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Recalculation of Dutch stationary GreenHouse Gas emissions based on sectoral energy statistics 1990-2002

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Remarks:
The views expressed in this paper are those of the author and do not necessarily reflect the policies of Statistics Netherlands.

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Executive summary

This report documents the recalculation of Dutch stationary GHG emissions by Statistics Netherlands in 2004/2005. This recalculation has been executed for the period 1990-2002 and was instigated by a change of methodology. Until the recalculation the primary data source for this part of the emission inventory was a database containing individual emission and activity data mostly originating from Annual Environmental Reports. After the change of methodology the Dutch energy statistics have become the primary data source.

To facilitate this change in methodology the energy statistics have been revised by Statistics Netherlands for 1990 and 1995-2002. In addition Energy research Centre Netherlands (ECN) has provided new energy data for the years 1991-1994 consistent with the rest of the time series. To calculate the emissions an IT-application has been developed to ensure reproducibility and minimize the risk of errors.

The result of the recalculation was a substantial improvement of the transparency and consistency of the reported emissions in IPCC categories 1A and 2. Major advances in the allocation of emissions to the right IPCC category have been made and several double counts have been eliminated. The most striking changes are:

a) The allocation of the emissions of all joint ventures to the Public electricity and heat sector (IPCC category 1A1a). In the old methodology some of the joint ventures were allocated to the industrial sector (1A2) and others to the Public electricity and heat sector.

b) The allocation of the industrial process emissions to IPCC category 2. Until the NIR 2004 most of the industrial process emissions were included in IPCC sector 1A because they could not be separated from the combustion emissions. Due to a new interpretation of non energy use (NEU) this distinction has been made possible.

c) All emissions are attributed to specific fuel types. Until the NIR 2004 a part of the emissions was reported as stemming from "Other fuels". Because all fuels used by the Dutch energy statistics can be allocated to the aggregated fuel types "Gaseous", "Liquid" and "Solid", the reporting of the use of "Other fuels" is eliminated.

In the future the emissions for this part of the GHG inventory will already be available before the 1st of July on a detailed level. The quality of this data set will already be (very) high and not many changes are to be expected. Before the end of the year final data will be available thus improving the timeliness. Also, because since 2005 biomass data is fully integrated in Dutch energy statistics, the calculation of emissions stemming from biomass use can be executed with the same methods and IT-application as the fossil fuel related emissions.

1. Introduction

The expert review teams that reviewed the Dutch reports 2002 and 2003 to the UNFCC (National Inventory Reports) raised questions about the transparency and consistency for the greenhouse gas emissions by industrial sectors. In the first half of 2004 a comparative study has been conducted by Statistics Netherlands to determine if a proposed new calculation method for stationary GHG emissions was of high enough standards to fulfil international obligations. This new method was aimed at improvement of transparency and consistency as well as accuracy of the inventory [Vergelijkend onderzoek emissieberekeningsmethoden, Huurman J.W.F and Zonneveld, E.A. CBS, July 2004].

In June 2004 the "Projectgroep CO_2" decided the results of the comparative study were encouraging enough to switch over to this new method based on the energy balance and to start recalculations for the entire period 1990-2002 based on this new method.

In the second chapter of this report the new calculation method is explained. Both the theoretical side and how this is reflected in the compiling process. The bottom line is to use energy statistics as the primary data source and combine these with sector or company specific emission and storage factors. This is in contrast to the old method which used energy statistics as a secondary data source next to Annual Environmental Reports submitted by companies.

In Chapter 3 an overview is given of the changes that have been made in the energy statistics to ensure accurate and consistent figures, for activity data as well as for the resulting emissions. Also the special treatment for the years 1991-1994, for which the energy figures of Energy research Centre Netherlands (ECN) have been used, is clarified [Explanation of the ECN-update of statistical energy balances for 1991-1994, Boonekamp, P.G.M. and Volkers, C, ECN September 2005).

The fourth chapter is used to elaborate the calculation of GHG emissions based on energy statistics for the period 1990-2002. Attention is given to the use of emission and storage factors, the exact allocation of emissions and missing values. Finally a summary of the recalculated figures is presented. This is done only in an aggregated form; for more details the National Inventory Report (NIR) or the Common Reporting Format (CRF) tables in the Dutch 2005 submission can be consulted.

In the fifth chapter the differences between the old and the new figures are for a large part explained. It is however difficult to give an exact overview of the changes. Therefore the reasons for the differences are described, but not always an exact difference in Mton is given.

In Chapter 6 some recommendations for the working process in the future are given. Also the (very) high dependence on energy statistics is mentioned.

This report is finalised in 2006 while the recalculations as such were conducted in 2004 and early 2005 (and reported in the NIR 2005). Therefore several improvements during the preparation of the NIR 2006 have also been included in this report.

2. Stationary GHG emissions based on sectoral energy statistics: the new method both in theory and in practice

2.1 Theory

In the new method the national energy statistics are the primary data source for activity data. This method, as presented in this chapter, calculates GHG emissions due to the consumption of fossil fuels[1]. This consumption can be separated in energy use, i.e. combustion, and non energy use, i.e. use as a feedstock. For both emission data is compiled. This new method can be characterised as a bottom up approach as energy statistics in the Netherlands are based on company surveys.

Emissions which originate from non fossil sources, like those emitted during the use of lime, or from the use of solvents are calculated separately[2]. Later on in the compiling process these emissions are combined with those stemming from fossil fuel use to complete the inventory.

Up to the NIR 2004 Dutch emission calculations have also been performed using a bottom up approach: The compiling process started with the emissions of individual companies (collected for the Emission Registration and stored in the ER-I[3] database). To asses the emissions of companies not included in the ER-I database information from the Dutch sectoral energy statistics (Nederlandse Energiehuishouding; NEH) was used for an extrapolation. This extrapolation combined with the individual emission data resulted in total emissions. The extrapolation was rather difficult and error-prone because data in the ER-I were not easy to match with the energy statistics. The difficulties most worth mentioning were differences in company boundaries/structures and the different fuel types that were being used.

In this method it would always be necessary to use the energy statistics to calculate emissions of companies not obliged to submit an annual environmental report (MJV in Dutch), the main data source for the ER-I database. This meant there was no way of avoiding the difficulties mentioned. More detailed information is included in a research report comparing the two methods for emissions calculations. [Vergelijkend onderzoek emissieberekeningsmethoden, Huurman J.W.F and Zonneveld, E.A. CBS, July 2004; in Dutch]. Mid 2004 it was decided to use energy statistics as the primary data source for activity data and use the ER-I (for activity data as well as for emissions) as an additional

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[1] All methods for the emission calculations are described in protocols; this specific method for calculating fossil fuel related emissions is described in more detail in several protocols, e.g. the protocol on stationary combustion (fossil), process emissions (fossil) etc.

[2] Solvents are mostly of fossil origin, but they are not part of the energy balance; the feedstock used to produce these solvents is regarded as non energy use. Therefore an alternative method has been developed which is described in the protocol non-fossil process emissions

[3] EmissieRegistratie-Individueel

information source. In this new method there is only one “backbone[4]”and one primary set of parameters like fuel types.

2.1.1 *Energy Statistics*

Statistics Netherlands compiles the annual Energy statistics in the Netherlands. In this compiling process information on the supply side[5] is combined with information on the energy use, the consumption side. The supply side is monitored completely by surveys, while for energy a sample survey is used for the industry and estimates for other sectors. The sample survey is extrapolated to a total energy use in the industrial sectors using different parameters like the number of people working in the companies. This extrapolation is added (by industry sector) to the individual dataset and can be regarded as a ‘dummy company’ representing the companies not included in the sample survey. The energy use in the non- industrial sectors is based on several sources: e.g. data on agricultural fuel use is obtained from the Dutch Agricultural Institute (LEI), and for energy use in households from the HOME research that the organisation of energy distributors (EnergieNed) conducts. The data quality is presumed to be highest for companies on the supply side, followed by the industry and then the other sectors.

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[4] The “backbone” used in the new method is the Company Register (ABR) of Statistics Netherlands which includes all companies active in the Netherlands. All companies are also assigned to (industrial) sectors by Statistics Netherlands.

[5] Typical examples of companies on the supply side are refineries and power plants, but large industrial companies with their own power generating facilities are also included

In the surveys as well as the publications Dutch energy statistics make use of the balance lines that are presented in table 1.

Dutch	*English*
Winning	Indigenous production
Aanvoer	Supply
Aflevering	Delivery
Beginvoorraad	Starting stocks
Eindvoorraad	Closing stocks
Inzet WKK	Input for CHP[6]
Inzet blending	Input for blending
Inzet voor overige omzettingen	Input for other transformations
Productie WKK	Output CHP
Productie blending	Output from blending
Productie uit overige omzettingen	Output from other transformations
Finaal energetisch verbruik	Final Energy Use
Finaal niet-energetisch verbruik	Final Non Energy Use

Table 1 Balance lines

To reduce the administrative burden on companies and avoid an unnecessarily complex survey, Statistics Netherlands uses different types of surveys. Companies on the consumption side for instance, do not have transformations (because then they would be part of the supply side) and therefore receive a survey without the questions on in- and output for CHP, Blending and Other transformations. The surveys are sent to almost 3000 companies, mostly on a quarterly base. After processing the data and combining them with in- and export statistics an energy balance for the Netherlands is made. Next to this overall balance, balances by industrial sub sector and by fuel type are published. The total set of these balances is known as the "Nederlandse Energiehuishouding" (which is Dutch for the "Dutch Energy Balance"; often the abbreviation NEH is used).

2.1.2 Calculations of emissions

After determining the right amounts of fuel use the emissions can be calculated. As in the old method [Description of the calculation of greenhouse gas emissions in the Netherlands, Spakman et al., 1997] the new method makes a distinction between energy use for fuel combustion and energy use for (chemical) processes. But the two methods hold a different way of allocation. Until the NIR 2004 (based on the old method) the energy use for fuel combustion was determined by aggregating the final energy use, input for CHP and input for other transformations of gaseous fuels (natural gas as well as

[6] This includes not only Combined Heat and Power, but also Electricity Only plants

residual gases like refinery gas or blast furnace gas). Energy use for (chemical) processes was equal to the final non energy use.

The new method is presented in the sections below.

Combustion emissions are in the new method calculated from:

- the final energy consumption
- the input for CHP and the input for steam boilers

As mentioned in paragraph 2.1, the input for CHP also includes the input for Electricity Only plants. The input for steam boilers is part of the column used for input for other transformations (the rest of the amount in this column is related to process emissions as it is part of the feedstock used. This is explained briefly in note 6 on the next page). In international energy statistics this input is known as 'input for Heat plants'.

$$EM(Mton) = (FEC(PJ) + CHP \,\&\, SB(PJ)) * EF(Mton / PJ)$$

EM = Emissions
FEC = Final Energy Consumption
CHP & SB = Input for Combined Heat and Power and Steam Boilers
EF = Emission Factor

Equation 1: Combustion Emissions

The calculation as presented in equation 1 can be executed for all fuels.

Process emissions are calculated based on final non energy use. However, due to the definition of final non energy use in Dutch energy statistics[7], not all of the non energy use as published in the NEH should be taken into account for the emissions calculation. To determine the correct amount of non-energy use we make a distinction in two types of processes:

"Closed" processes

Gases originating from the process are captured (for instance chemical waste gas)[8]. In this case potential process emissions are enclosed in the residual gas and will be emitted when this residual gas is combusted. Because the emission factor of the residual gas takes this into account these potential process emissions are included in the combustion emissions. This implicates that there are no (direct) process emissions for the closed processes.

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[7] When in a process energy is transformed into another form of energy combined with non energetic products, Dutch energy statistics use the produced amount of energy to calculate the input of energy for transformation. The rest is considered to be non energy use. This means for these processes, because of potential differences in carbon content between the forms of energy, there is no relation between the amount of carbon in the products and the non energetic use expressed in carbon.

[8] Because of the 100 % coverage of energy producing companies as mentioned in paragraph 2.1.1, the group producing these gases can be defined

$$EM(Mton) = 0$$

EM = Emissions

Equation 2: Process emissions from closed processes

"Open" processes

In open processes no residual gases are captured (it is also possible there is no monitoring of the production and consumption of these gases; this does however not affect the calculation method). In this situation direct process emissions can occur. The actual presence of emissions will differ by process type which is reflected in the corresponding carbon storage factor.

$$EM(Mton) = NEU(PJ) * EF(Mton/PJ) * (1 - CSF)$$

EM = Emissions
NEU = Non Energetic Use
EF = Emission Factor
CSF = Carbon Storage Factor

Equation 3: Process emissions from open processes

As in equation 1 the calculation is done for all fuels, each with its specific EF and CSF.

For refineries, coke factories and blast furnaces this calculation is only partly equivalent. It is known they have (virtually) no carbon storage in non energetic products, but not all emissions can be calculated. Assumed for refineries is that not all of the fuel used for combustion is reported. For the blast furnaces and coke factories is assumed they have process emissions which can not be calculated directly from the fuel use. To calculate their total emissions a carbon balance is used. The carbon loss calculated with this carbon balance has been added to the combustion emissions from the petroleum refining sector for the refineries while the carbon loss of the blast furnaces and coke factories is reported in 2C and 1B respectively. This allocation corresponds with the assumption they are not combustion emissions.

Further analysis (after the figures were delivered to TNO early 2005) has revealed that the energy statistics were indeed not totally accurate for the refineries. In the beginning of 2006 the energy and emission figures will be recalculated. Next to the inaccuracy in reporting and processing the energy data, another reason for the observed "carbon gap" has been discovered: an installation in one of the refineries produces pure CO_2 from heavy oil fractions. In the algorithm there was no method to differentiate between input for this specific installation which was being converted to CO_2 and input for the other installations where the fractions are being used in the refinery process. Therefore it was decided to change the new method: not to calculate these specific emissions using energy statistics and a carbon balance, but to add these emissions after the computer model has been used. Either the environmental report or the emission year report will be used as a data source.

2.2 In practice

The calculations described in paragraph 2.1.2 are being executed[9] for all companies in the survey, including the dummy companies to calculate emissions. This results in total combustion emissions for all sub sectors by fuel type and process emissions by type of process.

As mentioned ahead, the companies producing any type of fuel are part of the survey (and the dummy company representing the companies not included in the survey) cannot have closed processes (there is no production of residual gases). This is important because with a mix of open and closed processes in the dummy companies, the calculation method would result in no process emissions at all!

After having calculated the emissions for each company, the next step would be to aggregate the calculated emissions by sector and by fuel as required in the Common Reporting Format (CRF). A more detailed description of the allocation of emissions to the different CRF categories is given in Chapter 4 of this report.

2.2.1 Calculating the amount of energy use for combustion

As mentioned in the theory (section 2.1.2) the amount of energy use for combustion is calculated from the input for CHP, final energy use and the input for steam Boilers. The first two can be distinguished directly in Dutch energy statistics as is obvious from the balance items shown in table 1; the input for Steam boilers however can not directly be determined. This type of energy use is part of the input for other transformations: it is a transformation from one type of fuel to another (not being electricity because the in would be reported as input for CHP). To differentiate between the input for steam boilers and the input for other transformations (input used as a feedstock and not resulting in CO_2 emissions), the assumption is made that all input of gaseous fuels (liquid derived, coal derived and natural gas) for other transformations is an input for steam boilers. All the input for other transformations, e.g. the input of crude oil in refineries, is not. This rule is only valid however when there is not simultaneously a final non energy use of this specific gaseous fuel by this specific company. When there is also final non energy use it is assumed that it is a closed process with an input of a gaseous fuel, like for instance natural gas for the production of methanol.

There is one company both having steam boilers and a closed process, so to be able to calculate its emissions correctly this company has been split in two parts, the steam boiler and the rest of the company, to avoid omitting the combustion emissions of the steam boiler.

2.2.2 Calculating the amount of energy use for (chemical) processes

The database containing all activity (energy) data has a specific variable defined for the distinction between open and closed processes. For companies producing one of the residual gases (blast furnace gas, coke oven gas, refinery gas and chemical waste gas), implicating a closed process, the variable is set to 1. After this first step the companies having final non energy use and for which the variable is not set to 1, are supposed to have an open process. Therefore the variable is for these companies set to 0. For these companies the energy use for (chemical) processes is their final non energy use as reported and published in the national statistics, while for the other companies the energy use for

[9] An algorithm is used, working on a database containing the official energy statistics. This results in one set of energy data for both energy statistics and the emission inventory.

(chemical) processes (also known as “feedstock”) is the net input for other transformations (excluding the input for steam boilers which is regarded as activity data for combustion emissions) plus the net input for blending (virtually null) plus the final non energy use. Since there are not supposed to be any emissions from these processes, the algorithm doesn’t use these inputs except for the before mentioned exceptions (refineries, coke factories and blast furnaces) where a carbon balance is being used to calculate part of the emissions. The fact that process emissions are supposed to be zero implicates that the total (net) input is being seen as carbon storage. This fact is also used in the new Dutch reference approach.

2.2.3 Calculating emissions

The emission factor as well as the carbon storage factor can vary for each company or sector because not all fuels have exactly the same specifications although they are reported under the same type. This is especially the case for “exotic” fuels like residual gases. The database in which the calculations are being executed, offers the possibility to use different factors. While executing the calculations the program first searches for a company specific factor, than for a sector specific factor and when these are not present it uses the default value. The specific factors are based on secondary sources like the environmental year reports released by the companies, scientific studies et cetera. After the emission and storage factors have been set, they are used to calculate the emissions for each individual company.

2.2.4 Aggregating by sector and fuel

Every company registered in the Company Register is characterized by Statistics Netherlands following the NACE classification. For this classification the main economic activity of the company is being used as the primary indicator. The emissions and activity data are aggregated to a (part of a) NACE category. The fuels are the ones used in Dutch energy statistics (see Appendix 8.3) and it is possible to aggregate them to liquid, solid and gaseous fuels. Process emissions are also aggregated by sector and the specific sector determines the type of process.

3. Revision of the energy statistics for 1990-2002

The intended change to the new methodology required an additional[10] check whether the energy statistics were consistent in time, transparent and most of all qualitatively of high enough standards. Additional to these basic requirements the energy statistics had to fulfil some other conditions especially for emission calculations:

- Residual waste gases (especially those from chemical plants) should be monitored totally or not at all. This condition is valid on a company level. When the existence of waste gases is reported in the energy statistics this implies there are no (fossil fuel related) process emissions. When however a company only reports part of its gases, e.g. the part that is sold, and omits the part it uses itself, an underestimation of emissions will occur.
- It must be possible to make a distinction between steam boiler input and input as a feedstock. This distinction can be made by an algorithm. There is a specific reason for this condition: Input for a steam boiler is considered to be "input for other transformations" when the heat is being sold and it is considered "final energy use" when the heat is not being sold. Input as a feedstock is partly considered "input for other transformations and partly "non energy use". In the first situation the fuel use reported as "input for other transformation" is fuel use for combustion and leads to emissions. In the second situation however it is process fuel which does not result in emissions (if there are waste gases reported). An additional problem is the possibility of companies having both an input for a steam boiler and an input as a feedstock of the same fuel, so the situation occurs that it is not possible for the algorithm to properly address this fuel use. This situation occurred for one company as has been described in paragraph 2.2.

The check that has been performed for the years 1990 and 1995-2002 has lead to a number of corrections. In the next paragraphs the changes that were made in the energy statistics are described in detail. Furthermore Energy Centre Netherlands has combined the original set of energy statistics for 1991-1994 with the methodological changes over the years as they have registered them. Together with new data and insights which had become available after the corrections for the years 1990 and 1995-2002 by Statistics Netherlands, ECN prepared a set of energy balances for these years which are used as input for the emissions database. To make use of the ECN dataset some additional work was needed which is described in paragraphs 3.2.1 and 3.2.2.

3.1 Revision by Statistics Netherlands: 1990 and 1995-2002

In the following paragraphs most[11] of the changes in the energy statistics are described. Not all of them are of direct influence to the emission inventory, but because the statistics were being revised Statistics Netherlands decided to improve the figures as much as possible in the period of time that

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[10] In addition to the regular checks which are part of the process of compiling the statistics in the first place. Especially the consistency had to be improved because methodological changes in Dutch energy statistics were (almost) never applied to historical data.

[11] Some minor changes have been omitted in this report

was available. This meant that also some corrections have been made that were more of aesthetic value than important for the emission calculations.

3.1.1 Base metal industry

Until 1999 the use of coke and hard coal in blast furnaces was regarded as final energetic use in Dutch energy statistics. Then however, in consultation with the industry, this changed to non energetic use because it was regarded to be an oxidant in the blast furnace process. This new point of view had not been revised for the previous years, so for the years prior to 1999 the use of coke and coal used in the blast furnaces has been moved from energetic to non energetic. This change has no direct effect on total CO_2-emissions, only on the allocation of these emissions. In the old situation combustion emissions were very high while the calculated process emissions (calculated with a carbon balance) were negative. Now combustion emissions are lower and process emissions are positive (as they should be).

3.1.2 Net calorific value (NCV) of hard coal

The net calorific value of hard coal can fluctuate substantially, depending on the country of origin and the exact type of coal. Therefore a company and period specific NCV is submitted by every large company using hard coal. In the statistical process of preparing the energy balance this value is taken into account. In the information systems used however, there is no sufficient check whether this value is actually submitted and used. When it is not fed into the system, the default value for hard coal is being used to calculate the energy content. Because this default value is 29,3 MJ/kg which is substantially higher than the average NCV's for hard coal as reported by the companies (ca 24 MJ/kg in the energy sector-for public electricity and heat production- and 28,7 MJ/kg in the base metal industry and for coke factories), the calculated energy content can be up to 20% too high.

All records regarding hard coal have been checked and NCV's have been entered when not present. For the base metal industry (mostly blast furnaces) and the coke factories a default NCV has been used, advised by the industry. For companies in the energy sector the value for either the previous or the next period has been used as a reference. This correction has had effect on all years ranging from almost 0 PJ in 2002 to -5 PJ in 1995. Assuming an emission factor of about 100 kg CO2/GJ for hard coal this implicates an effect on CO_2-emissions ranging from 0 to -0,5 Mton on an annual basis.

3.1.3 Natural gas use in agriculture

The fuel use in the agricultural sector (which is for a large part natural gas use) is calculated by the LEI, the Dutch agricultural economic institute. They submit the data to Statistics Netherlands where the figures are incorporated into the energy balance. LEI policy however is to revise the fuel use data on a regular base. These revised figures had not been altered in the energy statistics yet, so the data on natural gas consumption in the agricultural sector had to be updated. Because Statistics Netherlands removes the statistical difference by attributing all natural gas not already allocated to one of the other sectors to the Commercial/Public services sector, the revision of agricultural fuel use data meant a switch from natural gas use in the agricultural sector to natural gas use in the Commercial/Public services sector.

3.1.4 Gas oil use in agriculture

In the agricultural sector gas oil is used for a large part by off-road vehicles. The data on these agricultural off-road vehicles can be separated into two categories:

- Gas oil use by agricultural vehicles owned by farmers. This data is collected by the LEI
- Gas oil use by agricultural vehicles not owned by farmers but by auxiliary companies (in Dutch "loonwerkbedrijven"). Data on the use of these vehicles have been collected by Statistics Netherlands until 1997. From 1998 on an extrapolation is being used.

Because the second category has not always been included in the energy statistics as fuel use by the agricultural sector, a correction was made for several years. This fuel use has been compensated by a decrease of the gas oil use in the Commercial/Public services sector to which the auxiliary companies were allocated previously.

3.1.5 Wrong data editing

During the production process of the energy balance thousands of questionnaires are processed by hand. Because of the large numbers involved, this is a possible source of errors. Although checks are performed on a regular base, some of these errors have slipped through. By analysing the time series some, but possibly not all, of them have been located and corrected. The possibility that any major errors still are included is very small however.

3.1.6 Removing companies out of the sample survey

To determine the fuel use in every sector, a sample survey is used (see also section 2.1.1). Not every company however can be used for the extrapolation of the survey because a company can have very specific fuel use characteristics which are not representative for other companies in the same sector.[12] Therefore some companies have to be excluded from the extrapolation. In the reanalysis a few other companies turned out to be too specific and have been removed. The effects are limited.

3.1.7 Reallocation of companies

Some companies were allocated to the wrong industry sector, e.g. in the organic chemical industry instead of the inorganic chemical industry. This has been altered. The effects however are only noticeable on subcategories because the CRF sectors are of a higher aggregation level than the sectors used in Dutch energy statistics.

3.1.8 Complete monitoring residual waste gas production and use

As mentioned earlier in the first part of this chapter, one of the most important criteria for the energy statistics to be applicable for emission inventory compiling, is the condition that residual waste gases are monitored completely or not at all. During the analysis of the energy data it turned out that two companies only reported part of these gases. To adjust for this incomplete reporting extra information has been used which was reported in their MJV. By dividing the part of total emissions attributable to the residual gas by the carbon content of the gas, the total amount of combusted (and produced) gas

[12] e.g. when a company has a unique production process

was calculated. By expressing this quantity of produced gas as a percentage of the total amount of feedstock use, it was possible to calculate the gas production for the years no MJV was available. In the energy balances this resulted in a shift from non energy use of the feedstock to input for other transformation. The output from other transformations of residual waste gases also increased as did the final energy use of these gases. This increased energy use resulted in an increase of combustion emissions stemming from residual waste gases of 0,5 Mton CO_2.

3.1.9 Non energetic use of fuels

In the years prior to 1999 the use of LPG, additives for lubricants and "other products not H27[13]" by the chemical industry was partly regarded to be energetic use. From 1999 on however this changed and almost all use was reported in the energy statistics as non energetic use. This new insight had not been revised for the years prior to 1999 so this has been done in this revision. Because the non energetic use of LPG, additives for lubricants and "other products not H27" in these specific parts of the chemical industry is supposed not to contribute to CO_2 emissions this means a net decrease of emissions.

Another change has been the non energy use of natural gas which had partly gone unnoticed for some years. This natural gas was used to produce industrial gases but there was some misunderstanding about the responsibility of reporting the fuel use data. This misunderstanding was caused by the fact these emissions were emitted on the site of another company. Correction for this omission has naturally resulted in a decrease of natural gas use in the Commercial/Public services sector.

3.1.10 Refining activities in the base chemical industry

Until 1999 the refining activities taking place in the base chemical industry have been published as a part of the refining sector. These refining activities mostly consisted of the transformation of Natural Gas Liquids to Other Light Oils. They have been shifted back to the base chemical sector to improve the consistency of the energy time series and did not have any effect on calculated emissions.

[13] These are products which are not part of Chapter 27 of the code book of International Trade Statistics

3.2 1991-1994

Data for the years 1991-1994 have been provided by the Energy Research Centre Netherlands. The study[14] that has been conducted was done on an aggregated level both for fuel types and sectors. Therefore some additional analysis was necessary to adjust the data. After these adjustments, which are described in more detail in paragraph 3.2.1, the data were processed by the same algorithm as the data for the other years. Next to the adjustment of the data also some additional input was necessary to compile the emission inventory.

3.2.1 Data format compatibility

First of all the data format as provided by ECN had to be converted to the CBS format. In tables 2 to 4 the different parameters are shown and matched with their NEH counterparts.

ECN	*NEH*
Final Energy Use	Final energy use + Input for CHP + Part of the input for Other transformations (i.e. input for Steam Boilers)
Final Non Energy Use	Final non energy use
Net input for Other Transformations	Part of the input for other transformations (except the input for Steam Boilers) – output for other transformations

Table 2 Fuel uses in both the ECN dataset and the NEH

The different types of fuel use are not directly sufficient. But because the only purpose is to calculate GHG emissions from the dataset[15] it is necessary to make a distinction between the energy use for combustion and the energy use for processes. To determine the fuel use for combustion is simple: this is equivalent to the Final Energy Use as presented in the ECN dataset. Energy for processes is calculated by adding the net input for other transformations to the non energy use of fuel. To distinguish between "open" and "closed" processes however additional information is necessary (see section 3.2.2).

[14] Explanation of the ECN-update of statistical energy balances for 1991-1994, Volkers C., Boonekamp, P.G.M. , 2005

[15] It is not necessary to publish on the same aggregation level as the NEH

ECN	*NEH*	*CRF*
Base metal iron and steel	Base metal iron and steel	1A2a
Base metal non ferro	Base metal non ferro	1A2b
Construction	Part of Other users, but available on a lower (non publishing) level	1A2f
Building materials industry	Building materials industry	1A2f
Central power generation	Central power generation	1A1a
Decentral power generation, joint ventures	Decentral power generation, joint ventures	1A1a
Chemical industry	Fertilizer industry + base chemical industry (organic, inorganic and other) + chemical products industry	1A2c
Coke factories	Coke factories	1A1c
Service Sector	Part of Other users in, but available on a lower (non publishing) level	1A4a
Distribution companies (part of Public electricity and Heat)	Distribution companies (part of Public electricity and Heat)	1A1c
Residential Sector	Residential Sector	1A4b
Agriculture	Part of Other users, but available on a lower (non publishing) level	1A4c
Other industry	Textile and leather industry + plastics, rubber & other industry + non-specifiable industry	1A2f
Other metal industry	Metal products industry	1A2f
Paper and pulp industry	Paper and pulp industry	1A2d
Refineries	Refineries	1A1b
Transport	Transport	1A3
Food and Drink	Food and Drink	1A2e
Waste incineration	Waste incineration	1A1a
Extraction companies	Extraction companies	1A1c

Table 3 Sectors in the ECN dataset and the NEH

The sectoral breakdown in the ECN dataset differs on some points with the breakdown used for the NEH, but as can be seen in table 3 the breakdown is sufficient to be used for the CRF.

ECN	*NEH*
Natural Gas	Natural Gas
Hard coal and coal derivatives (except derived gases)	Hard coal + Brown Coal + Coal derivatives
Blast Furnace Gas/ Oxygen Steel Gas	Blast Furnace Gas
Coke Oven Gas	Coke Oven Gas
Oil and Oil Products (except derived gases)	
Refinery Gas	Refinery Gas
Chemical Residual Gas	Chemical Residual Gas

Table 4 Fuel types in the ECN dataset and the NEH

The ECN-Fuel types are not exactly identical to the NEH-Fuel types, but they are disaggregated enough to be used directly in the compiling process.

3.2.2 Additional input

For a correct calculation of process emissions, it is necessary to distinguish between open and closed processes. This is possible for 1990 and 1995-2002 following the theory as explained in chapter 2, but for the period 1991-1994 some extra efforts have to be made. This is because of the aggregated types of fuel use in the ECN data and the fact that no individual data was available for these years. First the three types of fuel use are converted to the types known in the regular energy statistics. This means final energy use is "finaal energetisch verbruik", final non energy use is "finaal niet energetisch verbruik" and net input for other transformations is "inzet voor overige omzettingen" when positive and "productie overige omzettingen" when negative. Because there is no individual data available it is not possible to separate the open processes from the closed processes. However, because of the experience with the other years it is possible to identify the amount of non energy use for open processes. These open processes are the following:

- Natural gas use for ammonia production
- Lubricant use
- Petroleum coke use for anode production
- Natural gas use for industrial gas production
- Coke use for in the chemical industry for various purposes

The energy amounts for these open processes are subtracted from the totals and in the database converted to process emissions.

4. Compiling the emission inventory, allocation and results

In Chapter 3 a description is given of the process of preparing Dutch energy statistics for calculating GHG-emissions. This has been done for the entire period 1990-2002. In this chapter an overview is given for the compiling process of the emission inventory based on these (revised) energy balances. Not only data sources for emission factors and storage factors are given, but also on what ground the emissions have been allocated and what exceptions on the general allocation of emissions have been made.

4.1 Used factors

In the compiling process there are two types of factors being used in addition to the activity data. The determination of the correct activity data was explained in Chapter 3. The origin and use of the factors are described in the next two subparagraphs.

4.1.1 Emission factors

Emission factors are used both for the calculation of combustion emissions and process emissions and are a measure of the carbon content of the fuel. They can vary in different ways: by fuel, by plant or annually. Emission factors are available on three different levels in the database:

Company specific

Sources are the Annual Environmental Reports (MJV) of companies, the emission reports submitted to the Dutch Emission Trading Authority (NEA) or direct submissions to Statistics Netherlands by companies. They are most common for residual gases because these can be very plant/company specific, based on the exact type of (chemical) process.

CRF	*Subcategory*	*Fuel type*	*EF CO_2 (kg/GJ)*	*Data source*
1A1a	Public electricity and heat	- Blast Furnace gas/Oxygen Furnace gas average	241.85	AER
		- Residual chemical gas (liquid)	50-55	See chemical industry
		- Residual chemical gas (solids)	149.5	See chemical industry
1A1c	Refinery	- Refinery gas	46.0	Oil statistics
1A2a	Iron and steel	- Blast furnace gas/Oxygen furnace gas average	241.85	AER
1A2c	Chemical industry	- Residual chemical gas (liquid)	50-55	AER, NEA, direct
		- Residual chemical gas (solids)	149.5	NEA
		- Other oil products		
1A2f	Other industries	- Residual chemical gas (liquid)	50-55	AER

Table 5: Some examples of emission factors, both company and sector specific

Sector specific
This type of emission factor is mostly used for the years 1990-1994 when no company specific data were available. For the years 1991-1994 emission factors were partly based on ECN estimates. Also for hard coal and blast furnace gas sector specific data are available for the base metal industry and for the "Public electricity and heat" sector. When it is possible to use sector specific factors instead of plant specific, this is seen as an improvement: this will take care of some possible confidentiality issues, simplifies the calculation and is therefore more transparent.

National default
The national fuel list prepared by SenterNovem is used when no specific data are available. Until this recalculation another fuel list was being used, published in the report of Spakman et al., but this list was outdated and could not be matched to the fuel types used by Statistics Netherlands. Therefore SenterNovem coordinated the preparation of a new fuel list, which is added in Annex 7.1.

4.1.2 Carbon storage factors

Carbon storage factors are required to calculate emissions from open processes and are an indicator for the carbon-storage in the non-energetic products produced in these processes. In the old method they were used to calculate all types of process emissions including emissions during the use of non-energetic products. In the new method these emissions are calculated separately. This implies the old storage factors are not comparable to the new ones.

The storage factors are, equivalent to the emission factors, available on three levels:

Company specific
The factors can be based on data submitted in an AER, from technical literature or theoretically. An example of a literature based factor is the one that is used for ammonia production. The storage factor is determined by dividing the carbon stored in the produced urea by the carbon content of the natural gas used as feedstock. This data was collected from a study by Neelis et al[16].

CRF	*Subcategory*	*Fuel type*	*SF CO_2*
1A2a	Iron and steel	Hard coal	0
1A2c	Chemical industry	- Natural gas (fertilizer industry)	0,17
		- Natural Gas (industrial gas production)	0,2
		- Other oil products	
1A2e	Food processing, beverages and tobacco	- Coke oven coke (sugar whitening)	0
1A2d	Other industries	Petroleum coke (anode production)	0,95

Table 6 Some examples of storage factors: company and sector specific

[16] Improvement of CO_2 emission estimates from the non-energy use of fossil fuels in the Netherlands, Neelis et al. (2003)

Sector specific
Sector specific factors are used if possible. For instance the sugar industry uses cokes to whiten the sugar. They all use the same process in which all carbon from the coke is oxidised. Therefore a sector specific factor of 0 can be used. The same advantages apply as with the sector specific emission factors: confidentiality, simplicity and transparency.

National default
Usually 100 % storage is assumed, except for lubricant (50%). This choice was made because process emissions only occur during specific (known) processes.

4.2 Applying the theory to the CRF format

Following the calculation of the emissions, both from combustion and from industrial processes, the second part of the compiling process is the allocation of those emissions in the CRF categories. In the following paragraphs an overview of this allocation of the emissions is presented.

4.2.1 Combustion emissions

As mentioned in Chapter 3, Dutch energy statistics are available by NACE-code. In Table 3 the allocation of the used NEH sectors to their IPCC-categories is presented. Clearly all energy use and related emissions can be classified to the correct sub-sector. In figure 1 the main IPCC-categories for combustion emissions are displayed.

A. Fuel Combustion Activities (Sectoral Approach)
1. Energy Industries
2. Manufacturing Industries and Construction
3. Transport
4. Other Sectors
5. Other *(please specify)*(1)

Figure 1 Main categories for combustion

Special attention should be given to the joint ventures of energy companies and industrial companies (see also paragraph 5.1). Their fuel use and emissions are allocated to the public electricity and heat sector and not to their corresponding industry sector. It is however possible to create an overview of joint ventures by industry sector.

Emissions should be submitted by fuel type as shown in figure 2. Therefore the fuel types as being used in the calculating part of the compiling process are aggregated to solid, liquid and gaseous. There are no biomass data because in the methodology presented in this report, only emissions from fossil fuels are being treated. The biomass data however follows an equivalent trajectory. Furthermore there are no "Other fuels" because all the fuels used in the energy statistics can be allocated to the aggregates. The only exception to this rule is the fossil part of the waste incinerated in Waste Incineration Plants (AVI's in Dutch).

1.A.1. Energy Industries
Liquid Fuels
Solid Fuels
Gaseous Fuels
Biomass
Other Fuels

Figure 2 Fuel specification

4.2.2 Fugitive emissions

Fugitive emissions during oil and gas production are not calculated with this methodology because reliable data are not available in the energy statistics. In the future they might become available; at the moment a cooperation between Statistics Netherlands and TNO-NITG, the organisation responsible for the monitoring of the production companies, is being set up to improve the data on this subject. For the recalculation for the NIR 2005 an estimate by the Netherlands Environmental Assessment Agency (MNP) is being used[17].

1. B. 1. a. Coal Mining and Handling
i. Underground Mines[(2)]
Mining Activities
Post-Mining Activities
ii. Surface Mines[(2)]
Mining Activities
Post-Mining Activities
1. B. 1. b. Solid Fuel Transformation
1. B. 1. c. Other *(please specify)* [(3)]

Figure 3 Fugitive emissions

Fugitive emissions stemming from coke production are calculated from the difference between the carbon input of hard coal and the carbon output of coke oven coke, coke oven gas and coal tars (see also chapter 2.1.2). Questions can be raised about the allocation of these emissions because they might not be fugitive emissions, but industrial process emissions which should be located in Chapter 2 of the CRF. It is also possible that not the complete production and use of coke oven gas is being monitored. This would imply part of the emissions reported as fugitive emissions are actually emissions stemming from combustion. Please note, however that the total of the calculated emissions is correct.

[17] This estimate was provided by J.G.J. Olivier

4.2.3 Industrial process emissions

In the following subparagraphs all the subcategories of the Chapter 2 CRF-tables are presented.

4.2.3.1 Mineral Products

A. Mineral Products
1. Cement Production
2. Lime Production
3. Limestone and Dolomite Use
4. Soda Ash
Soda Ash Production
Soda Ash Use
5. Asphalt Roofing
6. Road Paving with Asphalt
7. Other *(please specify)*
Glass Production

Figure 4 Process emissions during the manufacture of mineral products

Most industrial process emissions from mineral products are not fossil fuel related except those arising during the production of soda ash. Emissions are calculated by multiplying the non energy use (NEU) of coke oven coke by the emission factor and the storage factor. Storage is assumed to be 0 % because of the chemical equation of the process. This is a typical example of a theoretically derived storage factor.

4.2.3.2 Chemical Industry

B. Chemical Industry
1. Ammonia Production (3)
2. Nitric Acid Production
3. Adipic Acid Production
4. Carbide Production
Silicon Carbide
Calcium Carbide
5. Other *(please specify)*
Carbon Black
Ethylene
Dichloroethylene
Styrene
Methanol
Production caprolactam
Production other chemicals
Carbon electrodes
Production activated carbon

Figure 5 Process emissions during the manufacture of chemical products

Most of the process emissions in the chemical industry are calculated from fossil fuel use. In the following sections the specific processes are dealt with.

Emissions arising during the production of ammonia are calculated from the non energy use of natural gas in the fertilizer industry. The storage factor that is being used has been derived from the carbon content of the urea production. For the urea production CO_2 from the fertilizer production process is used (this is also mentioned in paragraph 4.1.2). It is also known that CO_2 is being sold by these companies, but it is not subtracted from the emissions from ammonia production, because no reliable and complete data are available regarding the amounts sold and the parties sold to (export or within the country). In this case consistency prevails over correct allocation (at least for the years for which data is available). If this data becomes available for the entire time series, it will be possible to take it into account.

Emissions from Silicium Carbide production are calculated from the combustion of the residual gases produced during the process. Because this is a combustion process the emissions will not be reported under Industrial Process emissions but under 1A (Combustion). More specific: they are reported under 1A2c, the chemical industry[18].

Emissions stemming from Carbon Black production are calculated from the combustion of so-called "tail gas" which is produced during the production process of Carbon Black. These emissions are reported under 1A2c.

Emissions from Ethylene production are calculated from the combustion of the residual gases produced in the steam cracking process. These emissions are reported under 1A. Part of the emissions is allocated to the chemical industry (1A2c), but not everything: almost 30% is allocated to the "Public electricity and heat" sector (1A1a) because the residual gases are combusted in a joint venture. This shows already the difficulties that might arise with the new Guidelines.

Process emissions during the production of Styrene are also calculated from the combustion of the residual gases and are reported under 1A.

Emissions stemming from Methanol production are calculated from the combustion of the residual gases. Inquiries with the producing company by Statistics Netherlands resulted in a new estimate for the residual gas production (see section 3.1.8) and the company also provided the chemical composition of the gas, so an emission factor could be derived. The emissions are reported under 1A2c.

Emissions from the production of other chemicals can be categorized into four categories:

- Emissions during the manufacture of industrial gases. Emissions are calculated using the non energy use of natural gas. A storage factor of 20% is assumed based on a calculation from AER-data.
- Emissions during the fabrication of phosphorus. Emissions are calculated until 1998 from the non energy use of coke oven coke and a storage factor of 0 %. This factor is used because there is no storage of carbon in the end product: phosphorus. From 1999 on emissions are calculated from the combustion of phosphor oven gas and reported under 1A. The gas is partly combusted by the company itself and the rest is delivered to a nearby power plant. More details can be found in section 4.2

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[18] When the new (2006) Guidelines will not allow these emissions to be reported as process emissions the IT-application has to be changed. This is also the case for some of the following emission sources. A change in reporting would however cause major consistency problems between the energy statistics and the emission inventory. Since solving the existing inconsistencies was one of the reasons to start using the new method, this will not be an improvement.

- Emissions during the manufacture of pigments. Emissions are calculated from the non energy use of petroleum coke. The storage factor is based on AER data and is 30 %.
- Emissions from Carbon electrode production are calculated from the non energy use of petroleum coke and hard coal. This is very difficult which is confirmed in a personal communication with the environment coordinator of one of the producers of anodes. Analysis shows however that the calculated figures are reasonable.

4.2.3.3 Metal Production

1. Iron and Steel Production
Steel
Pig Iron
Sinter
Coke
Other *(please specify)*
Coke a.o. inputs in blastfurnace (- BF and oxygas)
Limestone use
2. Ferroalloys Production
3. Aluminium Production
4. SF_6 Used in Aluminium and Magnesium Foundries

Figure 6 Process emissions during the manufacture of metals

Emissions during the production of pig iron and steel in blast furnaces can be separated into three categories:

- Blast furnace gas and oxygen steel gas are being captured and combusted in this sector and the energy sector and reported under these categories in 1A
- There is a difference between the in- and output of fossil carbon in the blast furnaces. This carbon difference is regarded as process emissions (see also section 2.1.2). These emissions are calculated by determining the carbon content of the coke oven coke and hard coal which is used as feedstock and subtracting the carbon output which can be derived from the produced quantities of blast furnace gas and oxygen steel gas.
- Next to the fossil carbon used in the blast furnaces there is also some use of limestone. This is not calculated from fossil fuel use but estimated by the MNP

Emissions during the production of aluminium are the result of the use of anodes. Since anodes are not considered to be energy commodities, these emissions can not be calculated from the energy statistics. An estimate by the MNP, based on the production of aluminium and a default emission factor, is being used.

4.2.3.4 Other production

D. Other Production
1. Pulp and Paper
2. Food and Drink

Figure 7 Process emissions during the manufacture of other industrial products

Process emissions in the food and drink industry occur due to the use of coke in the sugar industry. Emissions are calculated from this non energy use with an assumed storage of 0 %. There are no (known) process emissions in the Pulp and paper industry.

4.2.3.5 Other

G. Other ***(please specify)***
Fireworks and candles
Indirect N2O from non agricultural NH3 sources
Indirect N2O from NO2 from combustion and industrial processe
Process emissions in other economic sectors
Degassing drinkwater from groundwater

Figure 8 Other process emissions

In this report only the method for calculating process emissions in other economic sectors is discussed. These emissions can be divided in two subcategories

- The use of lubricants in transport, industry and other sectors. The IPCC default of 50% is being used as a storage factor. This seems to be a bit low but there is no country specific value available
- The use of mineral waxes in the industry. It is assumed there is no storage

4.3 Additional calculations

4.3.1 Exceptions

Not all emissions are being allocated according to the methods discussed before. In the following paragraphs an overview is presented of these exceptions and their fuel use and corresponding emissions.

4.3.1.1 Unaccounted fuel in refineries

Equivalent to the carbon difference in coke ovens and blast furnaces there is a carbon difference detected when determining the emissions of refineries. This difference however is not regarded as a process emission, but it's more likely combusted fuel not accounted for in the energy statistics and/or the used emission factors are not completely accurate. Therefore these emissions are regarded, although calculated on a "process emissions way", to be combustion emissions. Obviously they can be allocated under liquid fuel related.[19]

Year	Energy (PJ)	CO_2 (kton)
1990	51,998	4569
1991	52,93	4261
1992	51,25	3826
1993	12,10	1422
1994	10,71	1091
1995	12,824	1724
1996	13,418	1434
1997	28,421	723
1998	40,926	1507
1999	32,33	1529
2000	36,819	1922
2001	47,999	2585
2002	35,479	1358

Table 7 Emissions in refineries due to unaccounted fuel consumption and/or inaccurate emission factors

[19] As can be read in paragraph 2.1.2 this exception is no longer valid except for the period 1990-1993 where the statistics for refineries were based on a net use of energy and didn't reveal some of the transformations.

4.3.1.2 Non energy use in the building materials industry

In the building materials industry, more specific the cement industry, non energy use of coal, mineral turpentine and petroleum coke is being reported. These quantities are assumed to be combusted in the cement ovens and are therefore regarded as combustion emissions. Another solution could have been the transfer from non energetic use to energetic use in the energy statistics, but when this was discovered the energy statistics were already final. In the next revision of the energy statistics this issue could be solved.

Year	CO_2 (kton)
1990	162
1991	148
1992	145
1993	160
1994	182
1995	156
1996	86
1997	74
1998	74
1999	74
2000	82
2001	63
2002	58

Table 8 Combustion emissions in the buildings material industry from non energetic use

4.3.1.3 Phosphor oven gas

Phosphor oven gas which is included in the energy statistics as chemical residual gas, is actually not liquid but solid. (it is comparable to blast furnace gas). In the SQL-database which is being used to calculate emissions it is possible to change the fuels aggregation level and this has been done. So for the years 1998-2002 the aggregation level of this gas was set to solid, both for the producing company and the power plant also using this gas. In the years prior to 1998 there was no observation of phosphor oven gas. Emissions for those years are therefore calculated from the use of coke which is mentioned in paragraph 4.3.2.3. The transferred amount can be found in table 9.

Year	CO_2 (kton)	N_2O (kg)	CH_4(kg)
1998	239	160	559
1999	272	182	636
2000	290	194	678
2001	300	201	703
2002	248	166	581

Table 9 Combustion emissions from phosphor oven gas

4.3.2 Missing values

Next to the emissions calculated in the database by the algorithm some additional emissions have been calculated separately and have been added.

4.3.2.1 Emissions from industrial gases production in 1990.

These emissions are estimated from the non energy use of natural gas in 1990 by the chemical industry and the emission and storage factors used in the other years.

Year	CO_2 (kton)
1990	90

Table 10 Emissions from industrial gas production

4.3.2.2 Emissions from soda-ash production for 1990 and 1995-1998.

For 1990 an estimate was made using the non energy use of coke by the chemical industry. For 1995-1998 energy data from the only soda ash producing company has been used to calculate the emissions. It was not possible for the algorithm to do the calculation because this company had two different sorts of processes (one open and one closed) so there was no calculation of process emissions (see also 2.1.2). This problem is not known to be occurring for any company anymore.

Year	CO_2 (kton)
1990	64
1995	70
1996	68
1997	73
1998	69

Table 11 Emissions from soda-ash production

4.3.2.3 Emissions resulting from the production of phosphor (1990 and 1995-1997)

There was no complete dataset available for produced and combusted phosphor oven gas until 1998. Therefore until then the emissions resulting from the combustion of this gas were calculated as process emissions. The following calculation method has been used for the period 1995-1997: no storage assumed in the products so the difference between carbon input and output for "other transformations" is supposed to be the activity data for the emissions. For 1990 another approach had to be used because there was no individual data available for this company. An estimate was made based on the use of cokes in the chemical industry.

Year	CO_2 (kton)
1990	300
1995	304
1996	347
1997	292

Table 12 Process emissions from phosphor production

4.3.3 Other corrections

4.3.3.1 Off-road vehicles

The fuel use and corresponding emissions by off-road vehicles have been subtracted from the concerned sectors (1A4a, 1A2f and 1A4c). This has been done to avoid double counting these emissions, since they are also calculated by the working group Transport of the Emission Registration. These figures are supposed to be of higher quality because they are calculated with emission factors for CH_4 and N_2O specific for mobile sources.

Year	*Energy (PJ)*	*CO_2 (kton)*	*N_2O (ton)*	*CH_4 (ton)*
1990	34,2	2541	21	116
1991	33,9	2519	20	115
1992	33,2	2467	20	113
1993	35,9	2667	22	122
1994	35,0	2601	21	119
1995	31,9	2367	19	108
1996	34,7	2578	21	118
1997	30,1	2236	181	102
1998	34,4	2559	21	117
1999	35,2	2614	211	120
2000	32,8	2438	20	112
2001	28,9	2149	17	98
2002	30,8	2288	181	105

Table 13 Fuel use and emissions by off-road vehicles

4.3.3.2 Venting and flaring

The natural gas use in Dutch energy statistics includes the amounts vented and flared, so these have also been subtracted to avoid double counting. The calculation of these emissions is performed by the RIVM (MNP) as mentioned in paragraph 4.2.2.

Year	*Energy (PJ)*	*CO_2 (kton)*	*N_2O (ton)*	*CH_4 (ton)*
1990	10,2	570	1	58
1991	9,8	550	1	56
1992	9,0	506	1	51
1993	7,6	426	1	43
1994	8,5	477	1	48
1995	6,4	357	1	36
1996	6,4	361	1	37
1997	4,5	254	0	26
1998	4,2	233	0	24
1999	3,3	185	0	19
2000	3,1	175	0	18
2001	3,2	180	0	18
2002	3,2	178	0	18

Table 14 : Energy amounts and calculated emissions from venting and flaring

4.4 Results

The calculated emissions have been provided to TNO on the lowest possible aggregation level (so-called RAP-codes) and have been used in the further production process for completing the CRF-tables. This recalculation was done for emissions from stationary combustion. Next to this recalculation also transport emissions were recalculated of which documentation is available in the NIR 2005.

The recalculated data resulted (together with data from other emissions not being calculated by Statistics Netherlands) in a new time series which can be seen in table 15.

CO_2 (Mton)	***1990***	***1991***	***1992***	***1993***	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***
Total	158,0	162,9	161,1	165,5	165,5	169,7	177,3	170,2	172,2	166,9	168,9	174,4	173,9
1A	148,4	153,5	152,3	157,1	156,3	160,3	168,1	161,0	163,5	158,2	160,4	166,5	166,1
1B	1,2	1,2	1,2	1,0	1,1	1,0	1,1	0,8	0,8	0,8	0,8	0,8	0,8
2	8,0	8,0	7,4	7,2	7,9	8,2	7,9	8,3	7,7	7,7	7,5	6,9	6,8

Table 15 CO_2 emissions CRF Submission 2005

In the table above only the emissions from Energy and Industrial Processes are shown because emissions from fossil fuel use are only apparent in these categories. Emissions calculated by the new method for stationary emissions include approximately 80 % of total CO_2 emissions.

5. Comparison to the old method

Due to the many changes it is very difficult to make a detailed comparison between the figures as reported in the NIR 2004 and those submitted in the NIR 2005. There have been changes not only in the level of emissions, but also in the allocation to the different subcategories of the CRF. Especially the renewed allocation of emissions into the Industrial Processes tables stands out. In table 16 an overview is given of the changes by main sector between the 2004 and 2005 submission of emission data.

Δ (Mton)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total	-1,1	-3,8	-4,6	-2,7	-3,4	-2,2	-2,4	5,8	0,5	0,7	-1,2	-2,0	-1,9
1A	-9,4	-12,2	-12,3	-9,5	-11,0	-9,8	-10,0	-1,5	-5,9	-5,6	-7,5	-7,5	-6,9
1B	1,0	0,9	0,8	0,5	0,5	0,3	0,4	0,1	-0,5	-0,6	-0,6	-0,7	-0,5
2	6,9	7,3	6,7	6,2	6,9	7,1	7,0	7,2	6,7	6,7	6,6	5,9	5,4

Table 16 Differences between NIR 2005 and NIR 2004 submission (main sectors)

Δ (Mton)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1A1	0,3	0,1	-1,8	0,9	1,5	4,6	3,9	5,8	5,2	4,8	2,0	2,7	2,8
1A2	-9,4	-10,4	-9,7	-7,9	-10,5	-14,7	-14,5	-8,4	-11,8	-11,1	-9,7	-10,5	-9,1
1A3	-3,4	-3,1	-3,1	-3,1	-2,7	-3,0	-2,7	-2,8	-3,1	-3,0	-2,8	-2,6	-2,7
1A4	2,5	1,7	1,7	1,6	0,8	2,8	2,8	3,3	3,3	3,0	2,4	2,5	1,6
1A5	0,6	-0,5	0,6	-1,1	-0,1	0,5	0,5	0,5	0,5	0,6	0,6	0,5	0,5

Table 17 Differences between NIR 2005 and NIR 2004 submission (subsectors 1A)

Table 17 presents an overview of the changes in the 1A sector. The most apparent change is the switch of emissions from the industry (1A2) to the energy sector (1A1). In the following paragraphs the reasons for this change, but also the other changes are clarified.

5.1 Joint ventures

In the old method there was no strict distinction between joint ventures and auto producer CHP. This resulted in an inconsistent dataset with the emissions of some joint ventures being reported in the energy sector (public electricity & heat) and others in the industry sector. This varied over the years and there was also a possible double count[20]. In the new method all joint ventures are allocated to the "Public electricity and heat" sector, because they are part of the NACE 40. These emissions are shown in table 18 and are graphically presented in figure 8. Joint ventures first appear in 1993 (in the ECN dataset) and increase sharply until 1999. From then on there is a little decrease in emissions.

Year	*Gaseous (Mton)*	*Liquid (Mton)*	*Solid (Mton)*	*Total (Mton)*
1993	1,4	0,0	0,0	1,4
1994	1,7	0,5	0,7	2,9
1995	3,3	1,8	0,7	5,7
1996	4,7	1,6	0,7	7,0
1997	5,3	1,9	0,6	7,8
1998	6,5	1,8	0,1	8,5
1999	8,1	2,0	0,1	10,2
2000	8,1	1,8	0,0	9,9
2001	7,6	1,9	0,0	9,4
2002	7,2	2,1	0,0	9,3
2003	7,3	2,0	0,0	9,3

Table 18 Emissions from joint ventures

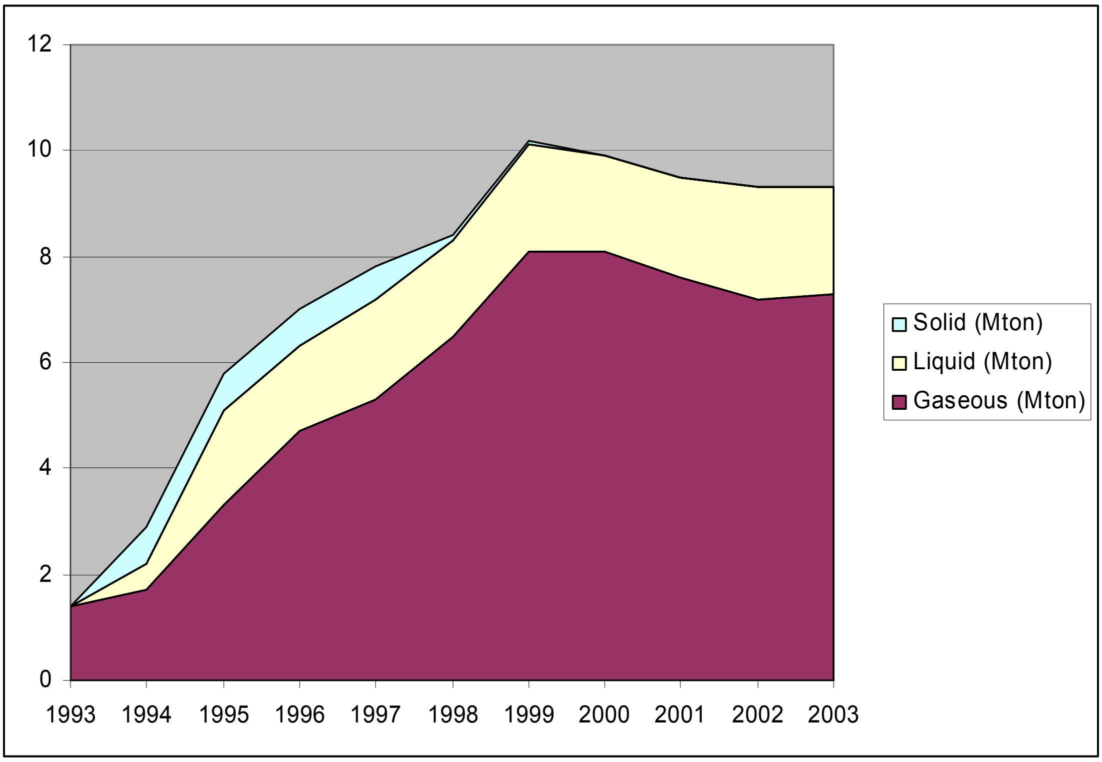

Figure 9 Emissions by joint ventures

[20] See also chapter 5.4

5.2 Emissions from Non energy use

In the old method, described in Spakman et al., emissions stemming from the non energy use of fuels were calculated using the column "finaal niet energetisch gebruik" in the "NEH" and storage fractions calculated by Gielen[21] in 1996. There are three major reasons why the emissions calculated following this methodology were not correct:

- The storage fractions were based on a producer approach instead of the consumer approach prescribed by the IPCC Guidelines. This results in a higher level of emissions because the Netherlands are a large exporter of oil products which oxidize during use.
- The storage fractions were calculated using incorrect energy data. The energy data have been adjusted in 1997 and when the revised data had been used the calculated storage fractions would have been much higher for oil products: 96% instead of 82%
- The column "finaal niet energetisch gebruik" is not suitable for calculating process emissions

In the following paragraphs these reasons will be explained on a more detailed level[22].

5.2.1 Consumer vs Producer Approach

The 1996 study of Gielen was based on production statistics of chemical products which partly oxidize during use. For each of these products a storage factor was used to calculate total storage. By dividing this total storage by the non energy use of energy products an averaged storage factor was derived. The fact that oxidation is taking place during use and not during production has not been taken into account. Because the Netherlands are a large net exporter of these chemical products CO_2 emissions in the Netherlands are actually 1 Mton lower than was assumed.

[21] Potential CO_2 emissions in the Netherlands due to carbon storage in materials and products, Ambio, Vol. 26, page 101-106, Gielen, D. J., 1997.

[22] The first of these reasons is described in Neelis et al (2003). The other two are mentioned in a memo by M.L. Neelis and J.W.F. Huurman sent to H.H.J. Vreuls from SenterNovem on July 16 2003

5.2.2 *Incorrect energy data*

The 1996 study used data for the year 1992 to calculate the carbon storage factors. Unfortunately the 1992 energy data were not correct. The energy data have been revised in 1997, but have never been used to recalculate the storage factors. In the table 19 the original and the corrected energy data and potential CO_2 are presented.

Energy commodity	*NEU 1992 before 1997 (PJ)*	*NEU 1992 before 1997 (Mton)*	*NEU 1992 from 1997 (PJ)*	*NEU 1992 from 1997 (Mton)*
Naphtha	27,0	1,98	20,3	1,49
LPG	71,4	4,51	68,2	4,30
Aromatics	71,1	5,35	51,1	3,84
Other light oils	25,3	1,77	22,9	1,60
Petroleum	0,3	0,02	0,3	0,02
Gasoil	2,3	0,17	2,3	0,17
Fuel oil	0,5	0,04	0,5	0,04
Other oil products	67,3	4,93	62,6	4,59
Total	265,2	18,77	228,2	16,06

Table 19 NEU in PJ and in Mton CO_2 for 1992 before and after correction in 1997

Storage from oil products as calculated by Gielen was 15,43 Mton CO_2. Using the original energy data the calculated storage factor for oil products is 82% (15,43/18,77) but when the original data is replaced by the corrected data, the storage factor increases to 96% (15,43/16,06). This results in 4 Mton less CO_2 emissions for the time series using the old (Spakman et al.) methodology .

5.2.3 *Not suitable*

As mentioned in paragraph 5.2.2 Gielen used the non energy use to calculate carbon storage and thus the resulting emissions. This is however not possible: the non energy use as published in Dutch energy statistics is not suitable to calculate storage or emissions[23]. This is already mentioned in paragraph 2.2.1. To calculate storage and/or emissions the individual data (preferably by process) have to be used. Because this data has never been available to inventory experts until last year there was no correct method to calculate CO_2 process emissions from energy statistics. From now on however the individual data can be used and it will be possible to determine the correct “process input”.

[23] Gielen was aware of this problem and has mentioned this in his article.

5.3 Transport

5.3.1 Domestic navigation

Until the NIR 2004 the emissions from domestic navigation were calculated using the deliveries to domestic shippers and default emissions factors. Research[24] showed a significant difference between the actual fuel use for inland shipping and the monitored deliveries so the choice was made to calculate emissions on fuel use data. This change in methodology results in a decrease in emissions of ca 0,4 Mton.

The difference in fuel use between the monitored deliveries and the calculated consumption is added to bunkers to maintain consistency with the energy statistics.

5.3.2 Domestic aviation

Like with domestic navigation a methodology change has been made from calculating with delivered fuel to fuel actually used. However, because it turned out to be very difficult a default value for all years has been used. This has had only a small effect on total emissions.

The difference in fuel use between the monitored deliveries and the estimated consumption is –as with the difference for domestic navigation- added to the bunkers to maintain consistency with the energy statistics.

5.3.3 Off road vehicles

Until the NIR 2004 fuel use and emissions from off road vehicles were separately reported in the transport sector. Because this was not according to the IPCC Guidelines in the NIR 2005 fuel use and emissions were placed in the sectors Agriculture and Manufacturing Industry (Construction). This has had no effect on total emissions but caused a shift of around 2,2 Mton from transport to the stationary sectors.

5.3.4 Fishery

The fuel use and emissions from fishery, more specific deep see fishing, have always been reported as bunkers. Because this was not according to the IPCC Guidelines in the NIR 2005 fuel use and emissions were allocated to the agricultural sector. This resulted in an increase of approximately 1,1 Mton of national emissions.

5.4 Double counting

The old calculation method for GHG emissions as described in Spakman et al[25] was prone to double counting. There were two possible scenarios:

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[24] EMS-protocol, emissies door binnenvaart: Motoren, Hulskotte et al., 2003

[25] This method used Annual Environmental Reports as primary data source and the energy statistics to make an extrapolation for the companies not submitting an AER.

- A company did not report its energy use properly in its AER. Because the extrapolation was made by subtracting the energy use of companies with AER from the energy statistics (by sector) underreporting of fuel use would lead to an overestimation of the extrapolation.
- A company submitting an AER is sometimes not directly comparable to the companies as used by Statistics Netherlands. This means that it is not always certain from which sector its energy use should be subtracted. When it is subtracted from the wrong sector an overestimation of the extrapolation in the correct sector will occur.

These two cases have occurred -for example one of the recalculations in the NIR 2003 originated because of a double count caused by improper reporting- but it is very difficult to asses the total amount of emissions which originated from these double counts. Looking at the results it will probably be somewhere between 1 and 2 Mton.

5.5 Process emissions

In the new method process emissions are reported separately while they were most of the time reported together in the old method. This was caused by the fact that companies submitted their total emissions and did not ditinguish between the two types of emissions. In the new method this problem is no longer occurring because the two types of emissions are calculated separately. This results in an decrease of emissions reported in 1A and an increase of emissions reported under the CRF Chapter 2 tables, ranging from 5,4 Mton in 2004 to 7,3 Mton in 1991.

6. Recommendations

6.1 Production process in the future

6.1.1 First calculation

To determine the yearly GHG-emissions a new production cycle should be started. Preliminary energy data and default or series specific factors can be used for a first calculation. This will usually be possible before July 1st of the next year. The quality of the data will already be (very) high and not many changes are to be expected.

6.1.2 Second calculation

The first step to be taken for a second (and final) calculation is the comparison of the energy data of energy statistics and the data of the Emission Registration (ER) or data from the NEA (the Dutch Emission Authority). For a distinct group of 60 companies the origin of observed differences will be located and if the data in the energy statistics are not correct they will be altered[26].

The next step is the comparison between the emissions as calculated with the algorithm and the figures submitted to the ER. If differences occur due to a specific emission or carbon storage factor used by a company, this specific factor could also be used for the algorithm. Criteria have been set[27] to decide when exactly to apply these specific factors and when not to. This yearly determination of emission and storage factors makes certain the calculated emissions are (almost) equal to the emissions submitted by the company to the ER, except in the case of an erroneous submission to the ER, which can not be corrected as mentioned in note 26.

After these first two steps the national emissions are recalculated with the improved energy data and specific emission and storage factors.

6.1.3 Biomass

In 2005 an extra effort by Statistics Netherlands has resulted in a complete inclusion of the statistics on renewable energy into the NEH. This allows the possibility of calculating emissions stemming from biomass (the memo-item for CO_2 and the emissions of CH_4 and N_2O) using the same methodology and IT-infrastructure as is used when calculating the fossil fuel related emissions. This possibility has not yet been utilized.

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[26] Due to confidentiality reasons it is not possible to change the energy figures in the ER based on knowledge from energy statistics.

[27] These criteria are available in the monitoring protocol (Ruyssenaars 2005)

6.2 Dependence on energy statistics

Due to the acceptance of this new method the importance of reliable and consistent energy statistics has even increased. This will mean that changes in the working process of the energy statistics department will have to be communicated with the GHG inventory compilers. In the Dutch situation this will not cause any problems because both energy statistics and (this part) of the inventory are prepared within Statistics Netherlands.

7. Annexes

7.1 National fuel list

Main group (Dutch language)	*Main group (English)* *IPCC (supplemented)*	*Unit*	*Heating value (MJ/unit)*	*CO_2 EF (kg/GJ)*
	A. Liquid Fossil, Primary Fuels			
Ruwe aardolie	Crude oil	Kg	42.7	73.3
Orimulsion	Orimulsion	Kg	27.5	80.7
Aardgascondensaat	Natural Gas Liquids	Kg	44.0	63.1
	Liquid Fossil, Secondary Fuels/ Products			
Motorbenzine	Petrol/gasoline	Kg	44.0	72.0
Kerosine luchtvaart	Jet Kerosene	Kg	43.5	71.5
Petroleum	Other Kerosene	Kg	43.1	71.9
Leisteenolie	Shale oil	Kg	36.0	73.3
Gas-/dieselolie	Gas/ Diesel oil	Kg	42.7	74.3
Zware stookolie	Residual Fuel oil	Kg	41.0	77.4
LPG	LPG	Kg	45.2	66.7
Ethaan	Ethane	Kg	45.2	61.6
Nafta's	Naphtha	Kg	44.0	73.3
Bitumen	Bitumen	Kg	41.9	80.7
Smeerolieën	Lubricants	Kg	41.4	73.3
Petroleumcokes	Petroleum Coke	Kg	35.2	100.8
Raffinaderij grondstoffen	Refinery Feedstocks	Kg	44.8	73.3
Raffinaderijgas	Refinery Gas	kg	45.2	66.7
Chemisch restgas	Chemical Waste Gas	kg	45.2	66.7
Overige olieen	Other Oil	kg	40.2	73.3
	B. Solid Fossil, Primary Fuels			
Antraciet	Anthracite	kg	26.6	98.3
Cokeskolen	Coking Coal	kg	28.7	94.0
Cokeskolen (cokeovens)	Coking Coal (used in coke oven)	kg	28.7	95.4
Cokeskolen (basismetaal)	Coking Coal (used in blast furnaces)	kg	28.7	89.8
Overige bitumineuze steenkool	Other Bituminous Coal	kg	24.5	94.7

Sub-bitumineuze kool	Sub-bituminous Coal	kg	20.7	96.1
Bruinkool	Lignite	kg	20.0	101.2
Bitumineuze Leisteen	Oil Shale	kg	9.4	106.7
Turf	Peat	kg	10.8	106.0
	Solid Fossil, Secondary Fuels			
Steen- en bruinkoolbriketten	BKB & Patent Fuel	kg	23.5	94.6
Cokesoven/ gascokes	Coke Oven/Gas Coke	kg	28.5	111.9
Cokesovengas	Coke Oven gas	MJ	1.0	41.2
Hoogovengas	Blast Furnace Gas	MJ	1.0	247.4
Oxystaalovengas	Oxy Gas	MJ	1.0	191.9
Fosforovengas	Phosphor Gas	Nm3	11.6	149.5
	C. Gaseous Fossil Fuels			
Aardgas	Natural Gas (dry)	Nm^3 ae	31.65	56.1[28]
Koolmonoxide	Carbon Monoxide	Nm^3	12.6	155.2
Methaan	Methane	Nm^3	35.9	54.9
Waterstof	Hydrogen	Nm^3	10.8	0.0
	Biomass[29]			
Biomassa vast	Solid Biomass	kg	15.1	109.6
Biomassa vloeibaar	Liquid Biomass	kg	39.4	71.2
Biomassa gasvormig	Gas Biomass	Nm3	21.8	90.8
RWZI biogas	Wastewater biogas	Nm3	23.3	84.2
Stortgas	Landfill gas	Nm3	19.5	100.7
Industrieel fermentatiegas	Industrial organic waste gas	Nm3	23.3	84.2
	D. Other fuels			
Afval (niet biogeen)	Waste (not biogenic)	kg	34.4	73.6

[28] Early 2006 a new study indicated that the emission factor for natural gas is in fact higher then 56.1 (about 56.8). This will result in emission recalculations

[29] The value of the CO_2 emission factor is shown as a memo item in reports for the climate agreement; The value is zero for emissions trading and for the Kyoto Protocol.

7.2 Sectors used in Dutch Energy Statistics

Dutch	*English*
Winningsbedrijven	Primary producers of energy sources
Cokesfabrieken	Cokeries
Aardolieraffinaderijen	Refineries
Elek.+warmtepr.bedr.centraal	Power plants (thermal)
Elek.+warmtepr.bedr.decentr.	Joint ventures for combined heat & power (CHP)
Vuilverbrandingsinstallaties	Refuse incinerators
Handelaren vaste brandstoffen	Solid fuels trade
Aardoliepr.hand.+opsl.bedr.	Oil products trade and storage
Dist.bdr.water,gas,elek,warmte	Energy distribution companies
Voedings- en genotmiddelenind.	Food, beverages and tobacco
Textiel-, kleding- en leerind.	Textile, clothes and leather industry
Papierind., drukk., uitgeverij	Paper and printing
Kunstmestindustrie	Artificial fertiliser industry
Organische basischemie	Organic chemical industry
Anorganische basischemie	Anorganic chemical industry
Overige basischemie	Other basic chemical industry
Chemische productenindustrie	Chemical products industry
Bouwmaterialenindustrie	Building materials industry
Basismetaalind. ijzer+staal	Basic metal industry, iron and steel
Basismetaalindustrie non-ferro	Basic metal industry non-ferro
Metaalproductenindustrie	Metal products industry
Kunststof-, rubber- en ov.ind.	Plastics, rubber and other manufacturing industry
Ind., niet te spec. ind.tak	Manufacturing industry, not specified
Transport	Transport
Huishoudens (excl. transport)	Households (excluding transport)
Overige afnemers	Other consumers