Peer Review of the 'Industrial processes' and 'Solvent and other product use' chapters of the draft National Inventory Report 2006

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1 Introduction

This report represents a 'peer review' of two chapters of a draft of the report *'Greenhouse Gas Emissions in the Netherlands 1990-2004, National Inventory Report (NIR) 2006'*:

- Chapter 4 Industrial Processes - Common Reporting Format (CRF) Sector 2
- Chapter 5 Solvent and other product use - CRF Sector 3

The review is based on material (draft NIR, past reviews etc.) sent by e-mail on December 13 and 22, 2005 by Harry Vreuls of SenterNovem and on the protocols for calculating greenhouse gas emissions in the Netherlands (www.greenhousegases.nl), downloaded on December 22, 2005. An overview of all the material used (including document names) is presented in Appendix 1.

The remarks are divided into general remarks (Chapter 2) and remarks on the NIR chapters 'Industrial Processes' (Chapter 3) and 'Solvent and other product use' (Chapter 4).

2 General comments

The NIR chapters on 'Industrial processes' and 'Solvent and other product use' will in detail be reviewed in the next two chapters of this report. In this chapter, more general comments on the contents of the NIR, the CRF tables and the protocols are summarised.

- The 'NIR-team' has made a great effort in preparing all the detailed protocols on the emission calculation methodologies. In principle, these protocols provide a sound basis for reviewers to assess how Greenhouse Gas (GHG) emissions are calculated in the Netherlands. Nevertheless, there is still improvement possible concerning the contents of respectively the NIR, the protocols and the CRF. The three sources together (Protocols, NIR and CRF) should, in principle, allow a reviewer to redo all emission calculations himself[1]. In my opinion, the contents of the three sources should be[2]:

  - Protocols: Detailed description of the applied methodology to calculate emissions.
  - NIR: General overview of methodological issues (summarised from protocols) and clarifying tables and figures (input data, intermediate results) if the emission calculation cannot directly be understood from the protocol and the CRF.
  - CRF: Overview of activity data, emission factors and emissions in tabular format with embedded calculations.

  In general, I have the impression that this division of contents is not too far off from what the 'NIR-team' had in mind when preparing the protocols, the NIR and CRF tables. However, several improvements are still possible:

  - The detailed description of CO_2 emission calculations for the steel industry (page 4-8 and 4-9 of the NIR) should be shifted from the NIR to protocol 1 (from the list of protocols given in Appendix 1).
  - Protocol 1 should contain more detailed information on the exact 'storage fractions' used for the various industries in which non-energy use is reported in the energy balances and the allocation of emissions to either 'Energy' and 'Industrial Processes'.
  - The tables with the share of the emissions covered by the protocol in the national total in 1990 and 2003 could in principle be removed from the protocols (because they can also be found in the CRF tables and have nothing to do with the methodology).
  - The sections on 'activity data and (implied) emission factors' and on 'methodological issues' in the NIR should be combined into one. Instead of only repeating the information from the protocols, this section should focus on

[1] Except when activity data are confidential.
[2] This depends, however, also on the official requirements for the contents of the NIR by the United Nations Framework Convention on Climate Change (UNFCCC). The current procedure (protocols describing the detailed methodologies and reference in the NIR to these protocols) should be checked with these official requirements.

those things that cannot directly be understood or deducted from the protocol and/or the CRF (e.g. the respective fractions of dolomite vs. limestone use).
  - The activity indicators and (implied) emission factors in the CRF should match the protocols (see next bullet point).
- In the CRF, activity data (1), emissions (2) and (implied) emission factors (EF, 3) are reported. In a number of cases (e.g. glass production, limestone and dolomite use, soda ash production, see next two Chapters for details), the activity data reported as input value in the CRF differs from the activity data, which is used in the actual calculation. Sometimes (e.g. lubricant use), activity data and EF's are even missing, whereas they have obviously been used in the calculation. As a result, the CRF is not very transparent, because the (implied) emission factors (calculated automatically by dividing emissions with the activity data) in the CRF do not correspond with the EF's mentioned in the protocol. My recommendation is to adjust the CRF in such a way that the (implied) emission factor in the CRF matches the EF mentioned in the protocol in all cases[3].
- At the moment, the protocols are not yet available in English on the website www.greenhousegases.nl. Since the protocols are indispensable for a proper understanding of the methodologies used, English protocols should be made available as soon as possible[4].
- Given the importance of the protocols, they should have a clear status and they should be referable. I therefore recommend adding authors, a document number, and the publication date to the protocols[4].
- For the review, a draft version of the NIR is used. In the Industrial Process chapter, the text is not yet complete and contains remarks like 'to be added' and 'to be explained', especially in the sections on uncertainties. Also the annexes to the NIR (except for the selection of CRF tables) were not available for the review. These two points makes a total and accurate review difficult to make.

[3] This will be difficult if the emissions in a certain category are based on more than 1 activity data (e.g. limestone *and* dolomite use). In those cases, the respective amounts of both should be mentioned as part of the NIR (if not confidential). In any case, the formula used should be clear.

[4] The protocols got an official status and were translated into English shortly after the protocols were downloaded for this review on December 22, 2005. The English protocols are, however, not yet available on the website www.greenhousegases.nl.

3 Industrial Processes (Chapter 4 of the NIR)

3.1 Section 4.1 - Overview of sector

- The first sentence of the second paragraph of Section 4.1 (Following ...) is incorrect English ('Following' could be replaced with 'The').
- Both the heading of Table 1 and the first row of the Table are wrong and confusing. The correct name of the sector is 'industrial processes' rather than 'industry'.
- Table 4.1 is not yet complete. For example, in the category mineral products (2A), only limestone and dolomite use are given.

3.2 Section 4.2 - Mineral products

- A number of remarks can be made about the CO_2 emission estimate for cement production:
  - There is a contradiction between protocol 2 (from the list of protocols in Appendix 1) and the NIR for cement production. According to the protocol, about half the clinker is imported; according to the NIR 35%.
  - According to protocol 2, the emissions from cement (clinker) production in 1990-1992 are based on estimates of cement production for 1990-1992 and the emission factor of 1993. Two additional variables are required: the clinker use per ton of cement and the amount of clinker imported. I assume the values for 1993 are used, but this is not explicitly stated. If the method is not changed as a result of the comment below, it would be good to add this in the protocol.
  - In March 2004, I received clinker production figures for 1984-2003 via a personal communication with Peter Mergelsberg (ENCI B.V. – Maastricht). The production figures for 1990 – 1992 were 769508 ton, 921815 ton and 830758 ton respectively. The emission estimates for 1990-1992 could be improved using these production figures.
  - The emission estimates for 2004 are at the moment still identical to 2003. I assume this will be updated before final publication of the NIR. If not, it would be good to report in Section 4.2.2 (methodological issues) why the 2003 value has been taken.
  - In protocol 2, reference is made on page 5 to waste, which is burned in cement ovens. These emissions are not monitored according to the text of the protocol. However, in the environmental report of the company to the government, the amount of waste used can be found and the CO_2 emissions from the use of this waste can therefore be added without much effort and it is advised to do so.
  - I remember from a previous project[5], that the deliveries of petroleum cokes to the cement industry are included in the energy statistics under 'final non-energy use'. Via the calculation of fossil CO_2 process emissions (protocol 1), the resulting emissions are probably calculated (using a storage fraction 0), but they are not included under Industrial Process. Maybe they are included under

[5] Neelis M, Patel M and de Feber, M, *Improvement of CO_2 emission estimates from the non-energy use of fossil fuels in the Netherlands,* Utrecht University, Copernicus Institute, Department of Science, Technology and Society, Report NW&S-E-2003-10, April 2003.

'Energy' emissions. If so, it should be mentioned explicitly in protocol 1 (and the NIR).

- Two remarks can be made about the CO_2 emissions of limestone and dolomite use:
  - The EF for limestone and dolomite use applied in the CRF is variable over time. This seems logical because the fraction of limestone vs. dolomite will changes from year to year. However the value (around 600 kg / ton in each year) is rather high when looking at the EF of dolomite use (477 kg / ton) and limestone (440 kg / ton). Most probably, this has something to do with the use of plaster rather than real limestone as activity indicator (explained in protocol 2), but this is not visible in the CRF (where limestone use is referred to and given as indicator). This might lead to confusion (see also general remarks).
  - The estimates for 2004 are at the moment still identical to 2003. I assume this will be updated before final publication of the NIR. If not, it would be good to report in Section 4.2.2 (methodological issues) why the 2003 value has been taken.
- Protocol 2 is clear on the calculation of CO_2 emissions from soda ash use, but the method seems illogical: The amount of soda use is partly (i.e. for the extrapolation) based on the production of glass, because the glass industry is one of the most important users of soda ash (according to the text). Since emissions from glass production are also separately estimated, the soda ash use is double-counted. This double-count is acknowledged, but no correction is applied, because the estimate is so uncertain. So, glass production is on the one hand thought to be decisive for the total soda ash use, but on the other hand, no correction is made for the double-count resulting from the soda ash use in the glass industry. This is rather contradictory. It seems more logical to replace the estimate for soda ash use with IE (i.e. as part of the estimate of CO_2 emissions of glass production) or to make an estimate for the fraction of the soda ash, which is used in the glass industry and to correct based on this fraction. The fraction of soda ash used in the glass industry might be easily retrievable via a personal communication with the only soda ash producer in the Netherlands.
- Two remarks can be made about the estimate for soda ash production:
  - The default emission factor mentioned in the text of the NIR (514 kg / ton) is the default factor for soda ash *use* rather than soda ash *production*. This should be changed. The emission factors for soda ash *production* should be added in the NIR.
  - According to the NIR, the activity data for soda ash production is the non-energy use of coke in this industry according to the *Environmental Report* of the company producing soda ash. In protocol 1, however, the non-energy use of coke according to the *Energy Statistics* is mentioned as the activity data used. Finally, in the CRF, the production of soda ash is reported as activity indicator. It would be good to change the text at the appropriate places to what is really done.
- According to the text an EF for glass production of 0.16 kg / ton is used. However, from the CRF tables it seems that a factor of 0.125 is used. This probably has something to do with the difference between gross (given as activity indicator in the CRF) and net glass production (used in the calculation). This is might lead to confusion and should be made consistent (see also general remarks).

- The Section on Activity data and (Implied) Emission factors and Section 4.2.2 on Methodological issues is just a repetition of information that can also be found in protocol 1 en 2. On the other hand, Section 2 of both protocol 1 and 2 contains detailed information on emissions for 2003, which has nothing to do with the methodology description (the main aim of the protocols). It might be good to reconsider the contents of NIR vs. protocols (see also general remarks in the previous chapter).

3.3 Section 4.3 - Chemical industry

- The text at the first bullet point on page 4-5 should be changed. Hydrogen is not chemically separated from natural gas, but is produced from natural gas.
- No protocol is currently available for N_2O emissions from caprolactam production. Both the EF and the activity data are confidential. This makes the resulting emission estimate not transparent. It might be good to develop a protocol for caprolactam production discussing at least the source of the activity data (probably Environmental Report ?), comparable to nitric acid production. As long as the protocol is unavailable, it might be good to briefly explain the procedure in the NIR[6].
- In protocol 1 on page 6, a table is given with storage fractions different as 0, which are used from 1990 onwards. These are probably fractions used in the IPCC-RA, but have nothing to do with the calculation of emissions in the National Approach. The section including the table should therefore be removed from the protocol.
- - On page 4-5 under the bullet point 'ammonia production', an emission percentage of 17% is used. The source quoted is Neelis et al. (2003). This fraction cannot directly be found in this source, but is derived from it. The appropriate sentence is therefore 'based on Neelis et al. (2003)'. This also holds for the same sentence on page 4-6. Surprisingly enough, this percentage is not explained or given on protocol 1, which seems to be the most appropriate place. My suggestion is to improve the method (see below) and describe it clearly in protocol 1. See also the general remark on the position of the NIR vs. the protocols and vice versa.
  - A more accurate and therefore better method for CO_2 emissions from ammonia production would be to calculate for each year the amount of carbon embodied during urea production (available at CBS since 1993 in the Prodcom database) and to deduct this amount from the total CO_2 embodied in the natural gas used for ammonia. Per ton of urea ($C_1N_2H_4O$), 0.2 ton of carbon (0.73 ton CO_2) is embodied. This will probably lead to a flexible percentage of carbon oxidized (rather than the fixed 17% used now).
- From the NIR and protocol 1, the reader gets a general idea of how fossil CO_2 process emissions for the chemical industry are calculated, but a lot of indispensable details (for exactly understanding the methods applied) are missing. Below are some examples:
  - It is unclear from both the NIR and the protocol what is included under 'Other Chemical Industry' in 2B5 (Other) of the CRF. One can deduct from the text that at least the industrial gases are included, but probably also other

[6] The protocol for caprolactam became available shortly after the protocols were downloaded for this review on December 22, 2005.

processes. Given the amount of emissions (~0.5 Mt CO_2) it is advisable to separately discuss this in more detail.

- According to the NIR (page 4-5), emissions from the use of fossil fuels as feedstock for the production of silicon carbide, carbon black, ethylene and methanol are included under the Energy emissions. In the protocol, the reason is given for ethylene and silicon carbide: emissions take place via the intermediate production of chemical waste gas, which is included under the Energy emissions. This might also be the case for methanol and carbon black, but this is not stated anywhere in the industrial process chapter of the NIR (it is, however, reported in the Energy Chapter, page 3-17/18). From my memory I recall (from a previous project[7]) that one of the two carbon black producers in the Netherlands was not reporting chemical waste gas before 1999, so how are emissions estimated for the period before 1999?

- Given the point made above, it seems vital (for reasons of transparency) to significantly expand the NIR and protocol 1 with respect to fossil process CO_2 emissions, not only for the chemical industry, but for all industries. The protocol should in my opinion include:
  - A general explanation of the problems associated with fossil process CO_2 emissions (e.g. the interaction with Energy emissions and the position of non-energy use in the Dutch energy statistics) and a better explanation of the general method to deal with these problems with the help of the 'open' versus 'closed' processes described by Huurman and Zonneveld[8].
  - The basis for all storage factors used to convert the non-energy use of fossil fuels to emissions (and storage). To my knowledge, non-energy use is reported in more processes than the 9 processes mentioned in the protocol, for example by a number of small companies in the metal industry. It is unclear to me how this non-energy use is dealt with. The starting point in the protocol should in my opinion not be a list of processes, but a list of industries in which non-energy use is reported. In this list, it should also be mentioned that for those companies that do report chemical waste gas, a storage fraction of 1 is applied to the non-energy use and the conversion saldo of the energy statistics.
  - The allocation principles used in dividing the emissions over 'Energy' and 'Industrial Processes'.

  Every year, the storage factors used should be given in the NIR and an overview should be given of the total CO_2 emissions resulting from the non-energy use of fossil fuels and the allocation of these emissions in the various source categories.

- Apart from a better reporting, the method of calculating fossil CO_2 emissions could be further improved:
  - In the method applied, direct CO_2 emissions (i.e. separate from chemical waste gas, which is burned) by companies also producing chemical waste gas are not calculated. In the terminology of Huurman and Zonneveld, these companies combine 'open' and 'closed' processes. An important example is ethylene oxide production, resulting in approximately 0.45 ton CO_2 per ton of ethylene oxide[9]. The capacity of ethylene oxide in the Netherlands is 460 kton[10], so the

[7] See reference in footnote 5.

[8] Huurman JWF and Zonnveld EA, *Vergelijkend onderzoek emissieberekeningsmethoden*, Centraal Bureau voor de Statistiek, 2004

[9] Neelis ML, Patel MK, Bach PW and Haije WG, *Analysis of energy use and carbon losses in the chemical and refinery industries,* Energy Research Centre of the Netherlands, Report ECN-I--05-008, September 2005

resulting emissions amount to approximately 200 kton CO_2 per year. It is relatively easy to add these emissions (with the help of Prodcom production data and a default emission factor) and it is advised to do so.

- In the method applied, not only emissions are calculated, but (implicitly[11]) also carbon storage in products. In a number of cases (e.g. the companies producing several products) it is not easy to assess whether the calculated storage is reasonable, but in some other cases (e.g. methanol and silicon carbide production), it is relatively straightforward to check with the help of production figure and the carbon content of the product whether the resulting (implicit) estimate for carbon storage is correct. A time-series analysis of the resulting carbon storage might in all cases yield valuable information on the uncertainties involved in the method applied.

3.4 Section 4.4 - Metal production

- - The protocol does not contain specific information on the calculation of emission for iron and steel production. Instead, the explanation is given in detail in the NIR. This raises questions about the contents of the NIR vs. the protocols and vice versa (see also general comments).
  - The text in the NIR (page 4-8 and 4-9) on the calculation of CO_2 emissions in the iron and steel industry is not fully clear and could be further improved. The assumed carbon content of iron ore and crude steel are for example not specified (why not give them in a Table). Furthermore it is stated that 'the C content in pig iron purchased and produced is assumed very small or nil, respectively'. This is not true; all pig iron contains approximately 4% carbon. However, the pig iron is used to produce steel and (almost) no pig iron is purchased or sold to my knowledge. It can therefore be neglected in the calculation. It might be better to rephrase. The detailed methodology description should in my opinion be part of protocol 1 (see also general remarks).
  - It could be useful to refer to Table 3.5 in the Energy chapter for a total overview of CO_2 emissions from iron and steel.

3.5 Section 4.5 - Food and drink production

- The emissions vary around 0.05 Gg (page 4-10). Given the large fluctuation in the activity data used (e.g. very low value in 1995), it might be better to rephrase (emissions are between this and that value).
- I would recommend adding the activity data (coke use) and the emission factor in the CRF Table. Currently they are not included.

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[10] *Product focus – Ethylene oxide and ethylene glycol,* Chemical Week, April 28, 2004

[11] Carbon storage is not directly calculated, but can easily be deducted by converting the energy balance of a company / sector into a carbon balance and subtracting the emissions from the total carbon used.

3.6 Section 4.6 - Production of halocarbons and SF6

- No comments, the protocols seem to adequately describe the methodology applied and the NIR contains a proper overview of the resulting emissions and an overview of the main methodological issues.

3.7 Section 4.7 - Consumption of halocarbons and SF 6

- No comments, the protocols seem to adequately describe the methodology applied and the NIR contains a proper overview of the resulting emissions and an overview of the main methodological issues.

3.8 Section 4.8 - Other industrial processes

- In the list of activity data 'fuel use' is mentioned as one of the activity data used. I assume this refers to the use of lubricants. This might lead to confusion in the chapter on industrial processes. It might be better to replace with 'Use of lubricants and waxes'. In general, the terminology for 'lubricant and waxes use' is not very clear in NIR and CRF. In the CRF, these are referred to as 'process emissions in other economic sectors'. In the text of the NIR, reference is made to 'production of waxes', 'fuel use', 'use of fuels for production of lubricants' and 'miscellaneous non-energy fossil fuel product uses (i.e. lubricant and waxes). My recommendation would be to replace with 'use of lubricants and waxes' at all places.
- In the CRF, the activity data for 'firework and candles (NA)' is not given. This data should however be available to be able to calculate the emissions, so I recommend adding the activity data for reasons of transparency.

4 Solvent and other product use (Chapter 5 of the NIR)

4.1 Section 5.1 - Overview of the sector

- No comments

4.2 Section 5.2 - Indirect CO_2 emissions from solvents and other product use (Paint application, degreasing and dry cleaning and other)

- In protocol 2, reference is made to a separate protocol for the calculation of emissions of non-methane volatile organic compounds (NMVOC). I could not find this protocol on the Internet. Since this protocol on NMVOC is so important for the calculation of the indirect CO_2 emissions, I would recommend adding this protocol as an appendix to protocol 2.
- Protocol 2 is unclear with respect to the carbon content used in the conversion of NMVOC to CO_2. On page 8 of the protocol it reads: *"The fractions are calculated for 1990 and 2000, but the trend is not robust for category 3A and 3B (because the 2000 emissions are only a small part of the total) and therefore, fixed fractions are used"*. I do not understand what is meant with this sentence. I am also not able to reproduce the CO_2 emissions from the CRF using the factors given on page 5-2 of the NIR and on page 8 of protocol 2. For example, in the CRF for 2003, an NMVOC emission for category 3A (paint application) of 26.3 kton is reported. According to the protocol and the NIR, the carbon fraction is 0.72. The CO_2 emissions can therefore be estimated at 26.3 * 0.72 * 44/12 = 69.4 kton CO_2. In the CRF, however, a value of 89.2 is reported. I recommend clarifying both protocol 2, the NIR and the CRF on this point.
- Protocol 2 and the NIR are unclear about how emissions in category 3C are calculated and reported. From the NIR it becomes clear that for the carbon content the average of the other three sectors is taken. However, the emissions are not reported, but (according to Section 5.1) included in the other three categories. It is unclear how this is done.
- The CRF would become more transparent if activity data and emission factors for indirect CO_2 would be added in the worksheet 'Table3.A-D'. The activity indicator should be the NMVOC emissions and the emission factor the carbon content as mentioned in the protocol.

4.3 Section 5.3 - Miscellaneous N_2O emissions from solvent and product use (use of N_2O for anaesthesia and N_2O from Aerosol cans)

- No comment. The protocols seem to adequately describe the methodology applied and the NIR contains a proper overview of the resulting emissions and an overview of the main methodological issues.

Appendix 1 Overview of material used for the review

	Document name	Source
NIR Chapters		Harry Vreuls (13-12-05)
Summary	NIR 2006 samenvatting.doc	
Chapter 1	NIR_2006_NLD_ch01_versie 28_11.doc	
Chapter 2	NIR_2006_NLD_ch02_TREN D-v3_LB.doc	
Chapter 4	NIR_2006_NLD_ch04_INDPR OC-vromversie 1.doc	
Chapter 5	NIR_2006_NLD_ch05_SOLV-DNijdamv1C_GA.doc	
Chapter 10	NIR_2006_NLD_ch10 RECALCULATIONS.doc	
CRF Tables		Harry Vreuls (13-02-05)
Tables for 1990-2004	CRF_1_11_05	
Monitoring protocols		www.greenhousegases.nl (December, 22 2005)
1 Fossil process emissions	CO2_CH4_N2O_Procesemissi es_fossiel.pdf	
2 Non fossil process emissions and product use	CO2_CH4_N2O_Procesemissi es_niet_fossiel.pdf	
3 Nitric acid production	2B2_N2O_Salpeterzuur.pdf	
4 PFK aluminium production	2C3_PFK_aluminiumproductie .pdf	
5 HFK-23 bij HCFK-22 productie	2E1_HFK_productie_HFCK-22.pdf	
6 HFK bij het ompakken van HFK's	2E3_HFK_ompakken_HFK.pd f	
7 HFK bij stationair koelen	2F1_HFK_Koeling_stationair.p df	
8 HFK uit comfortkoeling automobielen	2F1_HFK_Koeling_mobiel.pdf	
9 HFK uit hardschuimen	2F2_HFK_uit_hardschuimen.p df	
10 HFK aerosolen	2F4_HFK_aerosolen.pdf	
11 SF_6 productie en gebruik dubbelglas	2F8_SF6_Dubbelglas.pdf	
12 SF_6 halfgeleidersindustrie	2F8_SF6_PFK_Halfgeleiders.p df	
13 SF_6 sterkstroomindustrie	2F8_SF6_sterkstroom.pdf	
Background documents		Harry Vreuls (13-02-05)
Peer Review of draft 2005 NIR – Agriculture and LULUCF Chapters	Peer Review NIR2005 Amstel of chapters on Agriculture and LULUCF.doc	
Peer Review of draft 2005 NIR	Peer REview NIR2005 Pulles corrected.pdf	
Questions of UNFCCC centralised review and Dutch answers	answers 14 oct.doc	Received on 22-12-05
Comments by the Netherlands on the status report initial check of the 2005 inventory submission	comments on inititial check NIR 2005.doc	
Dutch reaction on potential adjustment suggested by the UNFCCC expert review team	Netherlands reaction on potential adjustment 1 Nov update.doc	
Dutch reaction on draft synthesis and assessment report 2005	reaction on draft SA part 1.doc	