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EUROSTAT Project of the

German Federal Environmental Agency

Harmonization of energy statistics used for CO_2 inventories

- Final Report -

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1 Preliminary remarks

Germany has committed itself in the United Nations Framework Convention on Climate Change (UNFCCC) – as have other Member States of the European Union – to prepare inventories of its annual greenhouse gas emissions by source categories. The EU is itself a signatory to the Convention. In accordance with Council Decision 1999/296/EG on a mechanism for monitoring emissions of CO_2 and other greenhouse gases in the Community, Member States are also required to submit annual national greenhouse gas inventories to the Commission for preparation of the EU inventory. The national inventories, compiled according to a common reporting format (CRF), are examined by the European Commission (as well as by EUROSTAT), with the support of the European Environmental Agency (EEA), before preparation of the EU inventory. The statistics submitted also include activity data, such as annual energy statistics.

In September 2000, EUROSTAT and the Environment Directorate-General launched a project for the harmonization of energy statistics used for CO_2 inventories[1], which comprises:

- Examination of energy statistics utilized for both sets of data (CRF and "Annual Questionnaires") for the years 1990, 1995 and 1998, as well as ascertainment and clarification of differences;

- Laying down a procedure at a national level, by means of which discrepancies between both sets of data can be avoided in future. The procedure will be agreed with EUROSTAT.

- Provision of updated energy statistics in annual questionnaires for the years 1990-1998, ensuring that both sets of data are comparable.

When the final reports of all Member States have been received, EUROSTAT will update its database and be able to prepare information on CO_2 emissions – which will differ insignificantly from information provided by Member States – and fully resolve any discrepancies.

Apart from Denmark, Finland, Sweden, the Netherlands, Norway, Austria, France and the United Kingdom, Germany also receives financial assistance for the conduct of the project.

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1 Cf. also: EUROSTAT, Unit F4 – Energy statistics: harmonization of energy data on CO_2 emissions. EUROSTAT Progress Report. Doc. ENERGY 1/12, Luxemburg, 10-11 Oktober 2001.

The German Federal Environmental Agency (UBA), in Berlin, undertook the processing of the project in a contract signed in November 2001, and itself instructed the German Institute for Economic Research (Deutsches Institut für Wirtschaftsforschung – DIW) and Öko-Institut - Institute for Applied Ecology to examine the data. DIW investigates the database on the energy-consumption side – that is, information on quantities and applied calorific values –, whereas Öko-Institut concerns itself with the analysis of CO_2 factors.

The following procedures are planned:

1. Energy data from both reporting systems has to be examined with respective national data sources in mind, differences identified and explanations found. In addition, an appropriate comparison should be made between data reported to EUROSTAT/IEA/UNECE by way of the annual questionnaires and the annual energy balances for Germany prepared by DIW on behalf of the AGEB (Working Group on Energy Balances).

2. Methods should be demonstrated for remedying divergencies of survey systems. It will also be necessary, in agreement with EUROSTAT, to carry out an appropriate harmonization procedure at a national level before respective data is submitted. This requires close co-ordination with the institutions that have previously completed the questionnaires and submitted them to EUROSTAT/IEA.

3. Allowing for the results of the preceding steps, data for the years from 1990 to 1998 should be improved, and comparability of data from both reporting systems should be established. Attention has to be paid to the specific problems that arise in Germany as far as the provision of data for 1990 is concerned.

4. Finally, precise recommendations should be made to reporting institutions in Germany for the preclusion of differences in future.

To improve understanding, a summary of the German system for preparing national energy balances is provided in Section 2 of this report. In Section 3, EUROSTAT energy balances are examined regarding possible divergence of the annual questionnaires and the energy data presented by the AGEB. Section 4 is devoted to an analysis of emission factors used by EUROSTAT, while Section 5 takes a closer look at the activity rates applied by the Federal Environmental Agency to energy-related CO_2 emissions. In Section 6, initial recommendations are made, which could be useful in future for avoiding the differences highlighted with this project.

2 On the German energy balance

2.1 Summary[2]

In the Federal Republic of Germany, energy-related statistical data is published by a number of bodies, often with differences in presentation, demarcation and aggregation. Energy industry associations formed the Arbeitsgemeinschaft Energiebilanzen - AGEB [Working Group on Energy Balances] in co-operation with economic research institutes, with a view to evaluating statistics from all sectors of the energy industry on the basis of uniform criteria, compiling data in a coherent form and making the facts and figures available to the public in the form of energy balances.

As of May 2002, members of the AGEB include six energy industry associations:

- Bundesverband der deutschen Gas- und Wasserwirtschaft e.V. (BGW – Association of the German Gas and Water Industry), Berlin,
- Bundesverband Braunkohle e.V. (DEBRIV – German Lignite Association), Cologne,
- Gesamtverband des deutschen Steinkohlenbergbaus (GVSt – General Association of the German Hard Coal Industry), Essen,
- Mineralölwirtschaftsverband e.V. (MWV – Association of the German Petroleum Industry), Hamburg,
- Verband der Elektrizitätswirtschaft – VDEW e.V. – German Electricity Association, Frankfurt/Main,
- VIK - Verband der Industriellen Energie- und Kraftwirtschaft e.V. - Association of Industrial Energy and Power Management, Essen,

and three economic research institutes:

- Deutsches Institut für Wirtschaftsforschung (DIW – German Institute for Economic Research), Berlin,
- Energiewirtschaftliches Institut an der Universität Köln (EWI – Institute of Energy Economics at the University of Cologne), Cologne,
- Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI – Rhine-Westfalia Institute for Economic Research), Essen.

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2 The remarks in this section are largely taken from the Preface to the Energy Balances published by the AGEB; cf. www.ag-energiebilanzen.de. This preface is to be found in the Annex to this report.

In 1994, the AGEB transferred responsibility for the preparation of energy balances to DIW; the energy balances published up to 1994 having been prepared by the General Association of the German Hard Coal Industry.

The AGEB first published a series of consistent energy balances based on uniform areas, conversion coefficients and sector demarcations in 1971, for the period 1950 to 1969. This series has been supplemented in succeeding years by energy balances drawn up with the same structure. Nowadays, the AGEB can look back on a continuous series of energy balances covering the period since 1950 (within the borders that applied up to 3 October 1990). For the years from 1991 to 1994, separate energy balances were also drawn up for the "new" Federal *Länder* (formerly East Germany) and for Germany as a whole (within the borders that exist from 3 October 1990 onwards).

The base year of 1990 plays a key role not only for national emission inventories, but in particular for the timing of agreed emission reduction targets within the framework of climate protection policy, The problem is that for 1990 as a whole Germany had no uniform state territory. Because of the radical – also economic – setbacks and fundamental organizational and structural dislocations in the territory of the GDR and the new federal *Länder*, respectively, opportunities to record energy statistics for eastern German for 1990 were extremely complicated. This also had repercussions for the "old" *Länder* (formerly FRG), for which the AGEB still drew up and published balances in the traditional way.

The Institut für Energetik (IfE), in Leipzig, assumed responsibility for drawing up an energy balance for the GDR and the new *Länder*, respectively, on a systematic basis compatible with West German balances, and for making a detailed and comprehensive presentation of the primary data.[3] For this purpose, the institute had recourse to a prior investigation, for which DIW had also been responsible, whose tasks had included the preparation of appropriate energy balances for the GDR for the years from 1970 to 1989.[4]

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3 Cf.. IfE Leipzig GmbH, Energiebilanz 1990 für die neuen Bundesländer. Von Jochen Hesselbach und Mitarbeit von Bernd Lemmnitz, Elke Lindner, Hans-Albert Müller und Ursula Zehrfeld. Untersuchung im Auftrag des Bundesministers für Wirtschaft. Leipzig, den 13.11.1991.

4 Cf. Deutsches Institut für Wirtschaftsforschung, Entwicklung des Energieverbrauchs und seiner Determinanten in der ehemaligen DDR. Von Hans-Joachim Ziesing. Untersuchung im Auftrag des Bundesministers für Wirtschaft. Im Unterauftrag: Institut für Energetik (IfE), Leipzig; Institut für Wirtschaftswissenschaften der Akademie der Wissenschaften, Berlin; Staatliche Vorratskommission für nutzbare Ressourcen der Erdkruste, Berlin. Berlin, April 1991.

For the energy balance to be presented within the scope of the present investigation for the year 1990 for Germany as a whole, the AGEB energy balance for the "old" *Länder* and the IfE energy balance for the "new" *Länder* are aggregated.

To maintain the informational value of energy balances, it is essential to take into account changes in the statistics on which they are based, processes of change in the energy industry and the developing requirements of data users. Corresponding modifications had already been made in the 1970s. A further series of modifications became necessary beginning with the energy balance for 1995. These concern, in the main, methodical modifications in the assessment of energy sources in accordance with normal international practice, for which there is no uniform yardstick, such as calorific value, as well as changes in some of the columns (energy sources) and lines (sectors) used in the balances on the basis of a new system adopted for the classification of manufacturing industry. In addition, for the years since 1995 energy balances have only been published for the territory of the Federal Republic of Germany as a whole, since the available statistics no longer allow separate balances for the "old" and "new" *Länder*. These changes with respect to methodology, energy sources, sectors and the geographical area covered must be taken into consideration, in particular, when comparing energy balances for different periods (cf. the remarks in the following Sections 2.2 and 2.3).

Energy balances provide an overall view of interrelationships within the energy industry in the form of a matrix. They not only indicate energy consumption in various sectors, but also the flow of energy sources from production to use in various areas of production, transformation and consumption. Due to their structure and informative value, energy balances occupy a central position in the system of energy statistics. They are used by politicians, companies and energy industry associations, as well as by research institutes concerned with energy issues, as an essential database for analyses, forecasts and economic policy decisions in the energy sector.

However, energy balances are important not only for energy policy, but also, to an increasing extent, for environmental policy. For example, it would be impossible to meet national reporting obligations under the UN Framework Convention on Climate Change without energy balances as the basis for determination of CO_2 emissions.

2.2 Data structure and data sources of energy balances

In drawing up energy balances, recourse is made to a multitude of data sources, in order to complete the individual sections of the balances. Up to and including 1994, the energy balance matrix comprised 38 energy sources and (excluding line totals) 70 lines for all areas, from generation to transformation and final energy sectors. With the modification of energy balances from 1995 onwards, the number of energy sources was reduced to 30 and that of lines (sectors) to 57 for the purpose of greater clarity. Altogether, this matrix now comprises about 500 empirical statistics.

The changes in the pattern of energy sources are shown in Overview 1. This overview also shows which of the energy sources listed separately up to 1994 have been aggregated into groups from 1995 onwards. It should be mentioned that primary data on each of the classified and later aggregated energy sources is always available to the Federal Environmental Agency for emission calculations, and is provided upon request by DIW with a note as to its current processing status. DIW automatically informs the Federal Environmental Agency of any subsequent revision of these detailed statistics

Overview 1 Patterns of energy sources in energy balances from 1990 to 1994 and from 1995 onwards

Energy source	Up to 1994	from 1995 onwards
Hard coal	Hard coal Hard coal coke Hard coal briquettes	Hard coal Hard coal coke Hard coal briquettes
	Hard coal-crude tar Hard coal-pitch Other coal by-products Crude benzene	Coal derivatives
Lignite	Lignite Lignite briquettes	Lignite Lignite briquettes
	Lignite coke Pulverized and dry coal	Other lignite products
	Hard lignite	Hard lignite (incl. peat)
Other solid fuels	Firewood Peat Sewage sludge/wastes	Assigned to renewable energy sources from 1995 on (see below)
Petroleum	Oil (crude) Naphtha	Oil (crude) Naphtha
	Motor gasoline Aviation gasoline	Gasoline
	Heavy fuel oil, kerosene Diesel fuel Heating oil, light Heating oil, heavy Petroleum coke Other petroleum products	Jet fuel Diesel fuel Heating oil, light Heating oil, heavy Petroleum coke Other petroleum products
		Liquid gas Refinery gas
Gases	Liquid gas Refinery gas	Assigned to petroleum products from 1995 on (see above)
	Coke oven gas, town gas Blast furnace gas	Coke oven gas, town gas Blast furnace gas and converter gas
	Natural gas LPG	Natural gas/LPG
	Colliery gas	Colliery gas
	Sewer gas	Assigned to renewable energy sources from 1995 on
Electrical power and other energy sources	Electricity	Electricity
	Hydropower	Assigned to renewable energy sources from 1995 on
	Nuclear power District heating	Nuclear power District heating
	Other energy sources	N/A from 1995
Renewable energy sources		Hydropower Wind and photovoltaic power plants Wastes and other biomass Other renewable energy sources
Energy sources as a whole	Primary energy sources Secondary energy sources Total	Primary energy sources Secondary energy sources Total

Supplementary to the group of renewable energy sources shown in the energy balance matrix, a detailed presentation is provided in the form of sub-balances from 1995 onwards, whose content is shown in Overview 2 and in the exemplary balance for 1999 in Overview 3.

Overview 2 Review of renewable energy sources recorded in the sub-balance

Group	**Energy sources**
Hydropower	Hydropower
Wind and photovoltaic plants	Wind power Photovoltaic
Waste and other biomass	Wood, straw and other solid substances
Other renewable energy sources	Biodiesel and other liquids Sewer gas incl. biogas Waste incineration, sewage sludge, landfill gas Geothermal heat Solar heat Heat pumps, gas-operated Heat pumps, electrical
Memo item	Electricity generation Heat generation

Overviews 4, 5 and 6 display the line structure of the energy balances up to 1994 and from 1995 onwards.

Whereas the structure of primary energy balances has remained unchanged, in the transformation balance – as can be seen in the overview – some sectors have been combined.

Overview 3 Exemplary sub-balance for renewable energy sources for 1999

Main balance	Hydro-power	Wind power, photovoltaic		Biomass and wastes				Other renewable energy sources				Electric. Genera-tion	Heat prod-uction
Energy balance col,	24	25		26				27				28	30
indigenous production	70725	20470		304101				8301					
Sub-balance	Hydro-powe	Wind powe	Photo-voltaic	Biomass Wood, straw and other solid	Biodiesel and Liquid substa	Sewer Incl.. biogas	Waste incineration sewa sludge, landfill-gas	Geo-thermal energy	Solar-thermal energy	Gas-operated Heat pumps	Electri-cal Heat pumps	Electri city	Heat
	TJ	TJ		TJ				TJ				Mill.kWh	TJ
indigenous production	70725	20362	108	208668	5585	17106	72742	407	3158	177	4559	-	-
Imports	-	-	-	-	-	-	-	-	-	-	-	-	-
Stock depletion	-	-	-	-	-	-	-	-	-	-	-	-	-
indigenous energy supply	70725	20362	108	208668	5585	17106	72742	407	3158	177	4559	-	-
Exports	-	-	-	-	-	-	-	-	-	-	-	-	-
Stock build-up	-	-	-	-	215	-	-	-	-	-	-	-	-
Primary energy consumpti	70725	20362	108	208668	5370	17106	72742	407	3158	177	4559	-	-
Hydropower plant	70725	-	-	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	20362	-	-	-	-	-	-	-	-	-	-	-
Photovoltaic	-	-	108	-	-	-	-	-	-	-	-	-	-
Biomass	-	-	-	30443	-	2988	-	-	-	-	-	-	-
Waste incineration	-	-	-	-	-	-	72742	-	-	-	-	-	-
Geothermal	-	-	-	-	-	-	-	407	-	-	-	-	-
Solar-thermal	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat pumps	-	-	-	-	-	-	-	-	-	-	-	-	-
Transformation input, total	70725	20362	108	30443	-	2988	72742	407	-	-	-	-	-
Hydropower plants	-	-	-	-	-	-	-	-	-	-	-	23613	-
Wind power plants	-	-	-	-	-	-	-	-	-	-	-	5656	-
Photovoltaic	-	-	-	-	-	-	-	-	-	-	-	30	-
Biomass	-	-	-	-	-	-	-	-	-	-	-	969	10550
Waste incineration	-	-	-	-	-	-	-	-	-	-	-	4281	26453
Geothermal	-	-	-	-	-	-	-	-	-	-	-	-	407
Solar-thermal	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat pumps	-	-	-	-	-	-	-	-	-	-	-	-	-
Transformation output, total	-	-	-	-	-	-	-	-	-	-	-	34549	37410
Hydropower plants	-	-	-	-	-	-	-	-	-	-	-	-	-
Wind power plants	-	-	-	-	-	-	-	-	-	-	-	-	-
Photovoltaic	-	-	-	-	-	-	-	-	-	-	-	-	-
Biomass	-	-	-	-	-	13797	-	-	-	-	-	-	-
Waste incineration	-	-	-	-	-	-	-	-	-	-	-	-	-
Geothermal	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar-thermal	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat pumps	-	-	-	-	-	-	-	-	-	-	-	-	-
Transformation consumption, total	-	-	-	-	-	13797	-	-	-	-	-	-	-
Non-energy con-sumption	-	-	-	-	-	-	-	-	-	-	-	-	-
Statistical differences	-	-	-	-	-	-	-	-	-	-	-	-	-
Final energy	-	-	-	178225	5370	321	-	-	3158	177	4559	-	7894
Manufacturing industry	-	-	-	14100	-	-	-	-	-	7	-	-	7
Transport	-	-	-	-	5370	-	-	-	-	-	-	-	-
Households	-	-	-	164125	-	-	-	-	2124	33	3403	-	5560
Trade, commerce, services	-	-	-	-	-	321	-	-	1034	137	1156	-	2327

Overview 4 Energy balances for Germany up to 1994 and from 1995 onwards: structure of the primary energy balance

	Up to 1994	from 1995 onwards
Primary energy balance	Indigenous production	Indigenous production
	Imports	Imports
	Stock depletion	Stock depletion
	Indigenous energy supply	Indigenous energy supply
	Exports	Exports
	International marine bunkers	International marine bunkers
	Stock build-up	Stock build-up
	Indigenous primary energy consumption	Indigenous primary energy consumption

Review 5 Energy balances for Germany up to 1994 and from 1995 onwards: structure of the transformation balance

		Up to 1994	from 1995 onwards
Transformation balance	Transformation input	Coke ovens Gas works	Coke ovens
		Hard coal briquette plants Lignite briquette plants	Hard coal and lignite briquette plants
		Public thermal power plants	Public thermal power plants (without CHP)
		Colliery power plants Other industrial CHP plants	industrial heat plants
		Nuclear power plants Hydro power plants	Nuclear power plants Hydro, Wind and Photovoltaic plants
		Heat plants, district heat plants	Public heat plants District heat plants
		Blast furnaces Refineries Other energy producers	Blast furnaces Refineries Other energy producers
		Transformation input, total	Transformation input, total
	Transformation output	Coke ovens Gas works	Coke ovens
		Hard coal briquette plants Lignite briquette plants	Hard coal and lignite briquette plants
		Public thermal power plants Colliery power plants other industrial heat plants Nuclear power Hydro power	Public thermal power plants (without CHP) industrial heat plants Nuclear power Hydro, Wind and Photovoltaic plants
		Heat plants, district heat plants	Public heat plants District heat plants
		Blast furnaces Refineries Other energy producers	Blast furnaces Refineries Other energy producers
		Transformation output, total	Transformation output, total
	Consumption in energy production and in transformation areas	Hard coal pit and briquette plants	Hard coal pit and briquette plants
		Coke ovens Gas works	Coke ovens
		Lignite pit and briquette plants Power plants Crude oil and natural gas production Refineries Other energy producers	Lignite pit and briquette plants Power plants Crude oil and natural gas production Refineries Other energy producers
		Energy consump. in transformation area, total	Energy consump. in transformation area, total
		Flaring & distrib. losses, assessment diff.	Flaring & distrib. losses, assessment diff.
		Indig. energy supply & transformation balance Non-energy consumption Statistical differences	Indig. energy supply & transformation balance Non-energy consumption Statistical differences

Review 6 **Energy balances for Germany up to 1994 and from 1995 onwards: pattern of final energy consumption**

	Up to 1994	from 1995 onwards
Final energy consumption by sector	**Final energy consumption**	**Final energy consumption**
	Other mining	
	Quarrying	
	Iron-producing industry	
	Iron, steel and malleable iron foundries	
	Drawing plants and cold rolling mills	
	Non-ferrous metal and semi-finished production, foundries	
	Chemical industry	Quarrying, other mining
	Paper, pulp and board	Food and tobacco
	Rubber processing	Paper industry
	Other basic materials & capital goods manufact.	Basic chemicals
	Total, basic materials & capital goods manufact.	Other chemical industry
	Mechanical engineering	Rubber and plastic goods
	Road vehicle and aerospace industry	Glass and ceramics
	Electrical engineering, precision mechanics, optics	Processing of non-metallic minerals
	Iron, sheet-metal, metal goods	Metal production
	Other capital goods manufacturers	Non-ferrous metals, foundries
	Total, capital goods manufacturers	Metal processing
	Glass and fine ceramics	Mechanical engineering
	Manufacture of plastic goods	Vehicle construction
	Textile industry	Other sectors
	other consumer goods manufacturers	
	Total, consumer goods manufacturers	
	Sugar industry	
	Other food industry	
	Luxury foodstuffs industry	
	Total, food & Luxury foodstuffs industry	
	Other mining and processing industry, total	Mining and quarrying, manufacturing industry, total
	Rail traffic	Rail traffic
	Road traffic	Road traffic
	Air traffic	Air traffic
	Coastal shipping and inland water transportation	Coastal shipping and inland water transportation
	Traffic, total	Traffic, total
	Households and small consumers, total	Households
	Military offices	Trade, commerce and services, other Consumers (incl. military offices)
		Total, Households and trade, commerce and services

Basic changes have inevitably arisen due to the new system of classification in the industrial area. The classification of manufacturing industry (*SYPRO*), which was in force until 1994, was superseded in 1995 – internationally binding – by the Classification of Economic Activities, 1993 Edition (WZ 93). On the basis of WZ 93, the economic activities of business enterprises, operations and other statistical units should be uniformly recorded in all official statistics.

The most important differences between both systems concern, inter alia, the considerably modified structure of manufacturing industry sectors as well as new activities (publishing, recycling etc.). Though little significant difference arises in the total of industrial final energy consumption, the comparability of individual economic activities is now only possible – if at all –to a very limited extent.[5] The classification of individual economic activities in the sectors "Mining and Quarrying, Manufacturing Industry", in accordance with the Classification of Economic Activities, 1993 Edition (WZ 93), is displayed in Overview 7.

Overview 7 Classification of economic activities in the sectors "Mining and Quarrying, Manufacturing Industry" in accordance with the Classification of Economic Activities, 1993 Edition (WZ 93) for energy balances for the Federal Republic of Germany.

Sector	WZ 93 Classification No.
Quarrying, other mining	10.30, 12, 13, 14
Food and tobacco	15, 16
Paper	21
Basic chemicals	24.1
Other chemical industry	24 without 24.1
Rubber and plastic products	25
Glass and ceramics	26.1, 26.2, 26.3
Mineral processing	26 without 26.1, 26.2, 26.3
Manufacture of basic metals	27.1
Non-ferrous metals, foundries (ferrous and non-ferrous metals)	27.4, 27.5
Metal processing	27 without 27.1, 27.4 and 27.5; incl. 28
Mechanical engineering	29
Vehicle construction	34, 35
Other sectors	all other classifications, apart from 10.10, 10.20, 11.10 11.20, 23.1, 23.2, 23.3

It should be pointed out that WZ 93 was replaced early in 2003 by the Classification of Economic Activities, 2003 Edition, which is based on the binding statistical classification of economic activities in the European Community (NACE Rev. 1.1) that was introduced by EC Decree. A large number of economic associations, responsible authorities and other institutions played a decisive role in the elaboration of these classifications. The outcome is an hierarchic classification of industrial sectors with 17 sections, 31 subsections, 60 divisions, 222 groups, 513 classes and 1041 subclasses, which enable statistical classification of all economic activities. An annotated version of WZ 2003 is in preparation. The transition to WZ

5 Concerning methodical changes cf. the numerous contributions to the monthly publication of the Federal Statistical Office (Statistischen Bundesamt), "Wirtschaft und Statistik"; for example: Nowack, M. und Weisbrod, J.: Auswirkungen der NACE-Verordnung und der Prodcom-Verordnung auf die kurzfristigen Statistiken im Bergbau und Verarbeitenden Gewerbe. In: Wirtschaft und Statistik, Issue 3/1995, p. 192 ff.

2003 will probably be of little consequence for energy balances, since no changes have been made to sector designations and classification numbers compared to WZ 93.

From the sectoral point of view, mention should also be made of the differentiation, with effect from 1995, of the "former" sectors "Households and Small Consumers" into Private Households on the one hand and "Trade, Commerce and Services" on the other hand, to which, incidentally, the energy consumption of the military is assigned (which is displayed separately in the evaluation tables of energy balances).

The most important sources of data for energy balances are listed in Overview 8; and here, official reports (of the Federal Statistical Office, for example) and semi-official reports (officially acknowledged or officially assigned to other institutions (for example, Statistik der Kohlenwirtschaft – an association of hard-coal- and lignite-mining representatives) are of particular significance. In this respect, the following should be noted:

- Statistics of the Federal Statistics Office are the main source for energy consumption data in the sectors, "Mining and Quarrying, Manufacturing Industry" in the public and industrial power industry as well as in foreign trade in energy sources.

- Information on the petroleum sector is primarily supplied by the Federal Office of Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle - BAFA). In accordance with the Petroleum Statistics Act, BAFA collects business-activity data on a monthly basis from companies active on the petroleum market in Germany. 'Large' companies file data on purchases of crude oil, manufacture of petroleum products in refineries, stocks, foreign trade and sales of petroleum products by selected customer groups in a so-called Integrated Petroleum Report. Smaller companies report only their foreign trade in petroleum products, and are included on this basis in the statistics, with the result that almost 100% market coverage is achieved. Official Petroleum Statistics are published monthly as a comprehensive report on current developments in the German petroleum sector. On the basis of this data, together with data from other statistics offices, such as the Federal Statistics Office, an annual supply and consumption balance is drawn up, on the basis of which data is also reported to the IEA, EU and UN (Annual Oil Statistics). Within the scope of petroleum statistics, there is close co-operation between government and industry. The Association of the German Petroleum Industry (MWM) itself publishes extensive statistics on the petroleum market. It should also be mentioned that data for the petroleum section of en-

ergy balances has been provided since 1996 by the Association of the German Petroleum Industry in agreement with the AGEB and on behalf of DIW.

- Where official statistics furnish no data for the coal sector, coal industry statistics provide the main data.

- The Federal Ministry of Economics and Employment (BMWA) is the main "supplier" of electricity- and gas-related data by way of its annual statistical reports on the electricity and gas industries.

- Data on the use of renewable energy sources is – compared, perhaps, to fossil energy sources – still affected by uncertainties, and concerns not so much electricity generating systems as more particularly thermal systems and diverse biogenic substances. Here, recourse could be made to special surveys of the Federal Statistics Office on behalf of EUROSTAT, to surveys of the VDEW (German Electricity Association) on the use of renewable energy sources for electricity generation, to surveys of the German Lignite Association (DEBRIV) on the use of wood fuel in private households, to information from the Federal Ministry for Consumer Protection, Food and Agriculture, as well as to a broad range of information from renewable energy industry associations.

Apart from data surveyed on an official basis, industry data represents an important source. In a number of cases, one is dependent on the personal communications of experts. Description of the non-energy consumption of renewable energy sources in the chemical sector is based, for example, on communications of the Chemical Industry Association (VCI) and the Association of the German Petroleum Industry (MWV).

Overview 8 Data sources for energy balances (ministries and associations, as of early 2003)

All energy sources	**Bundesministerium für Wirtschaft und Arbeit (BMWA) [Federal Ministry of Economics** Electricity Industry Department – Annual Statistical Reports Gas Industry Department - Annual Statistical Reports **Statistisches Bundesamt [Federal Statistics Office]** Annual Statistics for Manufacturing Industry Specialist Series 4 Manufacturing industry - Series 3.1 Production in Manufacturing Industry - Series 4.1.1 Employment, Turnover and Energy Supply of Mining and Manufacturing Companies - Series 6.4 Power Generating Facilities of Mining and Manufacturing Companies Specialist Series 7 Foreign Trade - Series 2 Foreign Trade by Types of Goods and Countries Selected statistics for the energy industry **Verband der Elektrizitätswirtschaft - VDEW - e.V.** VDEW Annual Statistics **Market research findings, company data, calculations by the AGEB**
Hard coal and lignite	**Statistik der Kohlenwirtschaft e.V.** Coal Mining in the German Energy Industry – Annual Reports Coal Industry Statistics Sales statistics and other unpublished energy statistics
Petroleum	**Bundesamt für Wirtschaft und Ausfuhrkontrolle (BAFA)** Official Petroleum Statistics for the Federal Republic of Germany **Mineralölwirtschaftsverband e.V. (MWV)** Petroleum Statistics – Annual Reports **Wirtschaftsverband Erdöl- und Erdgasgewinnung e.V.** Annual Reports **Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft [Federal Ministry for Consumer Protection, Food and Agriculture]** Diesel Consumption in Agriculture
Gas	**Federal Statistics Office, Düsseldorf Branch** Iron and Steel Statistics: Wood Fuel, Gas and Electricity Statistics **Wirtschaftsverband Erdöl- und Erdgasgewinnung e.V.** Annual Reports **Bundesverband der deutschen Gas- und Wasserwirtschaft e.V.** Gas Statistics – Annual Reports **Statistik der Kohlenwirtschaft e.V.** Gas Statistics **Deutscher Verband Flüssiggas e.V.** The LPG Market – Annual Reports
Renewable Energy Sources	**Federal Statistics Office**: Special surveys on behalf of EUROSTAT **VDEW**-Surveys on the use of renewable energy sources **Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft [Federal Ministry for Consumer Protection, Food and Agriculture]** Fuel wood survey by the **lignite industry** of private households **Renewable energy industry associations**
Other energy sources	**Arbeitsgemeinschaft Fernwärme e.V.** District Heating Reports
"Non-energy sources"	**Mineralölwirtschaftsverband e.V. (MWV)** **Verband der Chemischen Industrie e.V. (VCI)**

Overall responsibility for drawing up energy balances lies – commencing with the 1995 balance – with DIW; bearing in mind, as already mentioned, that the Association of the German Petroleum Industry and other associations represented in the AGEB examine the data related to their respective energy sources. As a whole, and given the limited data, energy balances provide a reliable picture of the supply and consumption patterns of energy quantities in the German economy.[6]

It cannot be ignored, however, that due to the growing liberalization of energy markets and in connection with the emergence of a European internal market, the energy data base – and not only the energy data base – appears to be deteriorating. With the Energy Statistics Act,[7] which came into force on the 1 January 2003 after ten years of effort, this has been partially remedied. Because of the requirement that the Energy Statistics Act should have a neutral effect on costs, not all desirable features, from an energy statistics point of view, could be incorporated into the Act. It was agreed, however, that there would be special surveys for particular areas (for example, for private households and trade, commerce and services, as well as for the biomass complex), which ought to alleviate the problem. It is still too early to assess the benefit, which the findings of surveys envisaged in the Energy Statistics Act and of the special surveys mentioned above will have for energy balancing; but the situation ought in any case to be better than without these new surveys.

2.3 The balance year 1990 and the energy balances for 1991 to 1994

Base year 1990 plays a key role not only for national emission inventories, but also in particular for the timing of agreed emission reduction targets within the framework of climate protection policy. The problem is that for 1990, as a whole, Germany had no uniform state territory. Because of the – also economically – radical setbacks and fundamental organizational and structural dislocations in the territory of the GDR and the new federal *Länder*, respectively, the opportunities to record energy statistics for eastern German for 1990 were extremely complicated. This also had repercussions for the "old" *Länder* (formerly FRG), for which the AGEB still drew up and published balances in the traditional way.

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6 For an assessment of the energy database compare also: Aktueller und längerfristiger Bedarf an energiestatistischen Basisdaten. Von Ralf Messer und Hans-Joachim Ziesing. Gutachten des Deutschen Institut für Wirtschaftsforschung im Auftrag des Bundesministers für Wirtschaft. June 1992.

7 Gesetz zur Neuregelung der Energiestatistik und zur Änderung des Statistikregistergesetzes und des Umsatzsteuergesetzes vom 26. Juli 2002, Artikel 1 "Gesetz über Energiestatistik (Energiestatistikgesetz – EnStatG)" (BGBl. I p. 2867). Zur Kommentierung vgl. Wolfgang Bayer, Amtliche Energiestatistik neu geregelt. In: Statistisches Bundesamt (Hrsg.) Wirtschaft und Statistik, Heft 1, 2003, p. 33 ff.

The Institut für Energetik (IfE) in Leipzig drew up an energy balance for the GDR and the new *Länder*, respectively, on a systematic basis compatible with West German balances (cf. Section 2.1).

To arrive at the energy balance for the year 1990 for Germany as a whole, which is to be presented within the scope of the present investigation, the AGEB energy balance for the old *Länder* and that of the IfE for the new *Länder* were aggregated. In accordance with the system in force from 1995 onwards, the following changes were made to the original balances for 1990 and for the years 1991 to 1994:

1. In accordance with the practice of international organizations (IEA, EUROSTAT, ECE), the so-called efficiency method, which has been applicable for energy balances in Germany since 1995, is pursued instead of the previously used substitution method.

   - The efficiency method applies for the assessment of those energy sources for which there is no common conversion criterion, such as net calorific value. This covers foreign trade in electricity, hydro and wind power as well as photovoltaic and nuclear power. The assessment of nuclear power is based on an assumed representative physical efficiency of 33% in energy transformation. In the case of electricity generation from hydropower and other renewable energy sources, for which a net calorific value cannot be applied (wind, photovoltaic), the respective energy consumption is equated with the net calorific value of the generated electrical energy. Foreign trade in electricity is likewise assessed on the basis of the net calorific value of electricity, namely 3,600 kJ/kWh. This implies an efficiency of 100%.

   - Until 1994, the assumption was made in energy balances that electricity generation from these energy sources substituted corresponding electricity generation in conventional thermal power plants, resulting in a reduction in fuel consumption in these power plants. In such cases, average specific fuel consumption in the conventional thermal power plants of the public supply industry was used as a simple value for primary energy assessment. In comparison to this substitution principle, the application of the efficiency method results, in the case of nuclear power, in higher, and with other energy sources in lower primary energy consumption.

2. Statistical differences, which were separately shown in the energy balances for the old *Länder* until 1994, are now more appropriately assigned to the area Households and Small Consumers (newly designated Trade, Commerce and Services). This statistical difference resulted ultimately from the difference between industrial electricity consumption according to industry reporting, on the one hand, and electricity consumption based on the structure of tariffs on the other hand. It always concerned actual consumption, however, which is now correctly assigned.

In the absence of appropriate data, the differentiation of final energy consumption according to manufacturing industry sectors, for which there was a clear systematic change with the transition, from 1995 onwards, from the Classification of Manufacturing Industry (*SYPRO*) to the Classification of Economic Activities, 1993 Edition (WZ93), could not be adjusted (see below).

For the purpose of switching the below-mentioned energy sources from the substitution to the efficiency method of assessment, specific fuel consumption for electricity generation was used, as shown in Table 1. Whereas with the substitution method, the old and new *Länder* and individual years have still been differentiated, due to highly varying values, assessment factors based on the efficiency method apply to all years, but differ (see above) between energy sources.

Table 1 **Specific fuel consumption for electricity generation from 1990 to 1994 using the substitution and efficiency methods**

	1990	1991	1992	1993	1994
	specific fuel consumption for electricity generation in kJ/kWh				
	... according to the substitution method				
Old *Länder*	9394	9407	9417	9372	9414
New *Länder*	11234	11083	11104	10878	10708
	... according to the efficiency method				
Nuclear power	10909				
Balance of foreign trade in electricity; hydro/wind power	3600				

The statistical differences in electrical energy that have been transferred to the sectors Households and Small Consumers (now: Trade, Commerce and Services) concern the quantities – displayed in Table 2 – by which sector consumption has increased.

Table 2 **Transfers of statistical differences in electrical energy to the sectors Households and Small Consumers (now: Trade, Commerce and Services).**

Figures in GWh	1990	1991	1992	1993	1994
Assignment of statistical differences in electrical energy to the sectors Households and Small Consumers (Trade, Commerce and Services)	8658	13848	14748	16522	18682

The energy balances for Germany and for the old and new *Länder* for the years 1990 to 1994 have been revised on the basis of the above changes. The energy balance for the base year 1990 is provided in the Annex. This balance, together with revised balances for 1991 to 1994 and the already-existing energy balances for Germany as a whole from 1995 to 1995, are enclosed with this report as Excel files on CD ROM.

In the opinion of DIW, these energy balances can be regarded as the authoritative *energy-statistical basis* for the determination of energy-related CO_2 emissions in Germany. For emission inventories, however, more detailed information is required, for instance on the structure of the energy sources that are employed.

It has to be acknowledged, however, that final energy balances are currently two years behind the "due" balance year. This disadvantage is diminished by the fact that detailed evaluation tables are presented in the summer of each year by AGEB together with figures for the preceding year. These evaluation tables contain the following information:

- Pattern of energy consumption by sector
- Primary energy consumption by energy source
- Indigenous primary energy production by energy source
- Total final energy consumption by energy source
- Final energy consumption of the rest of the mining industry and manufacturing industry by energy source
- Final energy consumption of transport by energy source
- Final energy consumption of households by energy source
- Final energy consumption of the Trade, Commerce and Services sector by energy source
- Final energy consumption of the military by energy source

- Use of energy sources for electricity generation.

The evaluation tables are simultaneously provided on the AGEB Website (see below) and therefore made generally available. It has to be mentioned, however, that information provided in the evaluation tables that is not directly obtained from final energy balances for past years is of a provisional nature.

Attention is drawn to this provisional nature, as well as to the current status of processing, in the evaluation tables themselves. Explicit reference should also be made in future to any changes/updating that have been carried out; for example as footnotes to the corresponding tables. Such a procedure is also planned for energy balances; that is, the tables in balances will contain the respective status of processing. As a rule, the published energy balances represent the final version. Should changes subsequently prove to be necessary, however, an explicit note to this effect will be published on the AGEB Website. All registered institutions and persons automatically receive such information by way of the e-mail distribution list.

3 EUROSTAT energy balances

3.1 Communications to EUROSTAT by Member States

EUROSTAT, like the International Energy Agency IEA, draws up energy balances for individual Member States and for the European Union as a whole. These energy balances are mainly based on the aggregation of a total of five standardized questionnaires (Annual Questionnaires), which have to be completed by individual states, and which contain information on production, foreign trade (imports and exports by countries), stock changes and consumption of energy sources in individual transformation and final consumption areas, as well as non-energy consumption in the preceding year. These questionnaires are sent to Member States in mid-year with the request to return them to EUROSTAT/IEA with an initial draft energy balance by the end of November.

The following five questionnaires are provided:

- *Annual Questionnaire on Oil:* Data on petroleum is recorded in thousand metric tonnes. In Germany, data is collected and compiled by the Federal Office of Economics and Export Control (BAFA), in co-operation with the Germany Petroleum Industry Association (MWV), and then submitted to the Federal Ministry of Economics and Employment (BMWA) and EUROSTAT/IEA.

- *Annual Questionnaire on Gas:* The production of and foreign trade in natural gas as well as changes in gas stocks are reported in million cubic metres at standard conditions and in terajoules (TJ), which relate to gross calorific value. Consumption quantities are only recorded in terajoules. The questionnaire is supplemented with data on gas pipelines and underground stocks. Up to and including 1997, the questionnaire was completed by the Electricity and Gas Industry Department of the Federal Ministry of Economics; since when the task has been undertaken by BAFA in co-operation with the corresponding department of the Federal Ministry of Economics (now: Federal Ministry of Economics and Employment, BMWA).

- *Annual Questionnaire on Solid Fuels:* This questionnaire serves the purpose of recording production and consumption data for coal (hard coal – comprising coking coal and steam coal – and lignite/brown coal), peat, briquettes (patent fuel) and coke. Data is reported in thousand tonnes, and a table with respective net calorific values is included in the questionnaire. The data is compiled by Statistik der Kohlenwirtschaft, whereby hard-coal data is prepared together with the General Association of the German Hard Coal Industry (GVSt), lignite data together with the Federal Lignite Association (DEBRIV), and the overall process co-ordinated with the responsible Department of the Federal Ministry of Economics and Employment (BAWA).

- *Annual Questionnaire on Renewables and Wastes:* In this questionnaire, which is similarly structured to the other questionnaires, the use of renewable energy sources and wastes is recorded and individual energy sources and types of waste differentiated. Apart from charcoal and liquid biofuels, which are recorded in thousand tonnes, data is reported in terajoules. Processing has up to now been carried out by the Federal Ministry of Economics and Employment (BMWA) in close co-operation with the Federal Statistical Office ("Destatis"). It is still unclear at the present time (January 2003) whether responsibility for energy statistics will in future remain with the BMWA, or whether responsibility will be transferred to the Federal Environment Ministry (BMU), as has happened in the case of renewable energy.

- *Annual Questionnaire on Electricity and Heat:* The questionnaire seeks information on the generation and consumption of electricity and heat, distinguishing between public and industrial (autoproducer) supply. Information is reported in GWh for electricity and in terajoules for heat, both for gross and net generation by energy sources. In addition, in the case

of electricity generation, fuel consumption quantities are also to be provided in natural units and in terajoules. Final consumption quantities are to be shown by sector and branch. This questionnaire is of particular importance, as it is used by EUROSTAT/IEA for the examination of information on fuel consumption for electricity and heat generation in the other questionnaires. The Electricity and Gas Industry Department at the BMWA compiles the required electricity data on the basis of information accumulated in monthly reports on public supply and the survey of industrial electricity generation by the Federal Statistical Office, and then forwards the questionnaire to EUROSTAT/IEA. Information on fuel consumption and the generation of heat cannot be provided, however, since the corresponding survey and its evaluation by the Arbeitsgemeinschaft Fernwärme (AGFW) [Working Group on District Heat] involves a considerable amount of time, and the required primary data can only becomes available much later. Sufficient official figures have not so far been surveyed, due to the absence of the necessary legal basis. It is to be expected, however, that this unsatisfactory situation will be improved with implementation of the Energy Statistics Act.

The questionnaires have been adapted over the years to changed demands. These concern not so much the selected reference years, but more the period from 1999 onwards. The Coal and Electricity Questionnaires, in particular, have been modified. Renewable energy sources and wastes, which had been included in these questionnaires before 1999, have been removed, and corresponding data is now surveyed with a separate questionnaire (Renewables and Wastes Questionnaire). The following explanatory notes describe the current status of the questionnaires, and also indicate differences compared with the questionnaires used for reference years. Only those points are dealt with that concern German reporting, beginning with the respective energy sources and concluding with consumption sectors, whose structure is principally the same in all questionnaires.

In the *Annual Questionnaire on Oil*, data is requested on crude oil, natural gas liquids (NGL), refinery feedstocks, ethane, liquid gas, naphtha, leaded and unleaded motor gasoline, aviation gasoline, kerosene-type jet fuel, other kerosene, gas/diesel oil, low-and high-sulphur fuel oil, fuel oil as a whole, petroleum, paraffin waxes, bitumen, lubricants, petroleum coke and other products. Petroleum coke and other products are assigned to non-energy consumption. In the German report, no information is provided for natural gas liquids and ethane. Motor gasoline is not shown as leaded or unleaded, aviation gasoline is not shown separately, and fuel oil is not distinguished according to low- and high-sulphur content. In contrast to the German en-

ergy balance, the EUROSTAT energy balance displays supplies and backflows in the petrochemical sector separately, and the required information is recorded in the questionnaire. The Oil Questionnaire, in contrast to the other questionnaires, concerns itself mainly with deliveries.

The *Annual Questionnaire on Natural Gas* covers associated gas produced in association with crude oil, non-associated ("natural") gas and colliery gas. On the supply side, data is required on production, imports, exports and stocks changes of these gases. Apart from data in million cubic metres at standard conditions, data is also to be reported in terajoules (TJ) in respect of gross calorific value, average gross calorific value (GCV, kJ/m^3) and average net calorific vale (NCV, kJ/m^3).

In the *Annual Questionnaire on Coal (Solid Fossil Fuels and Manufactured Gases)* data on the following energy sources is requested:

Hard coal: coal with a net calorific value greater than 23,865 kJ/kg on an ash-free but moist basis, which is divided into

- coking coal: coal whose quality allows the production of a coke suitable to support a blast furnace charge. Here, reference is made to the classifications laid down in certain countries;
- steam coal (other bituminous coal and anthracite): coal used for steam raising and space heating purposes and including all anthracite coals and bituminous coals not included under coking coal;
- sub-bituminous coal: non-agglomerating coal with a net calorific value of between 17,435 kJ/kg and 23,865 kJ/kg and containing more than 31 % volatile matter on a basis free of dry mineral matter;
- lignite/brown coal: non-agglomerating coals with a gross calorific value of less than 17,435 kJ/kg; and
- peat: only peat used for energy purposes should be reported here.

Data is also to be reported on the production and consumption of hard-coal briquettes (patent fuel), coke-oven coke, gas coke and BKB/lignite briquettes (including peat briquettes). German production of lignite/brown coal dusts is included in this category, as well as all other lignite products. The Gas Works Gas category (corresponding to the German designation "gas works") covers all types of gases, irrespective of the fuel used or the production technique. The questionnaire also covers coke-oven gas, blast furnace gas and converter gas (oxygen

steel furnace gas). The quantity of gases is to be reported in all cases in terms of gross calorific value.

Data on coal production is to be subdivided into underground and surface production.

The *Annual Questionnaire on Renewables and Wastes* is relatively new. It was distributed for the first time in 2000 for the year 1999 and covers the following energy sources: hydropower, geothermal energy (both for electricity generation and for heat), solar energy (subdivided into flat-plate collectors for domestic hot water or the heating of swimming pools, photovoltaic cells and solar thermal-electric plants). Passive solar energy for the direct heating, cooling and lighting of dwellings or other buildings is not included. Also requested is data on tide/wave/ocean energy, wind energy, the production and use of solid biomass, in particular charcoal, wood, wood wastes and other solid wastes (primarily purpose-grown energy plants and woody materials generated by an industrial process). The quantity of fuel used is to be reported on the basis of net calorific value. Biogases should also be reported on, including landfill gas, sewage sludge gas and other biogenic gases that are produced from the anaerobic fermentation of animal slurries and from wastes in abattoirs, breweries and other agro-food industries. Liquid biofuels cover biodiesel (extract from oil plants) and alcohol produced from biomass for energy purposes. Finally, wastes are also included in this questionnaire, differentiating between industrial wastes of non-renewable origin and municipal waste (including wastes similar to municipal waste).

The *Annual Questionnaire on Electricity and Heat* covers the production and use of electricity and heat. The definitions of input and output categories applied in this questionnaire are the same as those applied in the 'Fuel' Questionnaires. It should therefore be ensured that data on fuel used for electricity and heat production reported in this questionnaire are consistent with those reported in the other questionnaires. The Electricity Questionnaire exercises, as it were, a control function; and experience shows that this leads to difficulties wherever variedly demarcated data is reported without co-ordination between different bodies.

The *sectoral structure of the questionnaires* corresponds in the main with the structure of EUROSTAT energy balances; apart from finer points covered in the questionnaires that go beyond balancing requirements (for example, the subdivision of hard-coal production according to type of coal and method of production). They therefore also correspond in key points to the system applied in German energy balances. Considerably more importance is attached, however, to the area of industrial electricity and heat production, for which, in Germany, there

has up to now been a lack of sufficient reliable statistical material. A breakdown of imports and exports by country, which is a prominent feature of the questionnaires, is not carried out in the German Energy Balance.

3.2 Causes of possible discrepancies

Those institutions that report energy data to EUROSTAT/IEA are virtually identical with those that are associated with the AGEB. This does not necessarily guarantee, however, that the reported data is also identical. There have been cases in the past, where contradictory data has been reported on identical circumstances in individual questionnaires, as well as information deviating from energy balance data. One of the many reasons for this is that work on the questionnaires has not always been co-ordinated by the institutions providing statistics before submission to EUROSTAT/IEA. Another important factor concerns the point in time when the respective data is reported; that is, whether estimates are involved, or provisional values that can later be revised. It is also important, whether the data concerns deliveries or consumption, which is not always clear in the questionnaires. The data that flows into annual EUROSTAT/IEA questionnaires is therefore of varied validity.

Divergencies of data reported in annual questionnaires and energy balances are to be attributed in particular to differences in the timing of registration, since there is presently a gap of two years between submission of the questionnaires and presentation of the final balances. For this reason, provisional values reported to EUROSTAT/IEA can only be replaced by final data after a corresponding period of delay.

Further divergencies can be explained by the fact that gaps occur in reporting to EUROSTAT/IEA, due to fluctuation in staff responsible for processing the questionnaires, which have to be completed with extrapolation on the part of EUROSTAT/IEA that, for the time being, cannot be revised on account of a lack of conclusive data. This problem, however, should not occur in future.

Since both reporting systems are ultimately based on the same sources and primary data of official and semi-official statistics, discrepancies primarily occur as a of the selection of figures and their technical presentation; for instance, which joint categories are to be created, and how.

Initial consequences have been drawn from problems that have emerged in the past (see the corresponding recommendations below). In the meantime, all participants have reached

agreement on co-ordination, according to which data from individual questionnaires will now be put together in an initial provisional energy balance by the Federal Ministry of Economics and Employment (BMWA) in close co-operation with the institutions supplying data, the Federal Statistical Office and the AGEB, and will then be forwarded to EUROSTAT/IEA. This balance is essentially based on the evaluation tables drawn up by the AGEB, in which, depending on the availability of data, largely-disaggregated data for the preceding year is compiled in the early summer on primary energy consumption, non-energy consumption and final energy consumption by sector and energy source (see above). Estimated values are employed where data is not yet available.

There are obviously other causes of discrepancies that are more of a systematic nature. One of the aims of the project is to identify such causes. DIW analysis concentrates mainly on the following two potential causal complexes for differences in data used for the calculation of CO_2 emissions:

1. So far as natural quantities are concerned, it should be examined whether there are differences between the quantities reported under both systems, and, if the result is affirmative, how large – as a percentage – these differences are. The causes of these differences should also be examined, including the time of reporting, whether and – where applicable – to what extent earlier reports have been revised, and whether differences are of a systematic nature.

2. The applied conversion coefficients can lead, in the case of net calorific values, to considerable differences in results, in particular when the CO_2 factors relate to energy units and not to natural units. In general, energy balances are based on net calorific value, but, particularly with gases, this is not always the case, since here – for instance, in official statistics or price statistics – gross calorific value is used in the calculation of energy quantity. Irrespective of this, however, differences in net calorific values are possible simply because, in the case of aggregated groups of energy sources the net calorific values of the assigned energy sources are frequently not considered (the net calorific values of hard coal and lignite can vary widely according to type and origin). From that point of view, the type of data and its respective sources should be examined (on the problems of the connection between net calorific values and CO_2 emission factors, see Box 1). The causes that have been mentioned can lead, in varying combinations, to highly different results in the case of subsequent calculations (of CO_2 emissions, for example).

Box 1 On the problems of the connection between net calorific values and CO_2 emission factors

Statistical analysis indicates a linear connection between the net calorific value of an energy source and the accompanying CO_2 emission factor. It cannot be overlooked, however, that the variance is considerable. This becomes clear from a look at the formula with which the net calorific values of solid, liquid and gaseous fuels can be determined from elementary analysis or volume composition.

The calculation of net calorific value for solid and liquid fuels can be determined from the relation:

$$H_u = 34.8m_C + 93.8m_H + 10.46m_S + 6.28m_N + 10.8m_O + 2.5m_{H_2O}$$

with

H_u	*inferior (net) calorific value (MJ/kg)*
m_C	*mass ratio (%) of carbon (per cent)*
m_H	*mass ratio (%) of hydrogen (per cent)*
m_S	*mass ratio (%) of sulphur (per cent)*
m_N	*mass ratio (%) of nitrogen (per cent)*
m_O	*mass ratio (%) of oxygen (per cent)*
m_{H2O}	*mass ratio (%) of water (per cent)*

By excluding the last two terms, gross calorific value can also de determined.

The net calorific value of gases can be determined from the relation

$$H_u = 107.84v_{H_2} + 23.413v_{H_2S} + 12.633v_{CO} + 35.885v_{CH_4} + 56.494v_{C_2H_2} + 59.476v_{C_2H_4}$$
$$+64.349v_{C_2H_6} + 87.578v_{C_3H_6} + 93.213v_{C_3H_8} + 117.771v_{C_4H_8} + 123.883v_{nC_4H_{10}} + 123.053v_{iC_4H_{10}}$$

$$H_u = 34{,}8m_C + 93{,}8m_H + 10{,}46m_S + 6{,}28m_N + 10{,}8m_O + 2{,}5m_{H_2O}$$

with

H_u	*inferior (net) caloric value (MJ/m^3)*
v_{xxx}	*volume ratio (%) of different gas elements*

Above all in the case of solid fuels, but also with gases (less with liquid, as a rule highly standardized fuels), the net calorific values used in the energy balance are all estimated values, since fuel quality – depending on origin, for instance – can differ considerably. This applies for lignite and also for hard coal and different qualities of natural gas. Since these problems – especially for CO_2 emissions – cannot be ignored, the composition of energy source groups must be more strongly considered in the determination of CO_2 emission factors. According to Öko-Institut estimates and calculations, for instance, emission factors for crude lignite fluctuate from 103 t CO_2/TJ (Central German area) to 114 t CO_2/TJ (Lausitz area) to 117 t CO_2/TJ (Rhineland area). According to origin, emission factors for hard coal range from 93 t CO_2/TJ (German bituminous coal) to 95 t CO_2/TJ (coal imported from Poland) to 97 t CO_2/TJ (coal imported from Australia, South Africa and the USA). Less significant differences also arise in the case of natural gas from the North Sea, the Netherlands and Russia.

3.3 Comparative calculations and the achieved results

Comparison is based on the energy balances (in quantitative units and in tonnes of crude oil equivalent) published by EUROSTAT/IEA in Energy Statistics 1985-1998 on CD ROM, and

on the energy balances drawn up by the EGEB in natural units, terajoules and in thousand tonnes hard-coal equivalent.

3.3.1 Comparison of quantitative balances

3.3.1.1 Procedure

In a *first step*, an examination is made of the extent to which data from the questionnaires has flown into the EUROSTAT balances. For this purpose, EUROSTAT provides copies of the following documents:

- For 1989/1990, only the Annual Questionnaire on Electricity and Heat, completed by the Federal Ministry of Economics and forwarded to EUROSTAT on 23.10.1991. The data relates to the Federal Republic of Germany within the borders existing prior to 3 October 1990.
- For 1995, the Questionnaires on Hard Coal (Statistik der Kohlenwirtschaft) and Lignite/Brown Coal (Statistik der Kohlenwirtschaft), on the basis of which the Annual Questionnaire on Coal (Solid Fuels, Wastes and Manufactured Gases) is completed; in addition, the Annual Questionnaire on Oil drawn up by BAFA (at that time: BAW), the Annual Questionnaire on Natural Gas from BAFA and the Annual Questionnaire on Electricity and Heat from the Federal Ministry of Economics (forwarded to EUROSTAT on 13.02.1997).
- For 1998, the Questionnaires on Hard Coal and Lignite/Brown Coal (see above, forwarded on 21.02.2000), the Annual Questionnaire on Oil (forwarded on 10.03.2000) drawn up by BAFA, the Annual Questionnaire on Natural Gas (forwarded on 06.04.2000) from BAFA and the Annual Questionnaire on Electricity and Heat from the then Federal Ministry of Economics (forwarded on 26.01.2000).

For the purpose of comparison, recourse could be made to EUROSTAT energy balances, which were available both in a printed version and on CD ROM. In the energy balances, data is aggregated in joint categories, which are therefore only of limited value for the purpose of comparison with the questionnaires. The following comments relate, therefore, to the CD ROM version.

Reported data has generally been included in energy balances. The problem is that in the area of electricity generation data differs from that in the respective energy source questionnaires. For instance, in the case of hard coal and lignite/brown coal, the figures for fuel consumption have obviously been obtained, as a matter of principle, from the electricity questionnaire. However, with natural gas and petroleum this is not the case. In this connection it has to be mentioned, however, that data reported in the Questionnaire on Coal does not exclusively concern fuel consumption for electricity generation, but also covers quantities of fuel for heat

production. Data from the Questionnaire on Electricity relates, by contrast, exclusively to electricity generation.

Certain cells in the questionnaires could not be completed up to now by the German side at the time of survey, since the required data was not available. This primarily involves all data concerning heat production. But also in the area of associated gases, data is not available for coke oven gas and other gas produced in association with crude oil. Here, EUROSTAT has made its own estimates and identified them as such in the balances. Data has also not been reported on other coal by-products, and in this case EUROSTAT has left the respective cell blank. As a rule, EUROSTAT expects the questionnaires to be returned by 31 October of the following year. The relatively late submission of data by the German side has to do with problems of availability of the corresponding primary data, and these problems have got worse in subsequent years.

In a *second step*, quantitative balances from EUROSTAT and AGEB are compared and significant differences identified. This method has been conducted on an exemplary basis for the years 1995 and 1998, whereby the investigation concentrated on the following main cells for all listed energy sources:

- Indigenous production
- Imports
- Stock changes
- Primary energy consumption
- Transformation sector: input
  output
  consumption
- Non-energy consumption
- Final energy consumption in total by sector:
  - Mining, Quarrying, other Manufacturing Industry
  - Transport
  - Households and Trade, Commerce, Services.

A comparison of data for manufacturing industry at a branch level makes little sense, since, for systematic reasons, the composition of industry branches listed by EUROSTAT is different to that in German energy balances. The differences arise above all from the different assignment of individual industrial branches within the listed industrial groups, as well as between consumption sectors. In Overview 9, individual industrial sectors are compared on the basis of the classification applied by EUROSTAT/IEA and that applied in German energy

balances. Here, it can clearly be seen, which sectors correspond with each other, which sectors differ and where the difference lies.

Overview 9 Comparison of designations and accompanying NACE/WZ Nos. of industrial sectors in accordance with the demarcations of EUROSTAT/ IEA and the German energy balance

Total Industry – IEA Demarcation		**Energy Balance**		
Designation	**NACE No. / WZ 93 No.**		**Designation**	**EB-Col.**
Iron and Steel	27.1, 27.2, 27.3,	27.1	Metal Manufacture	54
	27.51 and 27.52	27.2, 27.3 and 28	Metal Processing	56
Chemical (incl. PetroChem)	24	24.1	Basic Chemicals	49
		24 without 24.1	Other Chemical Industry	50
Non-ferrous Metals	27.4, 27.53, 27.54	27.4 & 27.5	Non-ferrous Metals, Foundries	55
Non-metallic Mineral Products	26	26.1, 26.2, 26.3	Glass and Ceramics	52
		26 without 26.1, 26.2 and 26.3	Processing of Non-metallic Minerals	53
Transportation Equipment	34, 35	34, 35	Vehicle Construction	58
Machinery	28, 29, 30, 31, 32	29	Mechanical Engineering	57
Mining and Quarrying	13, 14	10.30, 12, 13, 14	Quarrying, Other Mining	46
Food Beverages Tobacco	15, 16	15, 16	Food and Tobacco	47
Pulp, Paper and Printing	21, 22	21	Paper	48
Wood and Wood Products	20		Included In "Other Industrial Branches"	
Construction	45		Incl. in the EB in sector "Trade, Commerce, Services"	
Textiles and Leather	17, 18, 19		Included In " Other Industrial Branches "	
Non-specified (industry)		25	Rubber and Plastic Products	51
		Remaining Nos.	**Other** Industrial Branches	**59**
		17	Textiles	
		18	Clothing	
		19	Leather	
		20	Wood (without Furniture Manufacture)	
		22	Publishing, Printing, Production of Recording, Picture and Data Media	
		30	Office and Data Processing Equipment	
		31	Equipment for Electricity Generation and Distribution	
		32	Broadcasting, Television and Telecommunications	
		33	Medical, Measuring and Control Systems, Optics	
		36	Furniture, Jewellery, Music Instruments, Sports Equipment, Toys and Other Products	
		37	Recycling	
Total industry			**Mining, Quarrying, Manufacturing Industry, total**	**60**

The following sectors are identical:

- "Transportation Equipment" and "Vehicle Construction;
- "Food Beverages Tobacco" and "Food and Tobacco".

The sector

- "Chemical (incl. PetroChem)" corresponds to the sector "Basic chemicals" plus "Other chemical industry"

and the sector

- „Non-metallic Products" corresponds with the sector "Glass, Ceramics" plus "Processing of Non-metallic Minerals".

Considerable differences are found in the sectors "Mining and Quarrying" and "Quarrying, Other Mining". In the German energy balance, in addition to "Ore Mining" and "Quarrying, Other Mining" (WZ 93 No. 13 and 14) – which are recorded by EUROSTAT – the energy consumption of "Peat Mining and Processing" and "Uranium and Thorium Ore Mining" is also recorded (WZ 93 No. 10.30 and 12). On account of low amounts of energy consumption, the quantitative difference between both entries is small enough to be ignored.

Larger differences arise in the sector "Iron and Steel", where, apart from "Metal Production", which is separately listed in the German balance (WZ 93 No. 27.1), EUROSTAT additionally records energy consumption for the "Manufacture of Pipes", "Other Initial Processing of Iron and Steel", "Manufacture of ferroalloys (without ECSC)" and "Iron and Steel Foundries" (WZ 93 Nos. 27.2, 27.3, 27.51 and 27.52). Some of these industries are separately listed in the energy balance under "Non-ferrous Metals" (WZ 93 Nos.: 27.4 and 27.5), "Metal Processing" (WZ 93 Nos. 27.2, 27.3) and "Manufacture of Metal Products" (WZ 93 No. 28.

Under "Pulp, Paper and Printing", EUROSTAT groups together the "Paper Industry" and "Publishing, Duplication of Recording, Picture and Data Media" (WZ 93 Nos. 21 and 22). Die AGEB reports "Paper Industry" on its own, "Publishing ..." being included in "Other Industrial Branches".

Great differences arise between the entries "Machinery", which with EUROSTAT encompasses "Manufacture of Metal Products", "Mechanical Engineering", "Manufacture of Office and Data Processing Equipment", "Manufacture of Equipment for Electricity Generation and Distribution" and "Radio, Television and Telecommunications" (WZ 93 Nos. 28, 29, 30, 31 and 32), and the row "Mechanical Engineering" with AGEB, which appears only in WZ 93 No. 29. All other branches are grouped together in German energy balances under "Other Industrial Branches". This includes "Wood and Wood Products" (WZ 93 No. 20) and "Textiles and Leather" (WZ 93 Nos. 17, 18 and 19), which, by contrast, are separately listed by EUROSTAT.

"Construction" (WZ 93 No. 45) is a special case. It is designated by EUROSTAT as an industry, whereas the German equivalent, "*Baugewerbe*", is assigned in Germany to "Trade, Com-

merce and Services" and, where data on energy consumption is available, is recorded accordingly.

The differing forms of presentation originate in different interests at a national and a European level. Quantitative differences in the data do not arise; both forms of presentation are based on official German statistics and may therefore be transformed from one into the other.

3.3.1.2 Results

The differences determined so far for hard coal, lignite/brown coal and petroleum are displayed in Table 3.

With *hard coal*, it is conspicuous that considerable differences occur between both balances with respect to production, stock depletion and input for transformation. These differences can be explained in the case of production, according to Statistik der Kohlewirtschaft, by the fact that EUROSTAT data is compiled on a tonnes of gross production basis (that is, the total quantity of mined hard coal of the most varied quality and ballast content), whereas AGEB has applied quantitative data on the basis of tonnes of ballast-free, marketable production. As a result, EUROSTAT figures are about 1,869 million tonnes higher than the figures for tonnes of gross production figures of Statistik der Kohlenwirtschaft. In the transformation sector, the difference has to do with the fact that EUROSTAT records consumption in power plants of the public supply industry in tonnes, whereas AGEB uses standardized tonnes of hard coal equivalent. This difference diminishes considerably, however, if values are compared in terajoules or crude oil equivalent.

Table 3 Differences in the energy balance data of EUROSTAT and *AG Energiebilanzen (AGEB*) for the balance year 1998

All figures in 1000 t	Hard coal			Lignite		Petroleum							
	Coal	Briquett	Coke	lignite (crude) hard lignite	Briquette and other lignite prods.	Crude oil	Gas-oline	Na-phtha	Jet fuel	Diesel fuel incl. LHO	Heating oil, hvy.	Liquid gas	Refinery gas
Indigenous production	6248	0	0	-149	0	53	0	0	0	0	0	0	0
Imports	0	0	0	-126	107	345	385	-448	104	202	-102	-23	-26
Stock depletion	818	0	3	-72	-17	0	186	41	102	564	155	76	0
Exports	0	-66	17	-140	26	0	0	0	32	-1	0	0	0
Intern. marine bunkers	0	0	0	0	0	-	-	-	-	-	0	-	-
Stock build-up	-	0	-	-	0	206	0	0	0	0	0	0	5
INDIG. PRIMARY ENERGY CONSUMPTION	**7066**	**66**	**-14**	**-207**	**69**	**192**	**571**	**-407**	**174**	**328**	**180**	**53**	**31**
Transformation input, total	2498	0	224	-3041	-7	193	-3995	-4884	0	-749	-2457	-381	-324
Transformation output, total	0	0	139	0	0	0	-3266	-170	39	-50	-714	-267	-225
Energy cons. in transformation area, total	2	0	0	-108	-2	0	0	0	0	46	642	77	148
Flaring & transport losses	-	-	-	-	-	-	0	0	0	-	0	0	0
NON-ENERGY CONSUMPTION	-	0	102	-1	-142	-	0	1145	11	-1	-581	-218	-123
Statistical differences	-360	66	405	3035	223	-1	187	106	90	67	133	79	-5
FINAL ENERGY CONSUMP.	**526**	**0**	**8**	**-92**	**-3**	**-**	**1**	**0**	**17**	**-173**	**-493**	**0**	**32**
Mining, Quarrying, Manufacturing Industry, total	530	0	8	-59	30	-	0	0	0	330	-546	-80	32
Transport, total	0	0	0	0	-28	-	191	0	376	43	0	61	0
Households	149	0	20	73	0	-	55	0	1	0	0	-36	0
Households; Trade, Commerce and Services	-4	0	0	-106	-5	-	-190	0	-359	-546	53	19	0

Energy sources such as tar and benzene, which are listed by AGEB under "Coal Derivatives", are not separately considered by EUROSTAT. These energy sources are included – in contrast to EUROSTAT – in German energy balances in the calculation of primary energy consumption and are solely assigned to non-energy consumption.

With *Lignite* (crude lignite including hard lignite) there are only minor differences with respect to production, imports and exports, which can be explained by quantities of peat that are recorded under hard lignite by AGEB, but are not recorded by EUROSTAT. The quantity of 3,014 million tonnes in the transformation sector, by which EUROSTAT data exceeds that of AGEB, roughly corresponds with the reported statistical difference, which amounts in EUROSTAT balances to 3,035 million tonnes, but is non-existent with AGEB.

In the case of *Petroleum*, differences primarily arise in the transformation sector, and are to be explained by the varied treatment of PetroChem in the area of Other Energy Producers. Quantitative flows (replacement of products, transfer of products, backflows from the petrochemicals industry), which are booked summarily by AGEB, are presented in detail by EUROSTAT. In the presentation of petroleum products, both sets of statistics also differ: EUROSTAT includes Diesel Fuel and Light Heating Oil in one cell, whereas AGEB records both

products separately. Similar problems arise in the case of Heavy Heating Oil and Residual Fuel Oil as well as Other Petroleum Products and Feedstocks. The differing entries primarily relate to deliveries for chemical processing according to information in Official Petroleum Statistics (*Amtlichen Mineralölstatistik, AMS*) of the Federal Office of Economics and Export Control (BAFA). This information forms the basis for data on petroleum consumption compiled by the Association of the Germany Petroleum Industry.

3.3.2 Comparison of net calorific values

3.3.2.1 Procedure

Besides publishing a balance in the respective units (tonnes, kWh and terajoules (TJ), EUROSTAT also produces another balance in crude oil equivalent – but not in terajoules – and a table of conversion coefficients. However, only a very broad range of conversion coefficients is provided in the table for major energy sources such as hard coal, lignite and crude oil. The conversion coefficients actually used by EUROSTAT for Germany had to be derived from data in tonnes and in tonnes of crude oil equivalent. These coefficients are compared with the net calorific values used by AGEB for its calculations and with the data reported to EUROSTAT by *Statistik der Kohlenwirtschaft.*

In Table 4, data on hard-coal production is displayed in different units with accompanying net calorific values. Due to rounding of input data, computational differences arise with the corresponding total calorific values of production. In the Questionnaire on Coal, EUROSTAT requires information on production differentiated according to type of coal (coking coal, other bituminous coal and anthracite as well as sub-bituminous coal). The German reports encompass not only the corresponding quantities, but also the accompanying net calorific values, on the basis of which EUROSTAT calculates calorific value, which is then published in the balance in tonnes of crude oil equivalent. The net calorific values, which are determined by corresponding recalculation, lie around 0.2% below those shown in the tonnes of gross production data of *Statistik der Kohlenwirtschaft*. AGEB uses tonnes of marketable, ballast-free production for quantitative data and the accompanying net calorific value. Certain differences arise in data in absolute terms solely due to differing primary data and the respective processes of calculation, but such differences can hardly be avoided, due to the reporting system.

Table 4 **Quantities and specific net calorific values of hard-coal production in Germany in selected years**

Unit	Production	Net calorific value	Total calorific value	Production	Nat calorific value	Total calorific value
	1000 t	NCV, in kJ/kg	terajoules	1000 t	NCV, in kJ/kg	terajoules
	1995			1998		
t of gross prod	58859	27105	1595373	45339	27223	1234264
t hard coal eq	54434	29308	1595352	42112	29308	1234218
t market. prod.	53565	29783	1595326	41640	29638	1234126
	1999			2000		
tt of gross prod	43848	27221	1193586	37376	27070	1011768
t hard coal eq.	40726	29308	1193598	34523	29308	1011800
t market. prod.	39523	30200	1193595	33591	30121	1011795

Source: *Statistik der Kohlenwirtschaft*, DIW calculations

3.3.2.2 Results

It turns out that important differences also exist in the net calorific values that are used (data for 1998):

For hard coal produced in Germany, EUROSTAT assumes a conversion coefficient of 27 168 kJ/kg, which corresponds neither to tonnes of marketable production (29 638 kJ/kg) as used by AGEB, nor to tonnes of gross production (27 223 kJ/kg) as used by *Statistik der Kohlenwirtschaft*.

The same applies for lignite. In this case, EUROSTAT coefficients of 8 840 kJ/kg for crude lignite and of 13 461 kJ/kg for imports of hard lignite both lie below AGEB coefficients of 8 931 kJ/kg and 14 962 kJ/kg, respectively. It can be established that the conversion coefficients used by EUROSTAT tend to be well below those used by AGEB.

4 Analysis of EUROSTAT emission factors

4.1 Methodical approach and databases

One cause of differences in data between EUROSTAT emission inventories and national inventories can lie in the choice of emission factors.

To begin with, the emission factors employed by EUROSTAT for energy-related CO_2 emissions were analysed. Since these emission factors were not explicitly available, however, they had to be identified by way of recalculation from jointly published energy balances and CO_2 inventories. The basis for this was provided by data for the years 1991 to 1998, available on CD ROM under the title, "Energy in Europe", which provided the following information:

- Energy balances encompass altogether 18 fossil fuels, differentiated according to individual utilization in the transformation sector and final consumption sectors.
- Inventories of CO_2 emissions cover a total of 30 fossil fuels (among them, a number of aggregates) and 30 source sectors (likewise including a few aggregates).

An initial analysis was carried out of the compatibility of both databases with regard to the determination of CO_2 emission factors. The classification of the following 14 fossil fuels in the inventory and energy balance is identical:

- Hard coal
- Hard-coal briquettes
- Hard-coal coke
- Crude lignite/brown coal
- BKB/Lignite briquettes
- Refinery gas
- Liquid gas
- Motor gasoline
- Kerosene and jet fuel
- Naphtha
- Diesel fuel and light heating oil (LHO)
- Heavy heating oil ("residual fuel oil")
- Other petroleum products
- Natural gases

Though emission values were available for the following fuels, the respective energy balance data was not correspondingly differentiated:[8]

8 Information in brackets concerning aggregations and classifications were made available by EUROSTAT on 22 November 2002; further clarification could not be obtained from EUROSTAT.

- Blast furnace gas, gas-works gas, coke-oven gas (grouped under manufactured gases)
- Hard lignite (grouped together with crude lignite)
- Lignite coke (classification still unknown))
- Bitumen, lubricants, petroleum coke, special boiling point (SBP) gasoline and white spirit, tar/benzene (aggregation and classification still unknown)
- Blast furnace coke (combined with hard-coal coke)

As a result, a number of not unimportant source categories escaped recalculation. Given the clear differences between the emission factors used by EUROSTAT and those used by the Federal Environmental Agency (UBA), a qualitative trend in differences (over- or underestimation of the resulting emissions) cannot be determined. In total, however, the bulk of emissions (>95 %) ought to have been covered, so that considerable informative value can be attached to the analysis.

Looking at the German emission inventory's coverage of energy-related CO_2 emissions, it has to be mentioned that CO_2 emissions from waste incineration are clearly *not* considered in the determination of emissions on the part of EUROSTAT, since under biomass the non-organic elements of municipal waste are covered, but only the organic elements of industrial waste (the classification of non-organic industrial waste is not yet known).

The emission factors were determined for the sectors and subsectors of the energy balance as the quotient of emission value and energy consumption. Since energy balance data was available in kilotonnes of crude oil equivalent and emissions in kilotonnes of CO_2, emission factors were determined (in t CO_2/TJ) using the following relation:

$$EF_{i;j} = \frac{E_{i;j}}{Q_{i;j} \cdot 41{,}868} \cdot 1000$$

with $EF_{i;j}$ *emission factor for fuel i in the energy balance sector j*
$E_{i;j}$ *CO_2 emission* for fuel i in the energy balance sector *j*
$Q_{i;j}$ *energy input* for fuel i in the energy balance sector *j*

The numerical value is the net calorific value 41,868 kJ per kg crude oil equivalent.

4.2 Results of recalculation

Overview 10 displays the results of recalculations, also in comparison to the emission factors used in the Federal Environmental Agency's inventory system.

Overview 10 Results of recalculation of emission factors, 1991-1998

	EUROSTAT emission factors	UBA emission factors and further information
	t CO_2/TJ	
Hard coal	94	UBA employs values of 92 to 94 according to source category - 92 for power and district heat plants - 93 for industrial incineration plants - 94 for households and small consumers
Hard-coal coke	106	UBA employs values of 100 to 113 according to source and origin
Hard-coal briquettes	93	UBA generally employs the value 93
Crude lignite	99	UBA employs values of 110 to 94 according to source category - 110 for industry, small consumers & military - 111 for power and district heat plants & remaining transformation - 112 for other industrial power plants As far as separate energy input data exists for the new *Länder*: 113; the value for Central German crude lignite should be around 100
Hard lignite	no emission factor, Included in crude lignite	UBA generally employs the value 97
BKB/Lignite briquettes	93	UBA employs values of 97 to 99 according to source and origin - 99 for power and district heat plants - 97 for other source categories UBA employs values of 64 to 65 according to source 98
Lignite coke	no emission factor, classification still unknown	UBA employs values of 96 to 111 according to source category - 96 for power and district heat plants - 107 for industrial incineration plants - 111 for remaining transformation and small consumers As far as separate energy input data exists for the new *Länder*: 97
Pulverized & dry coal	no emission factor, classification still unknown	UBA generally employs the value 98
Peat	no emission factor, classification still unknown	UBA generally employs the value 98
Crude oil	no emission factor, no emission factor,	UBA generally employs the value 80
Naphtha	73	UBA generally employs the value 80
Motor gasoline/fuel	69	UBA generally employs the value 72
Diesel fuel	73	UBA generally employs from 1991 the value 74
Kerosene & heavy fuel oil	71	UBA generally employs from 1991 the value 74
Light heating oil	73	UBA generally employs the value 74
Heavy heating oil	77	UBA generally employs the value 78
Liquid gas	62	UBA employs values of 64 to 65 according to source
Refinery gas	66	UBA generally employs the value 60
Petroleum coke	no emission factor, classification still unknown	UBA generally employs the value 101
Other petroleum products	73	UBA employs values of 78 to 80 according to source UBA employs values of 64 to 65 according to source 78
Coke-oven & town gas	combined in EUROSTAT energy balances	UBA generally employs the value 44
Blast furnace gas		UBA generally employs the value105; to avoid double counting of blast furnace process and blast furnace gas combustion, blast furnace gas Is assessed similar to hard-coal coke
Natural gas	56	UBA employs, according to origin, values of 55 to 56 for natural gas, 58 for LPG, 55 for colliery gas. As far as separate energy input data exists for natural gas for the new *Länder*: 55
Industry waste	only organic industry waste included	UBA generally employs – with the exception of special branches – the value 20
Municipal waste	All municipal waste included, but no emission factor determinable	UBA generally employs the value 15
Comment: These UBA emission factors represent implemented data resources as of March 2003.		

Sources: EUROSTAT, UBA, Öko-Institut calculations

The recalculations reveal that emission factors have not been differentiated by EUROSTAT according to the various source sectors. Energy consumption is therefore evaluated with the same emission factor in the power plant sector as – with the same fuel – in final energy sectors. This approach appears questionable, at least as far as coal is concerned. The same applies

for EUROSTAT's obvious assumption of the permanence of emission factors. Here, only a single divergence was discovered for crude lignite input in public thermal power plants.[9]

In the case of *hard coal* it is demonstrably clear that emission factors employed by EUROSTAT are always at the top end of the range of values used by the UBA; the spread of fuel consumption (high with power generation, low with small consumers) suggests that, in this case, emissions are exceeded on average by 2 t CO_2/TJ; that is, by about 2%. In the case of hard-coal coke, the value is substantially exceeded.

With *lignite,* on the other hand, emissions are clearly underestimated; differences in emission factors amount, in part, to over 10%.

The same applies for virtually all petroleum products; only in the case of refinery gas is the emission factor employed by EUROSTAT higher than the values on which UBA inventories are based. The difference for motor gasoline is of particular significance; in this case, emissions are assumed to be underestimated by about 7%.

The values employed for *natural gases* are very similar. Due to the predominant role of imported natural gas with high GCV for the current energy supply mix in Germany, there is considerable concurrence.

In the area of *waste incineration*, an underestimation of emissions is to be assumed, since the non-organic elements of municipal waste are also assigned to biomass, with an estimated neutral effect on CO_2. A corresponding underestimation of CO_2 emissions is also to be noted in respect of non-organic elements of industrial waste, where, as confirmed by EUROSTAT, only organic elements are considered.[10] It should also be mentioned – complementary to Overview 10 – that, due to recent research findings[11], with effect from the next reporting period in 2004 the following emission factors will very probably be generally employed for the drawing up of German inventories from 1990 onwards:

- Residual municipal waste (household waste): 45 t CO_2/TJ; net calorific value: 0.010377 TJ/t waste; CO_2 content: 0.472 t/t waste

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9 Whereas for crude lignite input an emission factor of 99 t CO_2/TJ is generally applied, this value drops in the year 1998 for public thermal power plants to 97 t CO_2/TJ. This can only be regarded as a data error.

10 A response from EUROSTAT with respect to this question is still awaited.

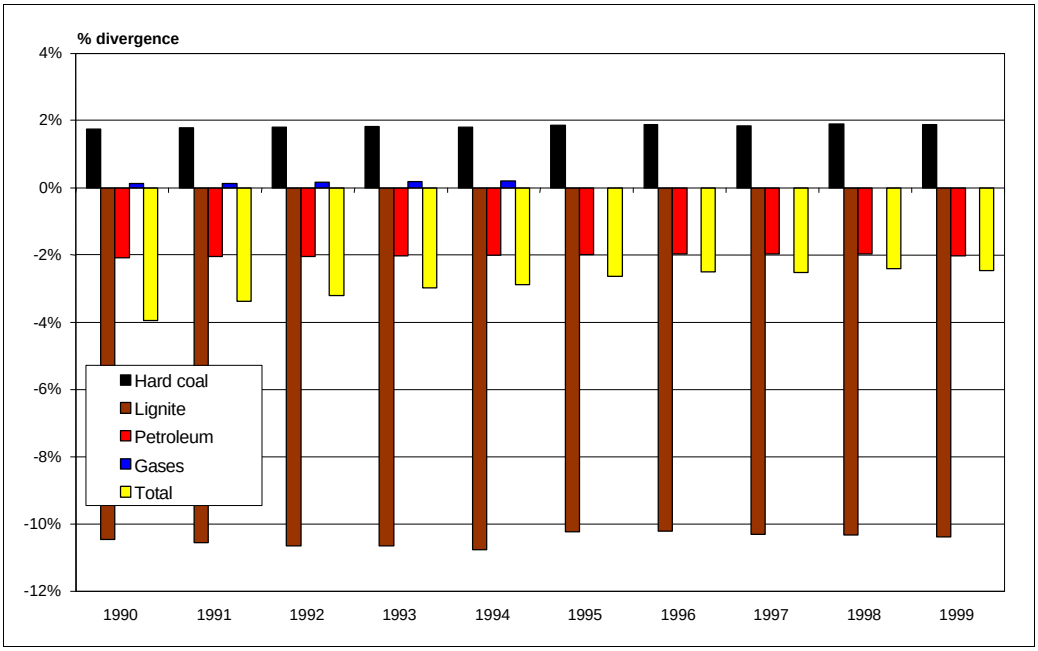
11 Project "Methodenoptimierung für Emissionsermittlung – und szenarien" (FKZ 299 42 245); Teilbericht Abfall/Abwasser; available under http://www.umweltbundesamt.de/luft/emissionen/f-und-e/index.htm

- Sewage sludge: 3 t CO_2/TJ; net calorific value: 0.008581 TJ/t waste; CO_2 content: 0.024 t/t waste
- Special industrial waste: 94 t CO_2/TJ; net calorific value: 0.0175 TJ/t waste; CO_2 content: 1.642 t/t waste.

4.3 Conclusions

Due to the considerable role that the burning of coal and petroleum products plays in German CO_2 emissions, the great differences in the emission factors for these fuels lead, in particular, to a significant underestimation of emissions. This applies also with respect to the uncertainties that arise through CO_2 emissions of these fuels, which, due to the lack of adequate databases, could not be considered for this analysis.

Overview 11 Divergence of UBA and EUROSTAT emission factors by fuel category, 1990-1999



Sources: EUROSTAT, UBA, Öko-Institut calculations

Divergencies arising from differing emission factors amount in the period 1990 to 1999 to between –39.5 million tonnes of CO_2 (1990) and –21.0 million tonnes of CO_2 (1999), on the basis of an identical framework of input quantities (according to the German energy balance and previous UBA supplementation for crude lignite and natural gas). In EUROSTAT calculations, CO_2 emissions in Germany are therefore underestimated by between -3,9 (1990) and –

2.4 per cent (1999). As Overview 11 makes clear, divergencies in particular fuel categories are considerably greater than the net balance.

The decisive conclusion at this point is that harmonization of data between EUROSTAT and German institutions may not be restricted solely to basic energy data, but must be extended by all means to *emission* factors. It also appears to be necessary for the German side to provide EUROSTAT with a complete set of emission factors representative of Germany, which should differentiate specific source categories and changes in the course of time. Until such time as these data are available fully differentiated[12], emission can be calculated with sufficient accuracy (>99 %) on the basis of the emission factors for Germany shown in Overview 10. For logical reasons, the emission factors should also be aggregated in line with fuel-differentiation practised by EUROSTAT.

5 Analysis of activity rates used by the UBA for energy-related CO_2 emissions

5.1 Preliminary remarks

The inventories of atmospheric contaminants drawn up by the UBA are based strictly on the energy balances for Germany drawn up by the AGEB. This applies in particular for energy-related CO_2 emissions. The activity rates used in this case are based almost exclusively on the totals contained in energy balances; in contrast to the determination of emissions of other atmospheric contaminants, for which the activity rates derived from energy balances are in part extended to take account of activity rates from other sources (for instance, in the case of the use of wood in the sectors Households and Small Consumers (Trade, Commerce, Services).

The energy balance data, which provides the basis for emission inventories, is further differentiated and regrouped for a variety of reasons, making use of a multitude of other data. This is due to

- demands resulting from different national and international reporting formats;
- the necessity of differentiated determination of emissions, since different processes and fuels have to be represented by different emission factors; and

12 The Federal Environmental Agency is currently drawing up an Internet-compatible database on emission factors (GERman Emission Factor Database – GEREF). A project description is available under www.umweltbundesamt.de/luft/emissionen/f-und-e/laufend/20141261.pdf.

- material differences concerning classification in the view of the UBA.

With regard to the last point, these differences result in only a limited number of cases from energy-related CO_2 emissions; more frequently, process or fuel differentiation relates to distinctions concerning acidifying substances (sulphur dioxide, nitrogen oxide, ammonia) or other classic contaminants (dusts, carbon monoxide) and greenhouse gases other than CO_2 (methane, non-methane volatile organic compounds (NMVOC), nitrous oxide).

Against this backdrop, the following comments are restricted to those differences that are relevant as far as energy-unrelated CO_2 emissions are concerned; and the basis is provided by a detailed analysis (Öko-Institut 2000) founded on the database up to 1995. Further analyses were made on the basis of the database of the UBA's Central System of Emissions (CSE) as at 19 December 2002. Previously drawn-up CO_2 inventories are therefore covered; but modifications can still arise for future inventories or expected inventory revision.

5.2 Supplementation of energy balance data

In the area of waste incineration, an initial supplementation of energy balance data was carried out by the UBA for the period up to 1994.

In rows 11, 15 and 16 of the energy balance (in the version from 1995 onwards; in the version valid until 1994 rows 13 and 18 are affected) the energy balance contains data on the input of sewage sludge, waste in public thermal power plants (row 11 in the version from 1995 onwards; row 13 in the version valid until 1994), public heat plants and district heat plants (rows 15 and 16 in the version from 1995 onwards; row 18 in the version valid until 1994).

This data was supplemented by the UBA with its own estimates of the total consumption of municipal waste in waste incineration plants, which were based on the evaluation of data provided by plant operators.

The difference between the total consumption of municipal waste, thus determined, in public power and heat supply and in energy balance data is divided proportionate to the energy balance data. Until 1994, this supplementation was only carried out for the old *Länder*; for the new Länder energy balance data was estimated without supplementation. Table 5 shows the situation for previously verified data.

Table 5 **Supplementation of activity rates in respect of the use of municipal waste in thermal power plants, heat plants and district heat plants for public supply, old *Länder* 1990-1994 and Germany 1995-1999**

	Public thermal power plants				Heat plants, district heat plants			
	Energy balance	CSE			Energy balance	CSE		
	Rows 13/11	Energy balance	Supplementary	Total	Rows18/15+16	Energy balance	Supplementary	Total
	TJ							
1990	22,216	22,216	9,967	32,183	20,970	20,970	9,407	30,377
1991	23,491	23,491	11,423	34,914	20,294	20,294	9,868	30,162
1992	25,952	25,952	12.339	38,291	19,892	19,892	9,457	29,349
1993	25,637	25,637	11,964	37,601	22,149	22,149	10,335	32,484
1994	29,384	29,384	12,463	41,847	21,372	21,372	9,064	30,436
1995	27,143	27,143	-	27,143	9,203	9,203	-	9,203
1996	29,233	29,233	-	29,233	7,516	7,516	-	7,516
1997	32,575	32,575	-	32,575	7,730	7,730	-	7,730
1998	29,847	29,847	-	29,847	12,189	12,189	-	12,189
1999	41,621	41,621	-	41,621	34,834	34,834	-	34,834
Note: old *Länder* 1990 to 1994, Germany from 1995 onwards								

Source: AG Energiebilanzen (AGEB), UBA, Öko-Instituts calculations

From 1995 on, the available database no longer contains such supplementation.

In the period up to 1994, as a result of supplementary activity rates, 300,000 additional tonnes of CO_2 emission occurred. A corresponding reduction in total emissions resulted from 1995 onwards merely as a result of the modified registration method.

A similar procedure is pursued for waste incineration in industrial thermal power plants. This supplementation of fuel quantity is connected, however, with differentiation of fuel for sulphite lye, which is irrelevant as far as energy-related CO_2 emissions are concerned.

Data on industrial waste incineration, as a whole, provides the basis in this case, as far as it is recorded by the Federal Statistical Office (FS 19, row 1.2). The consumption of sewage sludge, waste etc. in industrial thermal power plants (row 15 of energy balances up to 1994, row 12 in energy balances from 1995) and in other incineration plants (row 73 of energy balances up to 1994, row 60 in energy balances from 1995) is then deducted from this total.

This difference is added to the input of sulphite lye in industrial thermal power plants assignable to heat production, whilst the fuel quantity assigned to the consumption of sulphite lye for power generation in industrial thermal power plants is deducted from the total input of sewage sludge, waste etc. in industrial thermal power plants as shown in the energy balance (row 15 up to 1994, row 12 from 1995 onwards). For the new Länder, the total consumption of sewage sludge, waste etc. shown in the energy balance is assigned to industrial waste input (Table 6).

In the current version of CSE, these methods have not been applied to the period from 1995 onwards. The activity rates for this period currently in the UBA system are considerably lower than those documented in the energy balance; while the methods for determining this data have not so far been documented.

Table 6 Supplementation and differentiation of activity rates in respect of the use of industrial waste and sulphite lye in industrial thermal power plants and by other industrial heat producers, old *Länder* 1990-1994 and Germany 1995-1999

	Industrial thermal power plants				Industrial heat producers				
	Energy balance	CSE			Energy balance	CSE			
	Row 15/12	Energy balance	thereof ind. waste	thereof sulphite lye	Row 73/60	Energy balance	thereof ind. waste	Supplementary indust. waste	Supplementary sulphite lye
	TJ								
1990	31,921	31,921	28,690	3,231	0	0	0	0	9,655
1991	31,344	31,344	28,257	3,087	0	0	0	14,677	9,259
1992	28,157	28,157	25,164	2,993	537	537	537	14,763	8,977
1993	28,041	28,041	24,683	3,358	8,852	11,149	11,149	5,918	10,073
1994	32,290	32,290	28,890	3,400	5,661	5,661	5,661	15,612	10,000
1995	32,918	11,485	11,485	-	10,472	4,155	4,155	5,559	-
1996	35,510	10,818	10,818	-	10,038	3,389	3,389	5,446	-
1997	37,457	8,387	8,387	-	10,038	2,450	2,450	4,212	-
1998	56,442	14,879	14,879	-	14,254	3,820	3,820	1,212	-
1999	29,397	7,750	7,750	-	14,100	3,778	3,778	1,199	-

Notes: old *Länder* 1990 to 1994, Germany from 1995 onwards. Clarification is still required regarding the data used by the UBA for 1993.
The methods used to determine data that varies from that in the energy balance from 1995 onwards is not yet documented.

Sources: AG Energiebilanzen (AGEB), UBA, Öko-Institut calculations

Depending on the reference period, and taking into account supplementary quantities in respect of industrial waste (sulphite lye is irrelevant as far as energy-related CO_2 emissions are concerned), up to 300 000 tonnes of CO_2 result for the period up to 1994. The change in methodology from 1995 – that is, the incomplete consideration of quantities shown in the energy balance – leads to a reduction in calculated emissions of about 400,000 to 800,000 tonnes of CO_2 for industrial thermal power plants and 100.000 to 200,000 tonnes of CO_2 in respect of industrial heat producers.

Regarding the use of wastes, incineration in other transformation sector plants must also be mentioned. The energy balances of the old Länder from 1993 to 1994 contain data on the use of sewage sludge and waste under energy consumption in the transformation sector for coke ovens (row 38 of the energy balance); from 1995 corresponding data for Germany is listed under consumption in energy production and in the transformation areas for other energy producers (row 39 of the energy balance) (Table 7).

In the CSE, this use is interpreted as input of plastic wastes. CSE data corresponds with relevant energy balance data up to 1994; from 1995, however, it is no longer considered, though this has not so far been documented.

Table 7 **Supplementation and differentiation of activity rates in respect of the use of sewage sludge and waste in coke ovens and by other energy producers in the transformation sector, old *Länder* 1990-1994 and Germany 1995-1999**

	1993	1994	1995	1996	1997	1998	1999
				TJ			
Energy balance (rows 38 and 39)	5,540	6,212	11,511	12,969	13,707	14,080	13,797
Data implemented in the ZSE	5,540	6,212	0	0	0	0	0
Note: old *Länder* up to 1994, Germany from 1995							

Source: AG Energiebilanzen (AGEB), UBA, Öko-Institut calculations

The reduction in emissions resulting from a change in method amounts in the period from 1995 to 99 to between 0.9 and 1.1 million tonnes of CO_2.

A second energy balance supplementation occurs for the use of natural gas in compressors in the gas network. Up to 1994, this was accounted for with a flat rate of 0.5% related to indigenous natural gas consumption. Up to 1994, the corresponding activity rates are not deducted from the data in row 42 on energy consumption in the transformation sector; they are *additionally* considered on the emissions side.

For Germany as a whole, this resulted in the first half of the 1990s in annual emissions of about 700 000 tonnes of CO_2.

From 1995 onwards, the use of natural gas for gas compressors is determined on the basis of another procedure and no longer estimated *additional* to energy balance data.[13]

Another peculiarity concerns the use of crude lignite for lignite drying in the production of briquettes, dusts and dry coal. The UBA assumes that fuel consumption required for drying is recorded in the energy balance not under energy consumption in the transformation sector in row 40 (up to 1994; 35 from 1995) (energy consumption here is not of a reasonable magnitude), but rather in the transformation consumption of crude lignite in briquette plants (row 12 of the energy balance up to 1994, row 10 from 1995 onwards), and that its corresponding effect on emissions is to be taken into account.

- For the old *Länder*, crude lignite use for this purpose was recorded on the basis of information provided by Rheinbraun AG.

13 From 1995 onwards, 0.65% of total natural gas consumption for final energy consumption, own energy consumption of the transformation sector and non-energy consumption is estimated as natural gas consumption of network compressors. This consumption of natural gas is recorded in the energy balance under natural gas consumption of coke ovens (row 33 from 1995 onwards) and correspondingly deducted for the CO_2 inventory.

- For the new *Länder*, detailed GDR data for 1989 was extrapolated by the UBA for the period up to 1994.
- From 1995 onwards, data was calculated by the UBA by way of a fundamentally different methodical approach on the basis of data from boiler statistics.

Table 8 displays currently used data in comparison to production figures for BKB/lignite briquettes as well as pulverized and dry coal. The overview clearly demonstrates that considerable information is still required concerning the leap between the years of 1997 and 1998.

Table 8 Supplementation in respect of the use of the crude lignite for lignite drying, old and new *Länder* 1990-1994 and Germany 1995-1999

	Supplementary consumption of crude lignite For lignite drying			Transformation output BKB/lignite briquettes			Transformation output Dusts and dry coal		
	Old *Länder*	New *Länder*	Germany	Old *Länder*	New Länder	Germany	Old *Länder*	New Länder	Germany
	TJ								
1990	18,328	135,989	154,317	47,300	62,030	109,330	740,273	36,969	777,242
1991	20,263	68,993	89,256	56,044	64,059	120,103	352,168	35,464	387,632
1992	18,473	40,042	58,515	45,696	64,147	109,843	189,735	34,383	224,118
1993	17,680	26,789	44,469	43,165	59,724	102,889	150,138	25,200	175,338
1994	15,078	19,627	34,705	35,555	55,775	91,330	97,358	27,257	124,615
1995	-	-	21,196	-	-	96,802	-	-	79,420
1996	-	-	25,058	-	-	94,889	-	-	73,500
1997	-	-	24,354	-	-	68,953	-	-	69,721
1998	-	-	9,661	-	-	45,977	-	-	66,566
1999	-	-	6,008	-	-	40,595	-	-	65,060

Source: AG Energiebilanzen (AGEB), UBA, Öko-Institut calculations

Additional CO_2 emissions from the use of crude lignite for lignite drying amounted in 1990 to around 17 million tonnes, declining up to the mid-1990s to around 2.8 million tonnes. It is worth mentioning the strong decline in the use of crude lignite for lignite drying, which led to a drop of about 1.7 million tonnes in the corresponding emissions of CO_2, while no parallel development can be found in the production data for BKB/lignite briquettes or pulverized and dry coal.

The question of the use of crude lignite for lignite drying will be the subject of a review of methods and data at the UBA in the near future, with the intention of resolving this issue.

According to UBA estimates of energy consumption supplementary to the energy balance, a total of several million tonnes of CO_2 emissions occur. Furthermore, as a result of methodical regroupings with effect from 1995, considerable remission reductions occur (depending on the analytical approach, from 1 to 3 million tonnes of CO_2).

5.3 Regrouping of energy balance data

A considerable amount of regrouping is carried out at the UBA in the drawing up of inventories. These concern, on the one hand, the allocation of energy consumption in co-generation (CHP) plants, by which fuel consumption for power generation and for heat production are differentiated in the energy balance; and on the other hand, regrouping among different fuels and the transfer of individual fuel consumption to other areas of consumption.

The identification of the fuel consumption of industrial CHP plants assignable to heat production takes place at the UBA in a highly complex procedure, which cannot be discussed at this point, and which only affects the assignment of emissions among industrial thermal power plants (energy balance row 15 up to 1994, row 12 from 1995 on) and fuel consumption of other heat producers in the areas of other mining and manufacturing industry (rows 51 to 73 up to 1994, rows 46 to 60 from 1995 on).

In addition, the following regroupings and differentiation (relevant for energy-related CO_2 emissions) are carried out:

- The use of jet fuel in the trade, commerce and services sector (energy balance row 79) was assigned up to 1994 to petroleum consumption in small incineration plants. From 1995 on, the use of jet fuel in the trade, commerce and services sector, which then also covers the military, is wholly assigned to military air traffic. However, this shift corresponds merely to an emissions volume of a maximum of 30,000 tonnes of CO_2.

- 80% of jet fuel in the traffic sector is assigned to international aviation.

- The use of lignite in the area of public thermal power plants (energy balance row 13 up to 1994, row 11 from 1995 on) is partly differentiated according to origin (Rhineland, Helmstadt, Kassel, Brandenburg/Saxony and Saxony-Anhalt), but CO_2 emission factors are varied only for the old *Länder*, although CO_2 emission factors particularly for mining areas in the new *Länder* differ widely.

Apart from the above-mentioned allocation of fuel to the CHP sector, further differences in sector assignment through regrouping are only to be expected to a limited extent, and they cancel each other out in the sum total.

With differentiated consideration of crude lignite consumption, considerable differences – also in the total amount – can arise to emissions determined directly from the energy balance.

Against the background of available data, two procedures for resolving the lack of definition or changed pattern in the use of lignite are possible:

- The differentiation of activity rates (for the most important source categories; that is, public power generation, public district heat production and colliery power plants) according to the origin of crude lignite. Up to now, this has only been partially realized in the CSE (for example, for the old *Länder* up to 1994 and for Germany from 1995 on). Such differentiation has not taken place up to now for the new *Länder*, although here considerable shifts in the production pattern have occurred. Permanently differentiated treatment, based on data provided by DEBRIV and other sources, would, however, be basically possible.

- The annual determination of weighted emission factors for the total input of crude lignite (in the most important source categories, see above) according to area.

The corresponding decision has not yet been made by the UBA, but it initially concerns more the improvement of UBA inventorizing and less agreement between Germany and EUROSTAT. If the choice falls on the first variant – and much can be said for this choice in the light of the determination of emissions for contaminants other than CO_2 – weighted emissions factors have in any case to be determined for data submitted to EUROSTAT.

5.4 Requirements of reporting formats

For international reporting commitments, so far as the EU is concerned, two reporting formats are important:

- In 1999, the UNFCCC developed a new format for emissions reporting, the Common Reporting Format (CRF),[14] which follows the methodology of the IPCC Guideline of 1996 (UNFCCC 2002). The CRF should have been used since the year 2000 for the reporting of greenhouse gas inventories.

- In 2001, the UNECE (United Nations Economic Commission for Europe) developed the NFR (Nomenclature For Reporting) format, with which a correlation to CRF categories was deliberately introduced. In the NFR, the coding structure of the CRF and the IPCC

Guideline from 1996 was adopted. The demands on the NFR are laid down in the provisional Guideline on the Estimation and Reporting of Emission Data of the UNECE Executive Body for the Convention on Long-range Transboundary Air Pollution (CLTRAP) of the 2nd July 2002 (UNECE 2002).

NFR and CRF contain different detailed reporting commitments, which are presented in Overview 12 for the relevant area – within the framework of this study – of energy-related CO2 emissions (Category 1A – Fuel combustion activities).

14 The latest version of the CRF: FCCC/WEB/SBSTA/2002/1 12 August 2002: Guidelines for the Preparation of National Communications By Parties included in Annex I to the Convention, Part I: UNFCCC Reporting Guidelines on Annual Inventories, Table of the Common Reporting Format.

Overview 12 Consolidated reporting requirements of CRF and NFR for energy-related CO_2 emissions

NFR/ CRF Category	Designation	Comments
1 Energy		
1 A Fuel combustion activities		
1 A 1 Energy Industries		
1 A 1 a	Public Electricity and Heat Production	
1 A 1 b	Petroleum Refining	
1 A 1 c	Manufacture of Solid Fuels and Other Energy Industries	
1 A 2 Manufacturing Industries and Construction (ISIC)		
1 A 2 a	Iron and Steel	
1 A 2 b	Non-ferrous Metals	
1 A 2 c	Chemicals	
1 A 2 d	Pulp, Paper and Print	
1 A 2 e	Food Processing, Beverages and Tobacco	
1 A 2 f	Other (please specify)	
1 A 3 Transport		
1 A 3 a i (i)	International aviation < 1000m	Memo item
1 A 3 a i (ii)	International aviation > 1000m	Memo item
1 A 3 a ii (i)	Domestic < 1000m	
1 A 3 a ii (ii)	Domestic > 1000m	
1 A 3 b	Road transportation	
1 A 3 b i	Cars	
1 A 3 b ii	Light Duty Trucks	
1 A 3 b iii	Heavy Duty Trucks and Buses	
1 A 3 b iv	Motorcycles	
1 A 3 b v	Evaporative Emissions from Vehicles	
1 A 3 b vi	Tyre and brake-lining abrasion	
1 A 3 b vii	Road surface wear	
1 A 3 c	Railways	
1 A 3 d	Navigation	
1 A 3 d i	International Marine (Bunkers)	Memo item
1 A 3 d ii	National Navigation	
1 A 3 e	Other Transportation	
1 A 3 e i	Pipeline Transport	
1 A 3 e ii	Off-road	
1 A 4 Other sectors		
1 A 4 a	Commercial / Institutional	
1 A 4 b	Residential	
1 A 4 b i	Residential	
1 A 4 b ii	Other traffic in households and gardens	
1 A 4 c	Agriculture/Forestry/Fishing	
1 A 4 c i	Stationary	
1 A 4 c ii	Off-road Vehicles and Other Machinery	
1 A 4 c iii	Fishing	
1 A 5 Other		
1 A 5 a	Stationary	
1 A 5 b	Mobile	

From the analysis of national energy balances as well as those drawn up by EUROSTAT and the emission inventories ascertainable therefrom, the following conclusions can be drawn:

- For energy supply and manufacturing industries (categories 1A1 and 1A2), emissions can be adequately determined on the basis of the respective energy balances.

- For the transport and other sectors (categories 1A3, 1A4 and 1A4), a great deal of detail is required that partly goes beyond that available in energy balances; that is, apart from the sector and fuel classification of energy balances, further (structural) data has to be utilized.

In the context of European reporting, the above-mentioned sectors can hardly be adequately specified. Here, recourse must be made to communications of the Member States. In one area, however, a qualitative improvement in EU reporting can be achieved through the more consistent supply of information to EUROSTAT.

Emissions from international aviation are reported as memo items. The corresponding framework of reference is different, however, for Member States and for the EU as a whole. Not all emissions assigned to international aviation by Member States are attributable, from the EU point of view, to international aviation. Cross-border air transport within the EU is international aviation in the eyes of the Member States, but not from the EU point of view.

An improvement in reporting could be achieved in this respect if Member States reported energy consumption for aviation to EUROSTAT and other European institutions in three categories:

- energy consumption for national aviation,
- energy consumption for international aviation within the EU, and
- energy consumption for international aviation beyond the EU.

On the basis of this data, EU reporting could be more consistently structured for relevant international conventions and agreements.

6 Recommendations

These recommendations are to be distinguished between those that relate to the energy-statistics database and those that focus on emission-related issues.

With regard to the avoidance of differences in the energy statistics database, the following recommendations are of prime importance:

1. The energy-statistics database used for the determination of CO_2 emissions should always be the energy balances published by the *Arbeitsgemeinschaft Energiebilanzen* (AGEB). This applies not only for the national emissions inventory to be drawn up by the Federal Environmental Agency, but also to international institutions such as EUROSTAT and IEA, in so far as they make their own calculations of emissions.

2. The AGEB is advised to document the methodical steps and procedures for drawing up energy balances and data sources utilized for particular sections of the balance, so that transparency can be provided for third parties. The federal government should create the material conditions necessary for the realization of this task.

3. At present, final energy balances for Germany are only available for the years from 1990 to 1999. The AGEB, and the institute employed by it (DIW), are therefore urgently recommended to considerably reduce the time lag within a reasonable period. The aim should be to present energy balances at the latest twelve months after the end of the year under review. This target should be achieved by the end of 2004 at the latest. For this purpose, appropriate personnel and financial resources should be provided.

4. With publication of complete energy balances and the accompanying evaluation tables, the respective processing status has also to be declared. Subsequent revisions are to be clearly marked and automatically made available to users; for which purpose the AGEB E-mail distribution list is obviously best suited.

5. The completion and submission of annual questionnaires should be better co-ordinated, also from a timing and a material perspective. It should be ensured that arrangements made by all participants for this purpose are consistently realized. Accordingly, data from individual questionnaires should be compiled by the Federal Ministry of Economics and Employment (BMWA), in close co-operation with the institutions providing data (Federal Statistical Office and the AGEB) in an initial, provisional energy balance and forwarded to EUROSTAT/IEA in accordance with the deadlines set by these institutions. An important element of this provisional energy balance is the AGEB's evaluation tables. Data, which is not available at this point in time, is completed with appropriate estimates. With implementation of the recommendation under Point 3, the questionnaires should as far as possible directly adopt the final data of energy balances. On the treatment of possible subsequent revisions, see Point 4.

6. In so much as EUROSTAT uses data for the presentation of energy balances that differs from that provided in the questionnaires or in final German energy balances, the BMWA should be informed of these differences and of their causes. For its part, the BMWA should inform the UBA and the AGEB of such differences.

7. Corrections made by the UBA to the energy balance concerning emission-relevant quantities of fuel (municipal waste, industrial waste etc.) should be indicated, following final methodical clarification, in a memo item in the provisional energy balance. It is necessary for the UBA to be involved in measures of co-ordination laid out in Point 5.

Emission-related recommendations encompass the following points:

8. When calculating CO_2 emissions, EUROSTAT should use the emission factors employed by the UBA. For this purpose, aggregated emission factors should be provided annually by the UBA for energy sources and sectors of both the provisional energy balance drawn up in accordance with Point 5 and the published energy balance. The appropriate procedure should, where possible, be integrated into the procedures mentioned in Point 5, in order that the consistency of energy data and aggregated emission factors can be maintained, also with regard to updating.

9. The analysis of EUROSTAT data suggests that in drawing up and updating energy balances on the one hand, and in determining CO_2 emissions on the other hand, consistent databases or databases of the same status have not always been used. Possible problems of co-ordination on the part of EUROSTAT should be resolved as soon as possible in co-operation with the UBA (and where necessary with the AGEB). Co-ordination on the issue of applicable emission factors offers a suitable opportunity for this.

10. Within the scope of revision and verification of German inventories of atmospheric contaminants, the UBA should develop, as soon as possible, a methodology for the differentiation of international bunker fuels for aviation within and across EU borders, in order to allow proper determination of appropriate memo items at the EU level.

Agreement should also be reached with EUROSTAT to the effect that changes in energy data and emission factors, which in retrospect – due to new findings – turn out to be irrefutable, are later implemented. On the German side, a harmonization procedure must be found for the communication of energy data and emission factors, so that a high degree of consistency can be maintained between both sets of data. For this purpose, precise procedures have to be laid

down between the AGEB and the UBA on the one hand and the BMU and BMWA on the other hand.

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