REPORT

Compilation of data for Sweden to the GAINS model

- Development of a basis for a Swedish baseline scenario in the GAINS model

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Report Summary

Project title

Adaptation of Swedish energy and emission scenarios into a GAINS model format

Project sponsor

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Title and subtitle of the report

Compilation of data for Sweden to the GAINS model

- Development of a basis for a Swedish baseline scenario in the GAINS model

Summary

The purpose with the project was to create a robust system for development of national emission scenarios in the GAINS model that are consistent with Swedish official emission inventories and emission projections. Such a system required a structured compilation of information sources as well as a systematic method for re-formatting data.

The basis for the data compilation was the data used in the official Swedish emission inventory and emission projections. These data sometimes needed to be complemented for more detailed information from official sources such as the Swedish Transport Administration, Swedish Energy Agency, and the Swedish Environmental Protection Agency. Following this a data conversion tool was developed. After introducing Swedish data and projections into the GAINS model we could compare and analyse differences between emissions in the Swedish scenario in the GAINS model and the emissions in the official Swedish national reporting. The results showed that emissions were suitably aligned for SO_2, while NO_x and $PM_{2.5}$ emissions differed.

All in all, this project describes the process of developing a scenario for Sweden in the GAINS model based on national data. Special attention, and a systematic approach, is needed in the re-aggregation and re-allocation of fuels and sectors from a Swedish format to a GAINS model format. Further development of the approach used during re-allocation and re-aggregation of data is needed, as well as increased national knowledge regarding the current and expected use of air pollution emission control technologies in Sweden.

Keyword

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Summary

This report summarise the results from the project "Adaptation of Swedish energy and emission scenarios into a GAINS model format", financed by the Swedish Environmental Protection Agency and the research programme SCARP. The purpose with the project was to create a robust system for development of national emission scenarios in the GAINS model that are consistent with Swedish official emission inventories and emission projections. Such a system required a structured compilation of information sources as well as a systematic method for transferring numerical estimates on emission precursor activities into a GAINS model format. The GAINS model is an Integrated Assessment Model used to deliver decision support material mainly to international negotiations on air pollution.
The basis for the data compilation was the data used in the official Swedish emission inventory and emission projections. These data sometimes needed to be complemented for more detailed information from official sources such as the Swedish Transport Administration, Swedish Energy Agency, and the Swedish Environmental Protection Agency. Following this a data conversion tool was developed. This tool enabled a standardisation of the re-allocation and re-aggregation of emission precursor data (activity data) from Swedish energy related sources into a GAINS model format. A number of assumptions and generalisations were required during the data transfer, and expert estimates involving the GAINS model team were needed. After introducing Swedish data and projections into the GAINS model, and thereby creating a Swedish scenario in the GAINS model, we could compare and analyse differences between emissions in the Swedish scenario in the GAINS model and the emissions in the official Swedish national reporting.
The results showed that emissions were suitably aligned for SO_2, while NO_x and $PM_{2.5}$ emissions differed. The largest source for the differences in NO_x emissions was for the year 2005 the transport sector, where the information on vehicle age was different between the Swedish scenario in the GAINS model and the official Swedish national reporting. For 2020, the major differences were found in the industry and process sectors; the road transport sector; and the power plants. For $PM_{2.5}$ the largest differences were found in for the small scale combustion in the domestic sector.

All in all, this project describes the process of developing a scenario for Sweden in the GAINS model based on national data. Special attention, and a systematic approach, is needed in the re-aggregation and re-allocation of fuels and sectors from a Swedish format to a GAINS model format. Further development of the approach used during re-allocation and re-aggregation of data is needed, as well as increased national knowledge regarding the current and expected use of air pollution emission control technologies in Sweden.

Thesaurus

Explanation of abbreviations and terms in this report.

Abbreviation	Explanation
Activity data	Data on emission precursor activities (fuel use etc.).These are used in the GAINS model as one part of the emission and cost calculations.
ARTEMIS	Assessment and Reliability of Transport EMISsion model
BLIQ	Black Liquor
BO	Boilers
CAPRI model	Common Agricultural Policy Regionalised Impact analysis model
CH_4	Methane
CHP	Combined Heat and Power
CIAM	Centre for Integrated Assessment Modelling under CLRTAP
CLRTAP	Convention on Long Range Transboundary Air Pollution
CO_2	Carbon dioxide
CON	Energy Conversion
Control Strategy	A GAINS model control strategy is a joint description of all the technologies used (implemented) in a given emission scenario
Control technology	This GAINS model term refers to a technology or equipment that can be used (implemented) to reduce emissions of a pollutant.
CORINAIR	EU CORe INventory on AIR emissions programme
CRF	Common Reporting Format for reporting of GreenHouse Gas emissions
DOM	Residential and Service sector
EEA	European Environment Agency
EMEC model	Environmental Medium term EConomic *model*
EMEP model	The main model used under the CLRTAP to model emission dispersion, air concentration, and deposition fields for acidifying and eutrophying pollutants, photo-oxidants, and particulate matter (www.emep.int)
EMEP protocol	Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)
ETS	Emissions Trading System
EUROSTAT	Statistical office of the European Union
GAINS	Greenhouse Gas – Air Pollution Interactions and Synergies
GAINS IEA-scenario, (IEA_2008)	A scenario describing developments of Swedish economic activities and emissions in accordance with the International Energy Agency Energy scenario 'World Energy Outlook 2008'
GAINS PRIMES-scenario (BL 2009_Draft)	A scenario describing developments of Swedish economic activities and emissions in developed by European-scale models: PRIMES energy system model, TREMOVE / COPAIR transport model, CAPRI agricultural model
GHG	Greenhouse Gas
HFP	High Fossil fuel Prices
IAM	Integrated Assessment Model
IIASA	International Institute for Applied System Analysis
IEA	International Energy Agency
IEG	Increased Economic Growth
IIR	Informative Inventory Report

Implied emission factors	The implied emission factors is a resulting emission factor which represents a specific emission source (on the national level), that includes all different plants and abatement measures for this specific emission source.
IN	Industry
IPCC	Intergovernmental Panel on Climate Change
IVL	IVL Swedish Environmental Research Institute Ltd.
JTI	The Swedish Institution of Agriculture and Environmental Engineering
LULUCF	Land-Use, Land-Use Change and Forestry
MARKAL-Nordic	Energy system model used for projections of the Swedish energy system
NBF	The National Board of Forestry
NEC	National Emissions Ceilings
NFR	New Format for Reporting
NH_3	Ammonia
NIER	National Institute of Economic Research
NMVOC	Non-Methane Volatile Organic Compound
N_2O	Nitrous oxide
NO_x	Nitrogen oxides
NRMM	Non-Road Mobile Machinery
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter smaller than 2.5 µm
PM_{10}	Particulate Matter with an aerodynamic diameter smaller than 10 µm
PM_{BC} & PM_{OC}	Black and Organic carbon
PP	Power Plants
PRIMES	European-scale energy system model
SCB	Statistics Sweden
SCARP	Swedish Clean Air Research Programme
SEA	The Swedish Energy Agency
SJV	The Swedish Board of Agriculture
SLU	Swedish university of Agricultural Sciences
SMED	Svensk MiljöEmissionsData (Swedish Environmental Emissions Data)
SMHI	the Swedish Meteorological and Hydrological Institute
SNAP	Standardized Nomenclature for Air Pollutants
SO_2	Sulphur Dioxide
SRA	The Swedish Road Administration
Swedish EPA	Swedish Environmental Protection Agency
SWE BSL scenario	The GAINS model energy and emission baseline scenario for Sweden developed within this project
TFEIP	Task Force on Emission Inventories and Projections
TPES method	Total Primary Energy Supply method: The national energy balance is calculated based on the primary fuel used (as in contrast to the energy used).
TPS	Technical Production System
Unabated emission factors	All activity data in the GAINS model is associated with an 'uncontrolled/unabated emission factor'. The unabated emission factor describes the emissions that would occur if no emission control technology would be implemented.
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile Organic Compound
VTI	The Swedish National Road and Transport Research Institute
WGSR	Working groups on Strategies and Review under the CLRTAP

Contents

Introduction

High emissions of air pollutants cause adverse environmental impacts and health problems. Many air pollutants are dispersed over long distances, which is why air pollution is a problem that requires international collaboration. This problem was brought to public and policy attention in the late 60-ies. Following the political acceptance of the transboundary nature of air pollution, the United Nations Economic Commission for Europe (UNECE) Convention on Long Range Transboundary Air Pollution (CLRTAP) was created in 1979. Up until January 2013 the convention has 52 parties and 9 protocols have been agreed upon. Under the first protocol, the Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), the ratifying parties have agreed to report emission inventories of key air pollutants to the Convention.

The work and negotiations under CLRTAP are to a large extent performed via active communication between governmental representatives, scientists, and other stakeholders such as NGO:s and industrial organisations. One consequence of this close involvement of scientists is that much of the support material for negotiations are based on computer modelling such as Integrated Assessment Models (IAM). The key IAM in the CLRTAP is the Greenhouse Gas – Air Pollution Interactions and Synergies (GAINS) model that is developed by the International Institute for Applied System Analysis (IIASA). The GAINS modelling team provides the CLRTAP with scenario calculations on future emissions, emission abatement costs, environmental impacts and possibilities for further emission reductions.

The Swedish Environmental Protection Agency (Swedish EPA) has contracted IVL Swedish Environmental Research Institute Ltd. (IVL) to create a system for development of scenarios for Sweden in the GAINS model that are in line with the Swedish emission projections reported according to requirements in the CLRTAP EMEP protocol. This work has been performed as a joint activity with the Swedish Clean Air Research Programme (SCARP).

This report is a revised version of a report originally compiled during the winter 2010. In the report, the numbers presented are based on data and projections available during autumn and winter 2010. Under the period after December 2010, new Swedish official emission inventories and emission projections have been reported. So the Swedish emission estimates presented in this report are not corresponding to the latest available estimates.

Background

Sweden is, as a ratifying partner to the CLRTAP and all of its protocols, mandated to report national emission inventories of the air pollutants covered under the Convention. Furthermore, Sweden also reports national emission projections for the years 2020 and 2030 to the Convention. The Swedish EPA is the Swedish authority responsible for the timely and accurate reporting to the CLRTAP.

The emission inventory and projections work are performed by the consortium SMED (Swedish Environmental Emissions Data) on commission from the Swedish Environmental Protection Agency. SMED has performed national emission inventories of air pollutants for reporting to CLRTAP, and of greenhouse gases (GHG) for reporting to the United Nations Framework Convention on Climate Change (UNFCCC) since the year 2000. The inventory results in the form of reporting tables and accompanying detailed methodological reports are annually published on the Swedish EPA website (www.naturvardsverket.se), in addition to their submission to the relevant conventions. Emission projections are compiled bi-annually and submitted to CLRTAP as reporting tables.

The GAINS model (Amann et al., 2004, 2008a; Borken-Kleefeld et al., 2009; Böttcher et al., 2008; Heyes et al., 2011; Höglund-Isaksson et al., 2008) is an IAM that integrates modelling of emissions; emission abatement costs; regional emission dispersion; and ecosystem impacts to provide support to policy makers. The model exists in two main versions, the offline cost optimizing version maintained at IIASA, and the online scenario analysis version of the model. Both versions can use 7the same input data and results are transferable between the two versions. This text describes the online version of the model.

In the European version of the online model (covering the European countries) the modelled years are 1990 to 2050 in five-year intervals. In the model, exogenous input data on emission precursor activities, such as fuel use, provides information used to calculate unabated emissions for a specified scenario. The exogenous data can origin from either other European scale models or from national country-specific estimates. The model does not contain specific information on individual power plants; electricity conversion efficiencies; or regional energy balances. These types of exogenous data and projections have to be aggregated into fuel use as well as electricity and heat production before introduction as input data to the model. By using fuel and technology specific emission factors, emissions are calculated for the air pollutants: sulphur dioxide (SO_2); nitrogen oxides (NO_X); ammonia (NH_3); fine particulate matter ($PM_{2.5}$); black and organic carbon (PMBC & PMOC); volatile organic compounds (VOC); and the GHG:s; carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); and three fluorinated gases (HFC, PFC, SF_6). In the model, these emissions are then reduced by the scenario-specific use of emission control technologies as specified in the model. The level of implementation of emission control technologies is in the scenarios developed by IIASA specified by international emission legislations and emission limit values for each country. In the model, emissions of air pollutants are dispersed from countries to grid cells in a 50 by 50 km grid covering Europe. This enables the model to calculate impacts of air pollutants on environmental end points such as acidification, eutrophication, health impacts from long term exposure to particulate matter, and health impacts from short term exposure to ozone. This can be done for any scenario. Finally, the GAINS Europe model can calculate economic abatement costs associated with the abatement of air pollutants. The new version of the GAINS online model is available at http://gains.iiasa.ac.at/models/index.html while the background scenarios used and described in this study are available in a recently replaced version (http://gains.iiasa.ac.at/gains/EUR/index.login?logout=expired).

In addition to the above mentioned characteristics, there is an optimization version of the model available at IIASA. This version optimizes the lowest possible abatement costs needed to reach desired environmental end points. In the optimization version of the model, costs for reducing GHG:s can be considered for certain scenarios.

Scenario results from the GAINS model are used as supporting documentation to the negotiations on new emission limits or similar policy objectives in a number of international agreements. The model was used in the development of; the UNECE Gothenburg protocol (Multi-pollutant, multi-effect protocol), the EU National Emissions Ceilings (NEC) Directive and the EU Climate & Energy package (20/20/20 targets) (UNECE CLRTAP, 1999; OJ, 2001; OJ, 2009a,b,c,d). It supported the international work performed in the UNFCCC. Recently, it also used to support the recent negotiations preceding the revised Gothenburg Protocol. The negotiation on a revised Gothenburg protocol included discussions on new ambition levels in the protocol to 2020 and to also include control of $PM_{2.5}$ emissions. Scenario results from the GAINS model are also used for the review of the EU NEC directive. Within the CLRTAP the GAINS model results are presented as negotiation support to the national negotiators in the CLRTAP Working Group on Strategies and Review (WGSR), which is the political negotiations group of the CLRTAP.

In Sweden, national emission projections are compiled and reported to CLRTAP every other year. These projections are a result of collaboration between many governmental bodies and research institutes. The projections are also based on results from at least three models: the macroeconomic model EMEC (Östblom & Berg, 2006); the energy system model MARKAL-NORDIC (developed by Chalmers University and PROFU); and the transport model ARTEMIS (developed by the Swedish Road Administration and The Swedish National Road and Transport Research Institute (VTI)). Results from models and other projections are thereafter compiled and checked together with best available estimates on emission factors. All in all, this process delivers a Swedish national emission projection.

It is often the case that the GAINS model data and scenario results differ somewhat from the Swedish reported emission inventory and emission projections (Kindbom & Lövblad, 2008). The size of the difference is scenario-specific. It is naturally so that model results will differ from results created by other methods, such as emission inventories or projections based on national data. It is also the case that differences in scenario descriptions will imply differences in emission projections. On a national aggregation level, the model-calculated emissions are often in relatively good agreement with national emission inventories and projections, but discrepancies are common at a more disaggregated level. The GAINS model data is based on the data format used by Eurostat and the International Energy Agency. This format does in turn match fairly well with the sector format in the Standardized Nomenclature for Air Pollutants (SNAP) emission inventories. Sweden does however use the New Format for Reporting (NFR) sector classification in the emission inventories and emission projections. One of the challenges from a Swedish perspective is that if the emissions are not correct on a NFR sector level, the technical potential for further emission reductions might be over- or underestimated in the GAINS model. It also limits the credibility and usefulness of the GAINS model results when alternative scenarios are developed.

Purpose and objective

The purpose of this project was to create a robust system to develop national emission scenarios in the GAINS model that are consistent with Swedish official emission inventories and emission projections.

The objectives of this project were to:

1. Compile information sources needed for the creation of a Swedish energy and emission baseline scenario (SWE BSL scenario) in the GAINS model consistent with official emission inventories and projections in Sweden.
2. Develop a systematic method for transferring numerical estimates on emission precursor activities from Swedish data into the GAINS model format
3. Based on 1 and 2, develop a SWE BSL scenario from which emissions will be calculated. These emission calculations will then be analysed with respect to differences between the Swedish official emission inventories and emission projections, as basis for further development of Swedish scenarios in the GAINS model. To the extent possible, the SWE BSL scenario should be adjusted so that the scenario presents emission estimates similar to the emission projection in the Swedish reporting.

Description of terms used

In this report, data sources have been compiled, compared, re-allocated and re-aggregated in order develop a Swedish emission scenario in a GAINS model format that is comparable to the national emission reporting and to the national emission projections. These data originate from various sources and scenarios. In order to make the rest of this report readable the most important terms and scenarios are presented in detail here.

IIASA scenarios

Within the GAINS model there are many different scenarios developed by IIASA. In this report the scenarios "**GAINS PRIMES-scenario** (PRIMES_BSL_2009_14jan10)", and the "**GAINS IEA-scenario** (IEA WEO 2009RS; curr. AP polic)" were used. The scenario description presented within brackets above is the scenario name as it is presented in the GAINS online model. These scenarios served as guidelines for the aggregation and re-allocation of Swedish input data to the SWE BSL scenario, when national information was unavailable. These two scenarios were used as a basis for the re-allocation and re-aggregation since the two scenarios varied in detail with respect to sector and fuel aggregation.

The "GAINS PRIMES scenario" is based on the European-scale energy system model PRIMES energy projections, developed in mid-2009, for EU-27, Macedonia, Croatia, and Turkey (ICCS/NTUA, 2011). These include the projected impact of the European economic crisis up until mid-2009. For the agricultural sector the scenario use national data reported to the statistical office of the European Union (EUROSTAT) for the year 2005, and the scenario years are based on trends estimated by the Common Agricultural Policy Regionalised Impact analysis (CAPRI) model as of September 2009. In the scenario it is assumed an adoption of GHG mitigation options in the EU CO_2 Emissions Trading System (ETS) sectors at marginal costs less than the carbon price levels of 15 Euro/t CO_2 in 2015, 20 Euro/t CO_2 in 2020, 25 Euro/ton CO_2 in 2025, and 30 Euro/ton CO_2 in 2030 (in Euro 2008 prices).

The "GAINS IEA Scenario" includes energy activities originating from the "Reference Scenario" in the International Energy Agency (IEA) World Energy Outlook 2009 (IEA, 2009). The scenario for the agricultural activities is taken from the CAPRI model scenarios.

National activity data in the GAINS model

The Swedish long term prognosis report from the Swedish Energy Agency (SEA) is in this report referred to as "**Swedish long term prognosis**" (SEA, 2009a). When data from the Swedish long term prognosis (SEA, 2009a) is introduced in a re-aggregated and re-allocated form into the GAINS model data sets, it is referred to as "**The Swedish GAINS baseline activity data projection**", with the abbreviation "**SWE BSL scenario**".

National reporting of emission inventories and projections data

The activity data, emission factors and other information used for the national official Swedish reporting of emission inventories and of projections to CLRTAP in March 2009 are in this report referred to as "**the national reporting**".

SMED, Swedish Environmental Emission Data

SMED is a consortium which annually conducts the inventory and reporting under a framework contract with the Swedish Environmental Protection Agency. SMED is composed of Statistics Sweden, the Swedish Meteorological and Hydrological Institute (SMHI), IVL and the Swedish University of Agricultural Sciences (SLU).

Other sector specific information used for the GAINS SWE-BSL

For detailed information on the transport sector emission precursor data information from the ARTEMIS model and interviews with the Swedish Road Administration were used (Sjödin et al., 2006; SRA, personal communication, 2010). For detailed information on the agricultural sector emission precursor data, information from the Swedish EPA to the national reporting was used (Swedish EPA, personal communication, 2010). For detailed information on the emission precursor activities from industrial processes information from the National Institute of Economic Research were used (Sjöström & Östblom, 2008).

Emission calculations and projection reporting structures

The national reporting and the GAINS model do not use the same method to calculate emissions. The two concepts are also using different sector representations. Because of this, any exercise trying to calibrate the national reporting with a SWE BSL scenario needs to review emission calculation routines and allocation of emissions. In this chapter the results from the review and comparison between the two concepts with regards to emission calculations and sector descriptions are presented.

National reporting emission

Reported emission data in the Swedish inventory are derived in two principally different ways. Emission data can be obtained directly, e.g. from reported data in annual Environmental Reports, submitted from individual facilities to the supervising authorities. In other cases, emissions are calculated according to a generic equation, where activity information is multiplied with an emission factor to give the resulting emissions.

E=A*EF

Where:

A = emission precursor activity

E = emissions

EF = emission factor

The data needed to perform an inventory, covering all relevant pollutants and sources of emissions, thus requires annual information on the various activities generating emissions, as well as emission factors (amount of emissions per unit of activity) specified according to the activity. The data sources, methodologies, and emission factors used in the Swedish national emission inventory are described in detail in the annual Informative Inventory Report (IIR) (Swedish EPA, 2010).

National reporting of emissions and projections

The national air emission inventory is performed annually for the pollutants SO_2, NO_x, NH_3, VOC, PM (TSP, PM_{10} and $PM_{2.5}$), CO and several heavy metals and POPs. The emission inventory is reported according to the UNECE Guidelines for Estimating and Reporting Emission Data under the Convention on Long-Range Transboundary Air Pollution (UNECE, 2003) and with the EMEP/EEA (European Environment Agency) Air Pollutant Emission Inventory Guidebook (EMEP/EEA, 2009) as methodological guidance. Sweden also uses methods in accordance with the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse

Gas Inventories (IPCC, 1996) and methods that are in line with IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). Emission data are reported annually with time series going back to at least 1990. In Sweden, emission projections are compiled and reported to CLRTAP bi-annually. Historical emission data as well as projections are reported in the prescribed format, NFR.

The NFR reporting structure

Reporting to CLRTAP of national emissions, activity data and projections are made in the NFR-format. The NFR is broadly coherent with the CRF (Common Reporting Format), which is used for reporting of GHG emissions to UNFCCC. The actual reporting is made in NFR-tables in Excel.

The NFR is divided in the main sectors:

1. Energy
2. Industrial Processes
3. Solvents and other Product Use
4. Agriculture
5. Land-use, land-use change and forestry (LULUCF), only relevant for GHG reporting)
6. Waste
7. Other

Each of these main sectors consists of a number of categories or sub-categories. The objective of the reporting format is to create a transparent enough reporting, where emissions from important individual sources can be identified and traced throughout a time series. In reality, a number of compromises has to be made in order to reduce the reporting burden on countries, while at the same time accomplish a detailed enough, transparent and useful reporting.

Originally, the reporting to CLRTAP was made according to the SNAP. The SNAP format was developed as part of the EU core inventory on air emissions (CORINAIR) programme for distinguishing emission source sectors and activities. CORINAIR was a programme to establish air pollutant emission inventories in Europe, initiated by the European Environment Agency in the late 1980´s. The SNAP-format was in some ways more oriented towards technology-specific activities, and was in some areas more detailed regarding activities than the present NFR-format. In the late 1990´s and early 2000, it was however evident that the highest political priority in most countries was the emission inventories and reporting of GHG:s to the UNFCCC. The UNFCCC had developed its own reporting format, the CRF, and it had become a heavy burden on countries to maintain a double book-keeping of both the SNAP and the CRF for reporting of emissions to air from largely the same activities, but with a priority on different emissions. Thus, in order to benefit from the high political priority on emission inventories of GHG:s, and at the same time safeguard a continued reporting of air pollutant emissions, the TFEIP (Task Force on Emission Inventories and Projections) under CLRTAP developed the NFR-format, which largely is in agreement with the CRF, to facilitate the compilation and reporting of emission inventories of air pollutants.

GAINS model emission calculation

The emissions of air pollutants are in the GAINS model calculated by the use of four parameters. The first parameter is the emission precursor activity, usually called 'activity data'. An example of activity data is the use of coal in power plants, expressed as primary energy units. The second parameter is the 'unabated/ raw gas emission factor', which contains information on the emission per unit of activity if no emission control option is used. The third parameter is the 'reduction efficiency' of any considered emission control option. The 'reduction efficiency' is given as percentage of the 'unabated/raw gas emission factor'. The fourth parameter describes the extent to which the specified emission control option is used. This parameter is expressed as a percentage of the activity data considered. Expressed as a function, the emission calculation looks as follows:

$$E_i = \sum_{j,k,m} E_{i,j,k,m} = \sum_{j,k,m} A_{i,j,k} ef_{i,j,k} (1 - eff_m) X_{i,j,k,m}$$

Where:

i,j,k,m	Country, sector, fuel, abatement option
Ei	Emissions in country i
A	Activity in country i
Ef	"Raw gas" emission factor
effm	Reduction efficiency of the abatement option
X	Implementation rate of the considered option

(Source: Amann et al., 2004)

GAINS model structure

The GAINS model aggregates emissions from economic activities in a similar fashion to the IEA and Eurostat. It is well adapted to calculate emissions on a Corinair SNAP level of aggregation (EMEP/EEA, 2009). This aggregation level differs somewhat from the NFR system. This does in turn cause demand for a consistent approach to re-aggregation of results between the national reporting and the GAINS model. The sector aggregation in the GAINS model of highest concern for emissions of air pollutants are the sectors; energy conversion, electricity and heat production (power plants etc.), manufacturing industry, transport (mobile), residential and households (domestic), and agriculture. For detailed information on sector and fuel aggregation in the GAINS model, see

Activity data

The sources for the activity data used in the national reporting and the SWE BSL scenario can sometime differ. In the following text the sources to the activity data used in the national reporting and in the SWE BSL scenario are presented.

National reporting activity data

In the national reporting the activity data sources are often sector specific. Therefore, the activity data for each NFR sector are presented here.

The energy sector

Emissions from fuel combustion in Sweden are, if not specifically otherwise stated, determined as the product of fuel consumption, thermal value and emission factors (EF), specific for each fuel and sector of use, as shown in the equation below.

$Emissions_{fuel}$ (unit) = $\sum$ Fuel consumption (unit) * thermal $value_{fuel}$ * EF_{fuel}

Emission factors and thermal values are published annually as an appendix to the IIR (Swedish EPA, 2010).

Stationary combustion

Activity data for:

- **Energy industries**: Data from quarterly fuel statistics, a total survey conducted by Statistics Sweden at plant level and by fuel type.
- **Manufacturing industries**: quarterly fuel statistics, a sample survey conducted by Statistics Sweden. All data is at plant level and by fuel type.
- **Other sectors** (e.g. fuel used in households): Data from official statistical reports prepared by Statistics Sweden at national level and by fuel type.

Data on thermal values (energy content in a fuel) are mainly compiled by Statistics Sweden and the Swedish Energy Agency, and emission factors are provided by IVL and the Swedish EPA. Some fuel types are used in industrial processes rather than for energy purposes. This is the case for black liquor in the paper and pulp industry and for coal and coke in the metal industry. Emissions from these fuels are thus accounted for in the Industrial processes sector.

Mobile combustion

Data on fuel consumption at national level and by fuel type are collected by Statistics Sweden and used in combination with emissions data and fuel data from the Swedish Transport Agency, the Swedish Road Administration, the Swedish Rail Administration, the Civil Aviation Authority and the Swedish Military. Activity data is multiplied by thermal values, mainly provided by Statistics Sweden, and emission factors provided by, among others, IVL and the Swedish EPA.

Industrial processes

Data used in the inventory and supporting the national projection are mainly derived from the annual environmental reports from industrial facilities. The input information used can either be as emissions of a specific substance (calculated or measured by the industry), activity data, emission factors and other useful information. In some cases, when there are a large number of smaller companies within a specific sector, and all the environmental reports are not available, a combination of information available from environmental reports and production statistics at national level are used to estimate national emissions. Emission factors used are usually derived nationally based on available information from some facilities in a specific sector, and applied to the national level. The use of default emission factors is limited.

Solvent and other product use

This sector is a major source of Non-Methane Volatile Organic Compound (NMVOC) emissions. Emission estimates are to a large extent based on nationally derived emission factors and national activity data obtained from the Products Register kept by the Swedish Chemicals Agency.

Agriculture

Most data necessary for emission calculations from agricultural sources are collected from official statistical reports from Statistics Sweden. Some complementary information is collected from relevant associations, organisations and researchers, such as: the Swedish Dairy Association; Swedish Poultry Meat Association; SLU; the Swedish Institute of Agricultural and Environmental Engineering, and SJV. The calculations concerning forestry are based on information from the National Board of Forestry.

Waste

In the waste sector, emissions from a diversity of sources are in most cases accounted for using national statistics and emission factors. Emissions from incineration of waste for electricity and heat production are accounted for as energy sector emissions.

Projections of energy activity data in the national reporting

The energy sector is the most important reporting sector in terms of emissions relevant for the development of a SWE BSL scenario. The energy sector includes both stationary and mobile sources. In the bi-annual national projections of air pollutants, the projected activity data for the energy sector is based on projections of future energy use produced by the SEA in collaboration with the Swedish EPA and the Transport Agency.

The Swedish EPA uses the reported national activity data (Swedish EPA, 2010) and emissions for the base year (or latest available reported year) as a basis for developing the projections. The Swedish EPA starts its adaptation of the long term projections from SEA to the national reporting of projections by comparing the base year activity data. These two datasets are not identical, since they are based on different statistical sources. The SEA data for the base year (2005) are derived from the national annual energy balance (SEA, 2009a), while the Swedish EPA's nationally reported emissions for 2005 are based on activity data from e.g. the quarterly energy statistics and other statistical sources on fuel use for that year (Swedish EPA, personal communication, 2010).

The Swedish EPA builds the projected energy activity data for the national reporting as an extrapolation from the reported national base year data, by using the development of the use of individual fuels in the projections from the SEA (2009a) in its energy projections. The projected energy data in the national projections are thus expressed as a change in per cent in relation to the energy activity for a base year.

The Swedish EPA also adapts the projected future energy use to the reporting systems for reporting projections to UNFCCC and UNECE CLRTAP (CRF and NFR formats, respectively). The Swedish EPA thus produces the energy related activity data for projected years, in the required reporting format, based on the energy projections from the SEA. SMED then makes the emission calculations based on the projected energy activity data from the Swedish EPA.

Projections of emission factors and emissions in the national reporting

Projected emission factors take new legislation into account, but most importantly, include an assessment of general development and introduction of technologies influencing emission factors in the future. Projected emission factors for stationary and mobile combustion were developed by IVL in 2008, in cooperation with relevant experts, for several emission sources (Kindbom et al., 2008).

For the most important industrial processes projected emissions and/or emission factors were developed by IVL in close cooperation with trade associations and other relevant experts (Kindbom et al., 2008). Discussions were held on probable future development of production quantities, technological developments, and possible additional abatement measures in the various industrial sectors. Projections of economic growth from the National Institute of Economic Research (NIER) (Sjöström & Östblom, 2008) were also taken into consideration, but projections of economic growth in a specific industrial sector does however not automatically translate into a corresponding development of activity or emissions.

The SMED consortium reports emission factors for each year in the projections but does not compile and report information on specific emission control technologies. The emission factors that are used in the emission inventory and emission projections are "implied emission factors", which is averaged and generalised for e.g. a specific fuel and sector of use. The emission factors thus derived are based on assumptions and knowledge of the general level of technologies or introduction of abatement measures on the national level, which is required for reporting to UNECE CLRTAP. This lack of technology-specific details also creates a challenge when comparing national emission inventories and emission projections with the SWE BSL scenario results.

GAINS model activity data

In the GAINS model structure, the aggregation of activity data used for the energy, transport, domestic, and industry sectors are based on the Total Primary Energy Supply (TPES) approach used by the IEA. The TPES approach implies reporting of the net calorific content of energy carriers used for: electricity and heat production; transport activities; and industrial activities. Import and export as well as stock changes of energy carriers and electricity are corrected for to derive the national energy balance. Energy in international marine bunkers and heat pumps are not included in the national energy balance.

The IEA energy balance for a country uses a common unit and is based on the net calorific content of the energy carriers. The unit adopted by the IEA is the tonne of oil equivalent (toe), which is defined as 107 kilocalories (41.868 gigajoules). This quantity of energy is, within a few per cent, equal to the net heat content of 1 tonne of crude oil. The difference between the "net" and the "gross" calorific value for each fuel is the latent heat of vaporisation of the water produced during combustion of the fuel. For coal and oil net calorific value is about 5 % less than gross. For most forms of natural and manufactured gas the difference is 9-10 %, while for electricity there is no difference as the concept has no meaning in this case.

For the **GAINS PRIMES-scenario**, the sources to the energy related activity data origins from Eurostat statistics and European energy system scenarios developed with the PRIMES model (ICCS/NTUA 2011). For the agricultural sector, data are taken from the CAPRI agricultural model scenarios (Britz & Witzke, 2012).

For the **GAINS IEA-scenario**, energy system & transport projections are based on the IEA World Energy Outlook 2009 projections (IEA, 2009). For the agricultural sector, data are taken from the CAPRI agricultural model scenarios (Britz & Witzke, 2012).

Activity data sources to Swedish GAINS baseline projection

The activity data used to create a Swedish baseline emission scenario in the GAINS model was based on data and reports from the SEA, the Swedish Road Administration (SRA), expert communication and branch specific focus reports. These activity data was re-aggregated and re-allocated to match the GAINS model format. Appendix 2 presents the structure for how this was done. On an aggregated level, the most important assumptions made during the creation of the Swedish baseline emission scenario in the GAINS model was that activity data for the transport sector was based on activity data from the SRA, instead of using data from SEA (2009a).

Below, the data flow of activity data, the input data, to GAINS per sector is described.

Total energy balance

Activity data:

- The Swedish long term prognosis (SEA, 2009a; SEA 2010, personal communication; SRA 2010, personal communication).

Energy industries:

Activity data:

- The Swedish long term prognosis (SEA, 2009a, SEA 2010, personal communication).

Industry sub-sectors:

- Iron & steel, Pulp & paper, chemical, petrol-coal, and non-iron metallic (NMFM) industries are according the data given from SEA (2009a, SEA 2010, personal communication).
- Activity data to the sub-sector non-metallic minerals (other than combustion) are given from the IEA input data in the GAINS model (GAINS IEA Scenario).

Key assumption:

- ***Heat production*:** The heat production from the chemical, paper & pulp and other sub-sector for boilers (BO) are calculated by taken the primary fuel and multiply it with the heat factor 85% (IIASA 2010, personal communication).
- ***Biofuels*:** The input distribution of biofuels into the three sectors: industry (IN), Power Plants (PP), and Energy Conversion (CON), as well as the electricity from Black Liqour (BLIQ) used in Combined Heat and Power (CHP) plants for power production are based on information from the GAINS PRIMES scenario and Skogsindustrierna (2008).

Domestic sector

Activity data:

- The Swedish long term prognosis (SEA, 2009a, SEA 2010, personal communication).

Key assumption:

- Domestic gasoline and diesel oil in SEA (2009a) is in the GAINS model allocated to the transport sector.

Mobile sector:

Activity data:

- *Fuels*: The use of Biogas, diesel oil, EO1, EO 2-5, gasoline, Liquid Petroleum Gas (LPG) and natural gas was taken from the SRA (SRA, 2010, personal communication)
- **The use of hybrid (PHEV) vehicles** was in accordance with SEA (2009b). The use of gasoline in SEA (2009a) was reduced to compensate for the increase of electricity used in PHEV vehicles in SEA (2009b) (SEA, 2010, personal communication).
- **The estimation of number of vehicle** and **vehicle-km** was based on SRA (personal communication, 2010)

Key assumption:

- Gasoline and diesel oil used in Non-Road Mobile Machinery (NRMM) were re-allocated from the domestic sector in SEA (2009a) to the transport sector in the SWE BSL scenario, following different sectorial treatment in SEA and NFR. The amount of fuel transferred was based on Fridell & Åström (2009).

Agriculture sector:

Activity data:

- The emission precursor activities in the agricultural sector was given by the Swedish EPA (Swedish EPA, 2010, personal communication).

Key assumption:

- No assumptions was needed due to identical format in the data

Processes:

Activity data:

- The emissions from processes are in the GAINS model based on the amount of goods (in tons) produced in each process sub-sector. Data from NIER (Sjöström & Östblom, 2008) was used to estimate the growth in process activities.

Key assumption:

- It was assumed that the tons of commodities produced in the process sub-sectors can be derived from the development in 'economic value added' for the respective process sub-sectors

Calibration of national data

As presented earlier in this report, the scenarios created by IIASA with the SWE BSL scenarios and the national reporting generally use different sources for input data and different methods for calculating emissions. Therefore, some calibration of model input parameters was needed in order to create a SWE BSL scenario in the GAINS model that reproduced emission projections similar to the national reporting.

Calibration of activity data

National energy statistics and the Swedish long term prognosis classify fuel use in a classification system suitable for Swedish purposes. The GAINS model is developed to be relevant for all European countries. It can therefore in some cases be unsuitable to directly translate Swedish statistics into the GAINS model, adaptation is needed. Both the classification of fuels and sectors often differ. Through personal communication with GAINS model experts at IIASA (2010) and Swedish experts at the SEA (2010) a standardised approach for re-allocation of Swedish data on fuels and fuel use in sectors into the GAINS model fuels and sectors was developed. Appendix 2: Re-aggregation & re-allocation principles of energy activity data – from SEA & SRA to GAINS shows how the Swedish long term prognosis (SEA, 2009a) was converted to the GAINS model format. It should be stressed that the tables in Appendix 2: Re-aggregation & re-allocation principles of energy activity data – from SEA & SRA to GAINS are only for a reader who require detailed information on how the conversion was made. Appendix 2 also shows the total energy balance in the Swedish long term prognosis (SEA, 2009a). Activity data for transport related activities and agricultural activity data needed no re-calibration.

Calibration of emission calculations

When calibrating the Swedish emission baseline scenario in GAINS with the Swedish national emission projection it is important to ensure in-depth knowledge on the use of emission control technologies in Sweden as well as the fuel use for each NFR sector. From the GAINS model it is essential to calculate 'implied emission factor' and to perform a review of the 'raw gas emission factor' used as basis for the emission calculations in the GAINS model. More detailed data than in the reported NFR tables (Swedish EPA, 2010) are available in the Swedish TPS (technical production system) database (kept by Swedish EPA, https://tps.naturvardsverket.se/). These data were used for calibration of the SWE BSL scenario.

Implementation rate of emission control technologies

The national reporting does not specify the use of sector-specific emission control technologies. In the SWE BSL scenario, the current and future use of emission control technologies were based on the best available estimates, i.e. the use of emission control technologies as specified in the GAINS PRIMES-scenario. The emission control in the GAINS PRIMES-scenario was used for all sectors but the mobile sector. These estimations are under constant review and follow the new developments in international air quality agreements. As an example, the expected impacts from the newly adopted EC Industrial Emissions Directive are reflected in this specification of current and future use of emission control technologies.

For the road transport sector the existing Swedish models used to calculate emissions provide sufficient details on the current and future use of emission control technologies. Data was provided through personal communication with the SRA (2010, personal communication).

Results

Within this project an energy & emission scenario for Sweden in a GAINS model format consistent with the national reporting and projections was developed. This scenario was based on the same background data as is used in the national reporting and projections that was delivered to the UNECE CLRTAP in March 2009. Thanks to the review of data flow between different governmental bodies and the development of a conversion tools for re-allocation of fuels and sectors, future analysis can be more easily developed. Appendix 1 presents the classification of sectors and their aggregation in the GAINS model and Appendix 2: Re-aggregation & re-allocation principles of energy activity data – from SEA & SRA to GAINS presents the developed conversion key between sectors and fuels in the national reporting and the GAINS model.

Baseline emissions on a NFR-sector aggregation level

Based on the data compilation, translation and adaptation performed in this project, emissions on a NFR sector level were calculated with the GAINS model for the years 2005 and 2020 and the pollutants SO_2, NO_x, and $PM_{2.5}$.

National reporting vs SWE BSL scenario emissions

On a national level, the emissions reported and projected in the national reporting could with the data collected in this project be replicated by the GAINS model for SO_2. For NO_x and $PM_{2.5}$ relatively large inconsistencies still remained.

Table 1: National emissions of air pollutants in 2005 and 2020 – SWE BSL scenario vs national reporting.

National emission	2005		2020		unit
Scenario	SWE BSL	National reporting	SWE BSL	National reporting	
SO_2	36.1	37.1	28.6	28.8	kton
$PM_{2.5}$	23.3	31.9	16.1	31.4	kton
NO_x	200.0	175.5	99.6	112.7	kton

The major reasons to why the SWE BSL scenario results on emissions of $PM_{2.5}$ and NOx differed from the national reporting are presented in detail below.

Appendix 4 show disaggregated comparisons on a NFR-sector aggregation for SO_2 and the years 2005 and 2020, as well as results for NOx, and for $PM_{2.5}$.

SO_2 emissions

The emissions of SO_2 were in the SWE BSL scenario modelled in a very similar way to the national reporting for 2005, the only major differences in emissions were in the sectors shipping and waste combustion. For the year 2020, the national reporting projection for shipping corresponded better with the GAINS model calculations, but the emissions from power plants differed more than they did in 2005. This was mainly an impact of that the SWE BSL scenario introduced more emission removal technologies in 2020 than what is expected in the national reporting.

NO_x emissions

For NO_X in 2005, the largest source for the difference between the national reporting and the calculated emissions in the SWE BSL scenario was the NO_X emissions from road transport.

The fuel use was identical between the data in the national reporting and the SWE BSL scenario. But Swedish information on the vintage of the vehicle fleet in 2005 was not available for introduction into the SWE BSL scenario in this analysis, so the difference in emissions between the national reporting and the SWE BSL scenario was due to different assumptions on the vintage of the vehicle fleet and the emission factors. One potential reason for differences in the emission factors used might be that the climate conditions in Sweden aren't taken into account in the SWE BSL scenario emission factors.

For emissions of NO_X in 2020, the largest differences between the national reporting and the SWE BSL scenario were identified in: the industry and process sectors; the road transport sector; and the Power plants. The SWE BSL scenario emissions were lower than the national reporting emissions for the industry, process, and road transport sectors, while they were higher for power plants. The NO_X emissions from road transport were in the SWE BSL scenario overestimated in 2005, but were underestimated in 2020. This implies a large difference in the expected rate of vehicle turnover between the SWE BSL scenario and the national reporting.

$PM_{2.5}$ emissions

The SWE BSL scenario did not replicate the national reporting $PM_{2.5}$ emissions in 2005. The largest source of the discrepancy was in the Residential and Service (DOM) sector. In this sector, the SWE BSL scenario assumed a much higher standard of domestic boilers and had emission factors different from the national reporting. The difference in emission factors was probably caused by the new method for emission calculation that is used in Sweden and the national reporting.

The SWE BSL scenario calculated large emission reduction of $PM_{2.5}$ by 2020, while the national reporting assumed fairly constant emission levels. The difference was still largest for the DOM sector, but $PM_{2.5}$ emissions for all sectors were underestimated in the SWE BSL scenario compared to the national reporting.

Further emission reduction

SO_2 emissions in the SWE BSL scenario could be reduced from stationary power plants in 2020, but there are no new emission control technologies to be implemented. Emission reduction from stationary sources would rather be a result of a larger penetration of existing technologies. Appendix 3: Additional control measures presents the use of control technologies in 2020 for SO_2 and NO_x from stationary sources in the SWE BSL scenario. Appendix 3: Additional control measures also presents the possibilities for further use of more stringent emission technologies in 2020.

The emissions of NO_x could in the SWE BSL scenario be further reduced, but not by much. The current and additional control measures for NO_x emissions by 2020 are presented in Appendix 3: Additional control measures. No estimates on further reduction of $PM_{2.5}$ emissions were done in this analysis.

Alternative scenarios

Apart from the baseline energy projection, the Swedish long term prognosis (SEA, 2009a) also presents a national energy balance for other scenarios. In an alternative future where fossil fuel prices are to be higher than in the Swedish baseline energy projection, the scenario “high fossil fuel prices” (HFP) projects the national energy balance in 2020. Correspondingly, the scenario “increased economic growth” (IEG) projects the impact of high economic growth on the national energy balance in 2020 (SEA, 2009a). The development of a standardised structure for re-aggregation and re-allocation of SEA scenarios into GAINS model format in this project allowed for GAINS model analysis of what impact this would have on emissions of air pollutants.

Table 2: Air pollutant emissions in the SWE BSL, HFP, and IEG scenarios

2020	SWE BSL	HFP	IEG	unit
SO_2	28.6	28.48	28.64	kton
$PM_{2,5}$	16.1	16.07	16.16	kton
NO_X	99.6	99.23	100.13	kton

The analysis showed that the impact on air pollutant emissions would be limited in the alternative scenarios compared to the SWE BSL scenario.

Conclusions and recommendations

This project shows that it is possible to compile national background data to the GAINS model that corresponds to the national reporting. However, several steps are required before data can be introduced into the GAINS model. First of all, it is of highest importance to identify when national background data has been converted or adjusted, but not explicitly reported, before final submission of the national reporting. The experience from this project is that there often are adjustments being made in the final step of the national reporting, but these are not always reported. These adjustments need to be made available in order to have consistent data sets. National data are in most cases available on a sufficient level of detail for a successful implementation to the GAINS model.

Secondly, the introduction of national activity data into the GAINS model requires re-aggregation and re-allocation of fuels and sectors in order for the energy balance in the GAINS model to correspond to the energy balance in the national energy projections and the national reporting. To ensure consistency, a systematic conversion tool was developed in this project (presented in Appendix 2: Re-aggregation & re-allocation principles of energy activity data – from SEA & SRA to GAINS). Third, the current and projected use of emission control technologies is often not explicitly presented in the national reporting. This cause problems when translating estimates to the GAINS model. In this project, the use of emission control technologies in the Swedish reporting needed to be assumed prior to the introduction into the GAINS model. A recommendation for the future is that the Swedish national reporting more explicitly presents which emission control technologies that are considered for current years and assumed for future years. Without a proper inventory of emission control technologies currently in use and projected to be in use, there is a small chance of getting a useful SWE BSL scenario for Sweden. Also, an improved documentation of emission factors used is needed, both with respect to the emission factors used in the GAINS model and the national reporting.

All in all, in this project national background data has been collected, and a method and tools have been created that enables future quick comparison of emission results as calculated with the GAINS model with the national reporting. Emission calculations have been performed and the major sources for discrepancies between the national reporting and the SWE BSL scenario has been analysed. The identification of data sources and the use of a systematic method for transferring data from Swedish sources to the GAINS model format allows for sensitivity analysis on alternative futures. This allows Sweden to have easy access to decision support material for Swedish negotiators on international air quality issues calculated by using the same model as is used by the CLRTAP secretariat and the CLRTAP Centre for Integrated Assessment Modelling (CIAM) in the negotiations. The project results can also, given further development, allow for decision support under the EU negotiations for burden agreements of non-CO_2 GHG.

Recommendations

The re-aggregation and re-allocation method used in this project is currently burdened by assumptions, which need to be solved in the future. Of highest importance are:

- the impact of economic development on the construction rate of new power plants;
- the share between boilers and other combustion technologies used in the industry sector;
- the share of emissions between process related activities and energy related activities, and;
- the relation between economic projections on 'economic value added' and projections on produced commodities in processes.

Outside of necessary improvements in the methodology used to convert national activity data to the GAINS model format it is also very important that the current use and future development of emission control technologies in Sweden are explicitly clarified. These clarifications must also include presentation of emission factors for the emission control technologies.

These areas should be of priority for future work with Swedish scenarios in the GAINS model.

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Appendix 1: Abbreviations & Conversion Key

Table A 1: Fuel abbreviations in the GAINS model

GAINS abbreviation	Description
BC1	Brown coal/lignite, grade 1
BC2	Brown coal/lignite, grade 2 (includes peat)
DC	Derived coal (coke, briquettes)
ELE	Electricity
GAS	Natural gas (incl. CNG and derived gases)
GSL	Gasoline and other light fractions of oil; includes biofuels
H2	Hydrogen
HC1	Hard coal, grade 1
HC2	Hard coal, grade 2
HC3	Hard coal, grade 3
HF	Heavy fuel oil
HT	Heat (steam, hot water)
HYD	Hydro
LPG	Liquefied petroleum gas
MD	Medium distillates (diesel, light fuel oil; includes biofuels)
NUC	Nuclear
OS1	Biomass fuels
ARD	Agricultural residuals - direct use
BGS	Bagasse
BIO	Biogas
BMG	Biomass gasification
CHCOA	Charcoal
DNG	Dung
FWD	Fuelwood direct
OS2	Other biomass and waste fuels
BLIQ	Black liquor
WSFR	Waste fuel, renewable
WSFNR	Waste fuels, non-renewable
REN	Renewable energy other than biomass
GTH	Geothermal
SHP	Small hydro power
SPV	Solar photovoltaic
STH	Solar thermal
WND	Wind

Table A 2: Sector aggregation in the GAINS-model

Abbreviation Energy industries	**Description**	**Units**
PP	Power plants (public power and district heat plants, industrial CHP plants)	PJ
PP_EX_WB	Power & district heat plants: existing, wet bottom boilers	PJ
PP_EX_OTH	Power & district heat plants: existing, other boiler types	PJ
PP_NEW	Power & district heat plants: new	PJ
PP_IGCC	Power & district heat plants (new): Integrated Gasification Combined Cycle	PJ
PP_TOTAL	Power & district heat plants (total)	PJ
	Existing plant - commissioned in or before 1995	
CON	Fuel production and conversion (transformation) other than in power plants	
CON_COMB	Fuel production & conversion: combustion (other than in boilers)	PJ
CON_LOSS	Own use of energy sector and losses during production, transmission & distribution of final product	PJ
Manufacturing Industries		
IN	Industrial combustion	
IN_BO	Industry: combustion in boilers (heat only boilers)	PJ
IN_OCTOT	Industry: other combustion (all sectors)	PJ
IN_CON_BO	Industry, transformation sector, combustion in boilers	PJ
IN_ISTE_OC	Industry: iron and steel (other combustion)	PJ
IN_CHEM_BO	Industry: chemical industry (combustion in boilers)	PJ
IN_CHEM_OC	Industry: chemical industry (other combustion)	PJ
IN_NFME_OC	Industry: non-ferrous metals (other combustion)	PJ
IN_NMMI_OC	Industry: non-metallic minerals (other combustion)	PJ
IN_PAP_BO	Industry: paper and pulp production (combustion in boilers)	PJ
IN_PAP_OC	Industry: paper and pulp production (other combustion)	PJ
IN_OTH_BO	Industry: other sectors (combustion in boilers)	PJ
IN_OTH_OC	Industry: other sectors (other combustion)	PJ
IN_OC	Industry: other combustion (all sectors) except fuel consumption in cement and lime industry (used only for emissions calculations)	PJ
NONEN	Nonenergy use of fuels	PJ

Abbreviation Energy industries	**Description**	**Units**
Domestic sector		
DOM	Residential, commercial, services, agriculture, etc.	PJ
DOM_RES	redidential sector	PJ
DOM_COM	commercial sector	PJ
DOM_OTH	other domestic (agriculture, forestry, fishing, other)	PJ
Mobile		
TRA_RD	Road vehicles	PJ
TRA_RD_HD	Heavy duty trucks and buses	PJ, Gvehkm, thousand vehicles
TRA_RD_HDB	Heavy duty vehicles - buses	PJ, Gvehkm, thousand vehicles
TRA_RD_HDT	Heavy duty vehicles - trucks	PJ, Gvehkm, thousand vehicles
TRA_RD_LD2	Motorcycles, mopeds and cars with 2-stroke engines	PJ, Gvehkm, thousand vehicles
TRA_RD_LD4	Light duty vehicles with 4-stroke engines	PJ, Gvehkm, thousand vehicles
TRA_RD_LD4C	Light duty vehicles: cars and small buses with 4-stroke engines	PJ, Gvehkm, thousand vehicles
TRA_RD_LD4T	Light duty vehicles: light commercial trucks with 4-stroke engines	PJ, Gvehkm, thousand vehicles
TRA_RD_M4	Motorcycles with 4-stroke engines	PJ, Gvehkm, thousand vehicles

Abbreviation Energy industries	**Description**	**Units**
TRA_OT	Other transport, non-road	PJ
TRA_OTS	Other transport: maritime activities	PJ, thousand vehicles (or engines)
TRA_OTS_L	Other transport: maritime, large vessels, >1000 GRT	PJ, thousand vehicles (or engines)
TRA_OTS_M	Other transport: maritime, medium vessels <1000GRT	PJ, thousand vehicles (or engines)
TRA_OT_AGR	Other transport: agriculture and forestry	PJ, thousand vehicles (or engines)
TRA_OT_AIR	Other transport: air traffic (total civil aviation - national and international, as reported in energy balances)	PJ
TRA_OT_CNS	Other transport: mobile sources in construction and industry	PJ, thousand vehicles (or engines)
TRA_OT_INW	Other transport: inland waterways	PJ, thousand vehicles (or engines)
TRA_OT_LB	Other transport: other off-road; sources with 4-stroke engines (military, households, etc., for GAS also pipeline compressors)	PJ, thousand vehicles (or engines)
TRA_OT_LD2	Other transport: off-road; sources with 2-stroke engines	PJ, thousand vehicles (or engines)
TRA_OT_RAI	Other transport: rail	PJ, thousand vehicles (or engines)
Energy-related processes		
PR_CEM	Ind. Process: Cement production	Megaton
PR_LIME	Ind. Process: Lime production	Mt

Table A 3: Fuel and sector Conversion key between Swedish reporting and the GAINS model

GAINS	Swedish reporting
HF	Fuel oil
GAS	Landfill gas
BIO	Landfill gas
MD	Diesel oil
MD	Eo 1
HF	Eo 2-5
GSL	Kerosene
GAS	Carbide gas
DC	Coke
DC	Coke-oven gas
BC1	Coal
HC1	Coal
HC2	Coal
HC3	Coal
GAS	LD-gas
GAS	Blas furnace gas
GAS	Methane- and derived gas
GAS	Natural gas
HF	Petroleum cokes
LPG	Propane and butane
GAS	Refinery gas
OS2	Waste
WSFR	Waste
WSFNR	Waste
GAS	City gas
OS2	Liquid rosin
BC2	Peat
FWD	Biofuels
OS1	Biofuels
BLIQ	Biofuels
OS1	Other Biofuels
FWD	Other Biofuels
OS2	Other unspecified biofuels
WSFR	Other unspecified biofuels
WSFNR	Other unspecified biofuels
OS2	Other hard biofuels
WSFR	Other hard biofuels
WSFNR	Other hard biofuels

GAINS	Swedish reporting
MD	Other petroleum fuel
GSL	Aviation Gasoline
GSL	Bio-Alcohol
OS1	Biomass
FWD	Biomass
BC1	Coal
HC1	Coal
HC2	Coal
HC3	Coal
MD	Diesel Oil
GSL	Ethane
BMG	Gas Biomass
GAS	Gas Biomass
MD	Gas/Diesel Oil
GAS	Gaseous
GSL	Gasoline
GSL	Jet Kerosene
MD	Liquid Biomass
LPG	LPG
NOF	Lubricants
GAS	Natural Gas
OS2	Other Fuels
WSFR	Other Fuels
WSFNR	Other Fuels
OS2	Other Fuels\Other non-specified
WSFR	Other Fuels\Other non-specified
WSFNR	Other Fuels\Other non-specified
MD	Other Liquid Fuels (please specify)\Other non-specified
HF	Residual Fuel Oil
OS2	Solid Fuels
WSFR	Solid Fuels
WSFNR	Solid Fuels
ARD	Other Biofuels
BGS	Other Biofuels
BIO	Other Biofuels
BMG	Other Biofuels
CHCOA	Other Biofuels
DNG	Other Biofuels

Table A 3: Transport sector – translation key between GAINS and CFR/NFR codes

GAINS sector	CFR / NFR code	Description	Sub-category		Fuel
TRA_OT_LD2	1A4b	NRMM	Residential		Gasoline
TRA_OT_LD2	1A4c	NRMM	Agriculture		Gasoline
TRA_OT_LD2	1A4c	NRMM	Forestry		Gasoline
TRA_OT_CNS	1A2f	NRMM	Industry		Diesel
TRA_OT_CNS	1A3e	NRMM	Other		Diesel
TRA_OT_AGR	1A4c	NRMM	Agriculture		Diesel
TRA_OT_AGR	1A4c	NRMM	Forestry		Diesel
TRA_OT_RAI	1A3d	Railway	Railway		Diesel
TRA_OT_INW	1A3c	Marine	Leisure boat		Gasoline
TRA_OT_INW	1A5	Marine	Military		Gasoline
TRA_OT_AIR	1A3a	Aviation	Domestic	Cruise	Aviation gasoline
TRA_OT_AIR	1A3a	Aviation	Domestic	Cruise	Aviation turbine fuel
TRA_OT_AIR	1A3a	Aviation	Domestic	LTO	Aviation gasoline
TRA_OT_AIR	1A3a	Aviation	Domestic	LTO	Aviation turbine fuel
TRA_OT_AIR	1A5	Aviation	Military		Aviation gasoline
TRA_OT_AIR	1A5	Aviation	Military		Aviation turbine fuel
TRA_OT_AIR	Memo	Aviation	Bunkerin g	Cruise	Aviation turbine fuel
TRA_OT_AIR	Memo	Aviation	Bunkerin g	LTO	Aviation turbine fuel
TRA_OT_LB	1A4b	NRMM	Residential		Diesel
TRA_OT_LB	1A3e	NRMM	Other		Gasoline
TRA_OT_LB	1A2f	NRMM	Industry		Gasoline
TRA_OTS_M	1A3c	Marine	Domestic		Diesel- and Eo 1
TRA_OTS_M	1A4c	Fishing	Fiske		Diesel
TRA_OTS_M	1A5	Marine	Military		Diesel- and Eo 1
TRA_OTS_L	1A3c	Marine	Domestic		Eo 2-5
TRA_OTS_L	Memo	Military	Bunkering		Diesel

Appendix 1 sources:

Source: http://gains.iiasa.ac.at/index.php/home-page, December 2010

Kindbom K., Lövblad G., 2008, Resultat från datajämförelser mellan GAINS-modellen och den nationella rapporteringen- slutrapport,

Own expert estimates

Appendix 2: Re-aggregation & re-allocation principles of energy activity data – from SEA & SRA to GAINS

The conversions from the Swedish long term prognosis into GAINS model format were subject to a number of challenges. The main challenges involved the different perspectives on energy balance in GAINS and the SEA reporting, as well as the different level of aggregation for fuels and sectors. The GAINS model follows the energy balance calculation method and an aggregation method, the TPES method, used by the IEA. The TPES method is not directly used in the SEA prognosis. This difference required some adjustment of energy balances to achieve comparable values. The SEA energy scenarios for 2005, 2020 and 2030 introduced to the GAINS model are excluding the energy from heat pumps and residual heat as well as energy used in international shipping.

The conversion of the energy balance from the Swedish national reporting was performed by disaggregating the Swedish long term prognosis report (SEA, 2009a) and then re-aggregate the numbers to be suitable for the GAINS models sectors and fuels format. In some cases when disaggregating could not be satisfactorily performed, assumptions were made after consultation with sector or model experts.

The following bullets describe for relevant sectors the sources and major adjustments of energy data prior to the introduction into the Swedish GAINS baseline activity data projection (SWE BSL scenarios):

Energy use:

- **Power and heat production:** industrial activities, except from NMMI industry (Cement and lime), as well as conversion losses and non-energy uses are data taken from the Swedish long term prognosis (SEA, 2009a).
- **Industry sector:** NMNI industry: The projections (energy use and cement and lime produced) for the NMMI industry is taken from IEA GAINS scenario.
- **Transport sector:** The projections for marine and aviation fuel use are estimated from the Swedish long term prognosis (SEA, 2009a).
- **Transport sector:** The projections for road transport sector fuel use are delivered from the SRA as compiled in February 2009.
- **Transport sector:** The projections for non-road mobile fuel use activities (other than marine and aviation) are taken from the national reporting.

Electricity vehicles:

- **Transport sector:** The estimated use of electricity in the road transport sector as presented by the SEA (SEA 2009b).

Heat production:

- **Industry sector:** Heat produced for industry processes is not specified directly in the Swedish long term prognosis. The GAINS model requires estimates on heat produced in the industry sector to estimate the potential for efficiency improvements. The project group used 85 % conversion efficiency in industrial boilers (IND_BO) to estimate the total heat produced in the industry. (IIASA, personal communication 2010)
- **Heat pumps:** Heat pumps are excluded in the GAINS model.

Most important assumptions

The following bullets present the major assumptions introduced into the SWE-BSL scenario delivered to the GAINS model format:

Renewable and non-renewable waste and fuel:

- **Fuel production and conversion (transformation) other than in power plants (CON sector):** An IEA split between renewable and non-renewable waste fuel is introduced for the sectors fuel that burn waste. The split is 50/50 between renewable and non-renewable waste fuel for the sectors that burn waste fuel.
- **Industry sector:** the chemicals (CHEM) industry is assumed to only use non-renewable waste fuels.

PHEV-vehicles:

- **Transport sector:** The number of electricity vehicles in the GAINS model only corresponds to electric vehicles, not PHEV, and is calculated by assuming an electricity consumption of 0.24 kWh/km and an annual vehicle usage of 15 000 km/vehicle. Currently 0.12 kWh/km is common as an estimate for the energy used in the car that includes losses, but can also be the result of a larger engine effect. Therefor it is uncertainties in the energy used for transportation.

Most important uncertainties

In the process of re-aggregating and re-allocation Swedish energy balances to a GAINS model format, a number of uncertainties were identified. We tried to solve all uncertainties identified, but due to time constraints, some uncertainties still remained. The following bullets points present the most important remaining uncertainties in the SWE BSL scenario:

Remaining questions and uncertainties:

- **Macroeconomics** (NIER)**:** We used macro-economic estimates on sector-specific growth in economic value added as indicators on growth in production (tons) for the corresponding sectors in the GAINS model. This linear relation between growth in economic value added and growth in production (tons) needs to be improved. It is not certain that the relationship is linear.
- **Coal balance:** In the Swedish long term prognosis (SEA 2009a) 13 TWh of the coal use in 2005 is unspecified per sector. This fuel was in the SWE BSL scenario distributed to coal and gas in the NONEN sector in the GAINS model format.
- **Non-energy:** The non-energy use specified in SEA (2009a) was difficult to reconstruct. In the Swedish long term prognosis (SEA, 2009a) 90 PJ of fuel should be used for non-energy

purpose in 2005, 2020 and 2030. This number was difficult to achieve by a bottom-up summary in the SWE BSL scenario since there was also uncertainties regarding which energy carriers that would be used, as well as how much should be used for each non-energy purpose. As an example, it is in SEA (2009a) stated that 86 PJ of gasoline are for non-energy purpose, which is too high in order to have a total of 90 PJ.

- **Heat production:** Heat production within the industry sub-sector chemical industries and paper and pulp production was calculated by assuming 85 % energy conversion efficiency of the primary energy use (IIASA, personal communication, 2010).
- **Electricity production:** some of the electricity production (4,53 TWh) from derived coke and coke gas is given from SEA (personal communication, 2010) for the year 2005. This value was introduced as gas in the GAINS format. The corresponding values for 2020 and 2030 were calculated by using a linear relation with the increase in total energy demand for the iron and steel industry.
- **Electricity consumption:** Some of the electricity for the in-house consumption in power production was introduced in the GAINS model format for 2005 given from SEA (personal communication, 2010). The growth of in-house consumption was assumed to be corresponding to the growth in the corresponding power production for 2020 and 2030.
- **Marine and aviation fuel:** There was a discrepancy between aggregated and disaggregated data for the marine and aviation sector fuel use in the Swedish long term prognosis (SEA, 2009a). We used the disaggregated estimates.
- **Electricity vehicles:** There were uncertainties regarding the future use of electricity in passenger cars. We used the data from the special study developed by the SEA (2009b).

Data treatment in the conversion tool

The values for each energy demand sector, and the split between the different categories is shown in table A 5. The numbers in the parenthesis are the corresponding values taken from the long-term prognosis for each category (SEA, 2009a). The '+' and '-' signs in the fuel supply list indicates where the SEA (2009a) aggregated estimates have been adjusted to GAINS format by disaggregation of SEA estimates and re-aggregation into the GAINS model format. '+' indicates that a fuel was introduced into the corresponding GAINS model format fuel category, '-' indicates the opposite.

Table A 4: Re-aggregation of Swedish energy demand per sector to suit the GAINS format

Energy demand	Source and comments
Industrial sector	SEA (2009a) Skogsindustrierna (2008)
- Black liquor (BLIQ) moved to PP:	Skosgsindustrierna (2008): the fuel is used for electricity production in the CHP plants. The amount of fuel moved to PP corresponds to the fuel needed to produce electricity in CHP.
- Fuelwood (FWD) moved to CON_COMB	The amount of FWD moved to CON_COMB is based on the IEA scenario split of FWD use.

Energy demand	**Source and comments**
Transport sector	The Road Administration scenario Fridell &. Åström (2009) SEA (2009a)
- Energy use in the Transport sector	SEA (2009a): the energy use in the Long-term projection is removed from the input data to the GAINS model.
+ International aviation	SEA (2009a): the international aviation energy use is taken from the Long-term projection (SEA, 2009a)
+ Energy use data	The Road Administration: road transport Fridell &. Åström (2009a): other transport (non-road)
Domestic sector	SEA (2009a) Fridell &. Åström (2009)
- Gasoline use removed from the domestic sector	SEA (2009a): the gasoline use for the other transport sub-sector is removed from the input data to the GAINS format. Instead data projection from Fridell &. Åström (2009) are used.
- Diesel oil use removed from the domestic sector	SEA (2009a): The diesel oil use for the other transport sub-sector is removed from the input data to the GAINS format. Instead data projection from Fridell &. Åström (2009) are used.
International aviation and shipping	SEA (2009a)
- International shipping: removed from the total national energy use.	SEA (2009a): the international energy use for shipping are removed from the input data to the GAINS format.
- International aviation: removed from the total national energy use.	SEA (2009a): the international energy use for aviation are removed from the national energy use, but inserted in the transport sector to fit the GAINS format.
Non-energy purposes	SEA (2009a)
	SEA (2009): the non-energy purpose is used to balance the fuel demand and the fuel supply for total national energy use.
Distribution and conversion losses	SEA (2009a)
- Nuclear conversion losses removed from the national energy use.	SEA (2009): Nuclear conversion losses are excluded in distribution and conversion losses electricity. However, nuclear conversion losses are included in gross nuclear power (En_tot: PP_total: ele in the GAINS model)
- Biofuels moved to the industry sector	SEA (2009a): Some biofuels are moved to the Industry sector (OS)
Including: + Distribution and conversion losses: electricity + Distribution and conversion losses: district heating + Distribution and conversion losses: refinery + Distribution and conversion losses: gasoline	Inserted in sector: CON_LOSS: ELE CON_LOSS: HT CON_LOSS: GAS CON_LOSS: GAS
Total energy use: - International shipping (SEA, 2009a) - Heat pumps (SEA, 2009a) - Energy use, Transport sector and international aviation (SEA, 2009a) + International aviation (SEA, 2009a) + Energy use in the transport sector (Swedish Road Administration transport sector and Fridell &. Åström, 2009)	

Industry sector

Total energy use for the industry sector is presented in table A 8.

- A share of biofuels was moved from the industry sector to the Power plants; and: Fuel production and conversion (combustion other than in boilers), according to share specified in the PRIMES GAINS scenario.
- The input energy data for the non-metallic minerals sector (other combustion) were taken from the IEA GAINS scenario, and were excluded

from the sector 'other' in the industry sector.

- Heat production in the industry sector was calculated by using a 85 % conversion efficiency from primary fuel to heat in boilers. In the GAINS model, the Chemical and Power Plant industry use boilers for heat production, so it was only for these that heat production was calculated. This heat was then consumed within the industry and calibrated towards the final district heating demand for the industry, as given in the long-term prognosis (SEA, 2009a).

Transport sector

The activity data for the transport sector was based on different data sources, dependent on sub-sector.

- Activity data for road transport (TRA_RD) were based on data from the Swedish Road Administration and delivered from the ARTEMIS model, these data were adjusted for the expected introduction of renewable fuels as well as for hybrid, plug-in hybrid and pure electric vehicles as reported in SEA (2009a,b).
- Activity data for land based non-road mobile machinery were adjusted with data from Fridell & Åström (2009).
- Activity data for aviation, maritime transport and rail transport were based on SEA (2009a).
- The vehicle kilometres driven for the other transport subsector (TRA_OT) in the Swedish baseline emission scenario developed in this project was based on the vehicle fuel efficiency as described in the SWE BSL scenario 'PRIMES_BL_2009_DRAFT' and the vehicle number and fuel consumption from Fridell & Åström (2009).

The translation key between the GAINS transport sub-sector 'other' categories and the Swedish emission reporting classification, as well as the total energy use in the transport sector is presented in table A 4 (appendix 1) and table A 9 (appendix 2).

Domestic sector

The Total energy use in the domestic sector is presented in table A 10 in this appendix.

- The split in energy demand between the domestic sub-sectors, 'residential', 'commercial', and 'other', was based on the GAINS IEA scenario.

International aviation and shipping

- International aviation was included in the transport sector together with domestic aviation.
- International shipping was not included in the transport sector.
- **Total energy use in International aviation and shipping (SEA 2009a):**
    i. International aviation: removed from total national energy use, moved to transport sector and was included in the domestic aviation fuel (TRA_OT_AIR: GSL)
    ii. - International shipping: removed from total national energy use

Non-energy use purposes

- According to the long-term prognosis, fuel use for non-energy (NONEN) purposes is 90 PJ. However, the SEA report can not show the split of NONEN into the different primary energy carriers.
- The NONEN are also, according to the Long-term prognosis supposed to be nearly constant from 2005 to 2030.
- The NONEN were in total around 75-80 PJ between 2005 and 2030 in the SWE BSL scenario in order balance the total energy use for 2005, 2020 and 2030. This was due to differences in the aggregated and disaggregated data presented in SEA (2009a)

Total energy use in the NONEN is presented in table A 11.

Distribution and conversion losses

- Nuclear conversion losses were excluded from distribution and conversion losses for electricity. However, nuclear conversion losses were included as a part of the gross nuclear fuel use for power production (En_tot: PP_TOTAL: ELE).

In table A 12 and A 13, total energy use for distribution and conversion losses, as well as total electricity production are presented.

Table A 5: Total energy balance in the Swedish long term prognosis

Energy demand (PJ)	**2005**	**2020**	**2030**
1. Industry sector	557,3	579,6	590,4
2. Transport sector	327,6	370,8	374,4
3. Domestic sector	536,4	536,4	525,6
4. International aviation and shipping	111,6	144	158,4
5. Non-energy purposes	90	93,6	93,6
6. Distribution and conversion losses	694,8	716,4	723,6
			Diff: + 3,6*
Total energy demand: **(Sum total energy demand)** **Total Energy supply:**	**2318**	**2441**	**2466** **(2469,6)** **2473,2**
Energy supply (PJ)			diff: -3,6*
Coal, coke, etc.,	154,8	169,2	169,2
Biofuels, peat etc.	406,8	522	536,4
Combustible waste	42,8	67,3	69,5
Oil, including gasoline, aviation fuel, and light oils	673,2	666	666
Natural gas	32,4	57,6	82,8
Heat losses	36	28,8	28,8
Hydropower	262,8	248,4	248,4
Nuclear power (gross energy)	774	806,4	806,4
Wind-power	3,6	25,2	25,2
Export of electricity	-25,2	-82,8	-90

*This is the difference between the total energy demand and the sum of the parts as presented in SEA 2009a.

Table A 6: Total Swedish energy demand per fuel category adjusted to GAINS format

<table>
<tr><th>Energy supply</th><th>Source and comments</th></tr>
<tr><td>Coal, coke etc.</td><td>SEA (2009a)</td></tr>
<tr><td colspan="2">Total Coal, coke:
THE FOLLOWING COAL AND COKE SEGMENTS (SUBCATEGORIES) ARE REGROUPED IN ORDER TO FIT THE GAINS NOMENCLATURE & FORMAT:

SEA COAL, COKE ETc
Moved from Biofuel to balance coal, coke etc.:
+ Peat:
Moved to Oil to balance:
- Petroleum coke:
- Distribution & conversion losses:
Moved to Gas to balance:
- Coke gas and blast oven gas:
- Derived gas for district heating:
- Derived gas for electricity production:
- Distribution & conversion losses:
- Derived gas for electricity production:
= GAINS MODEL fuels: DC, BC1, BC2, HC1, HC2, HC3 in accordance to the following sector distribution (see the explanation):

Remaining coal, not introduced to GAINS model fuel sector coal groups
Calculation made by the project group: Coal insert Coal into GAINS format, NONEN
The remaining coal from the coal balance are distributed to the NONEN sector: GAS and DC
NONEN_GAS: moved from the coal balance to balance gas. The split for how much of the coal that will remain in the coal balance and will be moved to the gas balance are taken from the IEA ratio between the coal and gas in NONEN.
NONEN_DC: the remaining coal are inserted into DC in the NONEN sector.</td></tr>
<tr><td colspan="2">GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)</td></tr>
<tr><td colspan="2">HC: Hard coal, grad 1-3</td></tr>
<tr><td>Industry sector:
En_ind: IN_ISTE_OC: HC1:
En_ind: IN_CHEM_BO: HC1:
En_ind: IN_NFME_OC: HC1:
En_ind: IN_NMMI_OC: HC1:
En_ind: IN_PAP_BO: HC1:
En_ind: IN_OTH_BO: HC1:</td><td>Industry sector (SEA 2009a) table 53
• Coal:</td></tr>
<tr><td>Power Plants:
En_tot: PP_EX_OTH: HC1:
En_tot: PP_NEW: HC1:</td><td>Net electricity production and district heating consumption (SEA 2009a) table 39 and 40:
• Electricity consumption:
• Dist. heating consumption:</td></tr>
<tr><td>Distribution and conversion losses:
En_tot: CON_LOSS: HC1:</td><td>Energy balance (SEA 2009a) table 33
• Own consumption (electricity, district heating, refinery):
• Some are moved to GSL (Oil)</td></tr>
</table>

GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
DC: Derived coal (coke, briquettes)	
Industry sector: En_ind: IN_ISTE_OC: DC: En_ind: IN_CHEM_BO: DC: En_ind: IN_NFME_OC: DC: En_ind: IN_NMMI_OC: DC: En_ind: IN_OTH_OC: DC:	Industry sector (SEA 2009a) table 53: • Coke/K-gas: Coke:
Non-energy use of fuels: En_tot: NONEN: DC:	Non-energy use of fuels (SEA 2009a) table 33 • NONEN: coal, coke:
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
BC 2, peat (Brown coal/lignite grade 2 (include peat):	
Industry sector: En_tot: IN_OTH_BO: BC:	Industry sector (SEA 2009a) table 53 Biofuels, peat etc: peat:
Power Plants: En_tot: PP_EX_OTH:OS1 (FWD): BC:	Net ELE production, and district heating production (SEA 2009a) table 39 and 40 • Electricity production: • Dist. heating production:
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
Bio-fuels, peat etc.	SEA (2009a)
Moved from *Biofuel* to balance oil: - Ethanol: - FAME: Moved from *Biofuel* to balance gas: - Biogas: Moved from *Biofuel* to balance coal: - Peat:	
Total biofuels Industry sector: En_tot: IN_CON_BO: OS2 (WSFNR): En_tot: IN_CHEM_BO: OS2 (WSFNR): En_tot: IN_OTH_BO: OS2 (WSFNR): IN_PAP: (split according to the IEA scenario) OS1 (FWD): IN_PAP_BO: OS2 (BLIQ): IN_PAP_BO: OS2 (BLIQ): PP_EX_OTH: Fuel production and conversion: ELE has a 35% coefficient of utilization: The total conversion efficiency is 90%, meaning those 10% are losses. OS1 (FWD): CON_COMB: 10% are losses from Power Plants.	

GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
OS1 (biofuels):	
Industry sector: En_tot: IN_PAP_BO: OS1: Distribution and conversion losses: En_tot: CON_COMB: OS1 (FWD): OS1: Power Plants: En_tot: PP_EX_OTH: OS1 (FWD): OS1:* En_tot: PP_NEW: OS1 (FWD): OS1:*	Industry sector (SEA 2009a) table 53: Total biofuels (OS1 + OS2): Split in the industry: IN_PAP: In PAP_BO (FWD): CON_COMB (FWD): PP_EX_OTH (BLIQ): Net ELE production, and district heating production (SEA 2009a) table 39 and 40 • Electricity production: • Dist. heating production: * split from IEA
Domestic sector: En_dom: DOM_RES: OS1 (FWD): OS1: * En_dom: DOM_COM: OS1 (FWD): OS1: * En_dom: DOM_COM: OS1 (FWD): OS1: *	Domestic sector (SEA 2009a) table 62 • Domestic biofuel: * split from IEA
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
OS2 (waste etc.):	
Industry sector: En_tot: IN_CON_BO: OS2 (WSFNR): OS2 En_tot: IN_CHEM_BO:OS2 (WSFNR): OS2 En_tot: IN_PAP_BO: OS2 (BLIQ): OS2 En_tot: IN_OTH_BO: OS2 (WSFNR): OS2 Power Plants: En_tot: PP_EX_OTH: OS2 (BLIQ): OS1 En_tot: PP_EX_OTH: OS2 (WSFNR): OS2 En_tot: PP_NEW: OS2 (FWD): OS2	Industry sector (SEA 2009a) table 53: Split in the industry: IN_PAP: OS2 (BLIQ): IN_PAP_BO: OS2 (BLIQ): PP_EX_OTH: The rest from total biofuels: OS 2 (WSFNR): Net ELE production, and district heating production: (SEA 2009a) table 39 and 40 • Electricity consumption: • Dist. heating production:
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
Oil, including gasoline, aviation fuel, and light oils	SEA (2009a)
Removed from the GAINS format: - International shipping: Moved from *Coal* to balance oil: + Petroleum coke: Moved to from *Biofuels* to balance oil: + Ethanol: + FAME: + Dist. & conv. losses, own consumption: electricity, district heating., and refinery Calculation made by the project group: oil into GAINS format, NONEN The remaining oil from the oil balance are distributed to the NONEN sector: HF and GSL NONEN_HF and NONEN_GSL: The split between the heavy oil (HF) and gasoline (GSL) are taken from the IEA ratio in NONEN sector.	

GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
HF: petroleum oil:	
Distribution and conversion losses: En_tot: CON_COMB: HF: En_tot: CON_LOSS: HF:	Energy balance (SEA 2009a) table 33 • Dist. & conv. losses: refinery: District heating and refinery (SEA 2009a) table 37: Some are moved to dist. & conv. losses ELE *The split is from IEA
Industry sector: En_ind: IN_ISTE_OC: HF: En_ind: IN_CHEM_BO: HF: En_ind: IN_CHEM_OC: HF: En_ind: IN_NFME_OC: HF: En_ind: IN_NMMI_OC: HF: En_ind: IN_PAP_BO: HF: En_ind: IN_PAP_OC: HF: En_ind: IN_OTH_BO: HF:	Industry sector (SEA 2009a) table 53 • Coke/cokegas: petroleum oil: • Eo 2-5:
Domestic sector: En_dom: DOM: HF: * En_dom: COM: HF: * En__dom: OTH: HF: *	Domestic sector (SEA 2009a) table 62 • Eo 2-5: * split taken from IEA
Transport sector: En_mob: TRA_OTS_L: HF	Transport sector (SEA, 2009a) table 65 • EO 2-5
Power Plant: En_tot: PP_EX_OTH: HF: En_tot: PP_NEW: HF:	Net ELE production, and district heating production (SEA 2009a) table 39 and 40 • Electricity production: • District heating consumption:
Non-energy use of fuels: En_tot: NONEN: HF: **	Non-energy use of fuels (SEA 2009a) table 33 NONEN: coal, coke: ** Split taken from IEA, these are estimations

<table>
<tr><th colspan="2">GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)</th></tr>
<tr><th colspan="2">MD: Medium distillates (diesel, light fuel oil, including biofuels):</th></tr>
<tr><td><u>Industry sector:</u>
En_ind: IN_CON_BO: MD:
En_ind: IN_ISTE_OC: MD:
En_ind: IN_CHEM_BO: MD:
En_ind: IN_NFME_OC: MD:
En_ind: IN_PAP_BO: MD:
En_ind: IN_OTH_BO: MD:</td><td><u>Industry sector (SEA 2009a) table 53</u>
• Light oil:
• Diesel oil:
• Eo 1 (Fuel oil):</td></tr>
<tr><td><u>Domestic sector:</u>
En_dom: DOM: MD: *
En_dom: COM: MD: *
En_dom: OTH: MD: *</td><td><u>Domestic: SEA table 62</u>
• Diesel oil:
• Eo 1:
* split taken from IEA</td></tr>
<tr><td><u>Transport sector:</u>
En_mob: TRA_RD_LD4C: MD:
En_mob: TRA_RD_LD4T: MD:
En_mob: TRA_RD_HDB: MD:
En_mob: TRA_RD_HDT: MD:
En_mob: TRA_OT_CNS: MD:
En_mob: TRA_OT: AGR: MD:
En_mob: TRA_OT_LB: MD:
En_mob: TRA_OTS_L: MD:</td><td><u>Road: RD</u>
<u>ARTEMIS model scenario</u>
• SE_2009_Scen_130A, SE_Basecase_V2
• Diesel
<u>Transport sector (SEA, 2009a) table 65</u>
• FAME blend, FAME
<u>Other: OT</u>
<u>Fridell & Åström (2009)</u>
• Medium Distillates
<u>Marine: OTS</u>
<u>Transport sector (SEA, 2009a) table 65</u>
Diesel oil, EO1</td></tr>
<tr><td><u>Power Plants:</u>
En_tot: PP_EX_OTH: MD:
En_tot: PP_NEW: MD:</td><td><u>Net ELE production, and district heating production (SEA 2009a) table 39 and 40</u>
• ELE consumption:
• District heating consumption:</td></tr>
<tr><th colspan="2">GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)</th></tr>
<tr><th colspan="2">GSL: Gasoline and other light fractions of oil includes biofuels:</th></tr>
<tr><td><u>Distribution and conversion losses:</u>
En_tot: CON_COMB: GSL:</td><td><u>Energy balance (SEA 2009a) table 33</u>
• Own consumption (electricity, district heating, refinery):
Some are moved to GSL (Oil)</td></tr>
<tr><td><u>Domestic sector</u>:
En_dom: DOM: GSL:</td><td><u>Domestic sector (SEA 2009a) table 62</u>
• Gasoline:</td></tr>
<tr><td><u>Transport sector:</u>
En_mob: TRA_RD_LD2: GSL:
En_mob: TRA_RD_M4: GSL:
En_mob: TRA_RD_LD4C: GSL:
En_mob: TRA_RD_LD4T: GSL:
En_mob: TRA_RD_HDB: GSL:
En_mob: TRA_OT_LD2: GSL:
En_mob: TRA_OT_CNS: GSL:
En_mob: TRA_OT: AGR: GSL:
En_mob: TRA_OT_AIR:
En_mob: TRA_OTS_L: GSL:</td><td><u>Road: RD</u>
<u>ARTEMIS model scenario</u>
• SE_2009_Scen_130A, SE_Basecase_V2
• Petrol
<u>Transport sector (SEA, 2009a) table 65</u>
• Ethanol blend, Ethanol

<u>Other: OT</u>
<u>Fridell & Åström (2009)</u>
• Gasoline
<u>Aviation: OTS</u>
<u>Transport sector (SEA, 2009a) table 65</u>
Aviation fuels: national + international</td></tr>
<tr><td><u>Non-energy use of fuels:</u>
En_tot: NONEN: GSL: *</td><td><u>Energy balance (SEA 2009a) table 33</u>
• Non-energy purpose:
* split taken from IEA</td></tr>
</table>

GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
LPG: Liquefied petroleum gas:	
Industry sector: En_ind: IN_ISTE_OC: LPG: En_ind: IN_CHEM_BO: LPG: En_ind: IN_NFME_OC: LPG: En_ind: IN_NMMI_OC: LPG: En_ind: IN_PAP_BO: LPG: En_ind: IN_PAP_OC: LPG: En_ind: IN_OTH_OC: LPG:	Industry sector (SEA 2009a) table 53 • Liquefied petroleum gas:
Domestic sector: En_dom: COM: LPG: En_dom: OTH: LPG:	Domestic: SEA table 62 • Liquefied petroleum gas:
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
Natural gas	SEA (2009a)
+ City gas: Moved from *Biofuels* to balance gas: + Bio gas: Moved from *Coal* to balance gas: + Coke gas and blast oven: + Electricity (ele) production: + District heat production: + Distribution & conversion losses: Calculation made by the project group: Gas insert into GAINS format, NONEN The remaining gas from the gas balance are distributed to the NONEN sector: GAS NONEN_GAS: the remaining gas from the gas balance are inserted into the NONEN sheet in the GAINS model. The gas moved from the coal balance to the gas balance is added into the NONEN_GAS.	

GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
Natural gas	
Distribution and conversion losses: Gas, Coking plant, Blast furnace: En_tot: CON_LOSS: GAS:	Energy balance (SEA 2009a) table 33 • Distribution and conversion losses: gas
Industry sector: En_ind: IN_ISTE_OC: GAS: En_ind: IN_CHEM_BO: GAS: En_ind: IN_NFME_OC: GAS: En_ind: IN_PAP_BO: GAS: En_ind: IN_OTH_BO: GAS:	Industry sector (SEA 2009a) table 53 • Natural gas: • City gas: • Coke/coke gas: Coke-oven gas: • Coke/coke gas: Blast furnace gas
Transport sector: En_mob: TRA_RD_LD4C: GAS	ARTEMIS model scenario • SE_2009_Scen_130A, SE_Basecase_V2 • CNG Transport sector (SEA, 2009a) table 65 • Biogas
Domestic sector. En_dom: DOM_RES: GAS En_dom: DOM_COM: GAS	Domestic sector (SEA 2009a) table 62 • Natural gas: • City gas:
Power Plants: En_tot: PP_EX_OTH: GAS: En_tot: PP_NEW: GAS:	Power Plants: Natural gas (SEA 2009a) table 39 • Electricity prod (natural gas): • District heating prod. (natural gas): • ELE prod. (coke gas): • District heating prod. (coke gas): Net ELE production, and district heating production (SEA 2009a9 table 39 and 40 • Electricity consumption:
Non-energy use of fuels: En_tot: NONEN: GAS	Energy balance (SEA 2009a) table 33 Non-energy purpose:
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
Heat pumps	SEA (2009a)
Is excluded from the GAINS model	
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
Hydropower	SEA (2009a)
Is inserted in the Power plant sector (PP_TOTAL: HYD)	
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
Nuclear power (gross energy)	SEA (2009a)
Is inserted in the Power plant sector (PP_TOTAL: NUC)	
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
Wind power	SEA (2009a)
Is inserted in the Power plant sector (PP_TOTAL: REN)	
GAINS model fuel and sector combinations (grey) corresponding to Swedish data (white)	
Export of electricity	SEA (2009a)
Is the sum of the electricity production in the GAINS model (En_tot: SUM: ELE)	

Table A 7: Industry sector – reallocation principle from Swedish reporting to GAINS

Industry sector (SEA 2009a, table 53): Some biofuels are moved from the Industry sector to the power plant and conversion sectors: - PP_EX_OTH: OS: (BLIQ) - CON_COMB: OS1 (FWD)	
Input fuel per sub-sector in GAINS format	**Source and comments**
BC2: Brown coal/lignite, grade 2 (includes peat) En_ind: IN_OTH_BO: BC2:	Industry sector: SEA (2009a) table 53 • Bio-fuels, peat etc: peat:
HC1: Hard coal, grade 1 En_ind: IN_ISTE_OC: HC 1: En_ind: IN_CHEM_BO: HC1: En_ind: IN_NFME_OC: HC1: En_ind: IN_NMMI_OC: HC1: * En_ind: IN_PAP_BO: HC1: En_ind: IN_OTH_BO: HC1:	Industry sector: SEA (2009a) table 53 • Coal: * data from IEA scenario
DC: Derived coal (coke, briquettes) **En_ind:** IN_ISTE_OC: DC: **En_ind:** IN_CHEM_BO: DC: **En_ind:** IN_NFME_OC: DC: **En_ind:** IN_NMMI_OC: DC: * **En_ind:** IN_OTH_OC: DC:	Industry sector: SEA (2009a) table 53 • Coke/K-gas: Coke: * data from IEA scenario
OS2: Other biomass and waste fuel En_ind: IN_CON_BO: OS2 (WSFNR): En_ind: IN_CHEM_BO: OS2(WSFNR): En_ind: IN_OTH_BO: OS2 (WSFNR): En_ind: IN_PAP_BO: OS2 (BLIQ): En_ind: IN_PAP_BO: OS 1 (FWD): **Bio-fuels (OS2 and OS1): Moved from industry to PP and CON_COMB:** PP_EX_OTH: OS1 (BLIQ): CON_COMB: OS1 (FWD):	Industry sector: SEA (2009a) table 53 • Bio-fuels, peat etc: • Wood fuel and waste liquor:
HF: Heavy fuel oil En_ind: IN_ISTE_OC: HF: En_ind: IN_CHEM_BO: HF: En_ind: IN_CHEM_OC: HF: En_ind: IN_NFME_OC: HF: En_ind: IN_NMMI_OC: HF: * En_ind: IN_PAP_BO: HF: En_ind: IN_PAP_OC: HF: En_ind: IN_OTH_BO: HF:	Industry sector: SEA (2009a) table 53 • Eo 2-5 (Fuel oil): • Coke/K-gas: Petroleum coke: * data from IEA scenario

Input fuel per sub-sector in GAINS format	Source and comments
MD: Medium distillates (diesel, light fuel oil including biofuels) En_ind: IN_CON_BO: MD: En_ind: IN_ISTE_OC: MD: En_ind: IN_CHEM_BO: MD En_ind: IN_NFME_OC: MD: En_ind: IN_PAP_BO: MD: En_ind: IN_OTH_BO: MD:	Industry sector: SEA (2009a) table 53 • Light oil: • Diesel oil: • Eo 1 (Fuel oil):
LPG: Liquefied petroleum gas En_ind: IN_ISTE_OC: LPG: En_ind: IN_CHEM_BO: LPG: En_ind: IN_NMFE_OC: LPG: En_ind: IN_NMMI_OC: LPG: * En_ind: IN_PAP_BO: LPG: En_ind: IN_PAP_OC: LPG: En_ind: IN_OTH_OC: LPG:	Industry sector: SEA (2009a) table 53 • Liquefied petroleum gas: * data from IEA scenario
GAS: Natural gas (incl. CNG and derived gases) En_ind: IN_ISTE_OC: GAS: En_ind: IN_CHEM_BO: GAS: En_ind: IN_CHEM_OC: GAS: En_ind: IN_NMFE_OC: GAS: En_ind: IN_NMMI_OC: GAS: * En_ind: IN_PAP_BO: GAS: En_ind: IN_OTH_BO: GAS:	Industry sector: SEA (2009a) table 53 • Natural gas: • City gas: • Coke/Coke-gas: Coke-oven gas: • Coke/Coke-gas: Blast furnace gas: * data from IEA scenario
ELE: Electricity En_ind: IN_CON_OC: ELE: En_ind: IN_ISTE_OC: ELE: En_ind: IN_CHEM_BO: ELE: En_ind: IN_CHEM_OC: ELE: En_ind: IN_NMFE_OC: ELE: En_ind: IN_NMMI_OC: ELE: * En_ind: IN_PAP_BO: ELE: En_ind: IN_PAP_OC: ELE: En_ind: IN_OTH_BO: ELE: En_ind: IN_OTH_OC: ELE:	Industry sector: SEA (2009a) table 53 • Total electricity * data from IEA scenario
HT: Heat (steam, hot water) En_ind: IN_CON_BO: HT: En_ind: IN_ISTE_BO: HT: En_ind: IN_CHEM_BO: HT: ** En_ind: IN_CHEM_OC: HT: ** En_ind: IN_NFME_OC: HT: En_ind: IN_PAP_BO: HT: ** En_ind: IN_PAP_OC: HT: ** En_ind: IN_OTH_BO: HT: *** En_ind: IN_OTH_OC: HT: ***	Industry sector: SEA (2009a) table 53 • District heating: ** Chemical industry, and Paper & Pulp: CHEM_BO: primary energy BO * 0.85 CHEM_OC: (primary energy in CHEM_BO * 0,85) + district heating PAP_BO: primary energy BO * 0,85 PAP_OC: primary energy PAP_BO * 0,85 + district heating *** Other: OTH_BO: primary energy BO * 0,85 OTH_OC: To reach total district heating

Table A 8: Transport sector – detailed allocation of total energy use

Data sources for the Swedish reporting
Transport sector (SEA 2009a, table 62): + International maritime transport + National maritime transport + International aviation + National aviation + Renewable fuels used in road transport **SEA 2009b** + Electric vehicles in road transport **Swedish Road Administration – ARTEMIS model scenario SE_2009_Scen_130A, SE_Basecase_V2** + light duty cars = passenger cars + light duty trucks = LCV + heavy duty trucks = HGV + heavy duty buses = Bus + motorcycles **Fridell & Åström, 2009** + Non-road Mobile Machinery

Input fuel per sub-sector in GAINS format	Source and comments
HF: Heavy fuel oil: En_mob: TRA_OTS_L: HF	Transport sector (SEA, 2009a) table 65 • EO 2-5
MD: Medium distillates (diesel, light fuel oil including bio-fuels)	
En_mob: TRA_RD_LD4C: MD En_mob: TRA_RD_LD4T: MD En_mob: TRA_RD_HDB: MD En_mob: TRA_RD_HDT: MD	ARTEMIS model scenario • SE_2009_Scen_130A, SE_Basecase_V2 • Diesel Transport sector (SEA, 2009a) table 65 • FAME blend, FAME
En_mob: TRA_OT_CNS: MD En_mob: TRA_OT_AGR: MD En_mob: TRA_OT_LB: MD	Fridell & Åström (2009) • Medium Distillates
En_mob: TRA_OTS_L: MD	Transport sector (SEA, 2009a) table 65 • Diesel oil, EO1
GSL: Gasoline and other light fractions of oil, including bio-fuels:	
En_mob: TRA_RD_LD2: GSL En_mob: TRA_RD_M4: GSL En_mob: TRA_RD_LD4C: GSL En_mob: TRA_RD_LD4T: GSL En_mob: TRA_RD_HDB: GSL	ARTEMIS model scenario • SE_2009_Scen_130A, SE_Basecase_V2 • Petrol Transport sector (SEA, 2009a) table 65 • Ethanol blend, Ethanol
En_mob: TRA_OT_LD2: GSL En_mob: TRA_OT_CNS: GSL En_mob: TRA_OT_AGR: GSL	Fridell & Åström (2009) • Gasoline
En_mob: TRA_OT_AIR: GSL	Transport sector (SEA, 2009a) table 65 • Aviation fuels: national + international

Input fuel per sub-sector in GAINS format	Source and comments
GAS: Natural gas (incl. CNG and derived gases) En_mob: TRA_RD_LD4C: GAS En_mob: TRA_RD_HDB: GAS	ARTEMIS model scenario • SE_2009_Scen_130A, SE_Basecase_V2 • CNG Transport sector (SEA, 2009a) table 65 • Biogas
ELE: Electricity En_mob: TRA_RD_LD4C: ELE En_mob: TRA_OT_RAI: ELE	SEA 2009b • Electricity Transport sector (SEA, 2009a) table 65 • Electricity

Table A 9: Domestic sector- detailed allocation of total energy use

Domestic sector (SEA (2009a, table 62): Gasoline and diesel oil are removed from the domestic sector: - Gasoline: replaced by the non-road data from the Fridell &.Åström (2009) - Diesel oil:, replaced by the non-road data from the Fridell &. Åström (2009)	
Input fuel per sub-sector in GAINS format	**Source and comments**
OS1: Biofuels En_dom: DOM_RES: OS1: En_dom: DOM_COM: OS1: En_dom: DOM_OTH: OS1:	Domestic: SEA (2009a) table 62 • Wood fuels etc:
HF: Heavy fuel oil En_dom: DOM_RES: HF: En_dom: DOM_COM: HF: En_dom: DOM_OTH: HF:	Domestic: SEA (2009a) table 62 • E0 2-5:
MD: Medium distillates (diesel, light fuel oil, including biofuels) En_dom: DOM_RES: MD: En_dom: DOM_COM: MD: En_dom: DOM_OTH: MD:	Domestic: SEA (2009a) table 62 • Diesel oil: • Eo 1:
GSL: Gasoline and other light fractions of oil: including biofuels En_dom: DOM_RES: GSL: En_dom: DOM_COM: GSL: En_dom: DOM_COM: GSL:	Domestic: SEA (2009a) table 62 • Gasoline:
LPG: Liquefied petroleum gas En_dom: DOM_RES: LPG: En_dom: DOM_COM: LPG: En_dom: DOM_OTH: LPG:	Domestic: SEA (2009a) table 62 • Liquefied petroleum gas:
GAS: Natural gas (including CNG and derived gas) En_dom: DOM_RES: GAS: En_dom: DOM_COM: GAS: En_dom: DOM_OTH: GAS:	Domestic: SEA (2009a) table 62 • Natural gas: • City gas:
ELE: Electricity En_dom: DOM_RES: ELE: En_dom: DOM_COM: ELE: En_dom: DOM_OTH: ELE:	Domestic: SEA (2009a) table 62 • Electricity:
HT: Heat (steam, hot water) En_dom: DOM_RES: HT: En_dom: DOM_COM: HT: En_dom: DOM_OTH: HT:	Domestic: SEA (2009a) table 62 • District heating:

Table A 10: Non-energy purposes – detailed allocation of total energy use

Non-energy purposes:	
Input fuel per sub-sector in GAINS format	**Source and comments**
DC: Derived coal (coke, briquettes) En_tot: NONEN: DC: *	Energy balance (SEA 2009a) table 33 NONEN: DC (coke) *The amount of DC is according to the IEA scenario.
HF: Heavy fuel oil En_tot: NONEN: HF :*	Energy balance (SEA 2009a) table 33 *The split between NONEN HF and GSL are taken from the IEA scenario, to fit the total amount of oil (including gasoline, aviation fuel and light oils).
GSL: Gasoline and other light fractions of oil, includes biofuels En_tot: NONEN: GSL: *	Energy balance: SEA table 33 *The split between NONEN HF and GSL are taken from GAINS annex 1, to fit the total amount of Oil (including gasoline, aviation fuel and light oils).
GAS: Natural gas (incl. CNG and derived gases) En_tot: NONEN: GAS: **	Energy balance: SEA table 33 ** NONEN_GAS is a guess-estimation, only to fit the total amount of total energy use..

Table A 11: Distribution and conversion losses – detailed allocation of total energy use

Total distribution and conversion losses: (SEA 2009a, table 33):	
Input fuel per sub-sector in GAINS format	**Source and comments**
- Nuclear conversion losses:	Energy balance (SEA 2009a) table 33 Removed from the national energy use.
- Biofuels: moved to the industry sector	SEA (2009a): Some biofuels are moved to the Industry sector (OS)
Including: Distribution and conversion losses: electricity Distribution and conversion losses: district heating Distribution and conversion losses: refinery Distribution and conversion losses: gas Distribution and conversion losses: gasoline	Inserted into the GAINS format: CON_LOSS: ELE CON_LOSS: HT CON_LOSS: HF CON_LOSS: GAS CON_LOSS: GSL

Table A 12: Total electricity production – detailed allocation of total electricity production

Total Electricity production (SEA 2009a, table 33)	
Input fuel per sub-sector in GAINS format	**Source and comments**
Electricity distribution losses and in-house consumption: En_tot: CON_LOSS: ELE:	Energy balance (SEA 2009a) table 33 • In-house consumption in water, nuclear power and power plants: Electricity balance (SEA 2009a) table 37 • Distribution losses electricity: • Heat and refinery: • Unspecified electricity losses:
Electricity conversion losses (mostly nuclear power): Are included in: En_tot: PP_TOTAL: ELE:	Electricity balance (SEA 2009a) table 37 • Conversion losses (mostly nuclear):
Net Electricity production: En_tot: PP_TOT: ELE: Export = the sum of electricity in the GAINS format	Electricity balance: SEA table 37 Net electricity production.: + In-house consumption + Unspecified losses = Export of electricity
Distribution losses and conversion losses: Heat, heavy oil (from refinery), gas, own consumption (divided into GSL and HC)	
District heating: En_tot: CON_LOSS: HT:	Energy balance (SEA 2009a) table 40 • District heating
Heavy oil (from refinery): En_tot: CON_LOSS: HF: En_tot: CON_COMB: HF:	Energy balance (SEA 2009a) table 33 • Refinery: - Heat and refinery:
Gas, Coking plant, Blast furnace: En_tot: CON_COMB: GAS: * En_tot: CON_LOSS: GAS: *	Energy balance (SEA 2009a) table 33 • GAS: *The split is from IEA
Own consumption: (el, ref., district heat) En_tot: CON_LOSS: GSL: En_tot: CON_LOSS: HC 1:	Energy balance (SEA 2009a) table 33 Own consumption: *The split is from IEA

Appendix 2 sources:

Swedish Energy Agency (SEA) 2009a, Långsiktsprognosen 2008, ER 2009:14 (in Swedish)
Swedish Energy Agency (SEA) 2009b, Kunskapsunderlag angående marknaden för Elfordon och Laddhybrider (KAMEL), ER 2009:20 (in Swedish)
Fridell E., Åström S., 2009, Analysis of measures to reduce Swedish emissions by 2020 for NOX, PM2.5 and NMVOC Non-road machinery and shipping, IVL report U2617
Skogsindustrierna, 2008, Skogsindustrin – en faktasamling 2008
International Institute for Applied System Analysis (IIASA), 2010, personal communication (Janusz Cofala)
Swedish Energy Agency (SEA), 2010, personal communication (Malin Lagerquist)
ARTEMIS model scenario, SE_2009_Scen_130A, SE_Basecase_V2

Appendix 3: Additional control measures

Table A 13: Additional control measures for SO_2, 2020

Sector	Activity	Technology SWE BSL scenario	Technology Additional possibilities	Comment
CON_COM	BC1 BC2 HC1 HC2 HC3	**IWFGD:** Industry - wet flue gases desulphurisation	**IWFGD:** Industry - wet flue gases desulphurisation	Increased effort
	MD	**LSMD1:** Low sulphur diesel oil - stage 1 (0.2 % S) **LSMD2:** Low sulphur diesel oil - stage 2 (0.045 % S)	**LSMD2:** Low sulphur diesel oil - stage 2 (0.045 % S)	Technique switch
	OS2	**IWFGD:** Industry - wet flue gases desulphurisation	**IWFGD:** Industry - wet flue gases desulphurisation	Increased effort
IN_BO IN_OC	BC1 BC2	**IWFGD:** Industry - wet flue gases desulphurisation	**IWFGD:** Industry - wet flue gases desulphurisation	Increased effort
	HC1 HC2 HC3	**LSCO:** Low sulphur coal (0.6 %S) **IWFGD:** Industry - wet flue gases desulphurisation	**LSCO:** Low sulphur coal (0.6 %S) **IWFGD:** Industry - wet flue gases desulphurisation	Increased effort to IWFGD
	MD	**LSMD1:** Low sulphur diesel oil - stage 1 (0.2 % S) **LSMD2:** Low sulphur diesel oil - stage 2 (0.045 % S)	**LSMD2:** Low sulphur diesel oil - stage 2 (0.045 % S)	Technique switch
PP_EX_OTH PP_NEW	BC1 BC2	**PRWFGD:** Power plant - wet flue gases desulphurisation, already retrofitted	PWFGD	Technique switch
PP_EX_OTH PP_EX_WB PP_NEW	HC1 HC2 HC3	**PRWFGD:** Power plant - wet flue gases desulphurisation, already retrofitted	**PWFGD**:Power plant - wet flue gases desulphurization	Technique switch
PP_EX_OTH PP_NEW	HF	**LSHF:** Low sulphur fuel oil (0.6 %S) **PRWFGD:** Power plant - wet flue gases desulphurisation, already retrofitted **PWFGD**:Power plant - wet flue gases desulphurisation	**PWFGD**:Power plant - wet flue gases desulphurization	Increased effort to PWFGD
	MD	**LSMD1:** Low sulphur diesel oil - stage 1 (0.2 % S) **LSMD2:** Low sulphur diesel oil - stage 2 (0.045 % S)	**LSMD2:** Low sulphur diesel oil - stage 2 (0.045 % S)	Technique switch

Table A 14: Current and additional control measures for NOx, 2020

Sector	Activity	Technology SWE BSL scenario	Technology Additional possibilities	Comment
CON_COM	BC1 BC2 HC1 HC2 HC3	**ISFCM:** Combustion modification on solid fuels fired industrial boilers and furnaces	**ISFCSC**: Combustion modification and selective catalytic reduction on solid fuels fired industrial boilers and furnaces	Technique switch
	GAS HF	**IOGCM:** Combustion modification on oil and gas industrial boilers and furnaces	**IOGCSC:** Combustion modification and selective catalytic reduction on oil and gas industrial boilers and furnaces	Technique switch
	OS2	-	**ISFCSC:** Combustion modification and selective catalytic reduction on solid fuels fired industrial boilers and furnaces	Technique switch
DOM	GAS GSL LPG	-	**DGCCR:** Combustion modification on gasoil use in commercial and residential sectors	Technique switch
	HF	-	**DHFCM:** Combustion modification on heavy fuel oil use in commercial sector	Technique switch
IN_BO (no gas) IN_OC (gas)	BC1 BC2 HC1 HC2 HC3 GAS OS2	**ISFCM:** Combustion modification on solid fuels fired industrial boilers and furnaces	**ISFCSC**: Combustion modification and selective catalytic reduction on solid fuels fired industrial boilers and furnaces	Technique switch
	HF	**IOGCM:** Combustion modification on oil and gas industrial boilers and furnaces	**IOGCSC:** Combustion modification and selective catalytic reduction on oil and gas industrial boilers and furnaces	Technique switch
PP_EX_OTH	BC1 BC2 GAS HF	**POGCM**: Combustion modification on existing oil and gas power plants **POGCSC**	**POGCSC:** Combustion modification and selective catalytic reduction on existing oil and gas power plants	Increased effort
PP_EX_OTH PP_EX_WB	HC1 HC2 HC3	**PHCCM:** Combustion modification on existing hard coal power plants **PHCCSC**	**PHCCSC:** Combustion modification and selective catalytic reduction on existing hard coal power plants	Increased effort
PP_NEW	BC1 BC2 HC1 HC2 HC3	**PBCSCR:** Selective catalytic reduction on new brown coal power plants	**PBCSCR:** Selective catalytic reduction on new brown coal power plants	Increased effort
	GAS OS2 HF	-	**POGSCR**: Selective catalytic reduction on new oil and gas power plants	Technique switch

Sector	**Activity**	**Technology** SWE BSL scenario	**Technology** Additional possibilities	**Comment**
PR_CEM PR_NIAC	NOF	**PRNOX2:** Process emissions - stage 2 NOx control	**PRNOX3:** Process emissions - stage 3 NOx control	Technique switch
PR_COKE PR_LIME PR_OT_NFME PR_PIGI PR_PULP PR_SINT PR_SUAC	NOF	**PRNOX1**: Process emissions - stage 1 NOx control	**PRNOX3:** Process emissions - stage 3 NOx control	Technique switch

Appendix 4 sources:
IIASA GAINS model scenario: **GAINS PRIMES-scenario** (PRIMES_BSL_2009_14jan10)

Appendix 4: Emissions in 2005 and 2020

Table A 15: SO2 emissions 2005

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
Fuel production and conversion	**CON**			
1 A 1 b Petroleum refining		0.65		
1 A 1 c Manufacture of Solid Fuels and Other Energy Industries	CON_COMB	0.39	0.71	
1 B 2 b Natural gas	CON_LOSS	NO	0	
SUBTOTAL		**1.04**		**0.71**
Residential, commercial, services, agriculture, etc.	**DOM**		0	
1.A.4.b.i: Residential plants		1.04		
1 A 4 c i Agriculture/Forestry/Fishing: Stationary		0.21	2	
1.A.4.a.i: Commercial / institutional: stationary		0.19		
SUBTOTAL	**DOM**	**1.44**		**2.0**
Industry	**IND**			
	IN_BO		7.64	
	IN_OC		3.77	
			0	
1 A 2 a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel	PR_SINT	0.81	0.73	
1 A 2 b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals		0.08		
1 A 2 c Stationary Combustion in Manufacturing Industries and Construction: Chemicals		0.49		
1 A 2 d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print		3.43		
1 A 2 e Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages and Tobacco		0.33		
1 A 2 f i Stationary Combustion in Manufacturing Industries and Construction: Other (Please specify in your IIR)	PR_GLASS	2.23	0.65	
1 B 2 a v Distribution of oil products		NA		
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	PR_SUAC	0.50	0	
2 B 2 Nitric Acid Production	PR_NIAC	NA	0.08	
1 B 2 a iv Refining / Storage	PR_REF	0.99	4.72	
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	PR_OT_NFME	3.64	0	
2 D 1 Pulp and Paper	PR_PULP	6.69	0	
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)		0.22		
2 C 1 Iron and Steel Production	PR_PIGI	1.48	3.52	
SUBTOTAL		**20.92**		**21.11**
NFR/CRF-code:	**GAINS**	**Swedish**	**GAINS**	**GAINS**

	Sector/Activity	reporting	subsector	sector
	PR			
1 B 1 b Fugitive emission from Solid Fuels:Solid fuel transformation	PR_COKE	0.07	0	
1 B 1 c Other fugitive emissions from solid fuels		0.01	0	
2 B 4 Carbide Production		0.07		
2 C 2 Ferroalloys Production		0.21		
2 C 3 Aluminum Production		0.25		
SUBTOTAL		0.61		0
	IND + PR			
SUBTOTAL IND + PR		**21.53**		**21.11**
Power Plant	**PP**			
1 A 1 a Public Electricity and Heat Production	PP_EX_OTH	8.14	6.66	
	PP_EX_WB		0	
	PP_IGCC		0	
	PP_NEW		0.46	
	PP_TOTAL		0	
SUBTOTAL		**8.14**		**7.12**
	PR CEM&LIME			
2 A 1 Cement Production	PR_CEM	0.06	0.11	
2 A 2 Lime Production	PR_LIME	0.23	0.15	
SUBTOTAL		**0.29**		**0.26**
	TRA_OTS			
	TRA_OTS		0	
1 A 3 d ii National Navigation (Shipping)	TRA_OTS_L	3.87	1.93	
1A 4 c iii Agriculture/Forestry/Fishing: National Fishing	TRA_OTS_M	0.46	0.14	
SUBTOTAL		**4.34**		**2.07**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	TRA_OT			
	TRA_OT		0	
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	TRA_OT_AGR	0.00	0.35	
			0	
1 A 3 a ii (i) Civil Aviation (Domestic, LTO)	TRA_OT_AIR	0.05	0.11	
1 A 3 a i (i) International Aviation (LTO)		0.06		
1 A 2 f ii Mobile Combustion in Manufacturing Industries and Construction: (Please specify in your IIR)	TRA_OT_CNS	0.01	0.11	
1 A 3 d i (ii) International inland waterways	TRA_OT_INW	NO	0	
1 A 3 e i Pipeline compressors		0.00		
1 A 5 b Other, Mobile (Including military, land based and recreational boats)	TRA_OT_LB	0.12	0.1	
1 A 4 b ii Residential: Household and gardening (mobile)	TRA_OT_LD2	0.00	0	
1 A 3 c Railways	TRA_OT_RAI	0.00	0	
SUBTOTAL		**0.23**		**0.67**
	TRA_RD			
	TRA_RD		0	
1 A 3 b iii Road Transport:, Heavy duty vehicles	TRA_RD_HDB	0.02	0.01	
	TRA_RD_HDT		0.04	
	TRA_RD_LD2		0	
1 A 3 b i Road Transport:, Passenger cars	TRA_RD_LD4C	0.07	0.08	
1 A 3 b ii Road Transport:, Light duty vehicles	TRA_RD_LD4T	0.01	0.01	
1 A 3 b iv Road Transport:, Mopeds & Motorcycles	TRA_RD_M4	0.00	0	
SUBTOTAL		**0.10**		**0.14**
	OTHER			
7	OTHER_SO2	NO	0	
7	NONEN	NO	0	
SUBTOTAL		**0.00**		**0.00**
1 B 2 c Venting and flaring	WASTE_FLR	0.00	2	
6 C b Industrial Waste Incineration (d)	WASTE_RES	IE	0	
4 F FIELD BURNING OF AGRICULTURAL WASTES	WASTE_AGR	NO	0	
SUBTOTAL		**0.00**		**2.00**
TOTAL		**37.11**		**36.08**

Table A 16: SO2 emissions 2020

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	CON			
1 A 1 b Petroleum refining		0.65		
1 A 1 c Manufacture of Solid Fuels and Other Energy Industries	CON_COMB	0.39	0.73	
1 B 2 b Natural gas	CON_LOSS	NO	0	
SUBTOTAL		**1.04**		**0.73**
	DOM			
1.A.4.b.i: Residential plants		0.58		
1 A 4 c i Agriculture/Forestry/Fishing: Stationary		0.15	1.45	
1.A.4.a.i: Commercial / institutional: stationary		0.07		
SUBTOTAL		**0.80**		**1.45**
	IND			
	IN_BO		6.94	
	IN_OC		3.22	
1 A 2 a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel	PR_SINT	0.79	0.66	
1 A 2 b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals		0.08		
1 A 2 c Stationary Combustion in Manufacturing Industries and Construction: Chemicals		0.48		
1 A 2 d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print		2.96		
1 A 2 e Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages and Tobacco		0.29		
1 A 2 f i Stationary Combustion in Manufacturing Industries and Construction: Other (Please specify in your IIR)	PR_GLASS	2.30	0.15	
1 B 2 a v Distribution of oil products		NA		
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	PR_SUAC	0.67	0	
2 B 2 Nitric Acid Production	PR_NIAC	NA	0.07	
1 B 2 a iv Refining / Storage	PR_REF	1.45	4.08	
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	PR_OT_NFME	3.90	0	
2 D 1 Pulp and Paper	PR_PULP	4.32	0	
2 A 7 d Other Mineral products		0.25	3.2	
2 C 1 Iron and Steel Production	PR_PIGI	0.57		
SUBTOTAL		**18.07**		**18.32**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	PR			
1 B 1 b Fugitive emission from Solid Fuels:Solid fuel transformation	PR_COKE	0.02	0	
1 B 1 c Other fugitive emissions from solid fuels		0.01	0	
2 B 4 Carbide Production		0.05		
2 C 2 Ferroalloys Production		0.07		
2 C 3 Aluminum Production		0.14		
SUBTOTAL		**0.29**		**0**
	IND + PR			
SUBTOTAL IND + PR		**18.36**		**18.32**
	PP			
1 A 1 a Public Electricity and Heat Production	PP_EX_OTH	7.74	1.23	
	PP_EX_WB		0	
	PP_IGCC		0	
	PP_NEW		3.62	
	PP_TOTAL		0	
SUBTOTAL		**7.74**		**4.85**
	PR CEM&LIME			
2 A 1 Cement Production	PR_CEM	0.05	0.15	
2 A 2 Lime Production	PR_LIME	0.31	0.2	
SUBTOTAL		**0.36**		**0.35**
	TRA_OTS			
	TRA_OTS		0	
1 A 3 d ii National Navigation (Shipping)	TRA_OTS_L	0.32	1.06	
1A 4 c iii Agriculture/Forestry/Fishing: National Fishing	TRA_OTS_M	0.11	0.11	
SUBTOTAL		**0.43**		**1.17**
	TRA_OT			
	TRA_OT		0	
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	TRA_OT_AGR	0.00	0.01	
1 A 3 a ii (i) Civil Aviation (Domestic, LTO)	TRA_OT_AIR	0.02	0.14	
1 A 3 a i (i) International Aviation (LTO)		0.03		
1 A 2 f ii Mobile Combustion in Manufacturing Industries and Construction: (Please specify in your IIR)	TRA_OT_CNS	0.00	0	
1 A 3 d i (ii) International inland waterways	TRA_OT_INW	NO	0	
1 A 3 e i Pipeline compressors		0.00		
1 A 5 b Other, Mobile (Including military, land based and recreational boats)	TRA_OT_LB	0.04	0	
1 A 4 b ii Residential: Household and gardening (mobile)	TRA_OT_LD2	0.00	0	
1 A 3 c Railways	TRA_OT_RAI	0.00	0	
SUBTOTAL		**0.09**		**0.15**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	TRA_RD			
	TRA_RD		0	
1 A 3 b iii Road Transport:, Heavy duty vehicles	TRA_RD_HDB	0.00	0	
	TRA_RD_HDT		0.04	
	TRA_RD_LD2		0	
1 A 3 b i Road Transport:, Passenger cars	TRA_RD_LD4 C	0.00	0.08	
1 A 3 b ii Road Transport:, Light duty vehicles	TRA_RD_LD4 T	0.00	0.02	
1 A 3 b iv Road Transport:, Mopeds & Motorcycles	TRA_RD_M4	0.00	0	
SUBTOTAL		**0.00**		**0.14**
	OTHER			
7	OTHER_SO2	NO	0	
7	NONEN	NO	0	
SUBTOTAL		**0.00**		**0**
	WASTE			
1 B 2 c Venting and flaring	WASTE_FLR	0.00	1.4	
6 C b Industrial Waste Incineration (d)	WASTE_RES	IE	0	
4 F FIELD BURNING OF AGRICULTURAL WASTES	WASTE_AGR	NO	0	
SUBTOTAL		**0.00**		**1.4**
TOTAL		**28.83**	**0.00**	**28.56**

Table A 17: NOx emissions 2005

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	CON			
1 A 1 b Petroleum refining		1.48		
1 A 1 c Manufacture of Solid Fuels and Other Energy Industries	CON_COMB	0.14	1.86	
1 B 2 b Natural gas	CON_LOSS	NO	0	
SUBTOTAL		**1.61**		**1.86**
	DOM			
1 A 4 a i Commercial / Institutional: Stationary		0.69		
1 A 4 b i Residential: Stationary plants		4.72		
1 A 4 c i Agriculture/Forestry/Fishing: Stationary		0.62		
SUBTOTAL		**6.03**		**4.88**
	IND			
	IN_BO		8.35	
	IN_OC		5.09	
1 A 2 a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel	PR_SINT	1.06	0.12	
1 A 2 b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals		0.09		
1 A 2 c Stationary Combustion in Manufacturing Industries and Construction: Chemicals		1.48		
1 A 2 d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print		5.62		
1 A 2 e Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages and Tobacco		0.58		
1 A 2 f i Stationary Combustion in Manufacturing Industries and Construction: Other (Please specify in your IIR)	PR_GLASS	8.10	0	
1 B 2 a v Distribution of oil products		0.00		
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	PR_SUAC	1.04	0	
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	PR_OT_NFME	0.26	0.74	
2 B 2 Nitric Acid Production	PR_NIAC	0.25	0.65	
1 B 2 a iv Refining / Storage	PR_REF	0.07	10.5	
2 D 1 Pulp and Paper	PR_PULP	10.59	0	
2 A 7 a Quarrying and mining of minerals other than coal		0.02		
SUBTOTAL		**29.18**		**25.45**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	PR			
1 B 1 b Fugitive emission from Solid Fuels:Solid fuel transformation	PR_COKE	NA	0	
1 B 1 c Other fugitive emissions from solid fuels	???	0.07		
2 C 1 Iron and Steel Production	PR_PIGI	0.86	0	
2 B 4 Carbide Production	???	NA		
2 C 2 Ferroalloys Production	???	0.15		
2 C 3 Aluminum Production		0.01		
SUBTOTAL		**1.10**		**0**
	IND + PR			
SUBTOTAL IND + PR		**30.28**		**25.45**
	PP			
1 A 1 a Public Electricity and Heat Production	PP_EX_OTH	12.41	16.71	
	PP_EX_WB		0	
	PP_IGCC		0	
	PP_NEW		1.78	
	PP_TOTAL		0	
6 C c Municipal Waste Incineration (d)		IE		
SUBTOTAL		**12.41**		**18.49**
	PR CEM&LIME			
2 A 1 Cement Production	PR_CEM	NA	1.41	
2 A 2 Lime Production	PR_LIME	NA	0.78	
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)		0.48		
SUBTOTAL		**0.48**		**2.19**
	TRA_OTS			
1 A 3 d ii National Navigation (Shipping)	TRA_OTS_L	6.98	7.57	
1A 4 c iii Agriculture/Forestry/Fishing: National Fishing	TRA_OTS_M	3.74	2.52	
SUBTOTAL		**10.71**		**10.09**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	TRA_OT			
	TRA_OT			
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	TRA_OT_AGR	8.71	21.8	
1 A 3 a ii (i) Civil Aviation (Domestic, LTO)	TRA_OT_AIR	0.49	1.08	
1 A 3 a i (i) International Aviation (LTO)		0.70		
1 A 2 f ii Mobile Combustion in Manufacturing Industries and Construction: (Please specify in your IIR)	TRA_OT_CNS	14.86	6.18	
1 A 3 d i (ii) International inland waterways	TRA_OT_INW	NO	0	
1 A 3 e i Pipeline compressors		1.23		
1 A 5 b Other, Mobile (Including military, land based and recreational boats)	TRA_OT_LB	1.15	2.51	
1 A 4 b ii Residential: Household and gardening (mobile)	TRA_OT_LD2	1.66	0.09	
1 A 3 c Railways	TRA_OT_RAI	1.36	0	
1 B 2 a v Distribution of oil products		0.00		
SUBTOTAL		**30.16**		**31.66**
1.A.3.b	**TRA_RD**			
1 A 3 b iii Road Transport:, Heavy duty vehicles	TRA_RD_HDB	45.31	8.94	
	TRA_RD_HDT		57.88	
	TRA_RD_LD2		0.06	
1 A 3 b i Road Transport:, Passenger cars	TRA_RD_LD4 C	31.99	28.74	
1 A 3 b ii Road Transport:, Light duty vehicles	TRA_RD_LD4 T	6.09	9.46	
1 A 3 b iv Road Transport:, Mopeds & Motorcycles	TRA_RD_M4	0.22	0.23	
SUBTOTAL		**83.60**		**105.31**
	OTHER			
7 A OTHER (included in National Total for Entire Territory)	OTHER_NOX	NO	0	
SUBTOTAL		0.00		0.00
	WASTE			
1 B 2 c Venting and flaring	WASTE_FLR	0.07	0	
6 C b Industrial Waste Incineration (d)		0.12		
	WASTE_RES		0	
4 F FIELD BURNING OF AGRICULTURAL WASTES	WASTE_AGR	NO	0	
SUBTOTAL		**0.19**		**0.00**
TOTAL		**175.48**		**199.93**

Table A 18: NOx emissions 2020

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	CON			
1 A 1 b Petroleum refining		1.18		
1 A 1 c Manufacture of Solid Fuels and Other Energy Industries	CON_COMB	0.14	1.83	
1 B 2 b Natural gas	CON_LOSS	NO	0	
SUBTOTAL		**1.32**		**1.83**
	DOM			
1 A 4 a i Commercial / Institutional: Stationary		0.53		
1 A 4 b i Residential: Stationary plants		4.22		
1 A 4 c i Agriculture/Forestry/Fishing: Stationary		0.49		
SUBTOTAL		**5.25**		**4.43**
	IND			
	IN_BO		7.69	
	IN_OC		4.82	
1 A 2 a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel	PR_SINT	0.87	0.11	
1 A 2 b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals		0.08		
1 A 2 c Stationary Combustion in Manufacturing Industries and Construction: Chemicals		1.24		
1 A 2 d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print		5.26		
1 A 2 e Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages and Tobacco		0.47		
1 A 2 f i Stationary Combustion in Manufacturing Industries and Construction: Other (Please specify in your IIR)	PR_GLASS	7.98	0	
1 B 2 a v Distribution of oil products		0.00		
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	PR_SUAC	1.04	0	
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	PR_OT_NFME	0.24	0.97	
2 B 2 Nitric Acid Production	PR_NIAC	0.26	0.57	
1 B 2 a iv Refining / Storage	PR_REF	0.22	6.17	
2 D 1 Pulp and Paper	PR_PULP	9.40	0	
2 A 7 a Quarrying and mining of minerals other than coal		0.06		
SUBTOTAL		**27.13**		**20.33**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	PR			
1 B 1 b Fugitive emission from Solid Fuels:Solid fuel transformation	PR_COKE	NA	0	
1 B 1 c Other fugitive emissions from solid fuels	???	0.08		
2 C 1 Iron and Steel Production	PR_PIGI	0.84	0	
2 B 4 Carbide Production	???	NA		
2 C 2 Ferroalloys Production	???	0.084		
2 C 3 Aluminum Production		0.00		
SUBTOTAL		**1.00**		**0**
	IND + PR			
SUBTOTAL IND+PR		**28.13**		**20.33**
	PP			
1 A 1 a Public Electricity and Heat Production	PP_EX_OTH	14.67	3.21	
	PP_EX_WB		0	
	PP_IGCC		0	
	PP_NEW		14.71	
	PP_TOTAL		0	
6 C c Municipal Waste Incineration (d)		NE		
SUBTOTAL		**14.67**		**17.92**
	PR CEM&LIME			
2 A 1 Cement Production	PR_CEM	NA	1.94	
2 A 2 Lime Production	PR_LIME	NA	0.92	
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)		0.49		
SUBTOTAL		**0.49**		**2.86**
	TRA_OTS			
1 A 3 d ii National Navigation (Shipping)	TRA_OTS_L	5.94	7.63	
1A 4 c iii Agriculture/Forestry/Fishing: National Fishing	TRA_OTS_M	3.36	2.43	
SUBTOTAL		**9.30**	**0**	**10.06**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	TRA_OT			
	TRA_OT			
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	TRA_OT_AGR	2.96	7.44	
1 A 3 a ii (i) Civil Aviation (Domestic, LTO)	TRA_OT_AIR	0.26	1.37	
1 A 3 a i (i) International Aviation (LTO)		0.68		
1 A 2 f ii Mobile Combustion in Manufacturing Industries and Construction: (Please specify in your IIR)	TRA_OT_CNS	3.86	2	
1 A 3 d i (ii) International inland waterways	TRA_OT_INW	NO	0	
1 A 3 e i Pipeline compressors		1.23		
1 A 5 b Other, Mobile (Including military, land based and recreational boats)	TRA_OT_LB	0.88	1.69	
1 A 4 b ii Residential: Household and gardening (mobile)	TRA_OT_LD2	1.03	0.09	
1 A 3 c Railways	TRA_OT_RAI	0.37	0	
1 B 2 a v Distribution of oil products		0.00		
SUBTOTAL		**11.28**		**12.59**
1.A.3.b	**TRA_RD**			
1 A 3 b iii Road Transport:, Heavy duty vehicles	TRA_RD_HDB	23.03	1.52	
	TRA_RD_HDT		12.49	
	TRA_RD_LD2		0.18	
1 A 3 b i Road Transport:, Passenger cars	TRA_RD_LD4 C	15.33	10.74	
1 A 3 b ii Road Transport:, Light duty vehicles	TRA_RD_LD4 T	3.52	4.53	
1 A 3 b iv Road Transport:, Mopeds & Motorcycles	TRA_RD_M4	0.23	0.13	
SUBTOTAL		**42.11**		**29.59**
	OTHER			
7 A OTHER (included in National Total for Entire Territory)	OTHER_NOX	NO	0	
SUBTOTAL		0.00		0.00
	WASTE			
1 B 2 c Venting and flaring	WASTE_FLR	0.09	0	
6 C b Industrial Waste Incineration (d)		0.08		
	WASTE_RES		0	
4 F FIELD BURNING OF AGRICULTURAL WASTES	WASTE_AGR	NO	0	
SUBTOTAL		**0.17**		**0.00**
TOTAL		**112.70**	**0**	**99.61**

Table A 19: $PM_{2,5}$ emissions 2005

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	CON			
1 A 1 b Petroleum refining		1.17		
1 A 1 c Manufacture of Solid Fuels and Other Energy Industries	CON_COMB	0.00	0.095	
1 B 2 b Natural gas	CON_COMB1	NO	0.00	
	CON_COMB2		0.00	
	CON_COMB3		0.00	
SUBTOTAL		**1.18**		**0.095**
	DOM			
1 A 4 a i Commercial / Institutional: Stationary		0.26		
1 A 4 b i Residential: Stationary plants	DOM	5.27	0.028	
1 A 4 c i Agriculture/Forestry/Fishing: Stationary	DOM_FPLACE	0.54	0.00	
	DOM_MB_A		0.00	
	DOM_MB_M		0.00	
	DOM_PIT		0.00	
	DOM_SHB_A		0.00	
	DOM_SHB_M		0.00	
	DOM_STOVE_C		0.00	
	DOM_STOVE_H		0.00	
SUBTOTAL		**6.07**		**0.028**

NFR/CRF-code:	**GAINS Sector/Activity**	**Swedish reporting**	**GAINS subsector**	**GAINS sector**
Industry	**IND**			
	IN_BO		0.85	
	IN_BO1		0.00	
	IN_BO2		0.00	
	IN_BO3		0.00	
	IN_OC		0.10	
	IN_OC1		0.00	
	IN_OC2		0.00	
	IN_OC3		0.06	
1 A 2 a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel	PR_CAST	0.04	0.07	
	PR_SINT		0.00	
	PR_SINT_F		0.00	
1 A 2 b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals	PR_ALSEC	0.01	0.01	
1 A 2 c Stationary Combustion in Manufacturing Industries and Construction: Chemicals		0.10		
1 A 2 d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print		1.36		
1 A 2 e Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages and Tobacco		0.04		
1 A 2 f i Stationary Combustion in Manufacturing Industries and Construction: Other (Please specify in your IIR)	PR_GLASS	0.83	0.02	
	PR_BRICK		0.00	
1 B 2 a v Distribution of oil products		0.00		
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	PR_FERT	NE	0.22	
	PR_CBLACK		0.00	
	PR_OTHER		0.03	
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	PR_OT_NFME	0.03	0.05	
2 B 2 Nitric Acid Production		NA		
1 B 2 a iv Refining / Storage	PR_REF	0.04	0.12	
2 D 1 Pulp and Paper	PR_PULP	3.77	2.30	
2 D 3 Wood processing	PR_SMIND_F	NE	0.41	
2 A 7 a Quarrying and mining of minerals other than coal	MINE_OTH	0.00	0.10	
2 A 5 Asphalt Roofing		0.00		
SUBTOTAL		**6.21**		**4.35**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	PR			
1 B 1 b Fugitive emission from Solid Fuels:Solid fuel transformation	PR_COKE	NA	0.18	
	PR_BRIQ		0.00	
1 B 1 c Other fugitive emissions from solid fuels	???	0.02		
2 C 1 Iron and Steel Production	PR_PIGI	3.23	0.14	
	PR_PIGI_F		0.39	
	PR_EARC		0.72	
	PR_HEARTH		0.00	
	PR_BAOX		2.10	
	PR_CAST_F		0.29	
	PR_PELL		0.52	
2 B 4 Carbide Production	???	0.24		
2 C 2 Ferroalloys Production	???	0.07		
2 C 3 Aluminum Production	PR_ALPRIM	0.13	0.12	
1 B 1 a Fugitive emission from Solid Fuels: Coal Mining and Handling	STH_COAL	NO	0.00	
	MINE_BC		0.004	
	MINE_HC		0.00	
2A 7 c Storage, handling and transport of mineral products	STH_FEORE	IE	0.284	
2 B 5 b Storage, handling and transport of chemical products (Please specify the sources included/excluded in the notes column to the right)	STH_NPK	NE	0.017	
	STH_OTH_IN		0.014	
SUBTOTAL		**3.69**		**4.78**
	IND + PR			
SUBTOTAL IND + PR		**9.91**		**9.13**
	PP			
1 A 1 a Public Electricity and Heat Production	PP_EX_OTH	3.18	0.83	
	PP_EX_OTH1		0.00	
	PP_EX_OTH2		0.00	
	PP_EX_OTH3		0.00	
	PP_EX_WB		0.00	
	PP_IGCC		0.00	
	PP_NEW		0.07	
	PP_NEW1		0.00	
	PP_NEW2		0.00	
	PP_NEW3		0.00	
6 C c Municipal Waste Incineration (d)		IE		
SUBTOTAL		**3.18**		**0.89**

NFR/CRF-code:	**GAINS Sector/Activity**	**Swedish reporting**	**GAINS subsector**	**GAINS sector**
	PR CEM&LIME			
2 A 1 Cement Production	PR_CEM	0.28	1.053	
2 A 2 Lime Production	PR_LIME	0.21	0.007	
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)		0.11		
SUBTOTAL		**0.60**		**1.06**
	TRA_OTS			
1 A 3 d ii National Navigation (Shipping)	TRA_OTS_L	0.45	0.42	
1A 4 c iii Agriculture/Forestry/Fishing: National Fishing	TRA_OTS_M	0.06	0.055	
SUBTOTAL		**0.51**		**0.47**
	TRA_OT			
	TRA_OT		0.00	
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	TRA_OT_AGR	0.71	1.42	
1 A 3 a ii (i) Civil Aviation (Domestic, LTO)	TRA_OT_AIR	0.00	0.01	
1 A 3 a i (i) International Aviation (LTO)		0.00		
1 A 2 f ii Mobile Combustion in Manufacturing Industries and Construction: (Please specify in your IIR)	TRA_OT_CNS	0.75	0.38	
1 A 3 d i (ii) International inland waterways	TRA_OT_INW	NO	0.00	
1 A 3 e i Pipeline compressors		0.12		
1 A 5 b Other, Mobile (Including military, land based and recreational boats)	TRA_OT_LB	0.01	0.19	
1 A 4 b ii Residential: Household and gardening (mobile)	TRA_OT_LD2	0.15	1.08	
1 A 3 c Railways	TRA_OT_RAI	0.09	0.00	
SUBTOTAL		**1.84**		**3.08**
1.A.3.b	**TRA_RD**			
1 A 3 b iii Road Transport:, Heavy duty vehicles	TRA_RD_HDB	1.01	0.27	
	TRA_RD_HDT		1.59	
	TRA_RD_LD2		0.05	
1 A 3 b i Road Transport:, Passenger cars	LEAD_GASOL	0.51	0.00	
	TRA_RD_LD4 C		3.65	
1 A 3 b ii Road Transport:, Light duty vehicles	TRA_RD_LD4 T	0.42	1.35	
1 A 3 b iv Road Transport:, Mopeds & Motorcycles	TRA_RD_M4	0.11	0.03	
1 A 3 b vi Road Transport:, Automobile tyre and brake wear		0.84	*0.326**	
1 A 3 b vii Road Transport:, Automobile road abrasion		3.78	*3.103***	
SUBTOTAL		**6.67**		**6.94**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	OTS + OT + RD			
SUBTOTAL MOBILE		**9.01**		**10.50**
	OTHER			
7 A OTHER (included in National Total for Entire Territory)	OTHER_PM	NO	0.00	
	NONEN		0.00	
2 A 7 b Construction and demolition	CONSTRUCT	0.07	0.038	
SUBTOTAL		**0.07**		**0.04**
	AGR			
4 B 1 b Cattle Non-Dairy	AGR_BEEF	0.19	0.07	
4 B 1 a Cattle Dairy	AGR_COWS	0.09	0.02	
4 B 3 Sheep	AGR_OTANI	NE	0.00	
4 B 6 Horses		0.03		
4 B 8 Swine	AGR_PIG	0.15	0.13	
4 B 9 a Laying Hens	AGR_POULT	0.11	0.19	
4 B 9 b Broilers		0.16		
4 B 9 c Turkeys		0.00		
4 B 13 Other	AGR_OTHER	NE	0.00	
	AGR_ARABLE		0.00	
SUBTOTAL		**0.73**		**0.41**
	FARM			
4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products	STH_AGR	0.23	0.023	
4 D 2 b Off-farm storage, handling and transport of bulk agricultural products		NE		
SUBTOTAL		0.23		0.023
	RESIDENTIAL			
3 D 3 Other product use	RES_BBQ	0.64	0.676	
	RES_CIGAR		0.149	
	RES_FIREW		0.315	
SUBTOTAL		**0.64**		**1.14**
	WASTE			
1 B 2 c Venting and flaring	WASTE_FLR	0.03	0	
6 C b Industrial Waste Incineration (d)	WASTE_RES	0.00	0	
4 F FIELD BURNING OF AGRICULTURAL WASTES	WASTE_AGR	NO	0	
6 D OTHER WASTE (e)		0.21		
SUBTOTAL		**0.25**		**0.00**
TOTAL		**31.86**		**23.32**

Table A 20: $PM_{2,5}$ emissions 2020

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	CON			
1 A 1 b Petroleum refining		1.08		
1 A 1 c Manufacture of Solid Fuels and Other Energy Industries	CON_COMB	0.00	0.096	
1 B 2 b Natural gas	CON_COMB1	NO	0.00	
	CON_COMB2		0.00	
	CON_COMB3		0.00	
SUBTOTAL		**1.08**		**0.096**
	DOM			
1 A 4 a i Commercial / Institutional: Stationary		0.37		
1 A 4 b i Residential: Stationary plants	DOM	5.04	0.011	
1 A 4 c i Agriculture/Forestry/Fishing: Stationary	DOM_FPLACE	0.33	0	
	DOM_MB_A		0	
	DOM_MB_M		0	
	DOM_PIT		0.00	
	DOM_SHB_A		0.00	
	DOM_SHB_M		0.00	
	DOM_STOVE_C		0.00	
	DOM_STOVE_H		0	
SUBTOTAL	**DOM**	**5.74**		**0.01**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	IND			
	IN_BO		0.74	
	IN_BO1		0.00	
	IN_BO2		0.00	
	IN_BO3		0.00	
	IN_OC		0.06	
	IN_OC1		0.00	
	IN_OC2		0.00	
	IN_OC3		0.07	
1 A 2 a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel	PR_CAST	0.05	0.07	
	PR_SINT		0.00	
	PR_SINT_F		0.00	
1 A 2 b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals	PR_ALSEC	0.01	0.02	
1 A 2 c Stationary Combustion in Manufacturing Industries and Construction: Chemicals		0.10		
1 A 2 d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print		1.34		
1 A 2 e Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages and Tobacco		0.04		
1 A 2 f i Stationary Combustion in Manufacturing Industries and Construction: Other (Please specify in your IIR)	PR_GLASS	0.89	0.02	
	PR_BRICK		0.00	
1 B 2 a v Distribution of oil products		0.00		
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	PR_FERT	NE	0.22	
	PR_CBLACK		0.00	
	PR_OTHER		0.03	
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	PR_OT_NFME	0.03	0.05	
2 B 2 Nitric Acid Production		NA		
1 B 2 a iv Refining / Storage	PR_REF	0.04	0.11	
2 D 1 Pulp and Paper	PR_PULP	4.53	1.53	
2 D 3 Wood processing	PR_SMIND_F	NE	0.33	
2 A 7 a Quarrying and mining of minerals other than coal	MINE_OTH	0.00	0.16	
2 A 5 Asphalt Roofing		0.00		
SUBTOTAL		**7.03**		**3.42**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	PR			
1 B 1 b Fugitive emission from Solid Fuels:Solid fuel transformation	PR_COKE	NA	0.14	
	PR_BRIQ		0.00	
1 B 1 c Other fugitive emissions from solid fuels	???	0.02		
2 C 1 Iron and Steel Production	PR_PIGI	2.09	0.05	
	PR_PIGI_F		0.37	
	PR_EARC		0.37	
	PR_HEARTH		0.00	
	PR_BAOX		1.26	
	PR_CAST_F		0.29	
	PR_PELL		0.49	
2 B 4 Carbide Production	???	0.37		
2 C 2 Ferroalloys Production	???	0.08		
2 C 3 Aluminum Production	PR_ALPRIM	0.12	0.13	
1 B 1 a Fugitive emission from Solid Fuels: Coal Mining and Handling	STH_COAL	NO	0.00	
	MINE_BC		0.002	
	MINE_HC		0.00	
2A 7 c Storage, handling and transport of mineral products	STH_FEORE	IE	0.269	
2 B 5 b Storage, handling and transport of chemical products (Please specify the sources included/excluded in the notes column to the right)	STH_NPK	NE	0.022	
	STH_OTH_IN		0.014	
SUBTOTAL		**2.68**		**3.39**
	IND + PR			
SUBTOTAL IND+PR		**9.71**		**6.82**
	PP			
1 A 1 a Public Electricity and Heat Production	PP_EX_OTH	3.03	0.02	
	PP_EX_OTH1		0.00	
	PP_EX_OTH2		0.00	
	PP_EX_OTH3		0.00	
	PP_EX_WB		0.00	
	PP_IGCC		0.00	
	PP_NEW		0.16	
	PP_NEW1		0.00	
	PP_NEW2		0.00	
	PP_NEW3		0.00	
6 C c Municipal Waste Incineration (d)		IE		
SUBTOTAL		**3.03**		**0.18**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	PR CEM&LIME			
2 A 1 Cement Production	PR_CEM	0.27	1.454	
2 A 2 Lime Production	PR_LIME	0.19	0.009	
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)		0.12		
SUBTOTAL		**0.58**		**1.463**
	TRA_OTS			
1 A 3 d ii National Navigation (Shipping)	TRA_OTS_L	0.46	0.44	
1A 4 c iii Agriculture/Forestry/Fishing: National Fishing	TRA_OTS_M	0.06	0.059	
SUBTOTAL		**0.52**		**0.50**
	TRA_OT			
	TRA_OT		0.00	
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery	TRA_OT_AGR	0.73	0.30	
1 A 3 a ii (i) Civil Aviation (Domestic, LTO)	TRA_OT_AIR	0.00	0.02	
1 A 3 a i (i) International Aviation (LTO)		0.00		
1 A 2 f ii Mobile Combustion in Manufacturing Industries and Construction: (Please specify in your IIR)	TRA_OT_CNS	0.78	0.08	
1 A 3 d i (ii) International inland waterways	TRA_OT_INW	NO	0.00	
1 A 3 e i Pipeline compressors		0.11		
1 A 5 b Other, Mobile (Including military, land based and recreational boats)	TRA_OT_LB	0.01	0.09	
1 A 4 b ii Residential: Household and gardening (mobile)	TRA_OT_LD2	0.16	0.23	
1 A 3 c Railways	TRA_OT_RAI	0.09	0.00	
SUBTOTAL		**1.89**		**0.72**
1.A.3.b	**TRA_RD**			
1 A 3 b iii Road Transport:, Heavy duty vehicles	TRA_RD_HDB	1.05	0.06	
	TRA_RD_HDT		0.35	
	TRA_RD_LD2		0.01	
1 A 3 b i Road Transport:, Passenger cars	LEAD_GASOL	0.54	0.00	
	TRA_RD_LD4C		3.78	
1 A 3 b ii Road Transport:, Light duty vehicles	TRA_RD_LD4T	0.58	0.43	
1 A 3 b iv Road Transport:, Mopeds & Motorcycles	TRA_RD_M4	0.10	0.01	
1 A 3 b vi Road Transport:, Automobile tyre and brake wear		0.83	*0.405*	
1 A 3 b vii Road Transport:, Automobile road abrasion		3.75	*3.792*	
SUBTOTAL		**6.86**		**4.63**

NFR/CRF-code:	GAINS Sector/Activity	Swedish reporting	GAINS subsector	GAINS sector
	OTS + OT + RD			
SUBTOTAL MOBILE		**9.27**		**5.85**
	OTHER			
7 A OTHER (included in National Total for Entire Territory)	OTHER_PM	NO	0.00	
	NONEN		0.00	
2 A 7 b Construction and demolition	CONSTRUCT	0.06	0.056	
SUBTOTAL		0.06		0.06
	AGR			
4 B 1 b Cattle Non-Dairy	AGR_BEEF	0.20	0.05	
4 B 1 a Cattle Dairy	AGR_COWS	0.09	0.02	
4 B 3 Sheep	AGR_OTANI	NE	0.00	
4 B 6 Horses		0.03		
4 B 8 Swine	AGR_PIG	0.15	0.12	
4 B 9 a Laying Hens	AGR_POULT	0.10	0.19	
4 B 9 b Broilers		0.17		
4 B 9 c Turkeys		0.00		
4 B 13 Other	AGR_OTHER	NE	0.00	
	AGR_ARABLE		0.00	
SUBTOTAL		**0.74**		**0.39**
	FARM			
4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products	STH_AGR	0.25	0.024	
4 D 2 b Off-farm storage, handling and transport of bulk agricultural products		NE		
SUBTOTAL		**0.25**		**0.024**
	RESIDENTIAL			
3 D 3 Other product use	RES_BBQ	0.69	0.739	
	RES_CIGAR		0.163	
	RES_FIREW		0.345	
SUBTOTAL		**0.69**		**1.247**
	WASTE			
1 B 2 c Venting and flaring	WASTE_FLR	0.02	0	
6 C b Industrial Waste Incineration (d)	WASTE_RES	0.00	0	
4 F FIELD BURNING OF AGRICULTURAL WASTES	WASTE_AGR	NO	0	
6 D OTHER WASTE (e)		0.21		
SUBTOTAL		**0.23**		**0**
TOTAL		**31.38**		**16.12**

Appendix 5 sources:
Own calculations with the GAINS model