492	45	53	27	365
J66	1,098	82	135	20	675	25	199	41	51	18	305
J67	1,042	27	127	151	433	558	100	35	48	11	309
K	8,988	875	1,369	664	6,658	7,275	4,188	153	531	1,337	5,708
K70	1,075	132	151	113	770	589	219	29	58	408	974
K71	4,482	99	730	135	3,199	848	1,817	31	287	192	1,521
K72	1,048	80	147	46	708	796	301	16	56	97	313
K73	996	16	138	0	920	54	258	2	52	10	293
K74	1,387	548	204	370	1,061	4,988	1,593	75	79	630	2,608
L	8,722	430	247	855	6,690	2,673	2,329	297	531	641	8,335
M	4,888	549	150	623	4,915	982	1,008	107	1,215	253	3,266
N	6,653	259	165	1,060	4,268	2,362	2,058	314	2,050	333	5,063
O	12,435	996	610	1,157	14,742	5,690	9,789	245	765	420	5,127
O90	2,985	292	209	764	11,488	3,553	8,014	38	309	166	2,413
O91	3,872	177	136	60	219	106	0	23	149	72	383
O92	1,841	281	134	210	2,498	886	1,088	23	146	104	1,473
O93	3,737	246	131	123	537	1,143	687	161	161	78	858
P	0	0	116	0	0	0	0	0	364	0	214
Q	0	0	131	0	0	0	0	0	413	0	0
A_Q 01-99	703,327	60,119	84,336	288,328	277,192	385,064	164,328	48,200	297,768	48,822	474,155
TOT_HH	204,381	18,069	34,772	64,210	127,730	104,095	37,661	5,280	32,755	11,093	142,707
TOT_NACE_HH	907,708	78,188	119,107	352,538	404,922	489,160	201,989	53,480	330,524	59,915	616,861

* Source: Eurostat data base NAMEA AIR http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/database

Table 7: CO_2 coefficients for industries 2006 in 1,000 tonnes CO_2 per Euro mn output

CPA	Industries	DE	FR	NL	IT	UK	ES	SE	AT	BE	PO	NO
01	Agriculture	230	140	328	169	184	236	408	312	304	427	158
02	Forestry	48	140	368	25	60	67	371	301	337	480	72
05	Fishery	11	869	1,542	312	9	947	1,358	101	2,149	2,331	316
10.1	Hard coal	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*0*	*1*
10.2/3	Lignite	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
11	Petroleum, gas	*1*	*2*	*1*	*1*	*2*	*1*	*1*	*1*	*1*	*2*	*1*
12/13/14	Stones and earth	94	129	409	190	163	122	184	350	476	163	176
15.1-8	Food	64	91	94	83	59	55	44	62	65	73	45
15.9	Beverages	78	110	113	100	71	67	52	74	79	88	54
16	Tobacco	32	39	83	27	12	29	47	35	81	18	38
17	Textiles	83	117	40	213	162	206	55	45	61	237	29
18	Furs	21	14	63	29	18	19	15	67	98	18	7
19	Leather	36	50	27	31	45	26	17	39	27	27	66
20	Wood (ex. furniture)	125	75	61	59	148	49	15	50	107	121	26
21.1/9	Pulp, paper	402	374	374	374	374	374	217	374	374	374	374
21.2	Paper, paperboard	100	116	181	143	233	91	162	85	75	226	195
22.1	Publishing	39	22	32	43	9	36	5	39	85	21	8
22.2+3	Printed matter	69	38	55	76	15	62	9	69	147	36	14
23.1	Coke oven products	*7*	*9*	*7*	*6*	*7*	*6*	*8*	*10*	*6*	*9*	*8*
23.2	Refined petroleum products	*4*	*4*	*4*	*4*	*4*	*5*	*3*	*7*	*2*	*6*	*4*
23.3	Nuclear fuel	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
24.1	Basic chemicals	249	249	249	249	249	249	249	249	249	249	249
24.4	Pharmaceuticals	34	34	34	34	34	34	34	34	34	34	34
24 R	Other chemicals	68	68	68	68	68	68	68	68	68	68	68
25.1	Rubber	60	21	25	21	38	12	38	27	49	52	23
25.2/9	Plastic	24	9	10	9	15	5	15	11	20	21	9
26.1	Glass	413	446	185	513	118	453	151	356	301	140	126
26.2-9	Ceramic goods	1,223	1,324	549	1,521	349	1,344	449	1,055	893	414	372
27.1-3	Basic iron, steel	641	1,041	941	579	1,473	509	607	1,619	937	1,514	607
27.42	Aluminium	73	127	143	90	110	120	124	112	134	100	130
27.4 R	Other non-ferrous metal products	42	42	42	42	42	42	42	42	42	42	42
27.5	Casting of metals	125	125	125	125	125	125	125	125	125	125	125
28	Fabricated metals	34	53	28	15	59	11	22	22	30	145	13
29	Machinery	16	39	17	33	40	20	8	16	39	87	8
30	Office machinery	9	24	48	9	9	6	3	20	12	12	0
31	Electrical machinery	24	28	31	31	58	6	14	18	14	14	5
32	Communication	10	13	10	26	32	2	11	15	11	11	0
33	Medical and optical instruments	20	22	22	19	26	5	4	20	18	18	1
34	Motor vehicles	10	22	11	55	34	4	9	7	21	14	15
35	Other transport equipment	29	19	15	27	42	6	10	13	36	62	5
36	Furniture	38	31	37	27	112	16	13	27	31	31	9
37	Secondary raw material	41	116	54	26	48	56	214	25	149	48	52
40.1	Electricity	*150*	*25*	*163*	*145*	*142*	*108*	*35*	*81*	*78*	*283*	*2*
40.2	Gas	0	0	0	0	0	0	0	0	0	0	0
40.3	Steam	*76*	*155*	*84*	*76*	*99*	*76*	*82*	*99*	*76*	*115*	*113*
41	Water	4	7	14	7	7	7	1	7	17	7	10
45.1/2	Constructions	33	22	32	20	46	10	81	59	12	39	25
45.3-5	Building installation	34	22	32	20	46	10	81	59	12	39	25
50	Trade, repair services of vehicles	23	72	54	28	47	47	24	42	38	63	61
51	Wholesale trade	35	29	23	48	38	48	37	37	44	24	2
52	Retail trade	72	19	28	65	36	23	37	62	54	24	2
55	Hotel, restaurant services	54	38	88	26	22	29	10	37	50	141	11
60.1	Transport via railways	114	114	114	114	114	114	114	114	114	114	114
60.2/3	Oth. land transport, pipelines	184	184	184	184	184	184	184	184	184	184	184
61	Water transport	259	304	1,039	596	481	1,268	1,727	498	123	481	766
62	Air transport	1,236	241	1,452	754	2,045	1,036	851	333	123	651	528
63	Auxiliary transport services	132	187	373	179	157	46	242	214	123	157	18
64	Post, telecommunications	90	187	17	19	26	6	12	13	123	38	23
65	Monetary institutions	13	6	14	6	3	1	3	10	7	4	5
66/67	Insurance, pension funding	10	14	15	25	34	17	7	11	18	31	14
70	Real estate services	4	3	4	3	5	1	9	4	4	2	1
71	Renting of machinery	38	126	218	94	49	92	71	12	158	254	17
72	Computer	22	11	18	18	22	22	7	12	18	14	2
73	Research, development	18	26	65	17	26	58	13	33	79	25	1
74	Other business services	30	4	19	17	10	4	13	19	3	3	3
75.1/2	Public administration,	52	39	39	22	53	11	25	21	48	27	17
75.3	Social security services	27	39	39	22	53	11	25	21	48	27	17
80	Education services	37	47	36	13	27	13	11	38	41	83	8
85	Health and social work	26	23	36	20	18	14	8	12	31	31	12
90	Sewage	86	136	283	201	108	81	76	75	73	108	15
91	Membership organ. services	86	136	283	74	169	169	19	56	39	46	11
92	Cultural and sporting services	55	36	65	25	17	5	10	44	19	28	4
93/95	Priv. HHs with employed persons	43	38	137	65	42	96	34	95	57	95	94

* Energy branches (shaded lines): special calculation on basis of national energy balances; coefficients:1,000 tonnes CO_2 per output in terajoule.
Coefficients for industries 10.2/3, 24, 27.4R, 27.5, 40.2, 60 as for Germany.
Industry 21.1/9: source: special calculation for pulp and paper for Sweden.
Industry 27.1-3: source: special calculation for steel.
Industry 27.42: source: special calculation for aluminium.

Table 8: CO_2 coefficients for industries 2006 (Germany = 100*)

CPA	Industries	DE	FR	NL	IT	UK	ES	SE	AT	BE	PO	NO
01	Agriculture	100	61	142	73	80	103	177	135	132	186	69
02	Forestry	100	290	762	51	124	138	768	623	697	992	150
05	Fishery	100	8,128	14,418	2,919	87	8,848	12,697	943	20,087	21,787	2,953
10.1	Hard coal	100	488	488	488	488	488	488	488	488	201	488
10.2/3	Lignite	100	100	100	100	100	100	100	100	100	100	100
11	Petroleum, gas	100	320	77	165	270	100	100	100	100	275	171
12/13/14	Stones and earth	100	137	433	201	173	129	195	371	504	172	186
15.1-8	Food	100	142	145	129	92	86	68	96	102	114	70
15.9	Beverages	100	142	145	129	92	86	68	96	102	114	70
16	Tobacco	100	122	260	84	37	90	147	109	254	57	120
17	Textiles	100	140	48	257	196	248	66	54	73	285	35
18	Furs	100	67	305	139	89	90	71	324	477	89	33
19	Leather	100	140	77	88	126	72	46	108	77	77	185
20	Wood (ex. furniture)	100	60	49	47	119	40	12	40	86	97	21
21.1/9	Pulp, paper	100	93	93	93	93	93	54	93	93	93	93
21.2	Paper, paperboard	100	116	180	142	232	91	162	84	74	225	194
22.1	Publishing	100	55	80	110	22	90	13	100	215	53	21
22.2+3	Printed matter	100	55	80	110	22	90	13	100	215	53	21
23.1	Coke oven products	100	122	92	81	93	81	101	135	76	114	101
23.2	Refined petroleum products	100	102	112	97	117	135	68	202	67	161	105
23.3	Nuclear fuel	100	0	0	0	0	0	0	0	0	0	0
24.1	Basic chemicals	100	100	100	100	100	100	100	100	100	100	100
24.4	Pharmaceuticals	100	100	100	100	100	100	100	100	100	100	100
24 R	Other chemicals	100	100	100	100	100	100	100	100	100	100	100
25.1	Rubber	100	36	41	36	63	20	63	44	82	87	39
25.2/9	Plastic	100	36	41	36	63	20	63	44	82	87	39
26.1	Glass	100	108	45	124	29	110	37	86	73	34	30
26.2-9	Ceramic goods	100	108	45	124	29	110	37	86	73	34	30
27.1-3	Basic iron, steel	100	162	147	90	230	79	95	252	146	236	95
27.42	Aluminium	100	174	196	124	151	164	170	153	184	137	178
27.4 R	Other non-ferrous metal products	100	100	100	100	100	100	100	100	100	100	100
27.5	Casting of metals	100	100	100	100	100	100	100	100	100	100	100
28	Fabricated metals	100	156	82	45	171	32	64	64	89	423	37
29	Machinery	100	240	103	205	246	126	53	101	241	542	47
30	Office machinery	100	262	524	100	103	64	33	217	132	132	4
31	Electrical machinery	100	116	132	129	244	25	58	77	58	58	20
32	Communication	100	128	104	255	317	17	109	144	109	109	4
33	Medical and optical instruments	100	113	114	95	132	24	21	102	89	89	3
34	Motor vehicles	100	218	109	542	331	43	92	70	204	135	144
35	Other transport equipment	100	66	51	94	145	22	36	43	124	212	16
36	Furniture	100	81	98	73	297	41	34	71	81	81	25
37	Secondary raw material	100	284	132	64	117	136	524	61	363	117	127
40.1	Electricity	100	17	109	96	94	72	23	54	52	188	1
40.2	Gas	100	100	100	100	100	100	100	100	100	100	100
40.3	Steam	100	203	110	100	130	100	108	130	100	150	148
41	Water	100	176	359	177	176	176	27	176	446	176	256
45.1/2	Constructions	100	65	96	61	139	29	241	176	37	115	74
45.3-5	Building installation	100	65	96	60	139	29	240	176	37	115	74
50	Trade, repair services of vehicles	100	309	228	120	199	202	101	181	161	267	261
51	Wholesale trade	100	83	66	138	109	137	105	108	127	69	7
52	Retail trade	100	26	39	89	50	32	51	86	75	33	3
55	Hotel, restaurant services	100	71	164	49	42	54	18	69	93	262	20
60.1	Transport via railways	100	100	100	100	100	100	100	100	100	100	100
60.2/3	Oth. land transport, pipelines	100	100	100	100	100	100	100	100	100	100	100
61	Water transport	100	117	401	230	186	489	666	192	47	186	295
62	Air transport	100	20	117	61	165	84	69	27	10	53	43
63	Auxiliary transport services	100	142	283	136	119	35	183	162	93	119	14
64	Post, telecommunications	100	208	18	22	29	7	13	15	136	42	26
65	Monetary institutions	100	47	111	47	23	12	20	77	58	34	38
66/67	Insurance, pension funding	100	134	145	239	328	166	66	104	170	298	135
70	Real estate services	100	70	97	76	129	26	220	100	104	53	25
71	Renting of machinery	100	333	577	249	131	243	187	31	419	673	46
72	Computer	100	50	81	82	103	103	31	57	83	63	11
73	Research, development	100	145	363	96	144	326	70	183	445	139	8
74	Other business services	100	12	64	56	33	13	41	63	10	10	11
75.1/2	Public administration,	100	76	76	43	102	21	48	41	93	51	33
75.3	Social security services	100	148	148	84	200	42	94	80	182	100	64
80	Education services	100	126	97	35	73	35	31	102	111	223	22
85	Health and social work	100	91	142	77	70	55	32	49	121	121	47
90	Sewage	100	158	329	234	125	94	89	87	85	125	18
91	Membership organ. services	100	158	329	85	196	196	22	65	45	53	13
92	Cultural and sporting services	100	65	117	44	32	9	18	80	34	50	7
93/95	Priv. HHs with employed persons	100	89	319	153	98	225	80	222	134	221	219

* Energy branches (shaded lines): special calculation on basis of national energy balances; coefficients:1,000 tonnes CO_2 per output in terajoule.
Coefficients for industries 10.2/3, 24, 27.4R, 27.5, 40.2, 60 as for Germany.
Industry 21.1/9: source: special calculation for pulp and paper for Sweden.
Industry 27.1-3: source: special calculation for steel.
Industry 27.42: source: special calculation for aluminium.

Overview 1: Extended energy I/O model with values and mixed (hybrid) data

1. Model with values only

		1	2	3	HC	EX	Sum
P1	1	20	0	0	100	50	170
P2	2	0	5	30	0	0	35
EN*	3	5	5	0	20	0	30
	Sum	25	10	30	120	50	235
	VA	145	25	0			
	OP	170	35	30			
EN	3	50	50	0	100	TJ	
EN-Co		0.29	1.43	0			

Leontief-Inverse: inv(I-A)

Embodied energy of final demand

y		1	2	3	
150	1	1.13	0.00	0.00	1.13
0	2	0.05	1.40	1.40	2.85
20	3	0.04	0.20	1.20	1.44
		1.22	1.60	2.60	

Output X / Energy:

		1	2	3	SUM	Coe	1	2	3	SUM
P1	1	170	0	0	170	0.29	50	0	0	50
P2	2	7	0	28	35	1.43	10	0	40	50
EN	3	6	0	24	30	0	0	0	0	0
		183	0	52	235		60	0	40	100

2. Mixed model (no price differentiation)

		1	2	3	HC	EX	Sum	
P1	1	20	0	0	100	50	170	
P2	2	0	5	30	0	0	35	
EN*	3	50	50	0	200	0	300	300
	Sum						505	
	VA	170	35					
	OP	170	35	300				
				TJ				
EN	3	50	50	0	100	TJ		
EN-Co		0.29	1.43	0				

Leontief-Inverse: inv(I-A)

y		1	2	3
150	1	1.13	0.00	0.00
0	2	0.05	1.40	0.14
200	3	0.40	2.00	1.20

Output X / Energy:

		1	2	3	SUM	Coe	1	2	3	SUM
P1	1	170	0	0	170	0.29	50	0	0	50
P2	2	7	0	28	35	1.43	10	0	40	50
EN	3	60	0	240	300	0	0	0	0	0
		237	0	268	505		60	0	40	100

3. Mixed model (with price differentiation)

		1	2	3	PV	EX	Sum	
P1	1	20	0	0	100	50	170	
P2	2	0	5	30	0	0	35	
EN*	3	20	80	0	200	0	300	300
	Sum						505	
	VA	170	35					
	OP	170	35	300				
				TJ				
EN	3	20	80	0	100	TJ		
EN-Co		0.12	2.29	0				

Leontief-Inverse: inv(I-A)

y		1	2	3
150	1	1.13	0.00	0.00
0	2	0.02	1.59	0.16
200	3	0.18	3.64	1.36

Output X / Energy:

		1	2	3	SUM	Coe	1	2	3	SUM
P1	1	170	0	0	170	0.12	20	0	0	20
P2	2	3.18	0	31.8	35	2.29	7	0	73	80
EN	3	27.3	0	273	300	0	0	0	0	0
		200	0	305	505		27.3	0	73	100

Legend:

P1 branch 1
P2 branch 2
EN* energy branch
* : in calorific values (TJ: Terajoule)
EN-CO: energy coefficient

HC household consumption
EX export
VA gross value added
OP output

Overview 2: Classification of branches in the energy input-output table*)

No	Energy IOT	No	Monetary IOT (national publication)	CPA [1) 2)]
1	Products of agriculture	1	Products of agriculture	01
2	Products of forestry	2	Products of forestry	02
3	Fish and other fishing products	3	Fish and other fishing products	05
	Coal and lignite; peat	4	Coal and lignite; peat	10
4	Hard coal			10.1
5	Lignite			10.2
6	Crude petroleum and natural gas	5	Crude petroleum and natural gas	11
7	Weight v. uranium ores, ores, stones and earth, and other mining products			12/13/14
		6	Uranium and thorium ores	12
		7	Metal ores	13
		8	Other mining and quarrying products	14
8	Food products	9	Food products	15.1-8
9	Beverages	10	Beverages	15.9
10	Tobacco products	11	Tobacco products	16
11	Textiles	12	Textiles	17
12	Wearing apparel; furs	13	Wearing apparel; furs	18
13	Leather and leather products	14	Leather and leather products	19
14	Wood and products of wood (except furniture)	15	Wood and products of wood (except furniture)	20
15	Pulp, paper and paper products	16	Pulp, paper and paper products	21.1
16	Paper and paperboard	17	Paper and paperboard	21.2
17	Publishing	18	Publishing	22.1
18	Printed matter, recorded media	19	Printed matter, recorded media	22.2-3
	Coke, refined petroleum products and nuclear fuel	20	**Coke, refined petroleum products and nuclear fuel**	23
19	Coke oven products			23.1
20	Refined petroleum products			23.2
21	Nuclear fuel			23.3
22	**Basic chemicals**			24.1
23	Pharmaceuticals	21	Pharmaceuticals	24.4
24	**Chemicals (not incl. pharmaceuticals)**	22	Chemicals (not incl. pharmaceuticals)	24 (excl. 24.4)
25	Rubber products	23	Rubber products	25.1
26	Plastic products	24	Plastic products	25.2
27	Glass and glassware	25	Glass and glassware	26.1
28	Non-refractory ceramic goods, treated stone and earths	26	Non-refractory ceramic goods, treated stone and earths	26.2-8
29	Basic iron, steel and tubes and semi-finished products	27	Basic iron, steel and tubes and semi-finished products	27.1-3
	Non-ferrous metals and semi-finished products	28	Non-ferrous metals and semi-finished products	27.4
30	Aluminium and aluminium products			27.42
31	Other non-ferrous metal products			27.41/43-45
32	Foundry work services	29	Foundry work services	27.5
33	Fabricated metal products	30	Fabricated metal products	28
34	Machinery	31	Machinery	29
35	Office machinery and computers	32	Office machinery and computers	30
36	Electrical machinery and apparatus n.e.c.	33	Electrical machinery and apparatus n.e.c.	31
37	Communication equip., radio, television, other	34	Communication equip., radio, television, other	32
38	Medical, precision and optical instruments	35	Medical, precision and optical instruments	33
39	Motor vehicles, trailers and semi-trailers	36	Motor vehicles, trailers and semi-trailers	34

No	Energy IOT	No	Monetary IOT (national publication)	CPA [1) 2)]
40	Other transport equipment	37	Other transport equipment	35
41	Furniture; other manufactured goods n.e.c.	38	Furniture; other manufactured goods n.e.c.	36
42	Secondary raw material	39	Secondary raw material	37
		40	Electricity, steam and hot water supply	40.1/40.3
43	Production and distribution services of electricity			
44	Gas, distribution of gaseous fuels through mains	41	Gas, distribution of gaseous fuels through mains	40.2
45	Steam and hot water supply services			40.3
46	Collection, purification and distribution of water	42	Collection, purification and distribution of water	41
47	Building of complete constructions; civil engineering	43	Building of complete constructions; civil engineering	45.1-2
48	Building installation and other building work	44	Building installation and other building work	54.3-5
49	Trade and repair services of motor vehicles; retail trade of automotive fuel	45	Trade and repair services of motor vehicles; retail trade of automotive fuel	50
50	Wholesale trade and commission trade	46	Wholesale trade and commission trade	51
51	Retail trade services, ex. of motor vehicles	47	Retail trade services, ex. of motor vehicles	52
52	Hotel and restaurant services	48	Hotel and restaurant services	55
53	Transport via railways	49	Transport via railways	60.1
54	Other land transport, transport via pipelines	50	Other land transport, transport via pipelines	60.2-3
55	Water transport services	51	Water transport services	61
56	Air transport services	52	Air transport services	62
57	Supporting and auxiliary transport services	53	Supporting and auxiliary transport services	63
58	Post and telecommunications	54	Post and telecommunications	64
59	Services of the monetary institutions	55	Services of the monetary institutions	65
60	Insurance and pension funding services			66/67
		56	Insurance and pension funding services	66
		57	Sewage and refuse disposal services	67
61	Real estate services	58	Real estate services	70
62	Renting of machinery and equipment	59	Renting of machinery and equipment	71
63	Computer and related activities	60	Computer and related activities	72
64	Research and development services	61	Research and development services	73
65	Other business services	62	Other business services	74
66	Public administration and defence services	63	Public administration and defence services	75.1-2
67	Compulsory social security services	64	Compulsory social security services	75.3
68	Education services	65	Education services	80
69	Health and social work services	66	Health and social work services	85
70	Sewage and refuse disposal services	67	Sewage and refuse disposal services	90
71	Membership organisation services n.e.c.	68	Membership organisation services n.e.c.	91
72	Recreational, cultural and sporting services	69	Recreational, cultural and sporting services	92
73	Other services, private households with employed			93/95
		70	Other services	93
		71	Private households with employed persons	95

*) Bold: Additional breakdown in the energy IOT.
1) Classification of economic activities (edition 1993).
2) Area delimitation comparable to the statistical classification of products by activity in the European Community (1993 edition).

Overview 3: Classification of energy sources in Environmental-Economic Accounting of Germany

No	Energy sources	EB*)
1	Hard coal	x
2	Hard coal briquettes	x
3	Cokeoven coke	x
4	Coal by-products	x
5	Brown coal (lignite)	x
6	Brown coal briquettes	x
7	Other brown coal products	x
8	Dried brown coal	x
9	Crude oil	x
10	Gasoline	x
11	Naphta	x
12	Jet kerosene	x
13	Gas diesel	x
14	Light fuel oil	x
15	Heavy fuel oil	x
16	Petrol coke	x
17	Liquid gas	x
18	Refinery gas	x
19	Other mineral oil products	x
20	Coke oven gas, gas work gas	x
21	Blast furnace gas	x
22	Natural gas, nat. petr. gas	x
23	Pit gas	x
24	Hydropower	SAT
25	Wind-, photovoltaics stations	SAT
26	Wood, straw and solid waste	SAT
27	Biodiesel and non-solid waste	SAT
28	Sewage gas incl. biogas	SAT
29	Minicipal waste incl. landfill gas	SAT
30	Other renewable energies	x
31	Non-renewable waste, waste heat	x
32	Electricity	x
33	Nuclear energy	x
34	District heating	x

*) EB: Classification of energy sources in the national energy balance.
SAT: Classification of energy sources in the satellite bilance for renewable energy.

Diagram 1: Energy input for the production of aluminium and aluminium goods in Germany and for the production of imported aluminium goods