IMPROVING THE GREENLANDIC GREENHOUSE GAS INVENTORY

NERI Technical Report no. 817 2011

NATIONAL ENVIRONMENTAL RESEARCH INSTITUTE
AARHUS UNIVERSITY

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Data sheet

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Abstract: The project to improve the Greenlandic greenhouse gas (GHG) inventory was undertaken due to the recommendations made by the UNFCCC review team in connection with the 2008 and 2009 submissions by the Kingdom of Denmark. The improvements made to the Greenlandic GHG emission inventory were substantial. Firstly the full CRF format was implemented significantly increasing the level of detail. For the cross-cutting elements of the reporting a tier 1 uncertainty estimation was made. The uncertainty estimation showed a total uncertainty of the GHG emission of 5.8 %. A tier 1 key category analysis was made resulting in five key categories due to level in 2008 and five further key categories due to the trend. Three categories were key for both level and trend. For the individual source sectors numerous improvements were made. This was both related to the estimation of previously missing sources and to refining the methodologies that had been previously used. The changes made to the Greenlandic GHG inventory as a result of this project resulted in recalculations of the GHG emission of 14.3 Gg of CO_2 equivalents in 2007, which roughly corresponds to 2 % of the total GHG emissions.

Keywords:	Greenland, greenhouse gases, emission inventory, UNFCCC, Kyoto Protocol, CO_2, CH_4, N_2O, f-gases
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Preface

This project was funded by DANCEA administrated by the Danish Energy Agency. The project was completed in 2010 and the outputs from the project were instrumental for Denmark's ability to submit a complete reporting in line with the recommendations of the UNFCCC review team.

The project was carried out in close cooperation between the scientific staff at NERI, who is responsible for the Danish National System under the Kyoto Protocol and Statistics Greenland, which is responsible for preparing the Greenlandic greenhouse gas inventory.

The authors of this report would like to thank the following people for their valuable contributions to the project:

- Lone S. Simonsen, Government of Greenland.
- Mette Frost, Government of Greenland.
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- Rasmus Christensen, Researcher at the Greenlandic Aboretum

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Summary

The project to improve the Greenlandic greenhouse gas (GHG) inventory was undertaken due to the recommendations made by the UNFCCC review team in connection with the 2008 and 2009 submissions by the Kingdom of Denmark.

The objective was to address all points of concern raised by the UNFCCC review team, hereby ensuring that no potential problems were raised regarding the Greenlandic inventory during the review of the 2010 submission.

The project succeeded to complete all objectives, so that the Kingdom of Denmark was able to submit a complete inventory in the full CRF format within the deadline on April 15, 2010, and to resubmit within the requested six weeks on May 27, 2010.

The improvements made to the Greenlandic GHG emission inventory were substantial. Firstly the full CRF format was implemented significantly increasing the level of detail. This required a large effort to adapt the current data system and to develop the conversion procedures to generate the xml files needed for import to the CRF Reporter. Additionally there was the need for filling out notation keys for all the sectors not occurring in Greenland.

For the cross-cutting elements of the reporting a tier 1 uncertainty estimation was made. The uncertainty estimation showed a total uncertainty of the GHG emission of 5.8 %. The GHG emission trend since the base year has been an increase of 10.6 % and the uncertainty of the trend was estimated to 3.2 percentage point. The relatively low overall uncertainty is due to the low uncertainty of the carbon dioxide (CO_2) emission estimation and the high share of CO_2 of the total GHG emissions. A tier 1 key category analysis was made resulting in five key categories due to level in 2008 and five further key categories due to the trend. Three categories were key for both level and trend. The majority of key categories were in the energy sector, but the waste sector also has key categories, due to level or trend, while agriculture and industrial processes have key categories due to the emission trend.

An important element in the reporting is to ensure the quality of the emission estimates by implementing QA/QC procedures. Previously no documentation of the quality procedures existed even though several procedures were implemented. The documentation of the QA/QC procedures has been improved both on the sectoral level and the overall level. Additionally a number of checks were implemented in the development of the new data files used for importing data into the CRF Reporter.

For the individual source sectors numerous improvements were made. This was both related to the estimation of previously missing sources and to refining the methodologies that had been previously used.

The main improvements related to estimation of emissions from categories where emissions that had not previously been estimated, that is CO_2 emissions from mineral products, CO_2 emissions from solvent and other product use, N_2O emissions from agricultural soils and N_2O from wastewater handling.

For several source categories the estimation and/or reporting methodologies were improved; this was the case for HFCs, where the reporting where disaggregated according to more differentiated use categories. For enteric fermentation and manure management tier 2 methodologies were implemented replacing the previously used tier 1 methodology. For solid waste disposal on land a decay model was implemented similar to the IPCC tier 2 methodology. The calculation of emissions from open burning of waste was improved using the newest scientific literature available.

Emissions of indirect GHGs were estimated for the first time for the energy sector, industrial processes, solvent use and waste incineration.

For LULUCF CO_2 emissions/removals were estimated for all relevant categories (forest land, cropland and grazing land) as well as CO_2 emissions from liming.

The KP-LULUCF inventory for Greenland was completed for all the mandatory and elected activities and provided a very small contribution to the reduction commitment.

The changes made to the Greenlandic GHG inventory as a result of this project resulted in recalculations of the GHG emission of 14.3 Gg of CO_2 equivalents in 2007, which roughly corresponds to 2 % of the total GHG emissions. The largest recalculation took place in the waste sector where the emission of GHGs increased by approximately 16 Gg of CO_2 equivalents in 2007. The recalculations made in agriculture decreased the GHG emission in 2007 by approximately 2.3 Gg of CO_2 equivalents.

The 2010 submission for the Kingdom of Denmark under the Kyoto Protocol was reviewed in-country in the week from September 6 to 11. During the week the Greenlandic GHG inventory was presented and the vast improvements were acknowledged by the UNFCCC expert review team. There were no critical remarks on the Greenlandic GHG inventory. It can therefore be concluded that the project achieved its objective of improving the Greenlandic GHG inventory so that it was fully accepted by the UNFCCC expert review team.

Sammenfatning

Dette projekt er udført med det formål at forbedre de grønlandske drivhusgasopgørelser, efter anbefaling fra UNFCCC's team af reviewere i forbindelse med rapporteringerne for 2008 og 2009 for kongeriget Danmark.

Formålet har været at imødekomme alle problemstillinger fremført af UNFCCC's reviewteam for herved at sikre at ingen potentielle problemstillinger ville være at finde i de grønlandske opgørelser ved reviewproceduren af 2010-rapporteringen.

Det lykkedes at opfylde alle mål og derfor kunne Kongeriget Danmark fremsende en komplet opgørelse i det fulde CRF–format inden deadline d. 15. april 2010, og genfremsende inden for de begærede seks uger, dvs. d. 27. maj 2010.

Forbedringerne foretaget i de grønlandske drivhusgasemissionsopgørelser er omfattende. Først og fremmest blev det fulde CRF-format implementeret, hvilket øgede detaljeringsniveauet betragteligt. Dette indebar et stort stykke arbejde med at tilpasse det eksisterende datasystem og med at udvikle konverteringsprocedurerne til at generere de xml-filer, der var nødvendige for at importerer til CRF Reporter-systemet. Derudover var det nødvendigt at udfylde 'notation keys' for alle de sektorer, som ikke findes i Grønland.

Vedrørende rapporteringens elementer på tværs af sektorer blev der udført et Tier-1 usikkerhedsestimat. Usikkerhedsestimatet viser en samlet usikkerhed på drivhusgasudledningen på 5,8 %. Udviklingen i udledningen af drivhusgasser er siden basisåret steget med 10,6 % og usikkerheden i udviklingen er vurderet til 3,2 procentpoint. Den relativt lave totale usikkerhed skyldes den lave vurdering af usikkerheden i kuldioxid (CO_2)-udledningen samt den høje andel af CO_2 i den totale drivhusgasudledning. En Tier-1 'key category-analyse blev foretaget og denne resulterede i fem 'key categories' på baggrund af 2008-niveauet og yderligere fem 'key categories' på baggrund af udviklingen i drivhusgasudledningen. Tre kategorier var væsentlige for både niveau og udvikling. Størsteparten af 'key categories' blev fundet i energisektoren, men affaldssektoren også har 'key categories' på grund af "niveau" og "udvikling", mens landbrug og industri har 'key categories' på grund af udviklingen i udledningen.

Et vigtig factor i forbindelse med rapporteringen er at sikre kvaliteten af emissionsestimaterne ved at implementere QA/QC procedurer. Tidligere fandtes der ingen dokumentation over hvilke kvalitetsprocedurer der fandtes selvom adskillige procedurer allerede var implementerede. Dokumentationen af QA/QC-procedurerne er blevet forbedret både på sektorniveau og på det overordnede niveau. Derudover er en række tjekpunkter blevet implementeret under udviklingen af de nye datafiler der blev benyttet til at importere data ind i CRF Reporter.

For de enkelte kildesektorer blev der lavet adskillige forbedringer. Både i relation til vurderingen af tidligere manglende kilder, men også i relation til at forbedre de metoder, der havde været benyttet tidligere.

De vigtigste forbedringer i forbindelse med vurdering af udledninger fra de kategorier, der ikke tidligere havde været estimeret, var CO_2–udledninger fra mineralske produkter, CO_2–udledninger fra opløsningsmidler og anden produktbrug, N_2O-udledninger fra landbrugsjorde og N_2O fra håndtering af spildevand.

For adskillige kildekategorier gælder, at estimeringen og/eller rapporteringsmetoderne blev forbedret – dette var tilfældet for HFC'er hvor rapporteringen blev disaggregeret ud fra mere differentierede brugerkategorier. Med hensyn til husdyrs fordøjelsessystem samt håndteringen af gødning blev Tier-2-metoder implementeret som erstatning for den tidligere anvendte Tier-1-metode. Hvad angår deponering af affald blev en nedbrydningsmodel svarende til IPCC's Tier-2-metode implementeret. Beregning af emissioner fra åben afbrænding af affald blev forbedret ved at benytte den nyeste videnskabelige litteratur.

Emissioner fra indirekte drivhusgasser er for første gang beregnet for energisektoren, for industrielle processer, for opløsningsmidler samt for affaldsforbrænding.

For LULUCF gælder at der blev beregnet CO_2-emissioner/optag for alle relevante kategorier (skovområder, dyrkede arealer og græsningsområder) samt CO_2-emissioner fra kalkning.

KP-LULUCF opgørelsen for Grønland blev udført for alle obligatoriske og valgte aktiviteter og bidrog kun meget lidt til reduktionsforpligtelsen.

Ændringerne i den grønlandske drivhusgasopgørelse resulterede, på baggrund af dette projekt, i genberegninger af drivhusgasemissionen på 14,3 Gg CO_2-ækvivalenter i 2007 som rundt regnet svarer til 2 % af den samlede drivhusgasudledning. Den største genberegning blev foretaget i affaldssektoren hvor emissionen af drivhusgasser steg med omkring 16 Gg CO_2-ækvivalenter i 2007. De genberegninger, der er foretaget i landbrugssektoren, viser et fald i drivhusgasemissionen i 2007 med omkring 2,3 Gg CO_2-ækvivalenter.

Kongeriget Danmarks 2010-rapportering af drivhusgasemissionerne til Kyoto protokollen blev evalueret af eksterne eksperter i perioden 6. september til 11. september 2010. Den grønlandske drivhusgasopgørelse blev fremlagt og de omfattende forbedringer blev godtaget af UNFCCC's ekspertreviewteam. Der var ingen kritiske bemærkninger til den grønlandske drivhusgasopgørelse. Det kan derfor konkluderes, at projektet opnåede dets mål om at forbedre den grønlandske drivhusgasopgørelse så den fuldt ud kunne accepteres af UNFCCC's ekspertreviewteam.

Eqikkaaneq

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1 Introduction

Denmark has an obligation as a Party to the Climate Convention (UNFCCC) to report the anthropogenic emissions and removals of greenhouse gases (GHG) and indirect GHGs annually. The direct GHGs are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6); the indirect GHGs reported to the UNFCCC are sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC).

The reporting to the UNFCCC includes all territories within the Kingdom of Denmark, i.e. Denmark, Greenland and the Faroe Islands. Under the UNFCCC the Kyoto Protocol sets binding targets for reductions of GHG emissions. The Kyoto Protocol was ratified by Denmark on behalf of Denmark and Greenland, whereas the Faroe Islands chose not to join. The European Union is also a Party to both the Convention and the Kyoto Protocol. Neither Greenland nor the Faroe Islands are members of the European Union. Thus the obligation to report under the Monitoring Mechanism decision for the European Union is only applicable for Denmark.

As a consequence of these different territorial definitions, the Kingdom of Denmark has to prepare three different official submissions to the EU, UNFCCC and Kyoto Protocol respectively.

The regulations for reporting under the Kyoto Protocol are very strict and a failure to comply with the recommendations by the UNFCCC review team can lead to both adjustments of the reported GHG emissions and in severe cases, where the identified problems are with the National System a Question of Implementation can be raised. This can lead to a Party losing its rights to use the flexible mechanisms under the Kyoto Protocol.

During the UNFCCC review of the Danish 2009 submission under the Kyoto Protocol (UNFCCC, 2010) the Expert Review Team (ERT) identified the lack of a complete reporting of the Greenlandic GHG inventory as a problem and recommended that the Kingdom of Denmark improved the reporting in time for the 2010 submission.

The necessary improvements were multifaceted. There were both technical elements and scientific elements that had to be improved compared to the previous reporting.

The technical improvements needed were mainly connected to the use of the CRF (Common Reporting Format) Reporter tool for Greenland, the connection to the existent data systems in Statistics Greenland and the data systems at NERI where the submissions for Denmark and Greenland are aggregated. The level of detail in the CRF Reporter, i.e. the full CRF, is far beyond what was previously reported in the CRF Summary2 format, see Appendix 1 for an illustration of the Summary2 reporting used until the 2009 submission.

The scientific improvements were related to both the estimation of emissions and to documentation of the inventory and cross-cutting elements such as uncertainty estimation, key category analysis and QA/QC. Regarding the emission estimates all sectors were examined by NERI in cooperation with Statistics Greenland. For emission sources that had previously not been estimated, methodologies and emission factors were chosen in accordance with the IPCC Guidelines (IPCC, 1997) and the IPCC Good Practice Guidance (IPCC, 2000; IPCC, 2003) and the relevant emissions were estimated.

Also the methodologies and emission factors used in the previous inventories were checked, and in some cases changes were made as it was decided that data were available to allow for a more detailed estimation of emissions.

The objective of this project was to ensure that the Kingdom of Denmark could submit a complete GHG inventory in time for the 2010 submission and that the improvements were acknowledged by the UNFCCC review process.

The status of the Greenlandic GHG inventory as of the 2009 submission is described in Chapter 2. Based on the analysis of the completeness of the 2009 submission, the necessary improvements were decided. These improvements are described in detail in Chapter 3. Chapter 4 describes the resulting quantitative recalculations made to the Greenlandic inventory. Chapter 5 lists some recommendations for future improvements and Chapter 6 contains the conclusions derived from this project.

2 The Greenlandic greenhouse gas inventory as of the 2009 submission

The Greenlandic GHG inventory was until the 2009 submission reported in the aggregated CRF summary2 format. Additionally emissions from several sectors and subsectors were not estimated. The lack of a complete CRF reporting for the Kingdom of Denmark was criticised during the annual UNFCCC review of the Parties submissions. The incompleteness of the Greenlandic GHG inventory was also noted.

In the following chapters the status of the Greenlandic GHG inventory as of the 2009 submission will be described.

2.1 Energy

The energy sector includes emissions from fuel combustion and fugitive emissions from fuels. Emissions from waste incineration with energy recovery shall be reported in the energy sector according to the IPCC Guidelines (IPCC, 1997).

Presently there are no fugitive emissions from fuels occurring in Greenland since there is no coal mining or extraction of oil or natural gas.

The emission inventory for the energy sector in the 2009 submission was complete. However, due to the previous aggregated reporting the reference approach had not been implemented and emissions of indirect GHGs had not been estimated.

The improvements made to the inventory for the energy sector are further described in Chapter 3.2.

2.2 Industrial processes

In the 2009 submission only emissions of HFC's and SF_6 from consumption of halocarbons had been included.

Industrial processes also includes GHG emissions from a number of processes related to mineral products, chemical industry, iron and steel production and other production processes.

For Greenland the preliminary screening showed that emissions could occur from mineral products and other processes mainly related to food and drink production. Process related emissions from chemical industries and iron and steel production were determined to be not occurring and could therefore directly be reported as such in the CRF format.

Emissions of indirect GHGs had not previously been estimated.

The improvements made to the inventory for industrial processes are further described in Chapter 3.3.

2.3 Solvent and other product use

In the 2009 submission both emission of CO_2 and N_2O from this source category were reported as not estimated.

The sector includes NMVOC and CO_2 emissions from solvent use in connection with paint application, chemical products, degreasing and dry cleaning and other product use. This was deemed a probable source of emissions in Greenland.

This category also includes different uses of N_2O, e.g. as anaesthesia, in fire extinguishers or as propellant in aerosol cans. It could not be ruled out that this could be a source of emissions in Greenland.

The improvements made to the inventory for solvent and other product use are further described in Chapter 3.4.

2.4 Agriculture

The sector agriculture comprises the emissions related to livestock production including manure management and non-CO_2 emissions from agricultural soils. In the reporting format categories, which are not occurring in Greenland are also included such as rice cultivation, prescribed burning of savannas and field burning of agricultural residues. These categories were therefore filled out with the notation key indicating that the source is not occurring (NO).

In the 2009 submission emissions of CH_4 were reported for enteric fermentation and manure management. Emissions of N_2O were reported for manure management. Only emissions from sheep were included in the Greenlandic inventory.

Emissions related to agricultural soils were reported as not estimated. This includes N_2O emissions from e.g. use of synthetic fertiliser and manure excreted on pastures.

Agricultural soils could be expected to contribute significantly to the emissions of N_2O from Greenland.

The improvements made to the inventory for agriculture are further described in Chapter 3.5.

2.5 Land-use, land-use change and forestry (LULUCF)

Greenland is covering approximately 2,166,086 km^2. It has been estimated that 81 % is covered permanently with ice leaving only 410,449 km^2 ice free.

Due to the cold climate and the small constant population there is almost no land-use change occurring. The total area with Forests has been estimated to 218.5 hectares and five hectares with Cropland. Grassland is divided into improved Grassland covering 995 hectares and unimproved Grassland covering 241,000 hectares. Wetlands consist of man made water reservoirs – in total 1,076 hectares. Settlements cover 5,105 hectares. Land classified as "Other Land" is then 99.9 % of the total area.

The LULUCF sector differs from the other sectors in that it contains both sources and sinks of CO_2. LULUCF are reported in the new CRF format. Removals are given as negative figures and emissions are reported as positive figures according to the guidelines.

The improvements made to the inventory for LULUCF are described in Chapter 3.6.

2.5.1 Forests

Greenland is virtually without forests and therefore there exist no official forest statistics. All forests are situated in the most southern part of Greenland. In an attempt to introduce trees to Greenland research were carried out to find species adaptable for the Greenlandic climate. This resulted in establishment of the Greenlandic Arboretum, which covers 150 hectares out of the total area of 218.5 hectares.

2.5.2 Cropland

In 1990 there were no cropland occurring in Greenland. Due to the global warming it is now possible to have a few crops, which may mature. In 2001 the first five hectares with annual crops were established.

2.5.3 Grassland

Grassland in Greenland is dominated by unimproved grassland where the sheep are grazing. The total area with grassland has been estimated to 242,000 hectares. Of these only approximately 1,000 hectare are improved where stones have been removed combined with sowing of more high yielding species.

Since 1990 the area with improved grassland has been extended from 460 hectares to 995 hectares.

2.6 KP-LULUCF

The KP-LULUCF inventory was completed for the first time for the 2010 submission, which was the first year of mandatory reporting under the Kyoto Protocol.

Under the Kyoto Protocol there are two articles specifically concerning LULUCF (Article 3.3 and 3.4). Article 3.3 is mandatory for all Parties and requires reporting of emissions/removals from afforestation and reforestation activities since January 1 1990 and emissions/removals from deforestation. Article 3.4 was not mandatory and the Parties could choose to elect specific activities.

In connection with the initial report (MIM, 2006) the Kingdom of Denmark elected forest management, cropland management and grazing land management under Article 3.4, and this means that these activities also has to be reported for Greenland.

The KP-LULUCF inventory is further described in Chapter 3.7.

2.7 Waste

The waste sector includes emissions from solid waste disposal on land, wastewater handling and waste incineration without energy recovery. Waste incineration with energy recovery is to be included in the energy sector according to the IPCC Guidelines (IPCC, 1997).

In the 2009 submission CH_4 emissions from solid waste disposal on land and CO_2, CH_4 and N_2O emissions from waste incineration were reported. Additionally CO_2, CH_4 and N_2O emissions from open burning of waste were reported under other waste treatment.

Emissions of CH_4 and N_2O from wastewater handling were reported as not estimated. These emissions could potentially occur and it was therefore investigated further.

Emissions of indirect GHGs were not estimated for waste incineration in the 2009 submission.

The improvements made to the inventory for the waste sector are further described in Chapter 3.8.

2.8 Documentation

The documentation included in the 2009 submission of the National Inventory Report (NIR) was not complete according to the requirements in the UNFCCC reporting guidelines (UNFCCC, 2006).

For many of the sectors there were limited or no description of the methodology or the calculation parameters used to estimate emissions. There were also missing descriptions of the institutional arrangements and the process of inventory preparation.

A discussion of the emission trends and the underlying drivers was not included.

The improvements made to the documentation of the Greenlandic GHG inventory are further described in Chapter 3.9.

2.9 Cross-cutting issues

The UNFCCC reporting guidelines (UNFCCC, 2006) and the IPCC Good Practice Guidance (IPCC, 2000) requires several cross-cutting elements to be reported on in the annual NIR. These elements include:

- Uncertainty assessment.
- Key category analysis.
- QA/QC measures.
- Description of recalculations and improvements.
- Overall assessment of completeness.

None of these elements were included in the documentation for the Greenlandic GHG inventory in the 2009 submission.

The improvements made to the cross-cutting issues of the Greenlandic GHG inventory are further described in Chapter 3.10.

3 Improvements to the Greenlandic greenhouse gas inventory

As explained in Chapter 1 and Chapter 2 a number of improvements were needed. The improvements made during this project are documented in the following chapters. Besides the technical improvements needed, the improvements were focussed on ensuring the completeness of the Greenlandic GHG inventory. However, during the project a number of the existing calculation procedures were updated to better reflect the current knowledge or to implement higher tiers when the necessary data were readily available.

The full documentation of the Greenlandic GHG inventory as submitted in 2010 is available in Nielsen et al. (2010).

3.1 Technical improvements

One of the key improvements that had to be achieved in the project was the implementation of the full CRF reporting format for the Greenlandic GHG inventory.

The Parties are required to use the CRF Reporter software developed for the UNFCCC secretariat. NERI has experience in using the CRF Reporter since it was first introduced in 2007. An important element of the task was to determine how data could easily be transferred from the existing data management systems at Statistics Greenland to the CRF Reporter and to determine the way NERI should receive data in order to facilitate the aggregation of the Danish and Greenlandic data.

The background data (activity data and emission factors) for estimation of the Greenlandic emission inventories are collected and stored in central databases at Statistics Greenland. The databases are in SAS format and handled with software from the SAS Institute Inc.

Statistics Greenland developed the necessary routines in SAS to generate the xml files needed for the import in CRF Reporter. The correct export procedure from CRF Reporter for use in the aggregation process was developed by NERI and Statistics Greenland.

The implementation of the full CRF format increased the number of variables reported for each year from 106 to 3,205 compared to the summary2 format.

3.2 Energy

The emission inventory for the energy sector was considered complete prior to this project. However, improvements were made regarding the documentation, the implementation of the reference approach and regarding the estimation of indirect GHGs. Also the emissions from waste incineration with energy recovery were reallocated from CRF category

6C Waste Incineration to CRF category 1A1a Public Power and Heat Production in accordance with the IPCC Guidelines (IPCC, 1997).

The increased detail of the reporting format also necessitated improvements. In the detailed format emissions and fuel consumptions must be reported for more disaggregated sectors and for five different fuel groups (solid, liquid, gaseous, biomass and other fuels). To illustrate the dramatic increase in reporting detail the background tables for fuel combustion for Greenland in 2007 in the 2010 submission have been included in Appendix 2, and can be compared to the previous aggregated reporting format included in Appendix 1.

3.2.1 Indirect greenhouse gases

Emissions of indirect GHGs were estimated for the first time. Parties must report emissions of the indirect GHGs SO_2, NO_x, NMVOC and CO. The emissions of all four pollutants were estimated using IPCC tier 1 emission factors (IPCC, 1997) except for waste incineration with energy recovery where the Danish emission factors were used.

The majority of emissions of indirect GHGs originate from fuel combustion. SO_2 from fuel combustion accounts for 99.5 % of the Greenlandic SO_2 emission. NO_x, CO and NMVOC account for 99.2 %, 89.8 % and 75.8 %, respectively, of the Greenlandic emissions for these substances. The remaining emissions of these pollutants originate from solvent use and waste incineration without energy recovery.

3.2.2 The reference approach

For the first time the CO_2 emission was also estimated using the reference approach described in the IPCC Reference Manual (IPCC, 1997).

The reference approach is based on data for fuel production, import, export and stock change. The fraction of carbon oxidised has been assumed to be 1.00. The carbon emission factors are default factors originating from the IPCC Reference Manual (IPCC, 1997). The country-specific emission factors are not used in the reference approach, the approach being for the purposes of verification. In 2008 the fuel consumption rates in the two approaches differ by -0.1 % and the CO_2 emission differs by 0.9 %. In the period 1990-2008 both the fuel consumption and the CO_2 emission differ by less than 1.2 %. The differences in energy consumption are below 1 % for all years. The difference in CO_2 emission is above 1 % from 1990 to 2005, and below 1 % since 2006. According to IPCC Good Practice Guidance (IPCC, 2000) the difference should be within 2 %.

3.3 Industrial processes

Previously only emissions of f-gases had been reported. However, due to the more detailed reporting format improvements were needed to ensure compliance with the subdivision on different use categories for f-gases. Additionally, emissions from mineral products and food and drink had to be estimated.

3.3.1 Consumption of fluorinated gases

Previously the emissions from consumption of fluorinated gases were reported as totals for HFCs, PFCs and SF_6. Due to the more detailed reporting format the emissions had to be reported in a far more disaggregated way. The activity data on f-gases are now divided into domestic, commercial and industry, transport, and electrical equipment. Furthermore, the substances, which are accounted according to their trade names, are now transferred into "pure" substances for the purpose of reporting in the CRF.

3.3.2 Other industrial processes

During the project the following industrial processes categories were identified as source categories for Greenland:

- Limestone and dolomite use (CO_2).
- Asphalt roofing (CO_2, CO, NMVOC).
- Road paving with asphalt (CO_2, CO, NMVOC).
- Food and drink (NMVOC).

The activity data are import statistics from Statistics Greenland, while the emission factors for CO_2 refer to the IPCC Guidelines (IPCC, 1997) for limestone and dolomite use, and to the Danish inventory for asphalt roofing and road paving with asphalt (Nielsen et al., 2010).

The emission factors for CO and NMVOC also refer to the IPCC Guidelines and the Danish inventory.

3.4 Solvent and other product use

Emissions from this source category had previously not been estimated. The relevant gases from this source category are NMVOCs, which cause indirect CO_2 emissions, from use of solvents and NMVOC containing products and N_2O from different uses, e.g. anaesthesia.

The estimation of the emissions of NMVOC and CO_2 from the use of solvents was done by using the detailed methodology from the EMEP/Corinair Guidebook (2004). This is the same methodology used in the Danish inventory. The definition of VOC used is as defined in the solvent directive (Directive 1999/13/EC) of the EU legislation: "Volatile organic compound shall mean any organic compound having at 293.15 K a vapour pressure of 0.01 kPa or more, or having a corresponding volatility under the particular condition of use".

Import figures of chemicals and chemical containing products are obtained from Statistics Greenland. There is no production or export of chemicals and chemical containing products, therefore the import amount is assumed to be equivalent to the used amount.

The emission factors used in the Greenlandic inventory are the same as developed for the Danish inventory (Nielsen et al., 2010).

In 2008 the CO_2 emission from solvent use is estimated to 218 tonnes. Emissions peaked in 2005 with 326 tonnes.

Regarding the use of N_2O in Greenland this will be further investigated; during this project it was not possible to find documentation that any use of N_2O takes place.

3.5 Agriculture

For agriculture the entire subsector, agricultural soils, was not estimated in the 2009 submission. During the project it was further decided to improve the emission estimation for enteric fermentation and manure management since country-specific data were available.

3.5.1 Enteric fermentation and manure management

Previously the emissions from enteric fermentation and manure management were calculated using implied emission factors derived from the Danish emission inventory multiplied with the number of animals. This is equivalent to the IPCC tier 1 methodology.

In this project it was decided that it was possible to switch to the IPCC tier 2 methodology based on country-specific information. Country-specific data were available for energy intake by sheep and reindeer in Greenland, N-excretion and for volatile solids. For digestibility, ash content, methane conversion factor and methane producing capacity IPCC default values were used.

The implementation of a tier 2 methodology reduced the emissions from both enteric fermentation and manure management due to the lower energy intake of animals in Greenland compared to Denmark.

3.5.2 Agricultural soils

Emissions of N_2O takes place from agricultural soils. The subcategories found to be relevant for Greenland were direct emissions resulting from synthetic fertilizers, animal manure applied to soils, crop residue and cultivation of histosols, grazing animals and indirect emissions from atmospheric deposition and leaching and run-off. For all subcategories except cultivation of histosols the amount of nitrogen is calculated based on country-specific values. Default N_2O emission factors from the IPCC Guidelines are used to calculate emissions.

For cultivation of histosols the activity data are the area of organic soils (histosols) that is cultivated. In the submission May 27 2010 a country-specific emission factor was used derived by the same methodology as for Denmark. During the review of the 2010 submission, this was raised by the UNFCCC expert review team. Since the methodology used by Denmark and Greenland could not be satisfactory documented, it was decided to change the emission factor to the IPCC default value. This was done in the submission October 23 2010. This was the only issue raised during the review that had effect on the Greenlandic GHG inventory.

3.6 LULUCF

Significant improvements were needed to fulfil the reporting obligations even though the impact on the total emissions was expected to be small. The increased level of detail in reporting in the full CRF format also meant that significant improvements had to be made concerning the disaggregation of data.

Field burning of wooden biomass is not occurring. Wildfires may occur sporadic in the mountains and are reported as "Other land". Hence wildfires are reported as NO.

3.6.1 Forests

This is the first time Greenland submit a full inventory. A more thorough review of the current available forest data has been made since the last submission and this has caused a recalculation.

For Forest Land Remaining Forest Land three categories are used in the reporting: Larch, Other Conifers and Qinngua Valley. All afforestation is assumed to take place on land categorised as "other land".

Default factors from the IPCC Guidelines (IPCC, 2006) are used to estimate carbon stocks and carbon stock changes in the Greenlandic forest areas.

Fertilisation of forests and other land is negligible and all fertiliser consumption is therefore reported in the agricultural sector. No drainage of forest soils is made; also no liming takes place in forests.

3.6.2 Cropland

All cropland have been established since 1990 and are therefore reported as land converted to cropland. All land conversions to cropland are assumed to take place on grassland.

Default factors from the IPCC Guidelines (IPCC, 2006) are used to estimate carbon stocks and carbon stock changes in the Greenlandic agricultural area.

All liming are reported under grassland because of the very small area of cropland.

3.6.3 Grassland

The reporting for grassland distinguishes between "improved grassland" and "unmanaged grassland".

Default factors from the IPCC Guidelines (IPCC, 2006) are used to estimate carbon stocks and carbon stock changes in the Greenlandic grazing land area.

All liming are reported under grassland because liming is not occurring in the forests and the very small area with cropland.

3.7 KP-LULUCF

The reporting of LULUCF under the Kyoto Protocol was not mandatory until the 2010 submission, therefore it had not previously been reported. As mentioned in Chapter 2.6 the Kingdom of Denmark elected activities under article 3.4 of the Kyoto Protocol, so reporting had to be made for these activities in addition to the obligatory reporting of article 3.3 of the Kyoto Protocol.

Emissions and removals were estimated for article 3.3 and for the elected activities under article 3.4. The KP-LULUCF inventory is based on the LULUCF inventory elaborated under the UNFCCC. As described in Chapter 2.5 very little land in Greenland is used for forests, cropland or grazing land, thus the consequences for the emission inventory are also very limited.

The accounting under the Kyoto Protocol for 2008 is shown in Table 3.1.

Table 3.1 Accounting table for KP-LULUCF in 2008.

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net emissions-/removals			Accounting Parameters	Accounting Quantity
	BY(5)	2008	Total		
	(Gg CO_2 equivalent)				
A. Article 3.3 activities					
A.1. Afforestation and Reforestation					0.00
A.1.1. Units of land not harvested since the beginning of the commitment period		0.00	0.00		0.00
A.1.2. Units of land harvested since the beginning of the commitment period					IE,NA
Greenland		IE,NA	IE,NA		IE,NA
A.2. Deforestation		NA	NA		NA
B. Article 3.4 activities					
B.1. Forest Management		-0.05	-0.05		-0.05
3.3 offset				0.00	0.00
FM cap				916.67	-0.05
B.2. Cropland Management	IE,NA	0.02	0.02	IE,NA	0.02
B.3. Grazing Land Management	-0.23	-0.01	-0.01	-0.23	0.23

3.8 Waste

The waste sector consists of three main categories, all of which underwent significant changes as a result of this project. The largest change in terms of recalculation of emissions was the estimation of N_2O emissions from wastewater handling, whereas the largest methodological improvement was made for solid waste disposal on land, where a first order decay model was implemented.

3.8.1 Solid waste disposal on land

For solid waste disposal on land it was decided to implement a first order decay model equivalent to a tier 2 approach in the IPCC Guidelines,

since the necessary data to implement this far more detailed approach were available. The model combines country-specific information with IPCC default parameters.

3.8.2 Wastewater handling

The estimates for the waste sector previously did not include emissions from wastewater handling. The N_2O emissions from wastewater handling and human sewage were estimated. For human sewage the IPCC methodology was used, by estimating average protein consumption per capita for Greenland.

3.8.3 Waste incineration

The category Waste Incineration covers waste incinerated without energy recovery, both if this takes place in an incinerator and in case of open burning of waste. Previously the emissions from open burning were reported under Other Waste. The emission factors from waste incinerated in incinerators are assumed equal to waste incineration with energy recovery. These emission factors were updated based on information from a Danish study (Nielsen et al., 2010).

For open burning the emission calculation was totally revised based on default emission factors and standard parameters from the IPCC Guidelines (IPCC, 2006).

For emissions of indirect GHGs the emission factors refer to Danish values (Nielsen et al., 2010) for waste incineration and US EPA (1992) for open burning.

3.9 Documentation

The documentation of the Greenlandic GHG inventory has been significantly expanded. The full documentation report has been included in full as an annex to the National Inventory Report (NIR) (Nielsen et al., 2010).

The documentation report for the Greenlandic GHG inventory is to a great extent structured according to the recommended outline provided by the UNFCCC secretariat (UNFCCC, 2008).

The documentation includes the obligatory descriptions of the institutional arrangements in Greenland, the process of inventory preparation and discussion of the time-series trend and the key drivers for the development. Sectoral descriptions for all sectors have been included, including information on methodological issues, emissions, uncertainties, quality control and quality assurance procedures, recalculations and planned improvements.

As a result of the improvements made during this project the documentation of the Greenlandic GHG inventory increased from 20 pages in the 2009 submission to 133 pages in the 2010 submission.

3.10 Cross-cutting issues

For the first time a number of the required cross-cutting elements has been completed for the Greenlandic inventory. This includes an uncertainty calculation in line with the IPCC tier 1 methodology. Also, a key category analysis was made in accordance with the IPCC tier 1 methodology. (IPCC, 2000).

The QA/QC procedures have been documented for the first time. This includes both general QA/QC procedures and source specific QA/QC procedures. This has been thoroughly documented in Nielsen et al. (2010).

Additionally the completeness of the inventory is assessed and all recalculations and improvements have been transparently documented in the NIR.

3.10.1 Uncertainty analysis

A tier 1 uncertainty analysis was made in accordance with the IPCC Good Practice Guidance (IPCC, 2000). The uncertainty estimates covered all sectors of the Greenlandic GHG inventory. The uncertainties for the activity data and the emission factors used in the inventory are included in Table 3.2.

Table 3.2 Uncertainty factors for the activity data and emission factors used.

IPCC Source category	Gas	Base year emission	Year t emission	Activity data uncertainty	Emission factor uncertainty
		Input data	Input data	Input data	Input data
		Gg CO_2 eq	Gg CO_2 eq	%	%
1A Liquid fuels	CO_2	621	677	2	5
1A Municipal waste	CO_2	1	6	2	25
1A Liquid fuels	CH_4	1	1	2	100
1A Municipal waste	CH_4	0	0	2	100
1A Biomass	CH_4	0	0	2	100
1A Liquid fuels	N_2O	2	2	2	500
1A Municipal waste	N_2O	0	0	2	500
1A Biomass	N_2O	0	0	2	200
2A3 Limestone and dolomite use	CO_2	0	0	5	5
2A5 Asphalt roofing	CO_2	0	0	5	25
2A6 Road paving with asphalt	CO_2	0	0	5	25
2F Consumption of HFC	HFC	0	7	10	50
2F Consumption of SF6	SF_6	0	0	10	50
3A Paint application	CO_2	0	0	10	15
3B Degreasing and dry cleaning	CO_2	0	0	10	15
3C Chemical products, manufacturing and processing	CO_2	0	0	10	15
3D5 Other	CO_2	0	0	10	20
4A Enteric Fermentation	CH_4	6	6	10	100
4B Manure Management	CH_4	0	0	10	100
4.B Manure Management	N_2O	1	1	10	100
4D1 Direct N_2O emissions from agricultural soils	N_2O	0	2	20	50
4D2 Pasture range and paddock	N_2O	1	1	20	25
4D3 Indirect N_2O emissions from agricultural soils	N_2O	1	2	20	50
5A Forest	CO_2	0	0	5	50
5B Cropland	CO_2	0	0	5	50
5.C Grassland	CO_2	0	0	5	50
6A Solid Waste Disposal on Land	CH_4	4	4	10	100
6B Wastewater Handling	N_2O	15	16	30	100
6C Waste incineration	CO_2	3	3	10	25
6C Waste incineration	CH_4	2	2	10	50
6C Waste incineration	N_2O	1	1	10	100

The uncertainties of the activity data and the emission factors are based on the IPCC Good Practice Guidance (IPCC, 2000) and the expert judgement of NERI and Statistics Greenland.

The resulting overall uncertainties on the GHG inventory are shown in Table 3.3.

Table 3.3 Uncertainty, trend in emissions and trend uncertainty.

	Uncertainty, %	Trend, %	Trend uncertainty, %-age points
GHG	5.8	10.6	3.2
CO_2	5.3	9.7	3.1
CH_4	56	-5.6	9.0
N_2O	82	17	35
F-gases	51	10,717	4,768

The total Greenlandic GHG emission is estimated with an uncertainty of ±5.8 % and the trend in GHG emission since 1990 has been estimated to

be 10.6 % ± 3.2 %-age points. The GHG uncertainty estimates do not take into account the uncertainty of the GWP factors.

The uncertainty on CO_2 from liquid fuels in fuel combustion, N_2O emission wastewater treatment and CH_4 emission from enteric fermentation are the largest sources of uncertainty for the Greenlandic GHG inventory. The result is skewed by the fact that more than 90 % of the Greenlandic GHG emission is from fuel combustion of liquid fuels.

3.10.2 Key category analysis

Based on the IPCC Good Practice Guidance (IPCC, 2000) a tier 1 key category analysis (KCA) was made based on the CRF source categories. The KCA was made for both level and trend in 2008 and for the level in the base year (1990 for CO_2, CH_4 and N_2O, 1995 for f-gases). The analysis was only made including LULUCF since the LULUCF sector for Greenland contributes insignificantly to the overall emissions from Greenland.

The categorisation used results in a total of 33 categories. In the level KCA for the inventory for 1990, five key categories were identified. For the KCA for 2008, three categories were identified as key categories due to both level and trend. Two further categories were key categories due to level, while five other categories were key categories due to the trend. Of the five key sources due to level four are in the energy sector, of which CO_2 from liquid fuels - excluding transport in the analysis - contributes the most with 77.7 % of the national total. The remaining level key categories in the energy sector are all CO_2 emissions from the transport sector. Civil aviation, road transportation and domestic navigation comprise 7.3, 4.6 and 3.3 %, respectively, of the national total. The last key category is N_2O from wastewater handling. The trend assessment shows that consumption of HFCs, direct N_2O emissions from agricultural soils, enteric fermentation, CH_4 emission from waste incineration and indirect N_2O emissions from agricultural soils are key categories due to the trend.

Since no LULUCF categories are identified as key under the convention reporting, it is concluded that no KP-LULUCF categories are key (IPCC, 2003).

More details are included in Nielsen et al. (2010).

4 Influence of the recalculations on the Greenlandic greenhouse gas emissions

The recalculations made as a result of this project affected all sectors. For some sectors the result was a decrease of GHG emissions, while for other the result was an increase in GHG emissions. The recalculations are discussed both for the overall GHG emissions for Greenland in Chapter 4.1 and on a sectoral level in chapters 4.2 to 4.8.

4.1 Overall impact

The impact of all the recalculations performed is shown in Table 4.1.

Table 4.1 Overall impact of the recalculations on the Greenlandic greenhouse gas inventory, Gg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous submission	651.4	636.8	621.1	569.2	519.6	558.8	622.2	644.7	605.1	618.9
Latest submission	659.1	644.5	629.5	578.4	528.7	567.7	632.2	653.6	633.3	631.0
Difference, Gg	7.7	7.7	8.4	9.1	9.1	8.9	10.0	8.9	28.2	12.1
Difference, %	1.2	1.2	1.4	1.6	1.8	1.6	1.6	1.4	4.7	2.0
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous submission	691.1	642.6	603.7	675.3	663.6	663.0	686.5	679.3		
Latest submission	704.2	655.9	617.1	689.1	671.5	676.2	697.9	693.6	729.6	
Difference, Gg	13.1	13.3	13.4	13.9	7.8	13.1	11.4	14.3		
Difference, %	1.9	2.1	2.2	2.1	1.2	2.0	1.7	2.1		

The impact of the recalculations is an increase of emissions for all years of the time-series ranging from 7.0 Gg CO_2 equivalents in 2004 to 27.6 Gg CO_2 equivalents in 1998. This corresponds to 1.1 % and 4.6 %, respectively, for the two years. Generally the increase is between 1 and 2 % for all years with a tendency for the larger recalculations being in the more recent years in the time-series. The especially large recalculation in 1998 is due to large recalculations in the energy sector, see Table 4.2.

Table 4.2 Recalculations of the greenhouse gas emissions from the six reporting sectors, Gg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy	-2.3	-2.2	-1.9	-1.6	-1.4	-1.4	-1.2	-1.3	15.8	-1.0
Industrial processes	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.01
Solvent and other product use	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3
Agriculture	-3.2	-3.2	-2.7	-2.4	-2.7	-3.0	-2.2	-3.4	-1.7	-1.7
LULUCF	-0.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Waste	13.2	13.2	13.2	13.2	13.3	13.3	13.5	13.7	14.2	14.8
Continued	2000	2001	2002	2003	2004	2005	2006	2007		
Energy	-0.6	-0.5	-0.3	0.2	-6.1	-0.5	-2.3	0.5		
Industrial processes	0.02	0.04	0.05	0.06	0.07	0.06	0.05	0.05		
Solvent and other product use	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.2		
Agriculture	-2.0	-1.9	-1.6	-1.6	-1.7	-1.8	-1.7	-2.3		
LULUCF	-0.3	-0.4	-1.0	-0.3	-0.2	-0.5	-0.5	-0.2		
Waste	15.7	15.8	16.0	15.3	15.5	15.5	15.6	16.0		

Generally the largest recalculations have been made in the waste sector where the estimated GHG emissions have increased for all years. The other sectors with the largest recalculations are agriculture and energy. For agriculture the emissions decreased for all years due to the recalculations, while the energy sector increased for some years and decreased for others. The full explanations for the different sectors are provided in the following chapters.

4.2 Energy

The GHG emission inventory for the energy sector was considered complete prior to this project. However, several improvements were made resulting in recalculations. The impact of the recalculations is shown in Table 4.3.

Table 4.3 The quantitative impact of the recalculations on the energy sector, Gg CO_2 equivalents.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous submission	627.4	612.5	598.1	547.4	496.7	534.9	597.8	618.7	580.1	594.8
Latest submission	625.2	610.3	596.1	545.8	495.3	533.5	596.6	617.4	595.9	593.8
Difference, Gg	-2.3	-2.2	-1.9	-1.6	-1.4	-1.4	-1.2	-1.3	15.8	-1.0
Difference, %	-0.4	-0.4	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	2.7	-0.2
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous submission	668.3	618.4	579.5	649.6	637.2	636.0	659.6	651.7		
Latest submission	667.6	617.9	579.2	649.8	631.1	635.5	657.4	652.2	685.9	
Difference, Gg	-0.6	-0.5	-0.3	0.2	-6.1	-0.5	-2.3	0.5		
Difference, %	-0.1	-0.1	-0.1	0.0	-1.0	-0.1	-0.3	0.1		

The recalculations for the energy sector are minor for most years. However, some errors were corrected, which caused recalculation in 1998 and 2004 of 2.7 % and -1.0 %, respectively.

Table 4.4 shows the recalculations divided into the five main subsectors in the CRF format. It can be seen that all subsectors were affected by the recalculations. For the later years the largest recalculations took place in the transport sector and other sectors, which includes residential plants and fishery.

Table 4.4 Recalculation for the energy subsectors, difference between latest submission and previous submission, Gg CO_2 equivalents.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy Industries	-1.08	-1.06	-0.80	-0.57	-0.48	-0.16	0.03	-0.01	4.64	0.29
Manufacturing Industries and Construction	-0.16	-0.16	-0.15	-0.14	-0.12	-0.27	-0.28	-0.29	-0.25	-0.28
Transport	0.14	0.14	0.14	0.16	0.18	0.15	0.13	0.15	2.79	0.18
Other Sectors	-1.12	-1.10	-1.08	-1.03	-0.99	-1.05	-1.04	-1.09	8.63	-1.14
Other	-0.04	-0.04	-0.04	-0.04	-0.03	-0.05	-0.05	-0.05	-0.05	-0.05
Continued	2000	2001	2002	2003	2004	2005	2006	2007		
Energy Industries	0.74	0.76	0.92	1.52	1.56	1.64	1.68	-0.84		
Manufacturing Industries and Construction	-0.30	-0.28	-0.27	-0.31	-3.94	0.20	-0.46	6.33		
Transport	0.19	0.22	0.22	0.23	6.45	6.40	2.83	1.75		
Other Sectors	-1.19	-1.15	-1.12	-1.24	-11.26	-9.94	-7.68	-7.17		
Other	-0.05	-0.05	-0.05	-0.05	1.08	1.16	1.36	0.45		

4.3 Industrial processes

The inclusion of CO_2 emissions from mineral products caused a recalculation. The impact of this was very small; the CO_2 emission from this source category did not exceed 5 Mg in any year during the time-series.

Emissions from consumption of fluorinated gases were recalculated due to the more disaggregated reporting format. Also there were corrections made to the GWP value for some of the fluorinated gases in accordance with the UNFCCC reporting guidelines. (UNFCCC, 2006).

The total impact of the recalculation in industrial processes is shown in Table 4.5.

Table 4.5 The quantitative impact of the recalculations on industrial processes, Gg CO_2 equivalents.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous submission	NE	NE	NE	NE	NE	0.06	0.08	0.39	0.71	1.27
Latest submission	0.00	0.00	0.00	0.00	0.02	0.06	0.08	0.39	0.72	1.28
Difference, Gg						0.00	0.00	0.00	0.01	0.01
Difference, %						0.18	0.26	1.04	1.07	1.14
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous submission	1.85	2.93	3.86	4.70	5.36	5.44	5.51	6.02		
Latest submission	1.88	2.97	3.90	4.76	5.43	5.50	5.56	6.07	6.53	
Difference, Gg	0.02	0.04	0.05	0.06	0.07	0.06	0.05	0.05		
Difference, %	1.34	1.26	1.23	1.27	1.26	1.10	0.97	0.90		

4.4 Solvent and other product use

This sector was estimated for the first time. The GHG emission from this source category is estimated to between 0.21 and 0.33 Gg CO_2 equivalents during the time-series. The emission peaks in 2005 and is lowest in 1996 and 2007.

Table 4.6 The estimated emissions from solvent and other product use, Gg CO_2 equivalents.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Solvent and other product use	0.26	0.26	0.26	0.26	0.28	0.28	0.21	0.26	0.27	0.31
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Solvent and other product use	0.25	0.22	0.23	0.31	0.28	0.33	0.22	0.21	0.22	

4.5 Agriculture

In the agricultural sector the recalculation both included changes to the previously used methods and standard parameters and the inclusion of new source categories. The overall impact of the recalculations is shown in Table 4.7.

Table 4.7 The quantitative impact of the recalculations in the agricultural sector, Gg CO_2 equivalents.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous submission	12.4	12.5	11.2	9.9	10.8	11.7	12.1	13.4	12.4	11.8
Latest submission	9.2	9.3	8.4	7.5	8.2	8.7	9.9	10.0	10.6	10.1
Difference, Gg	-3.2	-3.2	-2.7	-2.4	-2.7	-3.0	-2.2	-3.4	-1.7	-1.7
Difference, %	-25.7	-25.6	-24.5	-24.3	-24.7	-25.6	-18.0	-25.7	-14.0	-14.6
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous submission	11.5	11.6	11.0	11.2	11.8	12.2	12.0	12.3		
Latest submission	9.5	9.7	9.4	9.5	10.1	10.5	10.4	10.0	11.6	
Difference, Gg	-2.0	-1.9	-1.6	-1.6	-1.7	-1.8	-1.7	-2.3		
Difference, %	-17.3	-16.0	-14.6	-14.4	-14.5	-14.4	-13.8	-18.6		

The overall impact of the recalculations is a significant decrease in the total GHG emission. The decrease is between 1.6 Gg (2002 & 2003) and 3.4 Gg in 1997. This equates to percentage reductions of between 14.4 and 25.7 during the time-series.

The recalculations for the subsectors in agriculture are shown in Table 4.8.

Table 4.8 Recalculation for the agricultural subsectors, difference between latest submission and previous submission, Gg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Enteric Fermentation	-2.6	-2.6	-2.3	-2.1	-2.3	-2.5	-2.6	-2.9	-2.6	-2.7
Manure Management	-3.0	-3.1	-2.7	-2.4	-2.7	-2.9	-3.0	-3.3	-3.0	-2.9
Agricultural Soils	2.4	2.4	2.3	2.1	2.3	2.4	3.4	2.8	3.8	3.9
Continued	2000	2001	2002	2003	2004	2005	2006	2007		
Enteric Fermentation	-2.6	-2.6	-2.4	-2.5	-2.6	-2.7	-2.7	-2.8		
Manure Management	-2.9	-2.9	-2.7	-2.8	-2.9	-3.0	-3.0	-3.0		
Agricultural Soils	3.5	3.6	3.5	3.6	3.8	4.0	4.0	3.5		

The emissions from agricultural soils were estimated for the first time and therefore constitute an increase in emissions for the whole time-series. The emissions from both enteric fermentation and manure management decreased as a consequence of the implementation of higher tier methodology and using some country-specific parameters in the emission calculation.

4.6 LULUCF

All years were recalculated based on the improved land use information required in this project. For most of the years the LULUCF sector became a net sink instead of a net source. For 2004 and 2007 the emission decreased, but for these two years the LULUCF sector is still a net source of emissions.

Table 4.9 The quantitative impact of the recalculations in the LULUCF sector.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous submission	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.14	0.14
Latest submission	-0.25	-0.20	-0.20	-0.19	-0.19	-0.18	-0.18	-0.18	-0.17	-0.17
Difference, Gg	-0.36	-0.32	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous submission	0.15	0.24	0.26	0.26	0.26	0.26	0.27	0.27		
Latest submission	-0.16	-0.15	-0.72	-0.08	0.03	-0.21	-0.27	0.06	-0.06	
Difference, Gg	-0.31	-0.39	-0.98	-0.34	-0.23	-0.48	-0.54	-0.20		

4.7 KP-LULUCF

As described in Chapter 2.5 and in Chapter 3.6 the KP-LULUCF was first reported in 2010. Additionally LULUCF is not part of the Annex A sources of the Kyoto Protocol and therefore it is not included in the total national emissions/removals of GHGs but is accounted for separately. Since Denmark elected cropland management and grazing land management where net-net accounting is used, the KP-LULUCF inventory is done for the base year (1990) and for the years in the commitment period. For the 2010 reporting this meant that KP-LULUCF inventories were submitted for 1990 and 2008.

The accounting quantity for the year 2008 is shown in Chapter 3.6.

4.8 Waste

The waste sector had the largest recalculations both in terms of absolute amounts of GHGs emitted and in percentage terms. Table 4.10 shows the total impact of the recalculations performed.

Table 4.10 The quantitative impact of the recalculations in the waste sector, Gg CO_2 equivalents.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Previous submission	11.5	11.7	11.8	11.8	11.9	12.1	12.1	12.1	11.8	10.9
Latest submission	24.7	24.8	24.9	25.0	25.2	25.4	25.6	25.7	26.0	25.7
Difference, Gg	13.2	13.2	13.2	13.2	13.3	13.3	13.5	13.7	14.2	14.8
Difference, %	115.1	112.7	112.1	111.8	111.0	109.9	112.1	113.2	120.9	135.4
Continued	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Previous submission	9.4	9.4	9.0	9.5	9.1	9.1	9.1	9.1		
Latest submission	25.1	25.2	25.1	24.8	24.6	24.6	24.7	25.0	25.4	
Difference, Gg	15.7	15.8	16.0	15.3	15.5	15.5	15.6	16.0		
Difference, %	167.5	167.0	177.0	160.3	170.9	170.7	171.3	175.7		

The recalculations result in increasing emissions for all years, which is mainly caused by the inclusion of emissions from wastewater handling. The total impact ranges from 13.2 Gg CO_2 equivalents in the first years of the time-series to 16.0 Gg CO_2 equivalents in 2008. The impact of the recalculations on the different subsectors is shown in Table 4.11.

Table 4.11 Recalculation for the waste subsectors, difference between latest submission and previous submission, Gg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Solid Waste Disposal on Land	-4.5	-4.5	-4.5	-4.5	-4.5	-4.6	-4.4	-4.3	-3.8	-3.2
Wastewater Handling	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
Waste Incineration	5.9	6.0	6.0	6.0	6.1	6.2	6.2	6.2	6.2	5.8
Other	-3.4	-3.5	-3.5	-3.5	-3.5	-3.5	-3.5	-3.5	-3.3	-3.0
Continued	2000	2001	2002	2003	2004	2005	2006	2007		
Solid Waste Disposal on Land	-2.0	-2.0	-1.8	-2.1	-1.8	-1.9	-1.9	-1.9		
Wastewater Handling	15.2	15.2	15.2	15.2	15.3	15.2	15.3	15.7		
Waste Incineration	5.1	5.1	5.0	4.7	4.6	4.6	4.6	4.6		
Other	-2.6	-2.6	-2.5	-2.6	-2.5	-2.5	-2.5	-2.5		

The category Other was previously used for reporting of emissions from open burning of waste. These emissions were recalculated and reallocated to waste incineration. The implementation of a first order decay model for solid waste disposal on land resulted in recalculated emissions that were lower compared to the previous estimates, ranging from 1.8 Gg CO_2 equivalents in 2002 and 2004 to 4.6 Gg CO_2 equivalents in 1995. Wastewater handling contributed with between 15.2 and 15.7 Gg CO_2 equivalents for the entire time-series.

5 Future improvements

The project of improving the Greenlandic GHG inventory achieved all the objectives. However, during the project some areas were identified as potential future improvements. The future improvements are related to further investigation on some minor sources of emissions, the possibility of acquiring more country-specific emission factors and improvements in some of the cross-cutting issues. The list of potential improvements is presented below.

- More country-specific CO_2 emission factors in the energy sector. Especially for gas/diesel oil and gasoline, that is by far the most important sources of CO_2 emissions in the Greenlandic inventory.
- Consider the feasibility of moving to higher tiers in the energy sector, especially for transport.
- Identify the single HFCs currently reported as an unspecified mix of HFCs.
- Investigate potential use of N_2O in Greenland and estimate associated emissions.
- Acquire actual lime consumption for agricultural lime application to be reported under the LULUCF sector.
- Obtain better data on waste amounts and composition going to solid waste disposal on land.
- Obtain better data for estimating emissions from wastewater handling.
- More country-specific uncertainty estimates.
- Consider the implementation of tier 2 key category analysis and tier uncertainty estimation.
- Further expand the QA/QC procedures.

6 Conclusion

The project to improve the Greenlandic GHG inventory was undertaken due to the recommendations made by the UNFCCC review team in connection with the 2008 and 2009 submissions by the Kingdom of Denmark.

The objective was to address all points of concern raised by the UNFCCC review team, hereby ensuring that no potential problems were raised regarding the Greenlandic inventory during the review of the 2010 submission.

The project succeeded to complete all objectives and thus the Kingdom of Denmark was able to submit a complete inventory in the full CRF format within the deadline on April 15 2010, and to resubmit within the requested six weeks on May 27 2010.

The improvements made to the Greenlandic GHG emission inventory were substantial. Firstly the full CRF format was implemented significantly increasing the level of detail. This required a large effort to adapt the current data system and to develop the conversion procedures to generate the xml files needed for import to the CRF Reporter. Additionally there was the need for filling out notation keys for all the sectors not occurring in Greenland.

For the cross-cutting elements of the reporting a tier 1 uncertainty estimation was made. The uncertainty estimation showed a total uncertainty of the GHG emission of 5.8 %. The GHG emission trend since the base year has been an increase of 10.6 % and the uncertainty of the trend was estimated to 3.2 percentage point. The relatively low overall uncertainty is due to the low uncertainty of the CO_2 emission estimation and the high share of CO_2 of the total GHG emissions. A tier 1 key category analysis was made resulting in five key categories due to level in 2008 and five further key categories due to the trend. Three categories were key for both level and trend. The majority of key categories were in the energy sector, but the waste sector also has key categories due to level or trend, while agriculture and industrial processes have key categories due to the emission trend.

An important element in the reporting is to ensure the quality of the emission estimates by implementing QA/QC procedures. Previously no documentation of the quality procedures existed even though several procedures were implemented. The documentation of the QA/QC procedures has been improved both on the sectoral level and on the overall level. Additionally a number of checks were implemented in the development of the new data files used for importing data into the CRF Reporter.

For the individual source sectors numerous improvements were made. This was both related to the estimation of previously missing sources and to refining the methodologies that had been used previously.

The main improvements related to estimation of emissions from categories where emissions had not previously been estimated, were CO_2 emissions from mineral products, CO_2 emissions from solvent and other product use, N_2O emissions from agricultural soils and N_2O from wastewater handling.

For several source categories the estimation and/or reporting methodologies were improved; this was the case for HFCs, where the reporting where disaggregated according to more differentiated use categories. For enteric fermentation and manure management tier 2 methodologies were implemented replacing the previously used tier 1 methodology. For solid waste disposal on land a decay model was implemented similar to the IPCC tier 2 methodology. The calculation of emissions from open burning of waste was improved using the newest scientific literature available.

Emissions of indirect GHGs were estimated for the first time for the energy sector, industrial processes, solvent use and waste incineration.

For LULUCF CO_2 emissions/removals were estimated for all relevant categories (forest land, cropland and grazing land) as well as CO_2 emissions from liming.

The KP-LULUCF inventory for Greenland was completed for all the mandatory and elected activities and provided a very small contribution to the reduction commitment.

The changes made to the Greenlandic GHG inventory as a result of this project resulted in recalculations of the GHG emission of 14.3 Gg of CO_2-equivalents in 2007, which roughly corresponds to 2 % of the total GHG emissions. The largest recalculation took place in the waste sector where the emission of GHGs increased by approximately 16 Gg of CO_2 equivalents in 2007. The recalculations made in agriculture decreased the GHG emission in 2007 by approximately 2.3 Gg of CO_2 equivalents.

The 2010 submission for the Kingdom of Denmark under the Kyoto Protocol was reviewed in-country in the week from September 6 to 11. During the week the Greenlandic GHG inventory was presented and the vast improvements were acknowledged by the UNFCCC expert review team. There were no critical remarks on the Greenlandic GHG inventory. It can therefore be concluded that the project achieved its objective of improving the Greenlandic GHG inventory so that it was fully accepted by the UNFCCC expert review team.

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Appendix 1

Summary2 table for Greenland for the year 2007 as in the 2009 submission.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2007
Submission 2009 v2.1
GREENLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions)	**649,15**	**15,37**	**8,77**	**6,01**	**0,00**	**0,00**	**679,31**
1. Energy	**646,18**	**0,88**	**4,63**				**651,68**
A. Fuel Combustion (Sectoral Approach)	646,18	0,88	4,63				651,68
1. Energy Industries	135,90	0,14	1,36				137,39
2. Manufacturing Industries and Construction	51,13	0,04	0,43				51,61
3. Transport	107,10	0,20	0,68				107,98
4. Other Sectors	345,04	0,49	2,09				347,61
5. Other	7,01	0,01	0,07				7,09
B. Fugitive Emissions from Fuels	NO	NO	NO				NO
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	NO	NO	NO				NO
2. Industrial Processes	**NO,NE**	**NO,NE**	**NO,NE**	**6,01**	**0,00**	**0,00**	**6,02**
A. Mineral Products	NE	NE	NE				NE
B. Chemical Industry	NO	NO	NO				NO
C. Metal Production	NO	NO	NO		NO	NO	NO
D. Other Production	NE						NE
E. Production of Halocarbons and SF_6				NO	NO	NO	0,00
F. Consumption of Halocarbons and SF_6				6,01	NO	0,00	6,02
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NE**		**NE**				**NE**
4. Agriculture		**8,55**	**3,71**				**12,26**
A. Enteric Fermentation		8,39					8,39
B. Manure Management		0,16	3,71				3,87
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NE	NE				NE
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry	**0,27**	**NA,NE**	**NA,NE**				**0,27**
A. Forest Land	-0,05	NA	NA				-0,05
B. Cropland	0,09	NA	NE				0,09
C. Grassland	0,22	NA	NE				0,22
D. Wetlands	NE	NE	NE				NE
E. Settlements	NE	NE	NE				NE
F. Other Land	NE	NE	NE				NE
G. Other	NE	NE	NE				NE
6. Waste	**2,71**	**5,94**	**0,43**				**9,09**
A. Solid Waste Disposal on Land	NE	5,92					5,92
B. Wastewater Handling		NE	NE				NE
C. Waste Incineration	0,64	0,00	0,06				0,71
D. Other	2,07	0,01	0,37				2,46
7. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Memo Items:							
International Bunkers	9,59	0,01	0,02				9,63
Aviation	NO	NO	NO				NO
Marine	9,59	0,01	0,02				9,63
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**NE**						**NE**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	679,05
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	679,31

Appendix 2

Detailed reporting format for fuel combustion for Greenland for the year 2007 as of the 2010 submission.

TABLE 1.A(a) SECTORAL BACKGROUND DATA FOR ENERGY

Fuel Combustion Activities - Sectoral Approach

(Sheet 1 of 4)

Inventory 2007

Submission 2010 v1.4

GREENLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		IMPLIED EMISSION FACTORS			EMISSIONS		
	Consumption		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	(TJ)	NCV/GCV	(t/TJ)	(kg/TJ)		(Gg)		
1.A. Fuel Combustion	9.011,96	NCV				648,87	0,06	0,01
Liquid Fuels	8.843,39	NCV	72,75	5,81	0,71	643,39	0,05	0,01
Solid Fuels	NA,NO	NCV	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Gaseous Fuels	NA,NO	NCV	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Biomass	99,12	NCV	135,37	30,00	4,00		0,00	0,00
Other Fuels	69,45	NCV	78,88	30,00	4,00	5,48	0,00	0,00
1.A.1. Energy Industries	1.946,85	NCV				135,80	0,01	0,00
Liquid Fuels	1.778,27	NCV	73,28	3,00	0,60	130,32	0,01	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	99,12	NCV	135,37	30,00	4,00	13,42	0,00	0,00
Other Fuels	69,45	NCV	78,88	30,00	4,00	5,48	0,00	0,00
a. Public Electricity and Heat Production	1.946,85	NCV				135,80	0,01	0,00
Liquid Fuels	1.778,27	NCV	73,28	3,00	0,60	130,32	0,01	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	99,12	NCV	135,37	30,00	4,00	13,42	0,00	0,00
Other Fuels	69,45	NCV	78,88	30,00	4,00	5,48	0,00	0,00
b. Petroleum Refining	NO	NCV				NO	NO	NO
Liquid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
c. Manufacture of Solid Fuels and Other Energy Industries	NO	NCV				NO	NO	NO
Liquid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO

TABLE 1.A(a) SECTORAL BACKGROUND DATA FOR ENERGY
Fuel Combustion Activities - Sectoral Approach
(Sheet 2 of 4)

Inventory 2007
Submission 2010 v1.4
GREENLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		IMPLIED EMISSION FACTORS			EMISSIONS		
	Consumption		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	(TJ)	NCV/GCV	(t/TJ)	(kg/TJ)		(Gg)		
1.A.2 Manufacturing Industries and Construction	788,19	NCV				57,77	0,00	0,00
Liquid Fuels	788,19	NCV	73,29	2,00	0,60	57,77	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
a. Iron and Steel	17,55	NCV				1,29	0,00	0,00
Liquid Fuels	17,55	NCV	73,28	2,00	0,60	1,29	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
b. Non-Ferrous Metals	NO	NCV				NO	NO	NO
Liquid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
c. Chemicals	NO	NCV				NO	NO	NO
Liquid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
d. Pulp, Paper and Print	12,25	NCV				0,90	0,00	0,00
Liquid Fuels	12,25	NCV	73,33	2,00	0,60	0,90	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
e. Food Processing, Beverages and Tobacco	296,53	NCV				21,74	0,00	0,00
Liquid Fuels	296,53	NCV	73,30	2,00	0,60	21,74	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
f. Other	461,86	NCV				33,84	0,00	0,00
Construction								
Liquid Fuels	255,30	NCV	73,25	2,00	0,60	18,70	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO

Mining								
Liquid Fuels	189,77	NCV	73,31	2,00	0,60	13,91	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Other non-specified								
Liquid Fuels	9,19	NCV	73,33	2,00	0,60	0,67	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Textile								
Liquid Fuels	7,59	NCV	73,33	2,00	0,60	0,56	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO

TABLE 1.A(a) SECTORAL BACKGROUND DATA FOR ENERGY

Inventory 2007

Fuel Combustion Activities - Sectoral Approach

Submission 2010 v1.4

(Sheet 3 of 4)

GREENLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		IMPLIED EMISSION FACTORS (2)			EMISSIONS		
	Consumption		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	(TJ)	NCV/GCV	(t/TJ)	(kg/TJ)		(Gg)		
1.A.3 Transport	1.528,09	NCV				108,99	0,01	0,00
Liquid Fuels	1.528,09	NCV	71,33	4,72	1,25	108,99	0,01	0,00
Solid Fuels	NA,NO	NCV	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Gaseous Fuels	NA,NO	NCV	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Biomass	NA,NO	NCV	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Other Fuels	NA	NCV	NA	NA	NA	NA	NA	NA
a. Civil Aviation	704,12	NCV				49,83	0,00	0,00
Aviation Gasoline	5,56	NCV	68,61	0,50	2,00	0,38	0,00	0,00
Jet Kerosene	698,56	NCV	70,79	0,50	2,00	49,45	0,00	0,00
b. Road Transportation	483,01	NCV				34,61	0,01	0,00
Gasoline	162,18	NCV	68,61	20,00	0,60	11,13	0,00	0,00
Diesel Oil	300,10	NCV	73,33	5,00	0,60	22,01	0,00	0,00
Liquefied Petroleum Gases (LPG)	NO	NCV	NO	NO	NO	NO	NO	NO
Other Liquid Fuels	20,72	NCV				1,47	0,00	0,00
Kerosene	20,72	NCV	71,15	20,00	0,60	1,47	0,00	0,00
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NA	NCV				NA	NA	NA
c. Railways	NA,NO	NCV				NA,NO	NA,NO	NA,NO
Liquid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NA	NCV				NA	NA	NA
d. Navigation	340,96	NCV				24,56	0,00	0,00
Residual Oil (Residual Fuel Oil)	NO	NCV	NO	NO	NO	NO	NO	NO
Gas/Diesel Oil	239,67	NCV	73,33	5,00	0,60	17,57	0,00	0,00
Gasoline	87,16	NCV	68,61	5,00	0,60	5,98	0,00	0,00
Other Liquid Fuels	14,12	NCV				1,00	0,00	0,00
Kerosene	14,12	NCV	71,15	5,00	0,60	1,00	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NA	NCV				NA	NA	NA
e. Other Transportation	NA	NCV				NA	NA	NA

TABLE 1.A(a) SECTORAL BACKGROUND DATA FOR ENERGY

Inventory 2007

Fuel Combustion Activities - Sectoral Approach

Submission 2010 v1.4

(Sheet 4 of 4)

GREENLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		IMPLIED EMISSION FACTORS			EMISSIONS		
	Consumption		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	(TJ)	NCV/GCV	(t/TJ)	(kg/TJ)		(Gg)		
1.A.4 Other Sectors	4.646,18	NCV				338,81	0,04	0,00
Liquid Fuels	4.646,18	NCV	72,92	7,90	0,60	338,81	0,04	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
a. Commercial/Institutional	936,90	NCV				68,49	0,01	0,00
Liquid Fuels	936,90	NCV	73,10	10,00	0,60	68,49	0,01	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
b. Residential	1.746,63	NCV				127,75	0,02	0,00
Liquid Fuels	1.746,63	NCV	73,14	10,00	0,60	127,75	0,02	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
c. Agriculture/Forestry/Fisheries	1.962,65	NCV				142,57	0,01	0,00
Liquid Fuels	1.962,65	NCV	72,64	5,03	0,60	142,57	0,01	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
1.A.5 Other	102,66	NCV				7,50	0,00	0,00
a. Stationary	NA	NCV				NA	NA	NA
b. Mobile	102,66	NCV				7,50	0,00	0,00
Military use								
Liquid Fuels	102,66	NCV	73,09	5,00	0,60	7,50	0,00	0,00
Solid Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NCV	NO	NO	NO	NO	NO	NO
Biomass	NO	NCV	NO	NO	NO	NO	NO	NO
Other Fuels	NO	NCV	NO	NO	NO	NO	NO	NO

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IMPROVING THE GREENLANDIC GREENHOUSE GAS INVENTORY

The project to improve the Greenlandic greenhouse gas (GHG) inventory was undertaken due to the recommendations made by the UNFCCC review team in connection with the 2008 and 2009 submissions by the Kingdom of Denmark. The improvements made to the Greenlandic GHG emission inventory were substantial. Firstly the full CRF format was implemented significantly increasing the level of detail. For the cross-cutting elements of the reporting a tier 1 uncertainty estimation was made. The uncertainty estimation showed a total uncertainty of the GHG emission of 5.8 %. A tier 1 key category analysis was made resulting in five key categories due to level in 2008 and five further key categories due to the trend. Three categories were key for both level and trend. For the individual source sectors numerous improvements were made. This was both related to the estimation of previously missing sources and to refining the methodologies that had been previously used. The changes made to the Greenlandic GHG inventory as a result of this project resulted in recalculations of the GHG emission of 14.3 Gg of CO2 equivalents in 2007, which roughly corresponds to 2 % of the total GHG emissions.

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