The Environmental Protection Agency

Ireland's
Informative Inventory Report 2017

Air Pollutant Emissions in Ireland 1990- 2015

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

The work of the EPA can be divided into three main areas:

Regulation: *We implement effective regulation and environmental compliance systems to deliver good environmental outcomes and target those who don't comply.*

Knowledge: *We provide high quality, targeted and timely environmental data, information and assessment to inform decision making at all levels.*

Advocacy: *We work with others to advocate for a clean, productive and well protected environment and for sustainable environmental behaviour.*

Our Responsibilities

Licensing

We regulate the following activities so that they do not endanger human health or harm the environment:

- waste facilities *(e.g. landfills, incinerators, waste transfer stations)*;
- large scale industrial activities (*e.g. pharmaceutical, cement manufacturing, power plants)*;
- intensive agriculture *(e.g. pigs, poultry)*;
- the contained use and controlled release of Genetically Modified Organisms *(GMOs)*;
- sources of ionising radiation *(e.g. x-ray and radiotherapy equipment, industrial sources)*;
- large petrol storage facilities;
- waste water discharges;
- dumping at sea activities.

National Environmental Enforcement

- Conducting an annual programme of audits and inspections of EPA licensed facilities.
- Overseeing local authorities' environmental protection responsibilities.
- Supervising the supply of drinking water by public water suppliers.
- Working with local authorities and other agencies to tackle environmental crime by co-ordinating a national enforcement network, targeting offenders and overseeing remediation.
- Enforcing Regulations such as Waste Electrical and Electronic Equipment (WEEE), Restriction of Hazardous Substances (RoHS) and substances that deplete the ozone layer.
- Prosecuting those who flout environmental law and damage the environment.

Water Management

- Monitoring and reporting on the quality of rivers, lakes, transitional and coastal waters of Ireland and groundwaters; measuring water levels and river flows.
- National coordination and oversight of the Water Framework Directive.
- Monitoring and reporting on Bathing Water Quality.

Monitoring, Analysing and Reporting on the Environment

- Monitoring air quality and implementing the EU Clean Air for Europe (CAFÉ) Directive.
- Independent reporting to inform decision making by national and local government *(e.g. periodic reporting on the State of Ireland's Environment and Indicator Reports)*.

Regulating Ireland's Greenhouse Gas Emissions

- Preparing Ireland's greenhouse gas inventories and projections.
- Implementing the Emissions Trading Directive, for over 100 of the largest producers of carbon dioxide in Ireland.

Environmental Research and Development

- Funding environmental research to identify pressures, inform policy and provide solutions in the areas of climate, water and sustainability.

Strategic Environmental Assessment

- Assessing the impact of proposed plans and programmes on the Irish environment *(e.g. major development plans)*.

Radiological Protection

- Monitoring radiation levels, assessing exposure of people in Ireland to ionising radiation.
- Assisting in developing national plans for emergencies arising from nuclear accidents.
- Monitoring developments abroad relating to nuclear installations and radiological safety.
- Providing, or overseeing the provision of, specialist radiation protection services.

Guidance, Accessible Information and Education

- Providing advice and guidance to industry and the public on environmental and radiological protection topics.
- Providing timely and easily accessible environmental information to encourage public participation in environmental decision-making *(e.g. My Local Environment, Radon Maps)*.
- Advising Government on matters relating to radiological safety and emergency response.
- Developing a National Hazardous Waste Management Plan to prevent and manage hazardous waste.

Awareness Raising and Behavioural Change

- Generating greater environmental awareness and influencing positive behavioural change by supporting businesses, communities and householders to become more resource efficient.
- Promoting radon testing in homes and workplaces and encouraging remediation where necessary.

Management and structure of the EPA

The EPA is managed by a full time Board, consisting of a Director General and five Directors. The work is carried out across five Offices:

- Office of Environmental Sustainability
- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet regularly to discuss issues of concern and provide advice to the Board.

IRELAND

INFORMATIVE INVENTORY REPORT 2017

AIR POLLUTANT EMISSIONS IN IRELAND 1990–2015

REPORTED TO THE SECRETARIAT OF THE UN/ECE

CONVENTION ON LONG-RANGE TRANSBOUNDARY

AIR POLLUTION AND TO THE EUROPEAN UNION

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EXECUTIVE SUMMARY

As a Party to the United Nations Economic Commission for Europe (UN/ECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP), Ireland is required to annually report emission data for a wide range of air pollutants and other substances released into the atmosphere. The data are needed to support the work of the Convention in addressing well-known environmental problems such as urban pollution, acidification and tropospheric ozone formation arising from classic pollutants, such as nitrogen oxides (NO_x), sulphur dioxide (SO_2), non-methane volatile organic compounds (NMVOCs), ammonia (NH_3), carbon monoxide (CO) and particulate matter (PM), and for the implementation of its Protocols on Heavy Metals and Persistent Organic Pollutants.

The UN/ECE revised 2014 Reporting Guidelines, Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution[1], describe the scope and reporting of the emission inventories and projections under the Convention. They specify the methodologies and procedures to be followed for submitting consistent and comparable data on an annual basis in a timely, efficient and transparent manner to meet the needs of the Convention. Under the Guidelines, Parties are strongly encouraged to submit an Informative Inventory Report (IIR) to support the evaluation of their up-to-date annual inventories and projections. The objective of the IIR is to describe the methodologies, input data, background information and the entire process of inventory compilation for transboundary air pollutant emissions and to give explanations for any improvements and recalculations of the inventories reported in previous submissions. The report is needed by expert review teams to assess the transparency, completeness and overall quality of the inventories as part of the review process being developed for the submissions from Parties to the Convention.

Member States of the European Union are required to report an Informative Inventory Report annually under Article 8(3) of Directive (EU) 2016/2284. This Directive sets out reduction commitments of certain atmospheric pollutants and repeals Directive 2001/81/EC. This report to the European Union fulfils this reporting obligation.

The Environmental Protection Agency (EPA) in Ireland has overall responsibility for national air emission inventories and projections pursuant to the establishment of the National Atmospheric Inventory System (NAIS) in 2007. The EPA Office Environmental Sustainability (OES) performs the role of inventory agency in Ireland and undertakes all aspects of inventory preparation and management and is responsible for the submission of results to CLRTAP. The present report constitutes Ireland's eight IIR submitted under the Convention, covering annual inventories for the period 1990−2015. The report aims to provide a comprehensive description of the procedures, methodologies and activity data used for the compilation of Ireland's air emission inventories and projections as presented in Ireland's 2017 submission under CLRTAP and to the European Union under Directive (EU) 2016/2284. The report shows how Ireland follows the guidelines for estimating and reporting of emission data in an attempt to ensure the transparency, accuracy, consistency, comparability and completeness of the reported emissions. In addition to complying with reporting requirements in this regard, the 2017 IIR is intended to inform the Government Departments and institutions involved, as well as other stakeholders in Ireland, of the level of emissions and the state of the art of Ireland's emission inventories and projections as they address the challenges to comply with commitments already established for particular air pollutants and to control emissions in general. An attempt has been made to give adequate descriptions of all methodological approaches and to provide pertinent information to

[1] Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution

facilitate the assessment of the emission estimates and the understanding of emission trends. The IIR is published on the web site of the EPA (http://erc.epa.ie/clrtap). It will be further developed for future submissions and updated annually in accordance with the UN/ECE Reporting Guidelines and Directive (EU) 2016/2284.

Chapter One Introduction

1.1 Convention on Long-Range Transboundary Air Pollution

The Convention on Long-Range Transboundary Air Pollution (CLRTAP) came into being in 1979 following the recognition that co-operation at international level was necessary to address environmental problems such as acidification associated with the transboundary transport and deposition of acidifying gases emitted into the atmosphere. The Convention was the first international legally binding instrument to deal with problems of air pollution on a broad regional basis. Besides laying down the general principles of international co-operation for air pollution abatement, the Convention sets up an institutional framework bringing together research and policy. The Executive Secretary of the United Nations Economic Commission for Europe (UN/ECE) acts as Secretariat to CLRTAP, and the Convention entered into force in 1983.

The aim of the Convention is that Parties shall endeavour to limit and, as far as possible, gradually reduce and prevent air pollution, including long-range transboundary air pollution. This objective is pursued under eight protocols that identify specific measures to be taken by Parties to cut their emissions of a wide range of air pollutants. The extent to which Parties to the Convention have ratified the various protocols varies. Of the eight protocols to date, Ireland has ratified the 1994 Oslo Protocol on Further Reduction of Sulphur Emissions and the 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides.

1.2 Inventory Reporting and Review under the Convention on Long-Range Transboundary Air Pollution (CLRTAP)

The Guidelines for Reporting Emissions and Projections Data under the Convention on Long-Range Transboundary Air Pollution (ECE/EB.AIR/125)[2] specify the scope, methodologies, formats and deadlines for annual inventory submissions by Parties to the Convention. These Guidelines were adopted by the Executive Body in December 2013 (ECE/EB.AIR/122/Add.1, decisions 2013/3 and 2013/4) and published in 2014. They are a revised version of the 2009 Guidelines for Reporting Emission data under the Convention (ECE/EB.AIR/97), which were approved by the Executive Body in 2008 (ECE/EB.AIR/96, para. 83 (b)). While the Guidelines make it clear that Parties are required to report only on the substances and for the years set forth in the protocols that they have ratified and that have entered into force, Ireland endeavours to estimate and report emissions for the full range of substances set down in Annex I of the Guidelines. These substances are nitrogen oxides (NO_x), sulphur oxides (SO_x), non-methane volatile organic compounds (NMVOCs), carbon monoxide (CO), ammonia (NH_3), particulate matter (PM), black carbon (BC), heavy metals (HM) and persistent organic pollutants (POPs).

The Guidelines state that an Informative Inventory Report (IIR) should be prepared for inclusion in the annual submission. The objective of the IIR is to describe the methodologies, input data, background information and the entire process of inventory compilation for air pollutants, as well as any improvements and recalculations of the inventories reported in previous submissions. The report is needed to support the evaluation of emission trends and may be used by expert review teams to assess the transparency, completeness and overall quality of the inventories as part of the review process established for submissions by the Parties to CLRTAP and the review process to be established under the NECD.

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[2] The Guidelines for Reporting Emissions and Projections Data under the Convention on Long-Range Transboundary Air Pollution (ECE/EB.AIR/125)

The present report constitutes Ireland's IIR for 2017, the eighth such report. It contains specific information on the national inventory for the years 1990−2015 as submitted to CLRTAP in February 2017, including descriptions of methods, data sources, quality assurance/quality control (QA/QC) activities and trend analysis. The structure of the report follows the structure proposed in Annex II to the reporting guidelines.

The IIR focuses on the year 2015 and the status of the inventories achieved for the time series up to 2015 is the basis for methodological description for the purposes of facilitating technical review and general assessment of Ireland's emission inventories. The IIR is designed to capture the cyclical nature of the reporting process and to clarify the chronology of changes and revisions that are part of normal inventory development. In this way, the report provides the basis for technical assessment and expert review of Ireland's air pollutant inventories. An attempt has been made to give adequate descriptions of all methodological approaches and to provide all the pertinent inventory information to facilitate the assessment of the emission estimates and the understanding of emission trends.

The IIR will be further developed and updated annually in accordance with the UN/ECE guidelines and is published on the web site of the EPA (http://erc.epa.ie/clrtap). Such updating is necessary to keep the UN/ECE Secretariat and other interested parties informed of the status of Ireland's air pollutant inventories and to document on-going improvements, recalculations and other developments affecting the estimates of emissions. Ireland is contributing to the Stage 3 in-depth review process for transboundary emission inventories by not only providing this IIR, but also providing expert reviewers to evaluate the submissions from other Parties to the Convention.

1.3 Inventory Reporting and Review under Directive (EU) 2016/2284

Directive (EU) 2016/2284 came into force on the 31st of December 2016. This inventory report and data submission fulfils Ireland's reporting requirements as set out in Article 10(2) of the directive. The inventory submission is fully consistent with the submission under the LRTAP Convention and will be subject to review in accordance with Article 10(3) of the directive.

Ireland's national total emissions of nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOCs) are not in compliance with the ceilings in Article 4(1) and Annex I to Directive 2001/81/EC[3]. Ireland has established adjusted annual national emission inventories for NOx and NMVOCs as allowed for under the flexibilities outlined in Articles 21(2) and 5(1) of the Directive 2016/2284. The adjusted inventories are established in accordance with Part 4 of Annex IV of the directive and are explained in detail in chapter 10 of this report.

1.4 Inventory Reporting by the Environmental Protection Agency

Under Section 52 of the Environmental Protection Agency Act, 1992 (DOE, 1992), the Agency is required to establish and maintain databases of information on the environment and to disseminate such information to interested parties. Section 55 of the Act states that the Agency must provide, of its own volition or upon request, information and advice to Ministers of the Government in the performance of their duties. This includes making available such data and materials as are necessary to comply with Ireland's reporting obligations and commitments within the framework of international agreements. These requirements are the regulatory basis on which the EPA has prepared annual inventories of air pollutants in Ireland for many years. The activities related to the compilation and reporting

[3] DIRECTIVE 2001/81/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2001 on national emission ceilings for certain atmospheric pollutants

of air pollutant emissions constitute one specific on-going project in the Agency's work programme. The inventories team is engaged in two other parallel projects dealing with emissions of other compounds.

The Department of Communications, Climate Action and Environment (DCCAE) has designated the EPA as the agency with responsibility for the submission of emission data to international bodies, including the Secretariat for CLRTAP and the European Union. The Agency’s Office of Environmental Sustainability (OES) currently compiles the national air pollutant emission inventories on behalf of the DCCAE for submission under CLRTAP and NECD.

1.4.1 National Atmospheric Inventory System

In 2005, UK consultants from the National Environmental Technology Centre (NETCEN) carried out a scoping study to identify the essential elements and structure of a national inventory system for Ireland to meet the needs of Decision 280/2004/EC (EP and CEU, 2004a) and to comply with obligations under Articles 5 and 7 of the Kyoto Protocol. The report (Thistlethwaite et al., 2005) describes how institutional arrangements among the EPA, its parent government department and other stakeholders may be reorganised, extended and legally consolidated across all participating institutions to strengthen inventory capacity within the EPA and to ensure that more formal and comprehensive mechanisms of data collection and processing are established for long-term implementation. The report sets out the extent of institutional participation, resource requirements and the form of legal arrangements necessary to perform the functions prescribed in the guidelines for national systems and enable Ireland to meet the objectives specified in those guidelines. The scoping study developed a QA/QC system as an integral part of the national system and the report made recommendations on internal inventory review and proposed a database system to facilitate more efficient data management and reporting. Whilst developed to meet the needs of Decision 280/2004/EC and the Kyoto Protocol, Ireland’s national system is also implemented to achieve emission inventories for transboundary gases for submission under CLRTAP and NECD.

The National Atmospheric Inventory System (NAIS) for Ireland was adopted by Government decision in April 2007. It establishes the necessary institutional, legal and procedural arrangements for the compilation of robust inventories of emissions of greenhouse gases (GHGs) and air pollutants to the atmosphere. It sets out formal procedures for the planning, preparation and management of the national atmospheric inventory and identifies clearly the roles and responsibilities of all the organisations involved in inventory compilation, reporting and review. A schematic overview of the national system is presented in Figure 1.1.

The principal objective of the NAIS is to ensure that Ireland can compile robust and verifiable annual inventories of emissions and report its emission estimates in accordance with relevant international obligations. The NAIS also facilitates the formal review of information submitted under international obligations, including the Kyoto Protocol, protocols under CLRTAP the NECD. Implementation of the national system ensures the transparency, consistency, comparability, completeness and accuracy of the national inventory in accordance with the established reporting guidelines, which incorporate methodological guidance and good practice.

Within the NAIS, the EPA’s OES is designated as the single national entity with overall responsibility for the national emission inventory in Ireland. The OES also performs the role of inventory agency, i.e. the Office compiles the annual inventory and delivers Ireland’s submissions to the various international organisations (European Commission (EC), European Environment Agency (EEA), United Nations Framework Convention on Climate Change (UNFCCC) and UN/ECE in accordance with agreed deadlines and reporting formats. In addition to the primary data received from the Key Data Providers (KDPs), the inventory team obtains considerable supplementary information from other teams in the OES, the Office of Evidence and Assessment and the Office of Environmental Enforcement within the EPA. These sources include Annual Environmental Reports (AERs) submitted by licensed companies and the National Waste Database. The inventory team also draws on national research related to air pollutant emissions and special studies undertaken from time to time to acquire the information needed to improve the estimates for particular categories and gases. The approval of the completed annual inventory involves sign-off by the QA/QC manager and the inventory manager before it is transmitted to the Board of Directors of the EPA via the Programme Manager of OES. Any issues arising from the Board of Directors' examination of the estimates are communicated to the inventory experts for resolution before final adoption of the inventory for submission and publication.

1.4.2 Scope of Inventories under the LRTAP Convention and Directive (EU) 2016/2284

The scope of Ireland's emission inventories under LRTAP Convention and Directive (EU) 2016/2284 is provided in Annex A1. It covers a wide range of air pollutants and other substances, which are reported in a standard electronic format for a predefined nomenclature of source categories, set down in the UN/ECE Reporting Guidelines. The air pollutants are referred to in seven groups as follows:

1. Main pollutants (NO_X, NMVOCs, SO_X, NH_3, CO);
2. Particulate matter ($PM_{2.5}$, PM_{10}, total suspended particulates (TSP), black carbon (BC));
3. Priority heavy metals (lead (Pb), cadmium (Cd), mercury (Hg));
4. Other heavy metals (arsenic (As), chromium (Cr), copper (Cu), nickel (Ni), selenium (Se), zinc (Zn));
5. Annex I Persistent Organic Pollutants: the POPs listed in Annex I to the Protocol on POPs which are substances scheduled for elimination;
6. Annex II Persistent Organic Pollutants: the POPs listed in Annex II to the Protocol on POPs which are substances scheduled for restrictions on use;
7. Annex III Persistent Organic Pollutants: the POPs listed in Annex III to the Protocol on POPs which are substances referred to in Article 3, Para. 5 (a), of the Protocol. Polycyclic aromatic hydrocarbons (PAHs): for the purpose of the emission inventories, the following four indicator compounds should be used: benzo[b]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene and indeno [1,2,3-cd]pyrene. Hexachlorobenzene (HCB) is also included in Annex I to the Protocol as a substance for elimination.

The list of source categories for inventory purposes is known as the NFR (Nomenclature for Reporting). It comprises coded activities across all socio-economic sectors identified as sources of one or more of the substances listed above and provides for the inclusion of other activities that may be specific to individual countries. Many of the NFR categories are split into a varying number of subcategories, which are designed to reflect their importance as sources of one or more pollutants and to provide an adequate level of transparency. In the compilation of annual inventories, significant subdivision of the given NFR categories is normally applied for the process of calculating the relevant emissions. The NFR facilitates the comparison of emissions among reporting countries and the synthesis and assessment of submissions at the UN/ECE level. The current version of the NFR, NFR 14, is given in Annex I of the Guidelines for Reporting Emissions and Projections Data under the

Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/125), which were adopted by the Executive Body in December 2013.

The reporting format also includes a number of *Memo Item* entries. These items refer to sources of emissions whose contributions are not included in a Party’s national total but which are to be reported because of their importance in relation to the overall assessment of emissions and for comparisons among Parties. The notable emission sources excluded from the reported national total for transboundary gases and included as Memo Items are emissions from international and domestic aviation during the cruise phase of a flight, and international shipping.

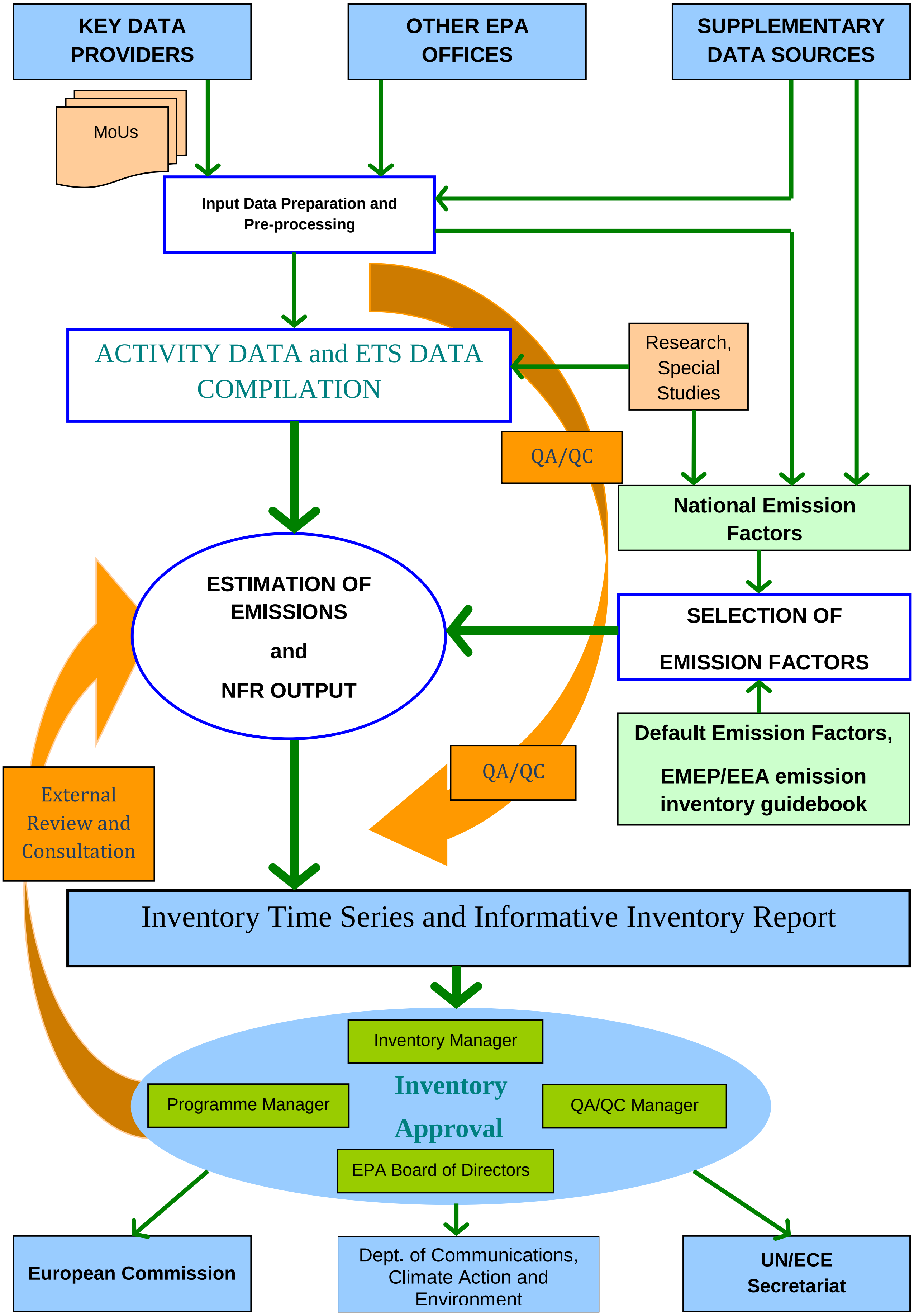

Figure 1.1. National Atmospheric Inventory System Overview

A set of notation keys has been adopted for use in completing the NFR reports to provide explanation and transparency where a numerical value does not appear for a particular pollutant/category combination. The notation keys are as follows:

(a) NO (not occurring) for activities that do not occur in the country;
(b) NE (not estimated) where emissions do occur but are not estimated, usually because they are considered negligible or the necessary data cannot be obtained;
(c) NA (not applicable) for activities that do not generate emissions of a particular pollutant;
(d) IE (included elsewhere) for emissions relating to a subcategory that are reported in another subcategory, usually at the next highest level;
(e) C (confidential) for emissions that could lead to the disclosure of confidential information;
(f) NR (not relevant) for emissions that are not required by the ratified protocols.

At four year intervals from 2017 onwards, the inventory submissions under CLRTAP should include compilations of emissions for a list of defined large point sources and aggregated sectoral gridded data for the European Monitoring and Evaluation Programme (EMEP) grid cells overlying the national territory. This information is used in EMEP models for evaluating long-range transport of air pollutants and for assessing emission deposition relationships in Europe. Ireland's 2017 submission contains data for large point sources and sectoral gridded data of emissions for 2015 on the EMEP grid. Information on gridded and LPS data is provided in chapter 8 of this report.

Parties to the Gothenburg Protocol shall report national projections every four years from 2015 onwards, for the years 2020, 2025 and 2030 and where available, also for 2040 and 2050, by 15th March for the pollutants: SO_x (as SO_2), NO_X, NMVOCs, NH_3 and $PM_{2.5}$, with voluntary reporting for black carbon. Other Parties are encouraged to provide projections for these pollutants. The Directive (EU) 2016/2284 requires emission projections every two years from 2017 onwards from European Member States. Information on projections is provided in chapter 9 of this report.

1.4.3 Inventory Preparation

The air pollutant emission inventory database normally contains information on measured emission quantities, activity statistics (populations, fuel consumption, vehicle/kilometres of travel, industrial production and land areas), emission factors and the associated emission estimates for the NFR list of source categories. In practice, very few measured emission data are available for the range of gases covered and, consequently, the emissions from most activities are estimated by applying emission factors for each source/gas combination to appropriate activity data for the activity concerned. Virtually all emissions may be ultimately derived on the basis of the product of activity data and emission factor. Even in the case where emission estimates for particular categories are reported directly to the inventory agency they will normally have been derived in this manner.

The reporting guidelines provide the general guidance for the preparation and reporting of annual inventories by Parties. They incorporate the methodologies given in the EMEP/EEA (European Environment Agency) Emission Inventory Guidebook, hereafter referred to as the Inventory Guidebook. The inventory preparation process involves the acquisition of the required statistical data for the inventory year concerned and the application of emission factors that characterise the rate of emission of the gases concerned. Some data analysis and preparatory calculations are generally needed in order to make available suitable combinations of activity data and emission factors at the level of disaggregation that gives the best estimate of emissions in the individual emission source categories. In the case of some source/gas combinations, it may be necessary to apply sophisticated models to generate the activity data, the emission factors or the emissions. The methods recommended by the Inventory Guidebook use a tier system. This provides methodologies at different levels of detail and sophistication, which take account of these issues and other factors, such as data availability, technical expertise, inventory capacity and other circumstances, which may vary considerably across countries.

1.4.4 Data Acquisition

In its capacity as the inventory agency, the OES of the EPA acquires the principal items of activity data from identified Key Data Providers (KDP) relevant to each of the NFR sectors. Most KDPs provide data directly to the OES, but some secondary KDPs provide their input to one of the primary KDPs for processing and incorporation into the information subsequently transmitted to the OES. Some KDPs may also deliver estimates of emissions or removals for their particular area of coverage or expertise. Table 1.1 lists the KDPs and the data they supply for use in transboundary gas emission inventories.

The NAIS provides for a formal Memorandum of Understanding (MoU) between each KDP and the inventory agency regarding the scope, quality and submission date of the data to be provided for the purposes of the national emission inventory. In the majority of cases, the data concerned are already routinely collected and published by the KDPs under existing mandates and established reporting programmes. Additional MoUs may be developed under the NAIS in cases where new or supplementary data sources need to be targeted. Under Section 69 of the EPA Act 1992, formal legal powers are assigned to the EPA, whereby the Agency may require any public body to provide information related to environmental quality and may make arrangements with other bodies for the provision of similar information. This provision can also be invoked by the OES to acquire specific information for inventory purposes as the need arises.

The Emissions Trading Unit was established under the EPA Office of Licensing and Guidance (OLG) in late 2003 to implement Directive 2003/87/EC (EP and CEU, 2003) in Ireland. The Emissions Trading Unit currently forms part of the OES and is another key component of the national system. Information compiled for participants in the Emissions Trading Scheme (ETS) under Directive 2003/87/EC is an important source of activity-specific and company-specific data on GHG emissions for approximately 102 installations in Ireland. The inventories for transboundary gases draw on relevant information regarding fuel quantities and fuel properties available under the ETS for these installations and fuel data are used for reconciliation with the national energy balance for major categories and matching of activity data for GHG inventories. The inventory agency in the OES obtains useful support and activity data from other EPA offices and programme areas, including the Environmental Licensing Programme, Office of Environmental Enforcement, and the Environmental Research Programme. These programmes and offices make various contributions that are used to determine or substantiate the activity data or emission factors for particular categories or individual activities, which ensures that country-specific information is exploited to the maximum extent possible. In all cases, consistency is maintained with data application for GHG inventories and vice versa.

1.4.5 Quality Assurance and Quality Control (QA/QC)

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation and development process. Reviews, preferably by independent third parties, should be performed upon a finalised inventory following the implementation of QC procedures. Reviews verify that data quality objectives were met, ensure that the inventory represents the best possible estimates of emissions and sinks, given the current state of scientific knowledge and data available, and support the effectiveness of the QC programme.

A QA/QC spreadsheet tool has been developed to manage and maintain Ireland's QA/QC system. This tool consists of several spreadsheets that provide procedures, guidance, forms and templates as required for the general QA/QC functions. The supporting manual (Thistlethwaite et al., 2005) provides a general overview to the QA/QC system and guidance on the application of the plan and procedures. The QA/QC plan identifies the specific data quality objectives related to the principles of transparency, consistency, completeness, comparability and accuracy required for Ireland's national inventory and provides specific guidance and documentation forms and templates for the practical implementation of QA/QC procedures. The spreadsheets include a brief introduction and a statement of the data quality objectives (DQOs) and how they will be met through the QA/QC system with reference to the relevant spread sheet tool template sheets and forms. The Introduction sheet links to the QA/QC plan which provides the schedules and procedures for the QA/QC system and lists all of the QA/QC activities that exist or are planned to make up Ireland's QA/QC system. The Plan sheet consists of tables that contain three different categories of QA/QC activity:

1. General activities covering the planning and management practices and procedures;
2. Activities that should be undertaken on an annual basis for management and preparation of the inventory;
3. Periodic activities that should be undertaken in response to specific events in the inventory and for periodic peer review or verification.

The inventory agency has implemented this approach to QA/QC for eleven annual reporting cycles. This involved the allocation of responsibilities linked to the national system and the use of the template spreadsheet system to record the establishment and maintenance of general inventory checking and management activities covering the overall compilation process, as well as the undertaking of specific annual activities and any necessary periodic activities in response to specific events or outcomes in inventory reporting and review. The system facilitates record keeping related to the chain of activities from data capture, through emission calculations and checking, to archiving and the identification of improvements.

Ireland's calculation spreadsheets in all sectors are structured on a time-series basis. This organisation is designed to facilitate the QA/QC process as well as more efficient trend analysis and to ensure ease of transfer of the outputs to the NFR tables. The inventory compilation is directly linked to the primary statistical inputs, which facilitates rapid year-on-year extension of the time series and efficient updating and recalculation, where appropriate, in the annual reporting cycle. Internal aggregation to various levels corresponding to the NFR tables provides immediate and complete checks on the results.

Quality Control (QC) is a system of routine technical activities, to measure and control the quality of the inventory as it is being developed. The QC system is designed to:

(i) Provide routine and consistent checks to ensure data integrity, correctness, and completeness;

(ii) Identify and address errors and omissions;

(iii) Document and archive inventory material and record all QC activities.

Quality control activities include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardised procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting.

Higher-tier QC activities include technical reviews of source categories, activity and emission factor data, and methods.

In recent years, the inventory agency has created and implemented a number of QA\QC tools. These spreadsheet-based tools are used to better inform the QA\QC process whilst providing transparent descriptions of the outcomes of checks. In each spreadsheet-based tool comments are added to explain anything highlighted by the checking process. The text from these tools (such as the recalculations assessment) then helps inform the update of the IIR. The tools used include:

1. Recalculations assessment – this spreadsheet tool calculates the percentage change of emission estimates between the current and previous inventory submissions using conditional formatting to highlight the significant changes. There is a separate table for each pollutant in which the entire time series is evaluated for all NFR codes. This check highlights the recalculations that have been made in the inventory so that they can be verified and justified by the inventory agency.
2. Trend assessment – this spreadsheet tool calculates the percentage change between the most recent year and the preceding year of the current inventory submission using conditional formatting to highlight the significant changes. There is a separate table for each pollutant in which the entire time series is evaluated for all NFR codes. This check helps identify any time series inconsistency with the newly reported data of the most recent year. Provided this is run annually and alongside the recalculations check, time series consistency should be maintained.
3. Pollutant specific assessments – there are two tools that check the following rules that should be maintained in an inventory: TSP ≥ PM_{10} ≥ $PM_{2.5}$; Total PAHs (1-4) = B(a)p + B(b)F + B(k)P + I(123)-cd. These simple checks help maintain the accuracy of the inventory.
4. Data value assessment – two tools check the entire time series for all pollutants to ensure that none of the following are reported: zero values, errors, negative values. These simple checks help maintain the accuracy and transparency of the inventory.
5. Annex I reporting template assessment – this tool evaluates whether all compiled Annex I reporting template files are comparable in structure and content to the template. This helps maintain the comparability of the inventory.
6. Notation keys assessment – this tool summarises the use of the different notation keys within the inventory. This tool has been implemented for all NEC pollutants across the entire time series. The tool helps the inventory agency evaluate, justify and document the use of notation keys in the inventory. By increasing the accuracy of the notation keys, the transparency of the inventory is improved and this allows the inventory agency to clearly identify areas where potential improvements could be made (e.g. the use of IE or NE).

The online tool provided by the Centre on Emissions Inventories and Projections (CEIP), RepDab, is used by the inventory agency to check the format, completeness and internal consistency of the Annex I reporting template submission files. Further details regarding the checks that are carried out can be found on the CEIP website.

In the 2017 reporting cycle, the inventory agency updated some of the default emission factors in accordance with the recently published EMEP/EEA Air Pollutant Emission Inventory Guidebook (2016). These EF changes are outlined in the sectoral chapters of this report.

Table 1.1 Key Data Providers and Information Covered by Memoranda of Understanding

Key Data Provider	Data Supplied	Deadline	Sector in which Data are Used
Sustainable Energy Authority of Ireland (SEAI)	National Energy Balance; Detailed national energy consumption disaggregated by economic sector and fuel	30 September	Energy, Waste
Department of Agriculture Food and the Marine (DAFM)	Nitrogen fertiliser sales, cattle populations from the AIM (Animal Identification and Movement) database, sheep statistics, poultry statistics	30 September	Agriculture
Central Statistics Office	Annual population, livestock populations, crop statistics, housing survey data	30 September	Agriculture, Industrial Processes, Waste
Bord Gáis	Analysis results for indigenous and imported natural gas	30 September	Energy
Marine Institute	Annual report on discharges, spills and emissions from offshore gas production installations	30 October	Energy
Emissions Trading Unit (OES, EPA)	Verified CO_2 estimates and related fuel and production data for installations covered by the EU ETS	30 April	Energy, Industrial Processes
Department of Communications, Climate Action and Environment (DCCAE)	National Oil Balance (as a component of the energy balance)	30 September	Energy
Road Safety Authority*	Road transport statistics from the National Car Testing (NCT) Service	30 April	Energy

*These bodies have MoUs with the SEAI rather than with the OES.

1.4.6 Inventory Compilation

The source data, calculation workbooks and outputs for all emissions to air are held on the server in the Monaghan Regional Inspectorate of the EPA. The annual inventory compilation for transboundary gases is undertaken in separate *Data Processing* folders for each sector, which are linked to the *Source Data* folders for the respective sectors at the same level. The *Outputs* folder and the *QA/QC* folder are also at this level. The *Outputs* folder contains the files used for the official submissions to the EU and the UN/ECE and for preparing summary reports and relevant media statements at national level. All calculation workbooks for the individual sectors contain a QA/QC worksheet, which are compiled collectively in the *QA/QC* folder. Data processing to compute the emission estimates is carried out at the most detailed level of aggregation possible, consistent with data availability and the outputs needed to populate the official electronic reporting format for the category concerned. These outputs are primarily the estimates of emissions and the corresponding activity data for each category.

Quality control procedures are an integral part of the inventory preparation and reporting cycle. Within the inventories team, quality control for each sector is undertaken by an inventory compiler who has not produced the emission estimates for that sector. Quality control involves a series of checks covering the data inputs and any necessary pre-processing, the calculation of emissions, and the generation of the output records that are subsequently compiled in the NFR. The checks cover such items as the comparison of inputs with those of previous years, the identification of errors and omissions, validating internal linking and calculation algorithms, replicating the aggregation of subcategories and ensuring an adequate level of completeness in NFR files to achieve transparency for external review purposes. A colour code system is used to distinguish between such elements as data taken from another spread sheet, calculated values, extrapolated or interpolated values, outputs for the NFR, and checks and annotations.

1.5 Key Category Analysis

Key category analysis for transboundary emissions is explained in the Inventory Guidebook, and is the same concept as that presented in the Intergovernmental Panel on Climate Change (IPCC) 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). This defines a key emission category as one that is prioritised within the national inventory system because its emission estimate has a significant influence on the Party's total inventory in terms of the absolute level of emissions, the trend in emissions, or both. The Inventory Guidebook provides several methods for undertaking the analysis of key categories that can be applied at any appropriate level of source aggregation, depending on the information available. The simplest approach (Approach 1) – identification based on contribution to emission level – is used here for the inventories of all substances to highlight which sources of emissions are the most important in Ireland.

In level assessment, key categories are those categories whose combined contribution to the total emission level, determined from the ranking of all categories on the basis of their individual contributions to the level, is 80 per cent. Information about key categories is considered to be crucial to the choice of methodology for individual sources and to the management and reduction of overall inventory uncertainty. The identification of such categories is recommended in order that inventory agencies can give them priority in the preparation of annual inventories, especially in cases where resources may be limited. Information on key categories is clearly also vital for the development of policies and measures for emissions reduction.

It is well established that fuel combustion in a small number of economic sectors is the major source of most air pollutants. This is true for classic pollutants such as SO_x and NO_X, which are reasonably well quantified in emission inventories and for which emissions have decreased considerably, and also for other substances (PM, POPs) for which inventories have much higher levels of uncertainty. The relative contributions of key categories is clearly shown by the results of the simple key category analysis shown in Table 1.2 and Annex A.2, Tables 1-15, which summarises NFR Level 2 key categories by pollutant. The dominance of categories under 1A (Energy: Combustion) highlights the importance of combustion sources. The four key categories (1A1a, 1A2f, 1A3b and 1A4bi) dominate the results of the key category analysis presented in Table 1.2. Agriculture sources (3B, 3D) are the main sources of emissions for NH_3. NMVOC's and particulate matter. Waste sector sources are the main driver of emissions for As, Cr, dioxins and PCBs.

Table 1.2. Key Category Analysis of Ireland's Air Pollutant Inventory 2015

Pollutant	Key Categories									Total (%)
NO_x	1A3bi 19.81%	1A3biii 18.82%	1A1a 11.91%	1A2f 8.64%	1A3bii 8.48%	1A3dii 6.82%	1A4bi 6.27%			80.75%
CO	1A3bi 43.71%	1A4bi 19.58%	1A1a 16.37%	1A2f 3.91%						83.57%
NMVOC	3B1b 25.04%	2H2 16.22%	2D3a 10.34%	3B1a 8.62%	1A4bi 8.56%	2D3d 3.65%	3Da1 3.33%	1A3bi 2.86%	3B3 2.36%	80.98%
SO_x	1A4bi 38.23%	1A1a 29.51%	1B2aiv 11.74%	1A2f 6.18%						85.66%
NH_3	3B1b 28.36%	3Da2a 26.49%	3B1a 12.85%	3Da3 12.02%	3Da1 8.47%					88.20%
TSP	1A4bi 27.39%	3Da1 20.60%	3B1b 8.53%	3B1a 8.05%	1A3bvi 4.35%	1A3bvii 3.70%	3B3 3.30%	1A1a 2.77%	1A2f 2.55%	81.24%
PM_{10}	1A4bi 31.11%	3Da1 25.62%	3B1b 4.87%	3B1a 4.60%	1A3bvi 4.26%	3B4gii 3.11%	1A2f 3.04%	1A1a 2.83%	3B4giii 2.45%	81.87%
$PM_{2.5}$	1A4bi 52.64%	3B1b 5.49%	3B1a 5.14%	1A2f 4.97%	1A3bi 4.17%	1A3bvi 3.98%	1A1a 3.15%	1A2gviii 2.80%		82.35%
Pb	1A3bi 62.13%	1A4bi 16.97%	1A3bvi 10.03%							89.12%
Cd	1A1a 25.10%	1A2gviii 23.08%	1A4bi 15.88%	1A3bi 8.60%	1A2f 8.07%					80.74%
Hg	1A1a 31.49%	1A4bi 30.78%	1A2f 8.39%	1A3bi 6.27%	5A 5.82%					82.76%
As	5C1bi 51.40%	1A1a 42.09%								93.49%
Cr	5C1bi 29.22%	1A3bvi 23.18%	1A1a 15.40%	1A4bi 10.83%	1A3bi 5.43%					84.06%
Cu	1A3bvi 57.82%	1A3bi 20.95%	1A3biii 5.90%							84.66%
Ni	1A1a 56.58%	1A4bi 12.80%	1A3bi 9.39%	1A3bvi 4.59%						83.37%
Se	1A1a 93.67%									93.67%
Zn	1A4bi 22.03%	1A3bvi 21.63%	1A2gviii 12.61%	1A3bi 11.82%	1A1a 7.67%	1A2f 7.54%				83.30%
PCDD/F	1A4bi 53.98%	5E 24.42%	2A1 5.69%							84.09%
PCBs	5E 45.42%	2A1 27.82%	1A4bi 17.01%							90.25%
HCB	3Df 68.54%	1A1a 27.75%								96.30%
PAHs	1A4bi 87.69%									87.69%
	1 Energy		**2 IPPU**		**3 Agriculture**		**5 Waste**			

1.6 Uncertainty Assessment

Undertaking a quantitative estimate of emissions uncertainty requires a substantial amount of detailed data on the uncertainty of both activity data and emissions factors for a diverse range of source types. It has not been possible to collect these data in full. However, it has been possible to characterise the uncertainties associated with sources in a more approximate way.

A semi-quantitative uncertainty analysis has been used to determine the overall emissions uncertainty for a number of pollutants for 2015 data. This uses a Tier 1 propagation of errors to obtain an uncertainty for the total emission. However the uncertainty assigned to the activity data and emission factor for each individual source is obtained from a combination of expert judgement and ranges of uncertainty obtained from the EMEP/EEA Emissions Inventory Guidebook. As a result, this assessment is uncertain in its own right. However the results do provide a good indication as to which sources are contributing the most to the overall uncertainty, and therefore where improvement effort should be targeted.

The methodology and results of the Tier 1 uncertainty analysis are presented in detail in Annex G, tables G.1 to G.6. The results can be summarised as follows:

Table 1.3 Emissions Uncertainties

Pollutant	Emission (ktonnes, 2015)	Uncertainty in 2015 (%)	Trend Uncertainty 1990-2015 (%)
NO_X	79.54	9.2	2.7
SO_2	17.63	36.3	3.2
NMVOC	101.34	82.2	24.7
NH_3	107.97	81.8	10.3
CO	109.13	14.9	1.4
PM_{10}	23.90	75.0	30.7

The total uncertainty in the NO_X emission in 2015 is dominated by the contribution from Agriculture/Forestry/Fishing liquid fuels (1.A.4; 100.05 per cent), then from road transport sector liquid fuels (1.A.3.b; 10.05 per cent). These two sources combined account for 63.5 per cent of the total NO_x emissions uncertainty.

Emissions of SO_2 are well characterised when compared to NO_X for the majority of emissions because they are combustion related (and therefore the uncertainty associated with the activity data is the same), but emission factors for SO_2 (i.e. the sulphur content of the fuel) is readily determined much more accurately than NO_X. However, fugitive emissions from petroleum products now contribute to 94.0 per cent of the overall uncertainty because of the highly uncertain emission factors (±300%).

Emissions of NMVOC from non-combustion sources are typically high in uncertainty because they are difficult to characterise by measurement. Manure management of cattle contributes to 93.3 per cent of the overall uncertainty because it is a large source of emissions (33.7 per cent in 2015) and, as with all Manure management categories, has poorly characterised emission factors (±300%). Domestic solvent use including fungicides is a large contributor because it has poorly characterised activity data and contributes to 10.3 per cent of total NMVOC emissions in 2015.

The uncertainty associated in NH_3 emissions are driven by the emission factors, with the activity data (number of livestock) typically being well characterised by comparison. The sources making the largest contributions to the overall uncertainty are ammonia losses from synthetic fertiliser use and animal manures deposited to pasture, range and paddock. The emission factors for these sources are currently assigned an uncertainty of ±200%, and they contribute to 95.6 per cent of the overall uncertainty.

The largest CO uncertainties are associated with the road transport sector and coal and peat combustion in the residential sector. This is because road transport is a large source of CO, and the emission factors for solid fuels in the residential sector are considered to be very uncertain.

Emissions of PM_{10} are generally high in uncertainty because many combustion sources are either not well characterised, or are variable in emission (small changes to combustion conditions can have very large impacts on PM_{10} emissions). Residential coal, biomass and peat combustion and the use of inorganic fertilizers are the largest contributors to the overall uncertainty. These are relatively large sources with very uncertain emission factors.

It is interesting to note that electricity generation and industrial combustion do not feature as major contributors to the overall uncertainty for any pollutants. This is because the use of point specific data allows the emission estimates to be particularly well characterised.

Chapter Two Analysis of Key Emission Trends

2.1 Introduction

Ireland's 2017 submission under the CLRTAP and the Directive (EU) 2016/2284 includes emission estimates for the period 1990−2015 in respect of all substances listed in Section 1.4.2 above. The primary emission time series is prepared on the basis of Ireland's published national energy balances, which record the amounts of fuels sold in the country. In recognition of the significant cross-border movement that occurs with respect to automotive fuels in some parts of Europe, the reporting guidelines allow for the reporting of emissions from road transport on the basis of fuels used within the country. This may result in a significant decrease in the national total emissions for some pollutants and the adjusted total is considered more appropriate for the assessment of performance in relation to certain protocols. This issue is relevant to Ireland in the case of the Sofia Protocol on NO_X emissions and, to facilitate the assessment, Ireland has also submitted inventories in which the estimates for road transport are based on fuels used in the country. Emission inventories based on fuel sold and fuel used are provided in this submission for all pollutants for the period 1990−2015 and for the year 1987, the base year for the Sofia Protocol.

This chapter provides an overview of the emission trends for the period 1990−2015 for all substances included in Ireland's 2017 submission under the CLRTAP and NECD. The general analysis of trends is performed only in respect of emissions estimated on the basis of fuels sold in Ireland.

2.2 Main Pollutants

2.2.1 Sulphur Dioxide (SO2)

Total sulphur dioxide emissions decreased by 90.5 per cent, from 185.16 kt in 1990 to 17.63 kt in 2015 (Figure 2.1). The Commercial/Institutional and Residential (1A4a and 1A4b) sectors combined account for 39.7 per cent of the total in 2015, a decrease of 81.8 per cent between 1990 (38.36 kt) and 2015 (6.99 kt). The Public Electricity and Heat Production (1A1a) sector remains one of the main sources of SO_2 emissions, contributing 29.5 per cent of the total in 2015, a decrease of 95.0 per cent between 1990 (103.04 kt) and 2015 (5.20 kt). An increase in consumption of coal, peat and oil in this sector in 1994 followed by decreased peat and oil consumption the following year caused a peak in emissions in 1994. In 1998 an increase in consumption of coal followed by a decrease the following year caused another peak in emissions in 1998. Combustion sources in the Manufacturing Industries and Construction (1A2) sector largely account for the remainder of the emissions, with contribution of 13.0 per cent in 2015. Emissions in this sector peaked in 1994 due to an increase in SO_2 from oil combustion in the installation which is the main contributor to emissions in Non-ferrous metals (1A2b). Emissions in Manufacturing Industries and Construction (1A2) have decreased in the 1990-2015 time series by 92.9 per cent. Combustion in Agriculture/Forestry/Fishing (1A4c) sector accounts for 0.3 per cent and Transport (1A3) combustion sources account for 1.4 per cent of national total emissions of SO_2 in 2015. The remainder of the SO_2 emissions arise from combustion sources in the Petroleum Refining (1A1b) and Manufacture of Solid Fuels and Other Energy Industries (1A1c) sectors, Fugitive emissions from Oil Refining & storage (1B2aiv) and Waste Incineration (5C1), which combined account for 16.1 per cent of the total in 2015 and are presented in Other NFR sectors in Figure 2.1. In 1990, coal combustion accounted for 51.4 per cent of SO_2 emissions and fuel oil contributed 30.6 per cent. By 2015, the share of SO_2

emissions from coal had decreased to 51.0 per cent and that from fuel oil had decreased to 4.1 per cent.

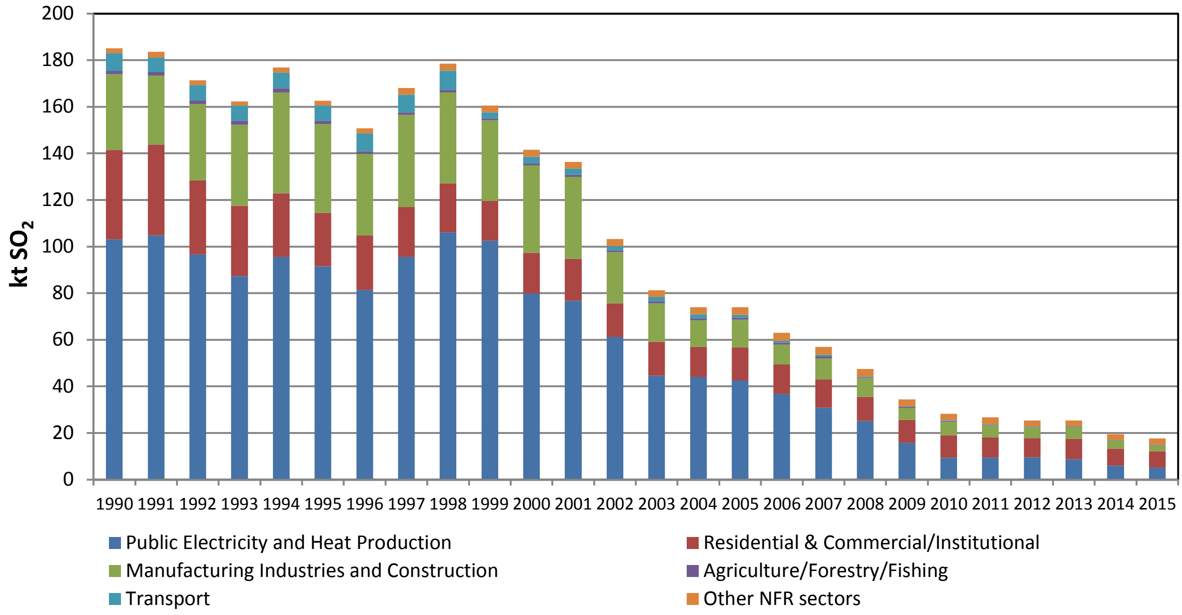

Figure 2.1 Emission Trend for Sulphur Dioxide 1990−2015

2.2.2 Nitrogen Oxides (NO_x)

Total nitrogen oxides emissions have decreased by 48.3 per cent, from 142.02 kt in 1990 to 73.46kt in 2015 (Figure 2.2). Road Transport (1A3b) is the principal source of NO_X emissions, contributing 51.1per cent (and 37.51 kt) of the total in 2015, with the transport sector as a whole accounting for 54.2 per cent (and 39.82 kt) of the national total. The Manufacturing Industries and Construction (1A2) sector accounts for an increasing percentage of the national total. The contribution of the sector in 1990 to the national total was 6.3 per cent (8.93 kt), which increased to 15.1 per cent share in 2007 (and 18.45 kt) as a result of the increases in cement production for construction during the economic boom in Ireland over the previous decade then reduced to 11.5 per cent share (8.48 kt) of the national total in 2011 due to the economic crisis impacting upon the sector. In 2015 the sector contribution increased to a 14.9 per cent share (and 10.95 kt) of the national total largely driven by an increase in cement production. The Public Electricity and Heat Production (1A1a) sector is another main source of NO_X emissions, accounting for 12.9 per cent of emissions in 2015. Emissions from this sector have decreased by 79.6 per cent between 1990 (46.37 kt) and 2015 (9.48 kt). Commercial/Institutional and Residential (1A4a and 1A4b) sectors combined account for 10.0 per cent of the total and combustion sources in Agriculture/Forestry/Fishing (1A4c) sector account for 6.0 per cent in 2015. The remainder of the NO_x emissions arise from combustion sources in the Petroleum Refining (1A1b) and Manufacture of Solid Fuels and Other Energy Industries (1A1c) sectors plus from the Pipeline Compressors sector (1A3e), as well as combustion sources in the Waste sector (5C1), which are presented in Other NFR sectors that together account for 1.9 per cent of the total in 2015.

The reductions in NO_X emissions arising from the use of catalytic converters in cars and heavy-duty vehicles have only become apparent in recent years, as the technology has been offset by large increases in vehicle numbers in the past 10 years. This effect is exaggerated in latter years by so-called fuel tourism, whereby a significant proportion of the automotive fuel sold in Ireland – the basis for the emission time series given in Figure 2.2 – is used by vehicles in other countries. The estimated level of fuel tourism is given in Annex A.3, together with the adjusted annual NO_X emissions based on fuels used in Ireland, which is relevant to the assessment of obligations in relation to the Sofia Protocol on NO_X emissions.

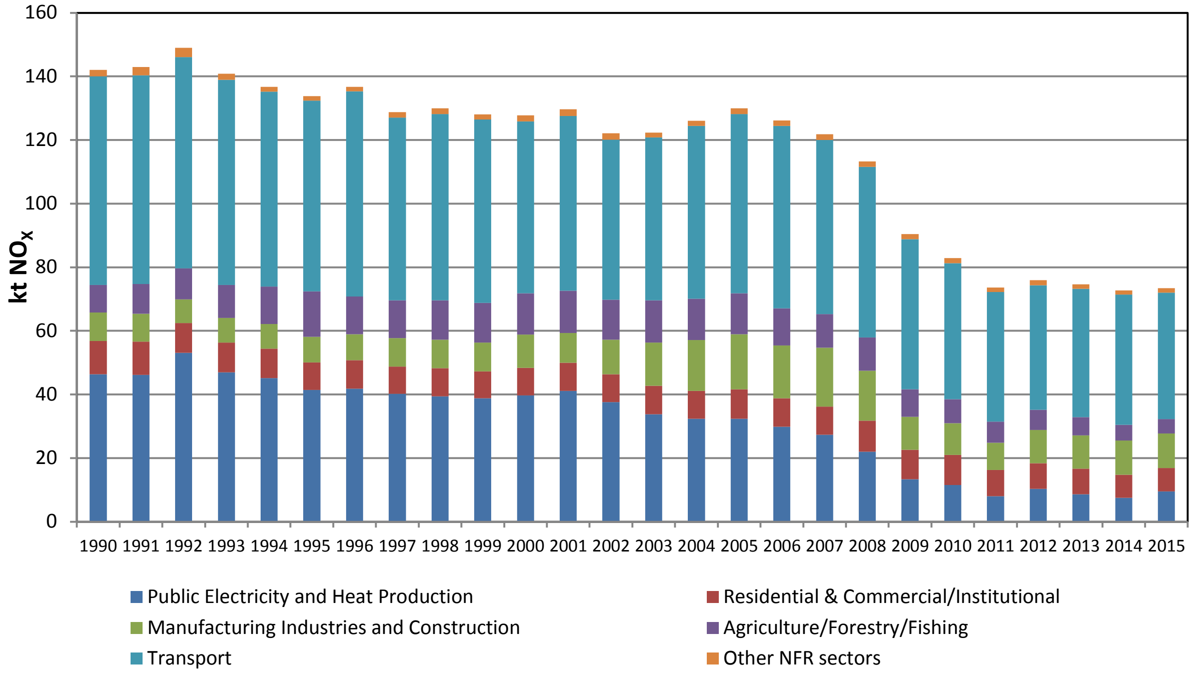

Figure 2.2 Emission Trend for Nitrogen Oxides 1990–2015

2.2.3 Ammonia (NH3)

Total ammonia emissions have remained relatively constant throughout the time series and have increased by 2.4 per cent, from 105.52 kt in 1990 to 108.10 kt in 2015 (Figure 2.3). Livestock production has historically accounted for the bulk of national total ammonia emissions in Ireland and, in 2015, Manure Management (3B) and Organic Fertilisers applied to soils combined accounted for 98.9 per cent of the national total. In 2015, Manure Management at 55.50 kt and 51.3 per cent share of the total showed an increase by 7.6 per cent from 51.59 kt in 1990. Organic Fertilisers cover emissions from the three sectors: Animal Manure applied to soils (3Da2a), Sewage Sludge applied to soils (3Da2b) and Urine and Dung deposited by grazing animals (3Da3), which combined at 42.22 kt accounted for 39.1 per cent of the total ammonia emissions in 2015 (indicating a 3.7 per cent increase from 40.70 kt in 1990). Inorganic N-fertilizers applied to soils (sector 3Da1) decreased by 29.2 per cent from 1990 (12.93 kt) and at 9.16 kt in 2015 accounted for 8.5 per cent of the national total. The small contribution by Transport (1A3) sources peaked in 2005, the main driver of which has been the increased use of cars with early generation three way catalysts in Road Transport (1A3b). Transport emissions have increased from 0.05 kt in 1990 to 0.84 kt (and 0.8 per cent share of the total) in 2015. The remainder of the ammonia emissions arise from Commercial/Institutional and Residential (1A4a and 1A4b) sectors combined (0.1 per cent share) and Other NFR sectors (Combustion in Manufacturing Industries and Construction (1A2), Combustion in off road Agricultural machinery (1A4cii), Fugitive emissions from Oil Refining & Storage (1B2aiv), Biological Treatment of Waste (5B1)) that together account for 0.3 per cent of the total in 2015.

Within livestock production, Manure Management (3B) at 55.50 kt in 2015 is the largest source of NH_3. In Ireland, approximately two-thirds (61.5 per cent) of animal manure is excreted at pasture annually, reflecting the relatively short period that cattle are housed.

Dairy Cattle (3B1a) and Non-Dairy Cattle (3B1b) account for the major part (41.7 per cent) of Agriculture sector ammonia emissions in 2015. Other livestock, which includes Sheep (3B2), Swine (3B3), Goats (3B4d), Horses (3B4e), Mules and asses (3B4f), Poultry (3B4g) and Other animals (manure management; 3B4h), combined account for 10.2 per cent of total Agriculture and 10.1 per cent of the national total ammonia emissions in 2015 (Figure 2.3). Throughout the 1990s, the cattle herd increased to reach a peak in 1998 of 7.6 million head, which along with associated increases in fertiliser nitrogen consumption increased ammonia emission totals from the whole agriculture sector, from 105.22 kt in 1990 to 119.16 kt in 1998. As a result of reforms to the Common Agricultural Policy (CAP), animal numbers and associated fertiliser nitrogen use have reduced, and ammonia emissions in agricultural sectors have fallen to 106.88 kt in 2015.

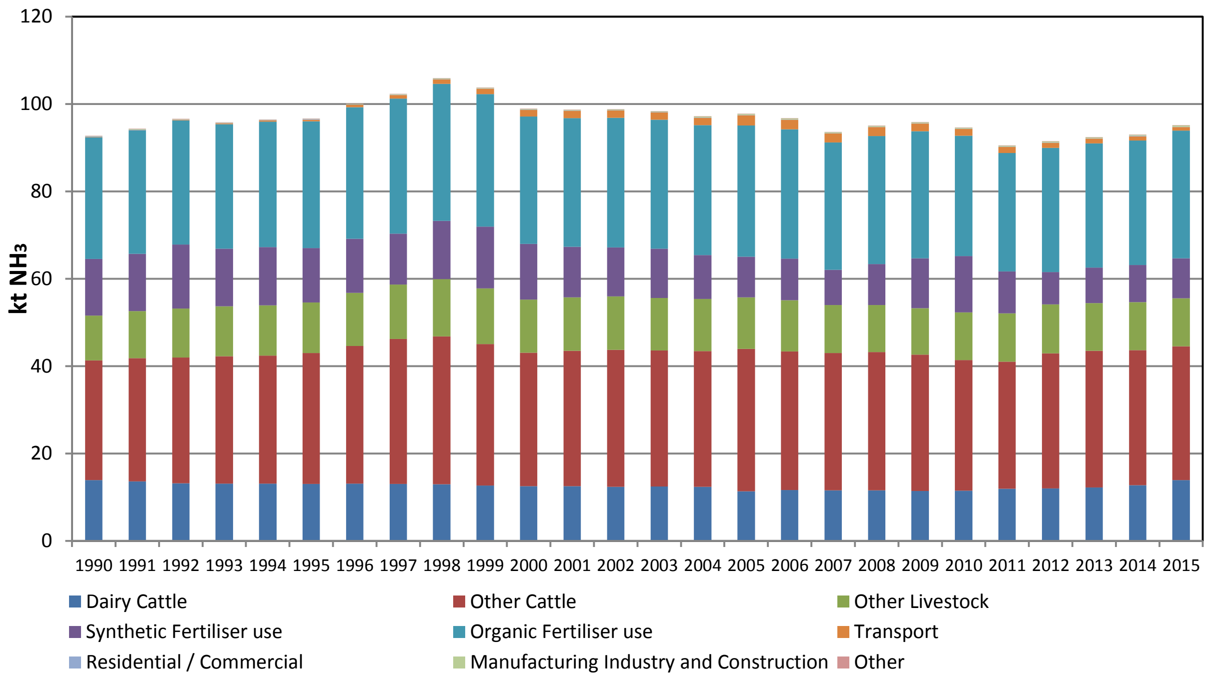

Figure 2.3 Emission Trend for Ammonia 1990−2015

2.2.4 Non-Methane Volatile Organic Compounds (NMVOCs)

Total non-methane volatile organic compound emissions have decreased by 30.5 per cent, from 145.45 kt in 1990 to 101.09 kt in 2015 (Figure 2.4). The NMVOC emissions are determined largely by the Agriculture sectors: 3B Manure Management and 3Da1 Inorganic N-fertilizers and emissions from solvents and other product use and the food and beverages industry. The inclusion of NMVOC emissions from manure management and fertiliser use in Ireland’s previous submission and the latest inclusion from the food and beverages industry in 2017, have added over 53kt of NMVOC, on average, to Ireland’s national total. The Agriculture sectors combined accounted for 42.6 per cent of the national total and showed an increase by 10.4 per cent between 1990 (39.04 kt) and 2015 (43.08 kt). The combined solvents use (2D, 2G and 2H) and fugitive emissions from oil sectors emissions (1.B.2.a) produced 38.7 per cent of the 2015 total of NMVOC emissions in Ireland, having increased by 12.1 per cent between 1990 (34.95 kt) and 2015 (39.16 kt). Combustion sources in the

Residential (1A4b) and Commercial/Institutional (1A4a) sectors are also important sources, accounting for 9.1 per cent of national total NMVOC emissions in 2015, a reduction of 68.3 per cent between 1990 (28.99 kt) and 2015 (9.20 kt). Technological controls for volatile organic compounds (VOCs) emitted by motor vehicles have been more successful than in the case of NO_X, and have contributed to a significant reduction in emissions from Road Transport (1A3b), with the total transport sector's contribution having decreased by 85.3 per cent between 1990 (38.20 kt) and 2015 (5.60 kt). This equates to contributions to the national total of 26.3 per cent in 1990, falling to 5.5 per cent in 2015. A total of five NFR source categories make up the source Other NFR sectors (Figure 2.4) contributing 0.6 per cent of national total NMVOC emissions in 2015. The largest source of emissions within this categorisation is Solid waste disposal on land sector (5A).

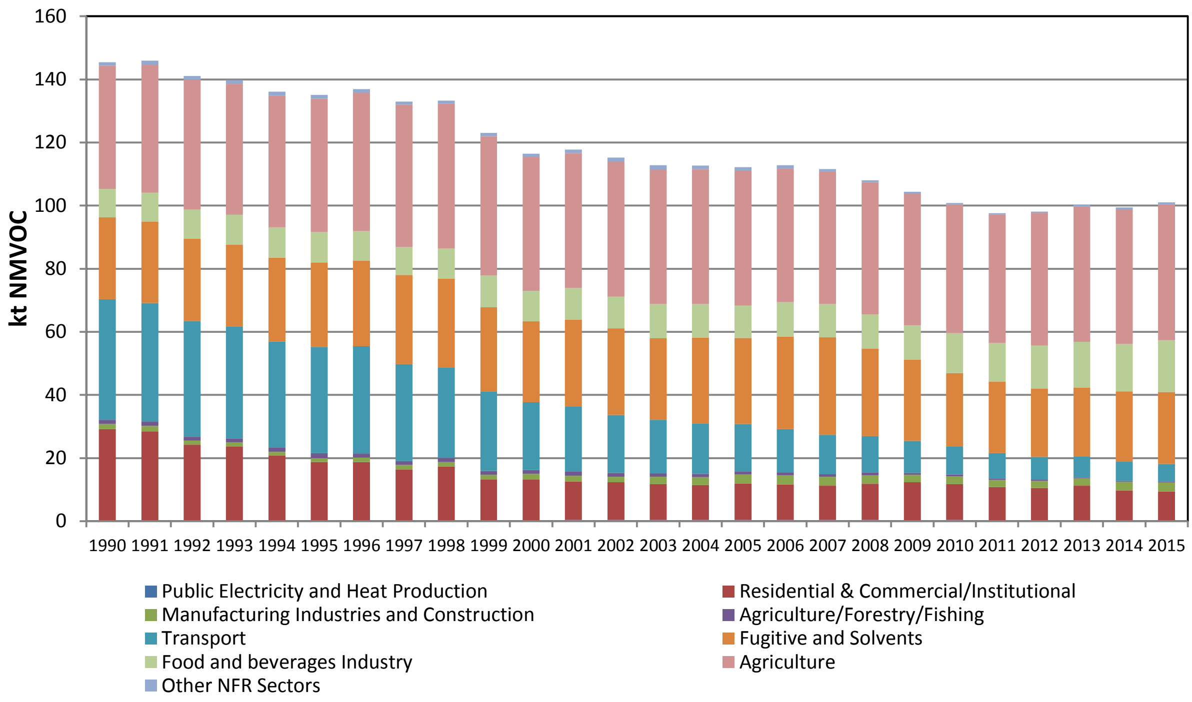

Figure 2.4 Emission Trend for Non-Methane Volatile Organic Compounds 1990−2015

2.2.5 Carbon Monoxide (CO)

Carbon monoxide emissions continue to decline, driven by major reductions due to three way catalysts in gasoline vehicles in Road Transport (1A3b), which is the principal source of CO, and a large decrease in the use of solid fuels for space heating in the Residential (1A4b) sector (Figure 2.5). National total CO emissions have reduced from 372.89 kt in 1990 to 106.82 kt in 2015, a reduction of 71.4 per cent. The Transport sector accounted for 50.8 per cent of national total emissions in 2015, a major reduction (80.3 per cent) from 275.21 kt in 1990 to 54.31 kt in 2015. Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined are another important source, accounting for 21.1 per cent of national total CO emissions in 2015, a reduction of 64.6 per cent between 1990 (63.47 kt) and 2015 (22.49 kt). Public Electricity and Heat Production (1A1a) sector reached its peak in 2001 (23.82 kt) and has decreased by 25.0 per cent to reach 17.86 kt in 2015, a reduction of 1.5 per cent on 1990 levels (18.14 kt). Combustion sources from Manufacturing Industries and Construction (1A2) account for 8.8 per cent of the national total in 2015 and at 9.37 kt showed a 15.3 per cent decrease on their 1990 levels (11.06 kt). Agriculture/Forestry/Fishing (1A4c) combustion sources account for 1.1 per cent of the total CO emissions in 2015. Fugitive emissions from Oil (1B2a) and Waste incineration (5C) emissions form the Other NFR sectors category and combined account for the remainder of CO emissions (1.5 per cent of the total) in 2015.

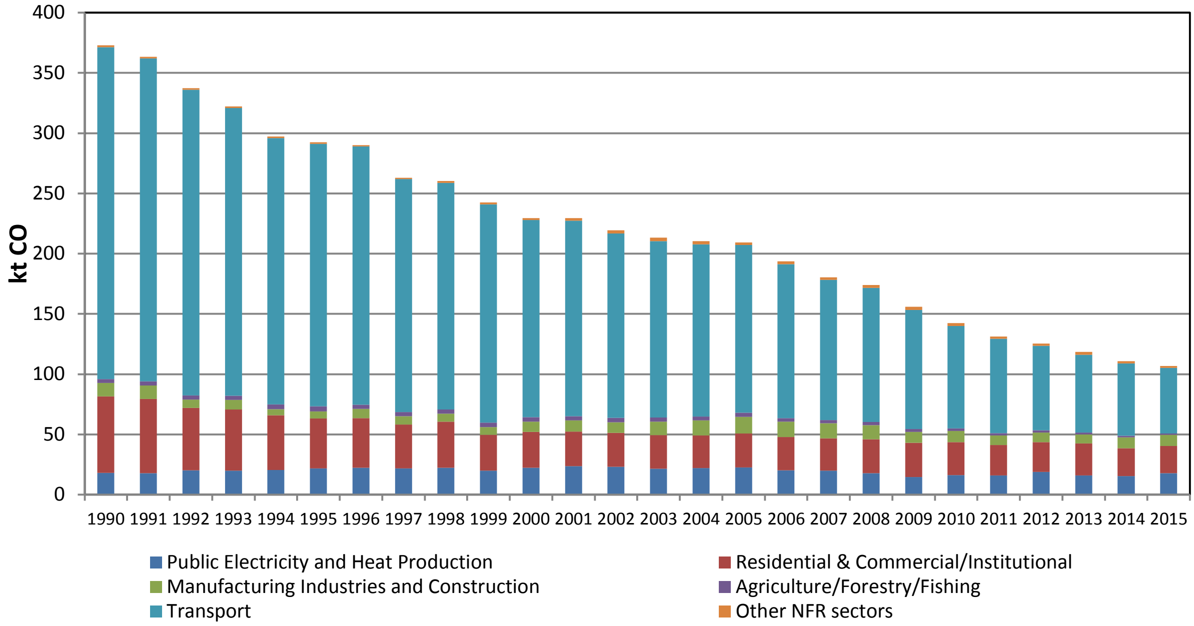

Figure 2.5 Emission Trend for Carbon Monoxide 1990–2015

2.3 Particulate Matter

Particulate matter emission estimates include PM with diameter less than 10 µm (PM_{10}), PM with diameter less than 2.5 µm ($PM_{2.5}$) and total suspended particulates (TSP).

2.3.1 Particulate Matter <10 µm Diameter (PM_{10})

Emissions of particulate matter <10 µm diameter amounted to 23.01 kt in 2015, a 46.2 per cent reduction from 42.78 kt in 1990 (Figure 2.6). The main determinant of the trend in PM_{10} emissions is Agriculture sector with 47.3 per cent share of the national total, and combustion in the Residential (1A4b) and Commercial/Institutional (1A4.a) sectors combined with 33.4 per cent share of the total in 2015.

Emissions from Agriculture arise from Inorganic N-fertilizers (3Da1), Off-farm storage, handling and transport of bulk agricultural products (3Dd) and Manure Management (3B) sectors that together in 2015 at 10.89 kt indicated a 0.1 per cent decrease on their 1990 levels. Part replacement of coal and peat in the Residential (1A4b) and Commercial/Institutional (1A4a) sectors are the second largest contributor to the total PM_{10} emissions, with 69.3 per cent reduction in emissions from these sectors, from being the largest contributor to the PM_{10} emissions (58.4 per cent of national total emissions) at 25.00 kt in 1990, emissions have fallen to 7.68 kt in 2015 (and 33.4 per cent of the national total emissions). Emissions from Transport (1A3), at 8.6 per cent share of the total increased throughout the 1990s with increased total vehicle kilometre travel particularly of diesel vehicles. However, the effect of the increase in vehicle numbers seen over the last decade has been offset somewhat by changes in the age structure of the national fleet and developments in diesel fuel technology resulting in decreased Transport emissions by 35.5 per cent (from 3.06 kt in 1990 to 1.97 kt in 2015).

Manufacturing Industries and the Construction sector (1A2) used to account for an increasing percentage of the national total PM_{10}, until reaching its peak of 2.50 kt in 2005. This is also evident with some other pollutants, and is due to the increase in cement production post-2000 following the entry into the market of two new plants. Emissions for this sector have decreased since 2005, and accounted for 6.7 per cent of the national total in 2015 (1.53 kt), representing a decrease across the 1990-2015 time series of 12.8 per cent. Public Electricity and Heat Production (1A1a) sector emissions accounted for 2.9 per cent of the national total in 2015 and at 0.68 kt reduced by 29.7 per cent from 1990 levels (0.96 kt). The decrease was due to the increased use of natural gas and wind for electricity generation, in proportion to coal and peat which still account for a large share of the fuel mix used. Fugitive emissions from Oil Refining/Storage (1B2a), Storage, handling and transport of chemical products (2B10b) and Manufacture of solid fuels (1A1c) sectors form the main components of the Other NFR sectors category and combined account for 0.5 per cent of the total PM_{10} emissions in 2015.

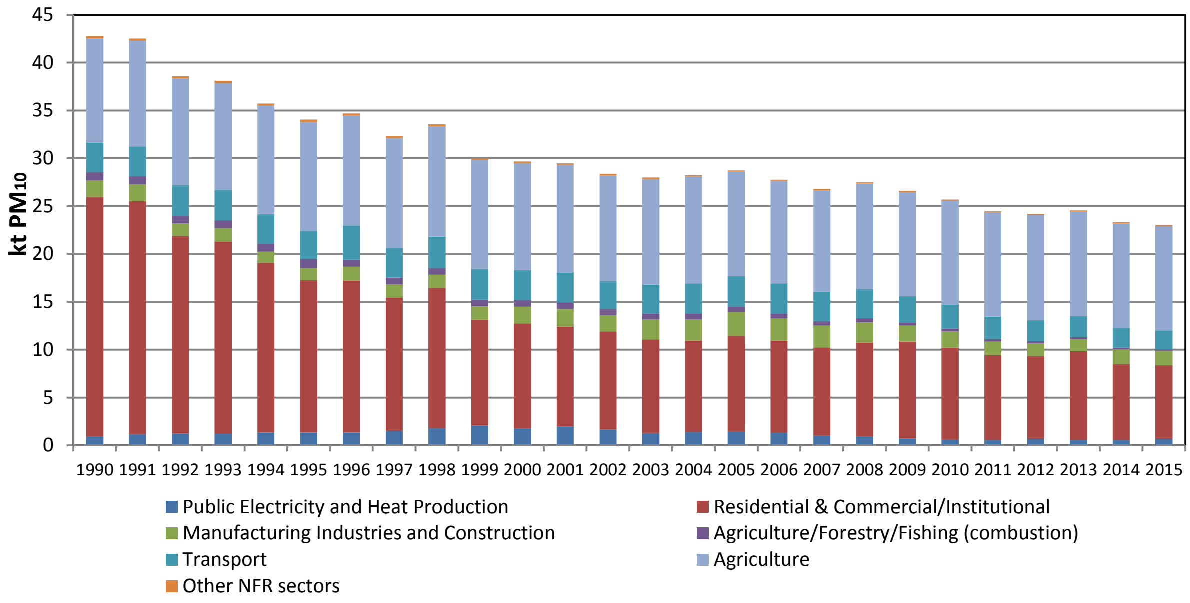

Figure 2.6 Emission Trend for Particulate Matter <10 µm in Diameter 1990−2015

2.3.2 Particulate Matter <2.5 µm Diameter ($PM_{2.5}$)

National total emissions of particulate matter <2.5 µm diameter amounted to 13.33 kt in 2015, a 59.4 per cent reduction on 32.81 kt in 1990 (Figure 2.7). Emissions from Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined are the main determinant of the trend with their 56.4 per cent share of the national total $PM_{2.5}$ emissions in 2015. There has, however, been a reduction of 69.3 per cent in emissions from these sectors between 1990 (24.48 kt and 74.6 per cent share) and 2015 (7.52 kt). Reduced use of coal and peat, with increased use of gasoil, kerosene and natural gas in the two sectors has resulted in lower emissions and a reduction in the contribution to the national total.

Emissions from Agriculture arise from Manure Management (3B) and Inorganic N-fertilizers (3Da1) sectors that together in 2015 at 2.15 kt accounted for 16.1 per cent of the national total and indicated a 1.9 per cent decrease on their 1990 levels (2.19 kt). Transport (1A3) contributed 1.56 kt (11.7 per cent share) to the national total in 2015. Emissions from Transport sector (1A3), dominated by Road Transport (1A3b) increased from 1990 (2.84 kt) to a peak in 1996 (3.26 kt), but have been decreasing since 2004, with a 45.0 per cent reduction between 1990 and 2015 which is largely due to technological advances and the age structure of the national fleet which in turn have been balanced by the increases in vehicle numbers over the time series (see comments in section 2.3.1 on the trends of PM_{10} emissions). Emissions from Manufacturing Industries and Construction (1A2) have decreased from 1.67 kt in 1990 to 1.48 kt in 2015 and 11.1 per cent share of national total emissions (a decrease of 11.6 per cent in the trend), the result of decreased fuel use, in particular petroleum coke in cement production (Non-metallic minerals, 1A2f).

Electricity and Heat Production (1A1a) sector accounts for 3.3 per cent of the national total emissions in 2015, a reduction of 32.1 per cent from 0.65 kt in 1990 and 0.44 kt in 2015. Combustion from the Agriculture/Forestry/Fishing sector accounted for 1.1 per cent of national total $PM_{2.5}$ emissions in 2015 and has reduced by 83.2 per cent from 1990 when emissions were 0.85 kt, compared to 0.14 kt in 2015. The remainder of the $PM_{2.5}$ emissions arise mainly from Manufacture of solid fuels (1A1c) and Oil Refining/Storage (1B2a) sectors, which are presented in Other NFR sectors that together account for 0.3 per cent of the total in 2015.

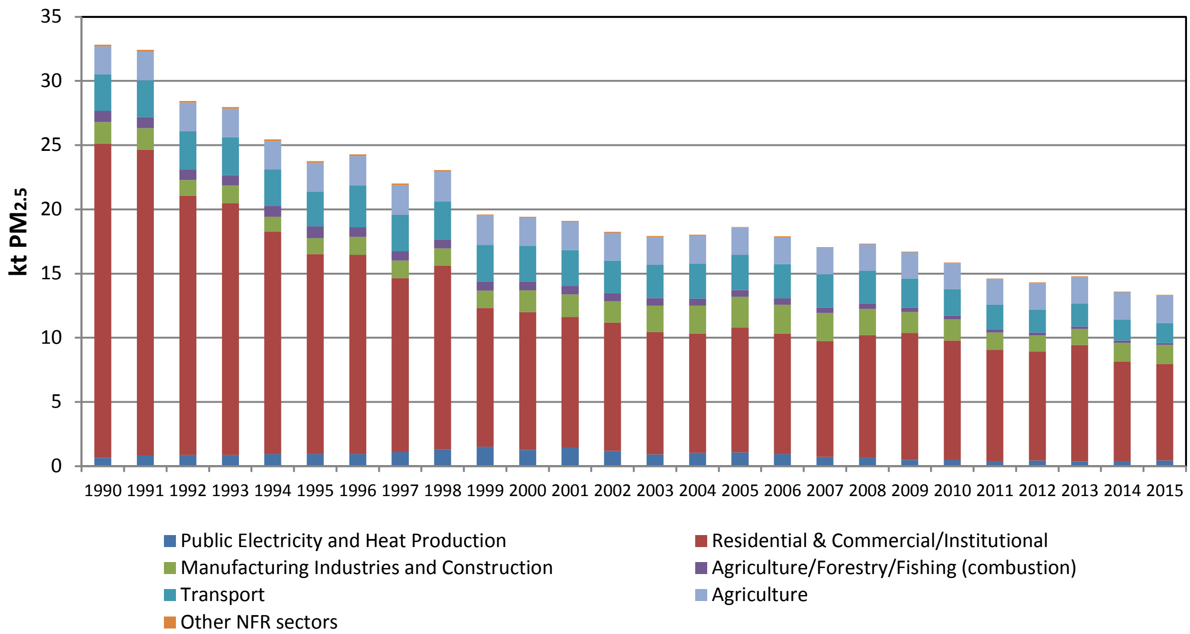

Figure 2.7 Emission Trend for Particulate Matter <2.5 μm in Diameter 1990−2015

2.3.3 Total Suspended Particulates (TSP)

Total suspended particulate emissions have decreased by 43.8 per cent, from 49.86 kt in 1990 to 28.01 kt in 2015 (Figure 2.8). The main driver of the TSP trend is emissions from the agriculture (Manure Management (3B) and Inorganic Fertiliser (3Da1)) sector at 14.73 kt (and 52.6 per cent share of the total). There has been a 1.2 per cent decrease on its 1990 levels (14.90 kt). Combined emissions from Residential (1A4b) and Commercial/Institutional (1A4a) sectors were the second largest contributor to the total TSP emission in 2015. There has, similar to emissions from both PM_{10} and $PM_{2.5}$, been a reduction of 69.3 per cent in emissions from these sectors between 1990 (27.49 kt) and 2015 (8.45 kt). In the time series, the part replacement of coal and peat with natural gas, gasoil and kerosene has resulted in the contribution of these sectors falling from 55.1 per cent of the national total in 1990 to 30.2 per cent in 2015.

Emissions from Transport (1A3) decreased by 35.4 per cent to 2015 (1.98 kt and 7.1 per cent share of national total) compared to 1990 (3.06 kt and 6.1 per cent share). Manufacturing Industries and Construction (1A2) account for an increasing proportion of emissions post-2000 as a result of the entry into the market of two new cement production plants (Non-metallic minerals, 1A2f). Emissions from the 1A2 sector had their peak in 2005 (2.59 kt) and although have been generally declining since, emissions increased 19.8 per cent between 2013 and 2015. At 1.60 kt in 2015 (5.7 per cent of the total) emissions have decreased from 2005 by 38.2 per cent and by 12.6 per cent from 1990 (1.83 kt). Public Electricity and Heat Production sector (1A1a) emissions have decreased by 32.8 per cent over the time series, from 1.23 kt in 1990 to 0.82 kt (and 2.9 per cent share of the total emissions) in 2015.

Emissions from Agriculture/Forestry/Fishing in 2015 (0.15 kt, 0.5 per cent of the national total) have decreased by 82.3 per cent since 1990 (0.87 kt). The remainder of the TSP emissions arise mainly from Manufacture of solid fuels (1A1c) and Storage, handling and transport of chemical products (2B10b) sectors, which are presented in Other NFR sectors that together account for 1.0 per cent of the total in 2015.

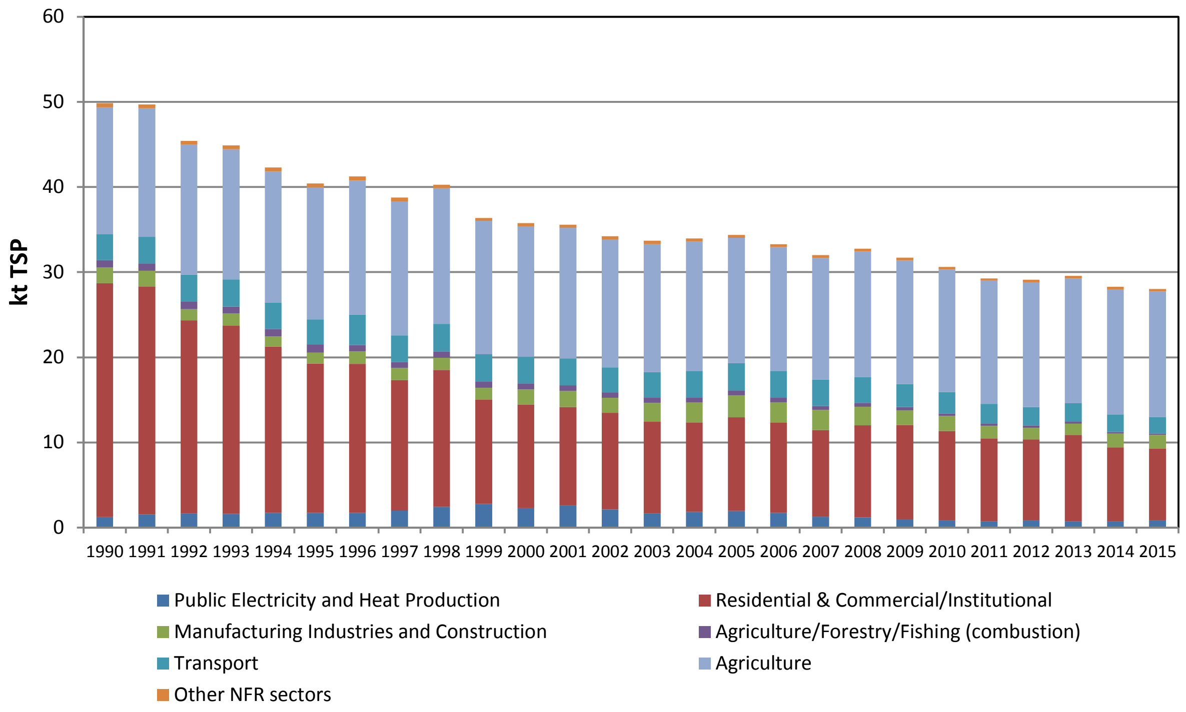

Figure 2.8 Emission Trend for Total Suspended Particulates 1990−2015

2.3.4 Black Carbon (BC)

Black Carbon emissions have decreased by 54.5 per cent, from 4.05 kt in 1990 to 1.85 kt in 2015 (Figure 2.9). The main driver of the BC trend is emissions from Transport (1A3). Emissions from the sector have reduced by 41.0 per cent between 1990 (1.35 kt) and 2015 (0.80 kt). Combined emissions from Residential (1A4b) and Commercial/Institutional (1A4a) sectors were the second largest contributor to total BC emissions in 2015. In 2015, combined emissions from the sectors were 0.59 kt (32.1 per cent share) and have reduced by 67.4 per cent since 1990 (1.82 kt). Manufacturing Industry and Construction (1A2) emissions accounted for 20.1 per cent of the total in 2015 (0.37 kt) having decreased by 4.5 per cent since 1990 (0.39 kt). Emissions from Agriculture/Forestry/Fishing in 2015 were 0.07

kt, which equates to a 84.2 per cent reduction on 1990 (0.47 kt). Public Electricity and Heat Production (1A1a) emissions have decreased by 52.9 per cent over the time series, from 0.02 kt in 1990 to 0.01 kt in 2015. The remaining 0.05 per cent in 2015 accounts for emissions from Petroleum refining (1A1b) and Industrial waste incineration (5C1bi),

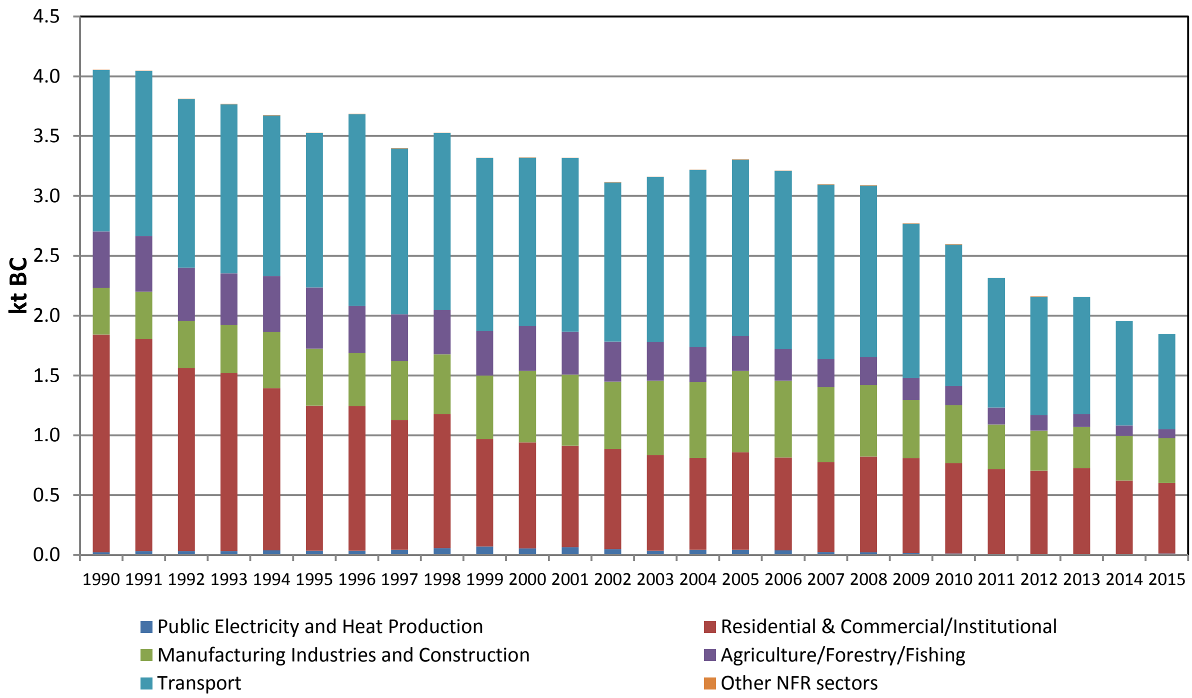

Figure 2.9 Emission Trend for Black Carbon 1990−2015

2.4 Priority Metals

2.4.1 Lead (Pb)

Over the 1990−2015 time series, total national Pb emissions have decreased by 89.2 per cent, from 124.09 t in 1990 to 13.27 t in 2015 (Figure 2.10). The Pb emissions trend is largely determined by Road Transport (1A3b). Emissions of Pb have decreased considerably since 1990. There was a marked decrease between 1999 and 2000 when the lead content of petrol was reduced. In addition there was an increase in the use of unleaded gasoline in road transport throughout the 1990s and the subsequent phasing out of leaded gasoline in 2000/2001. The contribution of Transport (1A3) to the much-reduced national total emissions has decreased by 91.2 per cent, from 109.28 t (88.1 per cent share) in 1990 to 9.63 t (72.6 per cent share) in 2015.

The second largest contributors to Pb emissions at 17.1 per cent share of national total in 2015 were the Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined. The use of coal and peat in the Residential (1A4b) and Commercial/Institutional (1A4a) sectors is being part replaced with natural gas, gasoil or kerosene. Emissions from these sources have fallen from 7.59 t in 1990 to 2.27 t in 2015, a reduction of 70.1 per cent. Combustion in Manufacturing Industries and Construction (1A2) accounted for 6.0 per cent share of the total in 2015, and emissions from Public Electricity and Heat Production sector (1A1a) were responsible for 4.2 per cent share in 2015. Emissions from Metal Production (2C) have decreased in recent years due to the closure of a number of foundries and were negligible in 2015. Similarly, emissions from Waste Incineration (5C) have also decreased to almost zero as a result of an outright ban on the incineration of clinical wastes in the mid-1990s. Incineration in 5C is now solely in relation to the destruction of vapours.

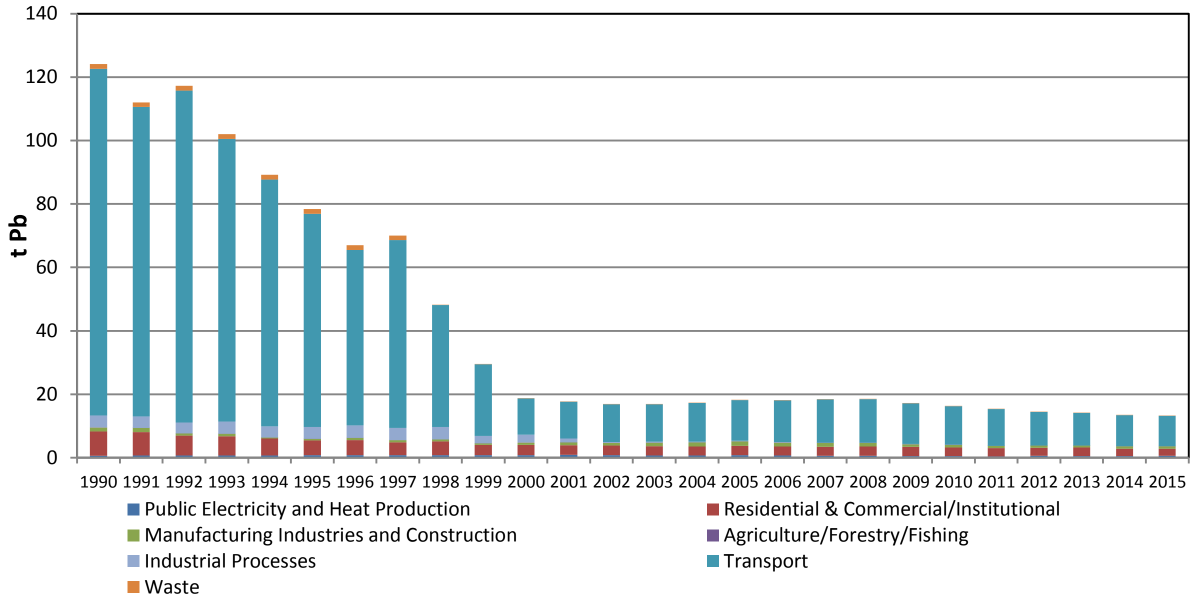

Figure 2.10 Emission Trend for Lead 1990–2015

2.4.2 Cadmium (Cd)

Total national emissions of Cd have decreased from 0.53 t in 1990 to 0.27 t in 2015 (Figure 2.11), a reduction of 49.1 per cent. Emissions of cadmium are largely determined by the Manufacturing Industries and Construction (1A2) sector (37.1 per cent share of national total in 2015), specifically combustion sources in Non-Ferrous Metals (1A2b). Across the time series, the contribution of combustion sources within the Manufacturing Industries and Construction (1A2) sector reached its peak in 2005 (0.10 t) subsequently decreasing to 0.08 t in 2012 and increasing back up to 2005 levels in 2014 and 2015. Public Electricity and Heat Production (1A1a) decreased from 1990 by 19.3 per cent and accounted for 26.5 per cent of the national total in 2015. Emissions from this source increased throughout the 1990s as a result of the combustion of increasing quantities of coal and peat for electricity generation. The use of coal has reduced across the time series.

Residential (1A4b) and Commercial/Institutional (1A4a) combustion is also an important source of Cd emissions, with combined emissions from these sectors accounting for 19.3 per cent of the national total in 2015 due to the continued use of the fossil fuels (coal, peat and oil); however, emissions from the sector have fallen by 53.1 per cent, from 0.11 t in 1990 to 0.05 t in 2015. Transport (1A3) sector emissions have been increasing in the time series (by 137.9 per cent) and in 2015 it accounted for 15.9 per cent of the national total cadmium emissions. Combustion sources from Agriculture/Forestry/Fishing (1A4c) sector accounted for 0.6 per cent of the total Cd emissions in 2015. As a result of the closure of the Irish Steel plant in late 2001, emissions from Metal Production (2C) are no longer a driver of the trend (0.1 per cent share in 2015) in national total emissions of Cd compared to a 46.5 per cent share (and main contributor to the total) in 1990.

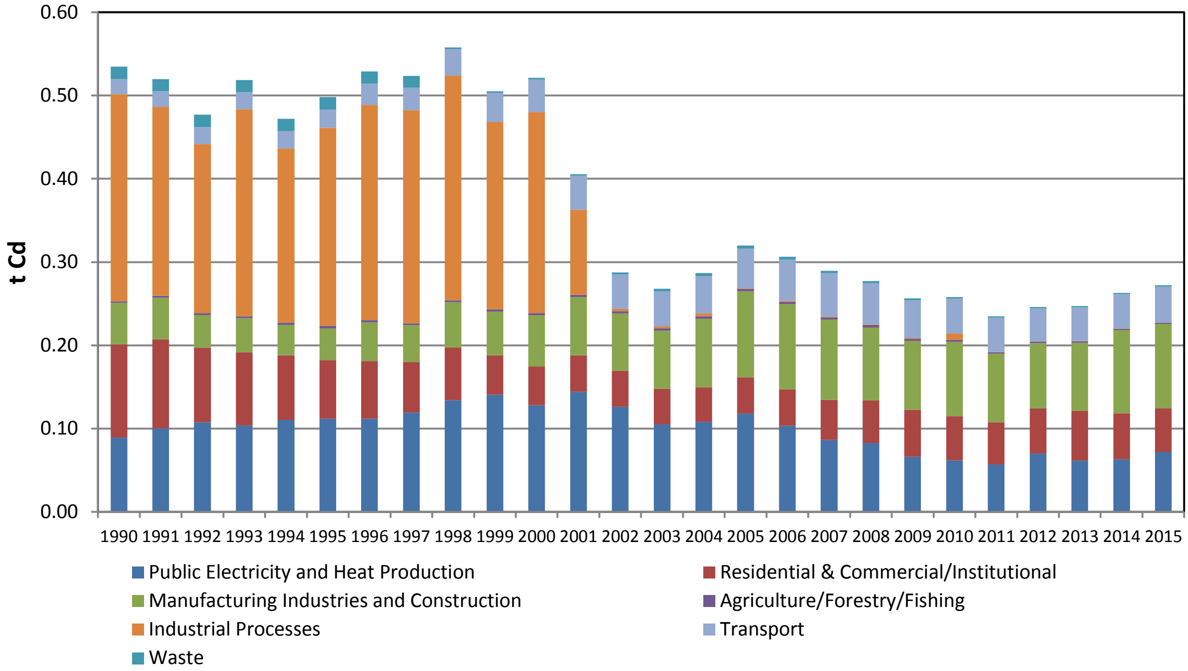

Figure 2.11 Emission Trend for Cadmium 1990–2015

2.4.3 Mercury (Hg)

Total national emissions of Hg have decreased from 0.81 t in 1990 to 0.35 t in 2015, a reduction of 56.5 per cent (Figure 2.12). Emissions from Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined account for the largest share of national total mercury emissions (34.0 per cent in 2015), having decreased by 61.5 per cent between 1990 and 2015 as a result of an increase in the use of natural gas and gasoil and a decrease in the use of coal and peat. Emissions from Public Electricity and Heat Production (1A1a) decreased by 4.0 per cent in the trend and accounted for 32.0 per cent of national total mercury emissions in 2015 (0.11 t). Combustion sources in Manufacturing Industries and Construction (1A2) accounted for 18.9 per cent of total emissions in 2015, a 23.6 per cent reduction since 1990. Emissions from this sector are largely dependent on the increased use of petroleum coke and coal as a fuel source in the cement industry after the entry of a number of additional cement producers into the Irish market post-2000 to reach their peak in 2005. The sectoral emissions decreased since 2005 and especially after 2008 when the Irish economy was impacted by the recession.

Similar to Pb and Cd emission estimates, Waste Incineration (5C) is no longer a significant source category (with its 2.3 per cent share of total emissions in 2015). The Transport (1A3) sector accounted for 6.9 per cent and combustion sources from Agriculture/Forestry/Fishing (1A4c) sector accounted for 0.2 per cent of the total Cd emissions in 2015. Glass Production (2A3) and Metal Production (2C) are no longer occurring due to plant closures (glass since 2010 and metal since 2002).

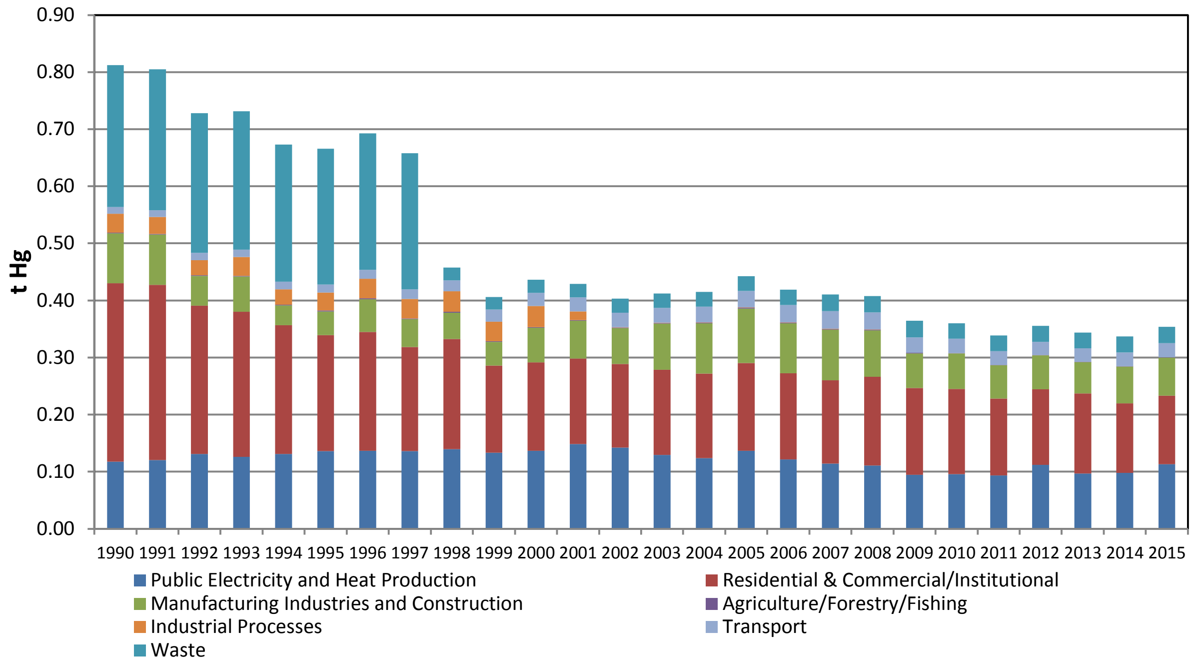

Figure 2.12 Emission Trend for Mercury 1990−2015

2.5 Other Metals

2.5.1 Arsenic (As)

Emissions of arsenic have decreased by 21.6 per cent from 1.59 t in 1990 to 1.25 t in 2015 (Figure 2.13). These emissions are largely dominated by incineration of hazardous and clinical wastes and crematoria in Waste Incineration sector (5C). Waste Incineration accounted for 51.4 per cent of national total arsenic emissions, having increased by 16.1 per cent from 0.55 t in 1990 to 0.64 t in 2015. The absolute and percentage contributions of this sector are increasing largely due to the increase in the number of cremations undertaken in Ireland which has increased by 225 per cent since 1990 and incineration of wood products historically treated with a preservative containing arsenic. Continued use of coal, peat and fuel oil as part of the fuel mix contributes largely (42.6 per cent share of the total in 2015) to the trend in emissions from Public Electricity and Heat Production (1A1a); however, arsenic emissions from the sector have decreased by 13.9 per cent over the time series due to the replacement of less-efficient peat plants with new plant, reductions in the quantities of coal combusted and fuel switching from oil to natural gas and wind energy.

The continued use of fossil fuels in the Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined results in the sectors accounting for 3.9 per cent of national total emissions in 2015, however, they have decreased by 67.8 per cent in the trend. Within the Manufacturing Industries and Construction (1A2) sector, the sub-sector Non-metallic minerals (1A2f) is responsible for the majority of total sector's emissions due to the increase in cement production and associated fuel use in the sector, in particular petroleum coke post-2000 with the entry into the market of new cement plants and reflecting more recent post-recession decrease in production and consequential lower emissions from the sector. The sector's As emissions contributed 1.8 per cent the total in 2015, a decrease of 45.2 per cent on the 1990 level. Metal Production (2C) is no longer an important source of As emissions, following the closure of the Irish Steel plant in 2001 and a reduction in emissions from Integrated Pollution Prevention and Control (IPPC)-licensed facilities. Emissions from this sector accounted for 13.6 per cent in 1990 (third largest contributor) and are reported as not occurring in 2015 due to the closure of the foundry which was a responsible for emissions from this sector between 2001 and 2013.

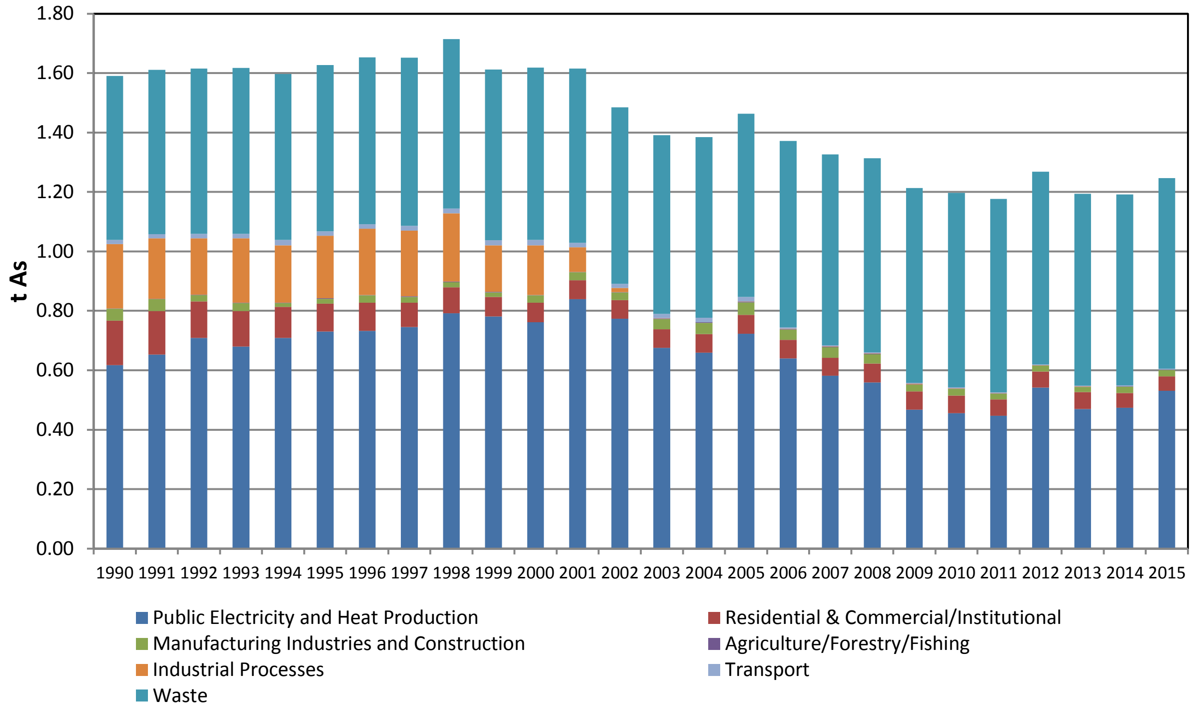

Figure 2.13 Emission Trend for Arsenic 1990−2015

2.5.2 Chromium (Cr)

Emissions of Cr have decreased by 44.7 per cent from 3.83 t in 1990 to 2.12 t in 2015 (Figure 2.14). Transport (1A3) and Waste Incineration (5C) sectors are the main two drivers of the chromium trend. The Transport (1A3) sector accounted for 31.8 per cent of estimated national total emissions in 2015. Emissions from this source category have increased by 139.4 per cent over the time series due to the large increase in vehicle numbers (128.8 per cent) in Ireland between 1990 (0.28 t) and 2015 (0.67 t). The incineration of hazardous and clinical wastes and crematoria contribute to emissions from Waste Incineration (5C). The sector is the second largest source of chromium emissions and accounted for 29.2 per cent of 2015 national chromium emissions, an increase of 15.9 per cent in the trend. The absolute and percentage contributions of this sector are increasing largely due to an increase in industrial waste incineration (5C1bi) which includes the incineration of wood that has historically been treated with preservative containing chromium.

Continued use of coal, peat and fuel oil as part of the fuel mix for Public Electricity and Heat Production (1A1a) means that the sector contributed 16.1 per cent to the emissions total in 2015. However, there has been a reduction in emission levels of 12.8 per cent between 1990 and 2015 as a result of the replacement of less-efficient peat plants with new plant, reductions in the quantities of coal combusted and fuel switching from oil to natural gas and wind energy. Emissions from Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined accounted for 11.7 per cent of the national total in 2015, having decreased, by 64.7 per cent over the time series, reflecting the part replacement of coal and peat with natural gas, gasoil and kerosene. Within the Manufacturing Industries and Construction (1A2) sector, the sub-sector Other (1A2f) is responsible for the majority of emissions largely due to the cement industry, as is evident with other heavy metal estimates. Emissions in 1A2 accounted for 10.7 per cent of national total chromium emissions and have increased by

20.9 per cent in the whole trend. Similar to other heavy metals estimates, the closure of the Irish Steel plant in 2001 has significantly reduced the effect of Metal Production (2C) on emission trends, from 44.9 per cent share of the total (and the main contributor to chromium emissions) in 1990. Emissions from the sector are reported as not occurring in 2014 and 2015 due to the closure of the foundry which was a responsible for emissions from this sector in 2013.

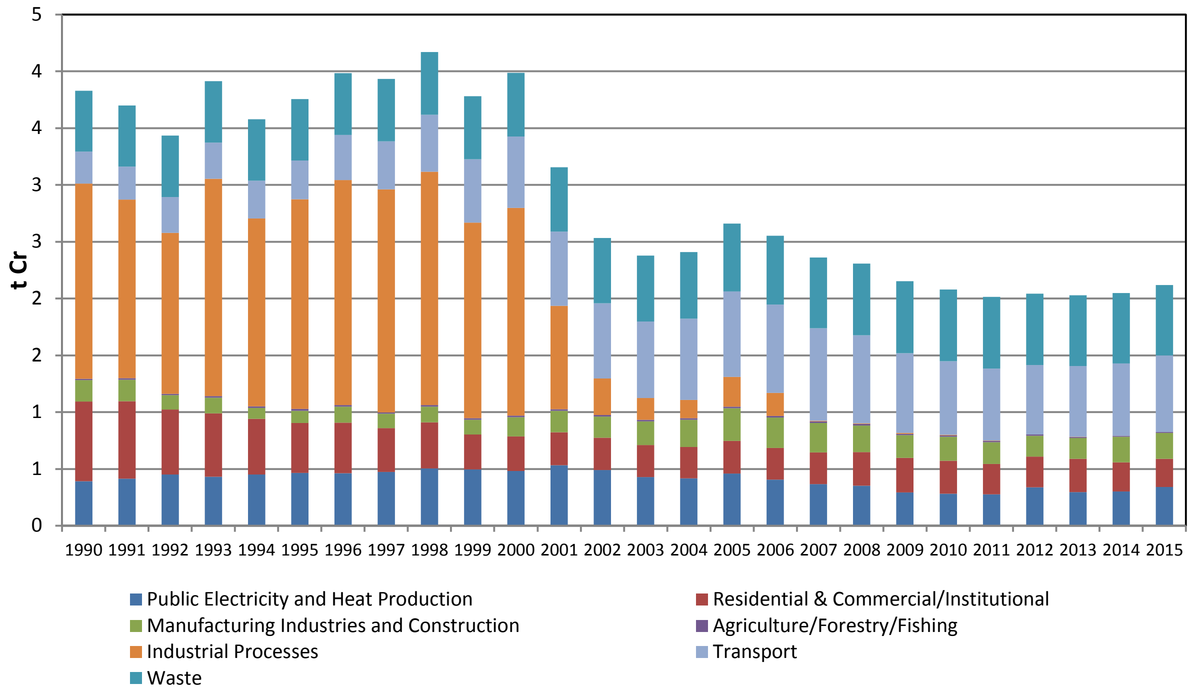

Figure 2.14 Emission Trend for Chromium 1990−2015

2.5.3 Copper (Cu)

Total copper emissions in Ireland were steadily increasing over the 1990−2007 period and have been steadily decreasing since (Figure 2.15). Total emissions in 2015 (18.59 t) were 17.6 per cent lower than in their peak in 2007 (22.56 t) but they are 82.7 per cent higher than in 1990 (9.64 t). This trend is determined mostly by the Transport (1A3) sector that accounted for 90.9 per cent of estimated national total copper emissions in 2015. Emissions from this source category have more than doubled over the time series due to a large increase in vehicle numbers in Ireland; an increase of 148.6 per cent between 1990 (6.80 t) and 2015 (16.90 t).

Continued use of coal, peat and fuel oil as part of the fuel mix results in a contribution of 3.1 per cent to the total emissions from Public Electricity and Heat Production (1A1a). However, a reduction in emission levels of 15.6 per cent is evident between 1990 and 2015 as a result of the replacement of older less-efficient generation plants, reductions in the quantities of coal combusted and fuel switching from oil to natural gas and wind energy. The Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined accounted for 2.1 per cent of emissions in 2015, showing a 69.4 per cent decrease in the trend. Waste Incineration (5C) emissions accounted for 1.8 per cent of the national total in 2015, having increased by 15.3 since 1990. Combustion sources from Agriculture/Forestry/Fishing (1A4c) sector accounted for 1.3 per cent of the total Cu emissions in 2015 (29.3 per cent decrease since 1990). The Manufacturing Industries and Construction (1A2) sector has decreased by 31.9 per cent between 1990 and 2015 (accounting for 0.7 per cent of the total in 2015). Emissions from the sector were increasing proportionately since 1990 reaching their peak in 2005 as a result of the entry into the market of new operators in the cement production sub-sector post-2000. The use of fossil fuels for combustion decreasing since 2005 as a result of economic circumstances. The closure of the Irish Steel plant in 2001 meant that copper emissions from Metal Production (2C) have made an insignificant contribution to the national total since 2001.

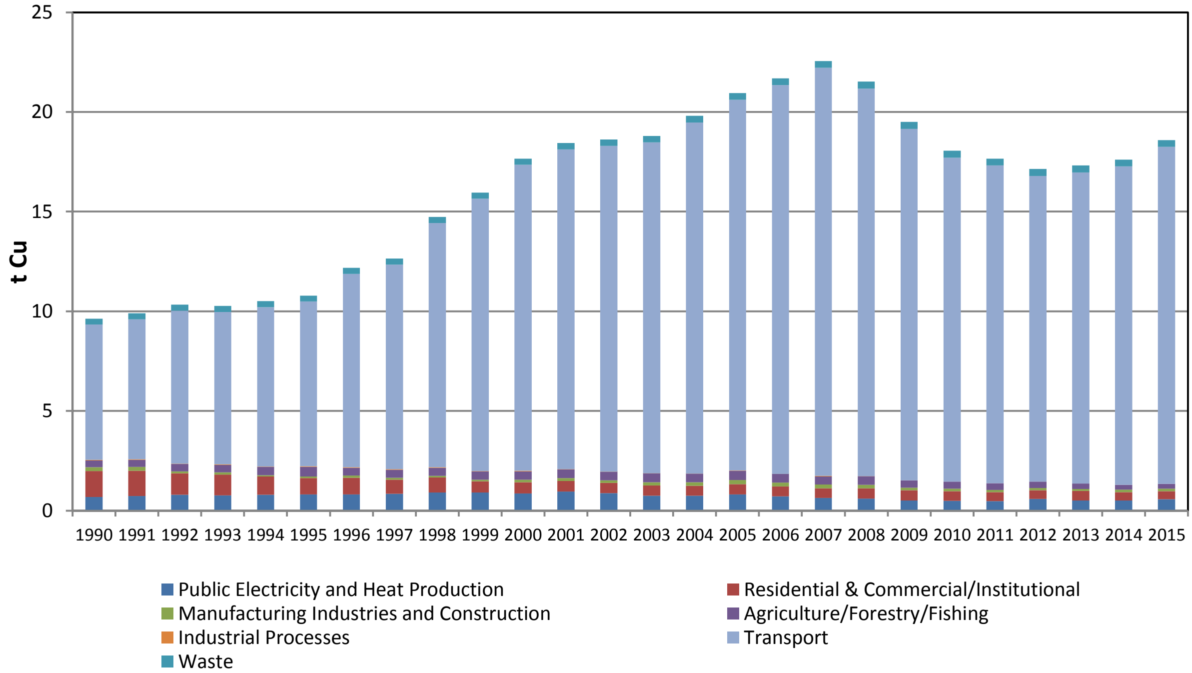

Figure 2.15 Emission Trend for Copper 1990−2015

2.5.4 Nickel (Ni)

National total emission estimates of nickel were steadily increasing over the 1990−1999 period and have been generally decreasing from 1999 onwards (Figure 2.16). Total emissions in 2015 (1.71 t) were 91.2 per cent lower than in their peak in 1999 (19.42 t) and 80.3 per cent lower than in 1990 (8.69 t). The main contributor to this trend is Public Electricity and Heat Production (1A1a) sector with 57.7 per cent share of the total nickel emissions in 2015. Continued use of coal, peat and fuel oil as part of the fuel mix results in a high contribution to the trend from this sector. However, similar to other sectors, a reduction in emission levels of 75.8 per cent is evident between 1990 and 2015 as a result of the replacement of older less-efficient generation plants, reductions in the quantities of coal combusted and fuel switching from oil to natural gas and wind energy.

The second largest contributor to the total nickel emissions in 2015 is Transport (1A3) sector with its 23.3 per cent share of the total. Emissions from Transport have reduced significantly over recent years and in 2015 showed a 49.1 per cent decrease compared to 1990 emission levels. Emissions from the Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined accounted for 12.9 per cent of emissions in 2015, a reduction of 70.1 per cent in emission levels since 1990. Again, a switch within these sectors from solid fuels (coal and peat) to less carbon intensive liquid fuels and natural gas affected the decrease of nickel emissions in the trend. Combustion sources from Agriculture/Forestry/Fishing (1A4c) sector accounted for 1.7 per cent of the total and Manufacturing Industries and Construction (1A2) for 4.2 per cent of total Ni emissions in 2015. Similar to other heavy metals estimates, the closure of the Irish Steel plant in 2001 has significantly reduced the effect of Metal Production (2C) on emission trends, from 33.5 per cent share of the total (and second largest contributor to nickel emissions) in 1990. Emissions in 2015 are reported as not occurring due to the closure of a foundry in the sector which was the last remaining source of emissions in the sector.

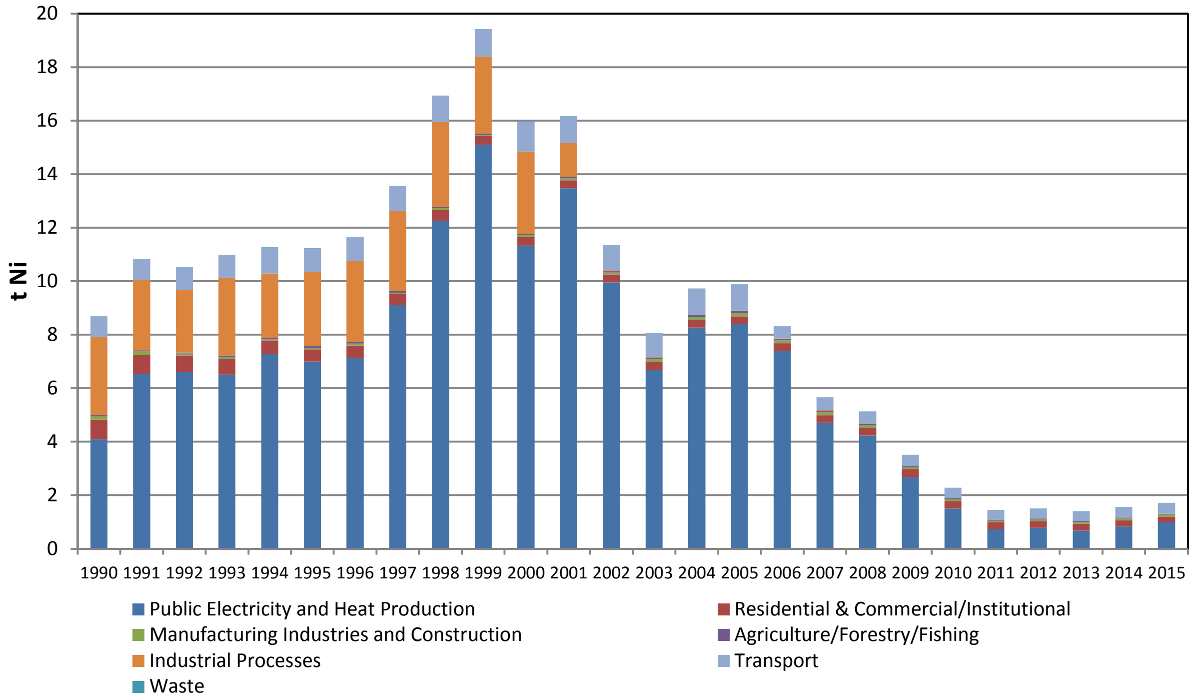

Figure 2.16 Emission Trend for Nickel 1990−2015

2.5.5 Selenium (Se)

National total emission estimates of Se have decreased by 14.5 per cent, from 2.03 t in 1990 to 1.74 t in 2015 (Figure 2.17). The main contributor to the trend has been the Public Electricity and Heat Production (1.A.1.a) sector and in 2015 it accounted for 94.7 per cent share of total selenium emissions. Emissions from this sector have decreased by 9.6 per cent from their 1990 level of 1.82 t to 1.64 t in 2015 due to the replacement of older less-efficient generation plants, reductions in the quantities of coal combusted and fuel switching from oil to natural gas and wind energy.

Transport (1A3) sector has been increasing in the time series and with its 3.1 per cent share of the national total in 2015 it has more than doubled in the trend compared to 1990. Fuel combustion in the Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined accounted for 1.2 per cent of selenium emissions in 2015, having decreased by 67.4 per cent from 1990. Emissions from Manufacturing Industries and Construction accounted for 0.8 per cent of the total, having decreased by 33.2 per cent from 1990. The remainder of the selenium emissions arise from combustion in Agriculture/Forestry/Fishing (1A4c) sector with its 0.2 per cent share of the national total in 2015. Glass production (2A3) under Industrial Processes and Product Use (IPPU) sector used to be an important contributor to the selenium emissions trend throughout the 1990s and up to 2002, accounting for an average of 4.0 per cent of the national total. This is no longer a contributor to the trend following closure of all glass production plants between 2002 and 2009. Metal Production (2C) accounted on average for 0.3 per cent of selenium emissions up to 2001 when closure of Ireland's only steel plant reduced emissions to negligible levels.

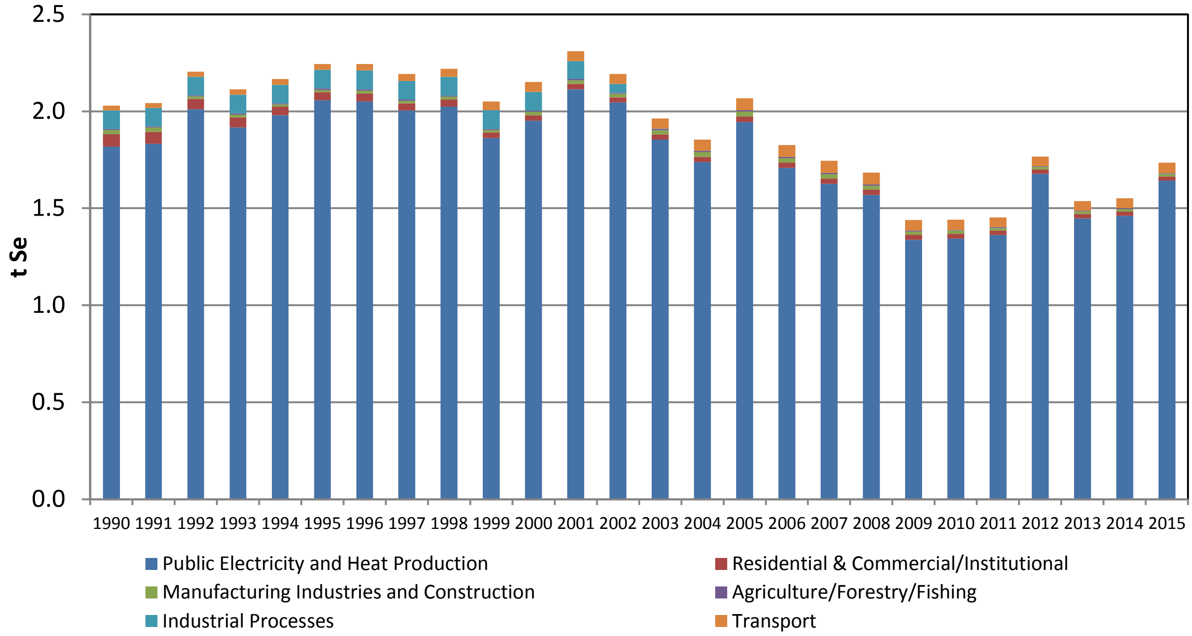

Figure 2.17 Emission Trend for Selenium 1990−2015

2.5.6 Zinc (Zn)

National total emissions of Zn amounted to 54.27 t in 1990 and have fallen by 62.7 per cent to 20.24 t in 2015. In the 1990−2001 period, the main determinant of the trend in zinc emissions was Metal Production (2C), accounting on average for 53.6 per cent of national total emissions throughout that period (Figure 2.18). However, following the closure of Ireland's only steel plant in 2001, emissions from this source sector are now almost negligible and limited to relatively small IPPC-licensed foundries and galvanising plants. The main determinant for the trend since 2002 has been the Transport (1A3) sector (40.8 per cent of national total zinc emissions in 2015) specifically Road Transport (1A3b) sub-sector has increased significantly since 1990 as a result of the increase in the number of vehicles on Irish roads. As a result, emissions from Transport sector have increased substantially (145.5 per cent), from 3.36 t in 1990 to 8.25 t in 2015.

The second largest source is emissions from combustion in Manufacturing Industries and Construction (1A2) have increased by 27.4 per cent from 3.93 t in 1990 to 5.00 t and contributed 24.7 per cent to national total zinc emissions in 2015. Emissions from the combined sectors of Residential (1A4b) and Commercial/Institutional (1A4a) accounted for 25.3 per cent of the national total in 2015. However, reduced use of coal and peat through part replacement with natural gas and gasoil has resulted in the reduction of zinc emissions from these sectors by 64.5 per cent, from 14.44 t in 1990 to 5.12 t in 2015. Emissions from combustion in. Public Electricity and Heat Production (1A1a) emissions have decreased by 40.0 per cent since 1990 and accounted for a 8.3 per cent share of national total in 2015. Similar to other pollutants the reduction is due the replacement of older less-efficient generation plants, reductions in the quantities of coal combusted and fuel switching from oil to natural gas and wind energy. The remainder of the zinc emissions arise from combustion in Agriculture/Forestry/Fishing (1A4c) sector with its 0.9 per cent share of the national total in 2015. Clinical Waste Incineration (5C) accounted for 0.1 per cent of the national total in 1990 however, following an outright ban on incineration of clinical waste in hospitals in 1997, emission from 5C are no longer a source.

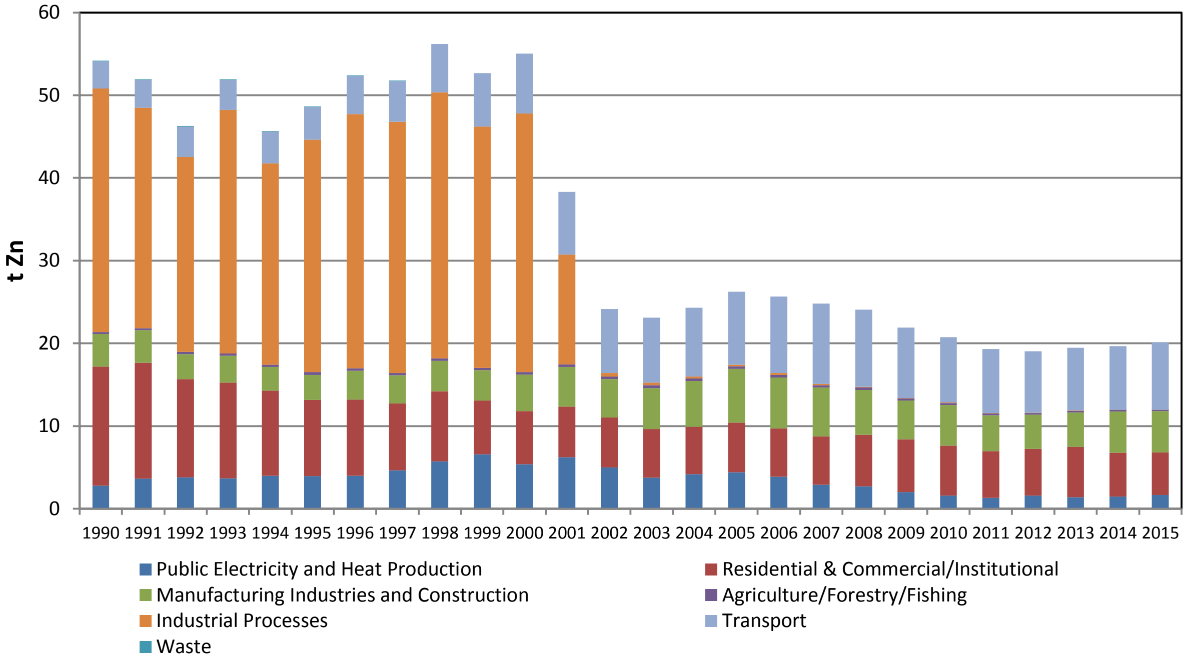

Figure 2.18 Emission Trend for Zinc 1990−2015

2.6 Persistent Organic Pollutants (POPs)

As part of Ireland's emission inventory improvement programme, the inventory agency tendered a project in 2007 to develop an inventory of persistent organic pollutants in Ireland. The project report (AEA/CTC, 2008) provides detailed information in relation to the methodological choice and activity data for the diverse range of sources that give rise to emissions of POPs within Ireland. For the purposes of identifying the major contributors to the trend in PCDD/F, PCBs, HCB and PAHs, some of this information is provided in the following sections. The approach was updated for the 2015 submission using the EFs provided in the Inventory guidebook (2013).

2.6.1 Dioxins and Furans (PCDD/F)

Dioxin and furan emission levels decreased from 66.28 g I-TEQ in 1990 to 26.26 g I-TEQ in 2015 (60.4 per cent reduction on 1990 levels). The main contributors to the trend are the Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined with a 54.9 per cent share of total emissions in 2015; however, emissions from these sectors have reduced (by 69.1 per cent) from 46.68 g I-TEQ in 1990 to 14.41 g I-TEQ in 2015 (Figure 2.19).

The second largest contributor to the trend is the Waste sector which is dominated by emissions from the Other Waste (5E) sector, where building and vehicle fires and residential burning of waste are the emission sources. Total emissions from the waste sector accounted for 26.8 per cent (7.05 g I-TEQ) of national total emissions in 2015, a reduction of 44.6 per cent on 1990 levels (12.73 g I-TEQ). Emissions from the sector peaked in 2003 (25.83 g I-TEQ) due to an increase in the assumed combustion of household waste that remains unaccounted for in national statistics. The introduction of unleaded petrol and technological improvements in road vehicles partly offset increased numbers of vehicles in the national fleet, however there is a 38.4 per cent increase in emissions in Transport (1A3), from 1.03 g I-TEQ in 1990 to 1.42 I-TEQ (5.4 per cent of total emissions) in 2015.

Process emissions from the manufacture of cement (2A1) in Industrial Processes and Product Use sector continue to be an important source of PCDD/F emissions in Ireland, accounting for 5.8 per cent of national emissions in 2015 (1.52 g I-TEQ), a 53.8 per cent reduction on 1990 levels (3.30 g I-TEQ). Combustion in Agriculture/Forestry/Fishing (1A4c) sector accounted for 5.1 per cent of emissions in 2015 (1.33 g I-TEQ) a decrease of 32.2 per cent on the 1990 emissions (1.96 g I-TEQ).

Public Electricity and Heat Production (1A1a) emissions have decreased by 9.2 per cent from their 1990 level of 0.58 g I-TEQ to 0.53 g I-TEQ and are responsible for a 2.0 per cent share of national total in 2015 due to the replacement of older less-efficient generation plants, reduction in the quantities of coal combusted and fuel switching from oil to natural gas and wind energy.

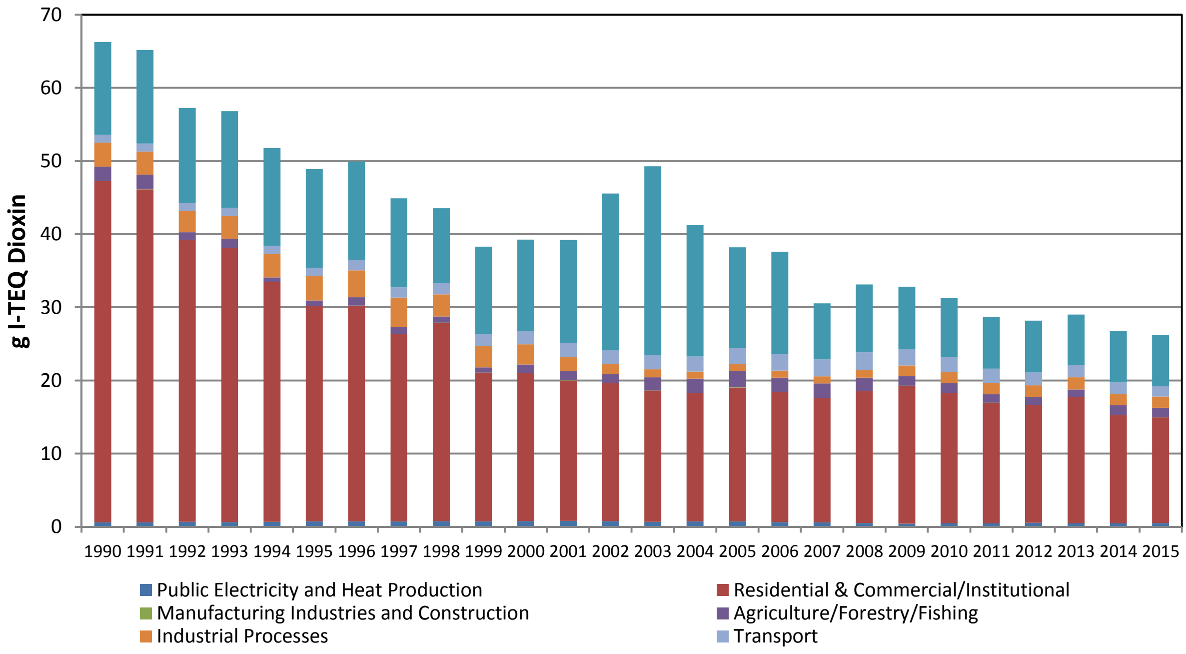

Figure 2.19 Emission Trend for Dioxins and Furans 1990−2015

2.6.2 Hexachlorobenzene (HCB)

Figure 2.20 outlines the trend in hexachlorobenzene emissions in Ireland across the 1990−2015 time series. The graph indicates that HCB emissions from Secondary Aluminium Processing (2C) which, for the period up to and including 1996, dominated the inventory with a contribution of 40 kg per year and is no longer a source of HCB emissions within Ireland due to the banning of hexachloroethane (HCE)-based cover gas use (HCB was present as a contaminant in such cover gases). Emissions since 1997 are more relevant to trend analysis up to 2015. There is very limited information on the release of HCB to air for most source sectors in Ireland. The main source is the use of contaminated pesticide in agricultural practices significantly increasing up to 2003 (1.27 kg), reaching its peak in 2004 (1.69 kg) and decreasing to 1.15 kg and 68.5 per cent share of total emissions in 2015, a 6.2-fold increase since 1990 (0.19 kg). The Public Electricity and Heat Production (1A1a) sector was the second largest source in 2014 accounting for 0.47 kg and a 28.0 per cent share of the national total, having decreased by 4.7 per cent between 1990 and 2015.

Incineration of hazardous and clinical wastes and crematoria included in the waste incineration (5C) accounted for 0.4 per cent share of national emissions in 2015, a decrease of 88.1 per cent since 1990. The remainder of the HCB emissions arise mainly from combustion in the Residential (1A4b) and Commercial/Institutional (1A4a), Manufacturing Industries and Construction (1A2) and Agriculture/Forestry/Fishing (1A4c) sectors, which combined are presented as “Other” NFR sectors in Figure 2.20 and account for 2.7 per cent of the total in 2015.

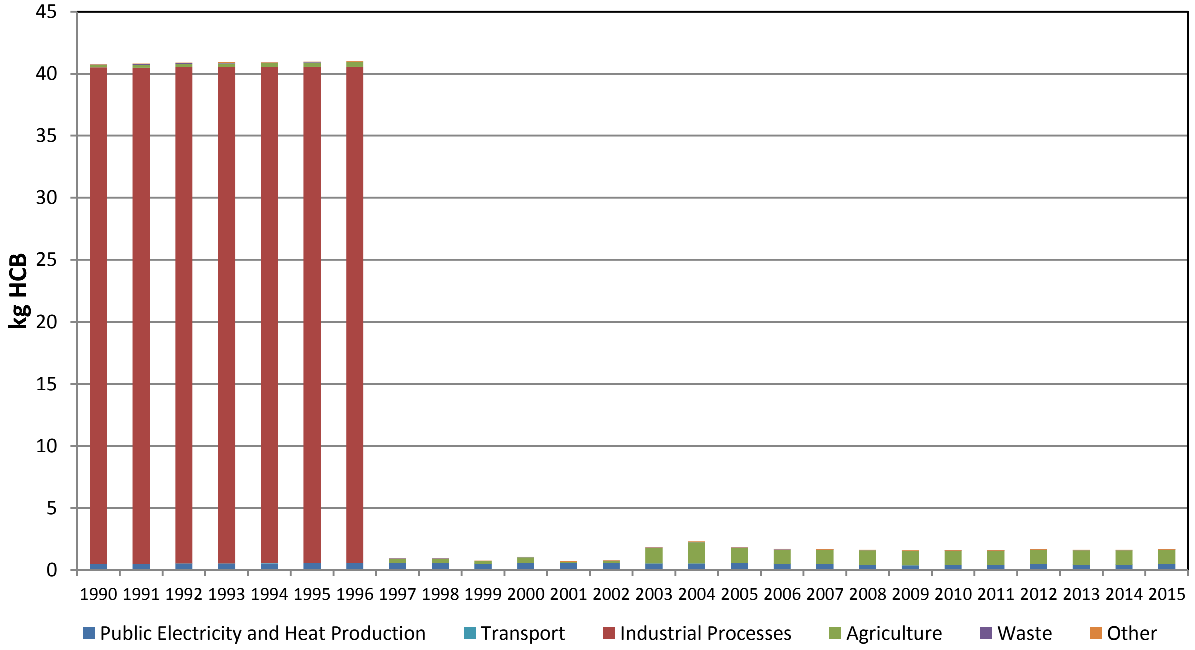

Figure 2.20 Emission Trend for Hexachlorobenzene 1990–2015

2.6.3 Polychlorinated Biphenyls (PCBs)

Estimated national total emissions of polychlorinated biphenyls have decreased by 60.5 per cent from 43.11 kg in 1990 to 17.02 kg in 2015. Emissions peaked in 2003 (74.49 kg) (Figure 2.21). Other Waste (5E) is the main contributor to the trend in PCB emissions in Ireland. In 2015, the emissions from the Waste sector were 8.63 kg (50.7 per cent of national total emissions), a decrease of 52.2 per cent compared to 1990 (18.04 kg). Emissions from the Waste sector peaked in 2003 (63.17 kg) due to an estimated increase in the quantity of household waste that remains unaccounted for in national statistics and which is assumed to be burned.

Combined emissions from the Residential (1A4b) and Commercial/Institutional (1A4a) sectors accounted for 17.0 per cent of the national total in 2015 (2.90 kg), a 70.6 per cent decrease from those estimated for 1990 (9.85 kg).

Public Electricity and Heat Production (1A1a) emissions were almost negligible in 2015. Emissions in this sector have reduced by 97.8 per cent since 1990 due to the replacement of older less-efficient generation plants, a reduction in the quantities of coal combusted and fuel switching from oil to natural gas and wind energy.

Cement Production (2A1) and Other Production, consumption, storage, transportation or handling of bulk products (2L) within the Industrial Processes and Product Use sector combined together were responsible for 4.74 kg and 27.8 per cent share of national total PCB emissions in 2015, a 65.2 per cent decrease from 1990 (13.62 kg and 31.6 per cent share of to the total in 1990). Of particular note for PCB emissions is the contribution of the

NFR Sector 2L (Other Production, consumption, storage, transportation or handling of bulk products), which in Ireland's inventory covers PCB use as dielectric fluid in electrical equipment such as transformers and capacitors. In the first fifteen years of the time series (1990−2005), Industrial Processes and Product Use sector was the second most important contributor to the trend and on average accounted for 22.1 per cent of the national total. However, through the introduction of Hazardous Waste Management Plans and the Waste Electrical and Electronic Equipment (WEEE) Regulations, emissions since 2006 have been decreasing in general. Increases in cement production have led to increases in fuel-combustion-based emissions in Manufacturing Industries and Construction (1A2) up until 2005. This source-sector emissions have decreased by 51.7 per cent between 1990 (1.57 kg) and 2015 (0.76 kg), with a contribution of 4.4 per cent to the national total in 2015.

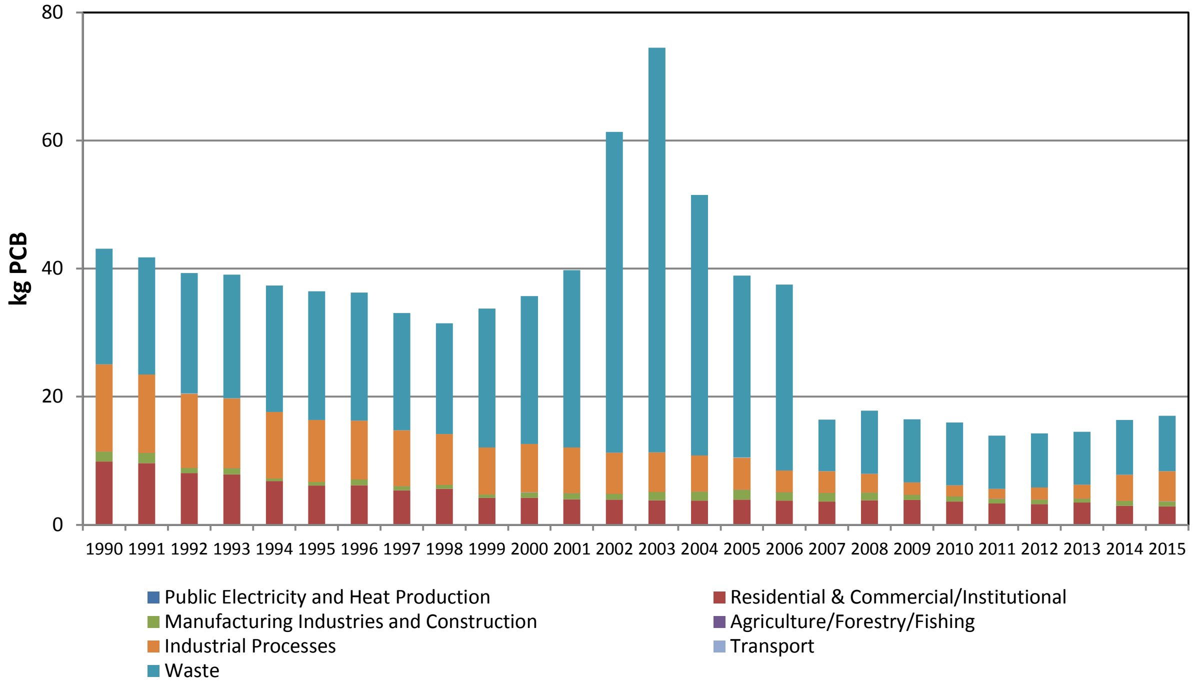

Figure 2.21 Emission Trend for Polychlorinated Biphenyls 1990−2015

2.6.4 Polycyclic Aromatic Hydrocarbons (PAHs)

For the purposes of this report, total PAHs in the form of the sum of emissions of benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-cd]pyrene are presented in Figure 2.22. All together the emissions from these combined four pollutants decreased by 67.7 per cent between 1990 (48.83 t) and 2015 (15.79 t). For all four PAHs, the main source sectors are the same. The inventories are dominated by emissions from combustion in the Residential (1A4b) and Commercial/Institutional (1A4a) sectors. In the Residential (1A4b) sector (main driver of the trend), the lack of combustion controls or abatement, together with relatively low-temperature combustion conditions, leads to high emissions of PAHs. Even though national total emissions of PAHs have generally declined across the time series, the Residential (1A4b) and Commercial/Institutional (1A4a) sectors combined accounted for 90.0 per cent of the national total in 2015, having decreased by 69.5 per cent from 46.62 t in 1990 to 14.21 t in 2015. The decline in emission levels is due primarily to the decline in the use of coal and sod peat for residential space heating, as reported in the National Energy Balance.

Combustion emissions in Manufacturing Industries and Construction (1A2) sector accounted for 7.8 per cent of the total in 2015 (1.22 t), a decrease of 38.9 per cent since 1990 (2.00 t). Emissions from Transport (1A3) have more than doubled (an increase of 150.6 per cent) to 0.28 t representing a 1.8 per cent share of the national total in 2015 for all four PAHs as compared to 0.2 per cent 1990 (0.11 t). Other Waste (5E) is the main driver in the Waste sector resulting in the Waste sector accounting for 0.2 per cent in the total PAHs emissions in 2015, a 22.7 per cent reduction since 1990.

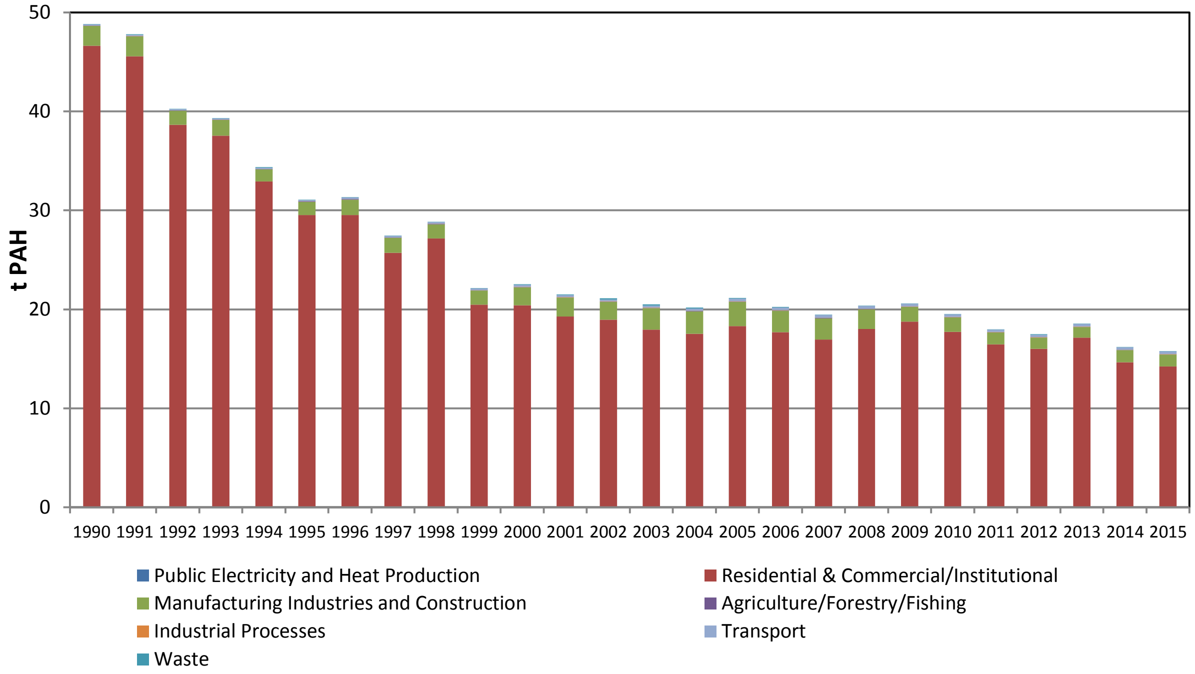

Figure 2.22 Emission Trend for Polycyclic Aromatic Hydrocarbons 1990−2015

Chapter Three Energy

3.1 Overview of the Energy (NFR 1) Sector

The Energy sector covers combustion and fugitive sources of emissions associated with the production, transport, conversion and use of fossil fuels. Emissions from combustion in this sector account for the bulk of total national emissions for the majority of substances covered in this IIR. Estimates of the various pollutants are included for all emission sources that occur in the country and the required level of disaggregation is achieved for sufficiently detailed completion of the NFR tables.

Annual energy balance sheets published by Sustainable Energy Authority Ireland (SEAI) are the principal source of activity data for computing the emissions in the Energy sector. Ireland's energy statistics are compiled using a combination of top−down and bottom−up methods and the annual energy balances have undergone major improvement over recent years to take account of emission inventory requirements and more harmonised reporting to Eurostat and the International Energy Agency (IEA). The annual submission of up-to-date energy balances from SEAI to the inventory agency is one of the primary data inputs covered by a MoU in Ireland's national system (Chapter One). A fully consistent set of energy balance sheets for the years 1990−2015 underlies the time-series estimates of emissions for *Energy* in this submission. The 2015 energy balance is provided in Annex B.

Substantial plant-level fuel-use data are also available for many important categories in the Energy sector, especially for more recent years, which allows bottom−up estimates to be derived for some pollutants using Tier 3 methods. These data are obtained through direct arrangements with the operators of certain plants through their returns under the Large Combustion Plant (LCP) Directive and the EU ETS and under environmental reporting related to their IPPC permits.

The emissions of SO_2 from fuel combustion are determined from the fuel properties, and fully representative emission factors are readily obtained for the fossil fuels used in most emission categories in Ireland. In general, other pollutants emitted from combustion sources are heavily reliant on emission factors from non-national sources. For all other pollutants, the emission factors are taken from various versions of the inventory guidebook (EMEP/EEA, 2009, 2013, 2016). The Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance (CEPMEIP), which is aimed at supporting national experts in reporting PM emission inventories, serves as the reference for emission factors in some sectors (1A1c, 1A3a and 1A4c) for the different forms of Particulate Matter (PM). PM emission factors for other sectors are derived from the Inventory Guidebook (EMEP/EEA, 2013). In the past, emission inventories for heavy metals and POPs received little attention in Ireland and special studies were necessary to compile national emission estimates for reporting purposes. The separate detailed studies on emissions of heavy metals and POPs in Ireland were undertaken by consultants (AEA/CTC, 2008; Netcen/CTC, 2006) and they made use of the best available emission factors for many emission sources, with strong dependence on UK information sources. The results from these studies were the basis for developing time-series emissions of heavy metals and POPs in the Energy sector in previous submissions. In this submission, many of the EFs for heavy metals and POPs are from the Inventory Guidebook (EMEP/EEA, 2013). Black Carbon (BC) was reported for the first time in 2016 submission and EFs are also from the Inventory Guidebook (EMEP/EEA, 2013).

3.2 Public Electricity and Heat Production (NFR 1A1a)

The production of electricity and heat from fossil fuels has traditionally been the most important source of key pollutants such as SO_2 and NO_X in most countries. Approximately 81.4 per cent of electricity production in Ireland (SEAI, 2016) is dependent on fossil fuels and Category 1A1a therefore remains one of the major emission categories. Emissions of SO_2, NO_X, CO, three particulate matter pollutants, BC, all nine heavy metals and POPs have decreased more or less significantly since 1990. NMVOCs were the only emissions that have increased in the time series. The level of emissions in Sector 1A1a depends heavily on the mix of fossil fuels and renewables used for electricity production. In 1990, heavy fuel oil (HFO), coal, peat and natural gas were the principal fuels used. The use of HFO, coal and peat declined as natural gas became the preferred fuel during latter years. However, the use of coal, peat and HFO in electric generation increased in 2015 in comparison to the year 2014 while the use of natural gas continued to decline after reaching its peak in 2010. Incineration emissions from Ireland's only waste-to-energy plant, however small, have been increasing since its operation started in 2011.

3.2.1 Emissions of Sulphur Dioxide and Nitrogen Oxides

Until 2000, the Electricity Supply Board (ESB) operated all public electricity power plants in Ireland. After 2000, a number of new gas-fired plants and one peat-fired plant were built by other operators, while the ESB replaced old peat-burning stations with new stations also burning peat and has been engaged in a major retrofit and improvement programme for plants in general. The shift to natural gas and the use of low-sulphur coal, combined with a decline in the sulphur content of fuel oil, have reduced SO_2 emissions by 95.0 per cent from 103.04 kt in 1990 to 5.20 kt in 2015. The sector's contribution to the overall SO_2 emissions in 2015 was 29.5 per cent as opposed to 55.7 per cent share in 1990. Incineration of non-renewable waste in MSW accounted for 0.4 per cent of SO_x emissions from power generation in 2015.

At the same time, the changed fuel mix, together with the application of extensive NO_X emission control technology and the more modern plants, has decreased NO_X emissions by 79.6 per cent from 46.37 kt (and 32.7 per cent share of total NO_x emissions) in 1990 to 9.48 kt (and 12.9 per cent share of the total) in 2015. In comparison to the year 2014, NO_x emissions increased by 25.8 per cent in 2015, however SO_2 emissions continued to decline in 2015. The ESB has supplied estimates of SO_2 and NO_X on a plant-by-plant basis to the inventory agency for all years since 1990, mainly for the purpose of compiling SO_2 and NO_X inventories under the LCP Directive. The emissions for power plants operated by other companies are obtained either directly from their LCP, AER or PRTR submissions or they can be estimated by the inventory agency from fuel data made available under the ETS. Incineration of non-renewable waste in MSW accounted for 1.2 per cent of NO_x emissions from power generation in 2015.

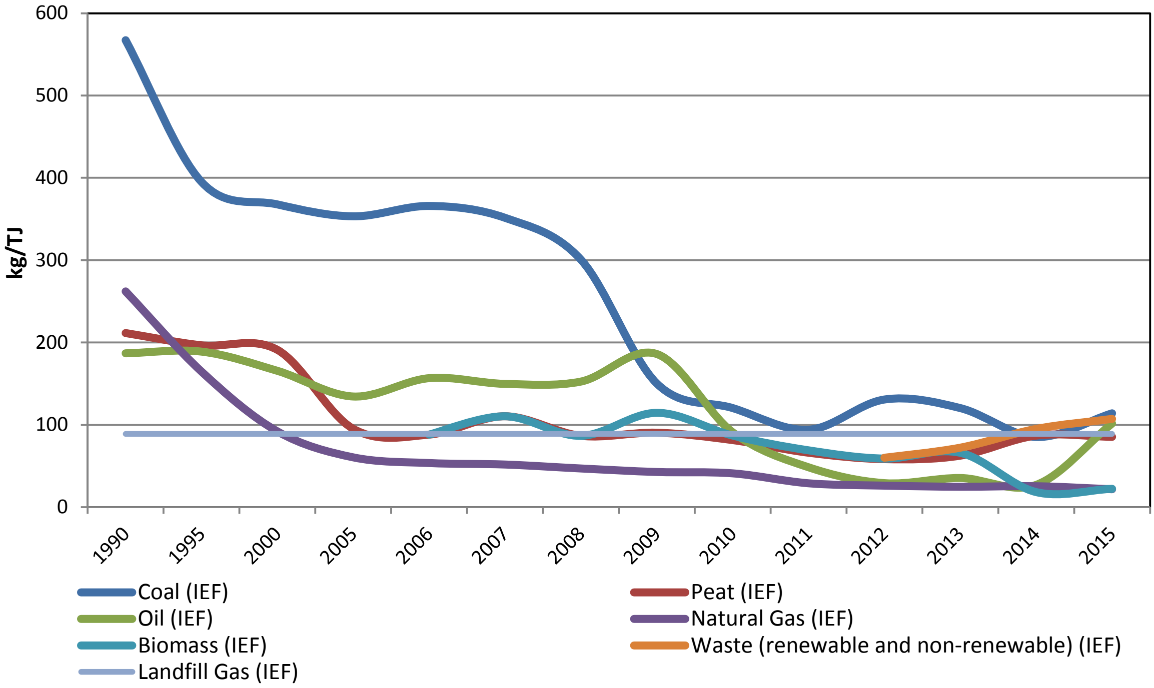

Figure 3.1 Nitrogen Oxide Implied Emission Factors for Category 1A1a

The weighted average emission factors of SO_2 and NO_X per fuel type (coal, peat, oil, natural gas, biomass and waste (MSW)) in Category 1A1a are given in Figures 3.1 and 3.2 as implied emission factors (IEFs) to illustrate the level of decrease due to the factors mentioned above. The SO_2 emission factors reflect the sulphur content and net calorific value of the fuels used in the particular year and they account for sulphur retention levels in the fuel ash of 5 per cent and 10 per cent for coal and peat, respectively. The NO_X emission factors (apart from landfill gas) are compiled from plant-level estimates that are determined from measurement, unit load factor and plant performance. Emission factors for landfill gas are default values as per the revised Inventory Guidebook (EMEP/EEA, 2013).

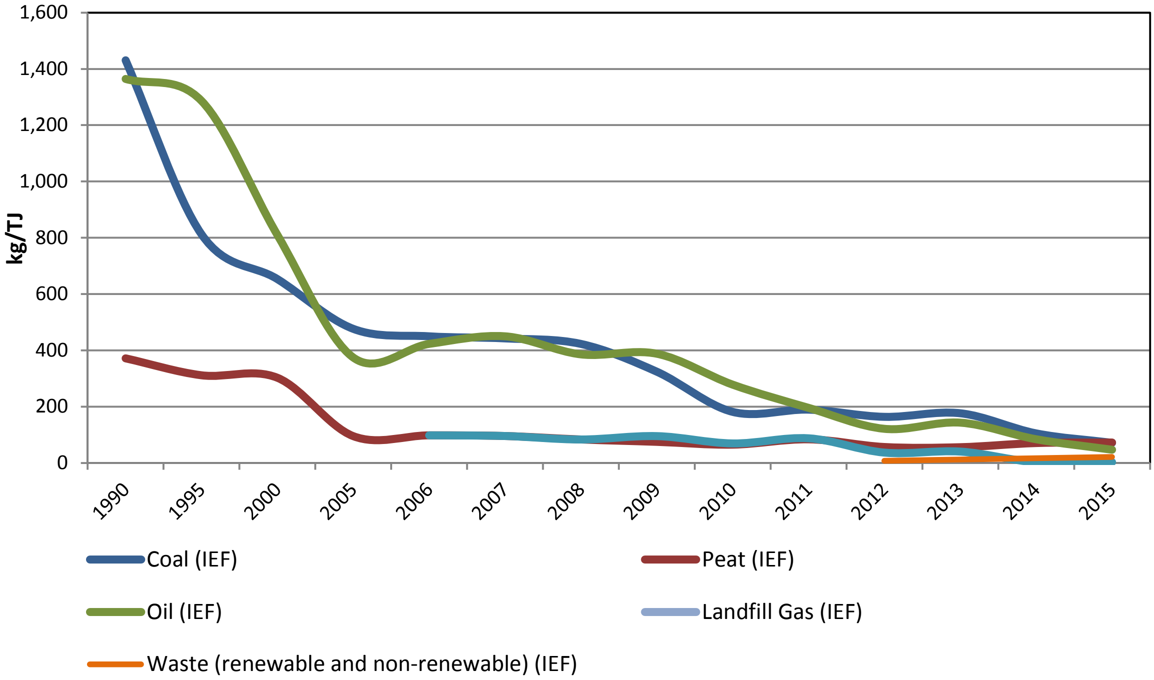

Figure 3.2 Sulphur Dioxide Implied Emission Factors for Category 1A1a

3.2.2 Emissions of Other Substances

The emissions of all substances other than SO_2 and NO_X in Category 1A1a are estimated by the inventory agency using the fuel-use energy data given by the national energy balance and appropriate emission factors taken from the Inventory Guidebook (EMEP/EEA, 2013) and plant-specific factors for non-renewable wastes from waste incineration. The emission factors for 2015 (split by pollutants and fuel type) and their sources are listed in Table C.1 of Annex C. In the case of heavy metals and POPs, the estimates are developed from the results of separate outsourced contracts to deliver time-series emission inventories of the two groups of substances to the EPA (AEA/CTC, 2008; Netcen/CTC, 2006) and default emission factors from the Inventory Guidebook (EMEP/EEA, 2013) are used.

3.3 Petroleum Refining (NFR 1A1b)

Emissions from fuel combustion at one small oil refinery in Ireland are estimated in this source category. Detailed information on the fuels used in different parts of the refinery in recent years is available through the company's AER, PRTR and ETS submissions. This allows for the selection of appropriate emission factors from national data and from international literature sources recognised as being fit for purpose by the emissions inventory community. In the case of heavy metals and POPs, the estimates are based on emission factors from the Inventory Guidebook (EMEP/EEA, 2013). The emission factors for 2015 and their sources are listed in Table C.2 of Annex C.

3.4 Manufacture of Solid Fuels and Other Energy Industries (NFR 1A1c)

Emissions from this source category refer to combustion emissions from the production of peat briquettes from milled peat at two plants in Ireland. As in the case of the oil refinery, the energy balance fuel-use data are supplemented by information reported by the plants under the ETS, which again allows for the selection of appropriate emission factors using national data and high quality international sources. The estimates for heavy metals and POPs are based on emission factors from the Inventory Guidebook (EMEP/EEA, 2013). The emission factors for 2015 and their sources are listed in Table C.3 of Annex C.

3.5 Manufacturing Industries and Construction (NFR 1A2)

This category covers emissions from combustion in manufacturing industries and construction activities. Category 1A2 is split into the following seven subcategories:

1.A.2.a	Iron and Steel
1.A.2.b	Non-Ferrous Metals
1.A.2.c	Chemicals
1.A.2.d	Pulp, Paper and Print
1.A.2.e	Food Processing, Beverages and Tobacco
1.A.2.f	Non-metallic minerals
1.A.2.g	Other Industry

Where it is possible to separate process emissions from those associated with fuel use, the process emissions associated with these industrial groups are reported in the Industrial Processes (NFR 2) sector (Chapter Four). The relevant process emissions in Ireland are largely those related to cement manufacture and some metal industries.

Comparison of the Sustainable Energy Authority of Ireland (SEAI) Energy Balance data with ETS fuel-use data indicates that the combustion activities within the 1.A.2 category are dominated by a limited number of large industrial processing plants. It is assumed that all biomass reported as fuel use within the SEAI Energy Balance is clean untreated wood and wood-processing waste. The ETS data for major wood-processing facilities indicate the use of large-scale biomass boilers, fired using wood biomass, chippings, pulp and wood dust. EPA contacts indicate that none of these wood-based fuels are pre-treated and hence emission factors applicable to clean wood use in large-scale boilers have been used to estimate POP emissions from these sources.

The Iron and Steel (1A2a) sector was dominated in the 1990s by fuel use and emissions from one electric arc furnace but, since its closure in 2001, the fuel use reported in 2002 in this sector related to a small number of iron foundries, which in total used only a very small amount of gasoil and LPG and since 2003 combustion emissions are not occurring. The process emissions from this industrial activity are described in chapter 4, section 4.4.1. The Non-Ferrous Metal (1A2b) subcategory is dominated by the very significant fuel use (mainly natural gas replacing popular in the 1990s fuel oil) reported at a single large alumina plant, whilst the Chemicals (1A2c) subcategory includes natural gas, kerosene, fuel oil, gasoil and LPG use at large chemical plants. The Food Processing, Beverages and Tobacco (1A2e) sector covers a diverse range of industrial plants, much of which is related to agriculture, with just over 30 installations reporting to the EU ETS and using predominantly natural gas and liquid fuels. The bulk of the fuel use reported in the energy balance under the 1A2f subcategory is accounted for by major cement works, lime producers, a small number of brickworks and fuel use at boiler plant within industries such as the pharmaceutical, glass and tile manufacturing sectors. All other industrial fuel use is reported under subcategory 1A2g. This sector covers a diverse range of manufacturing branches ranging from textile and leather, through machinery, transport equipment, wood products, mining (excluding fuel mining) and quarrying to other manufacturing businesses. There is no disaggregation between mobile and stationary machinery, so all emissions are reported under 1A2gvii.

The revised and expanded energy balance sheets developed by SEAI incorporate a mapping of industrial fuel use in combustion into the NFR subcategories 1A2a through 1A2g under sector 1A2 Manufacturing Industries and Construction. This facilitates the complete disaggregation of emissions at subcategory level. In addition, information on fuel consumption in 2015 was obtained in respect of a small number of energy-intensive industries (e.g. alumina production and cement manufacture) from their ETS returns, allowing their respective energy use amounts to be reconciled with the breakdown given in the national energy balance. Emissions in subcategories 1A2a through 1A2g are estimated on a top−down basis using disaggregated fuel use from the energy balance and the mix of country-specific and default emission factors as shown in Tables C.4 through C.10 of Annex C. The estimates for heavy metals and POPs are based on emission factors from the Inventory Guidebook (EMEP/EEA, 2013). Emission factors for heavy metals and POPs (including references) for NFR 1A2 (a−g) are shown in Table C.11 of Annex C.

3.6 Transport (NFR 1A3)

As abatement measures continue to reduce emissions of key pollutants from major stationary combustion sources, transport in general, and road transport in particular, has become more important as a source of atmospheric emissions in many countries. The effects of technological emission controls for passenger cars and other vehicles in Ireland have, to a large extent, been offset by the substantial increases in vehicle numbers, with the result that major reductions in the emissions of pollutants such as NO_X did not occur until 2007 when the economic situation caused an overall decrease in most emissions evident from 2008. In 2015 NO_X emissions from this sector reached 45.91 kt (57.7 per cent share of total) reflecting a decrease by 22.8 per cent on 59.44 kt emissions (and 43.7 per cent share) in 1990.

Road transport in Ireland is a larger source of NO_X than electricity production, and road traffic also continues to be the major source of CO, BC, Pb, Cr, Cu and Zn, although BC, Pb, Cr, Cu and Zn emissions are very small in absolute terms.

3.6.1 Domestic and International LTOs (NFRs 1A3aii(i) and 1A3ai(i))

As a relatively small island state, aviation emissions are dominated by the international component. Under the LRTAP Convention, only the landing and take-off (LTO) component of emissions for both domestic and international flights is reported in the national total. The cruise component, domestic and international, is reported as a memo item. After the motorway network was completed around 2008/09 and the upgrades of the Cork to Dublin rail line, domestic air travel was no longer competitive, leading to cessation of specific routes.

The fuel consumption associated domestic and international LTOs is estimated using a Tier 3a approach (Table 3.6.2, 2006 IPCC guidelines) based on origin and destination data for domestic air travel provided by the Irish Aviation Authority (IAA), the fuel consumption rates given by the Inventory Guidebook (EMEP/EEA, 2009, 2013) appropriate to the type of aircraft concerned and the length of the flights within Ireland. This approach is used for all years from 2004 to 2015 where airport pair data is available.

The inventory agency received 2015 flight data for all Irish airports from the IAA in 2016 completing the time series of data for 2004 to 2015. This data included all flights, domestic and international, on an origin and destination basis and by aircraft type for over 25 different Irish origin airports. For the years 1990 to 2003, the number of flights for each airport was estimated based on domestic passenger and aircraft movement statistics as well as the relationship between all Irish airports and Dublin airport which is the principal destination of all civil flights. Figures 3.3 and 3.4 and Table C.13 of Annex C present the number of LTOs, domestic and international, from Irish airports for all years from 1990 to 2015.

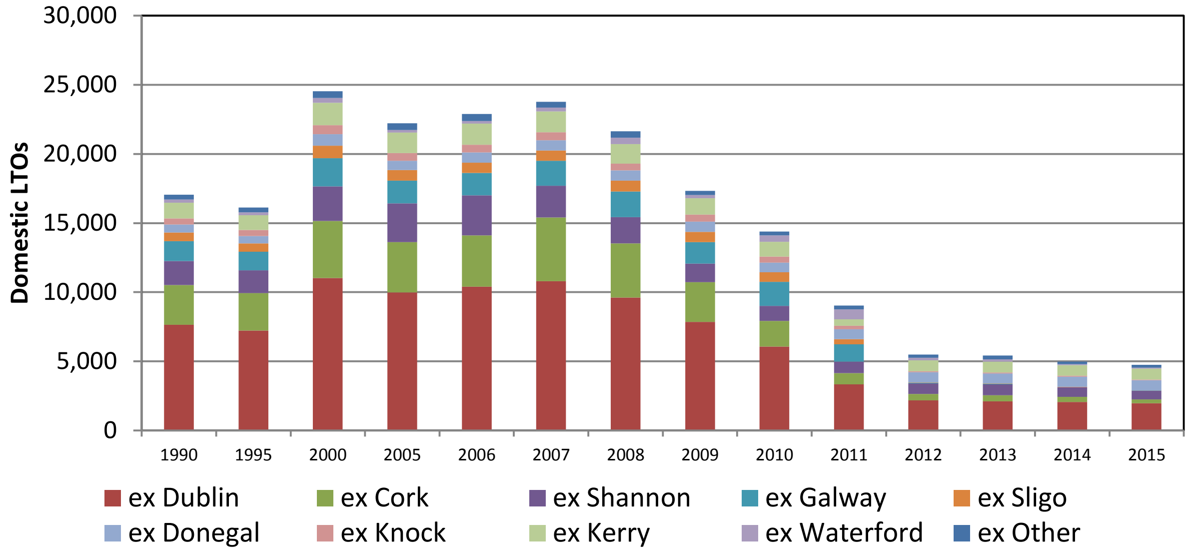

Figure 3.3 Number of Domestic LTOs from Irish airports 1990-2015

For data handling purposes, the inventory agency aggregated approximately 15 small regional airport/aerodrome pairs to "*Other*" which account for approximately 4.3 per cent of all domestic flights along with nine Irish airports which account for the remaining 95.7 per cent of all domestic flights in 2015. Table C.12 of Annex C outlines the distance between the airport pairs in nautical miles (nm) used in estimating fuel used in the cruise phase.

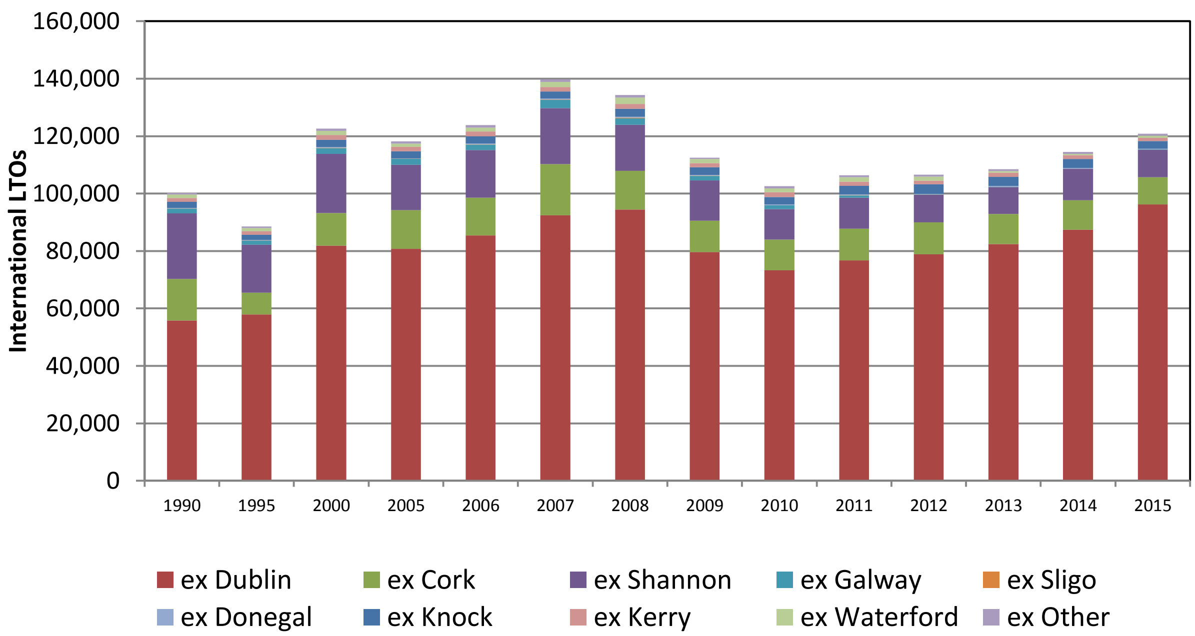

Figure 3.4 Number of International LTOs from Irish airports 1990-2015

The tier 3a methodology estimates both LTO and cruise emissions for domestic flights and LTOs for international flights based on origin and destination, flight distances and by aircraft type. The fuel used in the cruise element of international flights is derived by the following equation;

Int Cruise $_{(fuel)}$ = Total $_{(fuel)}$ – (Int LTO $_{(fuel)}$ + Domestic LTO $_{(fuel)}$ + Domestic Cruise $_{(fuel)}$)

The inventory agency estimated fuel consumption for the LTO and cruise phases of each domestic flight based on 37 aircraft types using fuel consumption emission factors from the Inventory Guidebook (EMEP/EEA, 2009). The fuel consumption for international LTOs is based on 136 aircraft types using fuel consumption emission factors from the Inventory Guidebook (EMEP/EEA, 2009). Tables C.14 and C.15 of Annex C outline the emission factors used for domestic and international LTOs for fuel, NO_x, HC and CO by aircraft type. Tables C.16 and C.17 of Annex C present implied emission factors (IEF) for fuel consumption, NO_x, HC and CO used in the LTO cruise phase of flights weighted by number of flights per airport.

3.6.2 Road Transport (NFR 1A3b)

The emissions of nine well-known pollutants (SO_2, NO_X, NMVOCs, NH_3, CO, TSP, PM_{10}, $PM_{2.5}$, BC) as well as seven heavy metals (Pb, Cd, Cu, Cr, Ni, Se, Zn) and POPs (Dioxins and Furans, PAHs) reported under sub-category 1.A.3.b Road Transport are estimated using the COPERT 4 v11.3 model (Gkatzoflias et al., 2012) developed within the CORINAIR programme for estimating a range of emissions from this important source.

The national total emissions in all cases are determined by the quantity of fuel sold in the country, as given by the energy balance. Approximately 58.13 petajoule (PJ) equivalent fuel energy from petrol, bioethanol, diesel, biodiesel and Liquefied Petroleum Gas (LPG) was consumed by road transport in Ireland in 1990. Consumption went up to 190.86 PJ in 2007 followed by a sharp decline to 145.88 PJ in 2012 and subsequently increasing to 160.38 PJ in 2015. The energy share in biofuel has continued to increase since of its introduction in 2005 and was 5.36 PJ in 2015 (0.05 PJ in 2005). It is known that significant proportions, e.g. 8.2% petrol and 6.1% diesel in 2015 of automotive fuels sold in Ireland are consumed outside the country (referred to as fuel tourism) and therefore separate estimates of emissions are produced on the basis of fuel amounts used within Ireland. For some countries, including Ireland, the national totals determined by fuels used are the basis for assessment of their performance in relation to relevant Protocols under CLRTAP. Annex A.3 outlines the methodology used to estimate the quantities of automotive fuels used in Ireland and includes the adjusted annual emissions for 1987 and the years 1990−2015. Compressed Natural Gas (CNG) as a fuel in road transport did not appear in the national balance until 2015; however, the amount of the fuel is very low. Approximately 0.0009 and 0.0005 terajoules (TJ) equivalent CNG fuel were sold in 2014 and 2015 for use in light duty vehicles in Ireland.

The emissions of SO_2 for road transportation are computed from the amounts of petrol and diesel used by motor vehicles, as reported in the energy balance, and the sulphur content of the fuels. For the other substances, the COPERT 4 v11.3 model estimates emissions on the basis of distance travelled using a detailed bottom−up approach (Tier 3) that accounts for such factors as fuel type, fuel consumption, engine capacity, driving speed and a wide range of applicable technological emission controls that may be applied across the different vehicle categories according to the age of vehicles. A total of 180 vehicle categories are determined by these variables in COPERT 4 v11.3. Figures C.1 through C.4 of Annex C show the trend in emission factors for NO_X, SO_2, NH_3 and NMVOCs per fuel type for road transportation over the period 1990−2015 determined by the COPERT variables for the vehicle fleet in Ireland. The methodologies for estimation of $PM_{2.5}$, PM_{10} and TSP were revised in this submission. In addition to the reporting of COPERT output of non-exhaust emission that includes brake and tyre wear emissions, road abrasion emissions for $PM_{2.5}$, PM_{10} and TSP were calculated and reported using emission factors from the Inventory Guidebook (EMEP/EEA 2016) and fuel adjusted mileage data from COPERT 4 v11.3 at the vehicle category level.

The primary model inputs for each year are the populations of vehicles in the relevant categories, their annual kilometres of travel in three selected speed classes, total fuel amounts and the fuel specifications. The numbers of vehicles are taken from annual bulletins of vehicle and driver statistics (DTTAS, 2016) and these are allocated to the different control technologies (Euro I, Euro II, etc.) on the basis of their age and the application dates of the controls in Ireland. Information to assign values of annual kilometres of travel for the three speed classes (corresponding to urban, rural and highway driving) used for the individual vehicle categories is taken from the National Roads Authority (NRA) and odometer records from the National Car Testing (NCT) and Commercial Vehicle Roadworthiness Test (CVRT) Service. Before the emissions are estimated in COPERT 4 v11.3, fuel balancing is undertaken in the model using inbuilt consumption rates for the different vehicle categories to ensure that the total fuel amounts calculated from annual kilometres and consumption rates for all vehicle categories match the input fuel quantities (the fuel sold as given in the energy balance or the fuel used as determined by Annex A.3) and therefore that emissions relate to the relevant total fuel amount. This fuel balancing may involve some adjustment to kilometres travelled or to the shares of total kilometres in the different road classes.

3.6.3 Railways (NFR 1A3c), National Navigation (NFR 1A3dii) and Other Transportation (NFR 1A3e)

The emissions under sub-categories 1A3c Railways and 1A3d National Navigation are calculated from the amounts of fuel used by these activities and the country-specific SO_x emission factors and default Inventory Guidebook (EMEP/EEA, 2013) emission factors for oil. No solid fuels have been used in railways since 1970. All emission factors for railways and navigation are given in Table C.20 of Annex C. These are minor sources of emissions in Ireland.

The emissions reported in sub-category 1A3e Other Transportation refer to the use of natural gas in pipeline compressor stations and emission factors (country-specific and default values) for this sub-category are given in Table C.21 of Annex C. The fuel use is estimated as the difference between the value given for natural gas under own use/losses in the energy balance sheets (Annex B) and the amount of gas estimated to be lost from the distribution network.

3.7 Other Sectors (NFR 1A4)

The NFR Subcategory 1A4 Other Sectors covers combustion sources in the Commercial/Institutional (1A4a), the Residential (1A4b), and Agriculture/Forestry/Fishing (1A4c) sectors. The Residential sector remains the most important source of emissions for the majority of substances in this subcategory in Ireland, while Agriculture/Forestry/Fishing is a major contributor to NO_X emissions, largely because of the influence of agricultural (off-road) machinery. The activity data for all 1A4 subcategories are taken directly from the energy balance. The emission factors for sub-category 1A4 Other Sectors are given in Tables C.22 through C.28 of Annex C.

3.7.1 Agriculture/Forestry/Fishing (NFR 1A4ci and ii)

This subcategory covers both stationary combustion (1A4ci) and mobile combustion (1A4cii) in Agriculture. The energy balance does not currently provide information on the end use of gasoil in agriculture. However, based on information received from agricultural experts, 90 per cent of total gasoil in the sector is assigned to mobile machinery with the remainder assigned to stationary combustion. For both stationary and mobile combustion, the emission factors used are presented in Table C.26 of Annex C.

Ireland utilises the Tier 2 approach outlined in the Inventory Guidebook (EMEP/EEA 2013) to estimate emissions of NO_x, NMVOC, CO, PM_{10}, $PM_{2.5}$ and TSP from mobile combustion in this sector. The Tier 2 emission factors are based on data from the Danish Inventory (Winther and Nielsen, 2006). The emission factors are grouped according to the EU emission legislation stages, and three additional layers are added to cover the emissions from engines prior to the first EU legislation stages. The country-specific SO_x emission factors and default Inventory Guidebook (EMEP/EEA, 2013) emission factors for NH_3 and BC are used for this sub-category. The implied emission factors are presented in Table C.27 of Annex C. Emission Factors for Heavy Metals and POPs are based on emission factors from the Inventory Guidebook (EMEP/EEA, 2013).

3.7.2 Agriculture/Forestry/Fishing: National Fishing (NFR 1A4ciii)

Emissions from this sub-category were reported for the first time in the 2013 submission. The national energy balance now includes marine diesel used in national fishing for the all years from 1990 to 2015. The emission factors used for this sub-category are country-specific (SO_x) and Inventory Guidebook (EMEP/EEA, 2013) default values for all other pollutants and are presented in Table C.28 of Annex C.

3.8 Fugitive emissions from Solid Fuels (NFR 1B1)

3.8.1 Coal mining and handling (1B1a)

Emissions from the NFR subcategory 1B1a Coal mining were reported for the first time in the 2015 submission. The national energy balance now includes coal mined in the years 1990 to 1995 when the last commercial coal mine was closed in Ireland. The emission factors used and the resulting time series of NMVOC, TSP, PM_{10} and $PM_{2.5}$ emissions are based on the Inventory Guidebook (EMEP/EEA, 2013) default values and are presented in Table 3.1.

Table 3.1. Fugitive Emissions from Coal mining and handling

Activity Data		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Coal mining	kt	25.00	1.00	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emission Factors															
Coal mining	kg NMVOC/t	0.80	0.80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Coal mining	kg TSP/t	0.09	0.09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Coal mining	kg PM_{10}/t	0.04	0.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Coal mining	kg $PM_{2.5}$/t	0.01	0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Emissions															
Coal mining	kt NMVOC	0.020	0.001	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal mining	kt TSP	0.002	0.000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal mining	kt PM_{10}	0.001	0.000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal mining	kt $PM_{2.5}$	0.000	0.000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

3.9 Fugitive emissions from Oil and Natural Gas (NFR 1B2)

3.9.1 Oil (NFR 1B2a)

The NFR Subcategory 1B2a is an important source of fugitive NMVOC emissions. Emissions of NMVOCs are estimated from two sources, Refining/Storage (1B2aiv) and Distribution of Oil Products (1B2av), using a simple default methodology. The emission factors from the Inventory Guidebook (2013) are used and the resulting time series of NMVOC emissions are presented in Table 3.2. Emissions of NMVOCs from these subcategories doubled in the period from 1990 to 2007 in line with the increases in crude oil throughput for the refinery and petrol distribution for the transport sector, but have since decreased due to the economic situation causing an overall decrease in most emissions.

Table 3.2. Fugitive Non-Methane Volatile Organic Compound Emissions

Activity Data		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Crude to refineries	kt	1,804.2	2,229.2	3,278.3	3,309.3	3,132.3	3,389.3	3,272.3	2,812.3	2,905.3	2,949.3	3,068.3	2,838.3	2,752.3	3,339.5
Petrol distribution	kt	885.0	1,037.0	1,493.0	1,710.8	1,736.6	1,770.6	1,688.1	1,536.5	1,387.5	1,314.0	1,194.8	1,124.4	1,064.5	1,009.1
Emission Factors															
Crude to refineries	kg/t	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Petrol distribution	kg/t	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Emissions															
Crude to refineries	kt	0.36	0.45	0.66	0.66	0.63	0.68	0.65	0.56	0.58	0.59	0.61	0.57	0.55	0.67
Petrol distribution	kt	1.77	2.07	2.99	3.42	3.47	3.54	3.38	3.07	2.77	2.63	2.39	2.25	2.13	2.02
Total emissions	kt	2.13	2.52	3.64	4.08	4.10	4.22	4.03	3.64	3.36	3.22	3.00	2.82	2.68	2.69

3.10 Recalculations in the Energy Sector

The results of recalculations for the combustion categories 1A1, 1A2, 1A3 and 1A4 are given in Tables 3.3 through 3.7 below.

Recalculations have been undertaken for the years 1990−2014 in the Energy sector (combustion and fugitive) to account for the following changes:

1A1 Energy Industries

- A revision to the energy balance for natural gas in 2015 in the petroleum refining, 1.A.1.b sub-category has resulted in a small recalculation for NMVOC and Hg. In addition, the decrease in SO_2 emissions in Public Electricity and Heat Production, 1.A.1.a sub-category for 2014 is attributable to a transcription error which occurred in the last submission.

1A2 Manufacturing Industries and Construction

- A revision in the energy balance for coal and natural gas for several sub-categories, e.g. Iron & Steel, 1.A.2.a; Non-metallic minerals, 1.A.2.f.; Other Industry Fuel, 1.A.2.g., etc. from 1990-2015 resulted in changes in the estimated emissions in almost every year in the time series. In addition, a correction in the energy conversion factors for several fuels also contributed to the recalculations, specifically in Cd, Hg and Pb emission figures.

1A3 Transport

- Recalculations are presented in tables 3.5 and 3.6 for 1. A. 3., Transport. However, the changes only occurred in 1.A.3. b., Road Transportation. Sulphur content in fuel for road transport was corrected in 2014 in addition to a revision of the bus and coach fleet. The inventory team found some evidence that Euro VI buses started penetrating the Irish fleet from 2014 and revised the fleet distribution for buses and coaches. In addition, an improvement in the adjustment of mileage with fuel, changed emissions slightly in 2008 to 2010 and 2012 to 2013.

1A4 Other Sectors

- A revision of the energy balance slightly changed fuel figures for diesel, natural gases and renewables in 2014 for 1.A.4., Other Sectors. However, the major changes in the recalculation in this sub category are attributed to the methodological improvement. Tier 2 emission factors for biomass were applied from EMEP/EEA (2013) that resulted in recalculation of NMVOC, Pb, Cd and Hg emissions in Commercial/Institutional, 1.A.4.a and Residential, 1.A.4.b subcategories. In addition, NAEI (2006) emission factors that were applied in Agriculture/Forestry/Fishing, 1.A.4.c for estimating Pb, Cd, Hg emissions from 1990 to 2014 were replaced by the emission factors from the Inventory Guidebook (EMEP/EEA, 2013). Recalculations are presented in table 3.7.

Table 3.3. Recalculations in Energy NFR 1A1

NFR Category	Pollutant	Unit	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016																
1A1a Public Electricity and Heat Production	NO_x	kt	46.37	41.39	39.72	32.33	32.38	29.87	27.33	22.02	13.32	11.52	8.00	10.30	8.57	7.54
	SO_2	kt	103.04	91.63	79.87	44.00	42.50	36.80	30.84	25.19	15.69	9.46	9.38	9.58	8.69	5.99
	NMVOC	kt	0.19	0.25	0.36	0.38	0.37	0.38	0.38	0.38	0.35	0.37	0.31	0.30	0.27	0.26
	Pb	t	0.63	0.75	0.78	0.66	0.73	0.64	0.57	0.54	0.45	0.44	0.44	0.54	0.47	0.48
	Cd	t	0.09	0.11	0.12	0.10	0.11	0.10	0.08	0.08	0.06	0.06	0.06	0.07	0.06	0.06
	Hg	t	0.12	0.13	0.13	0.12	0.13	0.12	0.11	0.11	0.09	0.09	0.09	0.11	0.09	0.10
1A1b Petroleum Refining	NO_x	kt	0.47	0.52	0.77	0.82	0.94	0.81	0.89	0.77	0.75	0.80	0.63	0.68	0.58	0.54
	SO_2	kt	0.75	0.58	0.78	0.70	0.91	1.03	1.03	0.98	0.88	0.67	0.90	0.43	0.57	0.57
	NMVOC	kt	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Pb	t	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
	Cd	t	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1c Manufacture of Solid Fuels and Other Energy Industries	NO_x	kt	0.08	0.06	0.07	0.13	0.10	0.11	0.10	0.11	0.13	0.11	0.08	0.09	0.11	0.09
	SO_2	kt	0.24	0.18	0.22	0.39	0.29	0.33	0.31	0.33	0.39	0.32	0.25	0.27	0.32	0.26
	NMVOC	kt	0.08	0.06	0.07	0.13	0.10	0.11	0.10	0.11	0.13	0.11	0.08	0.09	0.11	0.09
	Pb	t	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Submission 2017																
1A1a Public Electricity and Heat Production	NO_x	kt	46.37	41.39	39.72	32.33	32.38	29.87	27.33	22.02	13.32	11.52	8.00	10.30	8.57	7.54
	SO_2	kt	103.04	91.63	79.87	44.00	42.50	36.80	30.84	25.19	15.69	9.46	9.38	9.58	8.69	5.95
	NMVOC	kt	0.19	0.25	0.36	0.38	0.37	0.38	0.38	0.38	0.35	0.37	0.31	0.30	0.27	0.26
	Pb	t	0.63	0.75	0.78	0.66	0.73	0.64	0.57	0.54	0.45	0.44	0.44	0.54	0.47	0.48
	Cd	t	0.09	0.11	0.12	0.10	0.11	0.10	0.08	0.08	0.06	0.06	0.06	0.07	0.06	0.06
	Hg	t	0.12	0.13	0.13	0.12	0.13	0.12	0.11	0.11	0.09	0.09	0.09	0.11	0.09	0.10
1A1b Petroleum Refining	NO_x	kt	0.47	0.52	0.77	0.82	0.94	0.81	0.89	0.77	0.75	0.80	0.63	0.68	0.58	0.54
	SO_2	kt	0.75	0.58	0.78	0.70	0.91	1.03	1.03	0.98	0.88	0.67	0.90	0.43	0.57	0.57
	NMVOC	kt	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Pb	t	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
	Cd	t	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1c Manufacture of Solid Fuels and Other Energy Industries	NO_x	kt	0.08	0.06	0.07	0.13	0.10	0.11	0.10	0.11	0.13	0.11	0.08	0.09	0.11	0.09
	SO_2	kt	0.24	0.18	0.22	0.39	0.29	0.33	0.31	0.33	0.39	0.32	0.25	0.27	0.32	0.26
	NMVOC	kt	0.08	0.06	0.07	0.13	0.10	0.11	0.10	0.11	0.13	0.11	0.08	0.09	0.11	0.09
	Pb	t	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3.3. Recalculations in Energy NFR 1A1 (continued)

% Change in Emissions	Pollutant	Unit	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1A1a Public Electricity and Heat Production	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.7%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.3%	0.3%
	Pb	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Cd	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.5%	-0.1%	0.0%	0.0%
	Hg	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1A1b Petroleum Refining	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.3%
	Pb	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Cd	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%
	Hg	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.9%
1A1c Manufacture of Solid Fuels and Other Energy Industries	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Pb	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Cd	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Hg	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3.4 Recalculations in Energy NFR 1A2

NFR Category	Pollutant	Unit	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016 1A2 Manufacturing Industries and Construction	NO_x	kt	9.20	8.05	10.53	16.01	17.31	16.59	18.44	15.76	10.36	9.96	8.47	10.26	10.55	10.72
	SO_2	kt	31.93	38.06	37.56	11.41	11.97	8.49	8.94	7.85	5.07	5.85	5.23	4.36	4.85	3.26
	NMVOC	kt	2.27	1.86	2.72	3.34	3.86	3.88	3.78	3.53	3.13	3.31	3.16	3.08	3.17	3.67
	Pb	t	1.31	0.49	0.77	1.25	1.41	1.21	1.22	1.09	0.79	0.80	0.71	0.64	0.62	0.79
	Cd	t	0.02	0.06	0.09	0.12	0.16	0.16	0.15	0.13	0.13	0.14	0.13	0.12	0.13	0.16
	Hg	t	0.16	0.12	0.17	0.19	0.20	0.17	0.17	0.16	0.12	0.13	0.13	0.13	0.13	0.14
Submission 2017 1A2 Manufacturing Industries and Construction	NO_x	kt	8.93	8.05	10.53	16.01	17.31	16.59	18.45	15.77	10.37	9.96	8.48	10.43	10.55	10.73
	SO_2	kt	32.56	38.06	37.56	11.41	11.98	8.50	8.96	7.87	5.11	5.86	5.24	4.49	4.87	3.34
	NMVOC	kt	1.67	1.27	1.77	2.51	2.78	2.95	2.91	2.76	2.35	2.47	2.26	2.23	2.28	2.76
	Pb	t	1.31	0.49	0.77	1.25	1.41	1.21	1.22	1.08	0.79	0.80	0.71	0.69	0.62	0.79
	Cd	t	0.05	0.04	0.06	0.08	0.10	0.10	0.10	0.09	0.08	0.09	0.08	0.08	0.08	0.10
	Hg	t	0.09	0.04	0.06	0.09	0.10	0.09	0.09	0.08	0.06	0.06	0.06	0.06	0.06	0.06
% Change in Emissions 1A2 Manufacturing Industries and Construction	NO_x	kt	-3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	1.6%	0.0%	0.0%
	SO_2	kt	2.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%	0.7%	0.2%	0.3%	2.9%	0.3%	2.5%
	NMVOC	kt	-26.5%	-31.6%	-35.0%	-24.9%	-28.1%	-23.8%	-22.9%	-21.9%	-24.8%	-25.4%	-28.5%	-27.4%	-28.0%	-24.8%
	Pb	t	-0.1%	-0.3%	-0.3%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.2%	9.1%	-0.2%	-0.2%
	Cd	t	195.4%	-34.3%	-34.4%	-33.5%	-34.0%	-34.7%	-34.4%	-34.5%	-35.5%	-35.7%	-35.8%	-35.3%	-36.2%	-36.1%
	Hg	t	-44.6%	-64.3%	-63.3%	-54.4%	-51.7%	-49.2%	-47.1%	-47.8%	-51.4%	-52.2%	-56.1%	-54.6%	-57.9%	-54.1%

Table 3.5. Recalculations in Energy NFR 1.A.3 (a & b)*

NFR Category	Pollutant	Unit	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016																
1A3a(i) & (ii) International and Domestic Aviation	NO_x	kt	2.34	2.37	3.61	4.08	4.50	5.15	5.42	5.07	4.05	4.01	3.60	3.10	3.47	3.79
	SO_2	kt	0.35	0.38	0.59	0.70	0.81	0.93	0.98	0.92	0.72	0.74	0.66	0.55	0.64	0.71
	NMVOC	kt	0.22	0.20	0.28	0.32	0.30	0.32	0.35	0.32	0.26	0.24	0.24	0.20	0.21	0.22
1A3b Road Transportation	NO_x	kt	54.00	54.92	59.53	53.79	54.45	54.37	54.36	48.88	42.15	37.64	36.74	35.08	36.20	36.79
	SO_2	kt	5.39	5.14	1.66	1.35	0.54	0.54	0.35	0.14	0.05	0.04	0.04	0.04	0.04	0.04
	NMVOC	kt	34.66	33.04	23.16	16.26	15.25	13.83	12.60	11.32	9.80	8.49	7.69	6.86	6.36	5.78
	NH_3	kt	0.04	0.41	1.66	1.82	2.47	2.29	2.14	2.07	1.79	1.53	1.36	1.18	1.08	0.96
	Pb	t	109.16	67.17	11.37	12.21	12.85	13.13	13.58	13.71	12.81	12.08	11.53	10.66	10.22	9.76
	Cd	t	0.02	0.02	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04
	Hg	t	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
Submission 2017																
1A3a(i) & (ii) International and Domestic Aviation	NO_x	kt	2.34	2.37	3.61	4.08	4.50	5.15	5.42	5.07	4.05	4.01	3.60	3.10	3.47	3.79
	SO_2	kt	0.35	0.38	0.59	0.70	0.81	0.93	0.98	0.92	0.72	0.74	0.66	0.55	0.64	0.71
	NMVOC	kt	0.22	0.20	0.28	0.32	0.30	0.32	0.35	0.32	0.26	0.24	0.24	0.20	0.21	0.22
1A3b Road Transportation	NO_x	kt	54.00	54.92	59.53	53.79	54.45	54.37	54.36	48.74	42.42	38.23	36.74	35.03	36.03	36.59
	SO_2	kt	5.39	5.14	1.66	1.35	0.54	0.54	0.35	0.14	0.05	0.04	0.04	0.04	0.04	0.04
	NMVOC	kt	34.66	33.04	23.16	16.26	15.25	13.83	12.60	11.31	9.81	8.51	7.69	6.84	6.28	5.74
	NH_3	kt	0.04	0.41	1.66	1.82	2.47	2.29	2.14	2.07	1.79	1.53	1.36	1.18	1.06	0.96
	Pb	t	109.16	67.17	11.37	12.21	12.85	13.13	13.58	13.71	12.82	12.10	11.53	10.66	10.21	9.73
	Cd	t	0.02	0.02	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04
	Hg	t	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
% Change in Emissions																
1A3a(i) & (ii) International and Domestic Aviation	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1A3b Road Transportation	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%	0.7%	1.6%	0.0%	-0.1%	-0.5%	-0.5%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-4.3%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.1%	0.3%	0.0%	-0.2%	-1.2%	-0.7%
	NH_3	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.4%	-2.0%	0.3%
	Pb	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	-0.1%	-0.3%
	Cd	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.1%	0.2%	0.0%	0.0%	-0.1%	-0.3%
	Hg	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Emissions from both LTO and cruise are included here to capture all possible recalculations. However, the cruise component is reported as a memo item under the LRTAP Convention.

Table 3.6. Recalculations in Energy NFR 1A3 (c, d & e)

NFR Category	Pollutant	Unit	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016																
1A3c Railways	NO_x	kt	2.20	1.84	2.03	2.26	2.02	2.02	2.18	2.31	2.03	2.01	2.03	1.95	1.94	1.78
	SO_2	kt	0.25	0.14	0.12	0.12	0.11	0.11	0.11	0.05	0.06	0.06	0.06	0.06	0.05	0.02
	NMVOC	kt	0.20	0.16	0.18	0.20	0.18	0.18	0.19	0.21	0.18	0.18	0.18	0.17	0.17	0.16
	Pb	t	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1A3d(ii) National Navigation	NO_x	kt	2.14	2.29	3.78	5.59	5.20	6.12	4.83	5.01	4.88	4.90	4.25	4.49	4.39	5.50
	SO_2	kt	1.16	1.26	1.22	0.50	0.49	0.21	0.16	0.08	0.10	0.10	0.07	0.10	0.10	0.10
	NMVOC	kt	0.07	0.08	0.13	0.20	0.18	0.22	0.17	0.18	0.17	0.17	0.15	0.16	0.16	0.20
	Pb	t	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A3e(i) Pipeline Compressors	NO_x	kt	0.05	0.10	0.05	0.10	0.13	0.13	0.11	0.12	0.13	0.14	0.13	0.12	0.13	0.13
Submission 2017																
1A3c Railways	NO_x	kt	2.20	1.84	2.03	2.26	2.02	2.02	2.18	2.31	2.03	2.01	2.03	1.95	1.94	1.78
	SO_2	kt	0.25	0.14	0.12	0.12	0.11	0.11	0.11	0.05	0.06	0.06	0.06	0.06	0.05	0.02
	NMVOC	kt	0.20	0.16	0.18	0.20	0.18	0.18	0.19	0.21	0.18	0.18	0.18	0.17	0.17	0.16
	Pb	t	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1A3d(ii) National Navigation	NO_x	kt	2.14	2.29	3.78	5.59	5.20	6.12	4.83	5.01	4.88	4.90	4.25	4.49	4.39	5.50
	SO_2	kt	1.16	1.26	1.22	0.50	0.49	0.21	0.16	0.08	0.10	0.10	0.07	0.10	0.10	0.10
	NMVOC	kt	0.07	0.08	0.13	0.20	0.18	0.22	0.17	0.18	0.17	0.17	0.15	0.16	0.16	0.20
	Pb	t	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A3e(i) Pipeline Compressors	NO_x	kt	0.05	0.10	0.05	0.10	0.13	0.13	0.11	0.12	0.13	0.14	0.13	0.12	0.13	0.13
% Change in Emissions																
1A3c Railways	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Pb	t	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Cd	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Hg	t	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1A3d(ii) National Navigation	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Pb	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Cd	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Hg	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1A3e(i) Pipeline Compressors	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3.7. Recalculations in Energy NFR 1A4

NFR Category	Pollutant	Unit	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016																
1A4a Commercial/Institutional	NO_x	kt	3.06	2.84	3.16	3.02	3.30	3.13	3.24	3.56	3.11	3.12	2.86	2.88	2.68	2.45
	SO_2	kt	11.60	5.56	2.39	1.82	1.93	1.80	1.70	1.16	0.74	0.71	0.68	0.65	0.55	0.26
	NMVOC	kt	0.47	0.42	0.53	0.58	0.63	0.63	0.72	0.84	0.77	0.77	0.73	0.80	0.86	0.86
	Pb	t	0.18	0.03	0.02	0.15	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.00
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
1A4b Residential	NO_x	kt	7.38	5.82	5.45	5.71	5.94	5.84	5.66	6.13	6.16	6.36	5.44	5.18	5.37	4.77
	SO_2	kt	26.76	17.32	15.07	11.07	12.22	10.78	10.54	9.21	9.15	8.80	8.05	7.62	8.29	7.00
	NMVOC	kt	28.52	18.05	12.35	10.53	11.00	10.68	10.38	10.92	11.67	11.05	10.18	10.02	10.74	9.20
	Pb	t	7.40	4.67	3.20	2.72	2.84	2.75	2.64	2.80	2.96	2.80	2.59	2.52	2.71	2.31
	Cd	t	0.11	0.07	0.05	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.05	0.04
	Hg	t	0.32	0.26	0.25	0.28	0.28	0.29	0.27	0.30	0.29	0.31	0.26	0.27	0.27	0.24
1A4c Agriculture/Forestry/Fishing	NO_x	kt	8.70	14.28	12.99	13.00	12.88	11.69	10.63	10.40	8.69	7.55	6.69	6.35	5.71	5.01
	SO_2	kt	1.41	1.34	0.94	0.83	0.86	0.82	0.74	0.37	0.42	0.37	0.09	0.09	0.08	0.05
	NMVOC	kt	1.28	1.58	1.26	1.05	1.04	0.93	0.83	0.81	0.65	0.56	0.49	0.44	0.37	0.31
	Pb	t	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Submission 2017																
1A4a Commercial/Institutional	NO_x	kt	3.06	2.84	3.16	3.02	3.30	3.13	3.24	3.56	3.11	3.12	2.86	2.88	2.68	2.45
	SO_2	kt	11.60	5.56	2.39	1.82	1.93	1.80	1.70	1.16	0.74	0.71	0.68	0.65	0.55	0.26
	NMVOC	kt	0.47	0.42	0.53	0.58	0.62	0.61	0.65	0.71	0.60	0.62	0.54	0.57	0.56	0.53
	Pb	t	0.18	0.03	0.02	0.15	0.15	0.15	0.15	0.16	0.02	0.02	0.02	0.02	0.03	0.03
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	Hg	t	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
1A4b Residential	NO_x	kt	7.38	5.82	5.45	5.71	5.94	5.84	5.66	6.13	6.16	6.36	5.44	5.18	5.37	4.77
	SO_2	kt	26.76	17.32	15.07	11.07	12.22	10.78	10.54	9.21	9.15	8.80	8.05	7.62	8.29	7.00
	NMVOC	kt	28.52	18.05	12.35	10.53	10.99	10.65	10.18	10.78	11.38	10.75	9.97	9.73	10.46	8.93
	Pb	t	7.40	4.67	3.20	2.72	2.84	2.75	2.64	2.80	2.96	2.79	2.59	2.52	2.70	2.31
	Cd	t	0.11	0.07	0.05	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.05	0.04
	Hg	t	0.30	0.19	0.14	0.13	0.14	0.13	0.13	0.14	0.14	0.14	0.12	0.12	0.13	0.11
1A4c Agriculture/Forestry/Fishing	NO_x	kt	8.70	14.28	12.99	13.00	12.88	11.69	10.63	10.40	8.69	7.55	6.69	6.35	5.71	5.01
	SO_2	kt	1.41	1.34	0.94	0.83	0.86	0.82	0.74	0.37	0.42	0.37	0.09	0.09	0.08	0.05
	NMVOC	kt	1.28	1.58	1.26	1.05	1.04	0.93	0.83	0.81	0.65	0.56	0.49	0.44	0.37	0.31
	Pb	t	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3.7. Recalculations in Energy NFR 1A4 (continued)

% Change in Emissions	Pollutant	Unit	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1A4a Commercial /Institutional	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	-0.3%	-2.7%	-9.7%	-16.1%	-22.6%	-18.9%	-25.9%	-28.8%	-35.3%	-38.8%
	Pb	t	0.0%	0.0%	0.0%	0.0%	0.1%	0.8%	3.9%	7.6%	441.7%	405.8%	472.4%	527.9%	609.9%	651.7%
	Cd	t	0.0%	0.0%	0.0%	-0.2%	3.6%	30.3%	117.7%	202.3%	774.7%	756.7%	787.9%	810.5%	837.5%	849.2%
	Hg	t	0.0%	0.0%	0.0%	-0.6%	-0.7%	-0.9%	-0.2%	0.4%	1.2%	0.7%	1.4%	2.0%	3.0%	3.4%
1A4b Residential	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.3%	-1.9%	-1.3%	-2.5%	-2.7%	-2.1%	-2.9%	-2.6%	-2.9%
	Pb	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Cd	t	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%
	Hg	t	-8.7%	-23.8%	-42.4%	-52.7%	-52.0%	-53.5%	-53.1%	-54.4%	-51.8%	-55.7%	-52.7%	-54.6%	-53.3%	-53.9%
1A4c Agriculture/ Forestry /Fishing	NO_x	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
	SO_2	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
	NMVOC	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
	Pb	t	4940.0%	6461.9%	5114.1%	-48.0%	-48.0%	-48.0%	-47.9%	-47.8%	-47.9%	-47.8%	-47.7%	-47.8%	-47.9%	-47.9%
	Cd	t	14.6%	19.1%	15.1%	-12.1%	-10.6%	-10.1%	-9.9%	-8.3%	-9.0%	-7.7%	-6.8%	-7.7%	-9.5%	-10.0%
	Hg	t	760.0%	994.1%	786.8%	44.6%	43.6%	43.2%	43.1%	41.5%	42.2%	40.9%	39.7%	40.9%	42.7%	43.0%

3.11 Quality Assurance/Quality Control

The time series spreadsheet system developed for individual categories, together with direct linking to the energy balance, allows for simple and efficient checking of activity data, emission factors, annual emissions and aggregated totals. Year-on-year changes immediately highlight any omissions, anomalies or internal errors. Initial checks are conducted by the inventory compiler as part of the calculation process, which is followed by a second check and completion of the QA/QC sheets which are integral to the calculation workbooks by another member of the inventories team. Cross-checks are performed for fuel data against the available supplementary sources for particular categories, such as 1A1a Public Electricity and Heat Production and some industrial processes, while maintaining consistency with fuel-use application in the estimation of GHG emissions. When new versions of the COPERT model are introduced for calculations in 1A3b, the previous year's activity data is run in the new model to compare with the current year, and the current year's activity data is run in the old version of the model to compare with the previous year. This allows firstly for identification of changes due to the model, and secondly for identification of changes due to the activity data.

3.12 Planned Improvements

The nature of the substances covered in transboundary emission inventories and the diverse range of sources involved, many of which are unintentional or uncontrolled releases, inevitably result in estimates that can be highly uncertain. There is heavy reliance on default emission factors made available through the Inventory Guidebook or other references, which are often based on limited information or which can only be applied in a limited or aggregated way because the necessary detailed activity data are not available. For some substances and categories, the emissions must be estimated in an indirect way, such as on a per-capita basis, which adds further to level of uncertainty.

Notwithstanding these difficulties, there is scope for improvement in Ireland's transboundary emission inventories by updating emission factors using the information in the latest version of the Inventory Guidebook (EMEP/EEA, 2016) and by accounting more completely for technological improvements over time, which should be reflected in reduced emissions for the time series. This submission included many changes to emission factors based on the latest Inventory Guidebook and this work will continue in future submissions. The inventory agency plans to address these needs by attempting to apply Tier 2 emission factors that refer to different types of stationary combustion appliance for the fuels in common usage, especially in sub-categories 1A4a Commercial/Institutional combustion and 1A4b(i) Residential combustion. The inventory agency has set an inventory improvement priority to include CNG fuel in road transport in the next submission. The inventory agency will also endeavour to reduce the many remaining instances of the use of notation key "NE" by providing an estimate or concluding that the source category does not occur "NO" in future submissions.

3.13 Memo Items

The memo items of the NFR reporting format refer to activities for which the emissions are excluded from national totals. The use of fuels in domestic and international aviation (cruise phase) and marine bunkers are the most important of these activities. Some of the associated emissions, particularly from international aviation, are increasing very rapidly and it is therefore important that they are closely monitored for comparison with other sources and for the benefit of the international organisations that will have to develop control strategies for them in the future. The estimation of emissions for memo items is described here because they are calculated as part of the general estimation procedures for the Energy sector.

The national energy balance sheets include marine bunkers as a specific item and the emissions may be calculated directly. The approach used to for the cruise element of aviation is explained in Section 3.6.1 and this data is provided to SEAI for inclusion in the national energy balance.

Emission factors for international cruise aviation and navigation are documented in Tables C.19 and C.29 of Annex C.

Chapter Four Industrial Processes and Product Use

4.1 Overview of the Industrial Processes and Product Use (NFR 2) Sector

Details of emissions from Solvent and other product use (NFR 2D and 2G) can be found in Chapter Five of the IIR. This Chapter discusses emission estimates from all other categories within Industrial Processes and Product Use (NFR 2).

The Industrial Processes sector has historically not been a large source of emissions in Ireland. Indeed major industrial processes within the chemical sector and metal production that are common to many other developed countries have never been part of the economy in Ireland. Hence, many of the production processes within this sector are not relevant to the inventories of air pollutants in Ireland. Also of note is the fact that for a number of pollutants, it has not been possible to separate emissions from the combustion of fuel within industry and those associated with production processes. For all industries, fuel-based estimates of emissions have been collated and are reported under NFR Sector 1A2 (Manufacturing Industries and Construction). Where specific information is available in relation to process emissions as distinct from those associated with fuel combustion, they are reported under NFR Sector 2 (Industrial Processes and Product Use) and are discussed in this chapter. In the majority of these cases, process-specific information is sourced from Annual Environmental Reports, which form part of the reporting obligations under IPPC permits in Ireland. In some cases, production data (estimated and/or calculated) are also used where available.

Relevant subcategories under Mineral Products (2A), Chemical Industry (2B), Metal Production (2C) and Other Production Processes (2L) for which process emissions of various pollutants are reported under Industrial Processes and Product Use in Ireland are described in the following sections. Among these subcategories, Cement Production (2A1) is a key category for emissions of PCBs and Dioxins, accounting for 27.8 and 5.7 per cent, respectively, of the pollutants' national total emissions in 2015.

4.2 Mineral Products (NFR 2A)

The industrial processes for which estimates are included in Ireland's air pollution inventory under NFR 2.A are as follows:

2.A.1 Cement Production
2.A.2 Lime Production
2.A.3 Glass Production
2.A.6 Other mineral products

4.2.1 Cement Production (NFR 2A1)

Cement manufacture is a major mineral industry. During cement manufacture, raw materials, such as limestone, are finely ground and then transformed in a kiln at high temperatures (calcination) to produce clinker. Gypsum is then blended with clinker to produce cement. The combustion process in the cement kiln is an integral part of the production process, where the fuel ash becomes part of the cement clinker. It is therefore not possible in most cases to distinguish the process and combustion emissions from one another. As a result, because most of the pollutants originate from the fuels used, all emissions are generally reported under NFR Category 1A2f (Non-metallic minerals). The above is certainly true of all pollutants in Ireland's air pollutant inventory, with the exception of PCDD/F and PCBs, which are reported under Category 2A1 and are discussed in the following paragraphs.

There are at present four cement plants in Ireland, all of which use the dry kiln process, and they are currently fuelled by coal, petroleum coke and fuel oil, while a small amount of meat and bone-meal is used at one plant. Literature sources, in particular the UNEP Toolkit (2005) and the Inventory Guidebook (2006), provide some POP emission factors on an overall "per unit production basis" (per capita). These emission factors have been used to determine the total emissions from cement plants. Fuel-use data are available from plant operators as part of their reporting requirements under the EU ETS (Directive 2003/87/EC). Emissions from fuel use are calculated using combustion emission factors, while process emissions are calculated as the difference between the fuel-based estimates and the "per unit production" emission estimates.

Emission factors from the UNEP Toolkit (2005) and the Inventory Guidebook (EMEP/CORINAIR, 2006) for releases of PCDD/F to air range from 0.05 to 5 µg I-TEQ/t of cement produced, depending on the operating conditions and standards of abatement at production plants. As a result, plant-specific PCDD/F emission factors per unit production have been used to estimate total PCDD/F emissions from the industry in Ireland. The fuel-use data have been used to estimate the PCDD/F emissions from fuel combustion reported in subcategory 1A2f. The differences between fuel-based and per-unit-production-based values are reported under Sector 2A1 and these estimates range from 0.9 to 2.5 g I-TEQ across the time series. In 2015 at 1.51 g I-Teq this sector accounted for 5.7 per cent share of the total PCDD/F emissions, having decreased by 19.3 per cent since 1990 (1.87 I-Teq). Emissions for the time series are presented in Table 4.1.

There are limited data available on emission factors for PCBs from cement production, and uncertainties associated with the data are large, although cement production is unlikely to create significant emissions of PCBs under steady operation. Nevertheless, the Inventory Guidebook (EMEP/CORINAIR, 2006) provides an emission factor of 1 µg/t of cement produced, and this factor has been adopted for the inventory across all years. Electrostatic precipitators (ESPs) are typically used to abate emissions from cement kilns due to the high running temperatures of the kilns (in excess of 1,500°C). While this form of abatement works well for PCDD/F, this is not the case with PCBs or PAHs. Thus, it has been decided that the Inventory Guidebook emission factor should be used for all years without amendment. As for PCDD/F, fuel-use data have been used to estimate the fuel-combustion-derived PCB emissions, which are reported in Subcategory 1A2f. The differences in emissions between fuel-based estimates and per unit production estimates are reported under Category 2.A.1. In 2015 at 4.74 kg this sector accounted for 27.8 per cent share of the total PCB emissions, meaning these emissions have more than trebled since 1990 (1.07 kg). These emissions are presented in Table 4.1 (non-fuel emissions).

Table 4.1. Emission Time Series for Dioxins and Furans and Polychlorinated Biphenyls from Cement Production

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PCDD/F (g I-TEQ)	1.871	1.862	1.258	0.925	0.914	0.910	1.024	1.421	1.507	1.577	1.564	1.637	1.526	1.509
PCBs (g)	1.070	1.064	2.259	3.363	3.365	3.399	2.962	1.958	1.743	1.546	1.861	2.194	4.074	4.736

4.2.2 Lime Production (NFR 2A2)

The lime production process involves the grinding and "burning" of limestone ($CaCO_3$) to produce what is commonly termed "quicklime" (CaO). It can then be further treated by the addition of water, a process called slaking, to produce slaked lime (CaOH), which generates large amounts of heat and steam. The finished product can then be packaged and distributed for use. Currently, there are two lime plants in Ireland and a third that operated until 1999. It is understood that all three utilised limestone quarries and kilns to burn the limestone raw material. The nature of the fuel used and the abatement in place varies from plant to plant.

Process emissions from lime production are derived following the approach taken for the estimation of emissions from Cement Production (2A1) described in section 4.2.1, whereby process emission estimates are obtained as the difference between total emissions on a “per unit production” basis and those estimated from fuel combustion. In this case, it was found that fuel combustion estimates of emissions were generally larger than those estimated on a “per unit production” basis and therefore all emissions from lime production are assumed to be included in those reported within Sector 1A2f.

4.2.3 Glass Production (NFR 2A3)

The manufacture of glass was not a predominant industry in Ireland, being limited to three sectors: lead crystal, container glass, and glass wool. The only container glass plant closed in 2002, one of the lead crystal plants closed in early 2006, the glass wool plant closed in 2008 and the last one, (second of the two) lead crystal plant closed down in 2009. The pollutants for which process emission estimates have been made are particulate matter (TSP, PM_{10}, $PM_{2.5}$, BC) priority metals (Pb, Cd and Hg), other metals (As, Cr, Cu, Ni, Se and Zn), and PCDD/F. In addition, fuel-derived emissions from the glass industry are already accounted for within the Manufacturing Industries and Construction (1A2) sector.

Metal emissions can occur from glass processes from the metals contained in fossil fuels burnt to melt the glass and from metal additives to the glass. Metal emissions from industry fossil fuel use are accounted for within NFR Sector 1A2g (Other Manufacturing Industries). The metals emitted from glass production processes depend on the type of glass produced. Lead oxide and sometimes arsenic trioxide are used in the production of lead crystal glass and both metals can be emitted to air. Selenium and chromium compounds are used as colouring agents for container glass. Metal compounds are not believed to be used to any great extent in the production of glass wool. Of the glass processes outlined, all of the plants were regulated under Integrated Pollution Prevention Control IPPC licences. Therefore, there is some information available from their AERs until they closed down. Other licence information includes some details of plant design and operation, including capacities, fuel types and operating hours. In addition, confidential information in relation to production statistics has also been supplied to the inventory team.

Emission data for individual metals reported in AERs are limited to Pb emissions from the two lead crystal installations. These data have been used to estimate emissions of Pb from lead crystal production, while emission factors are used for the other glass processes. Literature emission factors are used from the Inventory Guidebook (EMEP/EEA, 2013) and, where deemed more appropriate, emission factors from the UK National Atmospheric Emissions Inventory (NAEI) database. The emission factors used are presented in Table D.1, Annex D. Total emissions for each metal from glass production are presented in Table 4.2.

Emission estimates from particulate matter were included in the inventory for the first time in this submission. The methodology uses confidential production data and emission factors from the Inventory Guidebook (EMEP/EEA 2013). The emission factors used are presented in Table D.1, Annex D.

The potential for PCDD/F emissions from glass production is generally low because of the long residence times in high-temperature conditions, although chlorine can be introduced via fuels and raw materials, and therefore there is some potential for PCDD/F emissions.

However, in the plants in Ireland, the main energy sources used were gas and electricity, and therefore PCDD/F emissions from fuel combustion were likely to be low. The information on abatement technology is uncertain for the glass manufacturing plants in Ireland. The URS Dames & Moore (2000) PCDD/F inventory report implies that one furnace would be fitted with abatement by 2005, but it is assumed that this is the large facility that closed in 2002. IPPC licence information implies that the environmental performance at the glass wool plant was improved in 1999, but the nature of the improvements is not clear.

Emission factors for PCDD/F are provided in the UNEP Toolkit (2005) for two different classes of facility: 0.2 µg I-TEQ/t of glass produced for a facility with no dust control, and 0.015 µg I-TEQ/t of glass produced for a facility with abatement. However, there have been improvements in environmental performance; therefore, the emission factor of 0.2 µg I-TEQ/t is used to estimate emissions in 1990, with a linear decrease to 0.11 µg I-TEQ/t in 2000 (URS Dames & Moore, 2000) and with a subsequent decrease to 0.015 µg I-TEQ/t by 2003 (when the container plant had closed) and remaining at this level up to 2009 when the last plant ceased its operation. Dioxin and furan emission estimates for glass production are presented in Table 4.2.

Table 4.2. Emission Time Series from Glass Production

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TSP (t)	22.56	22.56	21.88	6.01	6.21	6.07	5.08	0.01	NO	NO	NO	NO	NO	NO
PM10 (t)	20.08	20.08	19.48	5.30	5.47	5.35	4.47	0.01	NO	NO	NO	NO	NO	NO
PM2.5 (t)	17.68	17.68	17.15	4.67	4.82	4.71	3.94	0.01	NO	NO	NO	NO	NO	NO
BC (t)	0.10	0.10	0.09	0.09	0.10	0.09	0.08	0.00	NO	NO	NO	NO	NO	NO
As (kg)	17.57	17.57	17.55	0.18	0.18	0.18	0.15	NE	NO	NO	NO	NO	NO	NO
Cd (kg)	7.44	7.44	7.41	0.25	0.26	0.25	0.21	NE	NO	NO	NO	NO	NO	NO
Cr (kg)	23.90	23.90	23.69	1.77	1.85	1.80	1.50	NE	NO	NO	NO	NO	NO	NO
Cu (kg)	1.70	1.70	1.49	1.77	1.85	1.80	1.50	NE	NO	NO	NO	NO	NO	NO
Pb (t)	310.77	310.77	310.55	128.90	88.52	96.78	96.46	7.91	NO	NO	NO	NO	NO	NO
Hg (kg)	0.58	0.58	0.51	0.60	0.63	0.61	0.51	NE	NO	NO	NO	NO	NO	NO
Ni (kg)	18.46	18.46	18.25	4.00	3.36	3.46	3.16	0.14	NO	NO	NO	NO	NO	NO
Se (kg)	90.11	90.11	90.10	0.12	0.12	0.12	0.10	NE	NO	NO	NO	NO	NO	NO
Zn (kg)	33.47	33.47	31.07	33.57	30.32	30.63	27.13	0.80	NO	NO	NO	NO	NO	NO
PCDD/F (g I-TEQ)	0.54	0.39	0.26	0.01	0.01	0.01	0.01	0.00	NO	NO	NO	NO	NO	NO

4.2.4 Other (NFR 2A6)

The industrial processes included within NFR Sector 2A6 are Bricks and Ceramics Production and Asphalt Production. Each of these subcategories is described in the following sections in terms of the pollutants for which emission estimates are made.

4.2.4.1 Bricks and Ceramics Production

The production of bricks and ceramics is a small sector in Ireland with a total of four IPPC-licensed facilities in operation. Emission estimates are only made for PCDD/F as there are no data available in relation to process emissions of other pollutants and, furthermore, they are expected to be negligible (AEA/CTC, 2008). Direct production information in relation to the bricks and ceramics sector is not available; however, raw material input data are provided by the companies under the EU ETS. For the purposes of inventory estimates, as a worst-case scenario it is assumed that raw material input equals product output. Emission factors are sourced from the UNEP Toolkit (2005) in which two classes of facility are suggested: 0.2 µg I-TEQ/t of brick produced for a facility with no dust control and 0.02 µg I-TEQ/t of brick produced for a facility with abatement. The URS Dames & Moore (2000) report suggests an emission factor of 0.11 µg I-TEQ/t, which is the average of the two emission factors, and this value, has been used across the time series. The UNEP Toolkit (2005) does not include emission factors for ceramics production and therefore the emission factor for bricks is also applied to ceramics production. Dioxin and furan emission estimates for bricks and ceramics production are presented in Table 4.3.

Table 4.3. Dioxin and Furan Emission Time Series from Bricks and Ceramics Production

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bricks production PCDD/F (mg I-TEQ)	12.14	13.02	15.38	15.34	14.34	12.90	7.00	1.80	1.74	2.48	0.08	0.07	NO	1.62
Ceramics production PCDD/F (mg I-TEQ)	NO	NO	NO	0.032	0.061	0.049	0.043	NO	NO	NO	NO	NO	NO	NO

4.2.4.2 Asphalt Production

In the context of this inventory, the term "asphalt" is used to describe a bituminous product that may contain varying amounts of aggregate, used to build and maintain roads, whilst "bitumen" is assumed to be a heavy oil tar product which is used at elevated temperatures particularly in roofing materials for some buildings. Currently, only PCDD/F emission estimates from asphalt are included in Ireland's air pollution inventory.

Information in relation to the production of asphalt in Ireland is sourced from the European Asphalt Pavement Association (EAPA), which generates an annual report outlining the quantity and end use of asphalt produced in European countries. Production data are available from 1994 onwards, with pre-1994 production estimates assumed to be equal to those in 1994. The production levels until 2006 show an upward year-on-year trend due to increased road building in Ireland, from 2007 the trend has been decreasing.

In Ireland, bag filters were fitted to most asphalt production facilities prior to 2000 and it was suggested that all facilities would have bag filters by 2001 (URS Dames & Moore, 2000). The UNEP Toolkit (2005) gives a range in emission factors of 0.007 to 0.07 µg I-TEQ/t asphalt produced. Given the above information, the emission factor for PCDD/F from asphalt production of 0.07 µg I-TEQ/t is adopted for 1990. A linear decrease in the emission factor is then assumed to 0.039 µg I-TEQ/t by 2000, and a further linear decrease is assumed to 0.007 µg I-TEQ/t by the end of 2002. The emission factor is assumed to be 0.007 µg I-TEQ/t from 2003 and onwards. Dioxin and furan emission estimates for asphalt production are presented in Table 4.4.

Table 4.4. Dioxin and Furan Emission Time Series from Asphalt Production

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PCDD/F (mg I-TEQ)	133.0	92.2	111.7	23.8	24.5	23.1	19.6	23.1	16.1	12.6	13.3	16.1	12.6	12.6

4.3 Chemical Industry (NFR 2B)

The chemical industry is not a dominant industry in Ireland in relation to industrial processes and is not an important source of emissions. The two sources of emissions for which estimates are collated are NO_x emissions from Nitric Acid Production for some years and PM emissions from fertiliser storage, handling and transport.

4.3.1 Nitric Acid Production (NFR 2B2)

Nitric acid is used as a raw material mainly in the manufacture of nitrogen-based fertiliser. It may also be used in the production of adipic acid and explosives, for metal etching, and in the processing of ferrous metals. In the manufacture of nitrogenous fertilisers, the Haber Bosch process is utilised in which NH_3 is made by combining nitrogen from the air with hydrogen from natural gas and water, using the energy from the gas and a catalyst. Nitric acid is produced by burning (oxidising) the NH_3 over a catalyst. The nitric acid is combined with more NH_3 to produce ammonium nitrate, which is solidified into granules or bead-like prills for application to land using a fertiliser spreader. Up to its closure in 2002, there was one such plant in Ireland, which utilised the above process to produce calcium ammonium nitrate and other nitrogenous fertiliser blends. The inventory agency received direct correspondence from the plant in relation to the quantities of nitric acid produced and the measured emissions of NO_X. Emission estimates and associated activity data for NO_X emissions from nitric acid production are presented in Table 4.5. Abatement measures were installed at the plant in the mid-1990s and they are reflected in emission estimates from 1995.

Table 4.5 Nitrogen Oxides Emission Time Series from Nitric Acid Production

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Nitric acid (kt)	338.8	260	260	260	260	260	260	260	260	260	260	260	130
NO_x (kt)	1.680	1.672	1.823	0.960	0.280	0.280	0.280	0.280	0.280	0.280	0.303	0.374	0.187

4.3.2 Storage, Handling and Transport of Chemical Products (NFR 2B10b)

Emissions of TSP, PM_{10}, and $PM_{2.5}$ from the storage, handling and transport of chemical products (fertilisers) are estimated in Ireland's air pollutant inventory utilising national data on total fertiliser use in the country multiplied by an emission factor (Inventory Guidebook Tier 1 methodology). Following the closure of fertiliser manufacturing plants as part of the overall rationalisation of the sector post-2000, all fertiliser is now imported into Ireland either as a finished product or is further blended. National fertiliser sales data are available from Ireland's Department of Agriculture and Food. Inventory Guidebook emission factors of 100 g/t, 32 g/t and 4 g/t are then applied to estimate emissions of TSP, PM_{10} and $PM_{2.5}$, respectively. Emission estimates and associated activity data for particulate emissions from the storage and handling of fertilisers are presented in Table 4.6.

Table 4.6. Particulate Matter Emission Time Series from the Storage, Handling and Transport of Fertilisers

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fertilizer (kt)	1793	1921	1730	1479	1396	1330	1242	1172	1424	1204	1231	1487	1403	1395
TSP (kt)	0.179	0.192	0.173	0.148	0.140	0.133	0.124	0.117	0.142	0.120	0.123	0.149	0.140	0.140
PM10 (kt)	0.057	0.061	0.055	0.047	0.045	0.043	0.040	0.038	0.046	0.039	0.039	0.048	0.045	0.045
PM2.5 (kt)	0.007	0.008	0.007	0.006	0.006	0.005	0.005	0.005	0.006	0.005	0.005	0.006	0.006	0.006

4.4 Metal Production (NFR 2C)

This category includes a wide range of processes such as primary and secondary iron and steel production, aluminium production and other non-ferrous production. In this category, emissions are estimated for the following subcategories and pollutants:

2C1 Iron and Steel Production – As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn, PCDD/F;
2C2 Ferroalloys Production – As, Cd, Cr, Ni, Pb, Zn, HCB;
2C3 Aluminium Production – Zn;
2C5 Lead production – Pb;
2C7 Other metal production – Cd, Cr, Cu, Ni, Pb, Zn;

Ireland is a major European producer of Zn and Pb ores. The preparation of Pb and Zn concentrates does not produce emissions and the concentrates are exported for further processing.

4.4.1 Iron and Steel Production (NFR 2C1)

This sector covers the manufacture of iron and steel, an energy-intensive process likely to generate high emissions to air from the use of furnaces and sintering processes, as well as the manual handling of the raw material to finished goods, which can include hot and cold rolling, and turning, temping and cutting of metal to reach a desired end product. Steel production in Ireland has been limited to a single large electric arc furnace installation, which closed in 2001 but was operational throughout the period 1990−2001. One small foundry remained in operation contributing with negligible amount of emissions after the large plant's closure. The main plant produced up to 360 kt of steel per annum mainly from recycled scrap steel. It received an IPPC licence to operate just months before its closure, therefore no AERs were filed by the plant. However, some emission testing was carried out with respect to heavy metal emissions as part of its licence application.

Heavy metal emission estimates have been calculated using the aforementioned emission testing results for Cd, Cr, Pb, Ni and Zn, whilst for the remaining pollutants (i.e. As, Cu, Hg, and Se) Inventory Guidebook (EMEP/EEA, 2013) emission factors have been used, assuming no abatement at the plant. The emission factors used are presented in Table D.3, Annex D. Emission estimates for the 1990−2001 time series are shown in Table 4.8. Metal production data are available from the site for the period 1994−2001, with pre-1994 production assumed to be equal to that in 1994. Emission estimates are calculated by multiplying the production data by the relevant pollutant emission factor and assume that no abatement was in place at the plant.

Table 4.7. Emission Time Series from Iron and Steel Production

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
As (t)	0.130	0.117	0.103	0.130	0.106	0.124	0.136	0.135	0.143	0.134	0.144	0.060	NO
Cd (t)	0.216	0.194	0.170	0.216	0.176	0.205	0.226	0.223	0.237	0.222	0.239	0.099	NO
Cr (t)	1.428	1.284	1.126	1.428	1.165	1.358	1.494	1.476	1.568	1.467	1.577	0.657	NO
Cu (t)	0.023	0.021	0.018	0.023	0.019	0.022	0.024	0.024	0.025	0.023	0.025	0.011	NO
Pb (t)	1.753	1.576	1.382	1.753	1.430	1.667	1.834	1.812	1.925	1.802	1.936	0.807	NO
Hg (kg)	32.60	29.30	25.70	32.60	26.60	31.00	34.10	33.70	35.80	33.50	36.00	15.00	NO
Ni (t)	2.694	2.421	2.124	2.694	2.198	2.562	2.818	2.785	2.958	2.768	2.975	1.240	NO
Se (t)	0.007	0.006	0.005	0.007	0.005	0.006	0.007	0.007	0.007	0.007	0.007	0.003	NO
Zn (t)	27.75	24.94	21.87	27.75	22.64	26.38	29.02	28.68	30.47	28.51	30.64	12.77	NO
PCDD/F (g I-TEQ)	0.743	0.891	0.783	0.990	0.810	0.942	1.035	1.023	1.086	1.017	1.092	0.462	0.012
PCBs (kg)	0.619	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
B[a]p (t)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Electric arc furnaces are significant sources of POPs. The overall approach to report emissions of POPs from the iron and steel category has been to account for emissions from fuel combustion within Sector 1A2a, with the process emissions reported (where possible) under Sector 2C1, which have been estimated using the approach described with respect to Cement Production (2A1). Emission factors based on per unit production were used to calculate initial estimates of total emissions. These factors are sourced from the Inventory Guidebook (2013). The difference between estimates determined on this basis and those reported for fuel combustion sector 1A2a is then reported in sector 2C. Emission estimates for the sector are presented in Table 4.7 for PCDD/F.

4.4.2 Ferroalloys Production (NFR 2C2)

This sector covers a number of secondary sites engaged in iron and steel manufacture. Two types of installation are distinguished. The first type covers installations involved in the manufacture of ductile iron for use in street furniture, public benches, waste bins and manhole covers, and the second is the manufacture of cast iron for appliances. The process of creating ductile iron utilises electric arc furnaces to smelt the raw materials, iron and magnesium. In the manufacture of cast iron, ferrous and non-ferrous metals, including scrap metal, are used within the process. Since 1990, there have been three relevant facilities in Ireland. Due to a change in operations, one of these plants reported negligible emission estimates from 2003 onwards; one facility closed in 2014 leaving a single operating facility from 2014 onwards.

A number of the larger metal processing sites are regulated under IPPC. Some metal emission estimates and particulate emission estimates have been reported in AERs; however, not all installations report emissions in all years. In some cases, only production data and emissions of TSP are available. Where production data only were provided by the plant operator, they were used to calculate emissions of TSP using USEPA factors for dust emissions from abated/unabated iron foundry cupola processes. Estimates for metal emissions were then obtained from the TSP estimates based on Inventory Guidebook (EMEP/EEA, 2013) dust composition data for foundry dust. Abatement techniques are also taken into account in emission calculations at a plant-specific level, where this applies. Emission estimates of HCB for the time series 1990-1996 are presented in Table 4.8.

Estimates for TSP, PM_{10}, $PM_{2.5}$ and BC were made for the first time in this submission. TPM data reported in AERs were used to estimate emissions from TSP. Fractionation profiles based on the emission factors within the Inventory Guidebook (EMEP/EEA, 2013) were used to estimate PM_{10}, $PM_{2.5}$ and BC emissions.

The only source of HCB is the secondary manufacture of aluminium, for which the Inventory Guidebook (EMEP/EEA, 2013) indicates a factor of 5 g/t of aluminium. This factor has been used to estimate HCB emissions across the time series until use of the HCE-based cover gas was banned in 1996 and emissions are reported as not occurring for years after 1996.

Where production data are not available, TSP estimates have been used to estimate metal production across the time series using the BiPRO waste report (2005), Other POPs like PCDD/F, PCB and PAHs are reported under fuel combustion sector 1A2b. The HCB emission factor used is presented in Table D.3, Annex D, and process emission estimates for the 1990-1996 time series are presented in Table 4.8.

Table 4.8. Emission Time Series from Ferroalloys Production

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TSP (t)	70.57	70.57	5.57	1.32	1.69	1.03	1.02	1.93	1.28	0.66	0.29	0.64	NO	NO
PM10 (t)	59.99	59.99	4.74	1.12	1.43	0.88	0.86	1.64	1.09	0.56	0.24	0.54	NO	NO
PM2.5 (t)	42.34	42.34	3.34	0.79	1.01	0.62	0.61	1.16	0.77	0.39	0.17	0.38	NO	NO
Cr (t)	0.252	0.252	0.019	0.005	0.005	0.004	0.004	0.007	0.004	0.002	0.001	0.002	NO	NO
As (t)	0.069	0.069	0.005	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.000	0.001	NO	NO
Cd (t)	0.033	0.033	0.003	0.001	0.001	0.000	0.001	0.001	0.008	0.000	0.000	0.000	0.000	0.000
Ni (t)	0.115	0.115	0.008	0.002	0.002	0.002	0.002	0.003	0.002	0.001	0.000	0.001	NO	NO
Pb (t)	1.712	1.712	0.183	0.031	0.035	0.024	0.023	0.047	0.035	0.016	0.007	0.015	0.000	0.000
Zn (t)	1.407	1.407	0.345	0.022	0.036	0.027	0.022	0.040	0.041	0.011	0.005	0.011	0.000	0.000
PCDD/F (g I-TEQ)	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
HCB (kg)	40.000	40.000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
PCBs (kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B[a]p (t)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

4.4.3 Aluminium Production (NFR 2C3)

Ireland is an important producer of alumina at one large plant using the Bayer process (extraction of AlO_3 using NaOH). The production of alumina using the Bayer process gives rise to significant metal emissions and therefore process emissions are not estimated for this source. Ireland has some secondary aluminium processing for which estimates of Zn have been made following reports from the plant involved. The plant closed in late 2006 and therefore estimates are only provided for the 1990−2006 time series as presented in Table 4.9. Production data for the plant are not available and therefore estimates were made using PM as an indicator. The UK NAEI emission factor of 2.725 g/t is then applied (Table D.3, Annex D).

Table 4.9. Emission Time Series for Zinc from Aluminium Production

Year	1990	1995	2000	2001	2002	2003	2004	2005	2006
Zn (t)	0.029	0.029	0.029	0.029	0.043	0.019	0.026	0.011	0.011

4.4.4 Lead Production (NFR 2C5)

A significant quantity of Lead is mined in Ireland, but such mining is assumed not to be a significant source of emissions to air. Estimates at facility level of Lead emissions have been obtained from AERs. Emission estimates for the time series are presented in Table 4.10 and are reported as not occurring since 2009.

Table 4.10. Emission Time Series for Lead Production

Pollutant (unit)	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Pb (kg)	7.845	7.845	7.845	7.845	0.018	0.008	0.013	0.006	0.025	0.034	0.030	**NO**

4.4.5 Other Metal Production (NFR 2C7)

This category covers all other metal manufacture and manipulation, including any emissions from the mining of raw materials. A significant quantity of Zn is mined in Ireland, but such mining is assumed not to be a significant source of emissions to air. Ireland has a number of small aluminium casting companies in addition to facilities for wire manufacture and the manufacture of refined or secondary Pb and Cu products, as well as a number of Zn galvanising plants.

Estimates at facility level of the heavy metals Cd, Cr, Cu, Ni, Pb and Zn have been obtained from AERs with respect to these secondary metal operations. Emission estimates for the time series are presented in Table 4.11. Emissions arise from very few plants in the latter parts of the time series, and are therefore very sensitive to changes in activity of individual plants.

Table 4.11. Emission Time Series for Non-Ferrous Metal Production

Pollutant	Units	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cd (kg)	kg	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	NO	0.20	0.20	0.20	0.20	0.20
Cr (kg)	kg	15.00	211.00	211.00	256.33	194.49	0.08	0.06	0.07	NO	NO	NO	NO	NO	NO
Cu (kg)	kg	3.18	3.18	3.18	22.27	7.92	25.51	0.61	NO	NO	NO	NO	NO	NO	NO
Pb (kg)	kg	0.15	0.15	0.15	9.85	0.46	3.75	3.11	0.02	NO	0.30	0.30	0.40	0.41	0.30
Ni (kg)	kg	82.00	82.00	82.00	4.97	3.98	40.69	0.13	NO	NO	NO	NO	NO	NO	NO
Zn (kg)	kg	233.00	233.00	233.00	121.28	172.26	103.38	18.98	4.34	3.10	0.30	0.30	22.35	1.50	0.30

Process emissions of POPs (where applicable) are included in combustion emissions and reported as included elsewhere (IE) for category 2C7.

4.5 Other production, consumption, storage, transportation or handling of bulk product (NFR 2L)

The Other production, consumption, storage, transportation or handling of bulk product category in Ireland's air pollutant inventory includes emissions of PCDD/F and PCBs from leakage from electrical equipment and emissions of PCBs from fragmentisers and shredders. The main use of PCBs since the 1970s, when open uses were banned, has been as dielectric fluids in electrical equipment such as transformers and capacitors. However, the production and use of dielectric fluid containing PCBs has been highly regulated since 1986. Releases to the environment have decreased since 1990 as older PCB-containing equipment is taken out of service and is replaced by PCB-free equipment, which reduces the stocks that may lead to PCB emissions. It is also taken into consideration that, in some cases, trace PCDD/F may be present in PCB dielectric fluid. These arise from the original PCB synthesis process and from oxidation during dielectric breakdown events.

Electrical equipment, including white goods and electronic equipment, is partly recycled by breaking down the products in fragmentisers and shredders. Fragments are separated into ferrous scrap, a fraction containing non-ferrous scrap (which would then be processed separately), and a waste fraction that is typically disposed to landfill. Polychlorinated biphenyls are present in the capacitors of old electrical equipment. Hence, there is potential for PCBs to be released to air during fragmentiser operations.

4.5.1 Leakage from Electrical Equipment (NFR 2L)

The release of PCBs to the environment from electrical equipment is very difficult to estimate with any accuracy due to the large number of components potentially containing PCBs, the range of lifetime and replacement rates for PCB components, and the difficulties for users in identifying such components. Polychlorinated biphenyls have never been manufactured in Ireland. Production ceased in the UK in 1977 and in the rest of Europe and North America in

1986. Manufacturers of electrical equipment were then supplied with alternative dielectric media and replacement products entered the market. However, some countries outside the EU and North America continued to produce these substances until recently. Hence, products from those countries may have continued to contain PCBs until the mid-1990s. Current releases to the environment arise principally from the closed electrical appliances that still exist, as their useful life could be up to 40 years.

Activity data are very difficult to obtain on quantities of PCBs in existing transformers and associated leakage rates. A National Inventory of PCB Holdings for Ireland was originally prepared in 2001. This inventory has been updated a number of times, the most recent data corresponding to 2014. The report for this inventory provides an estimate of the total volume of PCB oil (confirmed and suspected) for 2014 of 22.19 m^3. This estimate includes both inventoried (confirmed) large and small holdings and estimated non-inventoried (suspected) holdings. Indications are that this is an overestimate and that many of the suspected holdings do not contain any PCBs. The estimate of holdings for 2014 represents a substantial decrease on the peak value in 2009 (522.06 m^3) following a large decrease in 2008 (114.29 m^3). This is partly due to methodological changes in the inventory compilation, which has given rise to a step change in the emission estimates. This issue requires further investigation to determine the level of inconsistency that may have been introduced across the current time series. The European Union's Chemical Legislation European Enforcement Network (CLEEN) initiated a project to compare inventories of PCBs in Member States of the EU. The CLEEN project documents summarise a large amount of information held within the EU offices (on PCB stocks) that have been reported by Member States to the EC but have not to date been published or synthesised by the Commission itself. Analysis of the CLEEN data indicates that Ireland has a lower than average PCB per-capita stock when compared with other Member States. All of this qualitative information points towards a lower than average prevalence of PCB-containing materials within electrical equipment in Ireland and this has been taken into consideration in the estimation method used for category 2L.

The derivation of activity data outlined above provides a time series of estimates of PCB-containing oil stocks in Ireland, based on a worst-case assumption that all of the as yet unreported transformer stocks do contain PCBs. The estimates range from 417,620 dm^3 of oil in 1990 to 22,191 dm^3 of oil (as reported by the EPA) in 2014. Data from the UK NAEI indicate that annual emissions of PCBs derived from dielectric fluid stocks can be estimated as 0.0005 kg PCBs/kg fluid, of which emissions to air comprise 0.06 g PCBs/kg emitted, with the remainder emitted to land. In the absence of source activity and monitoring data, these factors have been used to estimate Ireland's PCB emission estimates. The time series of PCB emissions from leakage of electrical equipment is presented in Table 4.12. As noted above, the current data gives rise to a sharp increase in emissions for 2009 to decrease again in 2010 and further in each consecutive year, caused by a change in the methodology used for estimating the volume of dielectric fluid containing PCBs. Total quantity of PCB containing oil contained in equipment in-situ at start of year for 2014 is substantially lower than previous years, resulting in decreased emissions.

The data on PCDD/F concentrations in dielectric PCB fluid from Dyke (1997) give a concentration in PCB dielectric fluid of 83.5 µg I-TEQ/kg of PCBs. It is assumed that the evaporation rate is the same for PCBs and PCDD/F so that for every kilogram of PCBs that is emitted to air, 83.5 µg I-TEQ of PCDD/F are emitted. Using this factor, estimates for PCDD/F emissions to air from dielectric fluid stocks in Ireland have been made. The time series of PCDD/F emissions from leakage from electrical equipment is presented in Table 4.12.

Table 4.12. Time Series of Polychlorinated Biphenyls and Dioxin and Furan Emissions from Leakage from Electrical Equipment

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PCDD/F (µg I-TEQ)	1.034	1.034	0.842	0.790	0.784	0.752	0.283	1.293	0.625	0.546	0.172	0.061	0.055	0.055
PCBs (kg)	0.012	0.012	0.010	0.009	0.009	0.009	0.003	0.015	0.007	0.007	0.002	0.001	0.001	0.001

4.5.2 Fragmentisers and Shredders (NFR 2L)

The practice of fragmenting or shredding electrical equipment currently occurs in a small number of IPPC-licensed facilities, where any suspected POP-containing components (e.g. capacitors) are removed and the residual material is then exported. White goods are also exported for recovery or treatment. The recycling of electrical and electronic goods has also been improved since the introduction of the WEEE Regulations in 2005. However, prior to the commencement of the WEEE Regulations and the All Island Fridge & Freezer Collection and Export Scheme in 2004, it is possible that white goods may have been shredded within Ireland, although there is little evidence that such practice was widespread. To provide a worst-case estimate for this potential emission, the UK NAEI activity data have been scaled on a per-capita basis to prepare estimates for Ireland for 1990−2005.

The shredding of End-of-Life Vehicles (ELVs) is another operation that may result in the possible emissions of POPs, and it has been found to be a relatively significant source in other European countries. Currently, two companies operate ELV shredders at three locations. The larger company operates two shredders but undertakes no monitoring of POPs on incoming vehicles or auto residue post-shredding. However, due to the ELV regulations all vehicles are “de-polluted” either on-site or prior to receipt from dismantlers, with all suspected contaminated materials being removed. In addition, the de-polluting process is expected to further improve in future years. Approximately 30,000 tonnes of auto residue (de-polluted vehicles) are shredded annually. Prior to the implementation of the ELV regulations the entire intact vehicle was shredded. Therefore, it can be assumed that for earlier years the shredding of ELVs would have resulted in larger quantities of shredded auto residue, with a higher potential for release of POPs.

Very limited data are available on emissions of POPs to air from fragmentisers, especially for the early part of the time series. Emission estimates for POPs are based on the Inventory Guidebook (2000) factor of 0.004 g/capita/year for PCB emissions from fragmentisers, which is considered to apply in the early part of the time series, around the time of the banning of PCBs (1985). The starting point for the time series of estimates of emissions from fragmentisers in Ireland is the estimated emissions in 1986 using population data and the factor of 0.004 g/capita/year, and this leads to an initial estimate of 14 kg PCBs emitted to air in Ireland in 1986. Assuming a 20-year lifespan of electronic equipment, it is reasonable to assume that 5 per cent of the 1986 emissions are removed each year, as old PCB-containing equipment is disposed to landfill and new PCB-free equipment is used as replacements. This assumption leads to an estimated time series of PCB emissions to air of 11.9 kg in 1990, falling to zero emissions by 2006 and are reported as NO for the period 2006 to 2015. Although this is a very broad “top−down” approach and is subject to significant uncertainty, there are very little additional data available to inform more accurate estimates. Emission estimates for the time series are presented in Table 4.13.

Table 4.13. Emission Time Series for Polychlorinated Biphenyls from Fragmentisers and Shredders

Year	1990	1995	2000	2001	2002	2003	2004	2005	2006
PCBs (kg)	11.920	8.643	5.305	4.617	3.917	3.184	2.427	1.654	NO

4.6 Recalculations in the Industrial Processes Sector

There were no recalculations to emission estimates for 1990−2014 as shown in Table 4.14.

4.7 Quality Assurance/Quality Control

Section 4.6 outlines that no recalculations were undertaken in the Industrial Processes sector in this reporting round. The inventory agency will continue to implement QA/QC procedures with respect to the estimates from the Industrial Processes sector in future submissions.

4.8 Planned Improvements

The inventory team will continue to review emission estimates for this sector in light of any new information that may become available for future submissions. In addition, the inventory team also plans to continue to outsource contracts on a periodic basis to re-examine and extend the inventory time series with respect to emissions of heavy metals and POPs. Main priority will be given to estimate emissions of PCDD/F for all years after 2001 and developing estimates of PCB and HCB for the full time-series from iron and steel production sector 2C1.

Following a recommendation from the Stage 3 Review Report, emission estimates for TSP, PM10 and PM2.5 for aluminium production (2C3) will be investigated for inclusion in the next submission.

Following a recommendation from the Stage 3 Review Report, the inventory agency will endeavour to undertake a review of particulate matter estimates in cement production. This will consider whether estimates are already included under 1A2f, or whether calculations should be made in 2A1

The inventory agency will endeavour to update as necessary any emission factors which have been updated in the latest version of the Inventory Guidebook (EMEP/EEA, 2016) and any updates available from the UK NAEI.

Table 4.14. Recalculations for Industrial Processes 1990–2014

NFR Category	Pollutant	Unit	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016																
2A3 Glass Production	Pb	t	0.31	0.31	0.31	0.14	0.13	0.09	0.10	0.10	0.01	NO	NO	NO	NO	NO
2A3 Glass Production	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO	NO	NO	NO	NO
2A3 Glass Production	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NE	NO	NO	NO	NO	NO
2A3 Glass Production	TSP	kt	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	NO	NO	NO	NO	NO
2A3 Glass Production	PM_{10}	kt	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.00	0.00	NO	NO	NO	NO	NO
2A3 Glass Production	$PM_{2.5}$	kt	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	NO	NO	NO	NO	NO
2B2 Nitric Acid Production	NOx	kt	0.96	0.28	0.30	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10b Storage, handling and transport of chemical products	TSP	kt	0.18	0.19	0.17	0.15	0.15	0.14	0.13	0.12	0.12	0.14	0.12	0.12	0.15	0.14
2B10b Storage, handling and transport of chemical products	PM_{10}	kt	0.06	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.05	0.04
2B10b Storage, handling and transport of chemical products	$PM_{2.5}$	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01
2C Metal Production	TSP	kt	0.07	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO
2C Metal Production	PM_{10}	kt	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO
2C Metal Production	$PM_{2.5}$	kt	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO
2C Metal Production	Pb	t	3.47	3.39	2.13	0.11	0.04	0.04	0.03	0.03	0.05	0.04	0.02	0.01	0.02	0.00
2C Metal Production	Cd	t	0.25	0.24	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
2C Metal Production	Hg	t	0.03	0.03	0.04	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Submission 2017																
2A3 Glass Production	Pb	t	0.31	0.31	0.31	0.14	0.13	0.09	0.10	0.10	0.01	NO	NO	NO	NO	NO
2A3 Glass Production	Cd	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO	NO	NO	NO	NO
2A3 Glass Production	Hg	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NE	NO	NO	NO	NO	NO
2A3 Glass Production	TSP	kt	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	NO	NO	NO	NO	NO
2A3 Glass Production	PM_{10}	kt	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.00	0.00	NO	NO	NO	NO	NO
2A3 Glass Production	$PM_{2.5}$	kt	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	NO	NO	NO	NO	NO
2B2 Nitric Acid Production	NOx	kt	0.96	0.28	0.30	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10b Storage, handling and transport of chemical products	TSP	kt	0.18	0.19	0.17	0.15	0.15	0.14	0.13	0.12	0.12	0.14	0.12	0.12	0.15	0.14
2B10b Storage, handling and transport of chemical products	PM_{10}	kt	0.06	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.05	0.04
2B10b Storage, handling and transport of chemical products	$PM_{2.5}$	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01
2C Metal Production	TSP	kt	0.07	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO
2C Metal Production	PM_{10}	kt	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO
2C Metal Production	$PM_{2.5}$	kt	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO
2C Metal Production	Pb	t	3.47	3.39	2.13	0.11	0.04	0.04	0.03	0.03	0.05	0.04	0.02	0.01	0.02	0.00
2C Metal Production	Cd	t	0.25	0.24	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
2C Metal Production	Hg	t	0.03	0.03	0.04	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 4.14. Recalculations for Industrial Processes 1990–2014 (cont'd)

% Change in Emissions																
2A3 Glass Production	Pb	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%					
2A3 Glass Production	Cd	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%					
2A3 Glass Production	Hg	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%						
2A3 Glass Production	TSP	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%					
2A3 Glass Production	PM_{10}	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%					
2A3 Glass Production	$PM_{2.5}$	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%					
2B2 Nitric Acid Production	NOx	kt	0.0%	0.0%	0.0%											
2B10b Storage, handling and transport of chemical products	TSP	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2B10b Storage, handling and transport of chemical products	PM_{10}	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2B10b Storage, handling and transport of chemical products	$PM_{2.5}$	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2C Metal Production	TSP	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
2C Metal Production	PM_{10}	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
2C Metal Production	$PM_{2.5}$	kt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
2C Metal Production	Pb	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2C Metal Production	Cd	t	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2C Metal Production	Hg	t	0.0%	0.0%	0.0%											

Chapter Five Solvent and Other Product Use

5.1 Overview of the Solvent and Other Product Use (NFR 2D-2L) Sector

The emission estimates presented in Solvent and Other Product Use (NFR 2D-2L) include Domestic solvent use including fungicides (2D3a), Road Paving with asphalt (2D3b), Coating Applications (2D3d), Degreasing and surface cleaning (2D3e), Dry Cleaning (2D3f), Chemical Products, Manufacture and Processing (2D3g), Printing (2D3h), Other Use of Solvents and Related Activities (2G) and Food and Beverages industry (2H2). Emissions are the result of continuing improvement of NMVOC emission estimates for Ireland through the outsourcing of tendered projects by the EPA. Road Paving with Asphalt 2D3b and Food and Beverages industry (2H2) are estimated for the first time in the 2017 submission as a result of on-going inventory improvements.

In 2012, the inventory agency commissioned a research project to update the NMVOC emission inventory for 2006-2013. This was a follow-on project to CTC/AEA (2005) and Finn et al. (2001) and also resulted in a revised dataset where new data and methodologies had become available. This approach was taken in accordance with the Inventory Guidebook (EMEP/EEA 2013) methodology for NMVOC emissions for Solvent and Other Product Use (NFR 2D-2L). The results of this project were provided in the 2016 submission. This project continued into 2016 and resulted in further improvements to the NMVOC emission inventory from Solvent Usage.

Emissions data were gathered using a similar methodology to previous approaches. Bottom-up data was mainly obtained from submissions of Annual Environmental reports (AERs) which detail emissions in a variety of reporting formats ranging from the Solvent Mass Balance Summary, Solvent Management Plan (SMP), Pollution Release and Transfer Register (PRTR), or the Annual Environmental Report returns Workbook. In addition, new data sources were used from legislation designed to limit and report solvent usage (Solvent Directive 1999/13/EC). In conjunction with these data, the number of operators within each category was estimated using NACE codes provided by the Central Statistics Office (CSO) or from expert opinion.

Top−down methods were used for activities not covered by the IPPC licensing system nor under the Solvent Directive (1999/13/EC). The most significant included the use of non-industrial paints, metal degreasing and the use of domestic solvents. Input in the form of activity data, solvent usage or VOC emissions data for each individual activity were collated into spreadsheets. Emissions were estimated by applying the Inventory Guidebook (EMEP/EEA 2013) methods, default emission factors and general guidance as appropriate. Scaling up to national level was applied where necessary.

Emissions reported in NFR 2014 format are aggregated from the Selected Nomenclature for Air Pollutants (SNAP) categories. SNAP codes are used in the Inventory Guidebook (EMEP/EEA 2013) where sectoral emission sources and emission factors are provided in this system. Therefore, SNAP codes are adopted in this chapter as it ensures that reporting of emissions is consistent with the guidebook and therefore other Parties submissions. Additionally, the use of SNAP codes facilitates a sub-sectoral analysis of drivers and trends.

For a number of sources, it was not possible to obtain reliable country-specific data (SNAP 060107: Paint Application: Wood, SNAP 060109: Non-Industrial Paint Application, SNAP 060408: Domestic Solvent Use). As a consequence of this, UK and other Parties' emission factors, and in some cases activity data (scaled by surrogate data), were used in the estimation methodology.

Obtaining country-specific data has been identified as an important issue in the past (Barry, S. and Regan, B., 2014). While new activity data were obtained for sectors that previously relied upon proxy sources, a number of sectors are still estimated using proxy information sources. Further reducing the dependence of these would require substantial investment, and the improvement that this would bring over using proxy based data is thought to be relatively small due to the similarity in lifestyle behaviour between the countries operating within the EU and therefore a common market place.

The main drivers associated with trends in implied emission factors relate to reduced solvent content of products, and in particular paints. The trends in activity data reflect the fact that Ireland experienced rapid economic growth from the late 1990s to 2007. As a result there was a substantial increase in the number of vehicles, growth in the number of individual households, and generally a higher per capita consumption of paints, cosmetics, toiletries, and other solvent containing products. Since 2007, there has been a rapid economic downturn, which has had a marked impact on consumption, and therefore emissions of NMVOC. As economic conditions began to improve emissions have also increased from 2012 to 2015.

Figure 5.1 illustrates the overall trend and shows a 11.2 per cent increase in total emissions between 1990 (32.8 kt of NMVOC) and 2015 (36.5 kt of NMVOC). The main contributor to the trend is sector 2H2 Food and Beverages industry, which is estimated for the first time in this submission, with 82.0 per cent increase between 1990 and 2015 it was responsible for 45.1 per cent share of emissions from solvent and other product use in 2015. The second largest contributor is sector 2D3a (Domestic Solvent Use including fungicides) with a contribution of 28.7 per cent of emissions from solvent and other product use (having increased by 32.2 per cent since 1990). Sector 2D3d (Coating Applications) accounted for 10.1 per cent in 2015 showing a decrease of 38.9 per cent between 1990 and 2015.

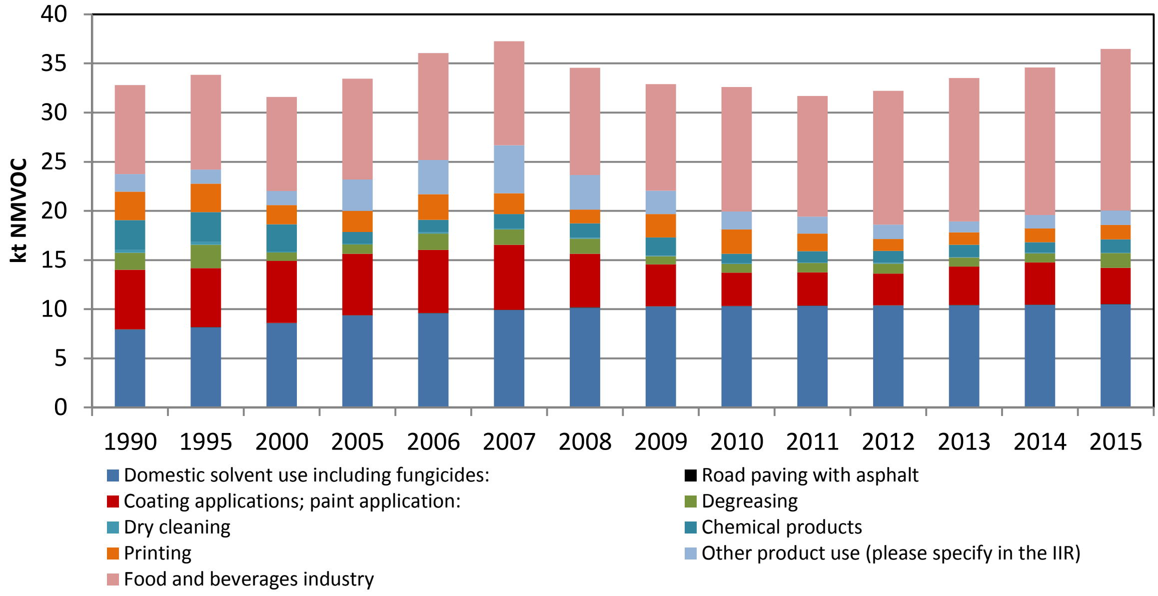

Figure 5.1. Non-Methane Volatile Organic Compounds Emission Trend for 2D-2L Other Solvent and Product Use 1990−2015

Sector 2D3a (Domestic Solvent Use including fungicides) is the second largest contributor to NMVOC emissions (Table 5.1). A Tier 2 method was implemented in this submission which has resulted in recalculations across the full time series. The new method uses population data obtained from the C.S.O and per capita emission factors for product use from the Inventory guidebook (EMEP/EEA, 2016). This approach was used as the statistics required for the use of Tier 2b approach were not complete in terms of the product types covered by domestic solvent use.

Sector 2D3b (Road paving with asphalt) emissions were estimated for the first time in 2017 and contribute less than 0.1 per cent of 2015 emissions. Emissions from the sector have decreased by 13.6 per cent since 1990.

Emissions from Coating applications (2D3d) have been decreasing since 2007 and reached their lowest level in 2012 before increasing in 2013 and 2014 and decreasing again in 2015. The main driver of NMVOC emissions from this emission category is the application of decorative paint (SNAP codes: 060103/060104). A number of factors contributed to the on-going decrease in emissions including; the substantial reduction in the solvent content of paint in recent years to comply with the Deco-Paints Directive (EP and CEU, 2004b), a greater awareness of environmental issues from the general public in addition to the economic downturn in Ireland. From discussions with industry, pressure from some of the larger retailers is noted to be one of the key drivers for the decrease in solvent use in architectural paint in particular. The sales of water-based paints have increased by 54.2 per cent between 1990 and 2015 whereas solvent-based paint sales have decreased by 7.8 per cent over the same period.

Emissions from 2D3e (Degreasing) decreased by 13.9 per cent between 1990 and 2015. Emissions peaked in 1996 at 2.5 kt. The methodology is based on net consumption of solvents (imports minus exports) provided by the CSO. The analysis showed that the main solvent used in this sector is Dichloromethane. The reductions are assumed to be driven by improved management practices and abatement technologies (open-top tanks have been phased out in the European Union as a result of the Solvents Emissions Directive 1999/13/EC). Emissions from this emission source accounted for 4.1per cent of the total emissions from solvent and other product use in 2015.

Data obtained under the reporting requirements of Solvent Directive (1999/13/EC) was used to estimate emissions from 2D3f (Dry Cleaning). Solvent usage, emissions data and national statistics were used to estimate emissions from this emission source. Emissions decreased by 84.4 per cent over the 1990-2015 period. Emissions from 2D3f accounted for 0.1 per cent of the total emissions from solvent and other product use in 2015.

2D3g (Chemical products) accounts for 3.7 per cent of emissions in solvent and other product use in 2015. In 1990, this sector accounted for 9.2 per cent. This emission category consists of fourteen emission sources, however, the majority of the emissions sources contribute very little to the overall emissions from the Chemical products sector. The diversity within these sectors is very large in terms of the type of process, the products made and the scale involved. The main driver of emissions from this emission source is Pharmaceutical Production (SNAP code 060306). Emissions from pharmaceutical production accounted for 83.7 per cent of emissions in the 2D3g in 2015. Emissions from 2D3g decreased by 55.7 per cent between 1990 and 2015. Emissions decreased as a result of the introduction of new management practices or through the use of abatement technology according the (CTC/AEA, 2005 and Barry S. and O' Regan B., 2014). This indicates that current policy strategies are having an impact on solvent use and emissions. In addition, large reductions in emissions were found in several emission sources between 1990 and 2015. For instance, emissions reduced significantly from SNAP code 060303 (Polyurethane Processing), SNAP code 060305 (Rubber Processing) and 060307 (Paint Manufacture). This was mainly a result of plant closures.

2D3h (Printing) emissions decreased 49.8 per cent over the 1990 to 2015. In 2015, the sector accounted for 4.0 per cent of total emissions from solvent and other product use. Emissions from this sector have increased for three consecutive years (5.4 per cent in 2013, 9.1 per cent in 2014 and 4.4 per cent in 2015). The economic downturn in Ireland in 2009 may be responsible for the prior decrease in emissions and a return to better economic conditions may be driving the emission increases in recent years. However, it is important to note that the print industry is included under the Solvent Directive (1999/13/EC) and is subject to IPPC licencing where applicable.

Emission sources from 2G4 include SNAP codes; 060401 (Glass Wool Enduction), 060402 (Mineral Wool Induction), 060404 (Fat, edible and non-edible oil extraction), 060405 (Application of Adhesives and Glues), 060406 (Preservation of Wood), 060407 (Underseal Treatment and Conservation of Vehicles), 060409 (Vehicle Dewaxing), 060602 (Use of tobacco) and 060303 (Use of shoes). The methodology for reporting 060404 (Fat, edible and non-edible oil extraction) was amended to include emissions from 1990 to 2015, whereas previously values were available from 2008 onwards and were based on emissions from one IPPC licenced facility. The updated methodology is Tier 2 method based on Oilseed rape crop yield data provided by the CSO and emission factor from the Inventory guidebook (EMEP/EEA 2016). Emissions from SNAP code 060602 (Use of tobacco) has been included in this submission using Tier 2 emission factor from Inventory guidebook (EMEP/EEA 2016) and excise volumes data obtained from Revenue. Emissions from category 2G4 accounted for 4.1 per cent of emissions from solvent and other product use in 2015 and have decreased by 17.5 per cent between 1990 and 2015. The most significant emission sources from Other Product Use in 2015 include Application of Glues and Adhesives (75.8 per cent), Preservation of Wood (18.6 per cent) and Fat, edible and non-edible oil extraction (4.2 per cent).

Sector 2H2 (Food and Beverage industry) is estimated for the first time in the 2017 submission and is the largest contributor to NMVOC emissions (Table 5.26-5.31). Tier 2 methodologies were applied to SNAP codes 040605 Bread, 040607 Production of Beer and 040608 Production of spirits, 040627 Meat frying and meat rendering, coffee roasting and feedstock, using activity data from C.S.O and Eurostat.

5.2 Domestic Solvent Use including fungicides (NFR 2D3a)

This subcategory covers SNAP sector 060408. This category addresses NMVOC emissions from the general use of products containing solvents by members of the public in their homes, but does not include the use of decorative paints. Many domestic products are also used in industry and commerce and in many cases, it is difficult or impossible to separate total sales into domestic and industrial components. Products that contain VOCs can be divided into a number of categories such as Cosmetic and Personal Care Products, Household Products, DIY products, Car Care Products, Varnish remover, Sealant and fillings Agents, Pharmaceutical Products Use and Pesticides. In this submission, a Tier 2 methodology was used with per-capita emission factors. This is the recommended approach to use where product statistics for the use of the Tier 2b approach are not complete in terms of the product types covered by domestic solvent use. Further study is planned to source appropriate product statistics to develop a Tier 2b approach. . Estimates of NMVOC emissions from domestic solvent use are provided in Table 5.1

Table 5.1. Non-Methane Volatile Organic Compound Emissions from Domestic Solvent Use

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
kt	7.93	8.14	8.57	9.35	9.57	9.89	10.14	10.25	10.30	10.34	10.37	10.38	10.42	10.48

5.3 Road Paving with asphalt (NFR 2D3b)

This sector covers the use of asphalt for road paving and covers SNAP sector 040611. This source is estimated for the first time in the 2017 submission using a Tier 2 methodology using annual weight of warm and hot mix asphalt used in Ireland for years 1993-2015 and the Tier 2 emission factor from the Inventory guidebook (EMEP/EEA 2016). Estimates of NMVOC emissions from Road Paving with asphalt are provided in Table 5.2.

Table 5.2. Non-Methane Volatile Organic Compound Emissions from Road paving with Asphalt

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.04	0.03	0.05	0.05	0.06	0.05	0.04	0.05	0.04	0.03	0.03	0.03	0.03	0.03

5.4 Coating Application (NFR 2D3d)

This sector covers the use of paints within the industrial, trade and domestic sectors. The term paint includes pigmented coatings and clear coatings such as lacquers and varnishes, with the exception of glues, adhesives and inks. Unless captured on release and either recovered or destroyed, the solvent content of paint can be considered to be emitted to the atmosphere. The subcategories covered in this source category are presented below, with the relevant SNAP code in parentheses. SNAP codes not included below are deemed not to occur in Ireland.

Paint Application – Car Repairing (060102)
Paint Application – Construction and Buildings (060103)
Paint Application – Domestic Use (060104)
Paint Application – Boat Building (060106)
Paint Application – Wood (060107)
Paint Application – Other Industrial Paint Application (060108)
Paint Application – Other Non-Industrial Paint Application (060109)

Dependent on the SNAP code of interest, both bottom−up and top−down approaches have been used in emission estimates. Where there is an absence of country-specific data, per-capita emission factors derived from a number of EU member states national inventories were used to estimate emissions in Ireland using population statistics. Further details of the methodological choices for this source category are provided in Barry, and O' Regan. (2014), CTC/AEA (2005) and in Finn et al. (2001).

5.4.1 Paint Application: Car Repairing (SNAP 060102)

Activity data was obtained from a number of sources. From 2006-2012, sales data was obtained from a large supplier and data was up-scaled based on market share and expert opinion. Data used in 1998 was calculated by Finn et al. (2001), data for 2000 and 2001 was provided by the British Coating Federation. Data was extrapolated and interpolated for the intervening years using passenger car numbers reported by the Department of Transport, Tourism and Sport each year (DTTAS, 2016). Emission factors were obtained using survey data from AEA/CTC (2005) and Barry and O' Regan (2014), default emission factors provided by the Inventory Guidebook (EMEP/EEA 2016) and where necessary, emission factors were calculated based on the average decrease in VOC content in known coating applications. The emission estimate includes thinners (EF 1000-835g/L), body fillers (EF 249-175g/L), top coat (720-420g/L) and primers (720-540g/L). This is considered a Tier 2 method. Emission estimates are provided in Table 5.3.

Table 5.3. Non-Methane Volatile Organic Compound Emissions from Paint Application: Car Repairing

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.19	0.21	0.31	0.43	0.74	0.81	0.68	0.44	0.38	0.36	0.26	0.25	0.25	0.25

5.4.2 Paint Application: Construction and Building (SNAP 060103) and Domestic Use (SNAP 060104)

Activity data was obtained from the Irish Decorative Surface Coating Association (IDSCA) for the period 2006-2015. The Irish Business and Employers' Confederation (IBEC) collated the total product sales for both water-based and solvent-based paints and provided the information to the inventory agency for the period 2000-2004. Following the experience in the UK (CTC/AEA, 2005), total product sales are proportioned between trade (Construction and Buildings) and retail (Domestic Use) use, assuming a 45:55 split in 1998, reaching 40:60 in 2003, and 30:70 in 2013. The split in 2015 is assumed to be the same as 2013. Estimates of paint sales prior to 1998 were extrapolated using GDP (R=0.70).

A number of emission factors were used to calculate NMVOC emissions from decorative coating applications. A survey of products found in popular retail chain stores was completed to establish a realistic emission factor for decorative surface coating products for recent years:

- Interior matt walls and ceiling paint was found to be 30g of VOC/l for solvent based paints and 22.5g of VOC/l for water based paints.
- Interior glossy walls and ceilings were found to have 76g of VOC/l for solvent based paint and 50g of VOC/l for water based paints.
- Exterior walls of mineral substrate were found to have 126g of VOC/l of solvent based paints and 9g of VOC/l for water based paints.
- Interior/exterior trim and cladding paints for wood and metal have an average solvent content of 324g of VOC/l of solvent based paints and 43g of VOC/l of water based paints.
- Primers were found to have an average solvent based paints of 201g of VOC/l and 45g of VOC/l for water based paints.

These emission factors were used for 2010-2015 while emission factors prior to this were assumed to be similar to 2007 limits outlined in the decorative paints directive. This was considered a Tier 2 method Emission estimates for this category are provided in Table 5.4.

Table 5.4. Non-Methane Volatile Organic Compound Emissions from Paint Application: Construction and Building (060103) and Domestic use (060104)

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
060104 kt	1.207	1.330	1.577	1.440	1.358	1.444	1.099	0.822	0.591	0.564	0.502	0.662	0.723	0.523
060103 kt	1.536	1.692	2.090	2.350	2.312	2.568	2.041	1.596	1.201	1.198	1.116	1.545	1.687	1.221

5.4.3 Paint Application: Boat Building (SNAP 060106)

Paint application in the Marine Sector includes a diverse range of products designed to prevent corrosion and protect ships hulls against damage from fouling. The formulation varies depending on the area being coated and application techniques also vary ranging from spraying to brushing and application by roller.

Activity data were obtained from a major marine coating supplier from 2010-2015 and was upscaled based upon the company's market share. Previous annual emissions were assumed to be the same as 2010. The supplier also provided an estimated industry product breakdown. Emission factors between products are relatively similar with Top coats, primers and anti-corrosion products having an estimated VOC content of 400g of VOC per kg of product while anti-fouling products are estimated to contain 440g of VOC per kg of product.

Paint Application in the Marine Sector in Ireland can be divided into domestic sector, cargo or freight sector and fishery sector. Larger vessels which require more product application are unable to dry dock in Ireland due to a lack of facilities to handle larger vessels. Therefore, sales data are adjusted based upon expert opinion to account for this (50 per cent of paint sales are considered to be applied elsewhere). This sector is a minor emission source for this reason. The methodology is considered a Tier 1 method. Estimates of NMVOC emissions from this source category are provided in Table 5.5.

Table 5.5. Non-Methane Volatile Organic Compound Emissions from Paint Application: Boat Building

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.102	0.089	0.103	0.111	0.115

5.4.4 Paint Application: Wood (SNAP 060107)

This subcategory refers to all paints used for the wood and wooden products sector but excludes the use of wood preservatives and creosote. Some activity data were available; however, no indication of the number of operators or market size was obtainable. Therefore, the emissions estimate was downscaled from UK data where consumption patterns and product range were considered to be comparable to Ireland. This involved using UK emissions data from the UK National Atmospheric Emissions Inventory (NAEI) and calculating per capita emissions (kg/per person) and applying this to Ireland using national population statistics. The methodology is considered a Tier 1 method. Estimates of NMVOC emissions from this source sector are provided in Table 5.6.

Table 5.6. Non-Methane Volatile Organic Compound Emissions from Paint Application: Wood

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	1.115	0.969	0.760	0.596	0.611	0.623	0.512	0.427	0.425	0.428	0.426	0.428	0.429	0.428

5.4.5 Paint Application: Other Industrial Sources (SNAP 060108)

The methodology for this source category involves the use of IPPC emissions data and scaling up to account for emissions in the non-IPPC sector based on information obtained from reporting under the Solvent Directive 1999/13/EC. Emissions varied slightly from those previously reported due to inclusion of corrected up to date emissions data. This category covers paints applied in industrial activities other than those already described in previous sections. Products painted include agricultural, construction and earth-moving equipment, aircraft, cans and drums, domestic appliances, electrical components, freight containers, machine tools, military vehicles, motor-vehicle components, office equipment, paper and plastics, and toys.

The scale of operation varies considerably from large operations employing automated roller coating to small-scale spraying painting. Processes may be enclosed or open air, and both air-dried and stove coatings are used. The emission estimate was up-scaled based on information obtained as a result of Solvents Directive 1999/13/EC. Estimates of NMVOC emissions from this source category are provided in Table 5.7. This methodology is considered a Tier 3 method

Table 5.7. Non-Methane Volatile Organic Compound Emissions from Paint Application: Other Industrial Sources

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	1.418	1.315	1.014	0.996	0.879	0.675	0.708	0.633	0.461	0.483	0.587	0.671	0.834	0.920

5.4.6 Paint Application: Other Non-Industrial Sources (SNAP 060109)

This category refers to the use of high performance protective and/or anti corrosive paints applied to structural steel, concrete and other substrates and any other non-industrial coatings. The sector includes coatings for offshore drilling rigs, production platforms and similar structures as well as road marking paints and non-decorative floor paints. Finn et al. (2001) obtained the activity data for this category as the difference between total paint sales in Ireland according to CSO data on paint sales and that used in other SNAP sectors under SNAP 0601. However, as no other data are available, emissions have been calculated following the advice of CTC/AEA (2005) using extrapolation from UK per capita estimates.

In order to establish whether the use of UK data is appropriate, per capita emissions were compared to other reporting parties. It was found that per capita emissions from this category range from 0.08 to 0.45 kg/person. The UK's per capita estimate is calculated at 0.14kg per person. This is considered to be a realistic estimate for Irish emissions and was used to estimate emissions. This involved calculating UK per capita emissions (kg/per person) and applying this to Ireland using national population statistics Estimates of NMVOC emissions from this source category are provided in Table 5.8. The methodology is considered a Tier 1 method

Table 5.8. Non-Methane Volatile Organic Compound Emissions from Paint Application: Other Non-Industrial Sources

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.490	0.401	0.466	0.337	0.418	0.388	0.321	0.264	0.234	0.251	0.251	0.262	0.263	0.244

5.5 Degreasing and Dry Cleaning (NFR 2D3e and 2D3f)

Degreasing and Dry Cleaning (2D3e and 2D3f) covers the four subcategories that constitute SNAP Sector 0602. The subcategories for which emission estimates have been made are as follows with the relevant SNAP code in parentheses:

Metal Degreasing (060201)
Dry Cleaning (060202)
Electronic Components (060203)
Other Industrial Cleaning (060204)

Activity data were obtained in the form of net consumption statistics (import minus exports) supplied by the CSO. Solvents included in the emissions estimate include perchloroethylene, dichloromethane, trichloroethylene and hydrocarbons from 1992-2015 before which time data are not available. The methodologies outlined in the Inventory Guidebook (EMEP/EEA 2016) and emissions data collected under the Solvents Directive 1999/13/EC are used to derive emission estimates. Further details of the methodological choices for this source category are provided in Barry, S. and O' Regan B. (2014).

5.5.1 Metal Degreasing (SNAP 060201), Electronics Manufacture (SNAP 060203) and Other Industrial Cleaning (SNAP 060204)

Degreasing is a process for cleaning water-insoluble substances, such as grease, fats, oils, waxes, carbon deposits, fluxes and tars, primarily from various metal products, but plastic, fibreglass, printed circuit boards and other products may also be treated by the same process. Therefore, a wide range of activities is covered.

The metalworking industries are the major users of solvent degreasing. Many manufacturers of electronic components also employ degreasing, but it is difficult to differentiate between the emissions emanating from degreasing and those from other sources. As a result, for the purposes of inventory estimates, emissions from Other Industrial Cleaning (060204) and Electronic Manufacture (060203) are included with Metal Degreasing (060201) as national statistics do not facilitate disaggregation of individual sectors.

The Inventory Guidebook (EMEP/EEA 2016) Tier 1 methodology is used for inventory estimates, and solvent consumption statistics (import minus exports) are used as the activity data. The default emission factor of 460g of VOC per kg of cleaning product is used. As data are not available for 1990-1991, the annual emission estimates for these years are assumed to be the same as 1992. Estimates of NMVOC emissions from this source category are provided in Table 5.9.

Table 5.9. Non-Methane Volatile Organic Compound Emissions from Metal Degreasing, Electronics Manufacture and Other Industrial Cleaning

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	1.744	2.386	0.847	0.953	1.674	1.557	1.531	0.789	0.885	0.925	1.004	0.902	0.922	1.501

5.5.2 Dry Cleaning (SNAP 060202)

Dry cleaning refers to any process to remove contamination from furs, leather, down leathers, textiles or other objects made of fibres, using organic solvents. Dry cleaning can be defined as the use of chlorinated organic solvents, principally perchloroethylene, to clean clothes and other textiles.

Emissions and usage data were obtained from the Solvents Directive 1999/13/EC for the years 2008-2010. In addition, the CSO provides information directly to the inventory agency in relation to perchloroethylene imports and exports. It is assumed that the net consumption (imports minus exports) in any year are used in that year for inventory estimates, even if there is some carryover of stock between years. Data are available from 1992-2015. Based on the percentage of perchloroethylene used in Dry Cleaning compared to national consumption in 2008-2010 and 2012, emissions were calculated for 1990-2007 and for 2011, 2013, 2014 and 2015. Estimates of NMVOC emissions from this source sector are provided in Table 5.10. The methodology is considered a Tier 3 methodology.

Table 5.10. Non-Methane Volatile Organic Compound Emissions from Dry Cleaning

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.282	0.272	0.090	0.085	0.124	0.105	0.093	0.063	0.053	0.058	0.075	0.057	0.068	0.044

5.6 Chemical Products, Manufacture and Processing (NFR 2D3g)

The mapping of Chemical Products, Manufacture and Processing (2D3g) to SNAP covers 14 subcategories in SNAP Code 0603. These subcategories are all industrial applications and, similar to Coating Application (2D3d), emission sources not included below are deemed not to occur in Ireland. The 9 subcategories for which emission estimates are made are as follows with the relevant SNAP code in parentheses:

PVC Processing (060302)
Polyurethane Processing (060303)
Rubber Processing (060305)
Pharmaceutical Products Manufacturing (060306)
Paints Manufacturing (060307)
Inks Manufacturing (060308)
Adhesives Manufacturing (060309)
Adhesive and Magnetic Tapes, Films and Photographs Manufacturing (060311)
Textile Finishing (060312)

Information pertaining to these sectors has been obtained from IPPC licenced companies with the exclusion of PVC processing (060302) which is based upon expert opinion from Finn et al. (2001). Estimates were up-scaled to reflect national emissions using the number of companies for each sector classified under European industrial activity classifications (NACE Rev.2) provided by the CSO. Emissions from Adhesive and Magnetic Tapes, Films and Photographs Manufacturing (060311) are included under SNAP code (060405) Industrial adhesive usage in section 5.8 Other Use of Solvents and Related Activities (2D3i-2G). Further details as to the exact methodological choices and the use of Inventory

Guidebook (EMEP/EEA 2016) methodologies applied in estimating emissions can be found in Finn et al. (2001), CTC/AEA (2005), and Barry and O' Regan (2014).

5.6.1 Polyvinyl Chloride (PVC) Processing (SNAP 060302)

The manufacture of polyvinyl chloride plastic involves an enclosed reaction or polymerisation step using the basic monomer to produce the resin, a drying step, and a final treating and forming step. Plastics are polymerised in completely enclosed vessels. Treatment of the resin after polymerisation varies with the proposed use. The major sources of air emission in plastics manufacture are the raw materials or monomers, solvents, or other volatile liquids emitted during the reaction, sublimed solids such as phthalic anhydride emitted in alkyd production, and solvents lost during storage and handling of thinned resins. Processing of PVC is not significant in Ireland. Emission data have been sourced from the installations involved which suggest an emission of 5 t/annum (Finn et al., 2001). The methodology is considered a Tier 1 method.

5.6.2 Polyurethane Processing (SNAP 060303)

This category deals with the application and subsequent discharge of organic compounds as blowing agents for creating polyurethane foams. Emissions are from the release of these blowing agents during foaming, or subsequently by the long-term release over several years. Polyurethane is used in building construction, for heat insulation, and for packaging material. For soft polyurethane foams, water may be used. Hard polyurethane foams utilise organic liquids as blowing agents.

Emission data have been sourced from IPPC-licensed companies involved in the manufacture of polyurethane and other foams. Estimates of NMVOC emissions from this category are provided in Table 5.11. The methodology is considered a Tier 1 method.

Table 5.11. Non-Methane Volatile Organic Compound Emissions from Polyurethane Processing

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.162	0.162	0.080	0.044	0.039	0.037	0.035	0.027	0.004	0.004	0.004	0.004	0.004	0.004

5.6.3 Rubber Processing (SNAP 060305)

No detailed information for rubber processing is available within the Inventory Guidebook (EMEP/EEA 2016). Therefore, it is assumed in inventory estimates that this category includes processes such as moulding and mixing of natural and synthetic rubbers. Operations involving trimming and cutting are ignored since VOC emissions would not be associated with such operations.

Emission data have been sourced from IPPC-licensed companies involved in rubber processing that utilise organic solvents. Estimates of NMVOC emissions from this category sector are provided in Table 5.12. Emissions from this sector were dominated by the manufacture of tennis balls from two companies both of which have ceased operation and account for the steep decline in emissions. The methodology is considered a Tier 2 method.

Table 5.12. Non-Methane Volatile Organic Compound Emissions from Rubber Processing

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.423	0.424	0.422	0.199	0.199	0.199	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

5.6.4 Pharmaceutical Products Manufacturing (SNAP 060306)

Depending on the nature of the pharmaceutical manufacturing facility, organic chemicals are used in the synthesis, extraction, fermentation and purification of Active Pharmaceutical Ingredients. Solvents are also used in the dilution of liquids, granulation, packaging and film coating. Thousands of individual products are categorised as pharmaceuticals. These products are usually produced in modest quantities in relatively small plants using batch processes. A typical pharmaceutical plant will use the same equipment to make several different products at different times.

The pharmaceutical industry is well established in Ireland and subject to IPPC licence requirements. Emission estimates have been made for 1998 and 2004 using an emission factor of 2 per cent of usage data (Finn et al. 2001, CTC/AEA, 2005) and for 2006-2015 using reported fugitive emissions data supplied by IPPC licenced facilities to the EPA. Slight changes to emissions previously reported have occurred in 2017 due to increased accuracy of reported emission data by facilities. Other years (1990-1997 and 2005 emissions estimates) are interpolated or extrapolated from these estimates. The methodology is considered a Tier 3 method. Estimates of NMVOC emissions from this source category are provided in Table 5.13.

Table 5.13. Non-Methane Volatile Organic Compound Emissions from Pharmaceutical Products Manufacturing

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	2.124	2.124	2.072	0.769	0.865	1.119	1.310	1.727	0.873	1.029	1.129	1.121	0.969	1.122

5.6.5 Coating Manufacture: Paint (SNAP 060307)

The manufacture of paint involves the dispersion of coloured oil or pigments in a vehicle, usually an oil or resin, followed by the addition of an organic solvent for viscosity adjustment. Only the physical processes of weighing, mixing, grinding, tinting, thinning and packaging take place. No chemical reactions are involved.

Input and usage data have been sourced from a number of installations for 1998 and 2004 and from 2007 to 2015 emissions data was obtained from AERs. Slight changes to emissions previously reported have occurred in 2017 due to increased accuracy of reported emission data by facilities. Emissions data were upscaled based on national statistics to reflect national emissions. Emissions were assumed to remain at 1998 levels for the period 1990-1997 as no emissions data was available. Other years in the time series are estimated by interpolation and extrapolation. This methodology is considered a Tier 3 method. Emission estimates for NMVOC are provided in Table 5.14.

Table 5.14. Non-Methane Volatile Organic Compound Emissions from Paint Manufacture

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.162	0.162	0.117	0.083	0.074	0.064	0.069	0.060	0.043	0.027	0.039	0.051	0.052	0.152

5.6.6 Inks Manufacturing (SNAP 060308)

There are four major classes of printing ink: letterpress and lithographic inks, commonly called oil or paste inks, and flexographic and rotogravure inks, which are referred to as solvent inks. These inks vary considerably in physical appearance, composition, method of application, and drying mechanism. Flexographic and rotogravure inks have many elements in common with the paste inks but differ in that they are of very low viscosity, and they almost always dry by evaporation of highly volatile solvents.

Emissions data were obtained from IPPC licensed facilities for 2008-2015. Where emissions estimates are based on usage data they are calculated based on an assumed emission factor of 2.5 per cent, which is the UK NAEI emission factor for this category (CTC/AEA, 2005). Emissions were assumed to remain at 1998 levels for the period 1990-1997 as no emissions data were available. Gaps in the time series were then filled by interpolation and extrapolation. The methodology is considered a Tier 2 method. Estimates of NMVOC emissions from this source category are provided in Table 5.15.

Table 5.15. Non-Methane Volatile Organic Compound Emissions from Inks Manufacturing

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.018	0.018	0.006	0.004	0.003	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001

5.6.7 Adhesives Manufacturing (SNAP 060309)

This category includes the manufacture of glues and adhesives as it was difficult to derive separate activity data for glues and adhesives from those obtained from IPPC-licensed installations. Minor changes to emissions previously reported have occurred in this submission due to increased accuracy of reported emission data by facilities.

Emissions and usage data were supplied for a number of years in the time series (1998, 2006-2015). Emissions were assumed to remain at 1998 levels for the period 1990-1997 as no emissions data were available. The methodology is considered a Tier 3 method Estimates of NMVOC emissions from this source category are provided in Table 5.16.

Table 5.16. Non-Methane Volatile Organic Compound Emissions from Adhesives Manufacturing

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.051	0.051	0.034	0.051	0.033	0.015	0.034	0.036	0.041	0.051	0.016	0.036	0.022	0.027

5.6.8 Textile Finishing (SNAP 060312)

Textile fabric finishing is part of the textile finishing industry. In fabric printing, a decorative pattern or design is applied to constructed fabric by roller, flat-screen or rotary-screen methods. Pollutants of interest in fabric printing are VOCs from mineral spirit solvents in print pastes or inks. Solvent use in this sector is usually associated with dry processing rather than wet processing of textiles.

Very little information is available for this activity. Two IPPC-regulated companies provided information to allow estimates to be made for a limited number of years (1998, 2004 and 2006-2015). Emissions were assumed to remain at 1998 levels for the period 1990-1997 as no emissions data were available. The remaining years were extrapolated. This was considered a Tier 1 method. Estimates of NMVOC emissions from textile finishing are provided in Table 5.17.

Table 5.17. Non-Methane Volatile Organic Compound Emissions from Textile Finishing

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.078	0.078	0.049	0.033	0.028	0.028	0.030	0.030	0.030	0.030	0.028	0.028	0.028	0.028

5.7 Printing (2D3h)

Printing involves the use of various types of inks, which may contain a proportion of organic solvents which may be diluted before use. Different inks have different proportions of organic solvents and require dilution to different extents. Printing can also require the use of cleaning solvents and organic dampeners. The main printing techniques identified include offset, cold-set web offset, heat-set web offset, sheet-fed offset, rotogravure, flexography, letterpress, and screen-printing.

Usage and emission data are sourced from IPPC-regulated companies and scaled for those not regulated by IPPC based on national statistics and average emissions. Estimates of NMVOC emissions from printing are provided in Table 5.18. The large decrease in emissions is due to abatement measures introduced by the companies operating in Ireland due to the Solvent Directive (1999/13/EC) and a general greater awareness of environmental issues by the print industry. While the printing industry was affected by the economic recession from 2008 in Ireland and resulted in a decreasing emission trend, emissions increased in 2009 due to emissions from two IPPC licenced facilities. The methodology is considered a Tier 3 method. Minor changes to emissions previously reported have occurred in this submission due to increased accuracy of reported emission data by facilities.

Table 5.18. Non-Methane Volatile Organic Compound Emissions from Printing

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	2.912	2.912	1.946	2.126	2.628	2.118	1.393	2.360	2.474	1.788	1.217	1.283	1.400	1.462

5.8 Other Use of Solvents and Related Activities (2D3i-2G)

This sector consists of 11 subcategories, which are a mixture of industrial and non-industrial activities, only some of which are applicable to Ireland. 2D3i (Other solvent use) and 2G4 Other product use, Use of shoes (060602) are not estimated for Ireland, 2G4 Other product use, Mineral wool enduction (060402), Other (060412) are not considered to occur in Ireland. The 7 subcategories for which emission estimates are made are as follows with the relevant SNAP code in parentheses:

Glass Wool Blowing/Enduction (060401)
Fat, edible and non-edible oil extraction (060404)
Application of Glues and Adhesives (060405)
Preservation of Wood (060406)
Underseal Treatment and Conservation of Vehicles (060407)
Vehicle Dewaxing (060409)
Use of Tobacco (060602)

Both bottom−up and top−down approaches are used in the estimation of emissions from the subcategories outlined, depending on the availability of data for each subcategory. Similar to the other categories, further information in relation to subcategory estimation methodologies can be found in Finn et al. (2001), CTC/AEA (2005) and Barry and O' Regan (2014).

5.8.1 Glass Wool Blowing/Enduction (SNAP 060401)

Glass fibre manufacturing is the high-temperature conversion of various raw materials into a homogeneous melt, followed by the fabrication of this melt into glass fibres. The two basic types of glass fibre products, textile and wool, are manufactured by similar processes. Within the category in Ireland, formaldehyde and phenol are used. Usage and emission data have been sourced from one IPPC-regulated company which ceased operation in 2009. Estimates of NMVOC emissions from this source category are provided in Table 5.19.

Table 5.19. Non-Methane Volatile Organic Compound Emissions from Glass Wool Blowing/Enduction

Year	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
NMVOC (kt)	0.003	0.003	0.003	0.003	0.003	0.003	0.005	0.005	0.005	0.005	0.001

5.8.2 Fat, edible and non-edible oil extraction (SNAP 060404)

This sector covers solvent extraction of edible oils from oilseeds and drying of leftover seeds before resale as animal feed. The extraction of oil from oil seeds is performed either mechanically or through the use of solvents, or both. Where solvent is used, it is generally recovered and cleaned for reuse. The seed may be subjected to solvent treatment many times before all the oil is extracted. The remaining seed residue is then dried and may be used as an animal feed. This sector was recalculated in this submission using statistics obtained from the C.S.O on the national yield of oilseed The Inventory Guidebook (EMEP/EEA, 2016) Tier 2 emission factor of 1.57g/kg of seed was applied.

Table 5.20. Non-Methane Volatile Organic Compound Emissions from Fat, edible and non-edible oil extraction

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.031	0.020	0.014	0.022	0.028	0.050	0.032	0.037	0.044	0.088	0.092	0.077	0.054	0.063

5.8.3 Application of Glues and Adhesives (SNAP 060405)

This sector covers the use of all adhesives excluding domestic adhesive usage and includes adhesive and magnetic tape production (SNAP 060311). These data include adhesives used for publications and packaging, footwear, construction, transport equipment, rubber and plastic products, abrasives, engineering, laminating and other sectors.

This estimate is based upon net consumption statistics (import minus export data) and the Inventory Guidebook (EMEP/EEA, 2016) default emission factor of 522 g/kg of adhesive. The methodology is considered a Tier 2 method. Estimates of NMVOC emissions from the application of glues and adhesives are provided in Table 5.21.

Table 5.21. Non-Methane Volatile Organic Compound Emissions from Application of Glues and Adhesives

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.540	0.313	0.755	2.986	3.263	4.610	3.138	2.031	1.121	1.293	0.872	0.702	0.972	1.123

5.8.4 Preservation of Wood (SNAP 060406)

This section refers to emissions from the industrial use of wood preservatives. It does not include emissions from the surface coating of timber with paints, varnishes or lacquer (which are covered under SNAP 060107), and it does not cover the use of wood preservatives by the public at large (which is covered under SNAP 060408). Wood preservation is carried out using solvent-based preservatives, water-based preservatives or creosote. Creosote is an oil product, prepared from coal tar distillation, and contains a high proportion of aromatic compounds such as PAHs. Regulations banning the sale of creosote took effect from June 2003. However, creosote may still be used for industrial applications, e.g. railway sleepers, telegraph poles and fencing, but with tougher restrictions on its composition and how it is applied. Creosote is gradually being replaced by water-borne preservatives. Preservatives based on organic solvents have a wide-ranging content of organic solvent, usually white spirit or other petroleum-based hydrocarbons. Water-borne preservatives consist of solutions of inorganic salts in water, with Cu, Cr and As (CCA)-based preservatives being the most widely used. Water-borne preservatives are not of concern to this inventory, as they do not contain VOCs.

In addition to bottom−up IPPC-licensed data, usage data was provided by the sole Creosote using company in Ireland. The Inventory Guidebook (EMEP/EEA, 2016) emission factor of 105 g/litre creosote applied is used. The methodology is considered a Tier 3 method Estimates of NMVOC emissions from wood preservation are provided in Table 5.22.

Table 5.22. Non-Methane Volatile Organic Compound Emissions from Preservation of Wood

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	1.150	1.026	0.578	0.145	0.147	0.174	0.314	0.294	0.616	0.336	0.468	0.313	0.322	0.275

5.8.5 Underseal Treatment and Conservation of Vehicles (SNAP 060407)

The application of coatings to the underside of car bodies is conducted for protection from stone chips and for sound deadening. In the aftermarket sector, coatings are applied to the underside of cars only during repair of damaged bodywork. Finn et al. (2001) stated that sources within the trade suggested that application of underseal in Ireland was zero or minimal. However, further contact with suppliers revealed that a market of 650 l/annum existed at the time (1998). It is assumed that this market existed for all years prior to 1998. However, CTC/AEA (2005) suggested that this market no longer exists in Ireland and that emissions decreased in a linear fashion up to 2003, after which emissions from the activity no longer occur. The approach uses an average solvent content of 20 per cent, a density of 1,000 kg/m^3, and assumes that 100 per cent of the solvent is emitted. Estimates of NMVOC emissions from this source category are provided in Table 5.23.

Table 5.23. Non-Methane Volatile Organic Compound Emissions from Underseal Treatment and Conservation of Vehicles

Year	1990	1995	2000	2001	2002	2003
NMVOC (Kg)	130	130	87	65	43	22

5.8.6 Vehicle Dewaxing (SNAP 060409)

In the past, some manufacturers of new cars applied a protective covering to parts of the car body after painting to provide protection during transport. Removal of this coating was carried out at the import centres using solvents. However, car manufacturers now invariably use either water-soluble wax that can be removed using hot water or self-adhesive film instead of wax. Consequently, it is assumed that emissions from this activity are now zero. Discussion with car distributors suggested that, historically, 20 per cent of new cars in Ireland were dewaxed and that the practice was discontinued after 2003. An emission factor of 1 kg/car is applied to estimate emissions using vehicle statistics provided by the CSO (Finn et al., 2001). Estimates of NMVOC emissions from vehicle dewaxing are provided in Table 5.24.

Table 5.24. Non-Methane Volatile Organic Compound Emissions from Vehicle Dewaxing

Year	1990	1995	2000	2001	2002	2003
NMVOC (kt)	0.035	0.035	0.023	0.017	0.012	0.006

5.8.7 Use of Tobacco (SNAP 060602)

This category is estimated for the first time in this submission. It comprises NMVOC emissions from the combustion (smoking) of tobacco products. Activity data was obtained from The Office of the Revenue Commissioners regarding the excise volumes of tobacco and includes an estimation of Illegal tobacco imported to Ireland from an illegal products research report produced by the Office of the Revenue Commissioners (Office of the Revenue Commissioners, 2015). The Inventory guidebook (EMEP/EEA, 2016) Tier 2 emission factor of 4.84 g/kg of tobacco is applied. Estimates of NMVOC emissions from Use of Tobacco are provided in Table 5.25.

Table 5.25. Non-Methane Volatile Organic Compound Emissions from Use of Tobacco

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.034	0.037	0.039	0.032	0.032	0.031	0.028	0.027	0.024	0.025	0.023	0.020	0.019	0.020

5.9 Food and Beverage Industry (NFR 2H2)

According to the EMEP/EEA Guidebook (EMEP/EEA, 2016) this sector includes emissions from all processes in the food production chain which occur after the slaughtering of animals and the harvesting of crops as well as drink manufacturing including production of alcoholic beverages. For Ireland Wine (040606) is not occurring and Sugar production (040625) and Flour production (040626) are not estimated. Emissions include Spirit production, Animal feed production and Bread production which are the most significant source of emissions in the Food and Beverage industry in Ireland. The 6 subcategories for which emission estimates are made for Ireland are as follows with the relevant SNAP code in parentheses, where applicable:

Bread (SNAP 040605)

Beer (SNAP 040607)

Spirits (SNAP 040608)

Meat fish etc. frying/curing (SNAP 040627)

Coffee Roasting

Feedstock

5.9.1 Bread (SNAP 040605)

This sector includes bread, cakes and baking products. Activity data on white bread and bread products production was obtained from EUROSTAT for years 1995 to 2015. The data for years 1990-1994 was taken to be the same as 1995 as no data was available for these years. Emissions from cakes were not included in this estimate as no activity data was available. Tier 2 emission factors from the Inventory guidebook (EMEP/EEA, 2016) were used for bread and cakes, biscuits and breakfast cereals i.e. baking goods. The NMVOC emissions from Bread are given in table 5.26.

Table 5.26. Non-Methane Volatile Organic Compound Emissions from Food and Beverage Industry; Bread

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	1.707	1.707	1.006	1.374	1.495	1.512	1.631	1.472	2.577	1.707	1.593	1.838	1.714	1.696

5.9.2 Beer (SNAP 040607)

This includes mainstream beer production and craft beer production which has seen a steady increase since 2005 and a significant increase in Ireland since 2010. Activity data was obtained from a variety of sources including the Irish Brewers Association reports and Independent Craft Brewers of Ireland and Bord Bia Report. The Inventory Guidebook (EMEP/EEA, 2016) Tier 2 emission factor of 0.035 kg/hL was used. The NMVOC emissions from Beer production is given in table 5.27.

Table 5.27. Non-Methane Volatile Organic Compound Emissions from Food and Beverage Industry; Beer

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.194	0.207	0.225	0.250	0.256	0.266	0.272	0.274	0.274	0.274	0.288	0.282	0.258	0.276

5.9.3 Spirits (SNAP 040608)

Spirit production is a significant source of NMVOC emissions within the Food and Beverage industry due to the growth of the Whiskey production industry in Ireland. Activity data was obtained for the years 2008, 2013 and 2014 from the Irish Whiskey Association Report (Irish Whiskey Association, 2015) and Irish Spirits Association data (Irish Spirits Association, 2015). Other years were extrapolated using this data. A Tier 2 emission factor of 15kg/hl alcohol was used from the Inventory Guidebook (EMEP/EEA, 2016). NMVOC emissions from Spirit production in Ireland are given in table 5.28.

Table 5.28. Non-Methane Volatile Organic Compound Emissions from Food and Beverage Industry; Spirits

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	3.382	4.093	4.803	5.514	5.656	5.798	5.940	6.426	6.912	7.398	7.884	8.370	9.521	10.776

5.9.4 Meat, fish etc., frying/curing (SNAP 040627)

Emissions mainly occur from the cooking of meat, fish and poultry, releasing fats and oils and their degradation products. Emissions from fish frying and curing were not estimated due to absence of accurate activity data. AD for fish frying is under investigation and included in the planned improvement section 5.13. Activity data was obtained from the CSO on tonnes of animal slaughterings in Ireland this was taken to be the equivalent of meat rendered in Ireland the Inventory guidebook (EMEP/EEA, 2016) emission factor of 0.33 kg/Mg of meat rendered was used. Activity data on human consumption of meat from the CSO was taken to equate to meat frying and using the Inventory Guidebook (EMEP/EEA, 2016) emission factor of 0.3 kg/Mg product was used this is considered a Tier 2 method. The NMVOC emissions from meat frying/curing are given in table 5.29.

Table 5.29. Non-Methane Volatile Organic Compound Emissions from Food and Beverage Industry; Meat, fish etc. frying/curing

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.398	0.402	0.450	0.438	0.446	0.439	0.424	0.405	0.425	0.426	0.415	0.424	0.457	0.459

5.9.5 Coffee Roasting

The roasting of coffee beans is a source of NMVOC emissions. This activity does not have a relevant SNAP code. Activity data for unroasted coffee imports was obtained from the UN Comtrade Database and the emission factor from the Inventory Guidebook (EMEP/EEA, 2016) Tier 2 emission factor was used to estimate emissions as can be seen in table 5.30.

Table 5.30. Non-Methane Volatile Organic Compound Emissions from Food and Beverage Industry; Coffee roasting

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.001	0.001	0.002	0.003	0.003	0.003	0.002	0.001	0.001	0.003	0.003	0.003	0.003	0.005

5.9.6 Feedstock

The processing of by-products to produce animal feeds is a source of NMVOC emissions in Ireland. The tonnage of animal feed produced was sourced from the CSO and the Inventory Guidebook (EMEP/EEA, 2016) emission factor of 1 kg/Mg feed was used to estimate emissions from this source as can be seen in table 5.31.

Table 5.31. Non-Methane Volatile Organic Compound Emissions from Food and Beverage Industry; Feedstock

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	3.351	3.222	3.100	2.700	3.019	2.583	2.636	2.263	2.490	2.466	3.425	3.655	3.063	3.228

5.10 Recalculations in the Solvent and Other Product Use Sector

Recalculations occurred in this reporting round due to the completion of a study designed to update the NMVOC emissions estimate for 2012 to 2013, which was subsequently reviewed and information and emission factors contained therein updated to take account of changes to methodologies and emission factors in the latest Inventory Guidebook (EMEP/EEA, 2016). This project focused on updating activity data, emission factors and in some cases methodologies as outlined in Barry, S. and O' Regan, B. (2015). All recalculations are presented in Table 5.32.

Domestic solvent use including fungicides (NFR 2D3a) Revisions were made to domestic solvent usage (SNAP 060408) to update to the emission factors used from the latest Inventory Guidebook (EMEP/EEA 2016). This resulted in a decrease (12.3 per cent on average) in emission estimates across the time series.

Coating Application (NFR 2D3d)

Revisions were made to several SNAP codes within this sector resulting in recalculations of an average of 5.5 per cent across the time series. The recalculations include:

- Revisions were made to SNAP 060103 Paint Application; Construction and Buildings and 060104 Paint application; Domestic uses (except 060107). Product sales for these SNAP codes were extrapolated for years 1990-1999 using GDP. The OECD GDP figures changed due to recalculation based on the change of reference year from 2005 to 2010. This caused a change in the emissions estimates for these years.

- Revisions were made to SNAP code 060107: Wood Paint Application. This activity is scaled from UK emissions data. For the years 2011-2014 updated data was used from NAEI which resulted in a recalculation of emissions based on latest available UK emissions data.
- Revisions were made to SNAP 060108: Other Industrial paint application. Emissions for years 1990-1997 and 1999-2003 are extrapolated using GDP. The OECD GDP figures changed due to recalculation based on the change of reference year from 2005 to 2010. This caused a change in the emissions estimates for these years.
- SNAP 060109: Non Industrial Paint Application This activity is scaled down from UK emissions data. For the years 1990-2014 updated data was used from NAEI which resulted in a recalculation of emissions based on latest available UK emissions data.

Degreasing and Dry Cleaning (NFR 2D3e and 2D3f)

- Revisions were made to Degreasing (SNAP 060201, 060203, 060204) as a minor revision was made to average Perchloroethylene usage in Dry cleaning was revised which impacted perchloroethylene consumption statistics. This resulted in a small recalculation.
- Revisions were made to Dry Cleaning (SNAP 060202) due to a minor revision to average Perchloroethylene usage due to the inclusion of emissions data made available as a result of data collected under the Solvent Directive (1999/13/EC) for 2012.

Chemical products (NFR 2D3g)

- Revisions were made to Pharmaceutical Production (060306). These revisions were a result of improved quality of reporting by facilities and changes made to the upscaling calculation.
- Revisions were made to Paints manufacturing (060307) due to improved quality of reporting by licenced facilities and updated emissions data.
- Revisions were made to Inks manufacturing (060308) due to changes to figures extrapolated for years 2002-2007. The emissions reported by one licenced facility were removed as they are included elsewhere in SNAP 060309.
- Revisions were made to Adhesive manufacture (060309). These revisions were a result of improved quality of reporting by operators and changes made to the upscaling calculation for years 2008-2014.

Printing (NFR 2D3h)

- Revisions are a result of improved quality of reporting by licenced facilities and revisions made to the upscaling methodology for years 2008-2014.

Other solvent and product use (NFR 2G)

- Emissions from fat, edible and non-edible oil extraction (060404) were revised as new activity data was obtained for the years 2008-2015. Emissions for years 1990-2007 were reported for the first time in this submission.
- Revisions were made to Preservation of wood (060406). Emissions for years 1990-1999 are extrapolated using GDP. The OECD GDP figures changed due to recalculation based on the change of reference year from 2005 to 2010. This caused a change in the emissions estimates for these years.

- Revisions were made to Underseal treatment and conservation of vehicles (060407). Emissions for years 1998-2002 were reported incorrectly for the time series. This was corrected in 2017.
- Tobacco burning was also included in the emission inventory for the first time in this submission.

Food and Beverages Industry (NFR 2H2)

Emissions from this sector were estimated for the first time in this submission following a review of the completeness of reporting of NMVOC emissions sources. The following SNAP codes reported estimated emissions for time series 1990-2015; Bread (SNAP 040605), Beer (SNAP 040607), Spirits (SNAP 040608), Meat fish etc. frying/curing (SNAP 040627), Coffee Roasting, Feedstock.

Table 5.32 Recalculations for Solvent and Other Product Use 1990–2014

NFR Category	Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016															
2.D.3.a Domestic solvent use including fungicides	NMVOC	kt	9.041	9.288	9.773	10.661	10.917	11.285	11.567	11.692	11.747	11.799	11.826	11.846	11.888
2.D.3.b Road Paving	NMVOC	kt	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.D.3.c Asphalt Roofing	NMVOC	kt	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.D.3.d Coating Applications	NMVOC	kt	7.552	7.266	6.803	6.257	6.439	6.639	5.180	4.099	3.272	3.231	2.998	3.632	3.663
2.D.3.e Degreasing	NMVOC	kt	1.744	2.387	0.858	0.954	1.674	1.639	1.546	0.778	0.888	0.934	1.017	0.909	0.937
2.D.3.f Dry Cleaning	NMVOC	kt	0.282	0.273	0.090	0.085	0.124	0.106	0.093	0.063	0.053	0.058	0.075	0.057	0.070
2.D.3.g Chemical products manufacturing or processing	NMVOC	kt	3.023	3.024	2.786	1.138	1.157	1.575	1.384	1.652	0.865	1.005	1.314	1.658	1.270
2.D.3.h Printing	NMVOC	kt	2.91	2.91	1.95	1.87	2.12	2.12	1.61	2.62	1.93	1.99	1.45	1.51	1.55
2.D.3.i, 2G Other solvent and product use	NMVOC	kt	1.341	1.056	1.359	3.136	3.415	4.789	3.452	2.327	1.739	1.632	1.343	1.280	1.327
2.H.2 Food and Beverages Industry	NMVOC	kt	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Submission 2017															
2.D.3.a Domestic solvent use including fungicides	NMVOC	kt	7.927	8.143	8.568	9.347	9.571	9.894	10.141	10.250	10.298	10.344	10.368	10.385	10.422
2.D.3.b Road Paving	NMVOC	kt	0.035	0.027	0.046	0.054	0.056	0.053	0.045	0.053	0.037	0.029	0.030	0.029	0.029
2.D.3.c Asphalt Roofing	NMVOC	kt	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.D.3.d Coating Applications	NMVOC	kt	6.047	6.004	6.310	6.238	6.406	6.604	5.452	4.273	3.378	3.381	3.234	3.921	4.294
2.D.3.e Degreasing	NMVOC	kt	1.744	2.386	0.847	0.953	1.674	1.557	1.531	0.789	0.885	0.925	1.004	0.902	0.922
2.D.3.f Dry Cleaning	NMVOC	kt	0.282	0.272	0.090	0.085	0.124	0.105	0.093	0.063	0.053	0.058	0.075	0.057	0.068
2.D.3.g Chemical products manufacturing or processing	NMVOC	kt	3.023	3.024	2.786	1.189	1.247	1.470	1.486	1.888	0.999	1.149	1.224	1.248	1.083
2.D.3.h Printing	NMVOC	kt	2.912	2.912	1.946	2.126	2.628	2.118	1.393	2.360	2.474	1.788	1.217	1.283	1.400
2.D.3.i, 2G Other solvent and product use	NMVOC	kt	1.794	1.434	1.412	3.190	3.475	4.871	3.512	2.389	1.806	1.741	1.455	1.112	1.367
2.H.2 Food and Beverages Industry	NMVOC	kt	9.033	9.632	9.587	10.279	10.875	10.600	10.904	10.841	12.679	12.274	13.608	14.572	15.016
% Change in Emissions															
2.D.3.a Domestic solvent use including fungicides	NMVOC	%	-12.3%	-12.3%	-12.3%	-12.3%	-12.3%	-12.3%	-12.3%	-12.3%	-12.3%	-12.3%	-12.3%	-12.3%	-12.3%
2.D.3.b Road Paving	NMVOC	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2.D.3.c Asphalt Roofing	NMVOC	%	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.D.3.d Coating Applications	NMVOC	%	-19.9%	-17.4%	-7.2%	-0.3%	-0.5%	-0.5%	5.2%	4.3%	3.2%	4.6%	7.9%	8.0%	17.2%
2.D.3.e Degreasing	NMVOC	%	0.0%	0.0%	-1.3%	-0.1%	0.0%	-5.0%	-1.0%	1.4%	-0.3%	-0.9%	-1.3%	-0.8%	-1.6%
2.D.3.f Dry Cleaning	NMVOC	%	-0.2%	-0.2%	-0.2%	0.1%	-0.1%	-0.2%	-0.2%	-0.2%	0.8%	-0.3%	-0.3%	-0.2%	-2.4%
2.D.3.g Chemical products manufacturing or processing	NMVOC	%	0.0%	0.0%	0.0%	4.4%	7.8%	-6.7%	7.4%	14.2%	15.4%	14.4%	-6.8%	-24.7%	-14.7%
2.D.3.h Printing	NMVOC	%	0.0%	0.0%	0.0%	13.6%	24.1%	0.0%	-13.6%	-9.9%	28.5%	-10.4%	-16.2%	-15.1%	-9.4%
2.D.3.i, 2G Other solvent and product use	NMVOC	%	33.8%	35.7%	3.9%	1.7%	1.8%	1.7%	1.7%	2.7%	3.8%	6.7%	8.4%	-13.1%	3.0%
2.H.2 Food and Beverages Industry	NMVOC	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Total	NMVOC	%	21.0%	22.5%	25.2%	28.0%	28.3%	24.5%	28.1%	29.4%	37.2%	34.8%	37.8%	37.6%	40.2%

5.11 Quality Assurance/Quality Control

The time series spreadsheet system developed for individual categories as described in Section 1.3.5 now allows for simple and efficient checking of activity data, emission factors, annual emissions and aggregated totals. Year-on-year changes immediately highlight any omissions, anomalies or internal errors. Initial checks are conducted by the inventory compiler as part of the calculation process, which is followed by a second check by another member of the inventories team and completion of the QA/QC sheets in calculation workbooks.

5.12 Overview of Notation Keys

Table 5.33 describes the notation keys used in the 2015 NMVOC emission inventory for Other Solvent and Product Use (2D-2L).

Table 5.33 Notation keys used in NMVOC emission inventory for NFR 2D-2L

NFR	Snap	Description	Notation Key	Reason
2D3a	060411	Domestic use of pharmaceutical products	IE	Included in 060408
2D3e	060203	Electronic components manufacturing	IE	Included under metal degreasing
2D3e	060204	Other industrial cleaning	IE	Included under metal degreasing
2D3g	060311	Adhesive, magnetic tapes, films and photographs manufacturing	IE	Included under 060405

5.13 Planned Improvements

The inventory team plans to continue the practice of outsourcing contracts on a periodic basis to re-examine and extend the inventory time series for emissions from Solvent and Other Product Use. This approach has been found to be an efficient way of compiling the estimates for sources and gases that the inventory experts in the EPA have not worked on in detail in the past.

The levels of solvent use and the emissions from solvents are changing substantially in response to product replacement and reformulation and emission controls being implemented under IPPC and the Solvents Directive (1999/13/EC). The reduction of solvent content has been captured in the methodologies, but this has relied on a number of assumptions, and the collection of real data is required to determine emissions with improved confidence.

In addition, liaison with industry will allow refinement of the estimates for activities subject to licensed controls and to reflect abatement measures in the time series. However, the per capita approach to estimating NMVOC emissions will remain the only option in several important categories, such as SNAP code 060107 (Paint Application: Wood).

Future improvements include refining the assumptions used in the current emission estimate. In particular, future work will investigate estimating historic values for NMVOC emission factors to more accurately reflect both product formulations and emissions in Ireland. The assumptions used in the current emission estimate will be further investigated and refined. These include further investigating product breakdown used in domestic solvent use (SNAP 060408), vehicle refinishing product sales (SNAP code 060102), decorative paint product sales (SNAP codes 060103 and 060104) and Meat and Fish frying (040627).

Chapter Six Agriculture

6.1 Overview of the Agriculture (NFR 3) Sector

The Agriculture sector is the largest source of NH_3 in Ireland and at 106.88 kt accounted for 98.8 per cent of national total NH_3 emissions (108.13 kt) in 2015. The vast majority of the remainder of national total emissions is attributable to Road Transport (1A3b) and a small fraction to combustion in the Industrial (1A2), Commercial (1A4a) and Residential (1A4b) sectors (detailed analyses of those sectors can be viewed in Chapter 2 Trends and Chapter 3 Energy). In the estimation of NH_3 emissions from agriculture, two different sources are generally distinguished: animal manure and synthetic fertiliser. Emissions of NH_3 from agriculture in Ireland's inventory are calculated using a Tier 2 approach developed by a member of the inventory team. The methodologies employed follow those utilised by Misselbrook et al. (2010, 2004) and the Inventory Guidebook (EMEP/EEA, 2013) and are described in the following sections. In previous submissions Ireland employed a Tier 2 emission factor based approach which followed those utilised by Misselbrook et al. (2004) and Hyde et al. (2003). The new methodology is based largely on the UK National Ammonia Reduction Strategy Evaluation System (NARSES) model for emissions from livestock and where required the Inventory Guidebook (EMEP/EEA, 2013) is also used. For the calculation of NH_3 emissions from nitrogen fertilizer application the Tier 2 approach provided in the Inventory Guidebook (EMEP/EEA, 2013) is adopted.

The trend in emissions of NH_3 from agricultural sources is shown in Figure 6.1. Management of animal manures produced 51.9 per cent of NH_3 emissions from agriculture in 2015, with the application of inorganic fertiliser and animal manures deposited and applied to soils (47.5%) accounting for the remainder. The NH_3 emission trend is largely determined by the cattle population and shows a steady increase up to 120.45 kt in 1998 (an increase by 14.2 per cent from 1990). There has been some decline in the populations of cattle and sheep since 1999, as well as a decrease in fertiliser use, which contributed to a downturn in NH_3 emissions in the 1999−2011 period. The NH_3 emissions from the agriculture sector in 2015 were 2.5 per cent higher than the emission levels in 1990 (105.51 kt) and 10.2 per cent lower than the peak levels in 1998.

Emissions of NMVOC, TSP, PM_{10} and $PM_{2.5}$ from manure management (3B) were estimated for the first time in the 2015 submission. Previously, inorganic fertilisers (3Da1) were the only category estimated for agriculture NMVOCs.

NMVOCs from agriculture are estimated to be 43.08 kt in 2015, accounting for 42.5 per cent of the NMVOC inventory total (101.34 kt). Emissions from manure management (3B) make up 92.2 per cent of agriculture related NMVOC in 2015, with the remaining 7.8 per cent from the application of Inorganic N-fertilisers (3Da1). For the calculation of NMVOC emissions, the Tier 1 and 2 approaches provided in the Inventory Guidebook (EMEP/EEA, 2013) are adopted.

Estimates for agriculture emissions of TSP, PM_{10} and $PM_{2.5}$ contribute significantly to national totals for these pollutants, accounting for 49.5 per cent, 45.5 per cent and 15.5 per cent of national totals respectively. For these calculations, Tier 1 and 2 approaches provided in the Inventory Guidebook (EMEP/EEA, 2013) are adopted.

The use of particular pesticides for arable farming can be a source of POP emissions, notably due to the trace content of HCB within some pesticides as a contaminant from the manufacturing process. Emissions of HCB from NFR Sector 3Df (Use of pesticides) are a key category in 2015, accounting for 68.5 per cent of national total HCB emissions.

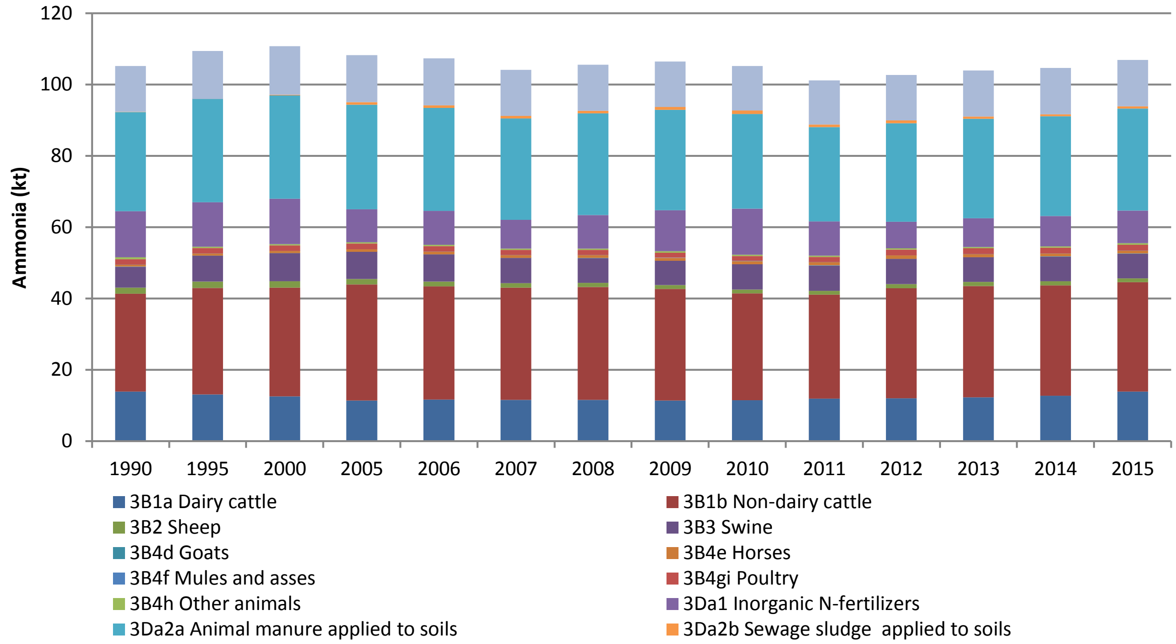

Figure 6.1. Emission Trend for Ammonia from Agriculture 1990−2015

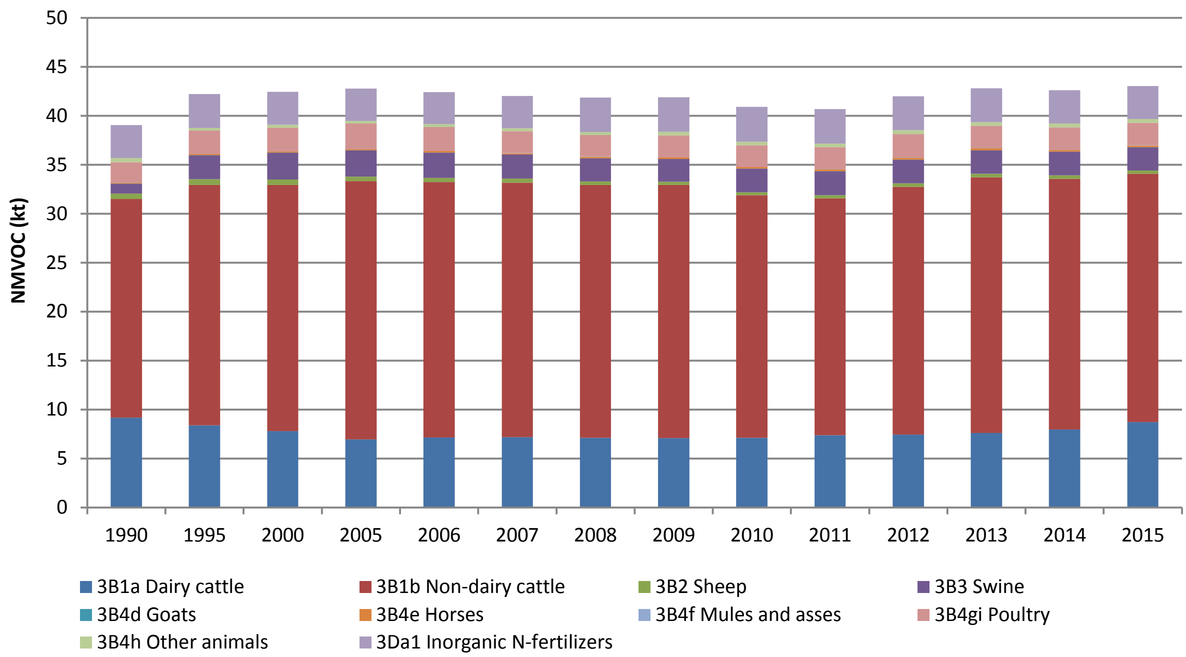

Figure 6.2. Emission Trend for NMVOC from Agriculture 1990−2015

6.2 Manure Management (NFR 3B)

The following sections outline the activity data, assumptions and calculations utilised in estimating NH_3, NMVOC, TSP, PM_{10} and $PM_{2.5}$ emissions from agriculture in Ireland. For

NH_3, the Tier 2 methodology uses a mass flow approach based on the concept of the flow of Total Ammoniacal Nitrogen (TAN) through the manure management system. Emissions are calculated for the same animal sub-categories as those utilised in Ireland's national greenhouse gas inventory (Table E.1 Annex E). The first step in the mass flow approach is the estimation of total annual nitrogen excretion by the animals. For dairy cows and suckler cows, Ireland utilises the method described in 2006 IPCC Guidelines (IPCC, 2006), chapter 10, further enhanced by country specific data on feeding practices and milk production (O'Mara, 2007, Duffy et al., 2017) to estimate N excretion. For all other categories of livestock, national values are utilised. Total nitrogen excretion is then apportioned to that which is deposited in buildings, collection yards (only applicable to dairy cows during milking) and grazing and the TAN for each category of animal is assigned accordingly to Table E.3 Annex E.

The method used to estimate NMVOC emissions is the tier 2 approach based on emission factors from Table 3.9 and Table 3.10 of the Inventory Guidebook (EMEP/EEA, 2013) for cattle, sheep, swine, goats, horses and mules and asses. A tier 1 approach is used to estimate NMVOC for poultry, fur animals and farmed deer using emission factors from Table 3-3 of the Inventory Guidebook (EMEP/EEA, 2013). The tier 2 approach considers NMVOC emissions from the following; silage stores, silage for feeding, housing, outdoor manure stores, manure application and from grazing animals as outlined in section 3.3.2 of the Inventory Guidebook (EMEP/EEA, 2013). The tier 1 approach for poultry, fur animals and farmed deer use the emission factor without silage feeding.

For TSP, PM_{10} and $PM_{2.5}$ emissions are estimated based upon animal numbers using a Tier 2 method for cattle and pigs and emission factors from Guidebook (EMEP/EEA, 2013) Table 3.11 of the Inventory Guidebook (EMEP/EEA, 2013). PM emissions from all other animal types are estimated using a tier 1 method and emission factors from Table 3.3 of the Inventory Guidebook (2013).

See Tables E.6 to E.9 of Annex E for additional information of the EFs used.

6.2.1 Cattle (NFR 3B1)

A Farm Facilities Survey conducted in 2003 (Hyde et al., 2008) provides the basis for the calculation of the number of days housed and the number of days spent grazing by cattle on farms in Ireland. National averages are used for the purpose of inventory calculations. Data for the number of days housed are presented in Table E.2.1. The number of days spent grazing is then calculated by subtracting these values from 365 (i.e. days in a year).

Two housing types are distinguished for cattle production systems in Ireland − liquid (slurry-based) and solid-manure-based housing. As a result of differing management practices on farms, a proportion of each of the cattle subdivisions is not housed (out-wintered) and therefore graze pasture for the full year. The proportion of each class of cattle that is managed in this manner is accounted for in Table E.2.1. For liquid manure based housing an emission factor of 32 per cent of the TAN available in liquid based housing is applied (Misselbrook et al., 2010). For solid manure based housing, emission factors of 23 per cent and 8 per cent of the TAN available in solid manure based housing are applied to cattle housed on straw and calves housed on straw, respectively (Misselbrook et al., 2010).

In addition to animal housing, emissions are estimated for cow collecting yards used during milking using an emission factor of 22.5 per cent of the TAN available (Misselbrook et al., 1998).

The storage of both liquid and solid manure is considered. Liquid manure is stored either below the animals in slatted floor housing or removed from the house to outdoor storage.

Emissions are calculated separately for indoor and outdoor storage. It is assumed that a crust will form in the indoor under slat storage. A fraction of the organic nitrogen in liquid manure is mineralised to TAN before emissions are calculated. A value of 0.1 (Dammingen et al., 2007) is applied. To fully account for all losses of N from liquid manure during storage estimates are made of N_2O, NO and N_2 losses during storage utilising the emission factors provided in Table 3.6 and Table 3.8 Chapter 3.B of the Inventory Guidebook (EMEP/EEA, 2013). An emission factor of 5 per cent of the TAN available in liquid manure stores is applied to estimate NH_3 emissions from liquid manure storage (Misselbrook et al., 2010).

Solid manure is generally stored in the shed or outside in heaps. The contribution of the nitrogen content of straw used for bedding is accounted for by utilising the data presented in Table 3-5 Chapter 3.B of the Inventory Guidebook (EMEP/EEA, 2013). Where manures are managed as solid, a fraction of the TAN is immobilised in organic matter. Immobilisation of nitrogen reduces the potential for NH_3 emissions from solid manures during storage and after landspreading. The value proposed in the Inventory Guidebook (EMEP/EEA, 2013) of 0.0067 kg kg $^{-1}$ (Kirchmann and Winter, 1989) is applied. To fully account for all losses of N from solid manure during storage estimates are made of N_2O, NO and N_2 losses during storage utilising the emission factors provided in Table 3-6 and Table 3-8 Chapter 3.B of the Inventory Guidebook (EMEP/EEA, 2013). An emission factor of 35 per cent of the TAN available in solid manure stores is utilised (Misselbrook et al., 2010).

Landspreading emissions are calculated by estimating the quantity of TAN available post storage of the manure (both liquid and solid) and accounting for the period of the year in which it is spread (i.e. spring, summer, autumn and winter) as outlined in Table E.5 Annex E. For liquid manure, a dry matter range of 4 to 8 per cent is assumed and two emission factors are applied, 48 per cent of the TAN available for the proportion applied in summer and 26 per cent for proportion applied in spring, autumn and winter (Misselbrook et al., 2010). For solid manure an emission factor of 68 per cent of the TAN available is applied regardless of the period of the year in which it is spread (Misselbrook et al., 2010). It is assumed that all cattle slurry is applied using the splashplate method and that all solid manure is broadcast spread.

For cattle grazing an emission factor of 6 per cent of the TAN available at grazing is applied (Misselbrook et al., 2010).

NMVOC emissions are estimated using Tier 2 emission factors from the Inventory Guidebook (EMEP/EEA, 2013). Estimates are made for housed cattle, manure storage, manure application, grazing cattle and for silage feeding / store based upon grass and silage feed intake data which is linked to the Tier 2 emission models developed to estimate methane emissions from cattle.

Emissions of TSP, PM_{10} and $PM_{2.5}$ are estimated using Tier 2 emission factors split by cattle type and housing category (liquid/solid housing).

6.2.2 Sheep (3B2)

Sheep in Ireland are categorised into those on upland and those on lowland areas. Four subcategories exist within both upland and lowland areas, namely ewes, rams, lambs and other sheep more than 1 year old. The CSO publishes sheep population statistics on an annual basis and, to derive the number of head on both lowland and upland areas, a number of assumptions are made as follows based on expert opinion. Total ewe and ram numbers are taken as the mean of the June and December CSO censuses. On this basis, the number of ewes and rams are subdivided using the ratio 55:45 (lowland/upland) for years up to and including 1997. For 1998 to 2004 inclusive, a ratio of 70:30 is used, reflecting the destocking of upland areas. For 2005 onwards, a ratio of 80:20 is used. The total number of lambs slaughtered in any 1-year period is used as the activity data for lambs. Monthly lamb slaughtering figures are available from the CSO. From 2001 onwards, these numbers are adjusted for the number of lambs that originate in Northern Ireland and that are slaughtered in Ireland and also for the number of lambs that are reared in the Republic but slaughtered in Northern Ireland. National totals are then subdivided similarly to the other categories of sheep. The numbers of other sheep over 1 year old are calculated from unpublished CSO data. Population statistics for each subcategory of sheep are presented in Table E.1, Annex E. Input data with respect to manure management practices are presented in Table E2.2 Annex E. Nitrogen excretion coefficients for all sub categories of sheep are provided in Table E.3 Annex E.

For sheep grazing, the emission factor applied for cattle of 6 per cent of the TAN available at grazing is utilised.

The emission factor for sheep housing is derived by adjusting the housing emission factor for beef cattle on solid manure systems by the ratio of excretal outputs of sheep and beef cattle which is then back-calculated to derive a value of 22 per cent of the TAN available in sheep housing (Misselbrook et al. 2010). Information on the number of days that sheep are housed during the winter period is derived from the Farm Facilities Survey (Hyde et al., 2008), which suggests a housing period of between 1.9 and 2.8 months for different animal classes. More specifically, lowland and upland ewes are assumed to be housed for 84 and 85 days/year. No differentiation is made for upland and lowland rams, lambs and other sheep >1 year old- being housed for 56, 28 and 67 days/year respectively. In Ireland, sheep are generally housed in solid-manure-based housing systems.

The NH_3 emission factors used for the storage and landspreading of solid manure used for Cattle (3B1) are also considered appropriate for sheep manure. For storage of solid manure and subsequent landspreading the emission factors for cattle are used. Account is also taken of the nitrogen added from straw used for bedding and the immobilisation of TAN in organic matter when solid manures are managed following the approach adopted for solid manure from cattle.

NMVOC emissions are estimated using Tier 2 emission factors from the Inventory Guidebook (EMEP/EEA, 2013) based on volatile solid (VS) excretion data. Estimates are made for housed sheep, manure storage, manure application and grazing sheep.

Emissions of TSP, PM_{10} and $PM_{2.5}$ are estimated using Tier 1 emission factors from Table 3.3 of Inventory Guidebook (EMEP/EEA, 2013).

6.2.3 Swine (NFR 3B3)

Detailed population statistics are available for seven subcategories of pigs in Ireland using national statistics published by the CSO as follows: sows in pig, gilts in pig, other breeding sows, boars, gilts not yet served and two categories of fattening pigs (<20 kg and >20 kg live weight). The CSO undertakes and publishes two censuses per year, one in June and one in December. The average of the two census values is used in deriving the pig populations in the seven subcategories, thus providing an appropriate measure of the number of pigs on farms for the purposes of the annual NH_3 emission inventory.

For the NH_3 inventory, it is assumed that all pigs are housed and that the housing systems are liquid/slurry-based. An emission factor of 33 per cent of the TAN in slurry produced by gilts in pig, gilts not yet served and pigs greater than 20 kg is applied. For sows in pig, other sows for breeding and boars, an emission factor of 19 per cent of the TAN produced in the slurry of these animal sub-categories is used and an emission factor of 15 per cent of the TAN in slurry produced by pigs under 20 kg.

For slurry storage, emissions of NH_3 are calculated separately for covered and uncovered stores based on the proportion of slurry stored in covered and uncovered storage. Emission factors of 13 per cent of the TAN available in covered storage and 52 per cent of the TAN available in uncovered slurry stores are applied (Misselbrook et al., 2010). As is the case with cattle slurry account is taken of the losses of N_2O, NO and N_2 according to Table 3-6 and Table 3-8 Chapter 4.B of the Inventory Guidebook (EMEP/EEA, 2009) and the mineralisation of organic nitrogen in the liquid manure is also accounted for.

It is assumed that all pig slurry is applied using the splashplate method. An emission factor of 19 per cent (Misselbrook et al., 2010) of the TAN available post storage is applied on the basis of pig slurry containing less than 4 per cent DM.

NMVOC emissions are estimated using Tier 2 emission factors from Table 3.10 of the Inventory Guidebook (EMEP/EEA, 2013) based on volatile solid (VS) excretion data. Estimates are made for housed pigs, manure storage and manure application.

Emissions of TSP, PM_{10} and $PM_{2.5}$ are estimated using Tier 2 emission factors from Table 3.11 of Inventory Guidebook (EMEP/EEA, 2013).

6.2.4 Poultry (NFR 3B4g)

Detailed population statistics are available for six subcategories of poultry in Ireland using national statistics collated by the Department of Agriculture as follows: layers, broilers, layer breeders, broiler breeders, turkeys and turkey breeders. The population statistics are provided in Table E.1, Annex E. The estimation of NH_3 emissions from poultry production utilises bird places as opposed to bird numbers so that production cycles are taken into account. The number of bird places is estimated from the annual bird population assuming that all bird places are full throughout the year after rest periods have been taken into account (rest periods are those periods after a production cycle in which the housing systems are emptied of all manure and bedding, thoroughly washed and prepared for the next batch of birds). In the case of broilers, there are 5.5 production cycles per year, with a 3- to 4-week rest period between production cycles. In the case of turkeys, there are 2.5 production cycles per year of approximately 120 days in length, with a 3- to 4-week rest period also applied. All other poultry subcategories have production cycles of over 1 year, and therefore no adjustments to population statistics are made.

It is assumed that all poultry are housed in some form of solid manure housing system. For a proportion of laying birds, free-range systems are in use, which consist of an area of grassland beside the bird house which the birds are allowed onto for a period of hours during the day. The percentage of laying birds that are housed in this type of system is based on statistics supplied by the Department of Agriculture, Food and Marine. An emission factor of 35 per cent of the uric acid nitrogen (UAN) is applied to the quantity of uric acid nitrogen which is deposited outdoors. Emission factors of 27 per cent, 8.1 per cent, and 19.2 per cent of UAN are applied to layer, broiler and turkey housing, respectively. The storage of poultry manure is separated into two classes, litter and layer manure. An emission factor of 17.8 per cent of UAN is applied to layer manure and 8.7 per cent for poultry litter (Misselbrook et al., 2010). To account for the loss of other nitrogen compounds, account is taken of the losses of N_2O, NO and N_2 according to Table 3-6 and Table 3-8 Chapter 3.B of the Inventory Guidebook (EMEP/EEA, 2013). It is assumed that all poultry manure is broadcast spread and an emission factor of 52.3 per cent of the UAN available post storage is applied (Misselbrook et al., 2010).

Tier 1 emission factors are applied to estimate NMVOC, TSP, PM_{10} and $PM_{2.5}$ emissions from poultry from Table 3-3 and Table 3.3 of Inventory Guidebook (EMEP/EEA, 2013).

6.2.5 Other livestock – Goats (NFR 3B4d), Horses (3B4e), Mules and Asses (NFR 3B4f) and Other Animals (3B4h)

Estimates were made for the first time in Ireland's 2015 submission for category Other Animals (3B4h). This category incorporates estimates for deer, mink and foxes and estimates are made for emissions of NH_3, NMVOC, TSP, PM_{10} and $PM_{2.5}$.

The categories goats (NFR 3B4d), Horses (NFR 3B4e) and Mules and Asses (NFR 3B4f) were included in NH_3 emission estimates for the first time in Ireland's 2012 submission and continue to be reported for all years. For goats the emission factors used in the estimation of NH_3 emissions are those used for lowland sheep in section 6.2.2. They are adjusted using the ratio of N excretion between the two animal species. For horses, mules and asses the emission factors presented in the Inventory Guidebook (EMEP/EEA, 2013) are utilised. NH_3 emissions for deer are based on beef cattle and emission factors from the Inventory Guidebook (EMEP/EEA, 2013). For mink and foxes, Tier 1 emission factors presented in the Inventory Guidebook (EMEP/EEA, 2013) are utilised.

NMVOC emissions are estimated for deer, mink and foxes using Tier 1 emission factors from the Inventory Guidebook (EMEP/EEA, 2013). Emissions from mink and foxes are estimated using the emission factors provided for fur animals. Tier 2 emission factors are applied for goats, horses, mules and asses, allowing for emissions to be split by proportion of animals housed / grazing. Emissions from manure storage and application are also estimated independently.

Tier 1 emission factors from the Inventory Guidebook (EMEP/EEA, 2013) are applied to estimate emissions of TSP, PM_{10} and $PM_{2.5}$ from goats, horses, mules and asses, mink and foxes. PM emissions from deer are not estimated, therefore the total emissions reported under subcategory Other Animals (3B4h) for these pollutants relate to emissions from mink and foxes only.

6.2.6 Uncertainties

There is extensive and up-to-date statistical data on all aspects of the agriculture sector in Ireland. The majority of this data is compiled and published by the Central Statistics Office and is the official source of the basic data for inventory purposes. The exception is for statistics on synthetic fertiliser use and the poultry population which are obtained from the Department of Agriculture Food and the Marine (DAFM). The CSO and DAFM are key data providers whose annual statistical inputs to the inventory agency are covered by Memorandum of Understanding (MOU) in Ireland's national system. As a result the uncertainty associated with animal population statistics is low at 1 per cent. The emission factor uncertainty associated with NH_3 emission factors for dairy and other cattle is 50 per cent and for all other livestock categories 100 per cent. The majority of NH_3 emission research is aimed at dairy cattle and other cattle therefore emissions from these categories are relatively well quantified in comparison to the other livestock categories. In comparison the uncertainties associated with NMVOC and PM_{10} emissions in agriculture are large due to the uncertainty (300 per cent) associated with the emission factors for both pollutants as discussed in the Inventory Guidebook (EMEP/EEA, 2013).

6.3 Agricultural Soils (NFR 3D)

6.3.1 Direct Soil Emissions of Ammonia - Inorganic N-fertilizers (NFR 3Da1)

The calculation of NH_3 emissions from nitrogen fertilizer application to agricultural soils utilises the Tier 2 approach outlined in chapter 3D of the Inventory Guidebook (EMEP/EEA, 2013). Total fertilizer sales and emission estimates for each year of the time series 1990-2015 (Table E.4, Annex E) are apportioned into the categories, Urea, CAN, Ammonium sulphate and other compounds according to the known sales of these compounds in each year as supplied to the inventory agency by the Department of Agriculture, Food and Marine. The calculation routine to estimate emissions utilises a range of mean spring air temperatures. The mean spring air temperature in Ireland is 6.5°C according to long term monitoring undertaken by the Met Eireann (Irish Meteorological Office) therefore one climatic region is adopted. No effect is applied for the application of nitrogen fertiliser to calcareous soils as the multiplier presented is for soils with a pH >7.0. The target soil pH for grassland and cereals in Ireland are 6.3 and 6.5, respectively. Using this approach the implied emission factor for urea is 13 per cent of the nitrogen applied and for all other compounds 1 per cent. See Table E.10 of Annex E for additional information of the EFs used.

6.3.2 Direct Soil Emissions of Non-Methane Volatile Organic Compounds - Inorganic N-fertilizers (NFR 3Da1)

Emissions of NMVOCs are estimated from the application of inorganic fertilisers (3Da1). The approach utilises the Inventory Guidebook (EMEP/EEA, 2013) simple methodology. An emission factor of 0.86 kg/ha (Table 3-1 chapter 3D) is applied to total fertilizer nitrogen sales.

6.3.3 Direct Soil Emissions of TSP, PM_{10} and $PM_{2.5}$ - Inorganic N-fertilizers (NFR 3Da1)

Estimates of TSP, PM_{10} and $PM_{2.5}$ were estimated from the application of inorganic fertilisers (3Da1) for the first time in Ireland's 2015 submission. The approach utilises the Inventory Guidebook (EMEP/EEA, 2013) simple methodology. The Inventory Guidebook lists the emission factor for TSP as 'not estimated'. In order to be consistent with inventory best practice, the Tier 1 emission factor for PM_{10} (1.56 kg/ha) has also been applied to estimate TSP from this category.

6.3.4 Direct Soil Emissions of NH_3 - Animal manure applied to soils (NFR 3Da2a)

Emissions from this subcategory were previously included in the totals under manure management (3B). Under the NFR 2014 reporting template these have now been split out and included under animal manure applied to soils (3Da2a). This subcategory covers emissions from the application of slurry (as TAN) to land. The TAN applied to land is back calculated as the remaining NH_3-N once emissions from storage (manure management phase) are removed. See section 6.2.2 above.

6.3.5 Direct Soil Emissions of NH_3 - Sewage sludge applied to soils (NFR 3Da2b)

Estimates of NH_3 were estimated from the application of sewage sludge (3Da2b) for the first time in Ireland's 2015 submission. The quantity of sewage sludge applied to land is estimated as part of the calculations for emissions of CH_4 and N_2O from wastewater in Ireland's Greenhouse Gas Inventory. The fraction of nitrogen volatilised is the same as applied in the GHG inventory, 0.2 kg NH3-N (IPCC, 2006).

6.3.6 Direct Soil Emissions of NH_3 - Urine and dung deposited by grazing animals (NFR 3Da3)

Emissions from this subcategory were previously reported under subcategory N-excretion on pasture range and paddock unspecified (4.D.2.c). The method follows the same approach as for NH_3 emissions from manure management systems, but applied to data on total N excreted at grazing for animals that are housed / outwintered.

6.3.7 Handling of Cereal Grains (NFR 3.D.d)

In this category, fugitive PM emissions in the form of TSP, PM_{10} and $PM_{2.5}$ are estimated from the bulk handling of cereal grains. The general method for estimating fugitive PM emissions involves multiplying the amount of material, which in this case is cereal grain (barley, wheat and oats), by an emission factor. Given the importance of agriculture to Ireland's economy, production statistics are freely available. Data in relation to the production of cereal grains are collated and provided by the Central Statistics Office (CSO). Emission factors of 100 g/t, 25 g/t and 4 g/t from the Inventory Guidebook are then applied to estimate emissions of TSP, PM_{10} and $PM_{2.5}$, respectively. Emission estimates of TSP, PM_{10} and $PM_{2.5}$ and activity data for cereal grains are presented in Table 6.1.

Table 6.1 Particulate Matter Emission Time Series from the Handling of Cereal Grains

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cereals (kt)	1,965	1,796	2,174	1,940	2,083	1,997	2,461	2,063	2,040	2,509	2,125	2,401	2,598	2,634
TSP (kt)	0.20	0.18	0.22	0.19	0.21	0.20	0.25	0.21	0.20	0.25	0.21	0.24	0.26	0.26
PM10 (kt)	0.049	0.045	0.054	0.048	0.052	0.050	0.062	0.052	0.051	0.063	0.053	0.060	0.065	0.066
PM2.5 (kt)	0.008	0.007	0.009	0.008	0.008	0.008	0.010	0.008	0.008	0.010	0.009	0.010	0.010	0.011

6.3.8 Uncertainties associated with Synthetic Fertilizer (3Da1), Organic fertilizers (3Da2c) and urine and dung deposited by grazing animals (3Da3).

Although losses of NH_3 from N-fertilisers applied to grass grazed by livestock are difficult to distinguish from subsequent NH_3 emissions from urine patches produced by grazing animals, those two emissions are calculated separately with emissions from grazing reported in 3Da3. The sources making the largest contributions to the overall uncertainty are ammonia losses from synthetic fertiliser use and animal manures deposited to pasture, range and paddock. The emission factors for these sources are currently assigned an uncertainty of ±200%, and they contribute to 95.6 per cent of the overall uncertainty.

6.4 Use of Pesticides (NFR 3.D.f)

The main source of POPs from pesticides is HCB contamination of currently used pesticides. Where available, annual pesticides usage data have been used, although for some years only import data are available and the use of import data to inform the annual usage estimates discounts any consideration of stockpiling (or use of existing supplies) of pesticides. In addition, the emission factors for HCB content in pesticides are typically based on quantities of the "active" ingredient, not the total weight of the pesticide. Import data are available for the years 1998−2006 for chlorothalonil and quintozene. Further to the import data, information has been gathered on pesticide usage. The Pesticide Usage Survey (No. 1) (DAF, 2003) for grassland and fodder crops quotes the quantity of chlorothalonil (weight of active ingredient) used as 6,903 kg. It should be noted that chlorothalonil is a fungicide mainly used with silage and therefore the greater use of this product is outside the spectrum of the 2003 study. The Pesticide Usage Survey (No. 2) (DAF, 2004) for arable crops quotes the use of chlorothalonil (weight of active ingredient) used as 190,776 kg. This is in comparison with the import that year which was 241,285 kg (weight of active ingredient).

The majority of emissions from pesticide usage enter the atmosphere due to the spraying application and subsequent volatilisation of POPs from the surface of plants. A paper investigating the ultimate fate of HCB from pesticide application (Xu, 2008) calculates the split of emissions to air, soil and water to be 70.2 per cent, 28.8 per cent and 1 per cent, respectively.

Total HCB emissions have been estimated on this basis. In addition, European legal approval sets a limit for HCB in chlorothalonil as 0.01 g/kg, whilst research in Canada (Benezon, 1999) indicates a working contamination of 0.018–0.026 g/kg, based on data from 1988 to 1998. European legislation also sets a limit for quintozene at 1 g/kg pesticide. Estimates presented here use 0.026 g/kg as a worst-case assumption on a linear progression to 2001 (the year that quintozene was banned), and from 2001 the European standard value has been applied. Emission estimates are presented in Table 6.2.

Table 6.2 Emission Estimates for Hexachlorobenzene Emissions from Pesticide Use

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
HCB (kg)	0.186	0.327	0.476	1.234	1.151	1.151	1.151	1.151	1.151	1.151	1.151	1.151	1.151	1.151

6.5 Recalculations in the Agriculture Sector

Recalculations in the agriculture sector are highlighted in tables 6.3 to 6.7. In this submission nitrogen excretion values for non-dairy (suckler) cows have been estimated using the method described in IPCC (2006), chapter 10, further enhanced by country specific data on feeding practices and milk production (O'Mara, 2007, Duffy et al., 2017). This has resulted in an on average 1 per cent increase in NH_3 emissions from 3B1b across the time series, a 0.5 per cent increase in NH_3 emissions on average from 3Da2a (Animal manure applied to soils) and 0.7 per cent increase in NH_3 emissions from 3Da3 (Urine and dung deposited by grazing animals). A revision to the quantities of sewage sludge applied to agricultural soils has resulted in a 41.5 per cent on average increase in emission of NH_3 from 3Da2b (Sewage sludge applied to soils). Revised estimates of the quantities of milk fed on farm for the period 2008 to 2014 has result in revised estimates of N excretion for dairy cows for those years. This has resulted in recalculation downwards of the emission of NH_3 associated with 3B1a (Dairy cattle) of between 0.1 per cent to 0.3 per cent between 2008 and 2014. Minor revisions to population statistics for recent years result in recalculations for 3B3 (Swine) for 2012 to 2014, 3B4gi (Laying hens) for 2014 and 3B4giv (Other poultry) for 2013 and 2014.

The same rationale for recalculations of NH_3 applies to recalculations of NMVOC from manure management. Emissions from 3B1b are on average 0.7 per cent higher for the years 1990-2014. Emissions from 3B1a (Dairy cattle) are on average 0.2 per cent lower over the period 2008-2014. Minor revisions to population statistics for recent years result in recalculations for 3B3 (Swine) for 2012 to 2014, 3B4gi (Laying hens) for 2014 and 3B4giv (Other poultry) for 2013 and 2014.

With respect to TSP, PM_{10} and $PM_{2.5}$, the minor revision to animal populations statistics has resulted in almost negligible recalculations for each of these pollutants (less than one-tenth of a per cent) for recent years, with the exception of other poultry (3B4giv) where the net effect is an over 6 per cent revision downwards in emissions of TSP, PM_{10} and $PM_{2.5}$.

6.6 Quality Assurance/Quality Control

The general QA/QC procedures set down in Ireland's QA/QC plan have been undertaken for the Agriculture sector. The spreadsheets incorporate transparent linking between input data statistics and calculations, as well as internal checks on the calculations and the outputs. The inventory experts are actively involved in assessing the outcomes of NH_3 emission research in Ireland and continually re-examine the underlying assumptions in inventory estimates with sector-specific experts in the Department of Agriculture and other related bodies.

6.7 Planned Improvements

A large number of input variables determine emissions in the Agriculture sector and the final results are very sensitive to changes in many of these variables. Assumptions relating to some parameters have an important bearing on the outcome. Whilst methodologies for the agricultural emission sources that are relevant in Ireland are now very comprehensive, they remain generalised and necessarily simplified considering the complex systems and processes involved. The key to developing better estimates and reducing uncertainty is to take full account of national circumstances of climate, soil types, livestock- and crop-production practices, manure management systems and other influencing factors in a robust and justifiable manner when applying these methodologies. This requires detailed data from research programmes, and large amounts of statistical data. Nevertheless, the inventory agency is continually developing emission estimates so that they fully reflect national circumstances within the availability of reliable statistics and research studies.

The inventory agency will consider revising the ammonia emission factors, if necessary, based on any updates in the latest Inventory Guidebook (EMEP/EEA, 2016) for the next annual submission.

Table 6.3. NH3 Recalculations for Agriculture 1990–2014

NFR Category	Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016															
3B1a Manure management - Dairy cattle	NH_3	kt	13.89	13.06	12.52	11.34	11.65	11.61	11.56	11.44	11.52	11.94	12.02	12.28	12.80
3B1b Manure management - Non-dairy cattle	NH_3	kt	27.23	29.64	30.25	32.15	31.39	31.19	31.27	31.06	29.74	28.84	30.48	31.13	30.47
3B2 Manure management - Sheep	NH_3	kt	1.73	1.76	1.76	1.52	1.40	1.28	1.19	1.11	1.10	1.12	1.17	1.16	1.15
3B3 Manure management - Swine	NH_3	kt	5.86	7.28	7.92	7.66	7.64	7.11	6.93	6.78	7.06	7.12	7.03	6.87	6.98
3B4d Manure management - Goats	NH_3	kt	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03
3B4e Manure management - Horses	NH_3	kt	0.53	0.58	0.60	0.68	0.74	0.76	0.82	0.84	0.91	0.91	0.95	0.87	0.81
3B4f Manure management - Mules and asses	NH_3	kt	0.04	0.04	0.03	0.03	0.04	0.04	0.05	0.05	0.04	0.05	0.05	0.04	0.04
3B4gi Manure management - Laying hens	NH_3	kt	0.52	0.37	0.35	0.40	0.41	0.37	0.37	0.44	0.44	0.42	0.53	0.58	0.58
3B4gii Manure management - Broilers	NH_3	kt	0.40	0.55	0.62	0.64	0.61	0.47	0.47	0.58	0.58	0.56	0.56	0.52	0.52
3B4giii Manure management - Turkeys	NH_3	kt	0.52	0.55	0.45	0.44	0.38	0.46	0.46	0.30	0.30	0.37	0.42	0.39	0.39
3B4giv Manure management - Other poultry	NH_3	kt	0.08	0.08	0.08	0.12	0.11	0.11	0.09	0.08	0.06	0.06	0.06	0.06	0.06
3B4h Manure management - Other animals (please specify in IIR)	NH_3	kt	0.57	0.33	0.36	0.35	0.35	0.35	0.34	0.43	0.41	0.38	0.40	0.40	0.41
3Da1 Inorganic N-fertilizers (includes also urea application)	NH_3	kt	12.93	12.46	12.74	9.29	9.52	8.07	9.42	11.43	12.86	9.60	7.41	8.07	8.53
3Da2a Animal manure applied to soils	NH_3	kt	27.71	28.81	28.80	29.05	28.70	28.33	28.32	28.15	26.46	26.34	27.40	27.79	27.77
3Da2b Sewage sludge applied to soils	NH_3	kt	0.02	0.02	0.19	0.44	0.41	0.44	0.59	0.64	0.47	0.47	0.47	0.42	0.48
3Da3 Urine and dung deposited by grazing animals	NH_3	kt	12.80	13.31	13.49	13.08	13.06	12.82	12.75	12.68	12.42	12.25	12.62	12.87	12.89
Submission 2017															
3B1a Manure management - Dairy cattle	NH_3	kt	13.89	13.06	12.52	11.34	11.65	11.61	11.55	11.43	11.48	11.91	11.99	12.25	12.77
3B1b Manure management - Non-dairy cattle	NH_3	kt	27.42	29.91	30.56	32.57	31.71	31.40	31.66	31.23	29.93	29.12	30.92	31.28	30.88
3B2 Manure management - Sheep	NH_3	kt	1.73	1.76	1.76	1.52	1.40	1.28	1.19	1.11	1.10	1.12	1.17	1.16	1.15
3B3 Manure management - Swine	NH_3	kt	5.86	7.28	7.92	7.66	7.64	7.11	6.93	6.78	7.06	7.12	7.03	6.88	6.98
3B4d Manure management - Goats	NH_3	kt	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03
3B4e Manure management - Horses	NH_3	kt	0.53	0.58	0.60	0.68	0.74	0.76	0.82	0.84	0.91	0.91	0.95	0.87	0.81
3B4f Manure management - Mules and asses	NH_3	kt	0.04	0.04	0.03	0.03	0.04	0.04	0.05	0.05	0.04	0.05	0.05	0.04	0.04
3B4gi Manure management - Laying hens	NH_3	kt	0.52	0.37	0.35	0.40	0.41	0.37	0.37	0.44	0.44	0.42	0.53	0.58	0.61
3B4gii Manure management - Broilers	NH_3	kt	0.40	0.55	0.62	0.64	0.61	0.47	0.47	0.58	0.58	0.56	0.56	0.52	0.52
3B4giii Manure management - Turkeys	NH_3	kt	0.52	0.55	0.45	0.44	0.38	0.46	0.46	0.30	0.30	0.37	0.42	0.39	0.39
3B4giv Manure management - Other poultry	NH_3	kt	0.08	0.08	0.08	0.12	0.11	0.11	0.09	0.08	0.06	0.06	0.06	0.06	0.06
3B4h Manure management - Other animals (please specify in IIR)	NH_3	kt	0.57	0.33	0.36	0.35	0.35	0.35	0.34	0.43	0.41	0.38	0.40	0.40	0.41
3Da1 Inorganic N-fertilizers (includes also urea application)	NH_3	kt	12.93	12.46	12.74	9.29	9.52	8.07	9.42	11.43	12.86	9.60	7.41	8.07	8.53
3Da2a Animal manure applied to soils	NH_3	kt	27.81	28.95	28.96	29.27	28.88	28.44	28.53	28.23	26.54	26.46	27.60	27.84	27.98
3Da2b Sewage sludge applied to soils	NH_3	kt	0.04	0.04	0.18	0.73	0.73	0.73	0.78	0.80	1.00	0.70	0.83	0.63	0.52
3Da3 Urine and dung deposited by grazing animals	NH_3	kt	12.86	13.39	13.59	13.21	13.16	12.89	12.87	12.71	12.49	12.34	12.75	12.91	12.98

% Change in Emissions															
3B1a Manure management - Dairy cattle	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.3%	-0.2%	-0.3%	-0.3%	-0.2%
3B1b Manure management - Non-dairy cattle	NH_3	%	0.7%	0.9%	1.0%	1.3%	1.0%	0.7%	1.3%	0.5%	0.6%	1.0%	1.4%	0.5%	1.3%
3B2 Manure management - Sheep	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B3 Manure management - Swine	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%
3B4d Manure management - Goats	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4e Manure management - Horses	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4f Manure management - Mules and asses	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4gi Manure management - Laying hens	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.2%
3B4gii Manure management - Broilers	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giii Manure management - Turkeys	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giv Manure management - Other poultry	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-6.0%	-6.0%
3B4h Manure management - Other animals	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3Da1 Inorganic N-fertilizers (includes urea application)	NH_3	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3Da2a Animal manure applied to soils	NH_3	%	0.4%	0.5%	0.6%	0.8%	0.6%	0.4%	0.7%	0.3%	0.3%	0.5%	0.7%	0.2%	0.7%
3Da2b Sewage sludge applied to soils	NH_3	%	61.1%	70.7%	-0.9%	65.0%	78.2%	64.9%	31.6%	26.5%	113.2%	48.0%	76.0%	50.4%	8.4%
3Da3 Urine and dung deposited by grazing animals	NH_3	%	0.5%	0.6%	0.7%	1.0%	0.8%	0.5%	0.9%	0.3%	0.5%	0.7%	1.0%	0.3%	0.7%

Table 6.4. NMVOC Recalculations for Agriculture 1990−2014

NFR Category	Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016															
3B1a Manure management - Dairy cattle	NMVOC	kt	9.16	8.39	7.82	6.96	7.16	7.16	7.13	7.09	7.13	7.39	7.44	7.63	7.98
3B1b Manure management - Non-dairy cattle	NMVOC	kt	22.21	24.41	24.95	26.19	25.88	25.85	25.64	25.70	24.62	24.08	25.20	25.99	25.15
3B2 Manure management - Sheep	NMVOC	kt	0.56	0.59	0.56	0.45	0.43	0.39	0.36	0.33	0.31	0.31	0.34	0.34	0.35
3B3 Manure management - Swine	NMVOC	kt	1.02	2.47	2.75	2.67	2.60	2.46	2.37	2.30	2.40	2.46	2.43	2.39	2.43
3B4d Manure management - Goats	NMVOC	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e Manure management - Horses	NMVOC	kt	0.11	0.12	0.12	0.14	0.15	0.15	0.17	0.17	0.18	0.18	0.19	0.18	0.16
3B4f Manure management - Mules and asses	NMVOC	kt	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3B4gi Manure management - Laying hens	NMVOC	kt	0.31	0.23	0.26	0.32	0.33	0.30	0.30	0.35	0.35	0.34	0.43	0.47	0.47
3B4gii Manure management - Broilers	NMVOC	kt	0.87	1.20	1.34	1.38	1.33	1.05	1.05	1.29	1.29	1.24	1.24	1.16	1.16
3B4giii Manure management - Turkeys	NMVOC	kt	0.74	0.79	0.65	0.62	0.54	0.65	0.65	0.43	0.43	0.53	0.60	0.55	0.55
3B4giv Manure management - Other poultry	NMVOC	kt	0.18	0.18	0.18	0.26	0.25	0.24	0.21	0.17	0.14	0.14	0.14	0.14	0.14
3B4h Manure management - Other animals	NMVOC	kt	0.41	0.25	0.29	0.29	0.29	0.29	0.29	0.37	0.36	0.36	0.38	0.38	0.38
3Da1 Inorganic N-fertilizers (includes urea application)	NMVOC	kt	3.36	3.45	3.39	3.29	3.26	3.29	3.55	3.53	3.55	3.53	3.48	3.44	3.42
Submission 2017															
3B1a Manure management - Dairy cattle	NMVOC	kt	9.16	8.39	7.82	6.96	7.16	7.16	7.13	7.08	7.11	7.37	7.43	7.61	7.96
3B1b Manure management - Non-dairy cattle	NMVOC	kt	22.32	24.54	25.11	26.38	26.06	26.02	25.81	25.86	24.77	24.20	25.32	26.13	25.60
3B2 Manure management - Sheep	NMVOC	kt	0.56	0.59	0.56	0.45	0.43	0.39	0.36	0.33	0.31	0.31	0.34	0.34	0.35
3B3 Manure management - Swine	NMVOC	kt	1.02	2.47	2.75	2.67	2.60	2.46	2.37	2.30	2.40	2.46	2.43	2.40	2.43
3B4d Manure management - Goats	NMVOC	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e Manure management - Horses	NMVOC	kt	0.11	0.12	0.12	0.14	0.15	0.15	0.17	0.17	0.18	0.18	0.19	0.18	0.16
3B4f Manure management - Mules and asses	NMVOC	kt	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3B4gi Manure management - Laying hens	NMVOC	kt	0.31	0.23	0.26	0.32	0.33	0.30	0.30	0.35	0.35	0.34	0.43	0.47	0.47
3B4gii Manure management - Broilers	NMVOC	kt	0.87	1.20	1.34	1.38	1.33	1.05	1.05	1.29	1.29	1.24	1.24	1.16	1.16
3B4giii Manure management - Turkeys	NMVOC	kt	0.74	0.79	0.65	0.62	0.54	0.65	0.65	0.43	0.43	0.53	0.60	0.55	0.55
3B4giv Manure management - Other poultry	NMVOC	kt	0.18	0.18	0.18	0.26	0.25	0.24	0.21	0.17	0.14	0.14	0.14	0.13	0.13
3B4h Manure management - Other animals	NMVOC	kt	0.41	0.25	0.29	0.29	0.29	0.29	0.29	0.37	0.36	0.36	0.38	0.38	0.38
3Da1 Inorganic N-fertilizers (includes urea application)	NMVOC	kt	3.36	3.45	3.39	3.29	3.26	3.29	3.55	3.53	3.55	3.53	3.48	3.44	3.42
% Change in Emissions															
3B1a Manure management - Dairy cattle	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.2%	-0.2%	-0.3%	-0.2%
3B1b Manure management - Non-dairy cattle	NMVOC	%	0.5%	0.6%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	1.8%
3B2 Manure management - Sheep	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%
3B3 Manure management - Swine	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
3B4d Manure management - Goats	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4e Manure management - Horses	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4f Manure management - Mules and asses	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4gi Manure management - Laying hens	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4gii Manure management - Broilers	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giii Manure management - Turkeys	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giv Manure management - Other poultry	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-5.7%	-5.7%
3B4h Manure management - Other animals	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3Da1 Inorganic N-fertilizers (includes urea application)	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 6.5. TSP Recalculations for Agriculture 1990–2014

NFR Category	Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016															
3B1a Manure management - Dairy cattle	TSP	kt	2.31	2.28	2.14	1.90	1.94	1.94	1.95	1.95	1.94	2.01	2.07	2.11	2.21
3B1b Manure management - Non-dairy cattle	TSP	kt	2.71	2.72	2.77	2.78	2.74	2.70	2.69	2.70	2.56	2.45	2.53	2.62	2.57
3B2 Manure management - Sheep	TSP	kt	1.11	1.16	1.11	0.89	0.86	0.79	0.71	0.66	0.60	0.62	0.67	0.68	0.70
3B3 Manure management - Swine	TSP	kt	0.82	1.03	1.13	1.10	1.08	1.01	0.98	0.96	1.00	1.02	1.00	0.98	1.00
3B4d Manure management - Goats	TSP	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e Manure management - Horses	TSP	kt	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05
3B4f Manure management - Mules and asses	TSP	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4gi Manure management - Laying hens	TSP	kt	0.22	0.16	0.19	0.23	0.23	0.22	0.22	0.26	0.26	0.25	0.31	0.34	0.34
3B4gii Manure management - Broilers	TSP	kt	0.55	0.77	0.86	0.88	0.85	0.67	0.67	0.82	0.82	0.79	0.79	0.74	0.74
3B4giii Manure management - Turkeys	TSP	kt	0.78	0.84	0.69	0.66	0.57	0.69	0.69	0.45	0.45	0.56	0.64	0.58	0.58
3B4giv Manure management - Other poultry	TSP	kt	0.05	0.05	0.05	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.04	0.04	0.04
3B4h Manure management - Other animals	TSP	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3Da1 Inorganic N-fertilizers (includes urea application)	TSP	kt	6.10	6.27	6.14	5.98	5.91	5.96	6.44	6.40	6.45	6.41	6.32	6.25	6.20
3Dd Off-farm storage, handling and transport of bulk agricultural products	TSP	kt	0.20	0.18	0.22	0.19	0.21	0.20	0.25	0.21	0.20	0.25	0.21	0.24	0.26
Submission 2017															
3B1a Manure management - Dairy cattle	TSP	kt	2.31	2.28	2.14	1.90	1.94	1.94	1.95	1.95	1.94	2.01	2.07	2.11	2.23
3B1b Manure management - Non-dairy cattle	TSP	kt	2.71	2.72	2.77	2.78	2.74	2.70	2.69	2.69	2.57	2.45	2.53	2.62	2.58
3B2 Manure management - Sheep	TSP	kt	1.11	1.16	1.11	0.89	0.86	0.79	0.71	0.66	0.60	0.62	0.67	0.68	0.70
3B3 Manure management - Swine	TSP	kt	0.82	1.03	1.13	1.10	1.08	1.01	0.98	0.96	1.00	1.02	1.00	0.98	1.00
3B4d Manure management - Goats	TSP	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e Manure management - Horses	TSP	kt	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05
3B4f Manure management - Mules and asses	TSP	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4gi Manure management - Laying hens	TSP	kt	0.22	0.16	0.19	0.23	0.23	0.22	0.22	0.26	0.26	0.25	0.31	0.34	0.34
3B4gii Manure management - Broilers	TSP	kt	0.55	0.77	0.86	0.88	0.85	0.67	0.67	0.82	0.82	0.79	0.79	0.74	0.74
3B4giii Manure management - Turkeys	TSP	kt	0.78	0.84	0.69	0.66	0.57	0.69	0.69	0.45	0.45	0.56	0.64	0.58	0.58
3B4giv Manure management - Other poultry	TSP	kt	0.05	0.05	0.05	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.04	0.04	0.04
3B4h Manure management - Other animals	TSP	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3Da1 Inorganic N-fertilizers (includes urea application)	TSP	kt	6.10	6.27	6.14	5.98	5.91	5.96	6.44	6.40	6.45	6.41	6.32	6.25	6.20
3Dd Off-farm storage, handling and transport of bulk agricultural products	TSP	kt	0.20	0.18	0.22	0.19	0.21	0.20	0.25	0.21	0.20	0.25	0.21	0.24	0.26
% Change in Emissions															
3B1a Manure management - Dairy cattle	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%
3B1b Manure management - Non-dairy cattle	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%	0.2%	0.0%	0.0%	0.0%	0.4%
3B2 Manure management - Sheep	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%
3B3 Manure management - Swine	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.00%	0.03%	0.04%	0.05%
3B4d Manure management - Goats	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4e Manure management - Horses	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4f Manure management - Mules and asses	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4gi Manure management - Laying hens	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4gii Manure management - Broilers	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giii Manure management - Turkeys	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giv Manure management - Other poultry	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-6.6%	-6.6%
3B4h Manure management - Other animals	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3Da1 Inorganic N-fertilizers (includes urea application)	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3Dd Off-farm storage, handling and transport of bulk agricultural products	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 6.6. PM_{10} Recalculations for Agriculture 1990−2014

NFR Category	Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016															
3B1a Manure management - Dairy cattle	PM_{10}	kt	1.06	1.05	0.98	0.87	0.89	0.89	0.89	0.89	0.89	0.92	0.95	0.97	1.02
3B1b Manure management - Non-dairy cattle	PM_{10}	kt	1.25	1.25	1.27	1.27	1.26	1.24	1.24	1.24	1.18	1.12	1.16	1.20	1.18
3B2 Manure management - Sheep	PM_{10}	kt	0.45	0.47	0.44	0.36	0.34	0.31	0.28	0.26	0.24	0.25	0.27	0.27	0.28
3B3 Manure management - Swine	PM_{10}	kt	0.37	0.46	0.50	0.49	0.48	0.45	0.44	0.43	0.44	0.45	0.44	0.44	0.44
3B4d Manure management - Goats	PM_{10}	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e Manure management - Horses	PM_{10}	kt	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3B4f Manure management - Mules and asses	PM_{10}	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4gi Manure management - Laying hens	PM_{10}	kt	0.22	0.16	0.19	0.23	0.23	0.22	0.22	0.26	0.26	0.25	0.31	0.34	0.34
3B4gii Manure management - Broilers	PM_{10}	kt	0.55	0.77	0.86	0.88	0.85	0.67	0.67	0.82	0.82	0.79	0.79	0.74	0.74
3B4giii Manure management - Turkeys	PM_{10}	kt	0.78	0.84	0.69	0.66	0.57	0.69	0.69	0.45	0.45	0.56	0.64	0.58	0.58
3B4giv Manure management - Other poultry	PM_{10}	kt	0.05	0.05	0.05	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.04	0.04	0.04
3B4h Manure management - Other animals	PM_{10}	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3Da1 Inorganic N-fertilizers (includes urea application)	PM_{10}	kt	6.10	6.27	6.14	5.98	5.91	5.96	6.44	6.40	6.45	6.41	6.32	6.25	6.20
3Dd Off-farm storage, handling and transport of bulk agricultural products	PM_{10}	kt	0.05	0.04	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.05	0.06	0.06
Submission 2017															
3B1a Manure management - Dairy cattle	PM_{10}	kt	1.06	1.05	0.98	0.87	0.89	0.89	0.89	0.89	0.89	0.92	0.95	0.97	1.02
3B1b Manure management - Non-dairy cattle	PM_{10}	kt	1.25	1.25	1.27	1.27	1.26	1.24	1.24	1.24	1.18	1.12	1.16	1.20	1.19
3B2 Manure management - Sheep	PM_{10}	kt	0.45	0.47	0.44	0.36	0.34	0.31	0.28	0.26	0.24	0.25	0.27	0.27	0.28
3B3 Manure management - Swine	PM_{10}	kt	0.37	0.46	0.50	0.49	0.48	0.45	0.44	0.43	0.44	0.45	0.44	0.44	0.44
3B4d Manure management - Goats	PM_{10}	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e Manure management - Horses	PM_{10}	kt	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3B4f Manure management - Mules and asses	PM_{10}	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4gi Manure management - Laying hens	PM_{10}	kt	0.22	0.16	0.19	0.23	0.23	0.22	0.22	0.26	0.26	0.25	0.31	0.34	0.34
3B4gii Manure management - Broilers	PM_{10}	kt	0.55	0.77	0.86	0.88	0.85	0.67	0.67	0.82	0.82	0.79	0.79	0.74	0.74
3B4giii Manure management - Turkeys	PM_{10}	kt	0.78	0.84	0.69	0.66	0.57	0.69	0.69	0.45	0.45	0.56	0.64	0.58	0.58
3B4giv Manure management - Other poultry	PM_{10}	kt	0.05	0.05	0.05	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.04	0.04	0.04
3B4h Manure management - Other animals	PM_{10}	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3Da1 Inorganic N-fertilizers (includes urea application)	PM_{10}	kt	6.10	6.27	6.14	5.98	5.91	5.96	6.44	6.40	6.45	6.41	6.32	6.25	6.20
3Dd Off-farm storage, handling and transport of bulk agricultural products	PM_{10}	kt	0.05	0.04	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.05	0.06	0.06
% Change in Emissions															
3B1a Manure management - Dairy cattle	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%
3B1b Manure management - Non-dairy cattle	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%	0.2%	0.0%	0.0%	0.0%	0.4%
3B2 Manure management - Sheep	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%
3B3 Manure management - Swine	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4d Manure management - Goats	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4e Manure management - Horses	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4f Manure management - Mules and asses	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4gi Manure management - Laying hens	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4gii Manure management - Broilers	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giii Manure management - Turkeys	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giv Manure management - Other poultry	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-6.6%	-6.6%
3B4h Manure management - Other animals	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3Da1 Inorganic N-fertilizers (includes urea application)	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3Dd Off-farm storage, handling and transport of bulk agricultural products	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 6.7. $PM_{2.5}$ Recalculations for Agriculture 1990−2014

NFR Category	Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2015															
3B1a Manure management - Dairy cattle	$PM_{2.5}$	kt	0.69	0.68	0.64	0.57	0.58	0.58	0.58	0.58	0.58	0.60	0.62	0.63	0.66
3B1b Manure management - Non-dairy cattle	$PM_{2.5}$	kt	0.82	0.82	0.84	0.84	0.83	0.81	0.81	0.81	0.77	0.74	0.76	0.79	0.78
3B2 Manure management - Sheep	$PM_{2.5}$	kt	0.13	0.14	0.13	0.11	0.10	0.09	0.09	0.08	0.07	0.07	0.08	0.08	0.08
3B3 Manure management - Swine	$PM_{2.5}$	kt	0.07	0.09	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.09	0.08	0.08	0.08
3B4d Manure management - Goats	$PM_{2.5}$	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e Manure management - Horses	$PM_{2.5}$	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
3B4f Manure management - Mules and asses	$PM_{2.5}$	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4gi Manure management - Laying hens	$PM_{2.5}$	kt	0.04	0.03	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.07
3B4gii Manure management - Broilers	$PM_{2.5}$	kt	0.07	0.10	0.11	0.12	0.11	0.09	0.09	0.11	0.11	0.10	0.10	0.10	0.10
3B4giii Manure management - Turkeys	$PM_{2.5}$	kt	0.11	0.11	0.09	0.09	0.08	0.09	0.09	0.06	0.06	0.08	0.09	0.08	0.08
3B4giv Manure management - Other poultry	$PM_{2.5}$	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3B4h Manure management - Other animals	$PM_{2.5}$	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3Da1 Inorganic N-fertilizers (includes urea application)	$PM_{2.5}$	kt	0.23	0.24	0.24	0.23	0.23	0.23	0.25	0.25	0.25	0.25	0.24	0.24	0.24
3Dd Off-farm storage, handling and transport of bulk agricultural products	$PM_{2.5}$	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Submission 2016															
3B1a Manure management - Dairy cattle	$PM_{2.5}$	kt	0.69	0.68	0.64	0.57	0.58	0.58	0.58	0.58	0.58	0.60	0.62	0.63	0.67
3B1b Manure management - Non-dairy cattle	$PM_{2.5}$	kt	0.82	0.82	0.84	0.84	0.83	0.81	0.81	0.81	0.78	0.74	0.76	0.79	0.78
3B2 Manure management - Sheep	$PM_{2.5}$	kt	0.13	0.14	0.13	0.11	0.10	0.09	0.09	0.08	0.07	0.07	0.08	0.08	0.08
3B3 Manure management - Swine	$PM_{2.5}$	kt	0.07	0.09	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.09	0.08	0.08	0.08
3B4d Manure management - Goats	$PM_{2.5}$	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e Manure management - Horses	$PM_{2.5}$	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
3B4f Manure management - Mules and asses	$PM_{2.5}$	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4gi Manure management - Laying hens	$PM_{2.5}$	kt	0.04	0.03	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.07
3B4gii Manure management - Broilers	$PM_{2.5}$	kt	0.07	0.10	0.11	0.12	0.11	0.09	0.09	0.11	0.11	0.10	0.10	0.10	0.10
3B4giii Manure management - Turkeys	$PM_{2.5}$	kt	0.11	0.11	0.09	0.09	0.08	0.09	0.09	0.06	0.06	0.08	0.09	0.08	0.08
3B4giv Manure management - Other poultry	$PM_{2.5}$	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3B4h Manure management - Other animals	$PM_{2.5}$	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3Da1 Inorganic N-fertilizers (includes urea application)	$PM_{2.5}$	kt	0.23	0.24	0.24	0.23	0.23	0.23	0.25	0.25	0.25	0.25	0.24	0.24	0.24
3Dd Off-farm storage, handling and transport of bulk agricultural products	$PM_{2.5}$	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
% Change in Emissions															
3B1a Manure management - Dairy cattle	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%
3B1b Manure management - Non-dairy cattle	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%	0.3%	0.0%	0.0%	0.0%	0.4%
3B2 Manure management - Sheep	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%
3B3 Manure management - Swine	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4d Manure management - Goats	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4e Manure management - Horses	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4f Manure management - Mules and asses	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4gi Manure management - Laying hens	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4gii Manure management - Broilers	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giii Manure management - Turkeys	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3B4giv Manure management - Other poultry	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-6.4%	-6.4%
3B4h Manure management - Other animals	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3Da1 Inorganic N-fertilizers (includes urea application)	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3Dd Off-farm storage, handling and transport of bulk agricultural products	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Chapter Seven Waste

7.1 Overview of the Waste (NFR 5) Sector

Emissions from the Waste sector cover a number of different source categories and pollutants. These are detailed below in Table 7.1. All sources are considered in detail in this chapter.

Table 7.1 Pollutant Emissions by Waste Source Category

NFR Source Category	Pollutants
5A Biological treatment of waste - Solid waste disposal on land	NMVOC, Hg, PCDD/F, PCB, TSP, PM_{10}, $PM_{2.5}$
5B1 Biological treatment of waste - Composting	NH_3, CO,
5B2 Biological treatment of waste - Anaerobic digestion at biogas facilities	NO, NA, NE
5C1a Municipal waste incineration	NO
5C1bi Industrial waste incineration	NO_x, SO_2, NMVOC, CO, TSP, $PM_{2.5}$, PM_{10}, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, PCDD/F, B[a]P, B[b]F, B[k]F, HCB, PCB
5C1bii Hazardous waste incineration	IE (5C1bi)
5C1biii Clinical waste incineration	NO_x, SO_2, NMVOC, CO, TSP, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/F, B[a]P, B[b]F, B[k]F, HCB, PCB
5C1biv Sewage sludge incineration	NO
5C1bv Cremation	NO_x, SO_2, NMVOC, CO, TSP, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, As, Cr, Cu, Ni, PCDD/F, I[123-cd]P, B[a]P, HCB
5C1bvi Other waste incineration	NO, NA
5C2 Open burning of agricultural waste	PCDD/F, B[a]P, B[b]F, B[k]F, PCB
5D Waste-water handling	NA, NE
5E Other waste	PCDD/F, B[a]P, B[b]F, B[k]F, I[123-cd]P, PCB

The Waste sector contains two key categories for four pollutants. Category Other waste (5E) is a key category for two pollutants: PCDD/F and PCBs. The category is the largest source of PCBs in Ireland's 2015 data inventory, accounting for 45.3 per cent of national total PCB emissions. The category accounts for 24.4 per cent of national total PCDD/F emissions. The second key category in the waste sector is Industrial waste incineration (5C1bi) for two pollutants: As and Cr, accounting for 51.4 per cent and 29.2 per cent of national total emissions, respectively.

7.2 Biological treatment of waste - Solid waste disposal on land (NFR 5A)

7.2.1 Main Pollutants

Landfill gas generated at solid waste disposal sites is a source of NMVOC emissions. In Ireland sector 5A has been responsible on average for 0.5 per cent of national total emissions across the full time series 1990-2015, showing a decrease of 43.6 per cent from 0.83 kt in 1990 to 0.47 kt in 2015. Emission factors for NMVOC were sourced from the Inventory Guidebook (EMEP/EEA, 2013) and are listed in Table F1 of Annex F. The activity data used is the net fugitive methane emissions from SWDS (kt) as calculated in the national greenhouse gas inventory, which are converted to landfill gas data (Gm^3) using STP molar conversion factors.

Emission of TSP, PM_{10} and $PM_{2.5}$ are also estimated. Emission factors from the Inventory Guidebook (EMEP/EEA, 2013) are applied to annual MSW data. Resulting emission estimates are included in Table 7.2 below.

Table 7.2. Emission Time Series for NMVOC TSP, PM_{10} and $PM_{2.5}$ from Solid Waste Disposal on Land

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC (kt)	0.83	1.01	0.80	0.64	0.66	0.39	0.29	0.18	0.18	0.24	0.19	0.29	0.41	0.47
TSP (t)	0.87	0.88	0.98	0.87	0.95	0.97	0.92	0.82	0.68	0.62	0.51	0.36	0.29	0.30
PM10 (t)	0.41	0.42	0.46	0.41	0.45	0.46	0.44	0.39	0.32	0.30	0.24	0.17	0.13	0.14
PM2.5 (t)	0.06	0.06	0.07	0.06	0.07	0.07	0.07	0.06	0.05	0.04	0.04	0.03	0.02	0.02

7.2.2 Heavy Metals

The relevant emissions in the Category 5A Solid Waste Disposal on Land sector in Ireland's air pollutant inventory include emissions of Hg from the disposal of batteries, electrical equipment, fluorescent lighting tubes, and measurement and control equipment in solid waste disposal sites (landfills). There is no direct estimate of the scale of disposal of the items mentioned at landfills in Ireland. However, Netcen/CTC (2006) provides a methodology to estimate emissions in Ireland using UK emission estimates, scaling by population for batteries and by household numbers for electrical equipment, fluorescent lighting and measurement and control equipment. Emission estimates for the above sources of Hg are presented in Table 7.3.

Table 7.3. Emission Time Series for Mercury from Solid Waste Disposal on Land

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hg (kg)	28.96	18.27	18.68	20.08	21.50	21.86	22.01	21.94	21.71	21.49	21.21	21.05	20.91	20.63

No data are available on emissions of POPs to air from municipal solid waste (MSW) disposal, although the emissions are likely to be negligible. There is potential for POP emissions to air from landfill gas (LFG) as described in the following section.

7.2.3 Landfill Gas and Persistent Organic Pollutants

There is potential for releases of POPs in landfill gas (LFG) through the transfer of POPs present in solid waste to the LFG that is generated by the waste. A proportion of this LFG escapes to air, with the remainder captured for flaring or utilisation for energy recovery. The proportion of LFG that is utilised for electricity generation is not considered in this chapter as it is accounted for in NFR Category 1A1a Public Energy and Heat Production (Chapter Three), from which POP emissions are negligible. There is currently no information in Ireland on the release of POPs from LFG and therefore emission estimates are based on the UK inventory.

Activity data on the quantity of LFG flared and LFG that escapes to the atmosphere have been obtained from Ireland's GHG emission inventory for the 1990−2015 time series. Emission factors have been taken from the UK NAEI (2006) for PCDD/F as 0.953 µg I-TEQ/t of escaping LFG and 0.614 µg I-TEQ/t of flared LFG (Table F.1 of Annex F). The emission factor for PCBs is 0.0008 kg/t of escaping gas (UK NAEI). Emission estimates and activity data for PCDD/F and PCBs are presented in Table 7.4.

Table 7.4. Time Series of Activity Data and Emissions of Dioxins and Furans and Polychlorinated Biphenyls from Landfill Gas

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
LFG emitted (kt)	111.7	138.1	120.7	118.1	126.4	94.2	85.2	73.0	74.1	82.3	75.8	86.9	99.1	103.6
LFG flared (kt)	NO	NO	3.9	28.6	29.0	40.4	46.6	52.1	49.9	44.2	45.1	39.0	25.5	15.5
PCDD/F (g I-TEQ)	0.106	0.132	0.120	0.148	0.156	0.139	0.138	0.133	0.132	0.133	0.128	0.131	0.126	0.118
PCBs (kg)	0.089	0.110	0.096	0.094	0.101	0.075	0.068	0.058	0.059	0.066	0.060	0.069	0.079	0.083

7.3 Biological treatment of waste - Composting (NFR 5B1)

Composting of organic waste, such as food waste, garden and park waste has taken place in Ireland since 2001. It consists of organic waste collected at kerbside and brought to civic amenity/temporary collections sites, as well as organic material composted at households. Activity data is sourced from National Waste Database Reports published by the EPA on a regular basis. Composting is a source of emissions of NH_3 and CO and the Tier 2 emission factors in the Inventory Guidebook (EMEP/EEA, 2013) of 0.66 kg/Mg waste and 0.56 kg/Mg waste are used, respectively. Emission estimates and activity data are presented in Table 7.5.

Table 7.5. Time Series of Activity Data and Emissions of NH_3 and CO from Composting

Year	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Waste composted (kt)	22.2	80.3	79.9	72.8	95.9	122.9	122.4	133.6	130.7	132.5	112.5	112.5
NH_3 (kt)	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
CO (kt)	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.03	0.03

7.4 Waste Incineration (NFR 5C)

Ireland carries out relatively little waste incineration compared with some European countries and there is currently no incineration, without energy recovery, of MSW. The Waste Incineration (5C) category includes estimates of air pollutant emissions from the incineration of clinical waste (5C1biii), industrial waste (5C1bi), including hazardous waste (5C1bii, emissions from crematoria (5C1bv), and the open burning/combustion of waste materials such as farm plastics (5C2).

There is incineration of municipal wastes in Ireland following the commissioning of an incinerator in 2011. However, it is a waste-to-energy facility, and as such emissions are reported under electricity generation (1A1a).

Approximately 50 per cent of health-care waste was incinerated during the 1990s, with a total of 150 incinerators in operation. By 1999, only two of these remained in operation and both closed the following year.

Most of the industrial installations that incinerate hazardous industrial wastes are in the pharmaceutical sector.

The practice of cremation is also less common in Ireland than in other countries but has increased in recent years due to the decrease in available burial plots, particularly in larger cities and towns in Ireland.

All the above are sources of heavy metals, POPs and combustion pollutants (NO_X, SO_2, NMVOC, CO, TSP, PM_{10}, $PM_{2.5}$ and BC) in Ireland.

7.4.1 Clinical Waste (5C1biii)

The incineration of Clinical Waste is no longer carried out in Ireland. The bulk of hazardous clinical waste in Ireland is now treated using non-incineration technologies (namely sterilisation and shredding), with the remaining waste disposed of through landfilling, exported for incineration or used as a fuel in cement kilns. In the early 1990s, the majority of hospitals operated on-site incinerator units where hazardous clinical waste was incinerated. A number of hospitals operated the practice of incinerating both hazardous and non-hazardous waste. Due to the implementation of stricter standards on incineration and the requirement for facilities to be licensed by the EPA, all incinerators were closed by the mid- to late-1990s. Prior to the closure of these facilities, a number of applications were made to the EPA in respect of IPPC licences. National reports and Government records contain some information on the quantity of health-care waste incinerated during the period of operation of the incinerators. From these sources, it was determined that an estimated 4,000 t of health-care waste was incinerated per annum. This value was used across the time series for the period 1990−1997, after which negligible quantities of health-care waste were incinerated up until the closure of the two remaining incinerators in 2000.

Emission estimates were derived for heavy metals using the quantity of health-care waste determined to be incinerated and Inventory Guidebook (EMEP/EEA, 2013) emission factors for As, Cd, Cr, Cu, Pb, Hg and Ni, assuming controlled air flow with no abatement. The emission factor for Zn was sourced from the UK NAEI. Emission factors are provided in Table F.1 of Annex F. Emission estimates for heavy metals are presented in Table 7.6.

Emissions of POPs from clinical wastes have been estimated using emission factors sourced from the UK NAEI. Dioxin and furan emission estimates are made utilising an emission factor of 372.1 μg I-TEQ/t health-care waste incinerated. This emission factor is used in the inventory for the period 1990−1997 until closure of all major plants. The PCB emission factor of 3.15 kg/Mt in 1990 reduces to 2.87 kg/Mt by 1995 and 2.36 kg/Mt by 1997, the last year of clinical waste incineration on the basis that environmental performance at the plants would have improved as in the UK. The emission factors for HCB from health-care waste incinerators have been estimated by taking the UK NAEI factor of 0.5 kg/Mt for 2006 and estimating the historical emission factors for 1990 and 1995 in proportion to those for PCBs in order to take account of the improvements in environmental performance that would have been introduced at some incinerators. Emission factors for intervening years are interpolated. Emission factors for 2006 are also available from the UK NAEI for benzo[a]pyrene, benzo[b]fluoranthene and benzo[k]fluoranthene, but there are no data for indeno[1,2,3-cd]pyrene. The emission factors for 2006 have been used to estimate emission factors for 1990 and 1995, scaling back in proportion to the emission factors for PCBs similar to that undertaken for HCB emission factors. Emission factors are given in Table F.1 of Annex F and the estimates for POPs are presented in Table 7.6.

Emission factors for: NO_X, CO, NMVOC, SO_X, TSP, PM_{10} and $PM_{2.5}$ were sourced from the Inventory guidebook (EMEP/EEA, 2013), using a Tier 1 approach, and are listed in Table F1 of Annex F. Resulting emission estimates 1990-1997 are included in Table 7.6 below.

Table 7.6. Time Series of Emissions from the Incineration of Clinical Waste

Year	1990	1991	1992	1993	1994	1995	1996	1997
NO_x (kt)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CO (kt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NMVOC (kt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO_x (kt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TSP (kt)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
PM_{10} (kt)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
$PM_{2.5}$ (kt)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
As (t)	0.00	0.00	0.00	0.00	0.00	0.00	NO	NO
Cd (t)	0.01	0.01	0.01	0.01	0.01	0.01	NO	NO
Cr (t)	0.00	0.00	0.00	0.00	0.00	0.00	NO	NO
Cu (t)	0.00	0.00	0.00	0.00	0.00	0.00	NO	NO
Pb (t)	1.46	1.46	1.46	1.46	1.46	1.46	NO	NO
Hg (t)	0.22	0.22	0.22	0.22	0.22	0.22	NO	NO
Ni (t)	0.00	0.00	0.00	0.00	0.00	0.00	NO	NO
Zn (t)	0.07	0.07	0.07	0.07	0.07	0.07	NO	NO
PCDD/F (g-I-TEQ)	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
PCBs (kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
HCB (kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B[a]p (kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B[b]F (kg)	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04
B[k}F (kg)	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04

7.4.2 Industrial Waste (5C1bi), Hazardous Waste (5C1bii) and Sewage Sludge (5C1biv)

The category Hazardous Waste Incineration (5C1bii) is reported in Industrial Waste Incineration (5C1bi) and reported as IE under the latter category. EU Directives on waste management have set the basis for strict regulatory control on the environmental performance of hazardous industrial waste incinerators. The incineration of Industrial Waste (5C1bi) (including hazardous waste) is now highly regulated in Ireland. There are currently only a small number of facilities based in the pharmaceutical and chemical sectors that operate incinerators for the treatment of hazardous waste. The facilities that operate these units report emissions to the atmosphere to the EPA as part of IPPC licensing requirements. The disposal of CCA treated wood (CCA being a preservative containing copper, chromium and arsenic) by burning is also included as a source in this sector.

Estimates of the quantity of hazardous waste incinerated at the relevant facilities, determined from returns to the National Waste Database (Carey et al, 1996; Crowe et al, 2000; Meaney et al, 2003; Collins et al, 2004a; Collins et al, 2004b; Collins et al, 2005; Le Bolloch et al, 2006; Le Bolloch et al, 2007; Le Bolloch et al, 2009; McCoole et al, 2009; McCoole et al, 2011; McCoole et al, 2012; McCoole et al, 2013), and information supplied by the facilities involved allowed for the calculation of heavy metal emission estimates. Emission factors sourced from the UK NAEI for As, Cd, Cr, Cu, Pb, Hg, Ni and Zn are used to estimate emissions. Emission estimates are presented in Table 7.7, while the emission factors used are presented in Table F.1 of Annex F.

The hazardous waste incinerators currently in use in Ireland are relatively modern units designed to optimise the burning process, with wet scrubber abatement systems in place to reduce the emissions of POPs to air. Further to the use of incinerators, there are also a number of facilities that use thermal oxidisers, which are subject to emission limit values. Annual Environmental Reports and IPPC Licence Applications provide adequate information in relation to the monitoring of PCDD/F emissions to air with limited information on the other relevant POPs. With respect to emissions of PAHs, emission factors sourced from the UK NAEI were applied to the tonnage of waste incinerated for each year. Pollutant-specific emission factors are presented in Table F.1 of Annex F. Emission estimates for POPs are presented in Table 7.7.

Emission factors for: NO_X, CO, NMVOC, SO_X, TSP, PM_{10} and $PM_{2.5}$ were sourced from the Inventory Guidebook (EMEP/EEA, 2013), using a Tier 1 approach, and are listed in Table F.1 of Annex F. Resulting emission estimates are included in Table 7.7 below.

Table 7.7. Time Series of Emissions from the Incineration of Industrial (incl. Hazardous & Sludge) Waste

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NOx (kt)	23.56	23.56	17.40	31.52	30.49	24.33	18.18	18.60	15.87	10.98	13.16	12.57	11.42	11.56
CO (kt)	1.90	1.90	1.40	2.54	2.45	1.96	1.46	1.50	1.28	0.88	1.06	1.01	0.92	0.93
NMVOC (kt)	0.20	0.20	0.15	0.27	0.26	0.21	0.15	0.16	0.13	0.09	0.11	0.11	0.10	0.10
SOx (kt)	1.27	1.27	0.94	1.70	1.65	1.31	0.98	1.00	0.86	0.59	0.71	0.68	0.62	0.62
TSP (kt)	0.27	0.27	0.20	0.36	0.35	0.28	0.21	0.21	0.18	0.13	0.15	0.14	0.13	0.13
PM_{10} (kt)	0.19	0.19	0.14	0.25	0.25	0.20	0.15	0.15	0.13	0.09	0.11	0.10	0.09	0.09
$PM_{2.5}$ (kt)	0.11	0.11	0.08	0.14	0.14	0.11	0.08	0.09	0.07	0.05	0.06	0.06	0.05	0.05
As (kt)	0.55	0.56	0.58	0.62	0.63	0.64	0.65	0.66	0.65	0.65	0.65	0.65	0.64	0.64
Cd (kg)	2.71	2.71	2.00	3.62	3.50	2.80	2.09	2.14	1.82	1.26	1.51	1.44	1.31	1.33
Cr (t)	0.53	0.54	0.56	0.60	0.61	0.62	0.63	0.63	0.63	0.63	0.63	0.62	0.62	0.62
Cu (t)	0.29	0.30	0.31	0.33	0.33	0.34	0.35	0.35	0.35	0.35	0.35	0.34	0.34	0.34
Pb (t)	0.04	0.04	0.03	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Hg (kg)	1.52	1.52	1.12	2.03	1.96	1.57	1.17	1.20	1.02	0.71	0.85	0.81	0.73	0.74
Ni (t)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zn (t)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
PCDD/F (g-I-TEQ)	0.03	0.03	0.08	0.02	0.01	0.60	1.11	0.42	0.01	0.01	0.01	0.01	0.00	0.00
PCBs (kg)	0.09	0.08	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
HCB (kg)	0.05	0.04	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B[a]p (kg)	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B[b]F (kg)	0.07	0.05	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B[k}F (kg)	0.07	0.05	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

7.4.3 Crematoria (5C1bv)

The practice of cremation is less popular in Ireland than in other countries. However, due to the decrease in the number of burial plots available, particularly in larger cities and towns, the number of cremations in Ireland has been steadily increasing. There are currently five crematoria operating in Ireland. Cremation has been in operation in Ireland for over a decade, with one of the crematoria open since the early 1990s. A pet crematorium is also currently operating in Ireland; however, emissions from this source are regarded as negligible. Data on the number of cremations in Ireland have been obtained via correspondence with crematoria operators or, in some cases, assumed capacity of the facility based on the equipment present and market share where no information on the number of cremations conducted was provided.

Heavy metals emissions are estimated using Inventory Guidebook (EMEP/EEA, 2013) emission factors for As, Cd, Pb, Cr, Hg, Ni, Cu Se and Zn and are presented in Table F.1 of Annex F. Emission estimates for each of the metals outlined are presented in Table 7.8.

Emissions of POPs from crematoria include PCDD/F, HCB and benzo[a]pyrene. Inventory Guidebook (EMEP/EEA, 2013) emission factors are used to derive emission estimates for the years 1990−2015 (Table F.1 of Annex F). Emission estimates are presented in Table 7.8.

Emission factors for: NO_X, CO, NMVOC, SO_X, TSP, PM_{10} and $PM_{2.5}$ were sourced from the Inventory guidebook (EMEP/EEA, 2013), using a Tier 1 approach, and are listed in Table F.1 of Annex F. Resulting emission estimates are included in Table 7.8 below.

Table 7.8. Time Series of Emissions from Crematoria

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NOx (t)	1.24	1.24	1.82	2.03	2.06	3.14	3.14	3.14	2.54	2.75	3.07	3.37	3.73	4.02
CO (t)	0.21	0.21	0.31	0.34	0.35	0.53	0.53	0.53	0.43	0.47	0.52	0.57	0.63	0.68
NMVOC (t)	0.02	0.02	0.03	0.03	0.03	0.05	0.05	0.05	0.04	0.04	0.05	0.05	0.06	0.06
SOx (t)	0.17	0.17	0.25	0.28	0.28	0.43	0.43	0.43	0.35	0.38	0.42	0.46	0.51	0.55
TSP (t)	0.06	0.06	0.08	0.09	0.10	0.15	0.15	0.15	0.12	0.13	0.14	0.16	0.17	0.19
PM_{10} (t)	0.04	0.04	0.06	0.07	0.07	0.10	0.10	0.10	0.08	0.09	0.10	0.11	0.12	0.13
$PM_{2.5}$ (t)	0.02	0.02	0.03	0.04	0.04	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.07	0.08
As (g)	20.42	20.42	29.94	33.45	34.03	51.72	51.72	51.72	41.96	45.38	50.62	55.54	61.48	66.25
Cd (g)	7.55	7.55	11.07	12.36	12.58	19.11	19.11	19.11	15.51	16.77	18.71	20.53	22.72	24.48
Cr (g)	20.34	20.34	29.83	33.32	33.90	51.53	51.53	51.53	41.81	45.21	50.43	55.34	61.25	66.00
Cu (g)	18.65	18.65	27.35	30.55	31.08	47.23	47.23	47.23	38.32	41.44	46.23	50.73	56.15	60.50
Pb (g)	45.05	45.05	66.07	73.80	75.08	114.1	114.1	114.1	92.58	100.1	111.7	122.5	135.6	146.2
Hg (kg)	2.24	2.24	3.28	3.66	3.73	5.66	5.66	5.66	4.59	4.97	5.54	6.08	6.73	7.25
Ni (kg)	0.03	0.03	0.04	0.04	0.04	0.07	0.07	0.07	0.05	0.06	0.06	0.07	0.08	0.08
PCDD/F (g-I-TEQ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCBs (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B[a]p (g)	0.02	0.02	0.03	0.03	0.03	0.05	0.05	0.05	0.04	0.04	0.05	0.05	0.06	0.06

7.4.4 Open Burning of Agricultural Wastes (5C2)

Open Burning of Agricultural Wastes, which includes the burning of crop residues, animal carcasses and poultry litter is a practice generally not undertaken in Ireland. Therefore, emission estimates from these sources are reported as “NO” (not occurring) for Heavy Metals.

Emissions from the open burning of farm plastics are the only source of emissions from agricultural wastes for which estimates are made. Information on the quantity of waste farm plastics that are burned in open fires is difficult to obtain. One of the largest sources of waste farm plastic, is waste plastic silage wrap and to a lesser extent synthetic fertiliser bags. The increased replacement of conventional silage with wrapped silage bales, which use substantially more plastic, has seen an increase in the quantity of this waste stream. A number of different sources of information were utilised in the derivation of emission estimates. Information on the quantities of silage plastic on the market was obtained from the Irish Farm Film Producers Group (IFFPG), and national agricultural statistics were provided by the CSO and the National Farm Survey. Using the area of land utilised for silage for each year of the time series, an estimate of the plastic used for conventional (pit) silage and baled silage is made. Account is taken of plastic recovery under the silage plastics collection service operated by both the IFFPG and the Farm Relief Services. The plastic collected is recycled and used to make products such as park benches, plastic bags, garden furniture and plastic piping.

Dioxin and furan emissions from the open burning of farm plastics are determined using estimates of the quantities of material burned and the UNEP Toolkit (2005) emission factor of 300 µg I-TEQ/t burned for the open burning of municipal wastes. The UK NAEI provides an emission factor of 510 kg/Mt burned for the estimation of PCB emissions. There is minimal data available on emission factors for PAHs; however, the emission factors from the UK NAEI for small-scale waste burning are used as a best estimate. Emission factors of 89.5 kg/Mt for benzo[a]pyrene, 405 kg/Mt for benzo[b]fluoranthene and 405 kg/Mt for benzo[k]fluoranthene are applied. No data is available for indeno [1,2,3-cd] pyrene. Emission factors are compiled in Table F.2 of Annex F and the emission estimates are presented in Table 7.9.

Emissions of NO_x, SO_2, NMVOC, CO and particles from this small source are not estimated, and are therefore reported as “NE”.

Table 7.9. Time Series of Emissions from the Open Burning of Farm Plastics

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PCDD/F (g-I-TEQ)	0.94	1.10	0.65	0.23	0.32	0.06	1.14	1.15	1.15	0.30	0.39	0.28	0.45	0.49
PCBs (kg)	1.59	1.86	1.11	0.39	0.54	0.10	1.94	1.95	1.96	0.50	0.67	0.48	0.77	0.84
B[a]p (kg)	0.28	0.33	0.20	0.07	0.09	0.02	0.34	0.34	0.34	0.09	0.12	0.08	0.13	0.15
B[b]F (kg)	1.26	1.48	0.88	0.31	0.43	0.08	1.54	1.55	1.55	0.40	0.53	0.38	0.61	0.67
B[k]F (kg)	1.26	1.48	0.88	0.31	0.43	0.08	1.54	1.55	1.55	0.40	0.53	0.38	0.61	0.67

7.5 Other Waste (NFR 5E)

This NFR category includes emissions from accidental vehicle and building fires and other burning, which constitutes bonfires, domestic burning of MSW and burning of construction wastes. These are all sources of POPs. Each of these combustion sources is described in the following sections.

7.5.1 Accidental Fires

Accidental fires are poorly controlled combustion events that can release large quantities of POPs into the environment. These include accidental fires of houses, other buildings and cars. A variety of materials can be burned in accidental fires, which can lead to some difficulty in obtaining detailed activity data and applying emission factors correctly. However, there are some data available in Ireland in relation to accidental building and vehicle fires from the Fire Services Department.

Vehicle fire statistics are only available since 2000, with the number of fires ranging from 1,600 to 7,700 per annum. With respect to earlier years, the URS Dames & Moore (2000) report suggests that the number of vehicle fires in 1998 was 4,130. It is assumed that, in the absence of any information, the number of vehicle fires per year in the period 1990−1997 is equal to that in 1998. Dioxin and furan emissions from vehicle fires are estimated using the

UNEP Toolkit emission factor of 94 µg I-TEQ/vehicle fire. An emission factor of 510 kg/Mt burned (UK NAEI) for PCB emissions from the open burning of MSW is used for accidental vehicle fires, assuming that on average 50 kg of material are burnt per fire (Dyke, 1997), while those in relation to PAHs, also based on the mass of material burnt, sourced from the UK NAEI, suggest values for benzo[a]pyrene of 0.06 mg/vehicle fire, for benzo[b]fluoranthene of 0.10 mg/vehicle fire, for benzo[k]fluoranthene of 0.03 mg/vehicle fire, and for indeno[1,2,3-cd]pyrene of 0.07 mg/vehicle fire.

The Fire Services Department also provides information in relation to building fires, which is disaggregated into the type of building and the number of fires that are chimney fires. Information is only available for the years 2000−2007 at this level of disaggregation. For data prior to 2000, no differentiation was made between chimney fires and other building fires. The proportion of chimney fires to the total number of building fires post-2000 is therefore used to estimate the number of chimney fires annually prior to 2000. Limited information is available on the quantity of material burnt in accidental fires both in Ireland and internationally. The assumed quantity of material burnt in each building fire is 2.28 t per fire (Lorenz et al., 1996) and approximately 10 kg in each chimney fire. Dioxin and furan emissions are estimated using an emission factor of 400 µg I-TEQ/t of material burned (UNEP Toolkit). For PCB emissions, the emission factor of 510 kg/Mt burned (UK NAEI) for the open burning of MSW is applied, while, for PAH emissions (UK NAEI), the emission factors equate to 1.2 kg/Mt for benzo[a]pyrene, 1.9 kg/Mt for benzo[b]fluoranthene, 0.67 kg/Mt for benzo[k]fluoranthene and 1.3 kg/Mt for indeno[1,2,3-cd]pyrene. Accidental vehicle fires and building fires emission estimates are summed to provide an estimate of the total emissions from accidental fires. Emission estimates for the 1990−2015 time series are presented in Table 7.10. Emission factors are compiled in Table F.2 of Annex F.

Table 7.10. Time Series of Emissions from Accidental Fires from Vehicles and Buildings

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PCDD/F (g-I-TEQ)	7.01	7.01	7.01	6.26	5.94	5.96	5.80	5.61	5.58	6.06	6.11	6.06	5.91	5.82
PCBs (kg)	8.54	8.54	8.54	7.41	7.02	7.15	6.91	6.70	6.62	7.15	7.17	7.15	7.11	7.09
B[a]p (kg)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
B[b]F (kg)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.03
B[k]F (kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
I(123-cd)P (kg)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

7.5.2 Other Burning

This section includes the emission of POPs from domestic bonfires, the burning of domestic waste both indoors and outdoors and the open burning of construction waste. Domestic bonfires normally include a variety of garden wastes (e.g. wood, leaves, etc.), and their importance with respect to POP emissions is greatly increased in cases where other wastes are added to the bonfires (e.g. plastics). Some households are not covered, or opt not to be covered, by waste collection systems and may burn household waste. Combustion of treated wood that has been used for construction, fencing and furniture can be a particularly significant source of POP emissions. For example, where wood is pre-treated with chlorinated fungicides, such as lindane or pentachlorophenol, its combustion can be a potentially significant source of PCDD/F emissions to air, whilst wood pre-treatment with creosote is a potential source for PAH emissions. However, the use of these chemicals has been significantly reduced in Ireland since the early 1990s.

For domestic bonfires, activity data are determined on a per-capita basis using the UK inventory as the reference, as no information is available in Ireland. For the burning of household waste, estimates for uncollected household waste were obtained for each of the years 2001 through to 2013, as well as for 1998 and 1995 from National Waste Reports (Carey et al., 1996; Crowe et al., 2000; Collins et al., 2004a, 2004b; Le Bolloch et al., 2006, 2007, 2009, McCoole et al, 2009; McCoole et al, 2011; McCoole et al, 2012; McCoole et al, 2013), with annual data interpolated for other years. “Uncollected waste” refers to the waste produced by the portion of the population not provided with, or not availing of, a waste collection service, corrected to take account of local conditions. This is calculated according to a standard methodology at the local authority level, based on total numbers of households, numbers of households served with waste collection, and quantities of waste collected per household in each local authority area. In addition, a proportion of households share waste collections services. Only the fraction of household waste that is combustible is burned. Compositional statistics at a national level are applied to estimate the quantities of combustible materials burnt.

Information on construction and demolition waste is available from National Waste Reports. The proportion of wood within this waste stream is estimated using data collected but not published in the National Waste Reports for the years 2004 and 2006, based on estimates of both authorised and unauthorised construction and demolition waste disposal. These values have been used for all other years in the absence of any other information. The URS Dames & Moore study (2000) suggests that 5 per cent of construction and demolition waste wood arising is burned on construction sites, whereas the UK NAEI suggests a value of 0.1 per cent. The value of 5 per cent is applied for the years 1990−1998, linearly decreasing for the years 1999-2003, with the value of 0.1 per cent applied for the period 2004−2015, based on correspondence with representatives from the National Construction and Demolition Waste Council who indicate that they would expect virtually no uncontrolled burning in urban areas.

The UNEP toolkit for open burning of construction and demolition waste wood (60 µg-I-TEQ/t burned) is applied to estimate PCDD/F emissions from bonfires on the basis that bonfires contain mainly wood and garden waste. Domestic burning of MSW contains material that varies and that often includes plastics and sometimes specific chemicals that potentially affect PCDD/F emissions. The UK NAEI suggests an emission factor of 173 µg-I-TEQ/t burned. This emission factor not only takes into account the wide range of materials in household waste but also other materials such as treated and untreated wood. In relation to PCDD/F emissions from wood burning, an emission factor of 60 µg I-TEQ/t is applied.

The estimated emission factor of 1.14 kg/Mt burned for PCBs from bonfires has been taken as the average of the UK NAEI emission factors for domestic wood combustion (e.g. fireplaces) (1.99 kg/Mt burned) and open burning of crop residues (0.29 kg/Mt). For the open burning of domestic wastes, the UK NAEI emission factor of 510 kg/Mt burned has been adopted for PCBs. There are no specific data on PCB emissions from the open burning of construction wood, but emission factors from the NAEI for industrial combustion of wood indicate no difference for treated and untreated wood. Emission factors for domestic wood combustion from the NAEI and the Inventory Guidebook range from 1.99 to 6 kg/Mt burned. The emission factor of 1.99 kg/Mt has been adopted for open burning of construction waste wood in Ireland.

Emission factors with respect to PAH emission estimates are also sourced from the UK NAEI. For bonfires, the emission factors are 1,300 kg/Mt for benzo[a]pyrene, 1,500 kg/Mt for benzo[b]fluoranthene, 500 kg/Mt for benzo[k]fluoranthene and 90 kg/Mt for indeno[1,2,3-cd]pyrene. For the open burning of domestic wastes, emission factors for small-scale waste burning are applied as follows: 89.5 kg/Mt for benzo[a]pyrene, 405 kg/Mt for both benzo[b]fluoranthene and benzo[k]fluoranthene. No data are available for indeno[1,2,3-cd]pyrene. These emission factors are also used to estimate emissions from the open burning of wood at construction sites.

The three sources of emissions described in previous paragraphs are summed to provide total emission estimates for Category 5.E Other Waste. Emission factors are compiled in Table F.2 of Annex F. Emission estimates for the 1990−2015 time series are presented in Table 7.10.

Table 7.11. Time Series of Emissions from Other Waste Burning

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PCDD/F (g-I-TEQ)	3.16	3.76	5.57	7.77	7.97	0.85	0.84	0.85	0.85	0.84	0.86	0.86	0.83	0.83
PCBs (kg)	7.73	9.46	14.75	21.21	21.78	0.73	0.65	0.69	0.69	0.69	0.69	0.69	0.69	0.69
B[a]p (t)	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B[b]F (t)	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
B[k]F (t)	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
I(123-cd)P (t)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

7.6 Recalculations in the Waste Sector

Recalculations in the waste sector (Table 7.12) in this submission are limited to estimates from:

Solid waste disposal on land (5A)

- NMVOC, Hg, dioxins and PCB emissions were recalculated for each year of the time series due to a revision in the estimation of CH_4 emissions from SWDS. This has resulted in a 29.4 per cent on average annual emission reduction from this source for NMVOC, a 20.5 per cent per annum average reduction in dioxins and 29.2 per cent per annum average reduction in PCBs.

Waste Incineration (5C)

- Revised activity for burning of farm plastics reported in Open burning of waste (5C2) accounts for the large recalculations for the years 2006-2014 for PCB, B[a]P, B[b]F and B[k]F emissions.
- In addition to the rationale for the pollutants above a revision of the emission factor for dioxin emissions from crematoria (now utilise Inventory Guidebook emission factor) results in reductions in emissions for the years 1990-2007 and 2013, with increased emissions in the remaining years.

Other waste (5E)

- Small recalculations to emission estimates of dioxins, PCBs, B[a]P, B[b]F, B[k]F and I[123-cd]P are the result of the correction of a transcription error for the years 1990-1999. A revision to the number of households, which is used as activity data for burning of uncollected household waste is the reason behind the recalculation of emissions of I[123-cd]P for 2013 and 2014.

7.7 Quality Assurance/Quality Control

Previous work has ensured that the estimates in the Waste sector are now fully consistent with other sectors in the inventory. This has allowed the detailed QA/QC procedures in the national inventory system to be implemented on data in the Waste sector in a manner consistent with other sectors.

7.8 Planned Improvements

The inventory team will continue to review emission estimates for this sector in light of any new information that may become available for future submissions. The inventory team also plans to continue to outsource contracts on a periodic basis to re-examine and extend the inventory time series with respect to heavy metals and persistent organic pollutants.

Table 7.12 Recalculations for Waste 1990−2014

NFR Category	Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2016															
5A Solid waste disposal on land	NMVOC	kt	0.88	1.09	0.95	0.93	1.00	0.75	0.67	0.58	0.59	0.65	0.60	0.70	0.80
5A Solid waste disposal on land	Hg	t	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
5A Solid waste disposal on land	PCDD/F	g-I-TEQ	0.11	0.13	0.12	0.15	0.16	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13
5A Solid waste disposal on land	PCBs	kg	0.09	0.11	0.10	0.09	0.10	0.08	0.07	0.06	0.06	0.07	0.06	0.07	0.08
5C Waste Incineration	NO_x	kt	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.02	0.02	0.01
5C Waste Incineration	SO_2	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	NMVOC	kt	0.20	0.20	0.15	0.27	0.26	0.21	0.15	0.16	0.13	0.09	0.11	0.11	0.09
5C Waste Incineration	TSP	kt	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	PM_{10}	kt	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	$PM_{2.5}$	kt	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	As	t	0.55	0.56	0.58	0.62	0.63	0.65	0.66	0.66	0.66	0.65	0.67	0.65	0.64
5C Waste Incineration	Cd	t	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	Cr	t	0.53	0.54	0.56	0.60	0.61	0.62	0.64	0.64	0.64	0.63	0.64	0.62	0.62
5C Waste Incineration	Cu	t	0.30	0.30	0.31	0.33	0.34	0.34	0.35	0.35	0.35	0.35	0.35	0.34	0.34
5C Waste Incineration	Pb	t	1.49	1.49	0.03	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02
5C Waste Incineration	Hg	t	0.22	0.22	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5C Waste Incineration	Ni	t	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	Zn	t	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	PCDD/F	g-I-TEQ	2.52	2.68	0.79	0.31	0.47	0.89	1.41	0.71	0.28	0.29	0.30	0.31	0.32
5C Waste Incineration	PCBs	kg	1.69	1.95	1.14	0.42	0.70	0.36	0.36	0.36	0.36	0.35	0.35	0.35	0.35
5C Waste Incineration	HCB	t	0.06	0.05	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5C Waste Incineration	B[a]P	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	B[b]F	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	B[k]F	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	I[123-cd]P	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5E Other Waste	PCDD/F	g-I-TEQ	10.15	10.75	11.69	13.39	13.55	6.91	6.95	6.91	6.76	6.66	6.62	6.50	6.48
5E Other Waste	PCBs	kg	16.25	17.98	21.83	27.91	28.39	7.89	7.82	7.85	7.81	7.78	7.77	7.73	7.73
5E Other Waste	B[a]P	t	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5E Other Waste	B[b]F	t	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
5E Other Waste	B[k]F	t	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5E Other Waste	I[123-cd]P	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*Prior to 1998, emissions were only reported for the sub-category 5Cbiii (Clinical waste incineration). For the years 1998-2014 this sub-category is NO. Other sub-categories of 5C are reported as NO, NA, IE, and NE.

Table 7.12 Recalculations for Waste 1990−2014 (continued)

NFR Category	Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Submission 2017															
5A Solid waste disposal on land	NMVOC	kt	0.83	1.01	0.80	0.63	0.66	0.39	0.29	0.18	0.17	0.24	0.19	0.29	0.41
5A Solid waste disposal on land	Hg	t	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
5A Solid waste disposal on land	PCDD/F	g-I-TEQ	0.10	0.13	0.12	0.15	0.16	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13
5A Solid waste disposal on land	PCBs	kg	0.08	0.11	0.10	0.09	0.10	0.08	0.07	0.06	0.06	0.07	0.06	0.07	0.08
5C Waste Incineration	NO_x	kt	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.02	0.02	0.02
5C Waste Incineration	SO_2	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	NMVOC	kt	0.20	0.20	0.15	0.27	0.26	0.21	0.15	0.16	0.13	0.09	0.11	0.11	0.10
5C Waste Incineration	TSP	kt	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	PM_{10}	kt	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	$PM_{2.5}$	kt	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	As	t	0.55	0.56	0.58	0.62	0.63	0.64	0.65	0.66	0.65	0.65	0.65	0.65	0.64
5C Waste Incineration	Cd	t	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	Cr	t	0.53	0.54	0.56	0.60	0.61	0.62	0.63	0.63	0.63	0.63	0.63	0.62	0.62
5C Waste Incineration	Cu	t	0.30	0.30	0.31	0.33	0.33	0.34	0.35	0.35	0.35	0.35	0.35	0.34	0.34
5C Waste Incineration	Pb	t	1.49	1.49	0.03	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02
5C Waste Incineration	Hg	t	0.22	0.22	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5C Waste Incineration	Ni	t	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	Zn	t	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	PCDD/F	g-I-TEQ	2.46	2.62	0.73	0.25	0.33	0.66	2.26	1.56	1.16	0.31	0.40	0.29	0.46
5C Waste Incineration	PCBs	kg	1.69	1.95	1.14	0.42	0.57	0.12	1.96	1.97	1.97	0.51	0.68	0.49	0.78
5C Waste Incineration	HCB	t	0.06	0.05	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5C Waste Incineration	B[a]P	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	B[b]F	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	B[k]F	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C Waste Incineration	I[123-cd]P	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5E Other Waste	PCDD/F	g-I-TEQ	10.17	10.76	11.69	13.39	13.55	6.91	6.95	6.91	6.76	6.66	6.62	6.50	6.48
5E Other Waste	PCBs	kg	16.27	18.00	21.83	27.91	28.39	7.89	7.82	7.85	7.81	7.78	7.77	7.73	7.73
5E Other Waste	B[a]P	t	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5E Other Waste	B[b]F	t	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
5E Other Waste	B[k]F	t	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5E Other Waste	I[123-cd]P	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*Prior to 1998, emissions were only reported for the sub-category 5Cbiii (Clinical waste incineration). For the years 1998-2014 this sub-category is NO. Other sub-categories of 5C are reported as NO, NA, IE, and NE.

Table 7.12 Recalculations for Waste 1990−2014 (continued)

NFR Category	Pollutant	Unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
% Change in Emission															
5A Solid waste disposal on land	NMVOC	%	-5.6%	-7.8%	-16.2%	-32.2%	-33.9%	-48.0%	-56.8%	-69.1%	-70.2%	-63.2%	-68.2%	-58.5%	-48.6%
5A Solid waste disposal on land	Hg	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%
5A Solid waste disposal on land	PCDD/F	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	-1.2%	-1.2%
5A Solid waste disposal on land	PCBs	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.1%	-2.0%	-1.6%
5C Waste Incineration	NO_x	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%
5C Waste Incineration	SO_2	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.8%
5C Waste Incineration	NMVOC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.1%
5C Waste Incineration	TSP	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%
5C Waste Incineration	PM_{10}	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%
5C Waste Incineration	$PM_{2.5}$	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%
5C Waste Incineration	As	%	0.0%	0.0%	0.0%	-0.3%	-0.4%	-0.6%	-0.7%	-0.8%	-0.7%	-0.2%	-2.6%	0.0%	0.0%
5C Waste Incineration	Cd	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.0%
5C Waste Incineration	Cr	%	0.0%	0.0%	0.0%	-0.3%	-0.4%	-0.6%	-0.7%	-0.8%	-0.7%	-0.2%	-2.6%	0.0%	0.0%
5C Waste Incineration	Cu	%	0.0%	0.0%	0.0%	-0.3%	-0.4%	-0.6%	-0.7%	-0.8%	-0.7%	-0.2%	-2.6%	0.0%	0.0%
5C Waste Incineration	Pb	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.1%
5C Waste Incineration	Hg	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%
5C Waste Incineration	Ni	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.7%
5C Waste Incineration	Zn	%	0.0%	0.0%											
5C Waste Incineration	PCDD/F	%	-2.5%	-2.3%	-6.9%	-19.8%	-29.7%	-26.5%	60.2%	119.9%	308.6%	4.3%	33.5%	-6.1%	43.5%
5C Waste Incineration	PCBs	%	0.0%	0.0%	0.0%	0.0%	-19.0%	-66.8%	448.1%	449.7%	454.8%	46.0%	92.4%	39.5%	122.3%
5C Waste Incineration	HCB	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.2%
5C Waste Incineration	B[a]P	%	0.0%	0.0%	0.0%	0.0%	-18.9%	-66.3%	445.4%	447.0%	452.5%	45.8%	92.0%	39.4%	121.9%
5C Waste Incineration	B[b]F	%	0.0%	0.0%	0.0%	0.0%	-18.9%	-66.5%	446.7%	448.3%	453.6%	45.9%	92.2%	39.5%	122.1%
5C Waste Incineration	B[k]F	%	0.0%	0.0%	0.0%	0.0%	-18.9%	-66.5%	446.7%	448.3%	453.6%	45.9%	92.2%	39.5%	122.1%
5C Waste Incineration	I[123-cd]P	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5E Other Waste	PCDD/F	%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5E Other Waste	PCBs	%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5E Other Waste	B[a]P	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5E Other Waste	B[b]F	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5E Other Waste	B[k]F	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5E Other Waste	I[123-cd]P	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.1%	-2.1%

*Prior to 1998, emissions were only reported for the sub-category 5Cbiii (Clinical waste incineration). For the years 1998-2014 this sub-category is NO. Other sub-categories of 5C are reported as NO, NA, IE, and NE.

Chapter Eight Gridded and LPS data

8.1 Overview of Gridded and LPS data reporting

It is mandatory to report gridded emissions and emissions from large point sources every four years both under the Convention on Long-Range Transboundary Air Pollution and under Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants (the revised National Emission Ceilings Directive).

The Guidelines for Reporting Emissions and Projections Data under the Convention on Long-Range Transboundary Air Pollution (ECE/EB.AIR/125), adopted in 2014, specify the scope, methodologies, formats and deadlines for annual inventory submissions by Parties to the Convention. The guidelines specify that at four yearly intervals, starting in 2017, Parties shall report updated aggregated sectoral (GNFR) gridded emissions and LPS emissions. The EMEP grid is defined in paragraph 14 of the reporting guidelines and refers to a 0.1°x0.1° latitude-longitude projection in the geographic coordinate World Geodetic System (WGS) latest revision, WGS 84. The EMEP domain covers the geographic domain between 30°N-82°N latitude and 30°W-90°E longitude.

The reporting guidelines under the Convention refers to the EMEP/EEA Guidebook for technical guidance on the spatial distribution of emissions. Directive (EU) 2016/2284 refers to the reporting guidelines under the Convention and as such the requirements under the two reportings are identical.

The development of a high-resolution model for distribution of emissions is part of an on-going research project funded by the EPA ("National mapping of GHG and non-GHG emissions sources". Ref: 2015-CCRP-MS.26). The project has developed a model for distributing emissions at a resolution of 1 km x 1 km covering all sectors and pollutants included in the official Irish emission inventory. The generated spatial emissions data (GNFR) is fully consistent with the reported emission inventories (NFR) under the LRTAP Convention. A list of GNFR categories is presented in Table 8.1 and the relationship between NFR and GNFR is presented in Table 8.2.

Table 8.1. List of GNFR categories

GNFR
A_PublicPower
B_Industry
C_OtherStationaryComb
D_Fugitive
E_Solvents
F_RoadTransport
G_Shipping
H_Aviation
I_Offroad
J_Waste
K_AgriLivestock
L_AgriOther
M_Other
'MEMO' ITEMS - NOT TO BE INCLUDED IN NATIONAL TOTALS
O_AviCruise
P_IntShipping
z_Memo
N_Natural

Table 8.2. Correspondence list for GNFR and NFR categories

NFR	NFR name	GNFR
1A1a	Public electricity and heat production	A_PublicPower
1A1b	Petroleum refining	B_Industry
1A1c	Manufacture of solid fuels and other energy industries	B_Industry
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	B_Industry
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	B_Industry
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	B_Industry
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	B_Industry
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	B_Industry
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	B_Industry
1A2gvii	Mobile Combustion in manufacturing industries and construction	I_Offroad
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B_Industry
1A3ai(i)	International aviation LTO (civil)	H_Aviation
1A3aii(i)	Domestic aviation LTO (civil)	H_Aviation
1A3bi	Road transport: Passenger cars	F_RoadTransport
1A3bii	Road transport: Light duty vehicles	F_RoadTransport
1A3biii	Road transport: Heavy duty vehicles and buses	F_RoadTransport
1A3biv	Road transport: Mopeds & motorcycles	F_RoadTransport
1A3bv	Road transport: Gasoline evaporation	F_RoadTransport
1A3bvi	Road transport: Automobile tyre and brake wear	F_RoadTransport
1A3bvii	Road transport: Automobile road abrasion	F_RoadTransport
1A3c	Railways	I_Offroad
1A3di(ii)	International inland waterways	G_Shipping

NFR	NFR name	GNFR
1A3dii	National navigation (shipping)	G_Shipping
1A3ei	Pipeline transport	I_Offroad
1A3eii	Other (please specify in the IIR)	I_Offroad
1A4ai	Commercial/institutional: Stationary	C_OtherStationaryComb
1A4aii	Commercial/institutional: Mobile	I_Offroad
1A4bi	Residential: Stationary	C_OtherStationaryComb
1A4bii	Residential: Household and gardening (mobile)	I_Offroad
1A4ci	Agriculture/Forestry/Fishing: Stationary	C_OtherStationaryComb
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	I_Offroad
1A4ciii	Agriculture/Forestry/Fishing: National fishing	I_Offroad
1A5a	Other stationary (including military)	C_OtherStationaryComb
1A5b	Other, Mobile (including military, land based and recreational boats)	I_Offroad
1B1a	Fugitive emission from solid fuels: Coal mining and handling	D_Fugitive
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	D_Fugitive
1B1c	Other fugitive emissions from solid fuels	D_Fugitive
1B2ai	Fugitive emissions oil: Exploration, production, transport	D_Fugitive
1B2aiv	Fugitive emissions oil: Refining / storage	D_Fugitive
1B2av	Distribution of oil products	D_Fugitive
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	D_Fugitive
1B2c	Venting and flaring (oil, gas, combined oil and gas)	D_Fugitive
1B2d	Other fugitive emissions from energy production	D_Fugitive
2A1	Cement production	B_Industry
2A2	Lime production	B_Industry
2A3	Glass production	B_Industry
2A5a	Quarrying and mining of minerals other than coal	B_Industry
2A5b	Construction and demolition	B_Industry
2A5c	Storage, handling and transport of mineral products	B_Industry
2A6	Other mineral products	B_Industry
2B1	Ammonia production	B_Industry
2B10a	Chemical industry: Other (please specify in the IIR)	B_Industry
2B10b	Storage, handling and transport of chemical products (please specify in the IIR)	B_Industry
2B2	Nitric acid production	B_Industry
2B3	Adipic acid production	B_Industry
2B5	Carbide production	B_Industry
2B6	Titanium dioxide production	B_Industry
2B7	Soda ash production	B_Industry
2C1	Iron and steel production	B_Industry
2C2	Ferroalloys production	B_Industry
2C3	Aluminium production	B_Industry
2C4	Magnesium production	B_Industry
2C5	Lead production	B_Industry
2C6	Zinc production	B_Industry
2C7a	Copper production	B_Industry
2C7b	Nickel production	B_Industry
2C7c	Other metal production	B_Industry
2C7d	Storage, handling and transport of metal products	B_Industry
2D3a	Domestic solvent use including fungicides	E_Solvents
2D3b	Road paving with asphalt	E_Solvents
2D3c	Asphalt roofing	B_Industry
2D3d	Coating applications	B_Industry
2D3e	Degreasing	E_Solvents
2D3f	Dry cleaning	E_Solvents
2D3g	Chemical products	E_Solvents
2D3h	Printing	E_Solvents
2D3i	Other solvent use	E_Solvents
2G	Other product use	E_Solvents
2H1	Pulp and paper industry	B_Industry
2H2	Food and beverages industry	B_Industry

NFR	NFR name	GNFR
2H3	Other industrial processes	B_Industry
2I	Wood processing	B_Industry
2J	Production of POPs	B_Industry
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	B_Industry
2L	Other production, consumption, storage, transportation or handling of bulk products	B_Industry
3B1a	Manure management - Dairy cattle	K_AgriLivestock
3B1b	Manure management - Non-dairy cattle	K_AgriLivestock
3B2	Manure management - Sheep	K_AgriLivestock
3B3	Manure management - Swine	K_AgriLivestock
3B4a	Manure management - Buffalo	K_AgriLivestock
3B4d	Manure management - Goats	K_AgriLivestock
3B4e	Manure management - Horses	K_AgriLivestock
3B4f	Manure management - Mules and asses	K_AgriLivestock
3B4gi	Manure management - Laying hens	K_AgriLivestock
3B4gii	Manure management - Broilers	K_AgriLivestock
3B4giii	Manure management - Turkeys	K_AgriLivestock
3B4giv	Manure management - Other poultry	K_AgriLivestock
3B4h	Manure management - Other animals	K_AgriLivestock
3Da1	Inorganic N-fertilizers (includes also urea application)	L_AgriOther
3Da2a	Animal manure applied to soils	L_AgriOther
3Da2b	Sewage sludge applied to soils	L_AgriOther
3Da2c	Other organic fertilisers applied to soils (including compost)	L_AgriOther
3Da3	Urine and dung deposited by grazing animals	L_AgriOther
3Da4	Crop residues applied to soils	L_AgriOther
3Db	Indirect emissions from managed soils	L_AgriOther
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	L_AgriOther
3Dd	Off-farm storage, handling and transport of bulk agricultural products	L_AgriOther
3De	Cultivated crops	L_AgriOther
3Df	Use of pesticides	L_AgriOther
3F	Field burning of agricultural residues	L_AgriOther
3I	Agriculture other	L_AgriOther
5A	Biological treatment of waste - Solid waste disposal on land	J_Waste
5B1	Biological treatment of waste - Composting	J_Waste
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	J_Waste
5C1a	Municipal waste incineration	J_Waste
5C1bi	Industrial waste incineration	J_Waste
5C1bii	Hazardous waste incineration	J_Waste
5C1biii	Clinical waste incineration	J_Waste
5C1biv	Sewage sludge incineration	J_Waste
5C1bv	Cremation	J_Waste
5C1bvi	Other waste incineration	J_Waste
5C2	Open burning of waste	J_Waste
5D1	Domestic wastewater handling	J_Waste
5D2	Industrial wastewater handling	J_Waste
5D3	Other wastewater handling	J_Waste
5E	Other waste	J_Waste
6A	Other (included in national total for entire territory)	M_Other
'MEMO' ITEMS - NOT TO BE INCLUDED IN NATIONAL TOTALS		
1A3ai(ii)	International aviation cruise (civil)	O_AviCruise
1A3aii(ii)	Domestic aviation cruise (civil)	O_AviCruise
1A3di(i)	International maritime navigation	P_IntShipping
1A5c	Multilateral operations	z_Memo
1A3	Transport (fuel used)	z_Memo
6B	Other not included in national total of the entire territory	z_Memo
11A	Volcanoes	N_Natural
11B	Forest fires	N_Natural
11C	Other natural emissions	N_Natural

8.2 Mapping methodology

The methodology used in the emissions mapping follow the guidelines in the 2016 EMEP/EEA emission inventory guidebook. The overall approach aims to allocate the national total emissions to the geographical location where they occur as accurately as possible. A distinction is made between point sources and area sources. Point sources are sources that can be treated individually and have an exact location, e.g. industrial plants. Area sources cover a group of minor emission sources with similar characteristics that cannot be treated individually because of the number of sources, e.g. residential plants. Some sectors are covered only by point sources or only by area sources, but many sectors cover both point and area sources. In the latter case point and area sources are treated separately in the data processing and following they are combined on sectoral level in the spatial emission mapping.

Emissions from point sources can be allocated to an exact location, e.g. the location of a power plant or an industrial plant. Activity data and/or emissions are available for a number of large plants e.g. from PRTR/E-PRTR reporting. These data are used either directly (emissions) or indirectly (activity data) to allocate point source emissions. Both locations and emissions are generally very accurate for point sources.

The individual source contribution cannot be determined for area sources, and emissions allocations are based on a number of spatial data sets. For each area source related available spatial data are evaluated and the closest related are used for emission mapping, taking into account completeness (must cover the entire national area), spatial resolution, accuracy, update frequency etc.

The 2016 EMEP/EEA Guidebook describe a tiered approach for spatial distribution of emissions, depending on the data availability and level of detail for the individual emission sources/sectors. Furthermore, different methodological tiers can be used for different pollutants from a source, e.g. point source emission data are most often available only for some pollutants, while emission mapping for remaining pollutants follow a lower tier method.

The concept of tiered mapping is summarised as follows:

- **Tier 3 methods** are based on closely related spatial emission or activity data, e.g. data for regulated processes and industries, and road traffic flows by vehicle type derived from surveys.
- **Tier 2 methods** are based on the use of surrogate statistics relate to the sector, e.g. heat demand for the residential sector, agricultural animal statistics, and land parcel identification system data
- **Tier 1 methods** are based on loosely related surrogate statistics, e.g. building use, population density, and land use.

The tiered methodology is outlined in the decision tree in Figure 8.1

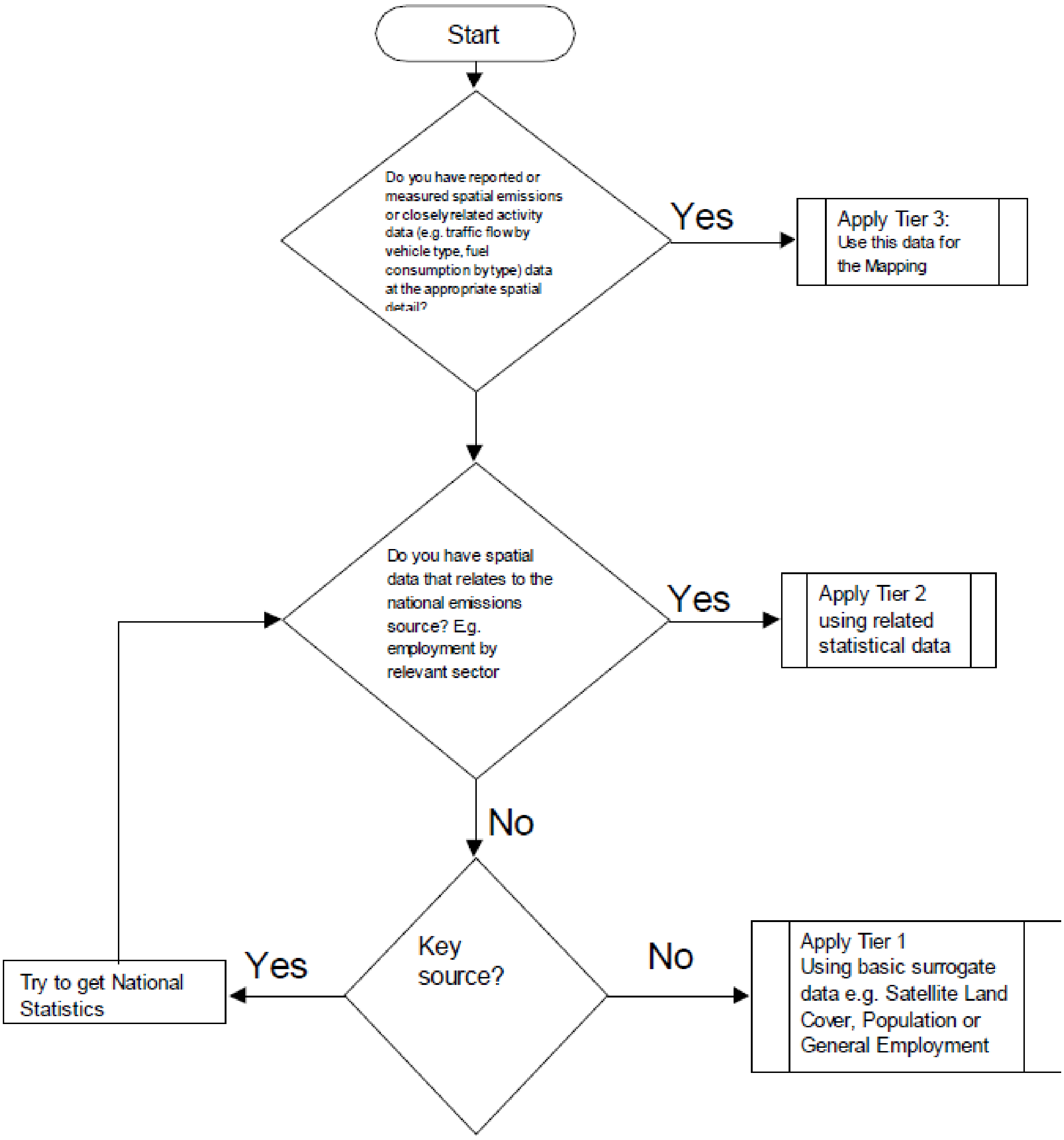

Figure 8.1 General decision tree for emissions mapping (EMEP/EEA 2016)

Mapping of Irelands emissions is done on a highly disaggregated level both regarding sectoral and spatial resolution. Spatial distribution keys (GeoKeys) are set up for each NFR category with a spatial resolution of 1 km x 1 km. GeoKeys are normalised tables including the share of an emission source that should be allocated to each grid cell. Some GeoKeys are used for all pollutants from a sector, while others are pollutant specific. Further, some sectors have been disaggregated into different sources and GeoKeys have been set up on source level and afterwards combined to create one overall GeoKey for the NFR sector. In this way, a high level of accuracy is ensured in the emission mapping as the highest tier level methodology is applied for all sources.

GeoKeys for the individual sectors/sources are built from a number of different spatial data. Some of the spatial data sets describe the emission allocation very accurate, e.g. E-PRTR reporting, while others are proxies for activity level or other related parameters; some being good proxies, e.g. mileage data for emissions from road transport, others being less good proxies, e.g. population density for domestic solvent use.

The common methodological approach is to make an overlay analysis of one or more spatial layers and the 1 km x 1 km grid in a Geographical Information System (GIS).

Preparation of the GeoKey for railway transport is described here as an example, and related maps are shown in Figure 8.2. Railway transport is an area source, and the emissions are spatially allocated to the railway network. The railway network is available as a digital map including the network as lines (Figure 8.2 a), which allow for the emissions to be distributed evenly to the railway network. Activity data based on railway statistics are added to the map's attribute data, and are used to improve the spatial distribution to allocate emissions according to the activity levels. An overlay of the railway network including activity data and the 1 km x 1 km grid is made in GIS (Figure 8.2 b), and the layers are intersected to cut the railway lines by the grid (Figure 8.2 c). The length of each line segment is calculated using standard GIS tools, and the share of each railway line in each grid cell is calculated. As more line segments can occur in the same grid cell, e.g. when two railway lines meet, the shares are summarised by grid cell to generate the GeoKey, which holds the share of the national emission by grid cell (Figure 8.2 d).

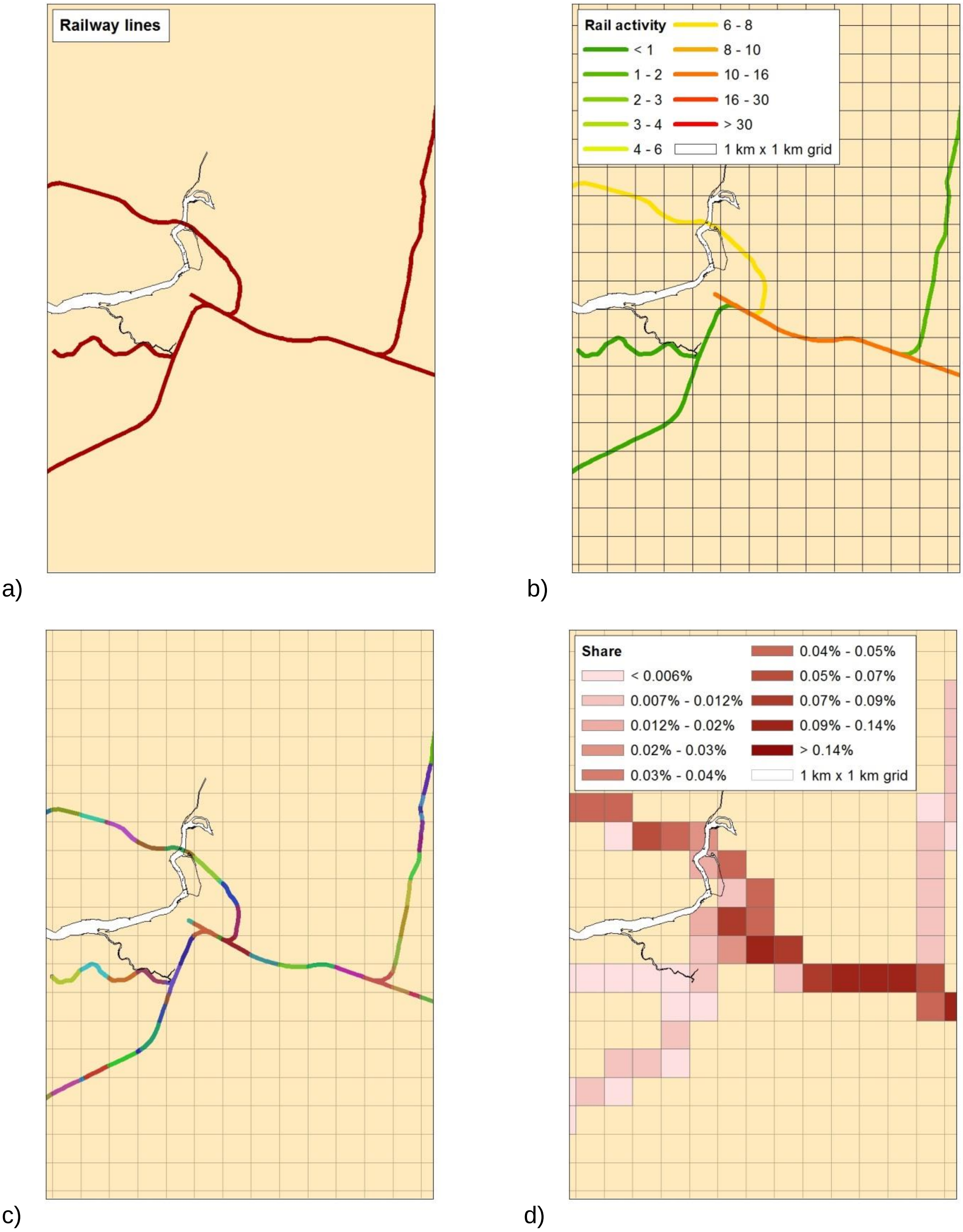

Figure 8.2 Example of GeoKey preparation

The emission mapping is made using an orthogonal grid with a resolution of 1 km x 1 km in the Irish projection TM65. The spatial emissions are redistributed into the reporting grid, the EMEP/EEA grid with a spatial resolution of 0.1 degree x 0.1 degree, using the share of each 1 km x 1 km grid cell that intersects the individual 0.1 degree x 0.1 degree grid cells.

8.3 Mapping methods for each GNFR

A summary of the data and mapping approaches used in compilation of the spatial inventory for Ireland are outlined in the tables below by GNFR sector. An indication of the tier 1-3 categorisation has also been provided as a simple measure of uncertainty in the approach applied. A more detailed description of the methodologies applied is available in Plejdrup et al. (2017)

8.3.1 Public Power (GNFR A_PublicPower)

Detailed location information for this sector were available on the individual large point sources for the NFR sector 1A1a Public Power. The emissions for some pollutants were available for the individual point sources, and in these cases, the data were used directly. For the pollutants where plant specific data were not available, the distribution is based on the activity data. The use of plant specific data and exact location of the emissions corresponds to a tier 3 method.

8.3.2 Industry (GNFR B_Industry)

As shown in Table 8.1, this GNFR covers many different source categories and hence the available spatial data vary across sectors. The categories include both combustion related categories and categories where the emissions are related to the process.

Where detailed emissions and location information were available, e.g. from the E-PRTR or the EU ETS on the individual point source emissions for the NFR sectors in GNFR B Industrial Combustion sector, these were used to map emissions to the known location. This is the case for e.g. emissions from refining and other energy industries (NFR categories 1A1b and 1A1c respectively).

For other source categories, some data are available at point source level, but the coverage does not match the national total. In these cases the emissions covered by point sources are allocated to the relevant point sources and the residual emission is distributed according to a more general spatial distribution key, e.g. industrial heat demand. These two distributions are then combined to one GeoKey covering the total sectoral emission.

This approach is considered a tier 2 or tier 3 method.

8.3.3 Other stationary combustion (GNFR C_OtherStationaryComb)

This GNFR category covers combustion in three subsectors, i.e. commercial/institutional, residential and agriculture. The most important sector in terms of emission contribution is residential combustion.

For commercial/institutional plants, the distribution is based on heat demand for commercial and public buildings as calculated by the Irish Heat Map. The Heat Map is based on a study from 2015 commissioned by SEAI to fulfil Ireland’s requirements under article 14 of the Energy Efficiency Directive (2012/27/EU). As part of this study a spatial representation of Ireland’s heat demand was developed.

For residential plants, the distribution is based on information from the 2011 census on primary fuel types in households combined with an estimated unit consumption calibrated with the estimated national residential fuel consumption and the emission factors used in the emission inventory.

For the agricultural sector, the spatial data on farmyards and buildings from the Land Parcel Information System (LPIS) were used.

This is considered tier 2/3 methodologies.

8.3.5 Fugitive Emissions (GNFR D_Fugitive)

This sector covers both categories estimated as point sources (e.g. coal mining/handling, service stations and flaring) and area sources (e.g. natural gas distribution).

The point source data have been used to allocate emissions and, where available, activity data have been incorporated to further improve the distribution of emissions. Information on coal mining areas as well as coal consumers were provided by the EPA, while a list of service stations was provided by the CSO. For natural gas distribution, the spatial information included for gas use in the Heat Map was utilised to distribute emissions.

This is considered tier 2/3 methodologies.

8.3.6 Solvents (GNFR E_Solvents)

The national emissions from domestic solvent use were mapped across the country using population density as spatial proxy. This approach is a tier 2 method.

For the remaining solvent use categories, there was some spatial information available, e.g. location of dry cleaners. However, both population density and industrial heat demand were used as spatial proxies to map emissions from coating applications, chemical products and printing. This is considered tier 1/2/3 methodologies.

8.3.7 Road transport (GNFR F_RoadTransport)

Spatial mileage data for national roads (NR) provided by TII for total mileage and % heavy vehicles are used to allocate emissions from road transport on NR. Road transport on other roads is estimated as the residual of the national total mileage used in the inventory, and emissions are allocated to roads other than national roads. As mileage data is not available for other roads than NR a polygon map of the road network is applied for mapping, thereby using road area as a proxy for the activity level. Separate GeoKeys are prepared for passenger cars including vans and 2-wheelers (PC), heavy vehicles including busses (HV), and all vehicles (PC+HV).

The approaches used are tier 3 for national roads and tier 2 for remaining roads.

8.3.8 National navigation (GNFR G_Shipping)

The estimates of the emissions from national navigation were mapped using a buffer zone of six nautical miles around the coast of Ireland. The buffer zone was adjusted to take into account the shortest path between headlands in Ireland. This approach is a tier 2 method.

8.3.9 Aviation (LTO) (GNFR H_Aviation)

National total emissions from aircraft operating on the ground and in the air over Ireland, up to an altitude of 1000 m (equating to the take offs and landing – LTO) were mapped at the locations of the airports including a five-kilometre buffer zone. The number of LTOs at each airport was used to further improve the distribution of emissions. This approach is a tier 3 method.

8.3.10 Off road mobile sources (GNFR I_Offroad)

This GNFR category comprises several different activities such as railways, fishing and agricultural machinery.

For railways, the railway network and data for annual passages were provided by Irish Rail and this information has been used to develop a GeoKey for this sector.

For fishing, the emissions have been distributed based on data for fishing areas within the Irish exclusive economic zone and fishing statistics.

For agricultural machinery, data on the number of different types of machinery at county level were obtained from the CSO and this information was combined with the land information from LPIS on cropland and improved grassland.

This is considered tier 2/3 methodologies.

8.3.11 Waste handling and treatment (GNFR J_Waste)

The estimates of the emissions from solid waste disposal on land were mapped at the locations of landfill sites. For composting 75 % of the emission were allocated to the licensed facilities while the remaining 25 % where allocated to non-urban residential buildings.

Emissions from clinical waste incineration, industrial waste incineration and cremation were mapped at the locations of the known facilities. Activity and location data for industrial waste incinerators and crematoria were available and used to weight emissions to areas of known activity proportionally.

Estimates of the national emissions from other waste handling (e.g. accidental fires) were mapped according to population density.

This is considered tier 1/2/3 methodologies

8.3.13 Agricultural livestock (GNFR K_AgriLivestock)

National emissions from pigs and poultry were distributed based on detailed data on farms and animal numbers from the 2010 agricultural census provided by UCD.

National emissions from mink were distributed based on farm locations and animal numbers provided by EPA.

National emissions from cattle, sheep and horses were distributed based on data from the 2010 agricultural census provided by CSO on the number of animals per electoral district combined with the Land Parcel Identification System (LPIS) data on location of farmyards and buildings.

National emissions from goats, mules and asses, and deer were distributed based on data from the 2010 agricultural census provided by CSO on the number of animals per county combined with the Land Parcel Identification System (LPIS) data on location of farmyards and buildings.

This approach is a tier 2/3 method.

8.3.14 Agricultural soils (Other emissions) (GNFR L_AgriOther)

National emissions from sources related to agricultural soils, e.g. application of fertiliser and manure as well as grazing animals were distributed on cropland and/or grassland from LPIS, taking into account the animal density when distributing emissions from animal manure. This approach is a tier 1/2 method.

8.3.15 Aviation (Cruise) (GNFR O_AviCruise)

This category includes cruise emissions from both national and international aviation. For national cruise emissions, the distribution is based on information on the number of flights between Irish airports and emissions are allocated to great circle lines between these airports.

For international cruise emissions, the majority of emissions will occur outside the Irish territory, but for the purposes of the submission, emissions are allocated evenly across the entire Irish area outlined by the Irish Exclusive Economic Zone (EEZ).

8.3.16 International navigation (GNFR P_IntShipping)

Emissions from international navigation will largely occur outside the Irish territory, but for the purposes of the submission, emissions are allocated evenly across the sea area outlined by the Irish Exclusive Economic Zone (EEZ).

8.4 National total emission mapped by the EMEP 0.1 degree x 0.1 degree grid

Figure 8.3 a-e present the mapped national total emissions for NO_x, SO_2, NMVOC, NH_3, and $PM_{2.5}$ in Ireland by EMEP 0.1 x 0.1 degree grid.

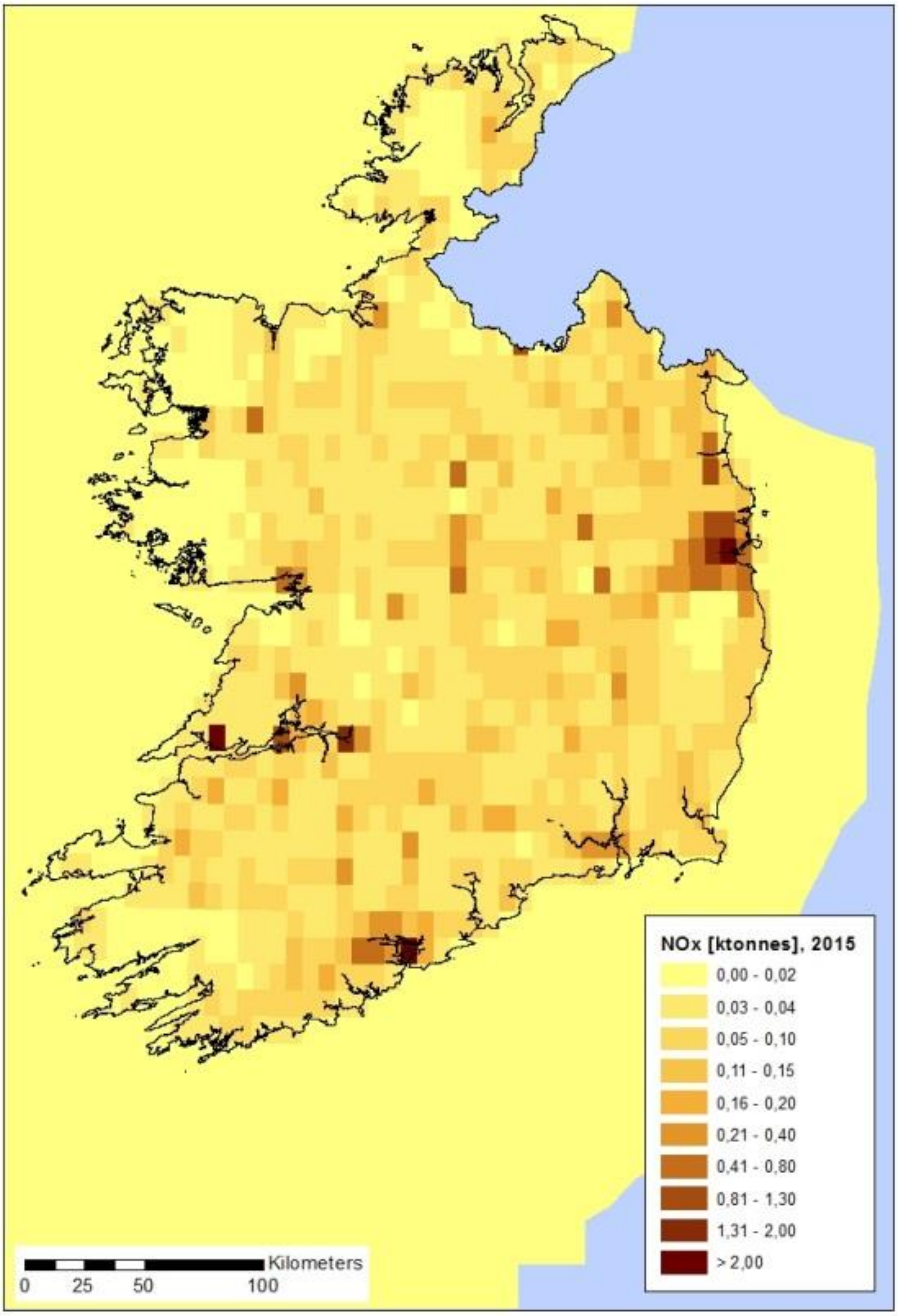

Figure 8.3(a) National Total Emissions in 2015 for NOx

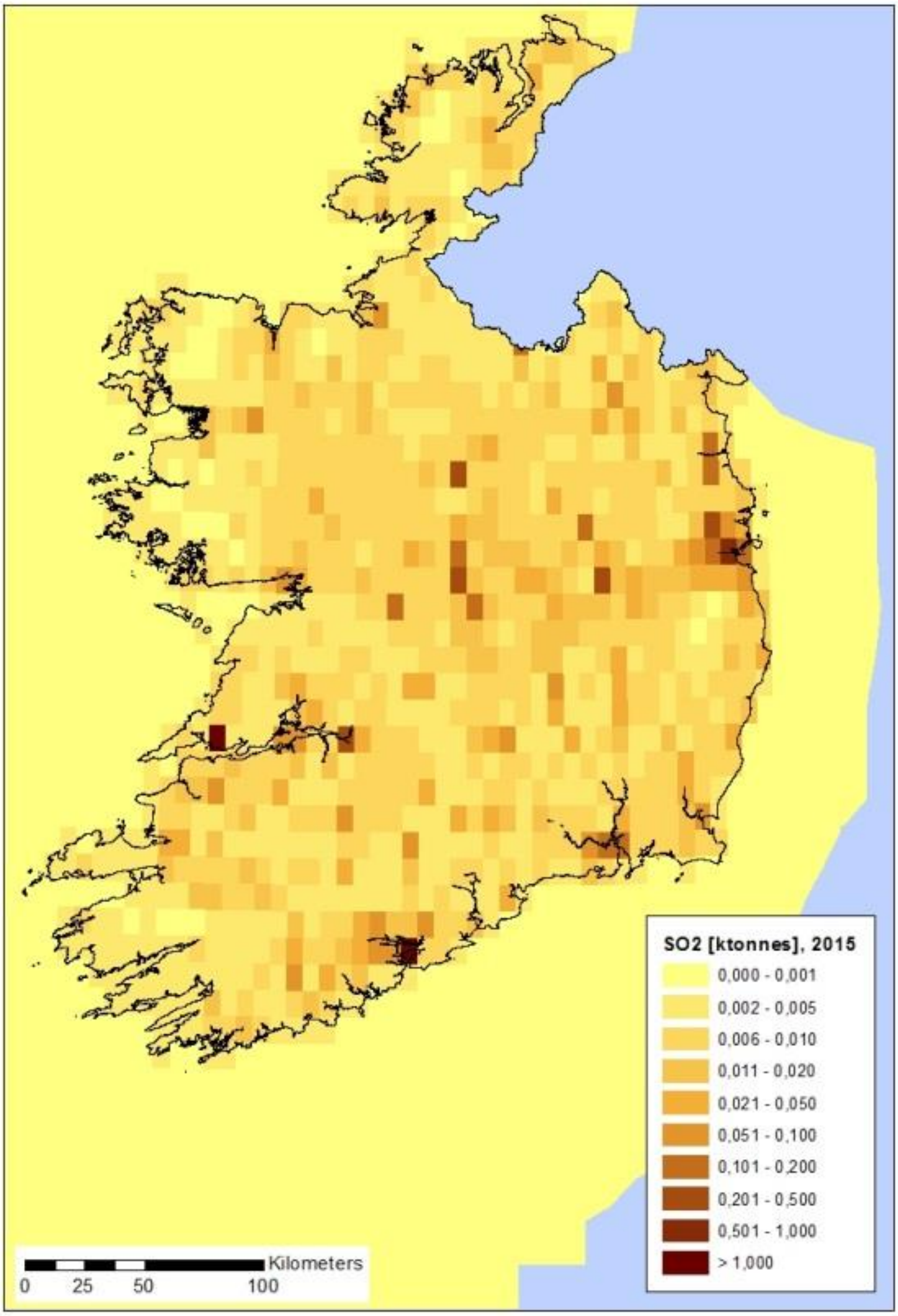

Figure 8.3(b) National Total Emissions in 2015 for SO2

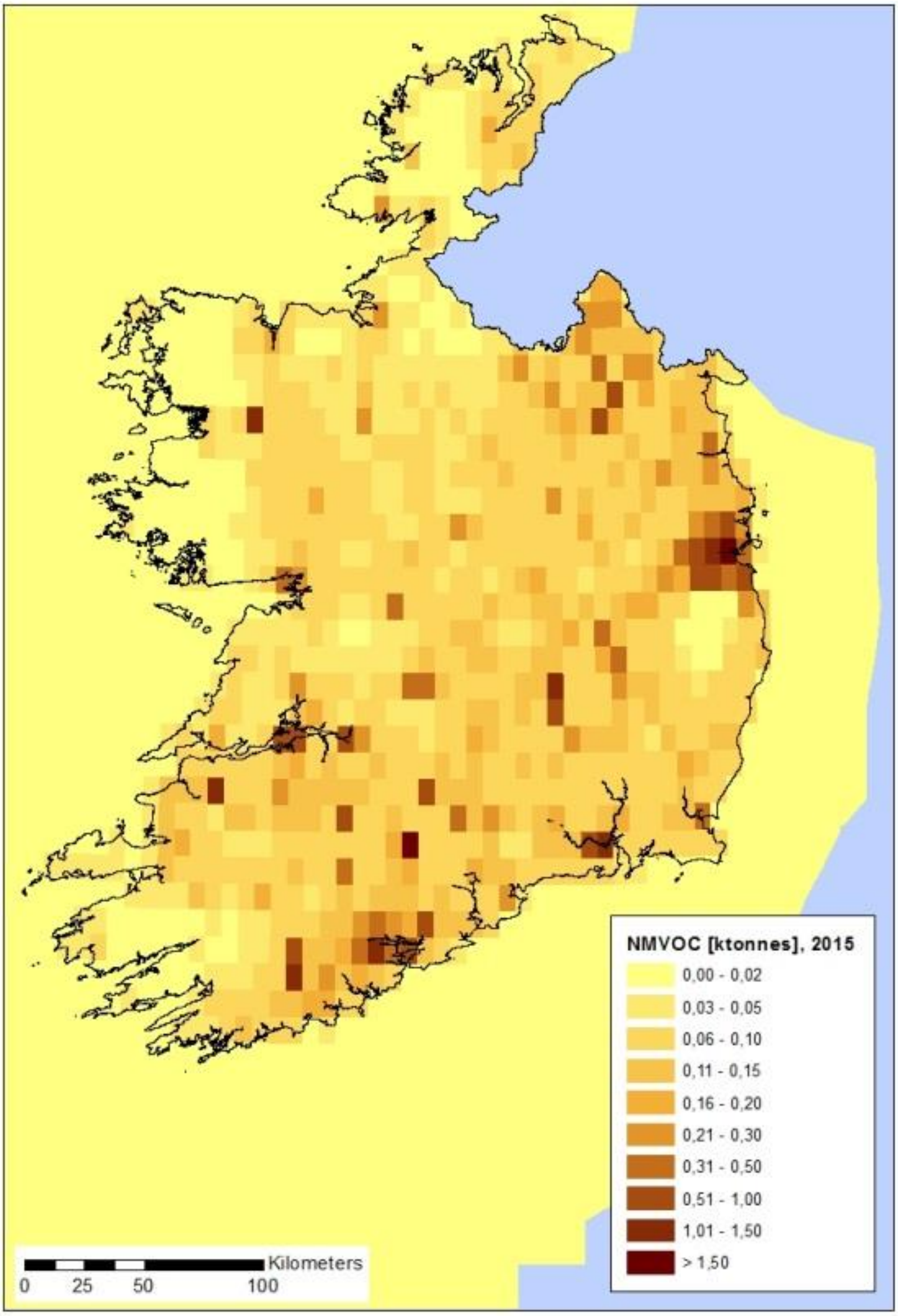

Figure 8.3 (c) National Total Emissions in 2015 for NMVOC

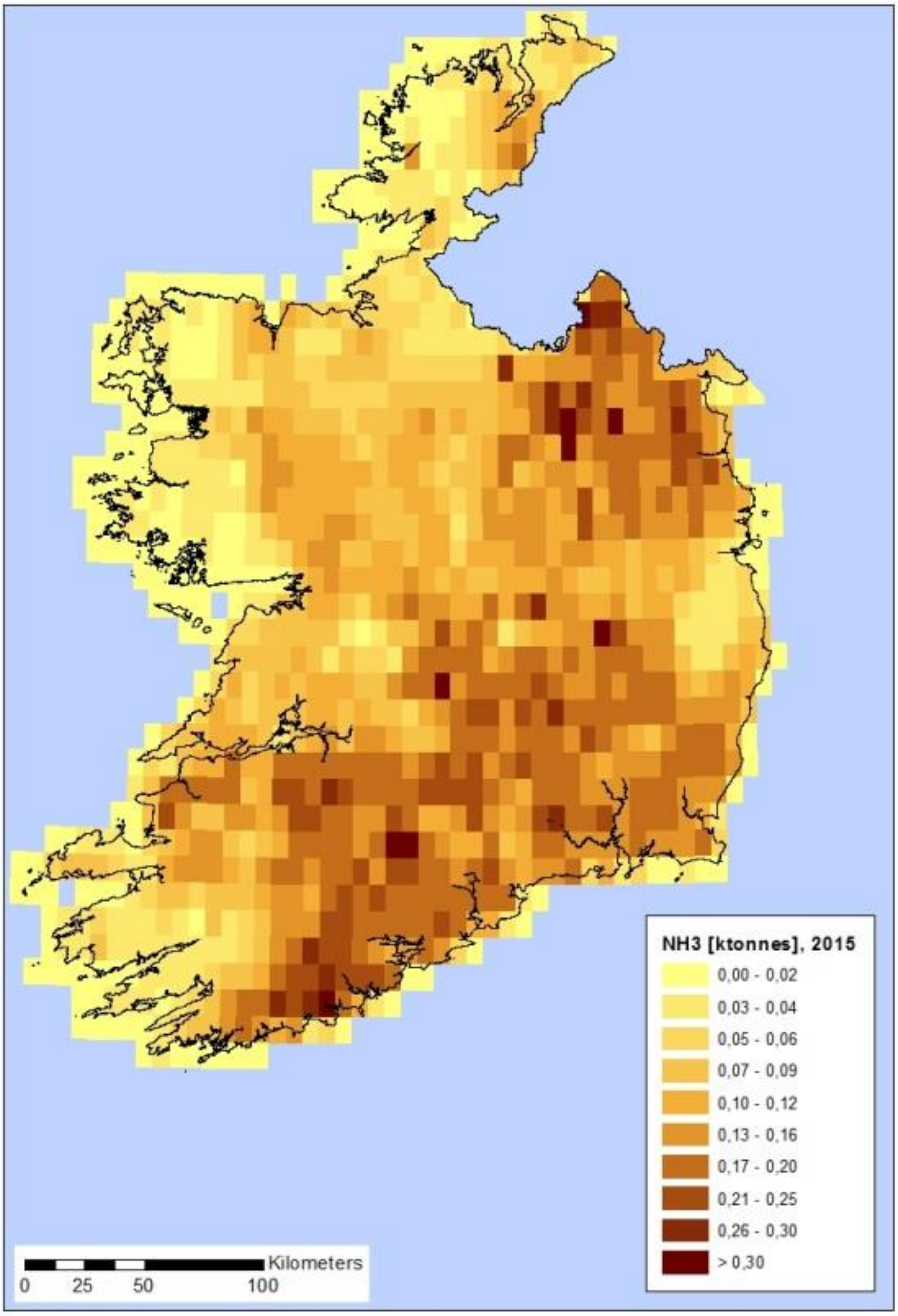

Figure 8.4 (d) National Total Emissions in 2015 for NH_3

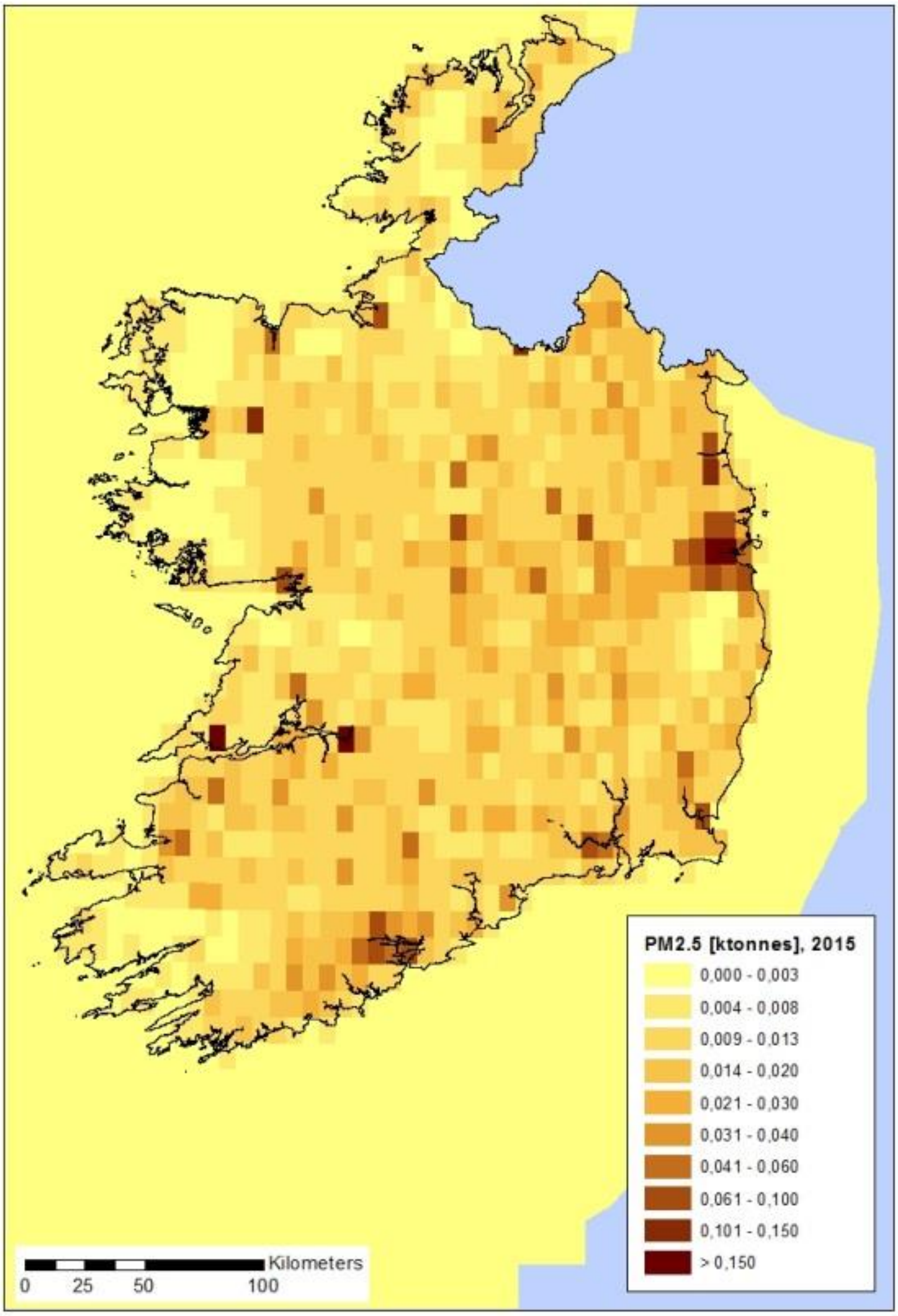

Figure 8.4 (e) National Total Emissions in 2015 for PM2.5

Chapter Nine Projections

9.1 Overview of Emissions Projections

This chapter presents the emission projections that have been compiled for reporting under the National Emissions Ceiling Directive and the Convention on Long Range Transboundary Air Pollution (CLRTAP).

Section 9.2 describes emission reduction targets for 2020 and 2030. Section 9.3 provides a short explanation of how energy forecasts are generated for both "With Existing Measures" and "With Additional Measures" scenarios. Information on key assumptions and underlying data are also provided.

Section 9.4 presents the emission projections for each of the pollutants covered, and considers the key trends across the time series which include the impact of national policies and measures (in response to European Directives and legislation) aimed at reducing greenhouse gas emissions. Sections 9.5 to 9.13 consider each of the main NFR source sectors, and provide a more detailed explanation of the emission projections compilation process for each sector.

The NEC Directive requires biennial reporting from 2017 of projected emissions for SO_2, NO_x, NH_3, NMVOC, $PM_{2.5}$ and, if available, Black Carbon covering projection years 2020, 2025, 2030 and, where available, 2040 and 2050.

The CLRTAP guidelines for reporting emissions and projections data state that parties to the Gothenburg Protocol within the geographical scope of the EMEP shall regularly update their projections and report every four years from 2015 onwards their updated projections, for the years 2020, 2025 and 2030 and, where available, also for 2040 and 2050. Parties to the other protocols are encouraged to regularly update their projections and report very four years from 2015. In addition parties should provide a "With Existing Measures" and where relevant a "With Additional Measures" projection estimate.

Projected emission estimates and supporting quantitative information were reported for SO_2, NO_x, NH_3, NMVOC, $PM_{2.5}$ and, Black Carbon under the NEC Directive and CLRTAP utilising the reporting template contained within annex IV of the Guidelines for Reporting Emissions and Projections Data under the CLRTAP[4].

This chapter details emission projections under both the With Existing Measures scenario and With Additional Measures scenario for the following pollutants for the period 2016-2030: NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$.

9.2 Emission Reduction Targets for 2020 and 2030

The Gothenburg Protocol includes national emission reduction commitments to be achieved in 2020 and beyond for NO_x, SO_x, NMVOC and NH_3 and $PM_{2.5}$.

The National Emission Ceilings Directive (NECD, 2001/81/EC) was reviewed as part of the Clean Air Policy Package and a new Directive came into effect in December 2016[5]. Emission reduction commitments have been set for Ireland for 2020 and 2030 for NO_x, SO_x, NMVOC, NH_3, and $PM_{2.5}$. Table 9.1 details the emission reduction targets in place for each

[4] http://www.ceip.at/reporting_instructions/annexes_to_guidelines/

[5] DIRECTIVE (EU) 2016/2284 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC

pollutant for 2020 under the Gothenburg Protocol and 2020 and 2030 under the new National Emissions Ceilings Directive.

Table 9.1. Emission Reduction Commitments for 2020 and 2030 (expressed as a percentage reduction of 2005 levels)

Pollutant	SO_2	NO_X	NH_3	NMVOC	$PM_{2.5}$
2020	65%	49%	1%	25%	18%
2030	85%	69%	5%	32%	41%

9.3 With Existing Measures and With Additional Measures Scenarios

Sustainable Energy Authority of Ireland (SEAI) compile national energy forecasts presenting energy trends into the future. The most recent forecast provides energy demand trends to 2035. These energy forecasts form the basis for almost all energy-related emission projections presented in this chapter. The latest energy forecasts include two scenarios which are used in national emission projections: *Baseline* and *NEEAP/NREAP* (adjusted for 2017 projections to reflect current progress and the trajectory towards achieving 2020 energy efficiency and renewable energy targets).

The *Baseline* energy forecast projects forward Ireland's energy demand, incorporating the expected impacts of policies and measures that were in place (e.g. legislatively provided for) by the end of 2015. It represents a hypothetical future scenario in which no further policy actions or measures have been taken. It excludes policies that are committed to but which do not yet have measures in place to deliver them. The *Baseline* energy forecast thus underpins the energy related *With Existing Measures* (WEM) air pollutant emission projections.

The *NEEAP/NREAP* energy forecast (adjusted for 2017 projections) presents an alternative view of future energy demand that accounts for further implementation of the National Renewable Energy Action Plan[6] (NREAP) and the 3rd National Energy Efficiency Action Plan[7] (NEEAP) based on current progress. Therefore this forecast includes existing *and* further implementation of planned policies and measures based on current progress. For 2017 projections, the latest *NEEAP/NREAP* energy forecast has been adjusted to reflect current progress and the trajectory towards achieving 2020 targets. This includes an expected shortfall in achieving full energy efficiency targets and renewable energy targets for electricity, transport and heat. The *NEEAP/NREAP* energy forecast (adjusted) therefore underpins the energy related *With Additional Measures* (WAM) emission projections.

For the *Baseline* energy forecast, the Economic and Social Research Institute (ESRI) use macro-economic projections which are produced using the COSMO model[8]. The baseline projections and underlying assumptions are described here in Chapter 1 of "Ireland's Economic Outlook: Perspectives and Policy Challenges", which was published on 5 December 2016[9]. Projections on the global economic environment, including oil prices, as based in simulations using the NiGEM model (National Institute Global Econometric Model[10]) maintained by the National Institute of Economic and Social Research[11]. Projections from the COSMO model were used to produce projections of the energy demand equation time series variables (i.e. demand equations by fuel and sector). The integration of energy demand into the COSMO model is work that is due to be undertaken in 2017.

6 http://www.dccae.gov.ie/energy/en-ie/Renewable-Energy/Pages/Action-Plan.aspx
7 http://www.dccae.gov.ie/energy/SiteCollectionDocuments/Energy-Efficiency/NEEAP%203.pdf
8 https://www.esri.ie/projects/modelling-the-irish-economy/
9 http://www.esri.ie/pubs/EO1.pdf
10 https://nimodel.niesr.ac.uk/
11 http://www.niesr.ac.uk/

Annual electricity demand, which is an output of the electricity demand equations/COSMO was transferred, as well as fuel prices, as an input into an electricity dispatch model to determine fuels used at an hourly level to service aggregate electricity demand. This process provides a high level of accuracy on the fuels used in the electricity sector. The software used for the energy forecasts to model the Irish Electricity Market is PLEXOS 7.4 R01. PLEXOS is a power systems modelling tool used for electricity market modelling and planning.

The energy forecast includes sectoral output figures and other relevant key variables such as price, economic growth, population and housing stock. To produce the finalised *Baseline* energy forecast, SEAI amends the output of the energy demand produced by ESRI (described above) to take account of the expected impact of energy efficiency measures put in place before the end of 2015 but which are considered too recent to be detectable in any time-series analysis. The *NEEAP/NREAP* energy forecast (adjusted) builds on the *Baseline* forecast with adjustments made to account for further implementation of additional policies and measures outlined in the NEEAP[5] and NREAP[4]. For 2017 projections, the *NEEAP/NREAP* energy forecast has been adjusted to reflect current progress and the trajectory towards achieving 2020 targets. This includes an expected shortfall in achieving energy efficiency and renewable energy targets.

The energy forecasts that underpin the energy-related emissions projections are based on macroeconomic projections as described above. Table 9.2 shows the key parameters underlying the macroeconomic outlook and therefore the *With Existing Measures* and *With Additional Measures* emission projections scenarios. The forecasts are based on international fuel import oil prices. Coal and gas prices were published by the United Kingdom's Department of Energy and Climate Change. The carbon prices are those circulated by the European Commission in June 2016. Carbon dioxide price assumptions in the non-ETS sectors are based in the medium term on the Finance Bill 2010[12] which saw the introduction of a carbon tax of €15 per tonne CO_2. In the longer term the carbon tax is assumed to follow the EU ETS carbon price.

Activity data forecasts and the methodological approach to emission projections from the agriculture and waste sectors are discussed in their respective sections.

Table 9.2. Key assumptions underpinning the energy forecasts

	2016 – 2020	2021-2025	2026-2030
Average Annual % Growth Rate			
GDP	+3.74%	+3.24%	+2.59%
GNP	+3.42%	+3.32%	+1.97%
Personal Consumption	+2.97%	+2.57%	+1.11%
	2020	**2025**	**2030**
Housing Stock ('000)	2,018	2,112	2,206
Population ('000)	4,834	5,027	5,209
EUETS: Carbon €$_{2013}$/tCO_2	15	22.5	33.5
Carbon tax €$_{2013}$/tCO_2	15	22.5	33.5
Coal $\$_{2013}$/boe	9.9	11.6	10.6
Oil $\$_{2013}$/boe	56.8	62.8	69.4
Gas $\$_{2013}$/boe	20.4	24.6	27.3
Peat €/MWh	25	25	25

[12] Finance Bill 2010. http://www.finance.gov.ie/ga/news-centre/press-releases/finance-bill-2010

9.4 Key Trends

Air pollutant emission projections have been generated for a WEM scenario and a WAM scenario. In the following sections, both scenarios are presented in the context of emission reduction targets set for 2020 and 2030. The WAM scenario is then considered in more detail.

Figures in the following sections include historic air pollutant emission estimates for 2005 to 2015 as contextual information. Tables in the following sections present projected emission estimates up to and including 2030 under both the WEM and WAM scenarios.

9.4.1 Sulphur Dioxide (SO_2)

Emission projections for SO_2 for the WEM and WAM scenarios are presented in Figure 9.1. The emission reduction targets for 2020 and 2030 are also presented.

Total SO_2 emissions under the WAM scenario are projected to be 11.8 kt in 2020. The emission projections predict compliance with the 2020 emission reduction target by 14.1 kt. Total SO_2 emissions are projected to be 8.3 kt in 2030 under the WAM scenario which is below the emission reduction target for that year.

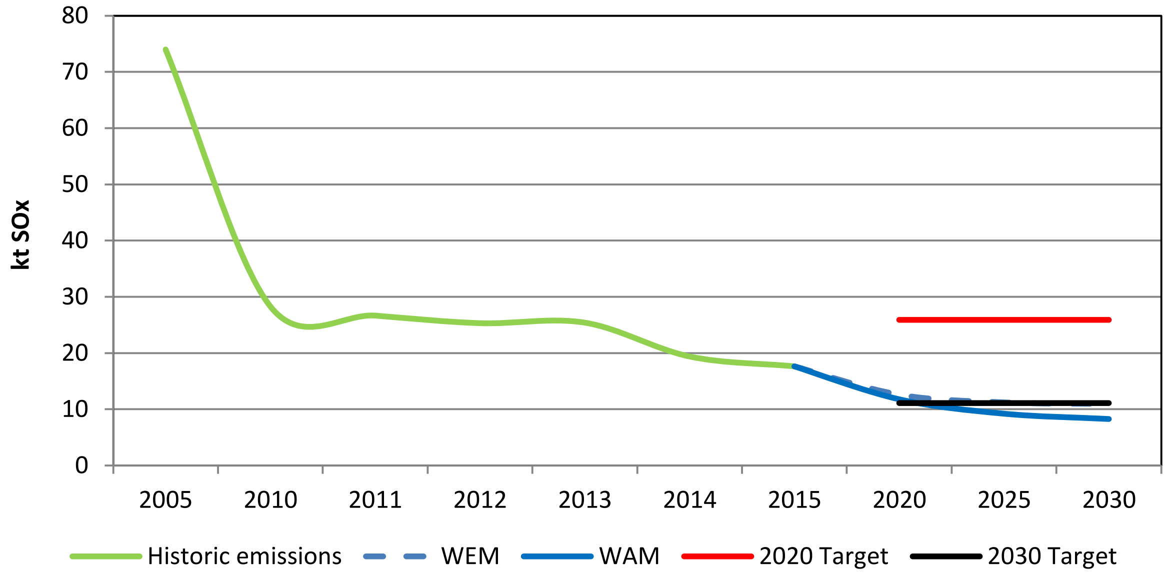

Figure 9.1 SO2 Emission Projections for the With Existing Measures and With Additional Measures Scenarios

The difference between the WEM and WAM scenarios is attributed to the effect of further penetration of renewables in electricity generation in addition to renewables and energy efficiency measures in buildings in the residential, commercial and manufacturing industries sectors.

Sulphur dioxide emissions under the WAM scenario by source sector are presented in Figure 9.2. Emissions from Public Electricity and Heat Production (1A1a) currently contribute approximately one-third of national total emissions of SO_2. From 2025 onwards, emissions are projected to significantly reduce further which is attributed to an assumption that coal will be replaced with gas that is used for electricity generation.

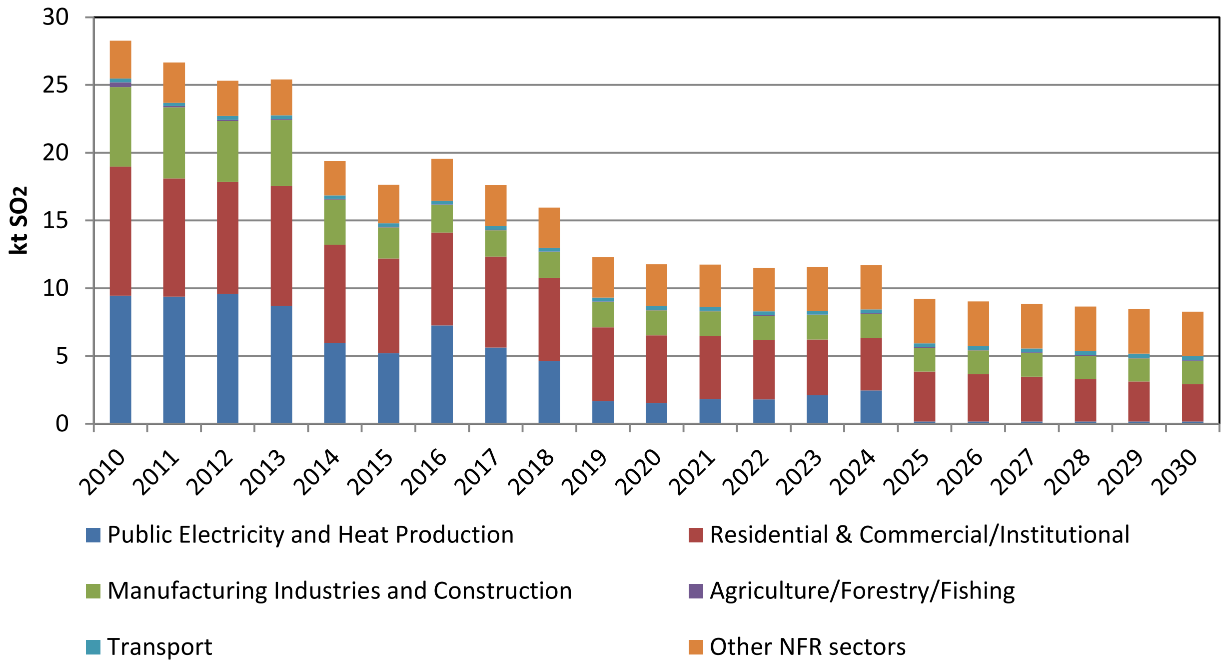

Figure 9.2 SO_2 Emission Projections for the With Additional Measures Scenario by Source Sector

Table 9.3. Projected Emissions of SO_2 under the With Existing Measures and With Additional Measures Scenarios (kt)

***With Existing Measures* scenario**					
	2015	**2016**	**2020**	**2025**	**2030**
Public Electricity and Heat Production	5.2	7.3	2.0	1.6	1.9
Residential & Commercial/Institutional	7.0	6.9	5.2	4.1	3.5
Manufacturing Industries and Construction	2.3	2.1	2.0	1.9	1.9
Agriculture/Forestry/Fishing	0.0	0.1	0.0	0.1	0.1
Transport	0.3	0.3	0.3	0.3	0.3
Other NFR sectors	2.8	3.1	3.1	3.3	3.3
TOTAL	**17.6**	**19.7**	**12.6**	**11.2**	**10.9**
***With Additional Measures* scenario**					
Public Electricity and Heat Production	5.2	7.3	1.5	0.2	0.2
Residential & Commercial/Institutional	7.0	6.9	5.0	3.7	2.8
Manufacturing Industries and Construction	2.3	2.0	1.8	1.8	1.7
Agriculture/Forestry/Fishing	0.0	0.1	0.0	0.1	0.1
Transport	0.3	0.3	0.3	0.3	0.3
Other NFR sectors	2.8	3.1	3.1	3.3	3.3
TOTAL	**17.6**	**19.5**	**11.8**	**9.2**	**8.3**

9.4.2 Nitrogen Oxides (NO_X)

Emission projections for NO_X for the WEM and WAM scenarios are presented in Figure 9.3. The emission reduction targets for 2020 and 2030 are also presented.

Total NO_X emissions under the WAM scenario are projected to be 57.3 kt in 2020. The emission projections predict compliance with the 2020 emission reduction target. Total NO_x

emissions in 2030 are projected to be 47.0 kt, which is an estimated 4.7 kt non-compliance with the emission reduction target.

Projected emissions across the time series show a steady decline for both the WEM and WAM scenarios. The forecasted replacement of coal with natural gas in Public Electricity and Heat Production (1A1a) under the WAM scenario reduces emissions of NO_x from the sector in 2025. The projected emissions trend is very much dominated by the transport (1A3) sector (Figure 9.4).

Similar to SO_2 the policies and measures aimed at the use of renewable fuels and improving energy efficiency in dwellings, commercial and public buildings and industry are responsible for the difference between the WEM and WAM scenarios.

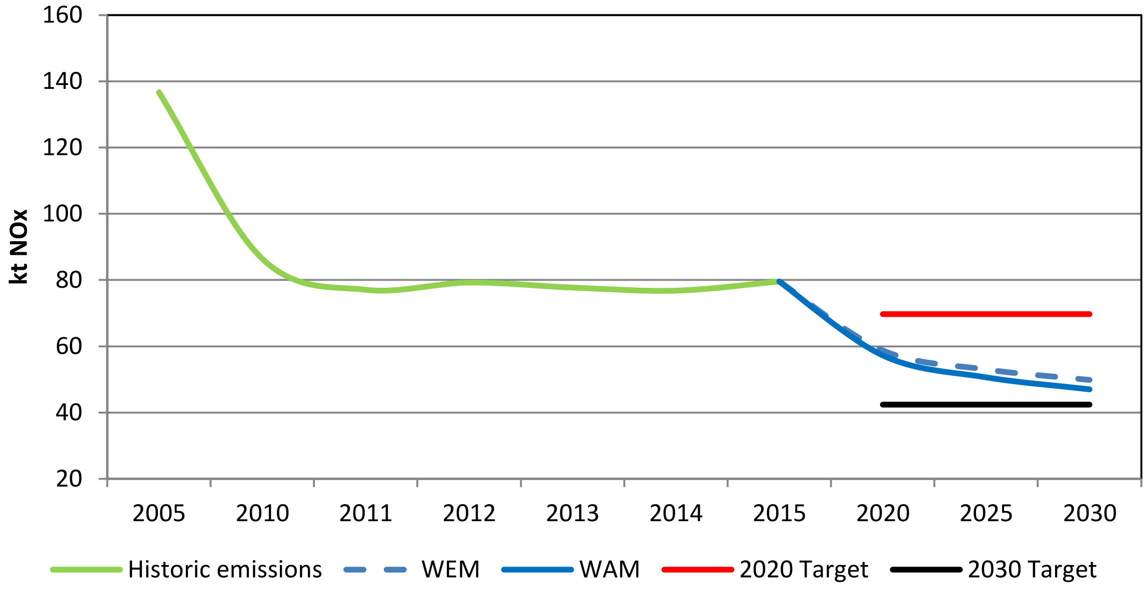

Figure 9.3 NO_X Emission Projections for the With Existing Measures and With Additional Measures Scenarios

Figure 9.4 presents the NO_X emissions under the WAM scenario by source sector. Emissions from transport (1A3) are the largest contributor to the total accounting for approximately 50% of national total emissions for much of the time series. Emissions from the transport sector (1A3) show a decrease across the time series.

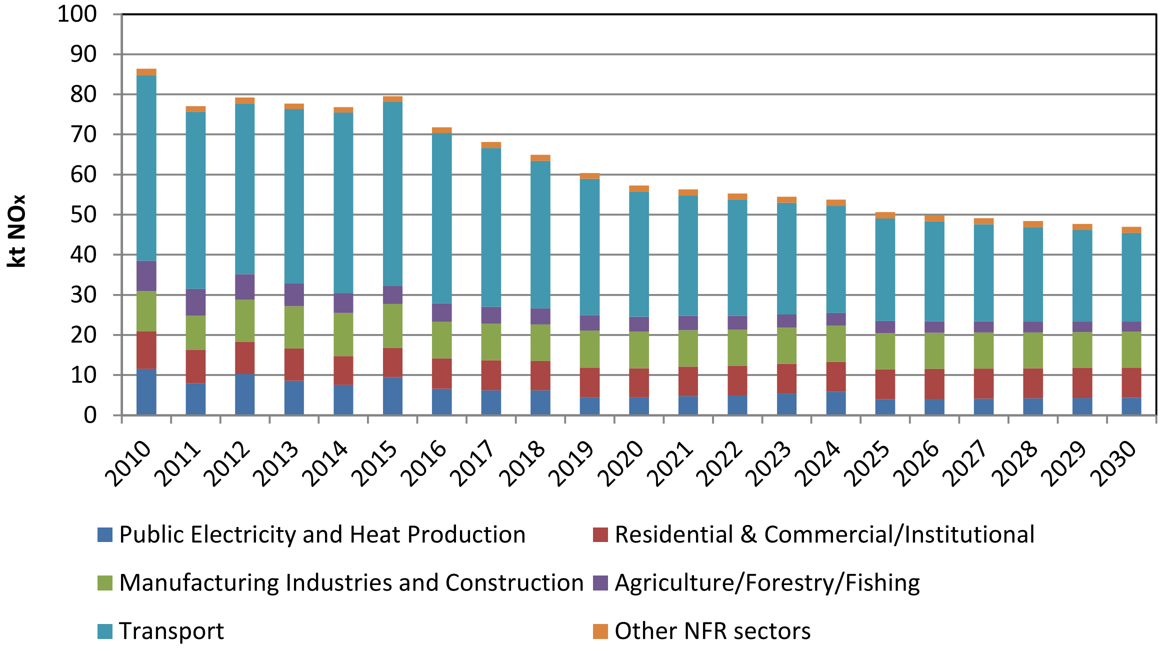

Figure 9.4 NO_X Emission Projections for the With Additional Measures Scenario by Source Sector

Table 9.4. Projected Emissions of NO_X under the With Existing Measures and With Additional Measures Scenarios (kt)

***With Existing Measures* Scenario**					
	2015	**2016**	**2020**	**2025**	**2030**
Public Electricity and Heat Production	9.5	6.6	5.1	5.4	6.1
Residential & Commercial/Institutional	7.4	7.6	7.5	7.8	7.9
Manufacturing Industries and Construction	11.0	9.5	9.7	9.7	9.6
Agriculture/Forestry/Fishing	4.4	4.6	3.7	3.0	2.5
Transport	45.9	42.5	31.2	25.5	22.1
Other NFR sectors	1.4	1.5	1.5	1.6	1.6
Total	**79.5**	**72.3**	**58.8**	**53.0**	**49.9**
***With Additional Measures* Scenario**					
Public Electricity and Heat Production	9.5	6.6	4.5	4.0	4.4
Residential & Commercial/Institutional	7.4	7.5	7.3	7.5	7.5
Manufacturing Industries and Construction	11.0	9.1	9.1	9.0	9.0
Agriculture/Forestry/Fishing	4.4	4.6	3.7	3.0	2.5
Transport	45.9	42.4	31.2	25.5	22.1
Other NFR sectors	1.4	1.5	1.5	1.6	1.6
Total	**79.5**	**71.8**	**57.3**	**50.6**	**47.0**

9.4.3 Ammonia (NH_3)

Figure 9.5 presents the emission projections for NH_3 for the WEM and WAM scenarios. The emission reduction targets for 2020 and 2030 are also presented.

Total NH_3 emissions under the WAM scenario are projected to be 116.5 kt in 2020. As a result an exceedance of the 2020 emission reduction target by 6.6 kt is projected. Post 2020, emissions decrease to 116.2 kt in 2030. Ireland's 2030 emission target of a 5 per cent reduction on 2005 levels results in a distance to the emission reduction target in 2030 of 10.7 kt under the WAM scenario. Compliance with the 2030 emission reduction target will present a significant challenge as a result.

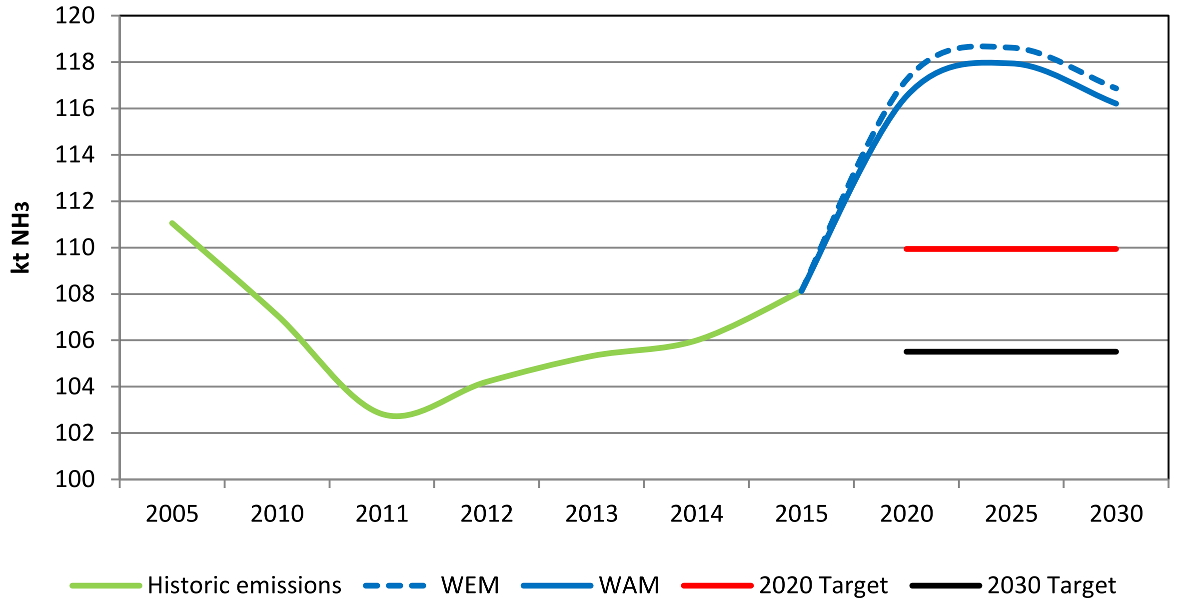

Figure 9.5 NH_3 Emission Projections for the With Existing Measures and With Additional Measures Scenarios

The WAM scenario includes a reduction in fertilizer nitrogen use due to the introduction of urease and nitrification inhibitors into the market. It is estimated that approximately 0.7 kt NH_3 may be saved on an annual basis as a result of this measure and is responsible for majority of the difference identified in Figure 9.5 between the WEM and WAM scenarios.

Ammonia emissions by source sector under the WAM scenario are presented in Figure 9.6. Emissions from dairy cattle show considerable growth (20 per cent) between 2015 and 2020, driven by the target of increasing milk production as set out in the Food Wise 2025 strategy (see section 9.12). This strategy is discussed in more detail in section 9.12. Post 2020 emissions from the agriculture sector continue to grow up until 2024 after which time emissions fluctuate which is attributed to a reduction in the quantity of emissions from the other cattle sector as the beef herd contracts.

It is forecasted that nitrogen (N) fertilizer application will increase by 21 per cent between 2015 and 2020 and remain relatively constant post 2020.

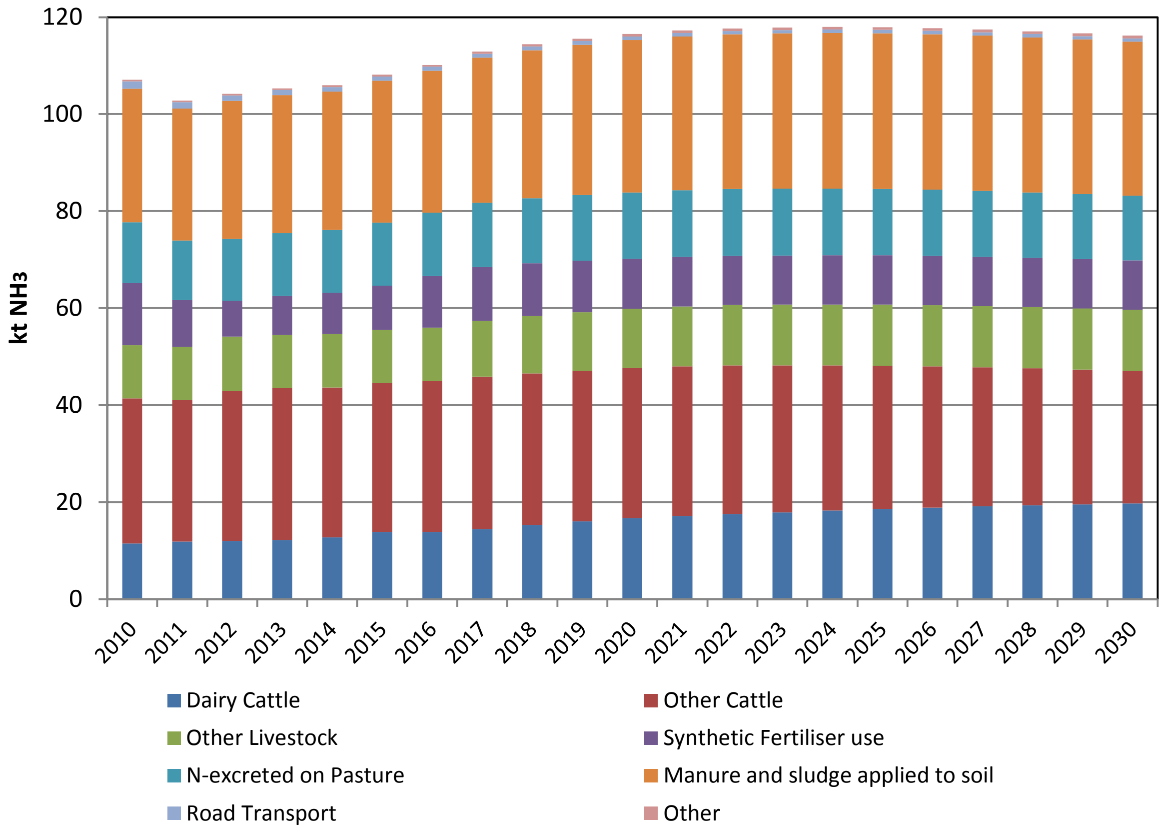

Figure 9.6 NH_3 Emission Projections for the With Additional Measures Scenario by Source Sector

Table 9.5. Projected Emissions of NH_3 under the With Existing Measures and With Additional Measures Scenarios (kt)

***With Existing Measures* Scenario**					
	2015	**2016**	**2020**	**2025**	**2030**
Dairy Cattle	13.9	13.8	16.7	18.6	19.7
Other Cattle	30.7	31.1	30.9	29.5	27.3
Other Livestock	10.9	11.0	12.2	12.6	12.6
Synthetic Fertiliser use	9.2	10.7	11.1	11.0	11.0
N-excreted on Pasture	13.0	13.0	13.7	13.7	13.3
Manure and sludge applied to soil	29.2	29.3	31.4	32.1	31.8
Road Transport	0.9	0.8	0.7	0.7	0.7
Other	0.4	0.4	0.4	0.4	0.4
Total	**108.1**	**110.2**	**117.2**	**118.6**	**116.9**
***With Additional Measures* Scenario**					
Dairy Cattle	13.9	13.8	16.7	18.6	19.7
Other Cattle	30.7	31.1	30.9	29.5	27.3
Other Livestock	10.9	11.0	12.2	12.6	12.6
Synthetic Fertiliser use	9.2	10.7	10.3	10.2	10.2
N-excreted on Pasture	13.0	13.0	13.7	13.7	13.3
Manure and sludge applied to soil	29.2	29.3	31.4	32.1	31.8
Road Transport	0.9	0.8	0.7	0.7	0.7
Other	0.4	0.4	0.5	0.5	0.6
Total	**108.1**	**110.2**	**116.5**	**117.9**	**116.2**

9.4.4 Non-Methane Volatile Organic Compounds (NMVOCs)

Figure 9.7 presents the emissions projections for NMVOC for the WEM and WAM scenarios. The emission reduction targets for 2020 and 2030 are also presented.

Article 4 (3) of the National Emission Ceiling Directive provides that emissions of non-methane volatile organic compounds from categories 3B (manure management) and 3D (agricultural soils) are not accounted for the purpose of complying with 2020 and 2030 targets. The *with existing measures* emissions and *with additional emissions* in addition to 2020 and 2030 targets displayed in Figure 9.7 exclude emissions from these categories (3B and 3D).

Total NMVOC emissions under the WAM scenario (excluding emissions from agricultural categories 3B and 3D) are projected to be 57.4 kt in 2020. The emission projections predict a distance to target of 4.8 kt. Emissions in 2030 are projected to be 57.4 kt which is 9.7 kt above the emission reduction target.

Projected emissions across the time series show a slight increase in both the WEM and WAM scenarios up to 2020 followed by a gradual reduction out to 2030. The trend of reduced emissions in the Residential (1A4b) and Commercial/Institutional (1A4a) sectors are counteracted by the increase in emissions from solvents and fugitive emissions.

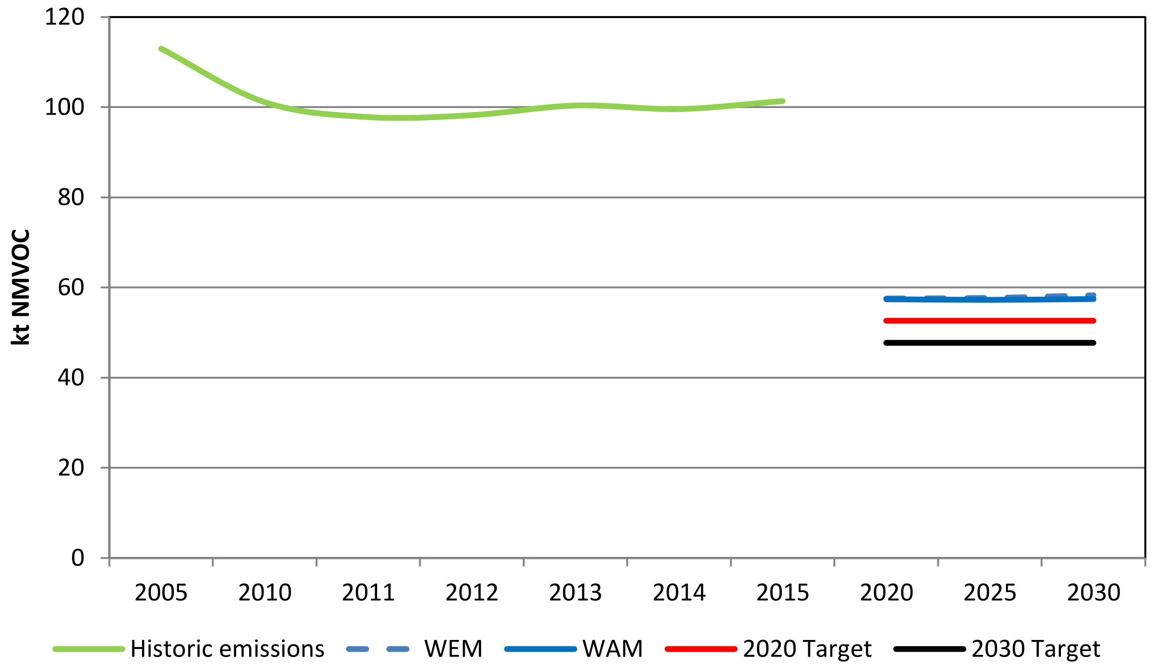

Figure 9.7 NMVOC Emission Projections for the With Existing Measures and With Additional Measures Scenarios[13]

Projected NMVOC emissions by source sector under the WAM scenario are presented in Figure 9.8. For the purposes of this graph emissions from Agriculture categories 3B and 3D are included in the projections from all years out to 2030. Projected emissions from Agriculture and Solvents and other product use are the drivers of the trend, cumulatively accounting for approximately 87 per cent on average of total emissions in 2030 under the WAM scenario.

[13] Article 4 (3) of the National Emission Ceiling Directive provides that emissions of non-methane volatile organic compounds from categories 3B (manure management) and 3D (agricultural soils) are not accounted for the purpose of complying with 2020 and 2030 targets. The *with existing measures* emissions and *with additional emissions* in addition to 2020 and 2030 targets displayed in this graph exclude emissions from these categories (3B and 3D)

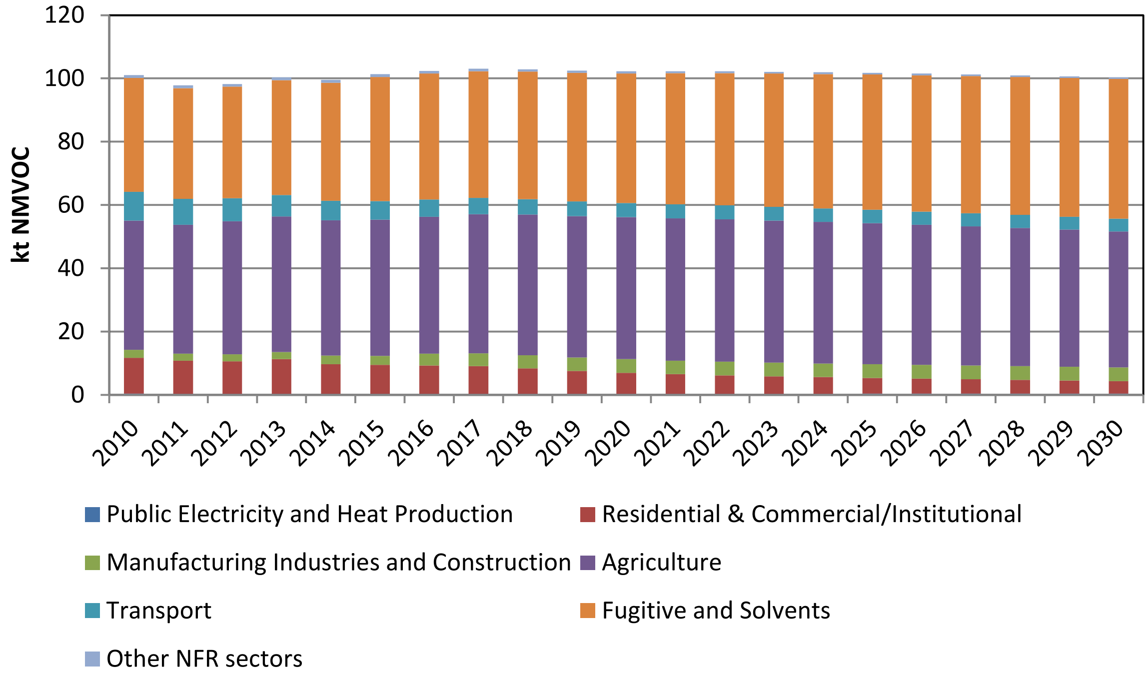

Figure 9.8 NMVOC Emission Projections for the With Additional Measures Scenario by Source Sector[14]

Table 9.6. Projected Emissions of NMVOC under the With Existing Measures and With Additional Measures Scenarios (kt)

***With Existing Measures* Scenario**					
	2015	**2016**	**2020**	**2025**	**2030**
Public Electricity and Heat Production	0.3	0.3	0.3	0.4	0.4
Residential & Commercial/Institutional	9.2	9.1	6.9	5.5	4.8
Manufacturing Industries and Construction	2.9	3.9	4.2	4.2	4.2
Agriculture	43.2	43.3	44.9	44.5	42.9
Transport	5.9	5.4	4.4	4.2	4.0
Fugitive and Solvents	39.2	39.8	41.0	42.8	44.3
Other NFR Sectors	0.9	0.9	0.7	0.5	0.5
Total	**101.4**	**102.6**	**102.4**	**102.2**	**101.2**
***With Additional Measures* Scenario**					
Public Electricity and Heat Production	0.3	0.3	0.3	0.4	0.4
Residential & Commercial/Institutional	9.2	9.0	6.7	5.0	3.9
Manufacturing Industries and Construction	2.9	3.8	4.3	4.4	4.4
Agriculture	43.2	43.3	44.9	44.5	42.9
Transport	5.9	5.4	4.5	4.2	4.0
Fugitive and Solvents	39.2	39.8	41.0	42.8	44.2
Other NFR Sectors	0.9	0.9	0.7	0.5	0.5
Total	**101.4**	**102.4**	**102.2**	**101.8**	**100.3**

[14] Note that for the purposes of this graph emissions from Categories 3B and 3D are included in the projections from all years out to 2030

9.4.5 Particulate Matter< 2.5 µm in diameter ($PM_{2.5}$)

Emissions projections for $PM_{2.5}$ for the WEM and WAM scenarios are presented in Figure 9.9. The emission reduction targets for 2020 and 2030 are also presented.

Total $PM_{2.5}$ emissions under the WAM scenario are projected to be 11 kt in 2020. The emission projections under the WAM scenario predict compliance with both the 2020 and 2030 emission reduction targets by a margin of 4.8 kt and 2.9 kt, respectively.

Projected emissions across the time series show a steady decline for both the WEM and WAM scenarios up to 2030 (Figure 9.9). This trend is largely the result of forecasted reductions in emissions in the Residential (1A4b) and Commercial/Institutional (1A4a) sectors.

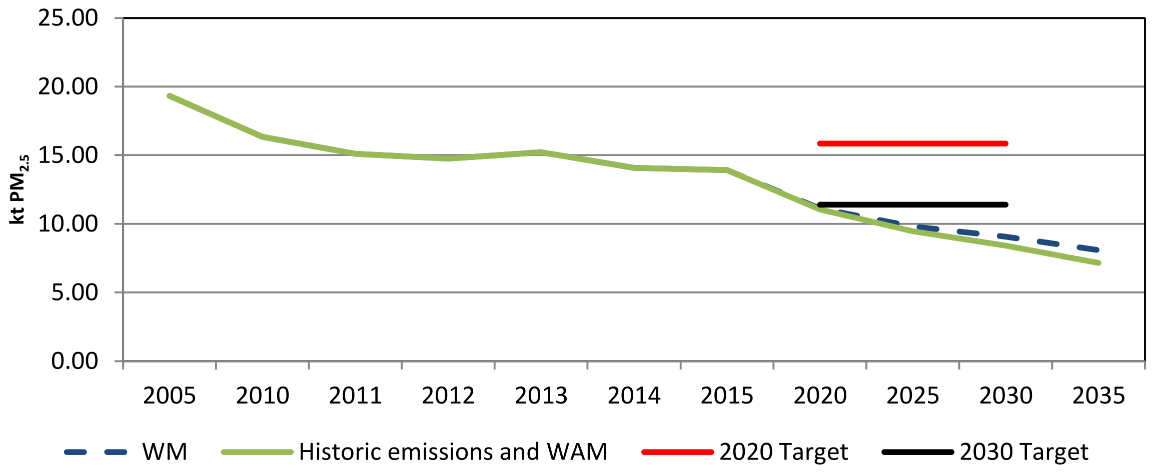

Figure 9.9 $PM_{2.5}$ Emission Projections for the With Existing Measures and With Additional Measures Scenarios

Figure 9.10 presents the projected $PM_{2.5}$ emissions under the WAM scenario by source sector. Emissions from Residential (1A4b) and Commercial/Institutional (1A4a) sectors cumulatively are the largest contribution to the projected emissions total by 2030, and also dominate the trend with time. Emissions from the Transport sector (1A3) decrease across the time series, due to the introduction of vehicles with improved emission control technologies.

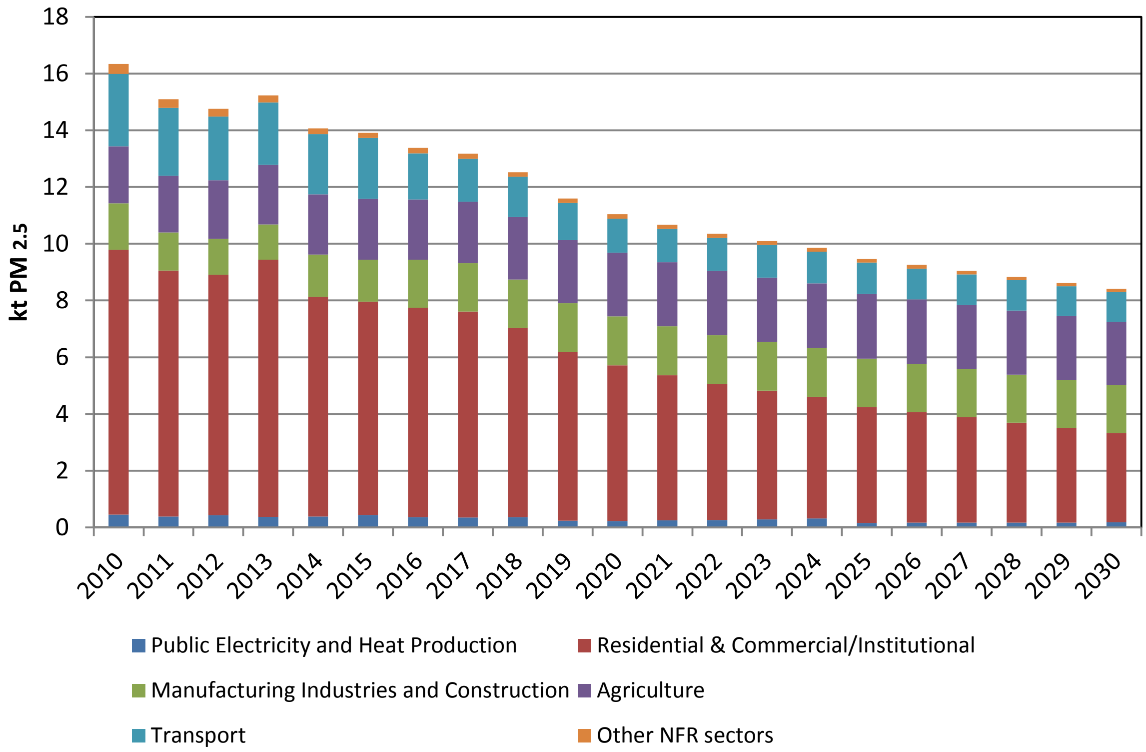

Figure 9.10 $PM_{2.5}$ Emission Projections for the With Additional Measures Scenario by Source Sector

Table 9.7. Projected Emissions of $PM_{2.5}$ under the With Existing Measures and With Additional Measures Scenarios (kt)

With Existing Measures Scenario					
	2015	**2016**	**2020**	**2025**	**2030**
Public Electricity and Heat Production	0.4	0.4	0.3	0.3	0.3
Residential & Commercial/Institutional	7.5	7.4	5.6	4.4	3.7
Manufacturing Industries and Construction	1.5	1.7	1.7	1.7	1.6
Agriculture	2.2	2.1	2.2	2.3	2.2
Transport	2.1	1.6	1.2	1.1	1.0
Other NFR Sectors	0.2	0.2	0.1	0.1	0.1
Total	**13.9**	**13.5**	**11.1**	**9.8**	**9.1**
With Additional Measures Scenario					
Public Electricity and Heat Production	0.4	0.4	0.2	0.2	0.2
Residential & Commercial/Institutional	7.5	7.4	5.5	4.1	3.2
Manufacturing Industries and Construction	1.5	1.7	1.7	1.7	1.7
Agriculture	2.2	2.1	2.2	2.3	2.2
Transport	2.1	1.6	1.2	1.1	1.0
Other NFR Sectors	0.2	0.2	0.1	0.1	0.1
Total	**13.9**	**13.4**	**11.0**	**9.5**	**8.4**

9.5 Energy Industries (NFR 1A1)

Public Electricity and Heat Production covers all electricity generation including electricity generated from renewable sources. The Plexos_Ireland model was used to model electricity generation. As an electrical systems model, the core input data comprises technical details of generators, transmission lines and loads as well as fuel costs, operational costs and emission reduction rates and costs.

In the *Baseline* energy forecast the renewable energy generated shows Ireland reaching 22.7 per cent of electricity consumption from renewable energy by 2020. Renewable electricity generation capacity is dominated by wind but also includes, for example, the operation of a second waste to energy incinerator and the continued development of landfill gas electricity generation. It is also assumed that electricity trading occurs through the 500 MW East-West interconnector. In 2030 it is estimated that renewable energy generation increases to 25 per cent of electricity consumption.

In the *NEEAP/NREAP* energy forecast (adjusted) (and therefore the *With Additional Measures* emissions scenario) it is assumed that for 2020 there is a 37.3 per cent share of renewable energy in electricity generation as a result of additional expansion in wind energy, biomass electricity generating capacity in addition to solar photo voltaics and the continued development of landfill gas electricity generation. The largest contribution is from wind which at 896 ktoe in 2020 is 62 per cent above that included in the *Baseline* and therefore the *With Existing Measures Scenario*. This falls short of the full target of 40 per cent share of renewable energy in electricity generation in 2020. In 2030 it is estimated that renewable energy generation reduces to 29 per cent of electricity consumption.

The *With Existing Measures* scenario tales into account the impact of current policies and measures in the energy sector including:

- Increased efficiency in power generation
- Reduced transmission and distribution losses
- 22.7% renewables by 2020
- Reduced electricity demand from energy efficiency measures in the various sectors including residential, industry, commercial/institutional

The *With Additional Measures* scenario takes into account the impact of additional policies and measures in the energy sector including:

- Reduced electricity demand from additional energy efficiency measures in industry, services and residential
- Increased electricity demand from electric vehicles roll-out
- Replacement of coal fired generation with natural gas
- 37.3% renewable by 2020

Emission factors for NO_X are based on those in the national inventory. Emission abatement (e.g. Selective Catalytic Reduction used in coal fired electricity generation) and compliance with the Industrial Emissions Directive (2010/75/EC) are taken into account.

In Ireland, biomass used for electricity generation is co-fired, generally with peat. It is currently not possible to separate the biomass component from reported emission levels in individual plant's IPC / Industrial Emissions Licence Annual Environmental Reports and therefore emissions are split on an energy basis with implied emission factors thus calculated for peat and biomass. This approach is applied for all future years to account for the combustion of biomass for electricity generation.

Emission factors for SO_2 are based on those in the national inventory. Emission abatement (e.g. flue gas desulphurisation used in coal fired electricity generation) and compliance with the Industrial Emissions Directive (2010/75/EC) are taken into account.

There has been significant reduction in the use of oil in electricity generation due to the closure and decommissioning of oil fuelled generation plants. Oil is also used as a start-up fuel in coal and peat fired generation stations. The 2015 SO_2 inventory emission factor for oil is assumed for all future years. Utilising the emission factor applied in the national inventory for 2015 allows for a decrease compared with historic years which is assumed to implicitly cover the impact of Directive 2009/30/EC (concerning a reduction of sulphur content of certain liquid fuels).
The SO_2, NMVOC and $PM_{2.5}$ emission factors for the other relevant fuel types (i.e. coal, peat biomass and non-renewable wastes) are assumed to remain constant at the value utilised in the national inventory for 2015. The same approach as that taken in NO_X emission estimates with respect to co-firing of biomass is applied to projected emission estimates for SO_2, NMVOC and $PM_{2.5}$.

9.5.1 Oil Refining and Solid Fuel Manufacturing (NFR 1A1b and 1A1c)

Projected NO_X, SO_2, NMVOC and $PM_{2.5}$ emissions from oil refining (one plant) and solid fuel manufacture are estimated. Energy forecasts are not available for these sectors. Projections are based on the growth rate of projected greenhouse gas emissions, which are provided to the EPA by the relevant installation operators.

9.6 Manufacturing Industries and Construction (NFR 1A2)

Projected NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ emissions are based on SEAI's *Baseline* and *NEEAP/NREAP* energy forecasts (2017 NEEAP and NREAP forecasts were adjusted) and are therefore estimated for both the WEM and WAM scenarios.

The *With Existing Measures* scenario takes into account the impact of current policies and measures in the industrial sector including:

- SEAI Large Industry Programme
- CHP deployment
- Accelerated Capital Allowance (ACA)
- Renewable Heat
- Carbon tax
- Better Energy Workplaces

The *With Additional Measures* scenario takes into account the impact of additional policies and measures in the industrial sector including:

- Increased share of renewable sources used for thermal energy
- Increased energy efficiency in buildings

The projected emission factors for NO_x and SO_2 from the combustion of coal, natural gas and petroleum coke are based on the weighted average emission factor for coal, natural gas and petroleum coke across the sub sectors 1A2a – 1A2g in 2015. Energy forecasts are only provided to the EPA at an aggregated industry level (i.e. 1A2). Emission factors for NO_x, SO_2, NMVOC, NH_3 and $PM_{2.5}$ for the combustion of other fuels are assumed to remain constant at 2015 values for all future years.

9.7 Transport (NFR 1A3)

Transport emissions cover Aviation (1A3a), Road Transportation (1A3b), Rail (1A3c), Navigation (1A3d) and Other transportation (Natural gas pipeline compressors, 1A3e). Projected emissions of NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ from road transport are based on SEAI's *Baseline* and *NEEAP/NREAP* energy forecasts (adjusted for 2017 forecasts) and are therefore estimated for both the WEM and WAM scenarios.

It is assumed that fuel use in rail will remain constant at 2015 levels for each year out to 2030.

Projected fuel combustion from navigation is assumed to be equal that combusted in the sector in 2015 for each projected year to 2030. Navigation (1A3d) emissions for each of the pollutants are assumed to remain constant at 2015 levels for each future year.

Other Transportation (1A3e) refers to the use of natural gas for combustion in natural gas pipeline compressor stations. Emissions from this sector are inferred from forecast gas demand in the residential, industrial and commercial and institutional services sectors from the energy forecasts provided by SEAI and are calculated for both the WEM and WAM scenarios.

The *With Existing Measures* scenario takes into account the impact of current policies and measures in the transport sector including:

- VRT and Motor Tax changes
- Improved fuel economy of private cars
- Public transport efficiency improvements
- Aviation efficiency
- Carbon tax
- Renewables

The *With Additional Measures* scenario takes into account the impact of additional policies and measures in the transport sector including:

- Electric vehicle deployment
- Natural gas transport savings between scenarios
- Increased share of renewable sources (e.g. biofuels) used for transport

9.7.1 Domestic aviation (NFR 1A3a)

NO_x, SO_2, NMVOC and $PM_{2.5}$ emission projections from aviation are estimated using the 2015 inventory and also forecasted data, where available, related to aircraft movements as provided to the EPA by the management authorities of Ireland's main airports (Dublin, Cork and Shannon).

Emissions associated with all LTO (landing and take-off) cycles are calculated. It is assumed that NO_X, SO_2, NMVOC and $PM_{2.5}$ emission factors remain constant at the values used in the 2015 national inventory.

9.7.2 Road transportation (NFR 1A3b)

Energy forecasts provide future demand for petrol, diesel, renewables and electricity use in the road transport sector for both the WEM and WAM scenarios.

In the energy forecast underpinning the WAM emission projection for road transport, it is assumed that renewables will account for 8 per cent of road transport fuel by 2020.

NO_x, SO_2, NMVOC, NH_3 and $PM_{2.5}$ emissions from road traffic are estimated using the COPERT model (COPERT 4 Version 11.3) developed within the CORINAIR programme (Gkatzoflias et al., 2012).

9.7.3 Rail (NFR 1A3c)

NO_x, $SO_{2,}$ NMVOC, NH_3 and $PM_{2.5}$ emission projections from rail transport are estimated. It is assumed that fuel use in the sector will remain constant at 2015 levels for each year out to 2030. It is also assumed that NO_x, NMVOC, NH_3 $PM_{2.5}$ emission factors remain the same as in the 2015 national inventory.

9.7.4 Navigation (NFR 1A3d)

NO_x, $SO_{2,}$ NMVOC, NH_3 and $PM_{2.5}$ emission projections from navigation are estimated. Gasoil/diesel consumption in in-land navigation is assumed to remain constant at the 2015 level out to 2030. $NO_{x,}$ NMVOC, NH_3 and $PM_{2.5}$ emission factors are assumed to remain constant at the 2015 level.

9.7.5 Gas Transmission (NFR 1A3e)

Emissions projections for NO_X, SO_2, NMVOC, and $PM_{2.5}$ from natural gas transmission in Ireland's natural gas pipeline network are estimated. Future gas demand for “own use and transformation” is inferred based on forecast gas demand in the residential, commercial and institutional services and industrial sectors. Subtracting the amount of gas estimated to be lost from the distribution network allows “own use” gas demand and associated emissions to be estimated. It is assumed that NO_X, SO_2, NMVOC and $PM_{2.5}$ emission factors remain the same as in the 2015 national inventory.

9.8 Residential and Commercial/Institutional (NFR 1A4)

9.8.1 Commercial/Institutional (NFR 1A4a)

Projected NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ emissions are based on SEAI's *Baseline* and *NEEAP/NREAP* energy forecasts (2017 NEEAP and NREAP forecasts were adjusted) and are therefore estimated for both the WEM and WAM scenarios.

Oil and gas account for the majority of non-electricity energy demand in this sector. These fuels are used predominantly for space-heating purposes. Projected emissions of NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ are estimated.

It is assumed that NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ emission factors remain the same as in the 2015 national inventory.

The *With Existing Measures* scenario takes into account the impact of current policies and measures in the commercial/institutional sector including:

- Public Sector Programme
- 2005 Building Regulations
- SEAI Small Business Support
- Supports for Exemplar Energy Efficient Projects (SEEEP) and Energy Efficiency Retrofit Fund (EERF)
- Accelerated Capital Allowance (ACA)
- Public Sector Building Demonstration Programme
- CHP deployment
- Renewable Heat
- Carbon tax
- Better Energy Workplaces
- Energy Supplier Obligation Scheme (non-residential)
- Better Energy Communities

The *With Additional Measures* scenario takes into account the impact of additional policies and measures in the commercial/institutional sector including:

- Increased share of renewable sources used for thermal energy
- Increased energy efficiency in buildings

9.8.2 Residential (1A4b)

Projected NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ emissions are based on SEAI's *Baseline* and *NEEAP/NREAP* energy forecasts (2017 NEEAP and NREAP forecasts were adjusted) and are therefore estimated for both the WEM and WAM scenarios.

Projected emissions of NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ are estimated. It is assumed that NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ emission factors remain the same as in the 2015 national inventory.

The *With Existing Measures* scenario takes into account the impact of current policies and measures in the commercial/institutional sector including:

- 2002 Building Regulations
- 2008 Building Regulations
- 2011 Building Regulations
- Efficient Boiler Standard
- Greener Homes Scheme
- Warmer Homes Scheme
- Better Energy Homes
- Energy Supplier Obligation Scheme (residential)

- Better Energy Communities
- Carbon Tax

The *With Additional Measures* scenario takes into account the impact of additional policies and measures in the commercial/institutional sector including:

- Increased share of renewable sources used for thermal energy
- Increased energy efficiency in buildings

9.9 Combustion in Agriculture and Fishing (NFR 1A4c)

Projected emissions of NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ are estimated for the combustion of diesel in the Agriculture sector and the combustion of diesel and fuel oil in the Fishing sector. Forecast fuel use in the agriculture sector is included in the energy forecasts.

Forecasted NO_X, NMVOC, NH_3 and $PM_{2.5}$ emission factors for mobile combustion in the agriculture sector are estimated following the Tier 2 approach outlined in the EMEP/EEA Inventory Guidebook. Emissions from the fishing sector are assumed to remain constant at the 2015 level for each projected year to 2030.

9.10 Mineral Products (NFR 2A)

Emission of air pollutants from Industrial Processes cannot usually be separated from the emissions from fuel combustion in industry. Emissions from industrial processes are therefore assumed to be included in projected estimates for the Manufacturing Industries and Construction (1.A.2) sector.

9.11 Non-Energy Products from Fuels and Non-Energy Products from Fuels and Solvent Use (NFR 2D)

Emissions projections of NMVOCs from solvent use and other products are estimated. GDP growth is used to project emissions out to 2030 with the 2015 inventory used as a starting point.

9.12 Agriculture (NFR 3)

The Agriculture sector is the largest source of NH_3 emissions in Ireland. Projected estimates of NH_3 from the Agriculture sector are undertaken using the same methodological approach as the current national inventory (Chapter 6). The methodology uses a mass flow approach based on the concept of the flow of Total Ammoniacal Nitrogen (TAN) through the manure management system.

Projected activity data (animal numbers, crop areas and fertiliser use) are provided by Teagasc (The Irish Agriculture and Food Development Authority) to the EPA in order to prepare agricultural emission projections. The activity data assumes that there is an expansion in the value of Irish agriculture over the period to 2025 to meet the targets set out in “Food Wise 2025”[15] published by the Department of Agriculture, Food and the Marine in 2015.

The FAPRI-Ireland model was used for preparing agricultural forecast data. This model is linked to the FAPRI world modelling system and so takes account of and contributes to, the projections for prices obtained and quantities traded on the world markets.

The majority of the data supplied to the EPA is disaggregated at the level of that used in inventory estimates. As is currently the case in the national agricultural NH_3 inventory the use of data from a Farm Facilities Survey (Hyde et al., 2008) forms the basis of the underlying assumptions with respect to manure management practices and is used for all projected years (Chapter 6 provides further details of the manure management practices assumed). The WAM scenario includes an estimate of the savings associated with the introduction of nitrification and urease inhibitors/stabilizers in synthetic nitrogen fertilizer to meet nutrient efficiency gains in the Ireland’s Rural Development Programme 2014-2020. It is envisaged that under this measure that there will be a reduction in the requirement (as currently forecasted) for nitrogen fertilizer of 10,000 tons nitrogen in 2018, increasing linearly to 30,000 tonnes in 2020 and is maintained at that level thereafter to 2030.

Projected emissions of NMVOC and $PM_{2.5}$ from manure management are estimated using the same approaches and methodologies as discussed in Chapter 6. The projected activity data that is utilized for NH_3 emission projections is also used to estimate projected emissions of NMVOC and $PM_{2.5}$ for the Agriculture sector.

9.13 Waste (NFR 5)

Air pollutant emission projections in the form of NO_X, SO_2, NMVOC, NH_3 and $PM_{2.5}$ are estimated for the waste sector. Non-methane volatile organic compounds are estimated from landfill gas production, whilst NO_X, SO_2, NH_3 and $PM_{2.5}$ emissions are estimated from the incineration of industrial waste and from cremation.

Solid waste disposal to landfill (5A) produces significant quantities of landfill gas. Projected landfill gas production is based on greenhouse gas emission estimates for the sector undertaken by the EPA and submitted to the European Commission under Regulation 525/2013. The emission factor utilized in the national inventory of 5.65 gm^{-3} NMVOC/m^3 landfill gas is used in projected emission estimates. Ireland has met all Landfill Directive[16] targets for diversion of biodegradable municipal waste from landfill to date.

The incineration of Industrial waste (5Cb) is now highly regulated in Ireland. There are currently only a small number of facilities based in the pharmaceutical and chemical sectors that operate incinerators for the treatment of industrial waste. It is assumed that the quantity of industrial waste incinerated and the emissions of NO_X, SO_2, NMVOC and $PM_{2.5}$ at these facilities will remain constant at the 2015 level for each projected year to 2030.

The practice of Cremation (5C1bv) is less popular in Ireland than in other countries. However, due to the decrease in the number of burial plots available, particularly in larger cities and towns, the number of cremations in Ireland has increased. There are currently five crematoria operating in Ireland. It is assumed that the number of cremations will increase at the average of the 2013-2015 level of increase for each projected year to 2030.

[15] Food Wise 2025. A 10-year vision for Irish agri-industry. Department of Agriculture, Food and the Marine, 2015. https://www.agriculture.gov.ie/foodwise2025/

[16] Council Directive 1999/31/EC on the landfill of waste

Chapter Ten Adjusted annual national emission inventories

10.1 Introduction

Ireland is a signatory to the Gothenburg Protocol but has not yet ratified it and so is not formally covered by its emission ceilings or the associated adjustment mechanism. However, Ireland has national emissions ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs) and ammonia (NH_3) under the National Emissions Ceilings Directive 2001/81/EC (NECD) which are identical to its Annex II Gothenburg Protocol 2010 ceilings. Ireland's national emission inventory submission for 2017 (1990 – 2015), reported in February 2017, estimate emissions of NO_x and NMVOCs which exceed the NECD emission ceilings from 2010 onwards. This is summarised in the table 10.1 below.

Article 21(2) of Directive (EU) 2016/2284 ("revised NEC Directive") indicates that Member States may apply Article 5(1) of the Directive in relation to the ceilings in Annex I to Directive 2001/81/EC. Article 5(1) allows Member States to establish adjusted annual national emission inventories where non-compliance with emission ceilings or reduction commitments occur due to applying improved emission inventory methods in accordance with best science. The information provided in this chapter follows the reporting requirements of the adjustment process presented in Article 5 and Part 4 of Annex IV of the Directive (EU) 2016/2284.

Ireland's latest inventory submission estimates emissions of NO_x and NMVOC as presented in Table 10.1. For both NO_x and NMVOC national emission ceilings are exceeded for all years since 2010. Ireland considers that this has arisen due to several factors including;

- New sources that have been added to the inventory, which were either not known when the NECD (2001/81/EC) ceilings were set, or for which there was no available methodology at the time
- Emission factors and methodologies which have been improved in accordance with best practice, resulting in an increase to the estimated emissions. These revisions were not foreseen when the NECD (2001/81/EC) ceilings were set.

Table 10.1. Summary of National Emissions and the NECD Emission Ceilings

	2010	2011	2012	2013	2014	2015
NO_x (kt of NO_2)	82.92	73.61	75.90	74.65	72.76	73.46
NO_x NECD 2010 Ceiling (kt of NO_2)	65.00	65.00	65.00	65.00	65.00	65.00
NMVOC (kt)	100.89	97.60	98.06	100.24	99.41	101.09
NMVOC NECD 2010 Ceiling (kt)	55.00	55.00	55.00	55.00	55.00	55.00

Ireland has undertaken a detailed assessment of the new and revised sources within the national inventory in the context of the requirements outlined in Part 4 of Annex IV in Directive (EU) 2016/2284, and is of the view that several changes to the national inventory should be included in the adjusted annual national emission inventory. The proposed adjustments for NO_x and NMVOC are summarised in the Tables 10.2a and 10.2b below.

Table 10.2a. Summary of NOx Adjustments

NFR	Source Sector Name	2010	2011	2012	2013	2014	2015	Comments
	NOx Adjustments (kt NO_2)	**-15.462**	**-14.821**	**-15.329**	**-16.518**	**-15.940**	**-13.175**	
1A3bi	Road transport - Passenger Cars	-4.804	-5.125	-5.957	-6.812	-6.973	-6.840	*Current (COPERT4) - Original (COPERT2 EFs x Current Fleet)*
1A3bii	Road transport - Light Duty Vehicles	-1.020	-0.785	-0.508	-0.356	0.306	0.841	
1A3biii	Road transport - Heavy Duty Vehicles	-2.012	-2.031	-1.758	-2.120	-2.052	-0.965	
1A3biii	Road transport - Buses	-0.448	-0.395	-0.368	-0.453	-0.311	0.530	
1A3biv	Road transport - Mopeds & Motorcycles	-0.006	-0.004	-0.003	-0.003	-0.002	-0.002	
1A3c	Rail	-0.665	-0.673	-0.644	-0.641	-0.588	-0.600	*Original EFs confirmed as being used in 1999 submission*
1A3dii	National Navigation	-2.249	-1.953	-2.064	-2.019	-2.527	-2.492	
1A4ai	Commercial Combustion (Stationary)	-1.272	-1.186	-1.174	-1.069	-0.959	-0.921	
1A4bi	Residential	-0.474	-0.458	-0.453	-0.514	-0.411	-0.375	
1A4ciii	National Fishing	-1.813	-1.502	-1.662	-1.850	-1.762	-1.549	
1B2aiv	Fugitive Emissions from Oil Refineries	-0.697	-0.708	-0.736	-0.681	-0.661	-0.801	*New source*
	NOx National Total (kt NO_2)	82.923	73.609	75.899	74.654	72.761	73.459	
	NOx Adjusted Total (kt NO_2)	**67.461**	**58.788**	**60.570**	**58.135**	**56.821**	**60.284**	
	NOx NECD Ceiling (kt NO_2)	65.000	65.000	65.000	65.000	65.000	65.000	

Table 10.2b. Summary of NMVOC Adjustments

NFR	Source Sector Name	2010	2011	2012	2013	2014	2015	Comments
	NMVOC Adjustments (kt)	**-53.649**	**-53.072**	**-55.725**	**-57.497**	**-57.738**	**-59.607**	
2G4	Other product use	-0.069	-0.112	-0.115	-0.097	-0.072	-0.083	*New source*
2H2	Food and beverages industry	-12.679	-12.274	-13.608	-14.572	-15.016	-16.441	
3B	Manure Management	-37.348	-37.152	-38.518	-39.385	-39.234	-39.707	
3Da1	Inorganic N Fertilisers	-3.553	-3.533	-3.484	-3.444	-3.416	-3.376	
	NMVOC National Total (kt)	100.887	97.598	98.056	100.245	99.412	101.090	
	NMVOC Adjusted Total (kt)	**47.238**	**44.526**	**42.331**	**42.748**	**41.674**	**41.483**	
	NMVOC NECD Ceiling (kt)	55.000	55.000	55.000	55.000	55.000	55.000	

The resulting adjusted annual national emission inventories show Ireland to be in compliance with the NMVOC ceiling for all years and in compliance with the NOx emission ceiling from 2011 onwards.

The justification and quantification of each adjustment application is provided in detail in the following sections and is also summarised in the excel spreadsheet (Annex VII Adjustment summary) that was submitted with the national emission inventory. The established adjusted annual emission inventory outlined here will be subject to a review by the European Commission as outlined in Article 5(6) of Directive (EU) 2016/2284, to assess whether

Member States have fulfilled the relevant conditions set out in Article 5(1) and Part 4 of Annex IV.
Without the adjustments indicated above, it is estimated that under the With Additional Measures scenario (WAM), Ireland will come into compliance with the NOx emission ceiling in 2018, but would not reach compliance with the NMVOC ceiling before compliance requirements change to emission reduction targets*.
****Ireland is currently finalising projections data for submission and will update this chapter accordingly and resubmit it's IIR for 2017 as outlined in section 8.1. The data presented in this paragraph thus relates to projections data submitted in 2016.***

10.2 Meeting the Requirements for an Adjustment

10.2.1 New Emission Sources

The Part 4.1.d.i of Annex IV of Directive (EU) 2016/2284 indicates that for new emission source categories, evidence must be provided that:

1. The new source category is acknowledged in scientific literature (and/or the EMEP/EEA Guidebook).
2. The source category was not included in the relevant historic national emissions inventory when the ceilings were set.
3. The emissions from a new sources category contribute to the MS not complying with their 2010 emissions ceilings under Directive 2001/81/EC.

All of the new sources identified in this adjustment application are included in the current version of the EMEP/EEA Guidebook, and were not included in the national emissions inventory in 1999 (when the targets contain within Directive 2001/81/EC were set). Tables 10.2a and 10.2b demonstrate that the identified new sources contribute to the exceedance of the NECD emissions ceilings.

As such, it is considered that all of the criteria are met for the new sources that have been identified.

Quantification of the adjustment for each of the new sources is presented in detail in sections 10.3 and 10.4. But the following general approach has been used:

The adjustment for new source has been obtained by multiplying the emission by -1.

10.2.2 Significantly Different Emission Factors

Part 4.1.d.ii of Annex IV of Directive (EU) 2016/2284 indicates that where significantly different emission factors (EFs) are used, the following evidence is required:

1. The original EF, and information on its origin or derivation.
2. Evidence that the original EF was used in determining the emission ceilings when they were set.
3. The updated EF, and information on its origin or derivation.
4. A comparison of the original and updated EFs, demonstrating that the change contributes to a MS being in exceedance.
5. A rationale for deciding whether the changes in EF are significant.

Section 10.3 and 10.4 below present the original and updated EFs and the quantified impact on the emissions estimates of the change. The sources of the EFs are also presented, and the original EFs were all used in the emission inventory in 1999, when the emission ceilings were set.

All of the changes to emission factors that are presented contribute to moving Ireland's national total emissions into compliance. All of changes are therefore considered to be "significant" in the context of attaining compliance with emission ceilings.

In calculating adjustments for revised EFs, it is not necessary to present the current activity data (since this can be derived from the current emission and the current emission factor). In presenting information to quantify the adjustment, the following approach has been used:

$$\text{Adjustment} = (EF_{Original} \times AD_{Current}) - (E_{Current})$$

Given that: $AD_{Current} = E_{Current}/EF_{Current}$

The adjustment can be written:

$$\text{Adjustment} = (EF_{Original} \times E_{Current}/EF_{Current}) - E_{Current}$$

The information provided in the tables for each of the adjustments in the following sections should therefore be sufficient to allow a review of the adjustment quantification.

The final adjustment value has been determined and provided at the individual NFR category level. Where there have been revisions to emission factors for sources within an NFR category, all revisions have been included i.e. both increases and decreases to emission factors have been included. This avoids selectively including only EF revisions which would result in a favourable revision of the national emissions inventory total – a process which is not considered to be appropriate. As a result, the adjustment values that are shown for each NFR category can be considered "net" adjustment values.

10.3 NO_x Adjustment Applications

10.3.1 1A3b Road Transport (NO_x)

Justification – Significantly Different EFs

Emission factors for NO_x from road transport were included in the EMEP/CORINAIR Emissions Inventory Guidebook (version 2) in 1999 which were applicable when the emission ceilings were set. However, the EFs used in the current national emissions inventory are higher than these original EFs. Ireland considers that the current NOx EFs for this source are significantly different, as defined by the Directive (EU) 2016/2284 and are eligible for an adjustment

Overall emissions from the different vehicle categories within road transport for the period 2010 to 2015 are;

- passenger cars (1A3bi) are now on average 80% higher
- light duty vehicles (1A3bii) are now on average 4% higher
- heavy duty vehicles (1A3biii) are now on average 60% higher
- buses and coaches (1A3biii) are now on average 4% higher
- mopeds and motorcycles (1A3biv) are now on average 14% higher

Quantification

The adjustment quantification is explained for each mode of road transport in the tables 10.3 to 10.8 below.
The general approach for quantification is presented in section 10.2.2. In this case the original emission factors are those that were used in the national inventory submission in 1999 and were derived from the COPERT II model using a Tier 3 methodology. The current EFs were derived from the COPERT 4 (v11.3) model using a Tier 3 methodology.

Table 10.3 Adjustment Quantification for Road Transport-1A3bi Passenger Cars (NO_x)

Activity (NFR)	Activity technology	Emission Factors: Current EF (g/km)	Emission Factors: Original EF (g/km)	Current NOx emission (tonnes): 2010	2011	2012	2013	2014	2015
1A3bi Passenger Cars	Conventional	0.544	0.571	88.53	68.77	62.95	29.30	25.88	17.99
	PC Euro 1 - 91/441/EEC	0.467	0.567	592.74	367.97	274.92	90.96	70.76	57.95
	PC Euro 2 - 94/12/EEC	0.308	0.280	3180.03	2568.20	2105.60	1851.85	1354.97	1089.97
	PC Euro 3 - 98/69/EC Stage2000	0.291	0.252	4822.81	4376.11	4113.00	3945.40	3176.28	2773.97
	PC Euro 4 - 98/69/EC Stage2005	0.311	0.105	5146.86	4780.60	4893.28	4988.74	5076.86	4826.57
	PC Euro 5 - EC 715/2007	0.458	0.121	0.00	1248.49	2308.68	3346.59	4105.21	4179.75
	PC Euro 6 - EC 715/2007	0.157	0.119	0.00	0.00	0.00	0.00	0.00	431.41
				13830.98	**13410.13**	**13758.43**	**14252.85**	**13809.96**	**13377.62**
				Adjustment (tonnes)					
	Conventional			1.66	1.29	1.16	0.55	0.51	0.36
	PC Euro 1 - 91/441/EEC			133.26	86.04	63.02	21.77	16.04	12.46
	PC Euro 2 - 94/12/EEC			-434.06	-316.01	-258.72	-225.26	-100.48	-99.04
	PC Euro 3 - 98/69/EC Stage2000			-1143.66	-880.20	-858.40	-838.04	-500.72	-376.32
	PC Euro 4 - 98/69/EC Stage2005			-3361.51	-3094.74	-3197.67	-3293.58	-3357.30	-3195.96
	PC Euro 5 - EC 715/2007			0.00	-921.45	-1706.84	-2477.39	-3031.49	-3076.45
	PC Euro 6 - EC 715/2007			0.00	0.00	0.00	0.00	0.00	-105.47
				-4804.31	**-5125.07**	**-5957.44**	**-6811.95**	**-6973.43**	**-6840.42**

Table 10.4 Adjustment Quantification for Road Transport-1A3bii Light Duty Vehicles (NO_x)

Activity (NFR)	Activity technology	Emission Factors: Current EF (g/km)	Emission Factors: Original EF (g/km)	Current NOx emission (tonnes) 2010	2011	2012	2013	2014	2015
1A3bii Light Duty Vehicles	Conventional	1.319	1.192	80.56	57.72	32.00	22.36	17.71	11.00
	LD Euro 1 - 93/59/EEC	1.148	0.497	371.74	296.24	248.19	205.63	138.69	87.39
	LD Euro 2 - 96/69/EEC	1.148	0.298	1928.43	1736.81	1358.72	1267.00	580.25	433.15
	LD Euro 3 - 98/69/EC Stage2000	0.954	1.066	2606.28	2594.70	2236.55	2140.30	1722.75	1436.40
	LD Euro 4 - 98/69/EC Stage2005	0.770	0.875	2340.51	2381.18	2132.70	2340.38	2410.39	2152.49
	LD Euro 5 - 2008 Standards	0.718	0.876	0.00	198.50	397.01	589.79	1292.11	1284.74
	LD Euro 6	0.253	0.876	0.00	0.00	0.00	0.00	0.00	189.21
				7327.52	**7265.14**	**6405.17**	**6565.46**	**6161.90**	**5594.37**
				Adjustment (tonnes)					
	Conventional			-7.69	-5.50	-3.04	-2.13	-1.69	-1.06
	LD Euro 1 - 93/59/EEC			-210.91	-168.08	-140.83	-116.68	-78.68	-49.56
	LD Euro 2 - 96/69/EEC			-1427.73	-1285.92	-1006.02	-938.13	-429.64	-320.65
	LD Euro 3 - 98/69/EC Stage2000			305.05	303.74	261.81	250.53	201.63	168.65
	LD Euro 4 - 98/69/EC Stage2005			321.14	326.74	292.67	321.20	330.74	296.15
	LD Euro 5 - 2008 Standards			0.00	43.59	87.19	129.54	283.78	282.63
	LD Euro 6			0.00	0.00	0.00	0.00	0.00	465.22
				-1020.13	**-785.43**	**-508.23**	**-355.67**	**306.13**	**841.38**

Table 10.5 Adjustment Quantification for Road Transport-1A3biii Heavy Duty Vehicles (NO_x)

Activity (NFR)	Activity technology	Emission Factors		Current NOx emission (tonnes)					
		Current EF (g/km)	Original EF (g/km)	2010	2011	2012	2013	2014	2015
1A3biii Heavy Duty Vehicles	Conventional	6.399	5.917	135.37	114.37	82.65	70.52	39.97	35.60
	HD Euro I - 91/542/EEC Stage I	4.195	3.787	220.14	185.95	155.65	147.10	60.98	35.67
	HD Euro II - 91/542/EEC Stage II	4.420	2.779	1487.65	1392.98	1104.50	1149.84	436.16	282.03
	HD Euro III - 2000 Standards	3.578	2.061	1846.56	1915.08	1687.90	1792.23	1556.12	1064.01
	HD Euro IV - 2005 Standards	2.541	1.441	1471.38	1556.62	1423.04	1734.04	1893.98	1485.24
	HD Euro V - 2008 Standards	1.436	1.468	0.00	73.00	158.02	428.53	1051.07	576.01
	HD Euro VI	0.116	1.468	0.00	0.00	0.00	0.00	0.00	19.44
				5161.10	**5238.00**	**4611.76**	**5322.26**	**5038.27**	**3498.01**
				Adjustment (tonnes)					
	Conventional			-28.31	-22.23	-13.24	-11.95	-4.61	-2.68
	HD Euro I - 91/542/EEC Stage I			-20.91	-17.64	-14.84	-13.91	-5.81	-3.47
	HD Euro II - 91/542/EEC Stage II			-545.98	-510.83	-405.17	-420.77	-160.77	-104.71
	HD Euro III - 2000 Standards			-781.13	-810.83	-715.40	-759.20	-658.97	-451.08
	HD Euro IV - 2005 Standards			-635.73	-673.04	-615.65	-749.67	-819.53	-642.98
	HD Euro V - 2008 Standards			0.00	3.13	6.13	-165.00	-402.26	12.71
	HD Euro VI			0.00	0.00	0.00	0.00	0.00	226.76
				-2012.07	**-2031.43**	**-1758.18**	**-2120.48**	**-2051.95**	**-965.46**

Table 10.6 Adjustment Quantification for Road Transport-1A3biii Heavy Duty Vehicles, Buses (NO_x)

Activity (NFR)	Activity technology	Emission Factors		Current NOx emission (tonnes)					
		Current EF (g/km)	Original EF (g/km)	2010	2011	2012	2013	2014	2015
1A3biii Heavy Duty Vehicles (Buses)	Conventional	10.196	9.719	912.30	749.26	697.15	474.38	315.47	82.35
	HD Euro I - 91/542/EEC Stage I	7.064	5.666	561.41	487.95	411.63	320.01	277.09	213.73
	HD Euro II - 91/542/EEC Stage II	7.676	11.656	2827.26	2452.41	2272.57	2369.62	2775.54	3614.45
	HD Euro III - 2000 Standards	6.296	3.350	2773.21	2406.81	2237.36	2049.82	2166.38	2585.23
	HD Euro IV - 2005 Standards	4.375	3.306	1264.12	1086.37	1018.19	1103.53	1362.73	1889.67
	HD Euro V - 2008 Standards	3.830	3.769	52.05	167.18	261.24	482.39	616.62	503.66
	HD Euro VI	0.304	4.487	0.00	0.00	0.00	0.00	3.27	27.74
				8390.36	**7349.99**	**6898.13**	**6799.75**	**7517.09**	**8916.82**
				Adjustment (tonnes)					
	Conventional			3.61	3.55	4.98	3.21	1.91	-3.86
	HD Euro I - 91/542/EEC Stage I			-112.98	-98.29	-83.11	-64.60	-55.86	-42.28
	HD Euro II - 91/542/EEC Stage II			1214.07	1058.56	995.83	1035.86	1295.49	1874.00
	HD Euro III - 2000 Standards			-1264.67	-1099.59	-1028.00	-940.89	-1002.40	-1209.48
	HD Euro IV - 2005 Standards			-283.56	-245.13	-233.65	-252.57	-321.23	-462.05
	HD Euro V - 2008 Standards			-4.45	-14.48	-23.79	-233.99	-290.76	-7.95
	HD Euro VI			0.00	0.00	0.00	0.00	62.28	381.16
				-447.98	**-395.38**	**-367.75**	**-452.99**	**-310.58**	**529.53**

Table 10.7 Adjustment Quantification for Road Transport-1A3biv Mopeds and Motorcycles (NO_X)

Activity (NFR)	Activity technology	Emission Factors: Current EF (g/km)	Emission Factors: Original EF (g/km)	Current NOx emission (tonnes) 2010	2011	2012	2013	2014	2015
1A3biv Mopeds and Motorcycles	Conventional	0.052	0.041	0.10	0.08	0.06	0.05	0.05	0.06
	Mop - Euro I	0.185	0.117	0.49	0.40	0.34	0.30	0.32	0.40
	Mop - Euro II	0.157	0.083	0.26	0.22	0.19	0.17	0.17	0.22
	Mop - Euro III	0.164	0.087	0.32	0.30	0.29	0.28	0.33	0.47
	Conventional	0.230	0.124	10.17	8.68	7.09	6.73	6.99	8.38
	Mot - Euro I	0.356	0.221	13.16	11.81	10.50	10.15	11.62	15.04
	Mot - Euro II	0.159	0.221	3.84	3.52	3.11	3.06	3.29	4.36
	Mot - Euro III	0.097	0.221	2.81	2.92	2.79	2.92	3.66	5.30
				31.14	**27.92**	**24.37**	**23.67**	**26.45**	**34.23**
				Adjustment (tonnes)					
	Conventional			-0.02	-0.02	-0.01	-0.01	-0.01	-0.01
	Mop - Euro I			-0.18	-0.15	-0.13	-0.11	-0.12	-0.15
	Mop - Euro II			-0.12	-0.10	-0.09	-0.08	-0.08	-0.10
	Mop - Euro III			-0.15	-0.14	-0.13	-0.13	-0.16	-0.22
	Conventional			-4.80	-4.08	-3.31	-3.15	-3.25	-3.86
	Mot - Euro I			-5.04	-4.52	-4.01	-3.86	-4.42	-5.71
	Mot - Euro II			1.27	1.20	1.09	1.13	1.25	1.69
	Mot - Euro III			3.15	3.37	3.28	3.59	4.61	6.81
				-5.90	**-4.44**	**-3.32**	**-2.63**	**-2.18**	**-1.55**

Table 10.8 Adjustment Quantification for Road Transport-1A3b Road Transport (NO_x)

Activity (NFR)	Activity technology	Emission Factors		Current NOx emission (tonnes)					
		Current EF (g/km)	Original EF (g/km)	2010	2011	2012	2013	2014	2015
1A3b Road Transport	1A3bi Passenger Cars			13830.98	13410.13	13758.43	14252.85	13809.96	13377.62
	1A3bii Light Duty Vehicles			7327.52	7265.14	6405.17	6565.46	6161.90	5594.37
	1A3biii Heavy Duty Vehicles and buses			13551.46	12587.99	11509.89	12122.01	12555.37	12414.83
	1A3biv Mopeds and Motorcycles			31.14	27.92	24.37	23.67	26.45	34.23
				34741.10	**33291.19**	**31697.86**	**32963.99**	**32553.68**	**31421.05**
				Adjustment (tonnes)					
	1A3bi Passenger Cars			-4804.31	-5125.07	-5957.44	-6811.95	-6973.43	-6840.42
	1A3bii Light Duty Vehicles			-1020.13	-785.43	-508.23	-355.67	306.13	841.38
	1A3biii Heavy Duty Vehicles and buses			-2460.05	-2426.81	-2125.92	-2573.47	-2362.53	-435.93
	1A3biv Mopeds and Motorcycles			-5.90	-4.44	-3.32	-2.63	-2.18	-1.55
				-8290.39	**-8341.75**	**-8594.91**	**-9743.72**	**-9032.01**	**-6436.51**

10.3.2 1A3c Railways (NO_x)

Justification – Significantly Different EFs

Emission factors for NO_x from Railways were included in the EMEP/CORINAIR Emissions Inventory Guidebook (version 2) in 1999 which were applicable when the emission ceilings were set. Ireland used an EF from the "Handbook of Emission Factors, Non Industrial Sources", (Ministry of Health and Environmental Protection, The Netherlands, 1980) in the emission inventory when the emissions ceilings were set. However, the EF used in the current national emissions inventory is higher than this original EF. Ireland considers that the current NOx EF for this source is significantly different, as defined by the Directive (EU) 2016/2284 and is eligible for an adjustment.

The current EF for NOx is 49% higher than the original EF.

Quantification

The adjustment quantification is explained in the table 10.9 below.

The general approach for quantification is presented in section 10.2.2. The original EF for railways is from the "Handbook of Emission Factors, Non Industrial Sources", (Ministry of Health and Environmental Protection, The Netherlands, 1980). Tables 53, 55 and 57 on pages 80-81 refer to diesel locomotives for freight and passenger trains and for shunting locomotives and show an EF for NOx of 35g/kg of fuel or 808.2 kg/TJ (NCV of Gasoil, 43.31 MJ/kg). This EF is rounded up in the original inventory to 810 kg/TJ.

Ireland now uses the EF from the Inventory Guidebook (EMEP\EEA, 2013) to replace the above referenced EF which was published in 1980.

Table 10.9. Adjustment Quantification for Railways (NOx)

Activity (Fuel)	Emission Factors		Current NO_x emissions (tonnes)					
	Current EF (kg/TJ)	Original EF (kg/TJ)	2010	2011	2012	2013	2014	2015
Gasoil / Diesel	1,209.93	810	2,013.05	2,034.85	1,948.41	1,940.35	1,780.01	1,814.06
			Adjustments (tonnes)					
Gasoil/Diesel			-665.39	-672.60	-644.03	-641.36	-588.36	-599.62
			Total Adjustment (ktonnes)					
Railways			**-0.67**	**-0.67**	**-0.64**	**-0.64**	**-0.59**	**-0.60**

10.3.3 1A3dii National Navigation (NO_x)

Justification – Significantly Different EFs

Emission factors for NO_x from National Navigation are included in the EMEP/CORINAIR Emissions Inventory Guidebook (version 2) in 1999 when the emission ceilings were set. Ireland used an EF for shipping from the "Handbook of Emission Factors, Non Industrial Sources", (Ministry of Health and Environmental Protection, The Netherlands, 1980) in the emission inventory when the emissions ceilings were set. However, the EF used in the current national emissions inventory is higher than this original EF. Ireland considers that the current NOx EF for this source is significantly different, as defined by the Directive (EU) 2016/2284 and is eligible for an adjustment.

The current EF for NOx is 85% higher than the original EF.

Quantification

The adjustment quantification is explained in the table 10.10 below.

The general approach for quantification is presented in section 10.2.2. The original EF for shipping/navigation is from the "Handbook of Emission Factors, Non Industrial Sources", (Ministry of Health and Environmental Protection, The Netherlands, 1980). Table 66 on page 91 refer to sea-going vessels and show an EF for NOx ranging from 35g/kg of fuel to 44 g/kg fuel depending on the percentage power in use. This would equate to an EF for NOx between 808.2 kg/TJ to 1015.9 kg/TJ (NCV of Gasoil, 43.31 MJ/kg).

Ireland now uses the EF from the Inventory Guidebook (EMEP\EEA, 2013) to replace the above referenced EF which was published in 1980.

Table 10.10. Adjustment Quantification for National Navigation (NO_x)

Activity (Fuel)	Emission Factors Current EF (kg/TJ)	Original EF (kg/TJ)	Current NO_x emissions (tonnes) 2010	2011	2012	2013	2014	2015
Gasoil / Diesel	1,812.59	980	4,897.08	4,251.32	4,492.80	4,394.62	5,501.37	5,426.06
			Adjustments (tonnes)					
Gasoil/Diesel			-2249.40	-1952.79	-2063.70	-2018.61	-2526.98	-2492.39
			Total Adjustment (ktonnes)					
National Navigation			**-2.25**	**-1.95**	**-2.06**	**-2.02**	**-2.53**	**-2.49**

10.3.4 1A4ai Commercial/Institutional Stationary Combustion (NOx)

Justification – Significantly Different EFs

Emission factors for NO_x from Commercial/Institutional stationary combustion are included in the EMEP/CORINAIR Emissions Inventory Guidebook (version 2) in 1999 when the emission ceilings were set. Ireland used EFs for combustion in commercial from Table 3.4 page 16 of "Corinair 1990 Emission Inventory for Ireland" report published by the Environmental Research Unit in July 1993. These EFs can also be referenced in Table 2.2 of "Corinair Technical annexes Volume 2, Default emission factors handbook" published by the European Commission in 1994. However, the EFs used in the current national emissions inventory are higher than these original EFs. Ireland considers that the current NOx EFs for these sources are significantly different, as defined by the Directive (EU) 2016/2284 and are eligible for an adjustment.

The current EFs for each fuel for this source;

- Fuel oil is 17% lower
- LPG is 48% higher
- Gasoil is 100% higher
- Natural Gas is 48% higher
- Biomass is 82% higher
- Biogas is 48% higher

than the original EFs.

Quantification

The adjustment quantification is explained in the table 10.11 below.

The general approach for quantification is presented in section 10.2.2. The original EFs for combustion in commercial are from Table 3.4 page 16 of "Corinair 1990 Emission Inventory for Ireland" report published by the Environmental Research Unit in July 1993. These EFs can also be referenced in Table 2.2 of "Corinair Technical annexes Volume 2, Default emission factors handbook" published by the European Commission in 1994. There are additional older references also available if needed.

Ireland now uses the EFs from the Inventory Guidebook (EMEP\EEA, 2013) to replace the above referenced EFs which were published in 1987, 1993 and 1994.

Table 10.11. Adjustment Quantification for Commercial/Institutional Stationary Combustion (NO_x)

Activity (Fuel)	Emission Factors		Current NOx emissions (tonnes)					
	Current EF (kg/TJ)	Original EF (kg/TJ)	2010	2011	2012	2013	2014	2015
Fuel Oil	100	120	41.24	41.24	41.24	41.24	41.24	41.24
LPG	74	50	24.05	22.93	22.12	26.79	24.07	24.43
Gasoil / Diesel	100	50	1,575.75	1,547.39	1,436.99	1,195.48	978.94	944.63
Natural Gas	74	50	1,420.12	1,178.01	1,295.24	1,306.64	1,285.95	1,278.08
Biomass	91	50	45.80	59.98	72.84	95.59	106.03	63.60
Biogas	74	50	11.87	13.08	12.12	13.78	16.03	16.92
			Adjustments (tonnes)					
Fuel Oil			8.25	8.25	8.25	8.25	8.25	8.25
LPG			-7.80	-7.44	-7.17	-8.69	-7.81	-7.92
Gasoil / Diesel			-787.88	-773.70	-718.50	-597.74	-489.47	-472.32
Natural Gas			-460.58	-382.06	-420.08	-423.77	-417.07	-414.51
Biomass			-20.63	-27.03	-32.82	-43.07	-47.77	-28.66
Biogas			-3.85	-4.24	-3.93	-4.47	-5.20	-5.49
			Total Adjustment (ktonnes)					
Comm/Instit Stationary Combustion			**-1.27**	**-1.19**	**-1.17**	**-1.07**	**-0.96**	**-0.92**

10.3.5 1A4bi Residential Stationary Combustion (NO_x)

Justification – Significantly Different EFs

Emission factors for NO_x from Residential stationary combustion are included in the EMEP/CORINAIR Emissions Inventory Guidebook (version 2) in 1999 when the emission ceilings were set. Ireland used EFs for combustion in residential from Table 3.4 page 16 of "Corinair 1990 Emission Inventory for Ireland" report published by the Environmental Research Unit in July 1993. These EFs can also be referenced in Table 2.2 of "Corinair Technical annexes Volume 2, Default emission factors handbook" published by the European Commission in 1994. However, the EFs used in the current national emissions inventory are generally higher than these original EFs. Ireland considers that the current NOx EFs for these sources are significantly different, as defined by the Directive (EU) 2016/2284 and are eligible for an adjustment.

The current EFs for each fuel for this source;

- Bituminous coal and Anthracite are 120% higher
- Lignite, sod peat and peat briquettes are 10% higher
- Kerosene and Gasoil are 2% higher
- Petroleum coke is Natural Gas is 49% lower
- Natural Gas and LPG are 16% lower
- Biomass is 20% lower

than the original EFs.

Quantification

The adjustment quantification is explained in the table 10.12 below.

The general approach for quantification is presented in section 10.2.2. The original EFs for stationary combustion in the residential sector are from Table 3.4 page 16 of “Corinair 1990 Emission Inventory for Ireland” report published by the Environmental Research Unit in July 1993. These EFs can also be referenced in Table 2.2 of “Corinair Technical annexes Volume 2, Default emission factors handbook” published by the European Commission in 1994. There are addition al older references also available if needed.

Ireland now uses the EFs from the Inventory Guidebook (EMEP\EEA, 2013) to replace the above referenced EFs which were published in 1987, 1993 and 1994, respectively.

Table 10.12. Adjustment Quantification for Residential Stationary Combustion (NO_x)

Activity (Fuel)	Emission Factors		Current NO_x emissions (tonnes)					
	Current EF (kg/TJ)	Original EF (kg/TJ)	2010	2011	2012	2013	2014	2015
Bituminous Coal	110.00	50.00	816.80	698.46	759.37	796.71	612.03	578.96
Anthracite[1]	110.00	50.00	306.56	310.39	300.19	381.04	338.19	312.50
Lignite	110.00	100.00	47.81	48.38	54.87	79.68	58.36	58.22
Sod Peat	110.00	100.00	761.99	749.14	588.14	588.14	588.14	588.14
Briquettes	110.00	100.00	405.68	362.01	399.88	415.41	332.81	335.73
Kerosene	51.00	50.00	2,157.51	1,705.30	1,457.41	1,507.66	1,428.64	1,653.96
LPG	42.00	50.00	65.67	60.27	58.13	70.41	63.25	64.20
Gasoil / Diesel	51.00	50.00	431.93	413.83	394.34	341.96	306.40	295.20
Petroleum Coke	51.00	100.00	28.36	18.49	21.14	23.36	18.07	13.89
Natural Gas	42.00	50.00	1,248.03	1,001.04	1,055.94	1,066.00	941.96	976.14
Biomass	80.00	100.00	89.56	75.36	92.45	95.14	85.90	108.41
			6,359.89	**5,442.68**	**5,181.86**	**5,365.50**	**4,773.75**	**4,985.35**
			Adjustments (tonnes)					
Bituminous Coal			-445.53	-380.98	-414.20	-434.57	-333.83	-315.80
Anthracite[1]			-167.22	-169.30	-163.74	-207.84	-184.47	-170.46
Lignite			-4.35	-4.40	-4.99	-7.24	-5.31	-5.29
Sod Peat			-69.27	-68.10	-53.47	-53.47	-53.47	-53.47
Briquettes			-36.88	-32.91	-36.35	-37.76	-30.26	-30.52
Kerosene			-42.30	-33.44	-28.58	-29.56	-28.01	-32.43
LPG			12.51	11.48	11.07	13.41	12.05	12.23
Gasoil / Diesel			-8.47	-8.11	-7.73	-6.71	-6.01	-5.79
Petroleum Coke			27.25	17.77	20.31	22.44	17.36	13.34
Natural Gas			237.72	190.68	201.13	203.05	179.42	185.93
Biomass			22.39	18.84	23.11	23.78	21.48	27.10
			Total Adjustment (ktonnes)					
Residential Stationary Combustion			**-0.47**	**-0.46**	**-0.45**	**-0.51**	**-0.41**	**-0.38**

[1] Includes Manufactured Ovoids

10.3.6 1A4ciii National Fishing (NOx)

Justification – A New Source/Significantly Different EFs

Activity data to estimate emission of NO_x from National Fishing did not exist in Ireland's national energy balance until 2012, when they were first introduced for the 1990-2010 energy balance. Marine diesel used in National Fishing is now included in the energy balance for all years from 1990 to 2015.

For a new source, Directive (EU) 2016/2284 requires that the source is currently included in scientific literature (such as the EMEP/EEA Guidebook), and that the source was not included in the historic national emissions inventory when emission ceilings were set. Both of these criteria are met, and it is therefore concluded that NO_x emissions from national fishing are a new source and are eligible for an adjustment.

The fuel allocated to National Fishing since 2012 did not increase the overall gasoil/diesel use in the energy balance estimates, as the fuel was re-allocated from the category Commercial/Institutional (1A4ai) stationary combustion. So while National Fishing is in effect a new source introduced in 2012, to avoid double counting it is more appropriate that an adjustment is considered on the basis of significantly different EFs.

Quantification

The adjustment quantification is explained in the table 10.13 below.

The general approach for quantification is presented in section 10.2.2. Ireland used EFs for stationary combustion in the commercial/Institutional category from Table 3.4 page 16 of "Corinair 1990 Emission Inventory for Ireland" report published by the Environmental Research Unit in July 1993. These EFs can also be referenced in Table 2.2 of "Corinair Technical annexes Volume 2, Default emission factors handbook" published by the European Commission in 1994.

Ireland now uses an EF for NO_x for National Fishing from the 2013 version of the EMEP/EEA Emissions Inventory Guidebook and is used to estimate emissions of NO_x for all years from 1990 to 2015 in the current inventory submission.

The current EF for gasoil for this source is 3525% higher than the original EF.

Table 10.13. Adjustment Quantification for National Fishing (NO_x)

Activity (Fuel)	Emission Factors		Current NO_x emissions (tonnes)					
	Current EF (kg/TJ)	Original EF (kg/TJ)	2010	2011	2012	2013	2014	2015
Gasoil/Diesel	1,812.59	50.00	1864.20	1544.13	1709.37	1902.07	1812.30	1593.33
			Adjustments (tonnes)					
Gasoil/Diesel			-1812.78	-1501.54	-1662.22	-1849.60	-1762.30	-1549.38
			Total Adjustment (ktonnes)					
National Fishing			**-1.86**	**-1.54**	**-1.71**	**-1.90**	**-1.81**	**-1.59**

10.3.7 1B2aiv Fugitive Emissions from Oil Refining (NOx)

Justification - A New Source

Fugitive emissions from oil refining were not included in Ireland's national emissions inventory in 1999, when the ceilings were set. A methodology is presented in the 2013 EMEP/EEA Guidebook, and this is currently used to estimate emissions that are included in the Irish national emissions inventory.

For a new source, the Directive (EU) 2016/2284 requires that the source is currently included in scientific literature (such as the EMEP/EEA Guidebook), and that the source was not included in the historic national emissions inventory when emission ceilings were set. Both of these criteria are met, and it is therefore concluded that NO_x emissions from fugitive emissions from oil refining are a new source and are eligible for an adjustment.

Quantification

Emissions have been calculated by using the Tier 1 methodology and emission factors presented in the Inventory Guidebook (EMEP\EEA, 2013), Chapter 1.B.2.a.iv Table 3-1. As a new source, quantification of the adjustment is achieved by subtracting the emissions from the national inventory total as shown in table 10.14 below.

Table 10.14. Adjustments for Fugitive emissions from Oil Refineries (NO_x)

Source Sector	Adjustments (ktonnes)					
	2010	2011	2012	2013	2014	2015
Fugitive Emissions from Oil Refineries	-0.70	-0.71	-0.74	-0.68	-0.66	-0.80

10.4 NMVOC Adjustment Applications

10.4.1 Other Product Use, 2G4 (NMVOC)

Justification - A New Source

NMVOC emissions from the following two sources are included in the Irish national emissions inventory:

- 2G4 Other Product Use: Seed oil extraction (SNAP060404 Fat, edible and non-edible oil extraction);
- 2G4 Other Product Use: Use of tobacco (SNAP060602).

Neither of these sources was included in Ireland's national emissions inventory in 1999, when the ceilings were set. Methodologies for both are presented in the 2016 EMEP/EEA Guidebook, and these are currently used to estimate emissions that are included in Ireland's national emissions inventory.

For a new source, the Directive (EU) 2016/2284 requires that the source is currently included in scientific literature (such as the EMEP/EEA Guidebook), and that the source was not included in the historic national emissions inventory when emission ceilings were set. These criteria are met for both sources, and it is therefore concluded that NMVOC emissions from extracting rapeseed oil from rapeseed, and the use of tobacco are both a new sources and are eligible for an adjustment.

Quantification

Emissions have been calculated by using the Tier 2 methodologies presented in the Inventory Guidebook (EMEP\EEA, 2016):

- Extracting oil from oilseed rape: The annual tonnage of oilseed rape used for oil extraction is combined with the EF in chapter 2D3i-2G Other Solvent and Product Use, Table 3.4 Fat, edible and non-edible oil extraction;
- Use of tobacco: The annual mass of all tobacco products is combined with the EF in chapter 2D3i-2G Other Solvent and Product Use, Table 3.14 Tobacco Consumption.

As a new source, quantification of the adjustment is achieved by subtracting the emissions from the national inventory total as shown in table 10.15 below.

Table 10.15. Adjustments for emissions from Other Product Use (NMVOC)

Source Sector	Adjustments (ktonnes)					
	2010	2011	2012	2013	2014	2015
Seed Oil Extraction	-0.04	-0.09	-0.09	-0.08	-0.05	-0.06
Use of tobacco	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
	Total Adjustment (ktonnes)					
Other product use	**-0.07**	**-0.11**	**-0.11**	**-0.10**	**-0.07**	**-0.08**

10.4.2 Food and Beverage Industry, 2H2 (NMVOC)

Justification - A New Source

NMVOC emissions from the food and beverage industry were not included in Ireland's national emissions inventory in 1999, when the ceilings were set. A methodology is presented in the 2013 EMEP/EEA Guidebook, and this is currently used to estimate emissions that are included in the Irish national emissions inventory.

For a new source, the Directive (EU) 2016/2284 requires that the source is currently included in scientific literature (such as the EMEP/EEA Guidebook), and that the source was not included in the historic national emissions inventory when emission ceilings were set. Both of these criteria are met, and it is therefore concluded that NMVOC emissions from the food and beverage industry are a new source and are eligible for an adjustment.

Quantification

Emissions have been calculated by using the Tier 2 methodologies presented in the Inventory Guidebook (EMEP\EEA, 2016), with EFs taken from the follow sources:

- Bread – chapter 2H2, Table 3-11
- Baking Products (Bread) - chapter 2H2, Table 3-18
- Beer - chapter 2H2, Table 3-27
- Spirits - chapter 2H2, Table 3-28
- Meat, frying - chapter 2H2, Table 3-19
- Meat, rendering - chapter 2H2, Table 3-2
- Coffee roasting - chapter 2H2, Table 3-23
- Feedstock - chapter 2H2, Table 3-22

As a new source, quantification of the adjustment is achieved by subtracting the emissions from the national inventory total as shown in table 10.16 below.

Table 10.16. Adjustments for emissions from the Food and Beverage Industry (NMVOC)

Source Sector	**Adjustments (ktonnes)**					
	2010	**2011**	**2012**	**2013**	**2014**	**2015**
Bread	-2.54	-1.69	-1.57	-1.81	-1.68	-1.65
Baking Products (Bread)	-0.04	-0.02	-0.02	-0.03	-0.04	-0.04
Beer	-0.27	-0.27	-0.29	-0.28	-0.26	-0.28
Spirits	-6.91	-7.40	-7.88	-8.37	-9.52	-10.78
Meat, frying	-0.11	-0.11	-0.11	-0.12	-0.12	-0.12
Meat, rendering	-0.32	-0.32	-0.30	-0.31	-0.34	-0.34
Coffee roasting	0.00	0.00	0.00	0.00	0.00	0.00
Feedstock	-2.49	-2.47	-3.43	-3.66	-3.06	-3.23
	Total Adjustment (ktonnes)					
Food and beverages industry	**-12.68**	**-12.27**	**-13.61**	**-14.57**	**-15.02**	**-16.44**

10.4.3 Manure Management, 3B (NMVOC)

Justification - A New Source

NMVOC emissions from manure management were not included in Ireland’s national emissions inventory in 1999, when the ceilings were set. A methodology is presented in the 2013 EMEP/EEA Guidebook, and this is currently used to estimate emissions that are included in the Irish national emissions inventory.

For a new source, the Directive (EU) 2016/2284 requires that the source is currently included in scientific literature (such as the EMEP/EEA Guidebook), and that the source was not included in the historic national emissions inventory when emission ceilings were set. Both of these criteria are met, and it is therefore concluded that NMVOC emissions from manure management are a new source and are eligible for an adjustment.

Quantification

Emissions have been calculated by using the methodology presented in the Inventory Guidebook (EMEP\EEA, 2013), Chapter 3b, Section 3.3.2 using a Tier 2 approach. Estimates are undertaken for each livestock type. Animal population data are combined with data on time spent in housing or at pasture combined with EFs from the Inventory Guidebook (EMEP\EEA, 2013) to give NMVOC emission estimates from housing, storage and application for each livestock type.

As a new source, quantification of the adjustment is achieved by subtracting the emissions from the national inventory total as shown in table 10.17 below.

Table 10.17. Adjustments from Manure Management (NMVOC)

Source Sector	Adjustments (ktonnes)					
	2010	2011	2012	2013	2014	2015
Manure Management – 3B1a Dairy cattle	-7.11	-7.37	-7.43	-7.64	-7.99	-8.74
Manure Management – 3B1b Non-dairy cattle	-24.77	-24.20	-25.32	-26.13	-25.60	-25.37
Manure Management – 3B2 Sheep	-0.31	-0.31	-0.34	-0.34	-0.35	-0.34
Manure Management – 3B3 Swine	-2.40	-2.46	-2.43	-2.40	-2.43	-2.39
Manure Management – 3B4d Goats	0.00	0.00	0.00	0.00	0.00	0.00
Manure Management – 3B4e Horses	-0.18	-0.18	-0.19	-0.18	-0.16	-0.16
Manure Management – 3B4f Mules and asses	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Manure Management - 3B4gi Laying hens	-0.35	-0.34	-0.43	-0.47	-0.47	-0.47
Manure Management - 3B4gii Broilers	-1.29	-1.24	-1.24	-1.16	-1.16	-1.16
Manure Management - 3B4giii Turkeys	-0.43	-0.53	-0.60	-0.55	-0.55	-0.55
Manure Management - 3B4giv Other poultry	-0.14	-0.14	-0.14	-0.13	-0.13	-0.13
Manure Management – 3B4h Other animals	-0.36	-0.36	-0.38	-0.38	-0.38	-0.38
	Total Adjustment (ktonnes)					
3B Manure Management	**-37.35**	**-37.15**	**-38.52**	**-39.38**	**-39.23**	**-39.71**

10.4.4 Inorganic N Fertilisers, 3D1a (NMVOC)

Justification - A New Source

NMVOC emissions from inorganic N fertilisers were not included in Ireland's national emissions inventory in 1999, when the ceilings were set. A methodology is presented in the 2013 EMEP/EEA Guidebook, and this is currently used to estimate emissions that are included in the Irish national emissions inventory.

For a new source, the Directive (EU) 2016/2284 requires that the source is currently included in scientific literature (such as the EMEP/EEA Guidebook), and that the source was not included in the historic national emissions inventory when emission ceilings were set. Both of these criteria are met, and it is therefore concluded that NMVOC emissions from manure management are a new source and are eligible for an adjustment.

Quantification

Emissions have been calculated by using the Tier 1 methodology presented in the Inventory Guidebook (EMEP\EEA, 2013), Chapter 3d, Section 3.2.

As a new source, quantification of the adjustment is achieved by subtracting the emissions from the national inventory total as shown in table 10.18 below.

Table 10.18. Adjustment from Inorganic N Fertilisers (NMVOC)

Source Sector	Adjustments (ktonnes)					
	2010	2011	2012	2013	2014	2015
Inorganic N Fertilisers	-3.55	-3.53	-3.48	-3.44	-3.42	-3.38

10.5 Impact of the flexibility on compliance

The established adjusted annual national emission inventories as allowed under the flexibility in Article 5(1) of Directive (EU) 2016/2284 show Ireland to be in compliance with the NMVOC ceiling for all years and in compliance with the NOx emission ceiling from 2011 onwards. The adjusted national inventories for NOx and NMVOC are presented in Figures 10.1 and 10.2

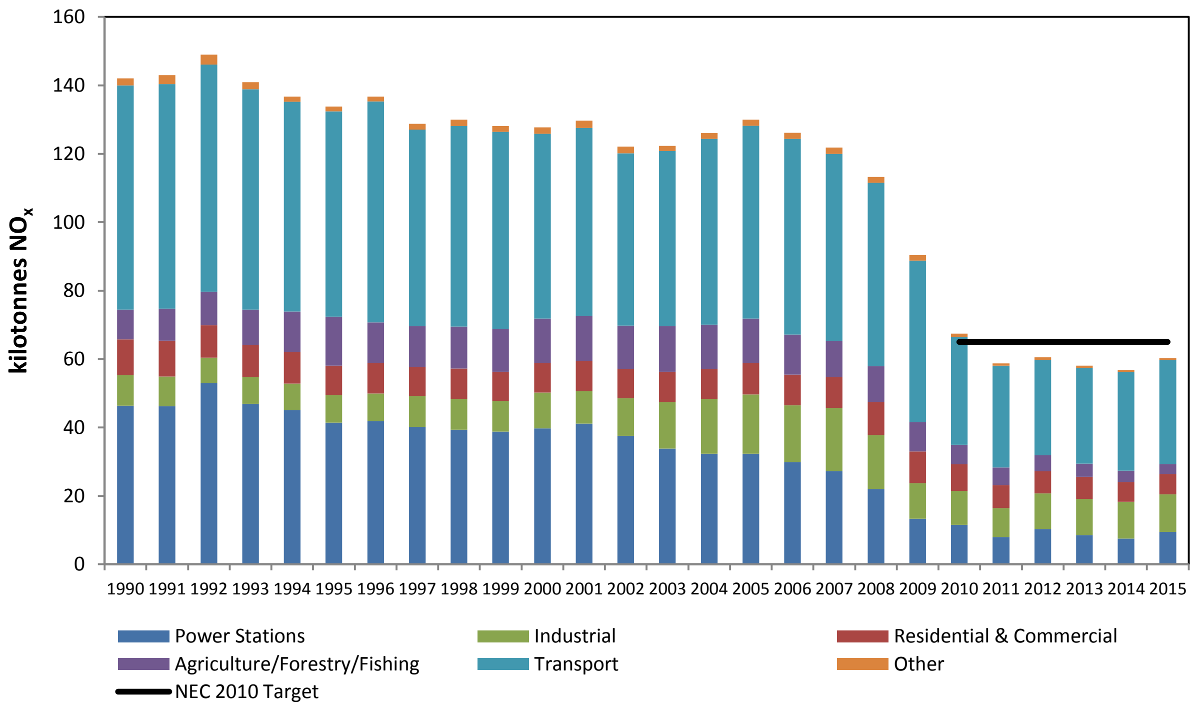

Figure 10.1 Emission Trend for NOx 1990−2015 (Adjusted Article 5(1))

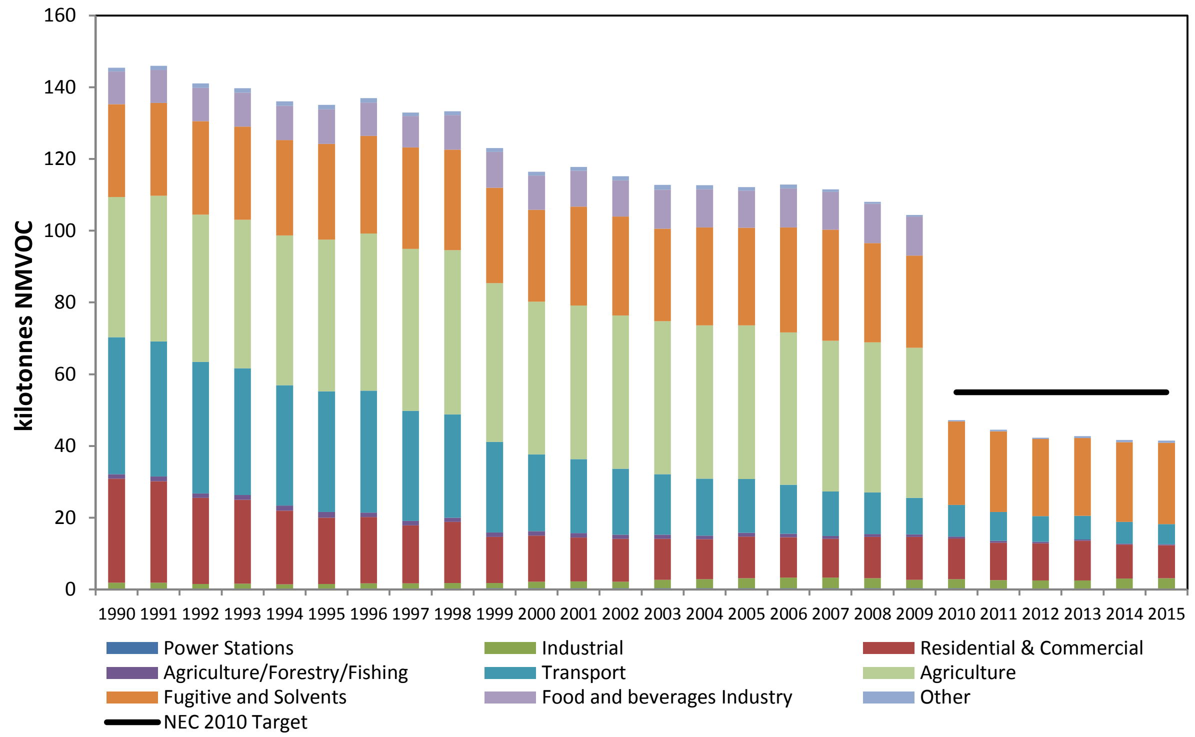

Figure 10.2 Emission Trend for NMVOC 1990−2015 (Adjusted Article 5(1))

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Glossary

ADDF	Annual Average Daily Flow
AER	Annual Environmental Report
As	Arsenic
B[a]P	Benzo[a]pyrene
B[b]F	Benzo[b]fluoranthene
B[k]F	Benzo[k]fluoranthene
BCF	British Coatings Federations
CAP	Common Agricultural Policy
Cd	Cadmium
CEPE	European Council of Producers and Importers of Paints, Printing Inks and Artists Colours
CEPMEIP	Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance
CLEEN	Chemical Legislation European Enforcement Network
CLRTAP	Convention on Long Long-Range Transboundary Air Pollution
CO	Carbon monoxide
CORINAIR	Co-ordinated Information on the environment in the European Community-AIR. CORINAIR was one of several collaborative exercises initiated under the CORINE programme to harmonise the collection and dissemination of information on the environment in the EU
CMMS	Cattle Movement and Monitoring Scheme
Cr	Chromium
CSO	Central Statistics Office
Cu	Copper
DEHLG	Department of Environment, Heritage and Local Government
DM	Dry matter
DTTAS	Department of Transport, Tourism and Sport
DQO	Data quality objective
EAPA	European Asphalt Pavement Association
ED	Electoral Division
ELV	End-of-Life Vehicle
EMEP	European Monitoring and Evaluation Programme, a co-operative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe
EPA	Environmental Protection Agency
E-PRTR	European Pollutant Release and Transfer Register
ESB	Electricity Supply Board
ESP	Electrostatic precipitators
ETS	Emissions Trading Scheme
EUROSTAT	Statistical Agency of the European Union
FFS	Farm Facilities Survey
Fossil Fuel	Peat, coal, oil and natural gas and associated derivatives
FUS	Fertiliser Use Survey
GHG	Greenhouse gas
Gg	Gigagram (10^9 g) = kilotonne = 1,000 tonnes

GNFR	Gridded Nomenclature for Reporting Codes
HCB	Hexachlorobenzene
HFO	Heavy fuel oil
Hg	Mercury
IBEC	Irish Business and Employers' Confederation
IEA	International Energy Agency
IEF	Implied Emission Factor
IFFPG	Irish Farm Film Producers Group
IIR	Informative Inventory Report
I[123-cd]P	Indeno[1,2,3-cd]pyrene
IPC	Integrated Pollution Control
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
KDP	Key Data Provider
ktoe	Kilotonnes of oil equivalent
LCP	Large Combustion Plant Directive
LFG	Landfill gas
LPS	Large Point Source
LTO	Landing and take-off
MoU	Memorandum of Understanding
MSW	Municipal solid waste
NAIS	National Atmospheric Inventory System
NAEI	National Atmospheric Emissions Inventory
NCT	National Car Testing
NETCEN	National Environmental Technology Centre
NEC	National Emission Ceilings
NFR	Nomenclature for Reporting Codes
NH_3	Ammonia
Ni	Nickel
NMVOC	Non-methane volatile organic compound
NO_x	Nitrogen oxides
NRA	National Roads Authority
OCLR	Office of Climate, Licensing, Research and Resource Use
OLG	Office of Licensing and Guidance
PAH	Polycyclic aromatic hydrocarbon
Pb	Lead
PCB	Polychlorinated biphenyl
PER	Pollution Emissions Register
PM	Particulate matter
PM_{10}	Particulate matter <10 μm in diameter
$PM_{2.5}$	Particulate matter <2.5 μm in diameter
POP	Persistent organic pollutant
PVC	Polyvinyl chloride
QA/QC	Quality assurance/quality control
S.I.	Statutory Instrument
Se	Selenium
SEAI	Sustainable Energy Authority of Ireland
SNAP	Selected Nomenclature for Air Pollution

SO_2	Sulphur dioxide
SO_X	Sulphur oxides
TAN	Total ammoniacal nitrogen
Teagasc	Irish Agriculture and Food Development Authority
TPM	Total particulate matter
TSP	Total suspended particulates
UAN	Uric acid nitrogen
UK NAEI	United Kingdom National Atmospheric Emission Inventory
UNECE	United Nations Economic Commission for Europe
VOC	Volatile organic compounds
WEEE	Waste Electrical and Electronic Equipment Regulation
Zn	Zinc

Annex A

A.1 Annex 1 Table 2015

A.2 Key Category Analysis 2015

A.3 Fuel Tourism in Road Transport and Nitrogen Oxides Emissions Based on Fuels Used

ANNEX 1: National sector emissions: Main pollutants, particulate matter, heavy metals and persistent organic pollutants

NFR 2014-2

COUNTRY:	IE	(as ISO2 code)
DATE:	15.02.2017	(as DD.MM.YYYY)
YEAR:	2015	(as YYYY, year of emissions and activity data)
Version:	v1.0	(as v1.0 for the initial submission)

XML Export for all entered years

Add a new year

IE: 15.02.2017: 2015	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)						POPs (1) (from 1990)								Activity Data (from 1990)						
																							PAHs													
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxins/ furans)	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	Total 1-4	HCB	PCBs	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels	*Other activity (specified)*	*Other Activity Units*
NFR AGgregation for Gridding and LPS (GNFR)	NFR Code	Longname	Notes	kt	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	t	t	t	t	t	t	g I-TEQ	t	t	t	t	t	kg	kg	TJ NCV	TJ NCV	TJ NCV	TJ NCV	TJ NCV		
A_PublicPower	1A1a	Public electricity and heat production		9.476	0.257	5.203	NE	0.439	0.676	0.823	0.010	17.862	0.539	0.068	0.112	0.525	0.326	0.565	0.969	1.626	1.552	0.520	0.000	0.003	0.003	0.000	0.005	0.466	0.000	3226	70092	69542	2770	1039	NA	*TJ NCV*
B_Industry	1A1b	Petroleum refining		0.541	0.016	0.574	NE	0.006	0.006	0.006	0.001	0.100	0.008	0.003	0.001	0.002	0.012	0.010	0.016	0.002	0.114	0.001	0.000	0.000	0.000	0.000	0.000	NA	0.000	4515	NO	1813	NO	NO	NA	*TJ NCV*
B_Industry	1A1c	Manufacture of solid fuels and other energy industries		0.066	0.066	0.197	NE	0.013	0.026	0.079	NE	1.146	0.005	0.001	0.001	0.005	0.003	0.005	0.003	0.015	0.012	0.007	0.000	0.000	0.000	0.000	0.000	0.004	0.000	NO	369	NO	NO	NO	NA	*TJ NCV*
B_Industry	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel		0.003	0.001	0.000	NO	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NO	NO	NO	NO	42	NO	NO	NA	*TJ NCV*
B_Industry	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals		0.975	0.579	0.053	NO	0.024	0.024	0.024	0.003	0.737	0.000	0.000	0.014	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.001	0.004	0.001	0.001	0.006	NO	NO	453	NO	24869	NO	NO	NA	*TJ NCV*
B_Industry	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals		0.372	0.094	0.058	NO	0.023	0.023	0.023	0.011	0.147	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.032	0.003	0.005	0.026	0.006	0.005	0.042	NO	NO	1121	NO	3554	NO	NO	NA	*TJ NCV*
B_Industry	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print		0.022	0.005	0.005	NO	0.002	0.002	0.002	0.001	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.002	0.000	0.000	0.003	0.000	0.000	113	0.458	141	NO	NO	NA	*TJ NCV*
B_Industry	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverAGes and tobacco		1.320	0.664	0.942	0.042	0.348	0.360	0.375	0.097	1.947	0.154	0.016	0.013	0.005	0.039	0.024	0.014	0.003	0.884	0.310	0.067	0.158	0.044	0.037	0.307	0.006	0.157	5313	957	7485	1123	NO	NA	*TJ NCV*
B_Industry	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals		6.876	0.761	1.089	0.044	0.691	0.726	0.759	0.151	4.267	0.505	0.022	0.030	0.015	0.077	0.070	0.048	0.008	1.524	0.845	0.186	0.335	0.102	0.081	0.705	0.008	0.599	7149	3521	705	1199	NO	NA	*TJ NCV*
I_Offroad	1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	0.170	0.028	0.091	0.023	0.020	0.162	0.008	0.001	IE	IE	IE	IE	NO	NA	*TJ NCV*
B_Industry	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)		1.386	0.763	0.148	0.179	0.389	0.398	0.415	0.108	2.258	0.131	0.063	0.008	0.002	0.112	0.030	0.010	0.003	2.552	IE	IE	IE	IE	IE	IE	NA	NA	5295	3	6608	1610	NO	NA	*TJ NCV*
H_Aviation	1A3ai(i)	International aviation LTO (civil)		1.018	0.141	0.084	NE	0.018	0.018	0.018	0.009	1.383	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.109	NE	NE	NE	NE	NE	NE	NA	NA	3744	NA	NA	NA	NO	NA	*TJ NCV*
H_Aviation	1A3aii(i)	Domestic aviation LTO (civil)		0.021	0.001	0.002	NE	0.001	0.001	0.001	0.000	0.013	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	NE	NE	NE	NE	NE	NE	NA	NA	72	NA	NA	NA	NO	NA	*TJ NCV*
F_RoadTransport	1A3bi	Road transport: Passenger cars		15.759	2.899	0.029	0.838	0.580	0.580	0.580	0.464	47.704	8.243	0.023	0.022	0.001	0.115	3.893	0.161	0.023	2.390	1.116	0.052	0.058	0.045	0.050	0.206	NA	NA	0	NA	NO	NA	NO	NA	*TJ NCV*
F_RoadTransport	1A3bii	Road transport: Light duty vehicles		6.745	0.370	0.009	0.017	0.296	0.296	0.296	0.247	2.053	0.010	0.006	IE	IE	0.030	1.034	0.043	0.006	0.608	0.352	0.015	0.017	0.013	0.014	0.060	NA	NA	55651	NA	NO	NA	NO	NA	*TJ NCV*
F_RoadTransport	1A3biii	Road transport: Heavy duty vehicles and buses		14.968	0.486	0.009	0.015	0.242	0.242	0.242	0.166	3.314	0.001	0.006	IE	IE	0.032	1.096	0.045	0.006	0.645	0.195	0.003	0.020	0.023	0.005	0.052	NA	NA	64	NA	NO	NA	NO	NA	*TJ NCV*
F_RoadTransport	1A3biv	Road transport: Mopeds & motorcycles		0.035	0.199	0.000	0.000	0.005	0.005	0.005	0.001	1.255	0.034	0.000	IE	IE	0.000	0.009	0.000	0.000	0.006	0.004	0.000	0.000	0.000	0.000	0.000	NA	NA	8	NA	NO	NA	NO	NA	*TJ NCV*
F_RoadTransport	1A3bv	Road transport: Gasoline evaporation		NA	1.401	NA	NA	NA	NA	NA	NA	NA	IE	IE	IE	IE	IE	IE	IE	IE	IE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NO	NA	*TJ NCV*
F_RoadTransport	1A3bvi	Road transport: Automobile tyre and brake wear		NA	NA	NA	NA	0.554	1.018	1.294	0.232	NA	1.330	0.006	IE	IE	0.491	10.747	0.079	0.011	4.375	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NO	58267	*10^6 km*
F_RoadTransport	1A3bvii	Road transport: Automobile road abrasion		NA	NA	NA	NA	0.297	0.550	1.101	0.006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NO	58267	*10^6 km*
I_Offroad	1A3c	Railways		1.814	0.161	0.024	0.000	0.047	0.050	0.053	0.034	0.370	NE	0.000	NE	NE	0.002	0.059	0.002	0.000	0.035	NE	0.001	0.002	NE	NE	0.003	NA	NA	1499	NO	NA	NA	NO	NA	*TJ NCV*
G_Shipping	1A3di(ii)	International inland waterways		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	*TJ NCV*
G_Shipping	1A3dii	National navigation (shipping)		5.426	0.194	0.097	NE	0.097	0.104	0.104	0.032	0.512	0.009	0.001	0.002	0.003	0.003	0.061	0.069	0.007	0.083	0.009	NE	NE	NE	NE	NE	0.006	0.003	2994	NO	NA	NA	NO	NA	*TJ NCV*
I_Offroad	1A3ei	Pipeline transport		0.119	0.004	0.000	NE	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	NE	NE	NE	NE	NE	NE	NE	NO	NA	2487	NA	NO	NA	*TJ NCV*
I_Offroad	1A3eii	Other (please specify in the IIR)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*TJ NCV*
C_OtherStationaryComb	1A4ai	Commercial/institutional: Stationary		2.369	0.517	0.251	0.026	0.200	0.250	0.310	0.095	1.121	0.020	0.009	0.011	0.002	0.018	0.006	0.002	0.002	0.663	0.093	0.039	0.211	0.040	0.037	0.326	0.003	0.000	10189	NO	17500	699	NO	NA	*TJ NCV*
I_Offroad	1A4aii	Commercial/institutional: Mobile		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	NE	NA	IE	NA	IE	IE	NO	NA	*TJ NCV*
C_OtherStationaryComb	1A4bi	Residential: Stationary		4.985	8.678	6.741	0.059	7.321	7.435	8.141	0.498	21.371	2.251	0.043	0.109	0.046	0.230	0.393	0.219	0.018	4.457	14.314	4.005	5.705	2.247	1.928	13.885	0.017	2.896	40020	17032	23241	1355	NO	NA	*TJ NCV*
I_Offroad	1A4bii	Residential: Household and gardening (mobile)		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	NA	IE	IE	IE	IE	NO	NA	*TJ NCV*
C_OtherStationaryComb	1A4ci	AGriculture/Forestry/Fishing: Stationary		0.063	0.006	0.010	NE	0.010	0.014	0.017	0.006	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.001	0.001	0.010	0.001	0.001	0.013	NE	NE	635	NO	NO	NO	NO	NA	*TJ NCV*
I_Offroad	1A4cii	AGriculture/Forestry/Fishing: Off-road vehicles and other machinery		2.775	0.207	0.022	0.001	0.105	0.106	0.106	0.059	1.035	NE	0.001	NE	NE	0.007	0.224	0.009	0.001	0.132	NE	0.004	0.007	NE	NE	0.011	NE	NE	5714	NA	NA	NO	NO	NA	*TJ NCV*
I_Offroad	1A4ciii	AGriculture/Forestry/Fishing: National fishing		1.593	0.057	0.014	NE	0.028	0.030	0.030	0.009	0.150	0.003	0.000	0.001	0.001	0.001	0.018	0.020	0.002	0.024	0.003	NE	NE	NE	NE	NE	0.002	0.001	879	NA	NA	NA	NO	NA	*TJ NCV*

Annex A.1 Annex 1Table (contd.)

C_OtherStationaryComb	1A5a	Other stationary (including military)		IE	IE	IE	NE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	NE	NA	IE	IE	IE	IE	NO	NA	*TJ NCV*
I_Offroad	1A5b	Other, Mobile (including military, land based and recreational boats)		IE	IE	IE	NE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	NE	NA	IE	NA	NA	NA	NO	NA	*TJ NCV*
D_Fugitive	1B1a	Fugitive emission from solid fuels: Coal mining and handling		NA	NO	NO	NA	NO	NO	NO	NO	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	*Coal produced [Mt]*
D_Fugitive	1B1b	Fugitive emission from solid fuels: Solid fuel transformation		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NO	*Coal used for transformatio*
D_Fugitive	1B1c	Other fugitive emissions from solid fuels		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Please specify*
D_Fugitive	1B2ai	Fugitive emissions oil: Exploration, production, transport		NA	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Crude oil produced [Mt]*
D_Fugitive	1B2aiv	Fugitive emissions oil: Refining / storAGe		0.801	0.668	2.071	0.004	0.014	0.033	0.053	NE	0.301	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	*Crude oil refined [Mt]*
D_Fugitive	1B2av	Distribution of oil products		NA	2.018	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	*Oil consumed [Mt]*
D_Fugitive	1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storAGe, distribution and other)		NA	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Gas throughput [Mn3]*
D_Fugitive	1B2c	Venting and flaring (oil, gas, combined oil and gas)		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	*Gas vented flared [TJ]*
D_Fugitive	1B2d	Other fugitive emissions from energy production	(a)	NE	NE	NE	NE	NO	NO	NO	NO	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
B_Industry	2A1	Cement production		IE	IE	IE	NA	NE	NE	NE	NE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	1.509	IE	IE	IE	IE	IE	NE	4.736	NA	NA	NA	NA	NA	3021	*Clinker produced [kt]*
B_Industry	2A2	Lime production		IE	IE	IE	NA	NA	NA	NA	NA	IE	NA	NA	NA	NA	NA	NA	NA	NA	NA	IE	NA	NA	NA	NA	NA	NA	IE	NA	NA	NA	NA	NA	236	*Lime produced [kt]*
B_Industry	2A3	Glass production		IE	IE	IE	NA	NO	NO	NO	NO	IE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE	NA	NA	NA	NA	NA	NA	NO	*Glass produced [t]*
B_Industry	2A5a	Quarrying and mining of minerals other than coal		NA	NA	NA	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	*Material quarried [Mt]*
B_Industry	2A5b	Construction and demolition		NA	NA	NA	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	*floor space constructed/d*
B_Industry	2A5c	Storage, handling and transport of mineral products		NA	NA	NA	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	*Amount [Mt]*
B_Industry	2A6	Other mineral products (please specify in the IIR)		NA	NA	NA	NA	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.014	0.010	NA	0.002	NA	0.012	NA	NA	NA	NA	NA	NA	NA	NO	*Please specify*
B_Industry	2B1	Ammonia production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*Ammonia produced [kt]*
B_Industry	2B2	Nitric acid production		NO	NA	NA	NE	NO	NO	NO	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	*Nitric acid produced [kt]*
B_Industry	2B3	Adipic acid production		NO	NA	NA	NA	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	*Adipic acid produced [kt]*
B_Industry	2B5	Carbide production		NO	NO	NO	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NO	*Carbide produced [kt]*
B_Industry	2B6	Titanium dioxide production		NO	NO	NO	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	*Titanium dioxide*
B_Industry	2B7	Soda ash production		NO	NO	NO	NA	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	*Soda ash produced [kt]*
B_Industry	2B10a	Chemical industry: Other (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NO	*Please specify*
B_Industry	2B10b	StorAGe, handling and transport of chemical products (please specify in the IIR)		NE	NE	NE	NE	0.006	0.045	0.140	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NO	*Please specify*
B_Industry	2C1	Iron and steel production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE	NO	NA	NA	NA	NA	NA	NE	*Steel produced [kt]*
B_Industry	2C2	Ferroalloys production		NO	NO	NO	NO	NO	NO	NO	NO	NO	0.000	0.000	NO	NO	NO	NO	NO	NO	0.000	IE	IE	IE	IE	IE	IE	NO	NA	NA	NA	NA	NA	NA	NE	*Ferroalloys produced [kt]*
B_Industry	2C3	Aluminium production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NO	*Aluminium produced [kt]*
B_Industry	2C4	MAGnesium production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NO	*MAGnesium produced [kt]*
B_Industry	2C5	Lead production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	IE	NE	NE	NE	NE	NE	NO	IE	NA	NA	NA	NA	NA	NE	*Lead produced [kt]*
B_Industry	2C6	Zinc production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NO	*Zinc produced [kt]*
B_Industry	2C7a	Copper production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NO	*Copper produced [kt]*
B_Industry	2C7b	Nickel production		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NO	*Nickel produced [kt]*
B_Industry	2C7c	Other metal production (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	0.000	0.000	NO	NO	NO	NO	NO	NO	0.000	IE	IE	IE	IE	IE	IE	NO	IE	NA	NA	NA	NA	NA	NO	*Please specify*
B_Industry	2C7d	Storage, handling and transport of metal products (please specify in the IIR)		NE	NE	NE	NE	NE	NE	NE	NE	NE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	NA	NA	NA	NA	NA	NE	*Amount (kt)*
E_Solvents	2D3a	Domestic solvent use including fungicides		NA	10.481	NA	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
E_Solvents	2D3b	Road paving with asphalt		NE	0.030	NE	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE	IE	NE	IE	IE	NE	NA	NA	NA	NA	NA	NA	NE	
B_Industry	2D3c	Asphalt roofing		NA	NE	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NE	
B_Industry	2D3d	Coating applications		NA	3.697	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	*Paint applied [kt]*
E_Solvents	2D3e	Degreasing		NA	1.501	NA	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	*Solvents used [kt]*
E_Solvents	2D3f	Dry cleaning		NA	0.044	NA	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.141	*Solvents used [kt]*
E_Solvents	2D3g	Chemical products		NE	1.341	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NE	*NA*
E_Solvents	2D3h	Printing		NA	1.462	NA	NA	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	*NA*
E_Solvents	2D3i	Other solvent use (please specify in the IIR)		NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	

Annex A.1 Annex 1Table (contd.)

E_Solvents	2G	Other product use (please specify in the IIR)		NE	1.480	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NE	*Please specify*
B_Industry	2H1	Pulp and paper industry		NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	*Pulp production [kt]*
B_Industry	2H2	Food and beverAGes industry		NA	16.441	NA	NA	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	*Bread, Wine, Beer, Spirits*
B_Industry	2H3	Other industrial processes (please specify in the IIR)		NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
B_Industry	2I	Wood processing		NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NE	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	*Please specify*
B_Industry	2J	Production of POPs		NE	NE	NE	NE	NO	NO	NO	NO	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NO	NA	NA	NA	NA	NA	NO	*NA*
B_Industry	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NE	NO	NA	NA	NA	NA	NA	NE	*NA*
B_Industry	2L	Other production, consumption, storAGe, transportation or handling of bulk products (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.000	NE	NE	NE	NE	NE	NE	0.001	NA	NA	NA	NA	NA	NA	*NA*
K_AGriLivestock	3B1a	Manure manAGement - Dairy cattle		NE	8.739	NA	13.890	0.715	1.098	2.393	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3433	*Population size (1000*
K_AGriLivestock	3B1b	Manure manAGement - Non-dairy cattle		NE	25.371	NA	30.669	0.764	1.163	2.535	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3493	*Population size (1000*
K_AGriLivestock	3B2	Manure manAGement - Sheep		NE	0.340	NA	1.134	0.081	0.271	0.677	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4870	*Population size (1000*
K_AGriLivestock	3B3	Manure manAGement - Swine		NE	2.388	NA	6.886	0.083	0.435	0.981	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1506	*Population size (1000*
K_AGriLivestock	3B4a	Manure manAGement - Buffalo		NO	NO	NA	NO	NO	NO	NO	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	*Population size (1000*
K_AGriLivestock	3B4d	Manure manAGement - Goats		NE	0.002	NA	0.036	0.000	0.001	0.002	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	16	*Population size (1000*
K_AGriLivestock	3B4e	Manure manAGement - Horses		NE	0.162	NA	0.795	0.013	0.020	0.045	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	93	*Population size (1000*
K_AGriLivestock	3B4f	Manure manAGement - Mules and asses		NE	0.008	NA	0.047	0.001	0.001	0.003	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9	*Population size (1000*
K_AGriLivestock	3B4gi	Manure mangement - Laying hens		NE	0.467	NA	0.672	0.065	0.336	0.336	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3268	*Population size (1000*
K_AGriLivestock	3B4gii	Manure mangement - Broilers		NE	1.163	NA	0.522	0.097	0.743	0.743	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10764	*Population size (1000*
K_AGriLivestock	3B4giii	Manure mangement - Turkeys		NE	0.550	NA	0.385	0.079	0.585	0.585	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1125	*Population size (1000*
K_AGriLivestock	3B4giv	Manure manAGement - Other poultry		NE	0.133	NA	0.060	0.006	0.039	0.039	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	272	*Population size (1000*
K_AGriLivestock	3B4h	Manure manAGement - Other animals (please specify in IIR)		NO	0.384	NA	0.403	0.001	0.002	0.004	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	199	*Population size (1000*
L_AGriOther	3Da1	Inorganic N-fertilizers (includes also urea application)		NE	3.376	NA	9.160	0.236	6.124	6.124	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	330959000	*Use of inorganic*
L_AGriOther	3Da2a	Animal manure applied to soils		NE	NE	NA	28.648	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3Da2b	SewAGe sludge applied to soils		NE	NE	NA	0.567	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3Da2c	Other organic fertilisers applied to soils (including compost)		NE	NE	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3Da3	Urine and dung deposited by grazing animals		NE	NE	NA	13.002	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3Da4	Crop residues applied to soils		NE	NE	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3Db	Indirect emissions from manAGed soils		NE	NE	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3Dc	Farm-level AGricultural operations including storAGe, handling and transport of AGricultural products		NA	NA	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3Dd	Off-farm storAGe, handling and transport of bulk AGricultural products		NA	NA	NA	NE	0.011	0.066	0.263	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3De	Cultivated crops	(b)	NE	NE	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3Df	Use of pesticides		NE	NE	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.151	NA	NA	NA	NA	NA	NA	NE	
L_AGriOther	3F	Field burning of AGricultural residues		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NE	*Area burned [k ha/yr]*
L_AGriOther	3I	AGriculture other (please specify in the IIR)		NO	NO	NO	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	*NA*

Annex A.1 Annex 1Table (contd.)

J_Waste	5A	Biological treatment of waste - Solid waste disposal on land		NA	0.469	NA	NA	0.000	0.000	0.000	NE	NA	NA	NA	0.021	NA	NA	NA	NA	NA	NA	0.076	NA	NA	NA	NA	NA	NA	0.047	NA	NA	NA	NA	NA	639	*Annual deposition of MSW at the SWDS [kt]*
J_Waste	5B1	Biological treatment of waste - Composting		NA	NE	NA	0.027	NE	NE	NE	NE	0.034	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
J_Waste	5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities		NA	NO	NA	NO	NE	NE	NE	NE	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	
J_Waste	5C1a	Municipal waste incineration	(c)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	IE	NA	IE	IE	NO	*MSW incinerated [kt]*
J_Waste	5C1bi	Industrial waste incineration	(c)	0.012	0.098	0.001	NE	0.000	0.000	0.000	0.000	0.001	0.017	0.001	0.001	0.641	0.619	0.342	0.002	NO	NE	0.003	0.000	0.000	0.000	NE	0.000	0.007	0.010	NA	NA	NA	NA	NA	13	*Waste incinerated [kt]*
J_Waste	5C1bii	Hazardous waste incineration	(c)	IE	IE	IE	NE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	NA	IE	NA	IE	IE	IE	*Waste incinerated [kt]*
J_Waste	5C1biii	Clinical waste incineration	(c)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NO	*Waste incinerated [kt]*
J_Waste	5C1biv	Sewage sludge incineration	(c)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	IE	IE	IE	IE	IE	IE	IE	IE	NA	NA	NA	NA	NA	NO	
J_Waste	5C1bv	Cremation	(c)	0.004	0.000	0.001	NE	0.000	0.000	0.000	NE	0.001	0.000	0.000	0.007	0.000	0.000	0.000	0.000	NO	NO	0.000	0.000	NE	NE	0.000	0.000	0.001	NE	NA	NA	NA	NA	NA	4868	*Incineration of corpses [Number]*
J_Waste	5C1bvi	Other waste incineration (please specify in the IIR)	(c)	NO	NO	NO	NO	NA	NA	NA	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	
J_Waste	5C2	Open burning of waste		NE	NE	NE	NE	NE	NE	NE	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.494	0.000	0.001	0.001	NE	0.001	NE	0.841	NA	NA	NA	NA	NA	NE	
J_Waste	5D1	Domestic wastewater handling		NA	NA	NA	NE	NE	NE	NE	NE	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NE	*Total organic product [Gg DC/yr]*
J_Waste	5D2	Industrial wastewater handling		NA	NA	NA	NE	NE	NE	NE	NE	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	*Total organic product [Gg DC/yr]*
J_Waste	5D3	Other wastewater handling		NA	NA	NA	NE	NE	NE	NE	NE	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	*Total organic product [Gg DC/yr]*
J_Waste	5E	Other waste (please specify in IIR)	(d)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	6.476	0.013	0.016	0.006	0.001	0.035	NE	7.732	NA	NA	NA	NA	NA	NE	*Please specify*
M_Other	6A	Other (included in national total for entire territory) (please specify in IIR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	*NA*
	NATIONAL TOTAL	**National total for the entire territory (based on fuel sold)**		79.544	101.341	17.633	108.129	13.908	23.903	29.728	2.241	109.129	13.268	0.272	0.354	1.247	2.120	18.587	1.712	1.736	20.231	26.517	4.431	6.665	2.556	2.182	15.834	1.679	17.022	########	91973.86	157988.17	8755.76	1038.76	NA	*NA*
	ADJUSTMENTS (Net total)	Sum of adjustments (negative value) from Annex VII		-12.374	-59.607																															*NA*
	NATIONAL TOTAL FOR COMPLIANCE	**National total for compliance assessment (please specify all details in the IIR)**	(e)	61.085	41.483	17.626	108.096	13.334	23.014	28.012	1.846	106.824	13.137	0.272	0.354	1.247	2.120	18.587	1.712	1.736	20.233	26.264	4.431	6.650	2.543	2.171	15.795	1.673	17.022							*NA*
'MEMO' ITEMS - NOT TO BE INCLUDED IN NATIONAL TOTALS																																				
O_AviCruise	1A3ai(ii)	International aviation cruise (civil)		3.158	0.095	0.711	NE	0.143	0.143	0.143	0.069	0.379	0.003	0.000	0.004	0.001	0.006	0.007	0.000	0.003	0.916	NE	NE	NE	NE	NE	NE	NE	NE	31582	NA	NA	NA	NA	NA	*TJ NCV*
O_AviCruise	1A3aii(ii)	Domestic aviation cruise (civil)		0.024	0.000	0.002	NE	0.001	0.001	0.001	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	NE	NE	NE	NE	NE	NE	NE	NE	74.3631	NA	NA	NA	NA	NA	*TJ NCV*
P_IntShipping	1A3di(i)	International maritime navigation		12.175	0.432	0.507	NE	0.275	0.297	0.297	0.076	1.147	0.010	0.010	0.003	0.010	0.011	0.052	0.755	0.043	0.056	0.201	0.001	0.003	0.001	0.001	0.006	NE	0.155	6682.298	NA	NA	NA	NA	NA	*TJ NCV*
z_Memo	1A5c	Multilateral operations		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	
z_Memo	1A3	Transport (fuel used)		39.820	5.605	0.247	0.838	1.563	1.974	1.977	0.795	54.311	9.634	0.043	0.024	0.003	0.675	16.898	0.399	0.054	8.148	1.424	0.072	0.082	0.068	0.059	0.282	NE	0.003	NE	NA	NA	NA	NA	NA	
z_Memo	6B	Other not included in national total of the entire territory (please specify in the IIR)		NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*NA*
N_Natural	11A	Volcanoes		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	*Please specify*
N_Natural	11B	Forest fires		NE	NE	NE	NE	NO	NO	NO	NO	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.097	0.140	0.091	0.045	0.052	0.328	NE	0.006	NA	NA	NA	NA	NA	NA	*Area of forest burned [ha]*
N_Natural	11C	Other natural emissions (please specify in the IIR)		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA	

(a) For example, fugitive emissions from the production of geothermal power could be reported here.
(b) Does not include emissions from application of fertiliser and manure (reported under 3D). NH_3 emissions from crops should be reported here.
(c) Excludes waste incineration for energy (this is included in 1A1) and in industry (if used as fuel).
(d) Includes accidental fires.

(e) The 'National Total for Compliance' includes any aggregated combination of i) adjustments to national totals; ii) national totals based on transport fuel used; iii) territory declared upon ratification of the relevant Protocol of the Convention.

Member States of the European Union may also use this line for reporting national totals for compliance purposes under the National Emission Ceilings Directive (NECD) if these differ from the main National Total. MS should consult the definitions of geographical coverage in the NECD to determine what should be included within the NECD National Total.

Annex A.2 Table 1: Key Category Analysis for Nitrogen Oxides

Level Assessment

NFR	NOx (kt)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	79.5445			
1A3bi	15.7590	19.81%	19.81%	x
1A3biii	14.9677	18.82%	38.63%	x
1A1a	9.4762	11.91%	50.54%	x
1A2f	6.8756	8.64%	59.19%	x
1A3bii	6.7449	8.48%	67.66%	x
1A3dii	5.4261	6.82%	74.49%	x
1A4bi	4.9854	6.27%	80.75%	x
1A4cii	2.7746	3.49%	84.24%	
1A4ai	2.3689	2.98%	87.22%	
1A3c	1.8141	2.28%	89.50%	
1A4ciii	1.5933	2.00%	91.50%	
1A2gviii	1.3860	1.74%	93.25%	
1A2e	1.3201	1.66%	94.91%	
1A3ai(i)	1.0180	1.28%	96.18%	
1A2b	0.9749	1.23%	97.41%	
1B2aiv	0.8015	1.01%	98.42%	
1A1b	0.5410	0.68%	99.10%	
1A2c	0.3722	0.47%	99.57%	
1A3ei	0.1194	0.15%	99.72%	
1A1c	0.0655	0.08%	99.80%	
1A4ci	0.0635	0.08%	99.88%	
1A3biv	0.0351	0.04%	99.92%	
1A2d	0.0215	0.03%	99.95%	
1A3aii(i)	0.0214	0.03%	99.98%	
5C1bi	0.0116	0.01%	99.99%	
5C1bv	0.0040	0.01%	100.00%	
1A2a	0.0031	0.00%	100.00%	

Trend Assessment

NFR	NOx, 1990 (kt)	NOx, 2015 (kt)	Trend (magnitude)	Trend %	% Cumulative	Key Category
1A1a	46.3740	9.4762	0.13011	34.52%	34.52%	x
1A3biii	11.2467	14.9677	0.06170	16.37%	50.89%	x
1A3bi	37.5194	15.7590	0.04570	12.12%	63.01%	x
1A2f	3.3392	6.8756	0.03622	9.61%	72.62%	x
1A3dii	2.1355	5.4261	0.03074	8.15%	80.77%	x
1A3bii	5.2129	6.7449	0.02718	7.21%	87.98%	
1A4cii	6.4607	2.7746	0.00742	1.97%	89.95%	
1A2gviii	1.1327	1.3860	0.00532	1.41%	91.37%	
1A4bi	7.3822	4.9854	0.00488	1.29%	92.66%	
1A4ai	3.0603	2.3689	0.00425	1.13%	93.79%	
1B2aiv	0.4330	0.8015	0.00403	1.07%	94.86%	
1A3c	2.1985	1.8141	0.00388	1.03%	95.89%	
1A3ai(i)	0.9358	1.0180	0.00346	0.92%	96.80%	
1A2e	1.5126	1.3201	0.00320	0.85%	97.65%	
1A4ciii	2.1497	1.5933	0.00246	0.65%	98.31%	
1A1b	0.4668	0.5410	0.00197	0.52%	98.83%	
1A2b	2.0331	0.9749	0.00159	0.42%	99.25%	
1A2a	0.2886	0.0031	0.00122	0.32%	99.57%	
1A3ei	0.0542	0.1194	0.00065	0.17%	99.74%	
1A3aii(i)	0.1108	0.0214	0.00032	0.08%	99.83%	
1A2c	0.5840	0.3722	0.00022	0.06%	99.89%	
1A3biv	0.0214	0.0351	0.00017	0.04%	99.93%	
1A1c	0.0810	0.0655	0.00013	0.04%	99.97%	
1A4ci	0.0901	0.0635	0.00008	0.02%	99.99%	
5C1bv	0.0012	0.0040	0.00002	0.01%	99.99%	
5C1bi	0.0236	0.0116	0.00002	0.00%	100.00%	
1A2d	0.0377	0.0215	0.00000	0.00%	100.00%	
National Total	135.8550	79.5445	0.00000	0.00%	100.00%	

Annex A.2 Table 2: Key Category Analysis for Sulphur Dioxide

Level Assessment

NFR	SO2 (kt)	% Contribution Level	% Cumulative	Key Category
National Total	17.633			
1A4bi	6.741	38.23%	38.23%	x
1A1a	5.203	29.51%	67.74%	x
1B2aiv	2.071	11.74%	79.48%	x
1A2f	1.089	6.18%	85.66%	x
1A2e	0.942	5.34%	91.00%	
1A1b	0.574	3.25%	94.26%	
1A4ai	0.251	1.43%	95.68%	
1A1c	0.197	1.11%	96.80%	
1A2gviii	0.148	0.84%	97.63%	
1A3dii	0.097	0.55%	98.18%	
1A3ai(i)	0.084	0.48%	98.66%	
1A2c	0.058	0.33%	98.99%	
1A2b	0.053	0.30%	99.29%	
1A3bi	0.029	0.16%	99.45%	
1A3c	0.024	0.14%	99.59%	
1A4cii	0.022	0.12%	99.71%	
1A4ciii	0.014	0.08%	99.79%	
1A4ci	0.010	0.06%	99.85%	
1A3biii	0.009	0.05%	99.90%	
1A3bii	0.009	0.05%	99.95%	
1A2d	0.005	0.03%	99.98%	
1A3aii(i)	0.002	0.01%	99.99%	
5C1bi	0.001	0.00%	100.00%	
5C1bv	0.001	0.00%	100.00%	
1A3ei	0.000	0.00%	100.00%	
1A3biv	0.000	0.00%	100.00%	
1A2a	0.000	0.00%	100.00%	

Trend Assessment

NFR	SO2, 1990 (kt)	SO2, 2015 (kt)	Trend (magnitude)	Trend %	% Cumulative	Key Category
1A1a	103.0440	5.2030	0.02523	28.82%	28.82%	x
1A4bi	26.7591	6.7410	0.02268	25.91%	54.74%	x
1B2aiv	1.1186	2.0705	0.01065	12.17%	66.91%	x
1A2b	15.9561	0.0532	0.00799	9.13%	76.03%	x
1A2f	2.0097	1.0895	0.00487	5.56%	81.59%	x
1A4ai	11.6043	0.2513	0.00466	5.32%	86.91%	
1A1b	0.7531	0.5738	0.00272	3.11%	90.02%	
1A2e	7.0091	0.9423	0.00148	1.69%	91.71%	
1A2gviii	4.3854	0.1479	0.00147	1.68%	93.39%	
1A3bi	2.3878	0.0286	0.00108	1.24%	94.63%	
1A1c	0.2430	0.1965	0.00094	1.07%	95.70%	
1A3biii	1.5371	0.0094	0.00075	0.85%	96.55%	
1A2c	1.9811	0.0580	0.00071	0.81%	97.37%	
1A3bii	1.4566	0.0089	0.00071	0.81%	98.18%	
1A4cii	1.1220	0.0220	0.00046	0.53%	98.71%	
1A2a	0.8802	0.0000	0.00046	0.52%	99.23%	
1A3ai(i)	0.0769	0.0842	0.00042	0.48%	99.70%	
1A2d	0.3389	0.0052	0.00015	0.17%	99.87%	
1A3dii	1.1607	0.0968	0.00008	0.09%	99.96%	
1A4ci	0.1247	0.0101	0.00001	0.01%	99.97%	
1A4ciii	0.1641	0.0140	0.00001	0.01%	99.98%	
1A3aii(i)	0.0084	0.0016	0.00000	0.00%	99.99%	
5C1bv	0.0002	0.0006	0.00000	0.00%	99.99%	
5C1bi	0.0013	0.0006	0.00000	0.00%	100.00%	
1A3biv	0.0045	0.0001	0.00000	0.00%	100.00%	
1A3c	0.2515	0.0238	0.00000	0.00%	100.00%	
1A3ei	0.0001	0.0002	0.00000	0.00%	100.00%	
National Total	184.3803	17.6329	0.00000	0.00%	100.00%	

Annex A.2 Table 3: Key Category Analysis for Non-Methane Volatile Organic Compounds

Level Assessment

NFR	NMVOC (kt)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTA	101.3412			
3B1b	25.3713	25.04%	25.04%	x
2H2	16.4408	16.22%	41.26%	x
2D3a	10.4806	10.34%	51.60%	x
3B1a	8.7394	8.62%	60.22%	x
1A4bi	8.6781	8.56%	68.79%	x
2D3d	3.6975	3.65%	72.44%	x
3Da1	3.3763	3.33%	75.77%	x
1A3bi	2.8993	2.86%	78.63%	x
3B3	2.3878	2.36%	80.98%	x
1B2av	2.0182	1.99%	82.98%	
2D3e	1.5014	1.48%	84.46%	
2G	1.4802	1.46%	85.92%	
2D3h	1.4617	1.44%	87.36%	
1A3bv	1.4008	1.38%	88.74%	
2D3g	1.3405	1.32%	90.07%	
3B4gii	1.1625	1.15%	91.21%	
1A2gviii	0.7629	0.75%	91.97%	
1A2f	0.7607	0.75%	92.72%	
1B2aiv	0.6679	0.66%	93.38%	
1A2e	0.6637	0.65%	94.03%	
1A2b	0.5793	0.57%	94.60%	
3B4giii	0.5500	0.54%	95.14%	
1A4ai	0.5171	0.51%	95.66%	
1A3biii	0.4864	0.48%	96.14%	
5A	0.4692	0.46%	96.60%	
3B4gi	0.4665	0.46%	97.06%	
3B4h	0.3837	0.38%	97.44%	
1A3bii	0.3702	0.37%	97.80%	
3B2	0.3404	0.34%	98.14%	
1A1a	0.2573	0.25%	98.39%	
1A4cii	0.2068	0.20%	98.60%	
1A3biv	0.1991	0.20%	98.79%	
1A3dii	0.1935	0.19%	98.98%	
3B4e	0.1616	0.16%	99.14%	
1A3c	0.1610	0.16%	99.30%	
1A3ai(i)	0.1407	0.14%	99.44%	
3B4giv	0.1330	0.13%	99.57%	
5C1bi	0.0984	0.10%	99.67%	
1A2c	0.0944	0.09%	99.76%	
1A1c	0.0655	0.06%	99.83%	
1A4ciii	0.0568	0.06%	99.88%	
2D3f	0.0441	0.04%	99.93%	
2D3b	0.0304	0.03%	99.96%	
1A1b	0.0163	0.02%	99.97%	
3B4f	0.0084	0.01%	99.98%	
1A4ci	0.0063	0.01%	99.99%	
1A2d	0.0045	0.00%	99.99%	
1A3ei	0.0040	0.00%	100.00%	
3B4d	0.0021	0.00%	100.00%	
1A3aii(i)	0.0013	0.00%	100.00%	
1A2a	0.0010	0.00%	100.00%	
5C1bv	0.0001	0.00%	100.00%	

Trend Assessment

NFR	NMVOC, 1990 (kt)	NMVOC, 2015 (kt)	Trend (magnitude)	Trend %	% Cumulative	Key Category
1A3bi	24.4059	2.8993	0.10168	21.15%	21.15%	x
1A4bi	28.5180	8.6781	0.08165	16.98%	38.13%	x
2H2	9.0331	16.4408	0.07032	14.63%	52.76%	x
3B1b	22.3204	25.3713	0.06661	13.85%	66.61%	x
2D3a	7.9266	10.4806	0.03398	7.07%	73.68%	x
1A3bv	8.0597	1.4008	0.03046	6.34%	80.02%	x
3B1a	9.1646	8.7394	0.01556	3.24%	83.26%	
3B3	1.0181	2.3878	0.01168	2.43%	85.69%	
3Da1	3.3614	3.3763	0.00691	1.44%	87.12%	
2D3g	3.0231	1.3405	0.00570	1.19%	88.31%	
1B2av	1.7699	2.0182	0.00533	1.11%	89.42%	
1A4cii	1.1928	0.2068	0.00451	0.94%	90.35%	
2D3h	2.9120	1.4617	0.00429	0.89%	91.25%	
2D3d	6.0469	3.6975	0.00426	0.89%	92.13%	
3B4gii	0.8678	1.1625	0.00383	0.80%	92.93%	
1A2gviii	0.3312	0.7629	0.00370	0.77%	93.70%	
1A2b	0.1239	0.5793	0.00345	0.72%	94.42%	
1A3bii	1.1416	0.3702	0.00311	0.65%	95.07%	
1A2f	0.4484	0.7607	0.00310	0.65%	95.71%	
1B2aiv	0.3608	0.6679	0.00289	0.60%	96.31%	
1A2e	0.4578	0.6637	0.00237	0.49%	96.80%	
2D3e	1.7435	1.5014	0.00183	0.38%	97.18%	
3B4gi	0.3083	0.4665	0.00174	0.36%	97.55%	
2G	1.7937	1.4802	0.00143	0.30%	97.84%	
1A4ai	0.4736	0.5171	0.00126	0.26%	98.11%	
2D3f	0.2818	0.0441	0.00110	0.23%	98.33%	
1A3biii	0.8969	0.4864	0.00107	0.22%	98.56%	
1A3dii	0.0736	0.1935	0.00099	0.21%	98.76%	
5A	0.8341	0.4692	0.00088	0.18%	98.94%	
1A1a	0.1935	0.2573	0.00084	0.17%	99.12%	
1A2a	0.1313	0.0010	0.00065	0.14%	99.25%	
3B4h	0.4101	0.3837	0.00064	0.13%	99.39%	
1A3biv	0.1516	0.1991	0.00064	0.13%	99.52%	
3B4e	0.1069	0.1616	0.00060	0.12%	99.65%	
3B2	0.5606	0.3404	0.00041	0.09%	99.73%	
5C1bi	0.2004	0.0984	0.00031	0.06%	99.80%	
1A2c	0.1740	0.0944	0.00021	0.04%	99.84%	
3B4giii	0.7381	0.5500	0.00017	0.04%	99.88%	
1A3c	0.1951	0.1610	0.00016	0.03%	99.91%	
1A3ai(i)	0.1763	0.1407	0.00011	0.02%	99.93%	
1A1b	0.0065	0.0163	0.00008	0.02%	99.95%	
3B4giv	0.1757	0.1330	0.00006	0.01%	99.96%	
1A1c	0.0810	0.0655	0.00006	0.01%	99.97%	
2D3b	0.0352	0.0304	0.00004	0.01%	99.98%	
1A3aii(i)	0.0079	0.0013	0.00003	0.01%	99.99%	
3B4f	0.0079	0.0084	0.00002	0.00%	99.99%	
1A3ei	0.0018	0.0040	0.00002	0.00%	99.99%	
1A4ciii	0.0767	0.0568	0.00002	0.00%	100.00%	
1A2d	0.0041	0.0045	0.00001	0.00%	100.00%	
3B4d	0.0024	0.0021	0.00000	0.00%	100.00%	
1A4ci	0.0090	0.0063	0.00000	0.00%	100.00%	
5C1bv	0.0000	0.0001	0.00000	0.00%	100.00%	
NATIONAL TOTAL	142.3584	101.3412	0.00000	0.00%	100.00%	

Annex A.2 Table 4: Key Category Analysis for Ammonia and Carbon Monoxide

Level Assessment

NFR	NH3 (kt)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	108.1285			
3B1b	30.6687	28.36%	28.36%	x
3Da2a	28.6477	26.49%	54.86%	x
3B1a	13.8900	12.85%	67.70%	x
3Da3	13.0020	12.02%	79.73%	x
3Da1	9.1605	8.47%	88.20%	x
3B3	6.8861	6.37%	94.57%	
3B2	1.1339	1.05%	95.62%	
1A3bi	0.8382	0.78%	96.39%	
3B4e	0.7952	0.74%	97.13%	
3B4gi	0.6721	0.62%	97.75%	
3Da2b	0.5670	0.52%	98.27%	
3B4gii	0.5222	0.48%	98.76%	
3B4h	0.4034	0.37%	99.13%	
3B4giii	0.3852	0.36%	99.49%	
1A2gviii	0.1786	0.17%	99.65%	
3B4giv	0.0598	0.06%	99.71%	
1A4bi	0.0589	0.05%	99.76%	
3B4f	0.0471	0.04%	99.80%	
1A2f	0.0444	0.04%	99.85%	
1A2e	0.0416	0.04%	99.88%	
3B4d	0.0363	0.03%	99.92%	
5B1	0.0270	0.02%	99.94%	
1A4ai	0.0259	0.02%	99.97%	
1A3bii	0.0166	0.02%	99.98%	
1A3biii	0.0150	0.01%	100.00%	
1B2aiv	0.0037	0.00%	100.00%	
1A4cii	0.0010	0.00%	100.00%	
1A3biv	0.0003	0.00%	100.00%	
1A3c	0.0002	0.00%	100.00%	

Level Assessment

NFR	CO (kt)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	109.1288			
1A3bi	47.7037	43.71%	43.71%	x
1A4bi	21.3710	19.58%	63.30%	x
1A1a	17.8619	16.37%	79.66%	x
1A2f	4.2671	3.91%	83.57%	x
1A3biii	3.3145	3.04%	86.61%	
1A2gviii	2.2584	2.07%	88.68%	
1A3bii	2.0527	1.88%	90.56%	
1A2e	1.9469	1.78%	92.35%	
1A3ai(i)	1.3832	1.27%	93.61%	
1A3biv	1.2549	1.15%	94.76%	
1A1c	1.1463	1.05%	95.81%	
1A4ai	1.1211	1.03%	96.84%	
1A4cii	1.0354	0.95%	97.79%	
1A2b	0.7370	0.68%	98.47%	
1A3dii	0.5115	0.47%	98.93%	
1A3c	0.3704	0.34%	99.27%	
1B2aiv	0.3006	0.28%	99.55%	
1A4ciii	0.1502	0.14%	99.69%	
1A2c	0.1467	0.13%	99.82%	
1A1b	0.0996	0.09%	99.91%	
5B1	0.0338	0.03%	99.94%	
1A4ci	0.0254	0.02%	99.97%	
1A3aii(i)	0.0129	0.01%	99.98%	
1A3ei	0.0119	0.01%	99.99%	
1A2d	0.0089	0.01%	100.00%	
1A2a	0.0012	0.00%	100.00%	
5C1bi	0.0009	0.00%	100.00%	
5C1bv	0.0007	0.00%	100.00%	

Annex A.2 Table 4: Key Category Analysis for Ammonia and Carbon Monoxide (continued)

Trend Assessment

NFR	NH3, 1990 (kt)	NH3, 2015 (kt)	Trend (magnitude)	Trend %	% Cumulative	Key Category
3Da1	12.9303	9.1605	0.03877	36.39%	36.39%	x
3B1b	27.4203	30.6687	0.02434	22.85%	59.24%	x
3B3	5.8592	6.8861	0.00836	7.84%	67.08%	x
1A3bi	0.0326	0.8382	0.00763	7.16%	74.24%	x
3B2	1.7316	1.1339	0.00607	5.70%	79.94%	x
3Da2b	0.0402	0.5670	0.00498	4.68%	84.61%	x
3B1a	13.8856	13.8900	0.00322	3.02%	87.64%	
3B4e	0.5262	0.7952	0.00243	2.28%	89.92%	
3B4h	0.5709	0.4034	0.00172	1.62%	91.53%	
3Da3	12.8558	13.0020	0.00164	1.54%	93.07%	
3Da2a	27.8070	28.6477	0.00143	1.34%	94.41%	
3B4giii	0.5169	0.3852	0.00137	1.29%	95.70%	
3B4gi	0.5182	0.6721	0.00134	1.25%	96.95%	
3B4gii	0.3985	0.5222	0.00108	1.01%	97.97%	
1A4bi	0.1479	0.0589	0.00088	0.82%	98.79%	
1A2gviii	0.0941	0.1786	0.00078	0.73%	99.52%	
3B4giv	0.0792	0.0598	0.00020	0.19%	99.71%	
1A3bii	0.0038	0.0166	0.00012	0.11%	99.82%	
1A3biii	0.0045	0.0150	0.00010	0.09%	99.92%	
3B4d	0.0405	0.0363	0.00005	0.05%	99.96%	
3B4f	0.0439	0.0471	0.00002	0.02%	99.98%	
1B2aiv	0.0020	0.0037	0.00002	0.01%	99.99%	
1A4cii	0.0013	0.0010	0.00000	0.00%	100.00%	
1A3biv	0.0001	0.0003	0.00000	0.00%	100.00%	
1A3c	0.0003	0.0002	0.00000	0.00%	100.00%	
NATIONAL T	105.5110	108.1285	0.00000	0.00%	100.00%	

Annex A.2 Table 5: Key Category Analysis for Total Suspended Particulates (TSP) and Particulate Matter <10 µm in Diameter (PM_{10})

Level Assessment

NFR	TSP (kt)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTA	29.7276			
1A4bi	8.1412	27.39%	27.39%	x
3Da1	6.1244	20.60%	47.99%	x
3B1b	2.5345	8.53%	56.51%	x
3B1a	2.3933	8.05%	64.56%	x
1A3bvi	1.2938	4.35%	68.92%	x
1A3bvii	1.1007	3.70%	72.62%	x
3B3	0.9808	3.30%	75.92%	x
1A1a	0.8235	2.77%	78.69%	x
1A2f	0.7590	2.55%	81.24%	x
3B4gii	0.7427	2.50%	83.74%	
3B2	0.6769	2.28%	86.02%	
3B4giii	0.5849	1.97%	87.98%	
1A3bi	0.5799	1.95%	89.94%	
1A2gviii	0.4153	1.40%	91.33%	
1A2e	0.3749	1.26%	92.59%	
3B4gi	0.3365	1.13%	93.73%	
1A4ai	0.3102	1.04%	94.77%	
1A3bii	0.2960	1.00%	95.76%	
3Dd	0.2634	0.89%	96.65%	
1A3biii	0.2417	0.81%	97.46%	
2B10b	0.1395	0.47%	97.93%	
1A4cii	0.1057	0.36%	98.29%	
1A3dii	0.1037	0.35%	98.64%	
1A1c	0.0786	0.26%	98.90%	
1B2aiv	0.0534	0.18%	99.08%	
1A3c	0.0526	0.18%	99.26%	
3B4e	0.0447	0.15%	99.41%	
3B4giv	0.0388	0.13%	99.54%	
1A4ciii	0.0304	0.10%	99.64%	
1A2b	0.0244	0.08%	99.72%	
1A2c	0.0230	0.08%	99.80%	
1A3ai(i)	0.0181	0.06%	99.86%	
1A4ci	0.0175	0.06%	99.92%	
1A1b	0.0057	0.02%	99.94%	
1A3biv	0.0050	0.02%	99.96%	
3B4h	0.0036	0.01%	99.97%	
3B4f	0.0030	0.01%	99.98%	
1A2d	0.0022	0.01%	99.99%	
3B4d	0.0022	0.01%	99.99%	
1A3aii(i)	0.0007	0.00%	100.00%	
1A3ei	0.0005	0.00%	100.00%	
5A	0.0003	0.00%	100.00%	
5C1bv	0.0002	0.00%	100.00%	
5C1bi	0.0001	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	

Level Assessment

NFR	PM10 (kt)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	23.90291			
1A4bi	7.43511	31.11%	31.11%	x
3Da1	6.12440	25.62%	56.73%	x
3B1b	1.16303	4.87%	61.59%	x
3B1a	1.09842	4.60%	66.19%	x
1A3bvi	1.01758	4.26%	70.45%	x
3B4gii	0.74274	3.11%	73.55%	x
1A2f	0.72593	3.04%	76.59%	x
1A1a	0.67635	2.83%	79.42%	x
3B4giii	0.58492	2.45%	81.87%	x
1A3bi	0.57993	2.43%	84.29%	
1A3bvii	0.55033	2.30%	86.60%	
3B3	0.43546	1.82%	88.42%	
1A2gviii	0.39756	1.66%	90.08%	
1A2e	0.36030	1.51%	91.59%	
3B4gi	0.33648	1.41%	93.00%	
1A3bii	0.29602	1.24%	94.23%	
3B2	0.27075	1.13%	95.37%	
1A4ai	0.24963	1.04%	96.41%	
1A3biii	0.24172	1.01%	97.42%	
1A4cii	0.10566	0.44%	97.86%	
1A3dii	0.10368	0.43%	98.30%	
3Dd	0.06585	0.28%	98.57%	
1A3c	0.04985	0.21%	98.78%	
2B10b	0.04465	0.19%	98.97%	
3B4giv	0.03883	0.16%	99.13%	
1B2aiv	0.03306	0.14%	99.27%	
1A4ciii	0.03045	0.13%	99.40%	
1A1c	0.02620	0.11%	99.51%	
1A2b	0.02440	0.10%	99.61%	
1A2c	0.02300	0.10%	99.70%	
3B4e	0.02048	0.09%	99.79%	
1A3ai(i)	0.01812	0.08%	99.87%	
1A4ci	0.01365	0.06%	99.92%	
1A1b	0.00565	0.02%	99.95%	
1A3biv	0.00497	0.02%	99.97%	
1A2d	0.00223	0.01%	99.98%	
3B4h	0.00160	0.01%	99.98%	
3B4f	0.00142	0.01%	99.99%	
3B4d	0.00087	0.00%	99.99%	
1A3aii(i)	0.00071	0.00%	100.00%	
1A3ei	0.00050	0.00%	100.00%	
5A	0.00014	0.00%	100.00%	
5C1bv	0.00013	0.00%	100.00%	
5C1bi	0.00009	0.00%	100.00%	
1A2a	0.00003	0.00%	100.00%	

Annex A.2 Table 6: Key Category Analysis for Particulate Matter <2.5 µm in Diameter ($PM_{2.5}$)

Level Assessment

NFR	PM2.5 (kt)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	13.9083			
1A4bi	7.3212	52.64%	52.64%	x
3B1b	0.7642	5.49%	58.13%	x
3B1a	0.7154	5.14%	63.28%	x
1A2f	0.6906	4.97%	68.24%	x
1A3bi	0.5799	4.17%	72.41%	x
1A3bvi	0.5536	3.98%	76.39%	x
1A1a	0.4385	3.15%	79.55%	x
1A2gviii	0.3895	2.80%	82.35%	x
1A2e	0.3483	2.50%	84.85%	
1A3bvii	0.2972	2.14%	86.99%	
1A3bii	0.2960	2.13%	89.12%	
1A3biii	0.2417	1.74%	90.85%	
3Da1	0.2356	1.69%	92.55%	
1A4ai	0.1996	1.44%	93.98%	
1A4cii	0.1050	0.76%	94.74%	
3B4gii	0.0969	0.70%	95.43%	
1A3dii	0.0968	0.70%	96.13%	
3B3	0.0830	0.60%	96.73%	
3B2	0.0813	0.58%	97.31%	
3B4giii	0.0787	0.57%	97.88%	
3B4gi	0.0650	0.47%	98.35%	
1A3c	0.0474	0.34%	98.69%	
1A4ciii	0.0284	0.20%	98.89%	
1A2b	0.0244	0.18%	99.07%	
1A2c	0.0230	0.17%	99.23%	
1A3ai(i)	0.0181	0.13%	99.36%	
1B2aiv	0.0144	0.10%	99.46%	
1A1c	0.0131	0.09%	99.56%	
3B4e	0.0130	0.09%	99.65%	
3Dd	0.0105	0.08%	99.73%	
1A4ci	0.0105	0.08%	99.80%	
1A1b	0.0056	0.04%	99.84%	
2B10b	0.0056	0.04%	99.88%	
3B4giv	0.0055	0.04%	99.92%	
1A3biv	0.0050	0.04%	99.96%	
1A2d	0.0022	0.02%	99.98%	
3B4f	0.0009	0.01%	99.98%	
3B4h	0.0008	0.01%	99.99%	
1A3aii(i)	0.0007	0.01%	99.99%	
1A3ei	0.0005	0.00%	100.00%	
3B4d	0.0003	0.00%	100.00%	
5C1bv	0.0001	0.00%	100.00%	
5C1bi	0.0001	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	
5A	0.0000			

Trend Assessment

NFR	PM2.5 1990 (kt)	PM2.5 2015 (kt)	Trend (magnitude)	Trend %	% Cumulative	Key Category
1A4bi	23.9201	7.3212	0.08887	41.05%	41.05%	x
1A2f	0.4980	0.6906	0.01468	6.78%	47.83%	x
1A3bvi	0.2136	0.5536	0.01420	6.56%	54.39%	x
3B1a	0.6895	0.7154	0.01292	5.97%	60.36%	x
3B1b	0.8193	0.7642	0.01272	5.88%	66.23%	x
1A3bi	0.5242	0.5799	0.01093	5.05%	71.29%	x
1A2gviii	0.2607	0.3895	0.00854	3.95%	75.23%	x
1A3bvii	0.1152	0.2972	0.00761	3.52%	78.75%	x
1A4cii	0.8015	0.1050	0.00729	3.37%	82.11%	x
1A3bii	1.1302	0.2960	0.00573	2.65%	84.76%	
1A1a	0.6458	0.4385	0.00500	2.31%	87.07%	
1A2e	0.4513	0.3483	0.00478	2.21%	89.27%	
3Da1	0.2345	0.2356	0.00416	1.92%	91.19%	
1A3biii	0.4102	0.2417	0.00204	0.94%	92.14%	
3B4gii	0.0723	0.0969	0.00203	0.94%	93.07%	
1A2b	0.2040	0.0244	0.00193	0.89%	93.96%	
1A2a	0.1328	0.0000	0.00174	0.80%	94.77%	
3B3	0.0694	0.0830	0.00164	0.76%	95.52%	
3B4gi	0.0430	0.0650	0.00143	0.66%	96.19%	
1A3dii	0.1218	0.0968	0.00137	0.63%	96.82%	
1A4ai	0.5621	0.1996	0.00124	0.57%	97.39%	
3B4giii	0.1057	0.0787	0.00103	0.48%	97.87%	
1A2c	0.1176	0.0230	0.00084	0.39%	98.26%	
3B2	0.1340	0.0813	0.00074	0.34%	98.60%	
1A3c	0.0575	0.0474	0.00070	0.32%	98.92%	
1A4ciii	0.0383	0.0284	0.00037	0.17%	99.10%	
1A3ai(i)	0.0150	0.0181	0.00036	0.17%	99.26%	
1B2aiv	0.0078	0.0144	0.00034	0.16%	99.42%	
3B4e	0.0086	0.0130	0.00029	0.13%	99.55%	
3Dd	0.0079	0.0105	0.00022	0.10%	99.65%	
1A1c	0.0162	0.0131	0.00019	0.09%	99.74%	
1A4ci	0.0149	0.0105	0.00013	0.06%	99.80%	
1A3biv	0.0030	0.0050	0.00011	0.05%	99.85%	
1A1b	0.0067	0.0056	0.00008	0.04%	99.89%	
2B10b	0.0072	0.0056	0.00008	0.04%	99.93%	
3B4giv	0.0073	0.0055	0.00007	0.03%	99.96%	
1A2d	0.0073	0.0022	0.00003	0.01%	99.97%	
3B4f	0.0008	0.0009	0.00002	0.01%	99.98%	
3B4h	0.0009	0.0008	0.00001	0.01%	99.99%	
1A3ei	0.0002	0.0005	0.00001	0.01%	99.99%	
1A3aii(i)	0.0026	0.0007	0.00001	0.01%	100.00%	
3B4d	0.0003	0.0003	0.00000	0.00%	100.00%	
5C1bv	0.0000	0.0001	0.00000	0.00%	100.00%	
5C1bi	0.0001	0.0001	0.00000	0.00%	100.00%	
5A	0.0001	0.0000	0.00000	0.00%	100.00%	
NATIONAL T	32.5669	13.9083	0.00000	0.00%	100.00%	

Annex A.2 Table 7: Key Category Analysis for Lead and Cadmium

Level Assessment

NFR	Pb (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	13.2684			
1A3bi	8.2433	62.13%	62.13%	x
1A4bi	2.2513	16.97%	79.10%	x
1A3bvi	1.3302	10.03%	89.12%	x
1A1a	0.5392	4.06%	93.18%	
1A2f	0.5047	3.80%	96.99%	
1A2e	0.1545	1.16%	98.15%	
1A2gviii	0.1310	0.99%	99.14%	
1A3biv	0.0337	0.25%	99.39%	
1A4ai	0.0199	0.15%	99.54%	
5C1bi	0.0173	0.13%	99.67%	
1A3bii	0.0105	0.08%	99.75%	
1A3dii	0.0090	0.07%	99.82%	
1A1b	0.0081	0.06%	99.88%	
1A3aii(i)	0.0060	0.05%	99.93%	
1A1c	0.0048	0.04%	99.96%	
1A4ciii	0.0026	0.02%	99.98%	
1A3biii	0.0013	0.01%	99.99%	
2C7c	0.0003	0.00%	99.99%	
1A3ai(i)	0.0003	0.00%	100.00%	
5C1bv	0.0001	0.00%	100.00%	
1A2c	0.0001	0.00%	100.00%	
2C2	0.0001	0.00%	100.00%	
1A2d	0.0001	0.00%	100.00%	
1A4ci	0.0001	0.00%	100.00%	
1A2b	0.0000	0.00%	100.00%	
1A3ei	0.0000	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	

Level Assessment

NFR	Cd (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	0.2721			
1A1a	0.0683	25.10%	25.10%	x
1A2gviii	0.0628	23.08%	48.18%	x
1A4bi	0.0432	15.88%	64.06%	x
1A3bi	0.0234	8.60%	72.66%	x
1A2f	0.0220	8.07%	80.74%	x
1A2e	0.0163	5.99%	86.73%	
1A4ai	0.0092	3.37%	90.10%	
1A3biii	0.0064	2.37%	92.47%	
1A3bvi	0.0063	2.32%	94.78%	
1A3bii	0.0061	2.24%	97.02%	
1A1b	0.0032	1.18%	98.20%	
5C1bi	0.0013	0.49%	98.69%	
1A4cii	0.0013	0.49%	99.17%	
1A3dii	0.0007	0.25%	99.42%	
1A1c	0.0006	0.22%	99.64%	
1A3c	0.0003	0.13%	99.77%	
1A4ciii	0.0002	0.07%	99.84%	
2C7c	0.0002	0.07%	99.92%	
2C2	0.0001	0.04%	99.95%	
1A3biv	0.0001	0.02%	99.97%	
5C1bv	0.0000	0.01%	99.98%	
1A3ai(i)	0.0000	0.01%	99.99%	
1A2c	0.0000	0.00%	99.99%	
1A3aii(i)	0.0000	0.00%	100.00%	
1A4ci	0.0000	0.00%	100.00%	
1A2d	0.0000	0.00%	100.00%	
1A2b	0.0000	0.00%	100.00%	
1A3ei	0.0000	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	

Annex A.2 Table 8: Key Category Analysis for Mercury and Arsenic

Level Assessment

NFR	Hg (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	0.3544			
1A1a	0.1116	31.49%	31.49%	x
1A4bi	0.1091	30.78%	62.27%	x
1A2f	0.0297	8.39%	70.67%	x
1A3bi	0.0222	6.27%	76.94%	x
5A	0.0206	5.82%	82.76%	x
1A2b	0.0136	3.83%	86.59%	
1A2e	0.0131	3.71%	90.30%	
1A4ai	0.0111	3.13%	93.43%	
1A2gviii	0.0081	2.28%	95.71%	
5C1bv	0.0073	2.05%	97.76%	
1A2c	0.0021	0.59%	98.35%	
1A3dii	0.0021	0.59%	98.94%	
1A1c	0.0009	0.26%	99.20%	
5C1bi	0.0007	0.21%	99.41%	
1A4ciii	0.0006	0.17%	99.58%	
1A1b	0.0006	0.16%	99.74%	
1A3ai(i)	0.0004	0.13%	99.87%	
1A3ei	0.0002	0.07%	99.94%	
1A2d	0.0001	0.03%	99.97%	
1A4ci	0.0001	0.02%	99.99%	
1A2a	0.0000	0.01%	100.00%	
1A3aii(i)	0.0000	0.00%	100.00%	

Level Assessment

NFR	As (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	1.2469			
5C1bi	0.6410	51.40%	51.40%	x
1A1a	0.5248	42.09%	93.49%	x
1A4bi	0.0459	3.68%	97.17%	
1A2f	0.0146	1.17%	98.34%	
1A2e	0.0049	0.39%	98.73%	
1A1c	0.0047	0.37%	99.11%	
1A3dii	0.0028	0.22%	99.33%	
1A4ai	0.0022	0.18%	99.51%	
1A2gviii	0.0019	0.16%	99.66%	
1A1b	0.0019	0.16%	99.82%	
1A4ciii	0.0008	0.07%	99.88%	
1A3bi	0.0006	0.04%	99.93%	
1A2c	0.0004	0.03%	99.96%	
1A3ei	0.0003	0.02%	99.98%	
1A3ai(i)	0.0001	0.01%	99.99%	
5C1bv	0.0001	0.01%	100.00%	
1A2d	0.0000	0.00%	100.00%	
1A4ci	0.0000	0.00%	100.00%	
1A2b	0.0000	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	
1A3aii(i)	0.0000	0.00%	100.00%	

Annex A.2 Table 9: Key Category Analysis for Chromium and Copper

Level Assessment

NFR	Cr (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	2.1201			
5C1bi	0.6194	29.22%	29.22%	x
1A3bvi	0.4914	23.18%	52.39%	x
1A1a	0.3264	15.40%	67.79%	x
1A4bi	0.2296	10.83%	78.62%	x
1A3bi	0.1152	5.43%	84.06%	x
1A2gviii	0.1117	5.27%	89.32%	
1A2f	0.0765	3.61%	92.93%	
1A2e	0.0392	1.85%	94.78%	
1A3biii	0.0322	1.52%	96.30%	
1A3bii	0.0304	1.43%	97.74%	
1A4ai	0.0183	0.86%	98.60%	
1A1b	0.0123	0.58%	99.18%	
1A4cii	0.0066	0.31%	99.49%	
1A3dii	0.0035	0.16%	99.66%	
1A1c	0.0029	0.14%	99.80%	
1A3c	0.0017	0.08%	99.88%	
1A4ciii	0.0010	0.05%	99.93%	
1A3ai(i)	0.0007	0.04%	99.96%	
1A3biv	0.0003	0.01%	99.97%	
1A2c	0.0002	0.01%	99.99%	
1A4ci	0.0001	0.01%	99.99%	
5C1bv	0.0001	0.00%	100.00%	
1A2b	0.0000	0.00%	100.00%	
1A2d	0.0000	0.00%	100.00%	
1A3aii(i)	0.0000	0.00%	100.00%	
1A3ei	0.0000	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	

Level Assessment

NFR	Cu (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	18.5868			
1A3bvi	10.7466	57.82%	57.82%	x
1A3bi	3.8932	20.95%	78.76%	x
1A3biii	1.0957	5.90%	84.66%	x
1A3bii	1.0341	5.56%	90.22%	
1A1a	0.5649	3.04%	93.26%	
1A4bi	0.3930	2.11%	95.38%	
5C1bi	0.3417	1.84%	97.22%	
1A4cii	0.2243	1.21%	98.42%	
1A2f	0.0704	0.38%	98.80%	
1A3dii	0.0608	0.33%	99.13%	
1A3c	0.0589	0.32%	99.44%	
1A2gviii	0.0296	0.16%	99.60%	
1A2e	0.0238	0.13%	99.73%	
1A4ciii	0.0179	0.10%	99.83%	
1A1b	0.0100	0.05%	99.88%	
1A3biv	0.0090	0.05%	99.93%	
1A4ai	0.0065	0.03%	99.97%	
1A1c	0.0051	0.03%	99.99%	
1A3ai(i)	0.0008	0.00%	100.00%	
1A2c	0.0002	0.00%	100.00%	
1A4ci	0.0001	0.00%	100.00%	
5C1bv	0.0001	0.00%	100.00%	
1A2b	0.0001	0.00%	100.00%	
1A3aii(i)	0.0000	0.00%	100.00%	
1A2d	0.0000	0.00%	100.00%	
1A3ei	0.0000	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	

Annex A.2 Table 10: Key Category Analysis for Nickel and Selenium

Level Assessment

NFR	Ni (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTA	1.7125			
1A1a	0.9690	56.58%	56.58%	x
1A4bi	0.2192	12.80%	69.39%	x
1A3bi	0.1608	9.39%	78.78%	x
1A3bvi	0.0787	4.59%	83.37%	x
1A3dii	0.0691	4.04%	87.41%	
1A2f	0.0482	2.82%	90.23%	
1A3biii	0.0451	2.63%	92.86%	
1A3bii	0.0426	2.49%	95.35%	
1A4ciii	0.0203	1.19%	96.53%	
1A1b	0.0161	0.94%	97.48%	
1A2e	0.0144	0.84%	98.32%	
1A2gviii	0.0098	0.57%	98.89%	
1A4cii	0.0092	0.54%	99.43%	
1A1c	0.0032	0.19%	99.62%	
1A3c	0.0024	0.14%	99.76%	
5C1bi	0.0019	0.11%	99.87%	
1A4ai	0.0017	0.10%	99.97%	
1A3biv	0.0004	0.02%	99.99%	
5C1bv	0.0001	0.00%	99.99%	
1A2c	0.0001	0.00%	100.00%	
1A3ai(i)	0.0000	0.00%	100.00%	
1A3aii(i)	0.0000	0.00%	100.00%	
1A2d	0.0000	0.00%	100.00%	
1A4ci	0.0000	0.00%	100.00%	
1A2b	0.0000	0.00%	100.00%	
1A3ei	0.0000	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	

Level Assessment

NFR	Se (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	1.7357			
1A1a	1.6259	93.67%	93.67%	x
1A3bi	0.0229	1.32%	94.99%	
1A4bi	0.0181	1.04%	96.03%	
1A1c	0.0151	0.87%	96.90%	
1A3bvi	0.0111	0.64%	97.54%	
1A2f	0.0078	0.45%	97.99%	
1A3dii	0.0069	0.40%	98.39%	
1A3biii	0.0064	0.37%	98.76%	
1A3bii	0.0061	0.35%	99.11%	
1A2gviii	0.0032	0.19%	99.29%	
1A2e	0.0032	0.18%	99.48%	
1A4ai	0.0025	0.14%	99.62%	
1A4ciii	0.0020	0.12%	99.74%	
1A1b	0.0019	0.11%	99.85%	
1A4cii	0.0013	0.08%	99.93%	
1A3ai(i)	0.0004	0.02%	99.95%	
1A3c	0.0003	0.02%	99.97%	
1A2c	0.0003	0.02%	99.99%	
1A4ci	0.0001	0.00%	99.99%	
1A3biv	0.0001	0.00%	100.00%	
1A3ei	0.0000	0.00%	100.00%	
1A2b	0.0000	0.00%	100.00%	
1A2d	0.0000	0.00%	100.00%	
1A3aii(i)	0.0000	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	

Annex A.2 Table 11: Key Category Analysis for Zinc

Level Assessment

NFR	Zn (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	20.2307			
1A4bi	4.4571	22.03%	22.03%	x
1A3bvi	4.3753	21.63%	43.66%	x
1A2gviii	2.5519	12.61%	56.27%	x
1A3bi	2.3904	11.82%	68.09%	x
1A1a	1.5521	7.67%	75.76%	x
1A2f	1.5244	7.54%	83.30%	x
1A2e	0.8836	4.37%	87.66%	
1A4ai	0.6632	3.28%	90.94%	
1A3biii	0.6446	3.19%	94.13%	
1A3bii	0.6084	3.01%	97.14%	
1A4cii	0.1319	0.65%	97.79%	
1A1b	0.1143	0.57%	98.35%	
1A3ai(i)	0.1086	0.54%	98.89%	
1A3dii	0.0829	0.41%	99.30%	
1A3c	0.0346	0.17%	99.47%	
1A2c	0.0319	0.16%	99.63%	
1A4ciii	0.0244	0.12%	99.75%	
1A4ci	0.0184	0.09%	99.84%	
1A1c	0.0124	0.06%	99.90%	
1A2b	0.0070	0.03%	99.94%	
1A3biv	0.0058	0.03%	99.96%	
1A3aii(i)	0.0036	0.02%	99.98%	
1A2d	0.0032	0.02%	100.00%	
2C7c	0.0003	0.00%	100.00%	
2C2	0.0001	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	
1A3ei	0.0000	0.00%	100.00%	

Annex A.2 Table 12: Key Category Analysis for Dioxins and Furans, Polychlorinated Biphenyls and Hexachlorobenzene

Level Assessment

NFR	Dioxin (g I-TEQ)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	26.5167			
1A4bi	14.3136	53.98%	53.98%	x
5E	6.4755	24.42%	78.40%	x
2A1	1.5092	5.69%	84.09%	x
1A3bi	1.1162	4.21%	88.30%	
1A2f	0.8450	3.19%	91.49%	
1A1a	0.5204	1.96%	93.45%	
5C2	0.4945	1.86%	95.32%	
1A3bii	0.3520	1.33%	96.64%	
1A2e	0.3100	1.17%	97.81%	
1A3biii	0.1950	0.74%	98.55%	
1A2gvii	0.1700	0.64%	99.19%	
1A4ai	0.0930	0.35%	99.54%	
5A	0.0756	0.29%	99.82%	
2A6	0.0142	0.05%	99.88%	
1A3dii	0.0090	0.03%	99.91%	
1A1c	0.0066	0.02%	99.94%	
1A3biv	0.0036	0.01%	99.95%	
5C1bi	0.0034	0.01%	99.96%	
1A2c	0.0033	0.01%	99.98%	
1A4ciii	0.0026	0.01%	99.99%	
1A3ei	0.0012	0.00%	99.99%	
1A1b	0.0009	0.00%	99.99%	
1A4ci	0.0009	0.00%	100.00%	
1A2b	0.0004	0.00%	100.00%	
1A2d	0.0003	0.00%	100.00%	
5C1bv	0.0001	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	
2L	0.0000	0.00%	100.00%	

Level Assessment

NFR	PCB (kg)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	17.0221			
5E	7.7320	45.42%	45.42%	x
2A1	4.7357	27.82%	73.24%	x
1A4bi	2.8955	17.01%	90.25%	x
5C2	0.8406	4.94%	95.19%	
1A2f	0.5986	3.52%	98.71%	
1A2e	0.1570	0.92%	99.63%	
5A	0.0473	0.28%	99.91%	
5C1bi	0.0102	0.06%	99.97%	
1A3dii	0.0026	0.02%	99.99%	
1A4ciii	0.0008	0.00%	99.99%	
2L	0.0007	0.00%	99.99%	
1A2gvii	0.0006	0.00%	100.00%	
1A1a	0.0002	0.00%	100.00%	
1A1b	0.0002	0.00%	100.00%	
1A2d	0.0001	0.00%	100.00%	
1A4ai	0.0000	0.00%	100.00%	
1A1c	0.0000	0.00%	100.00%	

Level Assessment

NFR	HCB (kg)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	1.6787			
3Df	1.1507	68.54%	68.54%	x
1A1a	0.4659	27.75%	96.30%	x
1A4bi	0.0173	1.03%	97.33%	
1A2f	0.0082	0.49%	97.82%	
1A2gvii	0.0081	0.48%	98.30%	
5C1bi	0.0066	0.40%	98.69%	
1A2e	0.0062	0.37%	99.06%	
1A3dii	0.0055	0.33%	99.39%	
1A1c	0.0044	0.26%	99.65%	
1A4ai	0.0035	0.21%	99.86%	
1A4ciii	0.0016	0.10%	99.96%	
5C1bv	0.0007	0.04%	100.00%	
1A2d	0.0000	0.00%	100.00%	

Annex A.2 Table 13: Key Category Analysis for Benzo[a]pyrene and Benzo[b]fluoranthene

Level Assessment

NFR	B(a)P (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	4.4308			
1A4bi	4.0051	90.39%	90.39%	x
1A2f	0.1862	4.20%	94.60%	
1A2e	0.0672	1.52%	96.11%	
1A3bi	0.0521	1.17%	97.29%	
1A4ai	0.0386	0.87%	98.16%	
1A2gvii	0.0278	0.63%	98.79%	
1A3bii	0.0153	0.35%	99.13%	
5E	0.0132	0.30%	99.43%	
2A6	0.0099	0.22%	99.65%	
1A2c	0.0046	0.10%	99.76%	
1A4cii	0.0040	0.09%	99.84%	
1A3biii	0.0034	0.08%	99.92%	
1A4ci	0.0012	0.03%	99.95%	
1A3c	0.0010	0.02%	99.97%	
1A2b	0.0006	0.01%	99.99%	
1A2d	0.0003	0.01%	99.99%	
5C2	0.0001	0.00%	100.00%	
1A1a	0.0001	0.00%	100.00%	
1A3biv	0.0001	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	
1A1b	0.0000	0.00%	100.00%	
5C1bi	0.0000	0.00%	100.00%	
1A1c	0.0000	0.00%	100.00%	
5C1bv	0.0000	0.00%	100.00%	

Level Assessment

NFR	B(b)F (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTA	6.6649			
1A4bi	5.7047	85.59%	85.59%	x
1A2f	0.3352	5.03%	90.62%	
1A4ai	0.2108	3.16%	93.79%	
1A2e	0.1585	2.38%	96.16%	
1A2gvii	0.0909	1.36%	97.53%	
1A3bi	0.0584	0.88%	98.40%	
1A2c	0.0257	0.39%	98.79%	
1A3biii	0.0204	0.31%	99.09%	
1A3bii	0.0171	0.26%	99.35%	
5E	0.0156	0.23%	99.59%	
1A4ci	0.0095	0.14%	99.73%	
1A4cii	0.0066	0.10%	99.83%	
1A2b	0.0042	0.06%	99.89%	
1A1a	0.0026	0.04%	99.93%	
1A2d	0.0020	0.03%	99.96%	
1A3c	0.0017	0.03%	99.99%	
5C2	0.0007	0.01%	100.00%	
1A2a	0.0001	0.00%	100.00%	
1A3biv	0.0001	0.00%	100.00%	
1A1c	0.0000	0.00%	100.00%	
5C1bi	0.0000	0.00%	100.00%	
1A1b	0.0000	0.00%	100.00%	

Annex A.2 Table 14: Key Category Analysis for Benzo[k]fluoranthene and Indeno[1,2,3-cd]pyrene

Level Assessment

NFR	B(k)F (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTA	2.5563			
1A4bi	2.2474	87.91%	87.91%	x
1A2f	0.1023	4.00%	91.92%	
1A3bi	0.0454	1.77%	93.69%	
1A2e	0.0440	1.72%	95.41%	
1A4ai	0.0399	1.56%	96.97%	
1A3biii	0.0228	0.89%	97.86%	
1A2gvii	0.0227	0.89%	98.75%	
1A3bii	0.0134	0.53%	99.28%	
1A2c	0.0057	0.22%	99.50%	
5E	0.0056	0.22%	99.72%	
1A1a	0.0026	0.10%	99.82%	
2A6	0.0017	0.06%	99.89%	
1A4ci	0.0011	0.04%	99.93%	
5C2	0.0007	0.03%	99.96%	
1A2b	0.0006	0.03%	99.98%	
1A2d	0.0004	0.01%	100.00%	
1A2a	0.0000	0.00%	100.00%	
1A3biv	0.0000	0.00%	100.00%	
1A1c	0.0000	0.00%	100.00%	
5C1bi	0.0000	0.00%	100.00%	
1A1b	0.0000	0.00%	100.00%	

Level Assessment

NFR	I(123-cd)P (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTA	2.1820			
1A4bi	1.9280	88.36%	88.36%	x
1A2f	0.0814	3.73%	92.09%	
1A3bi	0.0502	2.30%	94.39%	
1A2e	0.0371	1.70%	96.09%	
1A4ai	0.0368	1.69%	97.78%	
1A2gvii	0.0204	0.94%	98.72%	
1A3bii	0.0142	0.65%	99.37%	
1A2c	0.0055	0.25%	99.62%	
1A3biii	0.0052	0.24%	99.86%	
1A4ci	0.0010	0.04%	99.90%	
5E	0.0009	0.04%	99.94%	
1A2b	0.0006	0.03%	99.97%	
1A2d	0.0003	0.01%	99.99%	
1A1a	0.0002	0.01%	99.99%	
1A3biv	0.0001	0.00%	100.00%	
1A2a	0.0000	0.00%	100.00%	
1A1b	0.0000	0.00%	100.00%	
1A1c	0.0000	0.00%	100.00%	
5C1bv	0.0000			

Annex A.2 Table 15: Key Category Analysis for Polycyclic Aromatic Hydrocarbons

Level Assessment

NFR	Total PAH (t)	% Contribution Level	% Cumulative	Key Category
NATIONAL TOTAL	15.8340			
1A4bi	13.8852	87.69%	87.69%	x
1A2f	0.7052	4.45%	92.15%	
1A4ai	0.3260	2.06%	94.21%	
1A2e	0.3068	1.94%	96.14%	
1A3bi	0.2060	1.30%	97.44%	
1A2gvii	0.1618	1.02%	98.47%	
1A3bii	0.0601	0.38%	98.85%	
1A3biii	0.0518	0.33%	99.17%	
1A2c	0.0415	0.26%	99.43%	
5E	0.0353	0.22%	99.66%	
1A4ci	0.0128	0.08%	99.74%	
2A6	0.0116	0.07%	99.81%	
1A4cii	0.0106	0.07%	99.88%	
1A2b	0.0061	0.04%	99.92%	
1A1a	0.0054	0.03%	99.95%	
1A2d	0.0030	0.02%	99.97%	
1A3c	0.0028	0.02%	99.99%	
5C2	0.0015	0.01%	100.00%	
1A3biv	0.0003	0.00%	100.00%	
1A2a	0.0002	0.00%	100.00%	
1A1c	0.0000	0.00%	100.00%	
1A1b	0.0000	0.00%	100.00%	
5C1bi	0.0000	0.00%	100.00%	
5C1bv	0.0000	0.00%	100.00%	

Annex A.2 Table 16: Key Category Analysis for All Pollutants

Pollutant	Key Categories									Total (%)
NO_x	1A3bi 19.81%	1A3biii 18.82%	1A1a 11.91%	1A2f 8.64%	1A3bii 8.48%	1A3dii 6.82%	1A4bi 6.27%			80.75%
CO	1A3bi 43.71%	1A4bi 19.58%	1A1a 16.37%	1A2f 3.91%						83.57%
NMVOC	3B1b 25.04%	2H2 16.22%	2D3a 10.34%	3B1a 8.62%	1A4bi 8.56%	2D3d 3.65%	3Da1 3.33%	1A3bi 2.86%	3B3 2.36%	80.98%
SO_x	1A4bi 38.23%	1A1a 29.51%	1B2aiv 11.74%	1A2f 6.18%						85.66%
NH_3	3B1b 28.36%	3Da2a 26.49%	3B1a 12.85%	3Da3 12.02%	3Da1 8.47%					88.20%
TSP	1A4bi 27.39%	3Da1 20.60%	3B1b 8.53%	3B1a 8.05%	1A3bvi 4.35%	1A3bvii 3.70%	3B3 3.30%	1A1a 2.77%	1A2f 2.55%	81.24%
PM_{10}	1A4bi 31.11%	3Da1 25.62%	3B1b 4.87%	3B1a 4.60%	1A3bvi 4.26%	3B4gii 3.11%	1A2f 3.04%	1A1a 2.83%	3B4giii 2.45%	81.87%
$PM_{2.5}$	1A4bi 52.64%	3B1b 5.49%	3B1a 5.14%	1A2f 4.97%	1A3bi 4.17%	1A3bvi 3.98%	1A1a 3.15%	1A2gviii 2.80%		82.35%
Pb	1A3bi 62.13%	1A4bi 16.97%	1A3bvi 10.03%							89.12%
Cd	1A1a 25.10%	1A2gviii 23.08%	1A4bi 15.88%	1A3bi 8.60%	1A2f 8.07%					80.74%
Hg	1A1a 31.49%	1A4bi 30.78%	1A2f 8.39%	1A3bi 6.27%	5A 5.82%					82.76%
As	5C1bi 51.40%	1A1a 42.09%								93.49%
Cr	5C1bi 29.22%	1A3bvi 23.18%	1A1a 15.40%	1A4bi 10.83%	1A3bi 5.43%					84.06%
Cu	1A3bvi 57.82%	1A3bi 20.95%	1A3biii 5.90%							84.66%
Ni	1A1a 56.58%	1A4bi 12.80%	1A3bi 9.39%	1A3bvi 4.59%						83.37%
Se	1A1a 93.67%									93.67%
Zn	1A4bi 22.03%	1A3bvi 21.63%	1A2gviii 12.61%	1A3bi 11.82%	1A1a 7.67%	1A2f 7.54%				83.30%
PCDD/F	1A4bi 53.98%	5E 24.42%	2A1 5.69%							84.09%
PCBs	5E 45.42%	2A1 27.82%	1A4bi 17.01%							90.25%
HCB	3Df 68.54%	1A1a 27.75%								96.30%
PAHs	1A4bi 87.69%									87.69%
	1 Energy		2 IPPU		3 Agriculture		5 Waste			

Annex

A.3 Fuel Tourism in Road Transport and Nitrogen Oxides Emissions Based on Fuels Used

Introduction

Fuel tourism is the term given to the retail purchase of petrol or diesel in one country that is subsequently used in another country. Because of the significant price differentials between the Republic of Ireland (ROI) and the United Kingdom (primarily due to higher UK Excise Tax) and the proximity of population centres in Northern Ireland, the impact of fuel tourism has been significant in the Republic of Ireland for many years. In regards to the calculation and reporting of transboundary emissions to air that arise from road transport, the reporting protocols under the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the EU National Emission Ceilings Directive provide that a Party can make adjustments to its emission estimates to account for this phenomenon. The following sections outline how the extent of fuel tourism is quantified in Ireland and provides the results for the years 1990−2015.

In the 2017 submission fuel tourism figures were provided by the Department of Communications, Climate Action and Environment (DCCAE). Petrol fuel tourism was estimated at 2.4 per cent of petrol sales in the ROI in 2015.

The customer base for diesel is broader than for petrol and it is the primary fuel consumed by the commercial sector, particularly for road freight. In recent years, diesel has also begun to attain a larger share of the private car fuel trade, particularly in light of the bias of vehicle taxation systems towards diesel cars, which generally consume less fuel in relative terms than petrol cars. The regression method used estimated diesel fuel tourism at 17.1 per cent of diesel sales in the Republic of Ireland in 2015.

The approach to estimating fuel tourism is based on log-linear OLS regression of fuel consumption in the ROI against some relevant indicator variables, including the relative price of road transport fuels between the ROI and the UK. For both petrol and diesel, after running the regression, the relative prices are re-set to zero and a new estimate for consumption is derived. Fuel tourism is then estimated as the difference between these two variables for consumption. For diesel the following variables are used.

- Relative Price
- Number of HGVs
- Dummy Variable for Year (to allow for efficiency gains over time)

The cross price elasticity of demand for diesel between the UK and ROI is calculated as being 0.66 in this case, reflecting the greater carrying capacity of many diesel vehicles and the fact that a sizable proportion of diesel vehicles are used in a commercial rather than a domestic context. For petrol the equation is somewhat simpler (compared to the diesel estimate and includes

- Relative Price
- Number of Passenger Cars

- Dummy Variable for time set at zero for all years to 2008 and increasing sequentially thereafter

This latter variable accounts for the change to the method of applying car taxation during 2008 in ROI, where engine size was replaced by CO_2 emissions which in turn led to a sizable switch away from petrol and towards diesel cars. The cross price elasticity in terms of petrol is smaller, at 0.21, reflecting the lower volumes of commercial traffic which use petrol as a fuel of choice

Fuel Tourism 1990−2015 Time Series

The approach outlined above has been used to estimate fuel tourism in Ireland in 1987 and for the period 1990−2015, and Figure A3.1 shows the results of the analysis. Figure A3.1 indicates that the level of fuel tourism is substantial, particularly in the case of diesel for the years 1998−2007. These results are used to produce adjusted annual emission estimates for all substances except POPs in Ireland’s 2017 submission under CLRTAP, i.e. estimates of emissions based on fuels used in the country. The adjusted emissions are most relevant for Ireland in the case of nitrogen oxides (NO_X) as assessment in relation to obligations under the Sofia Protocol on NO_X emissions is undertaken with respect to emissions estimated on the basis of fuels used in Ireland. The adjusted NO_X emissions are given in Table A3.1 and are shown in Figure A3.2, which also shows Irelands target NO_X level under the Sofia Protocol.

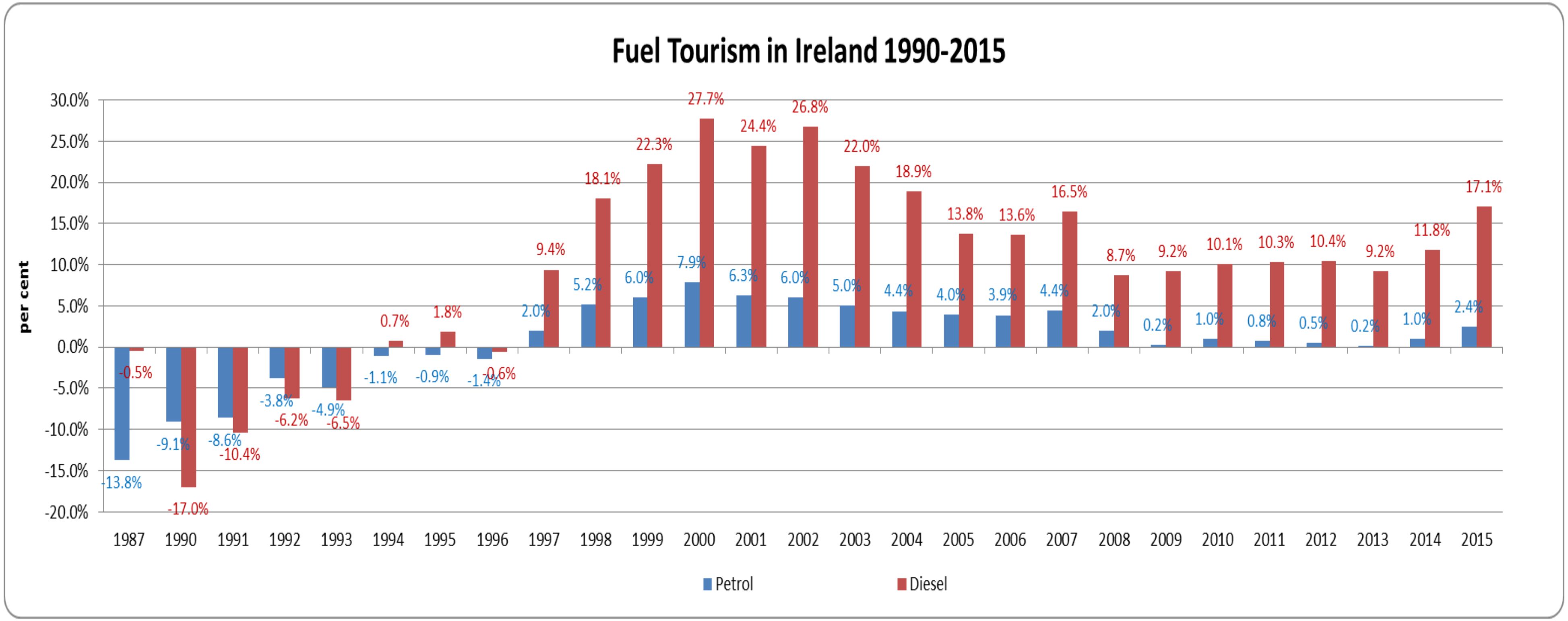

Figure A3.1. Percentage Fuel Tourism in Ireland 1987, 1990–2015

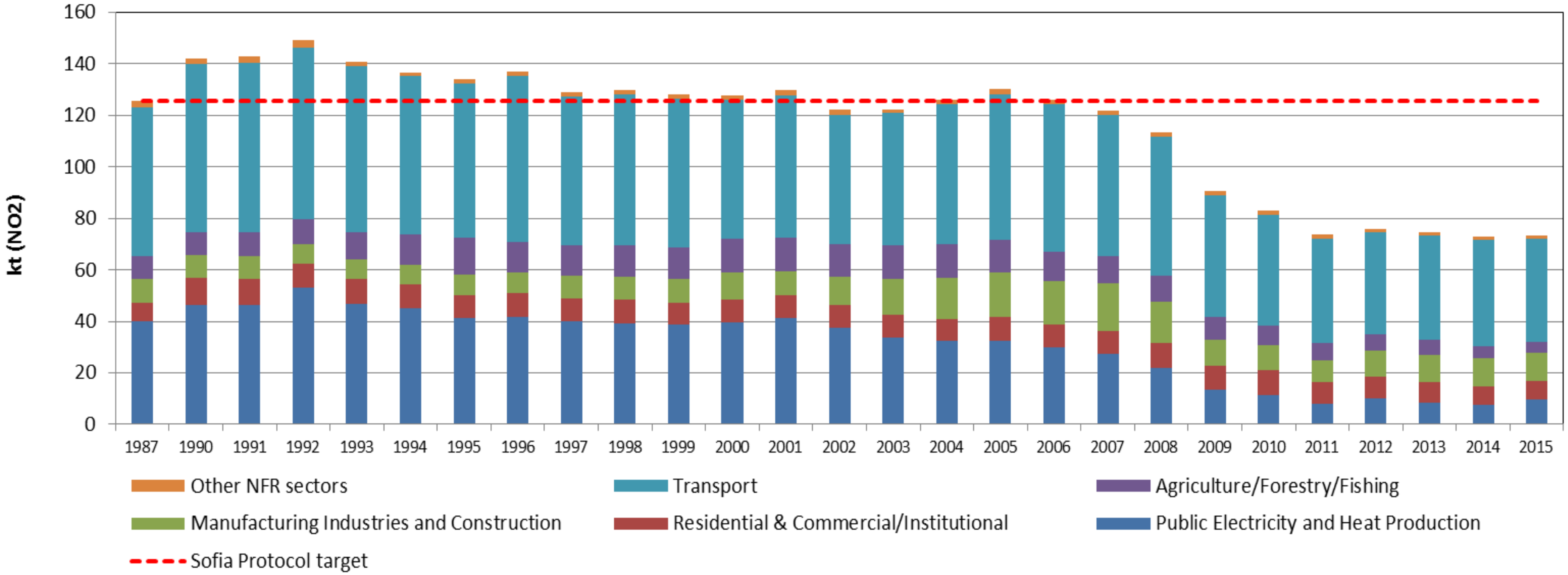

Figure A3.2. Emissions of Nitrogen Oxides in 1987 and 1990−2015 Based on Fuels Used in Ireland

Table A3.1. Emissions of Nitrogen Oxides in 1987 and 1990−2015 Based on Fuels Used in Ireland

	1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Public Electricity and Heat Production	40.142	46.374	46.188	53.065	46.944	45.100	41.391	41.864	40.192	39.384	38.769	39.720	41.145	37.621	33.812	32.333	32.384	29.874	27.330	22.022	13.320	11.516	7.995	10.303	8.569	7.536	9.476
Residential & Commercial/Institutional	7.238	10.443	10.463	9.428	9.361	9.265	8.662	8.932	8.538	8.887	8.516	8.618	8.813	8.686	8.893	8.739	9.240	8.972	8.902	9.694	9.274	9.479	8.305	8.062	8.045	7.226	7.354
Manufacturing Industries and Construction	9.207	8.928	8.728	7.388	7.786	7.777	8.050	8.127	8.975	8.980	8.988	10.529	9.413	10.883	13.580	16.009	17.313	16.592	18.447	15.765	10.370	9.961	8.477	10.428	10.551	10.727	10.953
Agriculture/Forestry/Fishing	8.703	8.700	9.360	9.830	10.367	11.739	14.276	11.850	11.921	12.307	12.573	12.990	13.224	12.586	13.303	13.003	12.877	11.694	10.629	10.399	8.691	7.547	6.694	6.348	5.708	5.006	4.431
Transport	57.660	65.602	65.600	66.346	64.446	61.374	60.039	64.594	57.490	58.584	57.579	53.976	54.930	50.372	51.225	54.324	56.352	57.273	54.710	53.693	47.166	42.801	40.708	39.235	40.398	40.962	39.820
Other NFR sectors	2.524	1.975	2.669	2.904	1.994	1.443	1.426	1.384	1.670	1.839	1.689	1.954	2.159	1.945	1.532	1.690	1.859	1.707	1.828	1.692	1.572	1.619	1.429	1.524	1.383	1.304	1.424
Total	**125.474**	**142.022**	**143.008**	**148.962**	**140.899**	**136.699**	**133.845**	**136.751**	**128.786**	**129.980**	**128.114**	**127.787**	**129.685**	**122.093**	**122.345**	**126.098**	**130.026**	**126.112**	**121.847**	**113.266**	**90.393**	**82.923**	**73.609**	**75.899**	**74.654**	**72.761**	**73.459**

Annex B Expanded Energy Balance Sheet for 2015

Table B.1 Expanded Energy Balance Sheet 2015

2015 Units = ktoe	NACE (Rev 2)	Coal	Bituminous Coal	Anthracite + Manufactured Ovoids	Coke	Lignite \ Brown Coal Briquettes	Peat	Milled Peat	Sod Peat	Briquettes	Oil	Crude	Refinery Gas	Gasoline	Kerosene	Jet Kerosene	Fueloil	LPG	Gasoil / Diesel /DERV
Indigenous Production		0	0				762	634	128		0								
Imports		1,481	1,419	49		13	0				9,120	3,725	0	850	446	1,216	118	120	2,279
Exports		11	0	10		1	7			7	1,777	0		414	19	85	1,147	16	60
Mar. Bunkers		0					0				160						14		146
Stock Change		-43	-50	6		0	5	-9	0	14	-303	-311		10	-7	9	6	-0	-5
Primary Energy Supply (incl non-energy)		1,426	1,369	45	0	12	759	625	128	7	6,880	3,415	0	445	420	1,140	-1,036	103	2,068
Primary Energy Requirement (excl. non-e		1,426	1,369	45	0	12	759	625	128	7	6,672	3,415	0	445	420	1,140	-1,036	103	2,068
Transformation Input		1,127	1,127	0	0	0	639	639	0	0	3,502	3,415	10	0	0	0	58	1	19
Public Thermal Power Plants		1,127	1,127				547	547	0		77						58		19
Combined Heat and Power Plants		0	0				7	7			10		10				0	1	0
Pumped Storage Consumption																			
Briquetting Plants		0					85	85			0								
Oil Refineries & other energy sector		0					0				3,415	3,415							
Transformation Output		0	0	0	0	0	65	0	0	65	3,481	0	107	644	150	0	1,142	53	1,355
Public Thermal Power Plants		0					0				0								
Combined Heat and Power Plants - Electricity		0					0				0								
Combined Heat and Power Plants - Heat																			
Pumped Storage Generation																			
Briquetting Plants							65			65	0								
Oil Refineries							0				3,481		107	644	150	0	1,142	53	1,355
Exchanges and transfers		15	-10	25	0	0	0	0	0	0	-18	0	0	1	310	-310	2	0	-6
Electricity																			
Heat																			
Other		15	-10	25							-18			1	310	-310	2		-6
Own Use and Distribution Losses		0					9	9			98		98				0	0	0
Available Final Energy Consumption		314	233	70	0	12	177	-23	128	72	6,744	-0	0	1,090	881	830	50	156	3,398
Non-Energy Consumption		0	0	0	0	0	0	0	0	0	208	0	0	0	0	0	0	0	0
Final non-Energy Consumption (Feedstocks)		0					0				208								
Total Final Energy Consumption		312	232	68	0	13	201	1	128	73	6,493	0	0	1,075	861	846	51	153	3,377
Industry*		106	106	0			1	1	0	0	464	0	0	0	86	0	41	106	107
Non-Energy Mining	05-09	0	0				0				30				3		1	0	26
Food & beverages	10-11	22	22				1	1			127				51		22	30	24
Textiles and textile products	13-14	0	0				0				2				1		0	0	1
Wood and wood products	16	0	0				0				2				0		0	0	2
Pulp, paper, publishing and printing	17-18	0	0				0				3				1		0	0	1
Chemicals & man-made fibres	20-21	0	0				0				27				12		5	3	7
Rubber and plastic products	22	0	0				0				9				0		0	5	3
Other non-metallic mineral products	23	84	84				0				171				8		4	1	34
Basic metals and fabricated metal products	24-25	0	0				0				11				0		4	5	2
Machinery and equipment n.e.c.	28	0	0				0				5				0		0	2	2
Electrical and optical equipment	26-27	0	0				0				38				0		0	36	1
Transport equipment manufacture	29-30	0	0				0				4				0		0	3	1
Other manufacturing	31-33, 12 & 15	0	0				0			0	36				9		4	19	4
Transport		0	0	0	0	0	0	0	0	0	4,657	0	0	1,075	0	846	0	3	2,733
Road Freight		0					0				603								603
Road Light Goods Vehicle											289								289
Road Private Car		0					0				2,012			925				3	1,084
Public Passenger Services		0					0				132			16					116
Rail		0					0				36								36
Domestic Aviation		0					0				3			1		3			
International Aviation		0					0				844					844			
Fuel Tourism		0					0				456			25					431
Navigation		0					0				71								71
Unspecified		0					0				210			107			0		103
Residential		206	126	68		13	201		128	73	956			0	775		0	37	138
Commercial/Public Services		0	0	0	0	0	0	0	0	0	243	0	0	0	0	0	10	8	226
Commercial Services		0	0	0		0	0				156				0		1	6	149
Public Services		0					0		0	0	87						9	2	77
Agricultural		0	0				0				152			0	0			0	152
Fisheries		0					0				21								21
Statistical Difference		2	1	2	0	-1	-24	-24	0	-0	43	-0	0	15	20	-16	-1	3	21

2015 Units = ktoe	Petroleum Coke	Naphta	Bitumen	White Spirit	Lubricants	Natural Gas	Renewables	Hydro	Wind	Biomass & Renewable Waste	Landfill Gas	Biogas	Liquid Biofuel	Solar	Geothermal	Non-Renewable Waste	Electricity	Heat	TOTAL
Indigenous Production						107	1,026	69	565	254	41	14	24	13	45	62			1,957
Imports	149	0	174	1	41	3,629	124			27			97				151		14,505
Exports	0	26	1	0	8	0	0			0			0				93		1,889
Mar. Bunkers							0												160
Stock Change	-3	-2	0	0	0	24	1			-1			1						-317
Primary Energy Supply (incl non-energy)	146	-28	173	1	33	3,761	1,150	69	565	281	41	14	122	13	45	62	58	0	14,096
Primary Energy Requirement (excl. non-e	146	-28	0	0	0	3,761	1,150	69	565	281	41	14	122	13	45	62	58	0	13,889
Transformation Input	0	0	0	0	0	1,943	115	0	0	69	41	5	0	0	0	25	56	0	7,406
Public Thermal Power Plants						1,620	107			66	41					25			3,503
Combined Heat and Power Plants						279	8			3		5							304
Pumped Storage Consumption																	46		46
Briquetting Plants							0												85
Oil Refineries & other energy sector						43	0										11		3,469
Transformation Output	0	30	0	0	0	0	41	0	0	24	15	3	0	0	0	6	1,806	0	5,400
Public Thermal Power Plants							37			22	15					6	1,596		1,596
Combined Heat and Power Plants - Electricity							4			1		3					185		185
Combined Heat and Power Plants - Heat							0												0
Pumped Storage Generation																	25		25
Briquetting Plants							0												65
Oil Refineries		30					0												3,481
Exchanges and transfers	-15	0	0	0	0	0	-635	-69	-565	0	0	0	0	-0	0	0	635	0	-3
Electricity							-635	-69	-565					-0			635		0
Heat																			0
Other	-15						0												-3
Own Use and Distribution Losses						60	0										245		412
Available Final Energy Consumption	131	2	173	1	33	1,758	401	0	0	212	0	9	122	13	45	37	2,197	0	11,629
Non-Energy Consumption	0		173	1	33	0	0	0	0	0	0	0	0	0	0	0	0	0	208
Final non-Energy Consumption (Feedstocks)			173	1	33	0	0												208
Total Final Energy Consumption	131	0	0	0	0	1,722	415	0	0	220	0	9	128	13	45	37	2,156	0	11,337
Industry*	124	0	0	0	0	767	174	0	0	171		3	0	0	0	37	847	0	2,397
Non-Energy Mining	0					12	0										61		102
Food & beverages	0					105	30			27		3					180		465
Textiles and textile products	0					1	0										11		14
Wood and wood products	0					2	115			115							36		156
Pulp, paper, publishing and printing	0					3	0										20		26
Chemicals & man-made fibres	0					65	0			0							154		245
Rubber and plastic products	0					4	0										37		50
Other non-metallic mineral products	124					17	29			29						37	54		391
Basic metals and fabricated metal products	0					422	0										67		500
Machinery and equipment n.e.c.	0					5	0										22		32
Electrical and optical equipment	0					123	0										105		266
Transport equipment manufacture	0					2	0										18		24
Other manufacturing	0					6	0										82		125
Transport	0	0	0	0	0	0	128	0	0	0	0	0	128	0	0	0	4	0	4,789
Road Freight							23						23						625
Road Light Goods Vehicle						0	11						11						300
Road Private Car							66						66						2,078
Public Passenger Services							5						5						137
Rail							0						0				4		39
Domestic Aviation							0												3
International Aviation							0												844
Fuel Tourism							17						17						473
Navigation							0												71
Unspecified							7						7						217
Residential	7					555	76			32				13	31		678		2,672
Commercial/Public Services	0	0	0	0	0	399	36	0	0	17	0	5	0	0	14	0	580	0	1,259
Commercial Services	0					175	31			17				0	14		416		777
Public Services						224	5					5					164		481
Agricultural						0	0										48		200
Fisheries							0												21
Statistical Difference	-0	2	0	0	0	36	-14	0	0	-8	0	0	-6	0	0	0	41	0	84

Annex C Emission Factors for Energy (NFR 1)

Table C.1 Emission Factors for NFR 1A1a

Emission Factors																		
	Code	Name			Inventory Year													
NFR Source Category	1.A.1.a	Public Electricity and Heat Production			2015													
Fuel	**Coal**			**Peat**			**Oil**			**Natural Gas**			**MSW Incineration**			**Landfill Gas**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	114.058	g/GJ	PS	85.466	g/GJ	PS	101.709	g/GJ	PS	21.857	g/GJ	PS	1.008	kg/Mg waste	PS	89.000	g/GJ	EMEP/EEA 2013
SO_x	71.323	g/GJ	PS	72.366	g/GJ	PS	46.724	g/GJ	PS	-	g/GJ	PS	0.199	kg/Mg waste	PS	-	g/GJ	EMEP/EEA 2013
NMVOC	0.900	g/GJ	EMEP/EEA 2013	0.900	g/GJ	EMEP/EEA 2013	2.30	g/GJ	EMEP/EEA 2013	2.60	g/GJ	EMEP/EEA 2013	0.006	kg/Mg waste	EMEP/EEA 2013	2.60	g/GJ	EMEP/EEA 2013
CO	313.000	g/GJ	EMEP/EEA 2013	13.000	g/GJ	EMEP/EEA 2013	15.100	g/GJ	EMEP/EEA 2013	39.000	g/GJ	EMEP/EEA 2013	0.040	kg/Mg waste	PS	39.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			NA			NA			NA		
TSP	8.400	g/GJ	EMEP/EEA 2013	10.200	g/GJ	EMEP/EEA 2013	35.400	g/GJ	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013	0.003*	kg/Mg waste	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013
PM_{10}	7.700	g/GJ	EMEP/EEA 2013	6.900	g/GJ	EMEP/EEA 2013	25.200	g/GJ	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013	0.003*	kg/Mg waste	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	5.200	g/GJ	EMEP/EEA 2013	2.800	g/GJ	EMEP/EEA 2013	19.300	g/GJ	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013	0.003*	kg/Mg waste	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013
BC	0.022	f-$PM_{2.5}$	EMEP/EEA 2013	NE		EMEP/EEA 2013	0.056	f-$PM_{2.5}$	EMEP/EEA 2013	0.025	f-$PM_{2.5}$	EMEP/EEA 2013	0.033	f-$PM_{2.5}$	EMEP/EEA 2013	0.025	f-$PM_{2.5}$	EMEP/EEA 2013
Pb	7.300	mg/GJ	EMEP/EEA 2013	7.300	mg/GJ	EMEP/EEA 2013	4.560	mg/GJ	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013	0.058	g/Mg waste	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013
Cd	0.900	mg/GJ	EMEP/EEA 2013	0.900	mg/GJ	EMEP/EEA 2013	1.200	mg/GJ	EMEP/EEA 2013	0.003	mg/GJ	EMEP/EEA 2013	0.005	g/Mg waste	EMEP/EEA 2013	0.003	mg/GJ	EMEP/EEA 2013
Hg	1.400	mg/GJ	EMEP/EEA 2013	1.400	mg/GJ	EMEP/EEA 2013	0.341	mg/GJ	EMEP/EEA 2013	0.100	mg/GJ	EMEP/EEA 2013	0.019	g/Mg waste	EMEP/EEA 2013	0.100	mg/GJ	EMEP/EEA 2013
As	7.100	mg/GJ	EMEP/EEA 2013	7.100	mg/GJ	EMEP/EEA 2013	3.980	mg/GJ	EMEP/EEA 2013	0.210	mg/GJ	EMEP/EEA 2013	0.006	g/Mg waste	EMEP/EEA 2013	0.210	mg/GJ	EMEP/EEA 2013
Cr	4.500	mg/GJ	EMEP/EEA 2013	4.500	mg/GJ	EMEP/EEA 2013	2.550	mg/GJ	EMEP/EEA 2013	0.001	mg/GJ	EMEP/EEA 2013	0.016	g/Mg waste	EMEP/EEA 2013	0.001	mg/GJ	EMEP/EEA 2013
Cu	7.800	mg/GJ	EMEP/EEA 2013	7.800	mg/GJ	EMEP/EEA 2013	5.310	mg/GJ	EMEP/EEA 2013	0.076	mg/GJ	EMEP/EEA 2013	0.014	g/Mg waste	EMEP/EEA 2013	0.076	mg/GJ	EMEP/EEA 2013
Ni	4.900	mg/GJ	EMEP/EEA 2013	4.900	mg/GJ	EMEP/EEA 2013	255.000	mg/GJ	EMEP/EEA 2013	0.001	mg/GJ	EMEP/EEA 2013	0.022	g/Mg waste	EMEP/EEA 2013	0.001	mg/GJ	EMEP/EEA 2013
Se	23.000	mg/GJ	EMEP/EEA 2013	23.000	mg/GJ	EMEP/EEA 2013	2.060	mg/GJ	EMEP/EEA 2013	0.011	mg/GJ	EMEP/EEA 2013	0.012	g/Mg waste	EMEP/EEA 2013	0.011	mg/GJ	EMEP/EEA 2013
Zn	19.000	mg/GJ	EMEP/EEA 2013	19.000	mg/GJ	EMEP/EEA 2013	87.800	mg/GJ	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013	0.025	g/Mg waste	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013
PCB	3.300	ng/GJ	EMEP/EEA 2013	3.300	ng/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	0.003	ug/Mg waste	EMEP/EEA 2013	NE		EMEP/EEA 2013
PCDD/F (I-TEQ)	10.000	ng/GJ	EMEP/EEA 2013	0.525	ng/GJ	PS	2.500	ng/GJ	EMEP/EEA 2013	0.500	ng/GJ	EMEP/EEA 2013	0.0525*	µg I-TEQ/Mg waste	EMEP/EEA 2013	0.500	ng/GJ	EMEP/EEA 2013
Benzo[a]pyrene	0.700	µg/GJ	EMEP/EEA 2013	0.700	µg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	0.560	µg/GJ	EMEP/EEA 2013	0.008	mg/Mg waste	EMEP/EEA 2013	0.560	µg/GJ	EMEP/EEA 2013
Benzo[b]fluoranthene	37.000	µg/GJ	EMEP/EEA 2013	37.000	µg/GJ	EMEP/EEA 2013	4.500	µg/GJ	EMEP/EEA 2013	0.840	µg/GJ	EMEP/EEA 2013	0.018	mg/Mg waste	EMEP/EEA 2013	0.840	µg/GJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	37.000	µg/GJ	EMEP/EEA 2013	37.000	µg/GJ	EMEP/EEA 2013	4.500	µg/GJ	EMEP/EEA 2013	0.840	µg/GJ	EMEP/EEA 2013	0.010	mg/Mg waste	EMEP/EEA 2013	0.840	µg/GJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	1.100	µg/GJ	EMEP/EEA 2013	1.100	µg/GJ	EMEP/EEA 2013	6.920	µg/GJ	EMEP/EEA 2013	0.840	µg/GJ	EMEP/EEA 2013	0.012	mg/Mg waste	EMEP/EEA 2013	0.840	µg/GJ	EMEP/EEA 2013
Total 4 PAHs	75.800	µg/GJ	EMEP/EEA 2013	75.800	µg/GJ	EMEP/EEA 2013	15.920	µg/GJ	EMEP/EEA 2013	3.080	µg/GJ	EMEP/EEA 2013	0.047	mg/Mg waste	EMEP/EEA 2013	3.080	µg/GJ	EMEP/EEA 2013
HCB	6.700	µg/GJ	EMEP/EEA 2013	6.700	µg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	0.045	mg/Mg waste	EMEP/EEA 2013	NE	µg/GJ	EMEP/EEA 2013

Table C.2 Emission Factors for NFR 1A1b

Emission Factors															
	Code	Name				Inventory Year									
NFR Source Category	1.A.1.b	Petroleum Refining				2015									
Fuel	**Refinery Gas**			**Fuel Oil**			**Natural Gas**			**Gasoil**			**LPG**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	94.758	g/GJ	PS	142.000	g/GJ	EMEP/EEA 2013	63.000	g/GJ	EMEP/EEA 2013	65.000	g/GJ	EMEP/EEA 2013	63.000	g/GJ	EMEP/EEA 2013
SO_x	127.886	g/GJ	PS	NA			0.281	g/GJ	EMEP/EEA 2013	15.885	g/GJ	PS	0.281	g/GJ	EMEP/EEA 2013
NMVOC	2.580	g/GJ	EMEP/EEA 2013	2.300	g/GJ	EMEP/EEA 2013	2.580	g/GJ	EMEP/EEA 2013	0.650	g/GJ	EMEP/EEA 2013	2.580	g/GJ	EMEP/EEA 2013
CO	6.070	g/GJ	PS	15.000	g/GJ	EMEP/EEA 2013	39.300	g/GJ	EMEP/EEA 2013	16.200	g/GJ	EMEP/EEA 2013	39.300	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			NA			NA		
TSP	0.890	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013	6.470	g/GJ	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013
PM_{10}	0.890	g/GJ	EMEP/EEA 2013	15.000	g/GJ	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013	3.230	g/GJ	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	0.890	g/GJ	EMEP/EEA 2013	9.000	g/GJ	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013	0.808	g/GJ	EMEP/EEA 2013	0.890	g/GJ	EMEP/EEA 2013
BC	0.184	f-$PM_{2.5}$	EMEP/EEA 2013	0.056	f-$PM_{2.5}$	EMEP/EEA 2013	0.086	f-$PM_{2.5}$	EMEP/EEA 2013	0.335	f-$PM_{2.5}$	EMEP/EEA 2013	0.086	f-$PM_{2.5}$	EMEP/EEA 2013
Pb	1.790	mg/GJ	EMEP/EEA 2013	4.560	mg/GJ	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013	4.070	mg/GJ	EMEP/EEA 2013	0.0015	mg/GJ	EMEP/EEA 2013
Cd	0.712	mg/GJ	EMEP/EEA 2013	1.200	mg/GJ	EMEP/EEA 2013	0.003	mg/GJ	EMEP/EEA 2013	1.360	mg/GJ	EMEP/EEA 2013	0.0003	mg/GJ	EMEP/EEA 2013
Hg	0.086	mg/GJ	EMEP/EEA 2013	0.341	mg/GJ	EMEP/EEA 2013	0.100	mg/GJ	EMEP/EEA 2013	1.360	mg/GJ	EMEP/EEA 2013	0.100	mg/GJ	EMEP/EEA 2013
As	0.343	mg/GJ	EMEP/EEA 2013	3.980	mg/GJ	EMEP/EEA 2013	0.210	mg/GJ	EMEP/EEA 2013	1.810	mg/GJ	EMEP/EEA 2013	0.120	mg/GJ	EMEP/EEA 2013
Cr	2.740	mg/GJ	EMEP/EEA 2013	2.550	mg/GJ	EMEP/EEA 2013	0.001	mg/GJ	EMEP/EEA 2013	1.360	mg/GJ	EMEP/EEA 2013	0.00076	mg/GJ	EMEP/EEA 2013
Cu	2.220	mg/GJ	EMEP/EEA 2013	5.310	mg/GJ	EMEP/EEA 2013	0.0001	mg/GJ	EMEP/EEA 2013	2.720	mg/GJ	EMEP/EEA 2013	0.000076	mg/GJ	EMEP/EEA 2013
Ni	3.600	mg/GJ	EMEP/EEA 2013	255.000	mg/GJ	EMEP/EEA 2013	0.001	mg/GJ	EMEP/EEA 2013	1.360	mg/GJ	EMEP/EEA 2013	0.00051	mg/GJ	EMEP/EEA 2013
Se	0.420	mg/GJ	EMEP/EEA 2013	2.060	mg/GJ	EMEP/EEA 2013	0.011	mg/GJ	EMEP/EEA 2013	6.790	mg/GJ	EMEP/EEA 2013	0.0112	mg/GJ	EMEP/EEA 2013
Zn	25.500	mg/GJ	EMEP/EEA 2013	87.800	mg/GJ	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013	1.810	mg/GJ	EMEP/EEA 2013	0.0015	mg/GJ	EMEP/EEA 2013
PCB	NE		EMEP/EEA 2013	24.251	ng/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	23.090	µg/GJ	NAEI 2006	NE		EMEP/EEA 2013
PCDD/F (I-TEQ)	NE		EMEP/EEA 2013	2.500	ng/GJ	EMEP/EEA 2013	0.500	µg/GJ	EMEP/EEA 2013	0.500	ng/GJ	EMEP/EEA 2013	0.500	ng/GJ	EMEP/EEA 2013
Benzo[a]pyrene	0.669	µg/GJ	EMEP/EEA 2013	19.886	µg/GJ	EMEP/EEA 2013	0.560	µg/GJ	EMEP/EEA 2013	18.934	µg/GJ	NAEI 2006	0.560	µg/GJ	EMEP/EEA 2013
Benzo[b]fluoranthene	1.140	µg/GJ	EMEP/EEA 2013	4.500	µg/GJ	EMEP/EEA 2013	0.840	µg/GJ	EMEP/EEA 2013	4.500	µg/GJ	NAEI 2006	0.840	µg/GJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	0.631	µg/GJ	EMEP/EEA 2013	4.500	µg/GJ	EMEP/EEA 2013	0.840	µg/GJ	EMEP/EEA 2013	4.500	µg/GJ	NAEI 2006	0.840	µg/GJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	0.631	µg/GJ	EMEP/EEA 2013	6.920	µg/GJ	EMEP/EEA 2013	0.840	µg/GJ	EMEP/EEA 2013	6.920	µg/GJ	NAEI 2006	0.840	µg/GJ	EMEP/EEA 2013
Total 4 PAHs	3.071	µg/GJ	EMEP/EEA 2013	35.806	µg/GJ	EMEP/EEA 2013	3.080	µg/GJ	EMEP/EEA 2013	34.854	µg/GJ	NAEI 2006	3.080	µg/GJ	EMEP/EEA 2013
HCB	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013

Table C.3 Emission Factors for NFR 1A1c

Emission Factors				
	Code	Name		Inventory year
NFR Source Category	1.A.1.c	Manufacture of Solid Fuels and Other Energy Industries		2015
Fuel	**Peat**			
Pollutant	**Value**	**Unit**	**Reference**	
NO_x	100.000	g/GJ	PS	
SO_x	300.000	g/GJ	PS	
NMVOC	100.000	g/GJ	EMEP/EEA 2009	
CO	1750.000	g/GJ	PS	
NH_3	NA			
TSP	120.000	g/GJ	CEPMEIP	
PM_{10}	40.000	g/GJ	CEPMEIP	
$PM_{2.5}$	20.000	g/GJ	CEPMEIP	
BC	NE		EMEP/EEA 2013	
Pb	7.300	mg/GJ	EMEP/EEA 2013	
Cd	0.900	mg/GJ	EMEP/EEA 2013	
Hg	1.400	mg/GJ	EMEP/EEA 2013	
As	7.100	mg/GJ	EMEP/EEA 2013	
Cr	4.500	mg/GJ	EMEP/EEA 2013	
Cu	7.800	mg/GJ	EMEP/EEA 2013	
Ni	4.900	mg/GJ	EMEP/EEA 2013	
Se	23.000	mg/GJ	EMEP/EEA 2013	
Zn	19.000	mg/GJ	EMEP/EEA 2013	
PCB	3.300	ng/GJ	EMEP/EEA 2013	
PCDD/F (I-TEQ)	10.000	µg/GJ	EMEP/EEA 2013	
Benzo[a]pyrene	0.700	µg/GJ	EMEP/EEA 2013	
Benzo[b]fluoranthene	37.000	µg/GJ	EMEP/EEA 2013	
Benzo[k]Fluoranthene	29.000	µg/GJ	EMEP/EEA 2013	
Indeno[1,2,3-cd]pyrene	11.000	µg/GJ	EMEP/EEA 2013	
Total 4 PAHs	77.700	µg/GJ	EMEP/EEA 2013	
HCB	6.700	µg/GJ	EMEP/EEA 2013	

Table C.4 Emission Factors for NFR 1A2a

Emission Factors												
	Code	Name				Inventory Year						
NFR Source Category	1.A.2.a	Combustion in Manufacturing: Iron and Steel				2015						
Fuel	**Coal**			**Kerosene**			**Fuel Oil**			**LPG**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	173.000	g/GJ	EMEP/EEA 2013	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013
SO_x	720.000	g/GJ	CS	8.959	g/GJ	CS	223.084	g/GJ	CS	0.670	g/GJ	EMEP/EEA 2013
NMVOC	88.800	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2009	23.000	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			NA		
TSP	124.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
PM_{10}	117.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	108.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Gasoil**			**Petroleum Coke**			**Natural Gas**			**Biomass**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	100.000	g/GJ	EMEP/EEA 2009	NO			74.000	g/GJ	EMEP/EEA 2013	NO		
SO_x	15.885	g/GJ	CS	NO			0.079	g/GJ	CS	NA		
NMVOC	10.000	g/GJ	EMEP/EEA 2009	NO			23.000	g/GJ	EMEP/EEA 2013	NO		
CO	40.000	g/GJ	EMEP/EEA 2009	NO			29.000	g/GJ	EMEP/EEA 2013	NO		
NH_3	NA			NO			NA			NO		
TSP	20.000	g/GJ	EMEP/EEA 2013	NO			0.780	g/GJ	EMEP/EEA 2013	NO		
PM_{10}	20.000	g/GJ	EMEP/EEA 2013	NO			0.780	g/GJ	EMEP/EEA 2013	NO		
$PM_{2.5}$	20.000	g/GJ	EMEP/EEA 2013	NO			0.780	g/GJ	EMEP/EEA 2013	NO		
BC	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	NO			0.040	f-$PM_{2.5}$	EMEP/EEA 2013	NO		

Table C.5 Emission Factors for NFR 1A2b

Emission Factors												
	Code	Name			Inventory Year							
NFR Source Category	1.A.2.b	Combustion in Manufacturing: Non-ferrous Metals			2015							
Fuel	**Coal**			**Kerosene**			**Fuel Oil**			**LPG**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	173.000	g/GJ	EMEP/EEA 2013	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013
SO_x	720.000	g/GJ	CS	8.959	g/GJ	CS	223.084	g/GJ	CS	0.670	g/GJ	EMEP/EEA 2013
NMVOC	88.800	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2009	23.000	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			NA		
TSP	124.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
PM_{10}	117.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	108.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Gasoil**			**Petroleum Coke**			**Natural Gas**			**Biomass**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	CS	13.227	g/GJ	CS	NO		
SO_x	15.885	g/GJ	CS	968.297	g/GJ	CS	0.079	g/GJ	CS	NA		
NMVOC	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2009	23.000	g/GJ	EMEP/EEA 2013	NO		
CO	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013	NO		
NH_3	NA			NA			NA			NO		
TSP	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	NO		
PM_{10}	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	NO		
$PM_{2.5}$	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	NO		
BC	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013	NO		

Table C.6 Emission Factors for NFR 1A2c

Emission Factors												
	Code	Name				Inventory Year						
NFR Source Category	1.A.2.c	Combustion in Manufacturing: Chemicals				2015						
Fuel	**Coal**			**Kerosene**			**Fuel Oil**			**LPG**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	173.000	g/GJ	EMEP/EEA 2013	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013
SO_x	720.000	g/GJ	EMEP/EEA 2013	8.959	g/GJ	CS	223.084	g/GJ	CS	0.670	g/GJ	CS
NMVOC	88.800	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2013	23.000	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			NA		
TSP	124.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
PM_{10}	117.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	108.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Gasoil**			**Petroleum Coke**			**Natural Gas**			**Biomass**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	100.000	g/GJ	EMEP/EEA 2009	NO			74.000	g/GJ	EMEP/EEA 2013	91.000	g/GJ	EMEP/EEA 2013
SO_x	15.885	g/GJ	CS	NO			0.079	g/GJ	CS	11.000	g/GJ	EMEP/EEA 2013
NMVOC	10.000	g/GJ	EMEP/EEA 2013	NO			23.000	g/GJ	EMEP/EEA 2013	300.000	g/GJ	EMEP/EEA 2013
CO	40.000	g/GJ	EMEP/EEA 2009	NO			29.000	g/GJ	EMEP/EEA 2013	570.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NO			NA			37.000	g/GJ	EMEP/EEA 2013
TSP	20.000	g/GJ	EMEP/EEA 2013	NO			0.780	g/GJ	EMEP/EEA 2013	150.000	g/GJ	EMEP/EEA 2013
PM_{10}	20.000	g/GJ	EMEP/EEA 2013	NO			0.780	g/GJ	EMEP/EEA 2013	143.000	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	20.000	g/GJ	EMEP/EEA 2013	NO			0.780	g/GJ	EMEP/EEA 2013	140.000	g/GJ	EMEP/EEA 2013
BC	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	NO			0.040	f-$PM_{2.5}$	EMEP/EEA 2013	0.280	f-$PM_{2.5}$	EMEP/EEA 2013

Table C.7 Emission Factors for NFR 1A2d

Emission Factors												
	Code	Name			Inventory Year							
NFR Source Category	1.A.2.d	Combustion in Manufacturing: Pulp, Paper and Print			2015							
Fuel	Coal			Kerosene			Fuel Oil			LPG		
Pollutant	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference
NO_x	173.000	g/GJ	EMEP/EEA 2013	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013
SO_x	720.000	g/GJ	CS	8.959	g/GJ	CS	223.084	g/GJ	CS	0.670	g/GJ	CS
NMVOC	88.800	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2013	23.000	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			NA		
TSP	124.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
PM_{10}	117.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	108.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	Gasoil			Petroleum Coke			Natural Gas			Biomass		
Pollutant	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference
NO_x	100.000	g/GJ	EMEP/EEA 2009	NO			74.000	g/GJ	EMEP/EEA 2013	NO		
SO_x	15.885	g/GJ	CS	NO			0.079	g/GJ	CS	NA		
NMVOC	10.000	g/GJ	EMEP/EEA 2013	NO			23.000	g/GJ	EMEP/EEA 2013	NO		
CO	40.000	g/GJ	EMEP/EEA 2009	NO			29.000	g/GJ	EMEP/EEA 2013	NO		
NH_3	NA			NO			NA			NO		
TSP	20.000	g/GJ	EMEP/EEA 2013	NO			0.780	g/GJ	EMEP/EEA 2013	NO		
PM_{10}	20.000	g/GJ	EMEP/EEA 2013	NO			0.780	g/GJ	EMEP/EEA 2013	NO		
$PM_{2.5}$	20.000	g/GJ	EMEP/EEA 2013	NO			0.780	g/GJ	EMEP/EEA 2013	NO		
BC	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	NO			0.040	f-$PM_{2.5}$	EMEP/EEA 2013	NO		

Table C.8 Emission Factors for NFR 1A2e

Emission Factors												
	Code	Name				Inventory Year						
NFR Source Category	1.A.2.e	Combustion in Manufacturing: Food Processing, Beverages and Tobacco				2015						
Fuel	**Coal**			**Kerosene**			**Fuel Oil**			**LPG**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	173.000	g/GJ	EMEP/EEA 2013	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013
SO_x	720.000	g/GJ	CS	8.959	g/GJ	CS	223.084	g/GJ	CS	0.670	g/GJ	CS
NMVOC	88.800	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2013	23.000	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			NA		
TSP	124.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
PM_{10}	117.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	108.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Gasoil**			**Petroleum Coke**			**Natural Gas**			**Biomass**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013	91.000	g/GJ	EMEP/EEA 2013
SO_x	15.885	g/GJ	CS	968.297	g/GJ	CS	0.079	g/GJ	CS	11.000	g/GJ	EMEP/EEA 2013
NMVOC	10.000	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2013	23.000	g/GJ	EMEP/EEA 2013	300.000	g/GJ	EMEP/EEA 2013
CO	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013	570.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			37.000	g/GJ	EMEP/EEA 2013
TSP	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	150.000	g/GJ	EMEP/EEA 2013
PM_{10}	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	143.000	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	140.000	g/GJ	EMEP/EEA 2013
BC	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013	0.280	f-$PM_{2.5}$	EMEP/EEA 2013

Table C.9 Emission Factors for NFR 1A2f

Emission Factors												
	Code	Name			Inventory Year							
NFR Source Category	1.A.2.f	Combustion in Manufacturing: Non-metallic minerals			2015							
Fuel	**Coal**			**Kerosene**			**Fuel Oil**			**LPG**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	638.931	g/GJ	PS	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013
SO_x	63.510	g/GJ	PS	8.959	g/GJ	CS	223.084	g/GJ	CS	0.670	g/GJ	CS
NMVOC	88.800	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2013	23.000	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			NA		
TSP	124.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
PM_{10}	117.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	108.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Gasoil**			**Petroleum Coke**			**Natural Gas**			**Biomass**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	100.000	g/GJ	EMEP/EEA 2009	822.108	g/GJ	PS	74.000	g/GJ	EMEP/EEA 2013	91.000	g/GJ	EMEP/EEA 2013
SO_x	15.885	g/GJ	CS	152.879	g/GJ	PS	0.079	g/GJ	CS	11.000	g/GJ	EMEP/EEA 2013
NMVOC	10.000	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2013	23.000	g/GJ	EMEP/EEA 2013	300.000	g/GJ	EMEP/EEA 2013
CO	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013	570.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			37.000	g/GJ	EMEP/EEA 2013
TSP	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	150.000	g/GJ	EMEP/EEA 2013
PM_{10}	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	143.000	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	140.000	g/GJ	EMEP/EEA 2013
BC	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013	0.280	f-$PM_{2.5}$	EMEP/EEA 2013

Table C.10 Emission Factors for NFR 1A2g

Emission Factors												
	Code	Name				Inventory Year						
NFR Source Category	1.A.2.g	Combustion in Manufacturing: Other				2015						
Fuel	**Coal**			**Kerosene**			**Fuel Oil**			**LPG**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	173.000	g/GJ	EMEP/EEA 2013	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013
SO_x	720.000	g/GJ	EMEP/EEA 2013	8.959	g/GJ	CS	223.084	g/GJ	CS	0.670	g/GJ	CS
NMVOC	88.800	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			NA		
TSP	124.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
PM_{10}	117.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	108.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Gasoil**			**Petroleum Coke**			**Natural Gas**			**Biomass**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2013	74.000	g/GJ	EMEP/EEA 2013	91.000	g/GJ	EMEP/EEA 2013
SO_x	15.885	g/GJ	CS	47.000	g/GJ	EMEP/EEA 2013	0.079	g/GJ	CS	11.000	g/GJ	EMEP/EEA 2013
NMVOC	10.000	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2013	23.000	g/GJ	EMEP/EEA 2013	300.000	g/GJ	EMEP/EEA 2013
CO	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013	570.000	g/GJ	EMEP/EEA 2013
NH_3	NA			NA			NA			37.000	g/GJ	EMEP/EEA 2013
TSP	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	150.000	g/GJ	EMEP/EEA 2013
PM_{10}	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	143.000	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	20.000	g/GJ	EMEP/EEA 2013	20.000	g/GJ	EMEP/EEA 2013	0.780	g/GJ	EMEP/EEA 2013	140.000	g/GJ	EMEP/EEA 2013
BC	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013	0.280	f-$PM_{2.5}$	EMEP/EEA 2013

Table C.11 Emission Factors for NFR 1A2 (Heavy Metals and Persistent Organic Pollutants)

Emission Factors (Heavy Metals and POPs)												
	Code	Name				Inventory Year						
NFR Source Category	1.A.2 (a-g)	Combustion in Manufacturing				2015						
Fuel	**Coal**			**Kerosene**			**Fuel Oil**			**LPG**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
Pb	134.000	mg/GJ	EMEP/EEA 2013	0.080	mg/GJ	EMEP/EEA 2013	0.080	mg/GJ	EMEP/EEA 2013	0.011	mg/GJ	EMEP/EEA 2013
Cd	1.800	mg/GJ	EMEP/EEA 2013	0.006	mg/GJ	EMEP/EEA 2013	0.006	mg/GJ	EMEP/EEA 2013	0.0009	mg/GJ	EMEP/EEA 2013
Hg	7.900	mg/GJ	EMEP/EEA 2013	0.120	mg/GJ	EMEP/EEA 2013	0.120	mg/GJ	EMEP/EEA 2013	0.540	mg/GJ	EMEP/EEA 2013
As	4.000	mg/GJ	EMEP/EEA 2013	0.030	mg/GJ	EMEP/EEA 2013	0.030	mg/GJ	EMEP/EEA 2013	0.100	mg/GJ	EMEP/EEA 2013
Cr	13.500	mg/GJ	EMEP/EEA 2013	0.200	mg/GJ	EMEP/EEA 2013	0.200	mg/GJ	EMEP/EEA 2013	0.013	mg/GJ	EMEP/EEA 2013
Cu	17.500	mg/GJ	EMEP/EEA 2013	0.220	mg/GJ	EMEP/EEA 2013	0.220	mg/GJ	EMEP/EEA 2013	0.0026	mg/GJ	EMEP/EEA 2013
Ni	13.000	mg/GJ	EMEP/EEA 2013	0.008	mg/GJ	EMEP/EEA 2013	0.008	mg/GJ	EMEP/EEA 2013	0.013	mg/GJ	EMEP/EEA 2013
Se	1.800	mg/GJ	EMEP/EEA 2013	0.110	mg/GJ	EMEP/EEA 2013	0.110	mg/GJ	EMEP/EEA 2013	0.058	mg/GJ	EMEP/EEA 2013
Zn	200.000	mg/GJ	EMEP/EEA 2013	29.000	mg/GJ	EMEP/EEA 2013	29.000	mg/GJ	EMEP/EEA 2013	0.730	mg/GJ	EMEP/EEA 2013
PCB	170.000	µg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
PCDD/F (I-TEQ)	203.000	ng/GJ	EMEP/EEA 2013	1.400	ng/GJ	EMEP/EEA 2013	1.400	ng/GJ	EMEP/EEA 2013	0.520	ng/GJ	EMEP/EEA 2013
Benzo[a]pyrene	45.500	mg/GJ	EMEP/EEA 2013	1.900	mg/GJ	EMEP/EEA 2013	1.900	mg/GJ	EMEP/EEA 2013	0.720	mg/GJ	EMEP/EEA 2013
Benzo[b]fluoranthene	58.900	mg/GJ	EMEP/EEA 2013	15.000	mg/GJ	EMEP/EEA 2013	15.000	mg/GJ	EMEP/EEA 2013	2.900	mg/GJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	23.700	mg/GJ	EMEP/EEA 2013	1.700	mg/GJ	EMEP/EEA 2013	1.700	mg/GJ	EMEP/EEA 2013	1.100	mg/GJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	18.500	mg/GJ	EMEP/EEA 2013	1.500	mg/GJ	EMEP/EEA 2013	1.500	mg/GJ	EMEP/EEA 2013	1.080	mg/GJ	EMEP/EEA 2013
Total 4 PAHs	146.600	mg/GJ	EMEP/EEA 2013	20.100	mg/GJ	EMEP/EEA 2013	20.100	mg/GJ	EMEP/EEA 2013	5.800	mg/GJ	EMEP/EEA 2013
HCB	0.620	µg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013

Emission Factors (Heavy Metals and POPs)												
	Code	Name				Inventory Year						
NFR Source Category	1.A.2 (a-g)	Combustion in Manufacturing				2015						
Fuel	**Gasoil**			**Petroleum Coke**			**Natural Gas**			**Biomass**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
Pb	0.080	mg/GJ	EMEP/EEA 2013	0.080	mg/GJ	EMEP/EEA 2013	0.011	mg/GJ	EMEP/EEA 2013	27.000	mg/GJ	EMEP/EEA 2013
Cd	0.006	mg/GJ	EMEP/EEA 2013	0.006	mg/GJ	EMEP/EEA 2013	0.0009	mg/GJ	EMEP/EEA 2013	13.000	mg/GJ	EMEP/EEA 2013
Hg	0.120	mg/GJ	EMEP/EEA 2013	0.120	mg/GJ	EMEP/EEA 2013	0.540	mg/GJ	EMEP/EEA 2013	0.560	mg/GJ	EMEP/EEA 2013
As	0.030	mg/GJ	EMEP/EEA 2013	0.030	mg/GJ	EMEP/EEA 2013	0.100	mg/GJ	EMEP/EEA 2013	0.190	mg/GJ	EMEP/EEA 2013
Cr	0.200	mg/GJ	EMEP/EEA 2013	0.200	mg/GJ	EMEP/EEA 2013	0.013	mg/GJ	EMEP/EEA 2013	23.000	mg/GJ	EMEP/EEA 2013
Cu	0.220	mg/GJ	EMEP/EEA 2013	0.220	mg/GJ	EMEP/EEA 2013	0.0026	mg/GJ	EMEP/EEA 2013	6.000	mg/GJ	EMEP/EEA 2013
Ni	0.008	mg/GJ	EMEP/EEA 2013	0.008	mg/GJ	EMEP/EEA 2013	0.013	mg/GJ	EMEP/EEA 2013	2.000	mg/GJ	EMEP/EEA 2013
Se	0.110	mg/GJ	EMEP/EEA 2013	0.110	mg/GJ	EMEP/EEA 2013	0.058	mg/GJ	EMEP/EEA 2013	0.500	mg/GJ	EMEP/EEA 2013
Zn	29.000	mg/GJ	EMEP/EEA 2013	29.000	mg/GJ	EMEP/EEA 2013	0.730	mg/GJ	EMEP/EEA 2013	512.000	mg/GJ	EMEP/EEA 2013
PCB	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	0.060	µg/GJ	EMEP/EEA 2013
PCDD/F (I-TEQ)	1.400	ng/GJ	EMEP/EEA 2013	1.400	ng/GJ	EMEP/EEA 2013	0.520	ng/GJ	EMEP/EEA 2013	100.000	ng/GJ	EMEP/EEA 2013
Benzo[a]pyrene	1.900	mg/GJ	EMEP/EEA 2013	1.900	mg/GJ	EMEP/EEA 2013	0.720	mg/GJ	EMEP/EEA 2013	10.000	mg/GJ	EMEP/EEA 2013
Benzo[b]fluoranthene	15.000	mg/GJ	EMEP/EEA 2013	15.000	mg/GJ	EMEP/EEA 2013	2.900	mg/GJ	EMEP/EEA 2013	16.000	mg/GJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	1.700	mg/GJ	EMEP/EEA 2013	1.700	mg/GJ	EMEP/EEA 2013	1.100	mg/GJ	EMEP/EEA 2013	5.000	mg/GJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	1.500	mg/GJ	EMEP/EEA 2013	1.500	mg/GJ	EMEP/EEA 2013	1.080	mg/GJ	EMEP/EEA 2013	4.000	mg/GJ	EMEP/EEA 2013
Total 4 PAHs	20.100	mg/GJ	EMEP/EEA 2013	20.100	mg/GJ	EMEP/EEA 2013	5.800	mg/GJ	EMEP/EEA 2013	35.000	mg/GJ	EMEP/EEA 2013
HCB	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	5.000	µg/GJ	EMEP/EEA 2013

Table C.12 Distances between airport pairs used to estimate fuel consumption for cruise phase

Nautical Miles		Cork	Galway	Donegal	Dublin	Knock	Kerry	Shannon	Sligo	Waterford	Other
		EICK	EICM	EIDL	EIDW	EIKN	EIKY	EINN	EISG	EIWF	
EICK	Cork		89.18	192.52	124.89	124.88	43.37	54.12	146.58	56.04	89.18
EICM	Galway	89.18		106.92	96.28	36.93	70.51	35.94	60.13	95.09	89.18
EIDL	Donegal	192.52	106.92		121.75	70.16	177.15	142.26	46.80	177.42	89.18
EIDW	Dublin	124.89	96.28	121.75		95.56	139.93	105.34	97.52	79.89	89.18
EIKN	Knock	124.88	36.93	70.16	95.56		106.99	72.70	23.53	121.02	89.18
EIKY	Kerry	43.37	70.51	177.15	139.93	106.99		38.25	130.45	89.97	89.18
EINN	Shannon	54.12	35.94	142.26	105.34	72.70	38.25		95.53	74.21	89.18
EISG	Sligo	146.58	60.13	46.80	97.52	23.53	130.45	95.53		137.05	89.18
EIWF	Waterford	56.04	95.09	177.42	79.89	121.02	89.97	74.21	137.05		89.18
	Other	89.18	89.18	89.18	89.18	89.18	89.18	89.18	89.18	89.18	

Table C.13 Number of Domestic and International LTOs

Domestic LTOs No.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	7657	6944	6885	5921	6153	7235	7742	8134	8991	10183	11018	10947	10849	11261	12143	9976	10392	10803	9611	7844	6074	3331	2190	2101	2058	1980
ex Cork	2872	2604	2582	2221	2307	2713	2903	3050	3372	3819	4132	4106	4069	4223	4438	3649	3721	4608	3919	2872	1861	809	445	441	382	259
ex Shannon	1737	1576	1562	1343	1396	1641	1757	1845	2040	2310	2500	2484	2462	2555	2865	2809	2892	2277	1897	1349	1077	834	764	800	696	636
ex Galway	1425	1293	1282	1102	1145	1347	1441	1514	1674	1895	2051	2038	2019	2096	2224	1631	1615	1815	1848	1563	1746	1252	51	31	NO	11
ex Sligo	620	562	557	479	498	586	627	658	728	824	892	886	878	912	946	759	748	754	785	741	678	381	35	25	24	20
ex Donegal	581	527	523	449	467	549	588	617	682	773	836	831	824	855	717	684	747	736	754	739	697	721	733	723	732	725
ex Knock	445	404	400	344	358	421	450	473	523	592	641	637	631	655	753	565	557	568	481	510	454	253	79	83	67	60
ex Kerry	1133	1027	1019	876	910	1070	1145	1203	1330	1506	1630	1620	1605	1666	1755	1477	1515	1506	1418	1170	1048	460	781	776	775	778
ex Waterford	236	214	213	183	190	223	239	251	278	314	340	338	335	348	254	181	191	279	456	231	472	707	175	155	67	68
ex Other	347	314	312	268	279	328	350	368	407	461	499	496	491	510	539	495	518	411	476	305	282	277	241	282	191	205
Total	**17053**	**15465**	**15334**	**13187**	**13703**	**16113**	**17242**	**18115**	**20024**	**22679**	**24538**	**24381**	**24164**	**25080**	**26634**	**22226**	**22896**	**23757**	**21645**	**17324**	**14389**	**9025**	**5494**	**5417**	**4992**	**4742**

International LTOs No.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	55852	55883	54508	53675	59073	57901	63622	68297	73636	77422	81886	84365	82626	80766	95337	80726	85400	92464	94445	79668	73356	76791	78842	82481	87460	96269
ex Cork	14462	14499	10796	6839	6667	7636	9186	8963	8478	9684	11309	11362	10089	12190	13860	13456	13210	17784	13462	10840	10664	11007	11122	10459	10235	9469
ex Shannon	22817	20455	17827	16611	15328	16659	18126	15413	17567	19731	20672	18415	14147	14445	14831	15811	16504	19449	16075	14037	10493	10785	9601	9328	10870	9561
ex Galway	1626	1586	1452	1347	1415	1435	1588	1618	1740	1865	1988	1993	1866	1875	1915	2139	1989	2937	2174	1627	1353	793	69	87	NO	49
ex Sligo	62	61	55	51	54	55	61	62	66	71	76	76	71	72	27	34	36	164	204	36	54	45	21	23	12	8
ex Donegal	203	198	181	168	177	179	198	202	217	233	248	249	233	234	121	147	268	320	410	218	260	291	264	299	330	210
ex Knock	2070	2019	1848	1714	1802	1827	2021	2060	2216	2375	2531	2537	2375	2387	2203	2381	2571	2378	2726	2728	2593	2930	3275	3179	3187	2667
ex Kerry	1358	1324	1212	1124	1182	1198	1326	1351	1453	1558	1660	1664	1558	1566	1846	1626	1675	1622	1751	1429	1658	1538	1246	1378	1238	1200
ex Waterford	1221	1191	1090	1011	1063	1077	1192	1215	1307	1400	1493	1496	1401	1408	1161	1122	1351	1800	2152	1502	1404	1468	1452	536	496	740
ex Other	617	602	551	511	537	545	603	614	660	708	754	756	708	712	943	695	854	849	862	419	712	747	702	745	659	621
Total	**100287**	**97817**	**89520**	**83052**	**87298**	**88511**	**97921**	**99795**	**107341**	**115048**	**122617**	**122913**	**115074**	**115655**	**132244**	**118137**	**123858**	**139767**	**134261**	**112504**	**102547**	**106395**	**106594**	**108515**	**114487**	**120794**

Table C.14 Domestic LTO EFs by aircraft type

Aircraft Type	kg of fuel per LTO	NO_x kg/ LTO	HC kg/ LTO	CO kg/ LTO
A30B	1540.55	23.20	5.54	25.84
A310	1540.55	23.20	5.54	25.84
A320	802.33	10.83	1.92	17.59
A321	802.33	10.83	1.92	17.59
A332	2231.52	36.13	2.11	21.50
A333	2231.52	36.13	2.11	21.50
A343	2231.52	36.13	2.11	21.50
AT43	115.20	1.02	0.00	0.86
AT72	137.00	1.35	0.00	0.86
ATP	569.51	4.19	1.01	9.69
B462	569.51	4.19	1.01	9.69
B463	569.51	4.19	1.01	9.69
B733	825.39	8.25	0.67	11.83
B734	825.39	8.25	0.67	11.83
B737	784.12	7.84	0.63	11.24
B738	763.48	7.64	0.62	10.94
B752	1253.00	19.73	1.23	12.55
B762	1617.09	26.03	0.88	6.08
B763	1617.09	26.03	0.88	6.08
B764	1617.09	26.03	0.88	6.08
BE20	51.80	0.24	0.13	0.76
BE40	58.30	0.24	0.23	1.87
CL30	569.51	4.19	1.01	9.69
CL60	569.51	4.19	1.01	9.69
DC10	2381.18	41.71	22.83	61.62
GLF2	569.51	4.19	1.01	9.69
GLF4	569.51	4.19	1.01	9.69
GLF5	569.51	4.19	1.01	9.69
H25B	569.51	4.19	1.01	9.69
LJ31	569.51	4.19	1.01	9.69
LJ45	569.51	4.19	1.01	9.69
LJ60	569.51	4.19	1.01	9.69
MD11	1003.06	12.34	1.92	6.52
MD82	1003.06	12.34	1.92	6.52
MD83	1003.06	12.34	1.92	6.52
T154	2190.00	14.00	75.90	116.81
Other	49.57	0.29	0.20	0.75

Table C.15 International LTO EFs by aircraft type

Aircraft Type	kg of fuel per LTO	NO_x kg/ LTO	HC kg/ LTO	CO kg/ LTO
A30B	1540.55	23.20	5.54	25.84
A109	51.80	0.24	0.13	0.76
A124	3413.87	55.94	37.25	78.23
A306	1540.55	23.20	5.54	25.84
A310	1540.55	23.20	5.54	25.84
A318	802.33	10.83	1.92	17.59
A319	802.33	10.83	1.92	17.59
A320	802.33	10.83	1.92	17.59
A321	802.33	10.83	1.92	17.59
A332	2231.52	36.13	2.11	21.50
A333	2231.52	36.13	2.11	21.50
A748	569.51	4.19	1.01	9.69
AC90	50.53	0.29	0.20	0.75
AJET	569.51	4.19	1.01	9.69
AN72	569.51	0.29	1.01	9.69
AT43	115.20	1.02	0.00	0.86
AT45	115.20	1.02	0.00	0.86
AT72	137.00	1.35	0.00	0.86
ATP	569.51	4.19	1.01	9.69
B190	61.10	0.26	0.63	2.23
B350	59.40	0.25	0.23	1.89
B461	569.51	4.19	1.01	9.69
B462	569.51	4.19	1.01	9.69
B463	569.51	4.19	1.01	9.69
B732	919.70	7.97	0.58	4.82
B733	825.39	8.25	0.67	11.83
B734	825.39	8.25	0.67	11.83
B735	825.39	8.25	0.67	11.83
B736	825.39	8.25	0.67	11.83
B737	784.12	7.84	0.63	11.24
B738	763.48	7.64	0.62	10.94
B742	3413.87	55.94	37.25	78.23
B744	3402.16	56.64	1.85	19.50
B752	1253.00	19.73	1.23	12.55
B753	1253.00	19.73	1.23	12.55
B762	1617.09	26.03	0.88	6.08
B763	1617.09	26.03	0.88	6.08
B764	1617.09	26.03	0.88	6.08
B772	2562.84	53.64	22.77	61.38
BE9L	51.80	0.24	0.13	0.76
BE9T	51.80	0.24	0.13	0.76
BE20	51.80	0.24	0.13	0.76
BE40	58.30	0.24	0.23	1.87
BE58	58.30	0.24	0.23	1.87
BE76	58.30	0.24	0.23	1.87
C10T	30.40	0.17	0.03	0.29
C25A	30.40	0.17	0.03	0.29
C25B	30.40	0.17	0.03	0.29
C56X	30.40	0.17	0.03	0.29
C130	306.50	2.22	0.90	1.95
C160	306.50	2.22	0.90	1.95
C172	30.40	0.17	0.03	0.29
C182	30.40	0.17	0.03	0.29
C208	30.40	0.17	0.03	0.29
C210	30.40	0.17	0.03	0.29
C340	50.53	0.29	0.20	0.75
C441	50.53	0.29	0.20	0.75
C500	50.53	0.29	0.20	0.75
C510	50.53	0.29	0.20	0.75
C525	666.07	5.19	32.86	32.72
C550	666.07	5.19	32.86	32.72
C551	666.07	5.19	32.86	32.72
C560	666.07	5.19	32.86	32.72
C650	666.07	5.19	32.86	32.72
C680	666.07	5.19	32.86	32.72
C750	666.07	5.19	32.86	32.72
CL30	569.51	4.19	1.01	9.69
CL60	569.51	4.19	1.01	9.69
CN35	666.07	5.19	32.86	32.72
CRJ2	666.07	5.19	32.86	32.72
D228	126.70	1.23	0.00	0.71
D328	126.70	1.23	0.00	0.71
DC10	2381.18	41.71	22.83	61.62
DC86	876.10	7.26	0.77	5.35
DC87	876.10	7.26	0.77	5.35
DC93	876.10	7.26	0.77	5.35
DH8C	189.00	1.89	0.64	1.57
DH8D	215.40	2.49	0.00	1.15
E135	569.51	4.19	1.01	9.69
E145	569.51	4.19	1.01	9.69
E170	569.51	4.19	1.01	9.69
E190	569.51	4.19	1.01	9.69
F2TH	569.51	4.19	1.01	9.69
F27	173.60	0.39	1.73	7.53
F50	126.70	1.28	0.00	0.73
F70	744.38	5.79	1.42	13.68
F100	744.38	5.79	1.42	13.68
F900	569.51	4.19	1.01	9.69
FA7X	569.51	4.19	1.01	9.69
FA50	569.51	4.19	1.01	9.69
G150	569.51	4.19	1.01	9.69
GALX	3413.87	55.94	37.25	78.23
GLEX	569.51	4.19	1.01	9.69
GLF2	569.51	4.19	1.01	9.69
GLF3	569.51	4.19	1.01	9.69
GLF4	569.51	4.19	1.01	9.69
GLF5	569.51	4.19	1.01	9.69
H25A	569.51	4.19	1.01	9.69
H25B	569.51	4.19	1.01	9.69
JS31	45.60	0.38	0.05	0.52
JS41	62.70	0.47	0.09	0.82
L101	1412.83	12.57	65.40	26.37
L188	260.50	1.80	0.84	1.81
L410	127.70	1.30	0.00	0.73
LJ31	569.51	4.19	1.01	9.69
LJ35	569.51	4.19	1.01	9.69
LJ45	569.51	4.19	1.01	9.69
LJ60	569.51	4.19	1.01	9.69
MD11	1003.06	12.34	1.92	6.52
MD82	1003.06	12.34	1.92	6.52
MD83	1003.06	12.34	1.92	6.52
MD87	1003.06	12.34	1.92	6.52
MD90	1003.06	12.34	1.92	6.52
MU2	126.70	1.23	0.00	0.71
P46T	51.18	0.29	0.20	0.75
P68	51.18	0.29	0.20	0.75
PA31	51.18	0.29	0.20	0.75
PA32	51.18	0.29	0.20	0.75
PA34	51.18	0.29	0.20	0.75
PA44	51.18	0.29	0.20	0.75
PA46	51.18	0.29	0.20	0.75
PC9	51.18	0.29	0.20	0.75
PC12	51.18	0.29	0.20	0.75
PRM1	569.51	4.19	1.01	9.69
RJ1H	569.51	4.19	1.01	9.69
RJ70	569.51	4.19	1.01	9.69
RJ85	569.51	4.19	1.01	9.69
SB20	155.40	1.13	0.04	0.85
SF34	75.20	0.50	0.22	0.43
SH36	86.00	0.42	0.68	3.21
SR22	51.18	0.29	0.20	0.75
SW4	46.80	0.39	0.04	0.51
T154	2190.00	14.00	75.90	116.81
TBM7	51.18	0.29	0.20	0.75
TRIN	51.18	0.29	0.20	0.75

Table C.16 Domestic LTO IEFs by airport

IEF kg fuel/LTO	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	539.4	539.4	539.4	539.4	539.4	539.4	539.4	539.4	539.4	539.4	539.4	539.4	539.4	539.4	484.8	509.3	615.3	545.3	555.0	559.5	506.5	420.2	398.6	351.2	337.7	382.2
ex Cork	391.7	391.7	391.7	391.7	391.7	391.7	391.7	391.7	391.7	391.7	391.7	391.7	391.7	391.7	216.7	238.1	412.6	407.9	443.1	505.2	518.3	415.1	180.8	181.2	189.8	239.8
ex Shannon	1361.6	1361.6	1361.6	1361.6	1361.6	1361.6	1361.6	1361.6	1361.6	1361.6	1361.6	1361.6	1361.6	1361.6	1432.0	1491.0	1476.9	1351.3	1377.9	1287.7	1114.3	816.3	858.9	704.2	740.5	914.9
ex Galway	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	132.2	117.7	118.4	122.9	146.2	174.4	124.3	121.3	113.6	97.4	83.2	NA	49.6
ex Sligo	112.8	112.8	112.8	112.8	112.8	112.8	112.8	112.8	112.8	112.8	112.8	112.8	112.8	112.8	111.2	110.5	113.2	112.5	112.3	114.9	115.0	93.4	53.4	50.3	49.6	49.6
ex Donegal	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	112.9	111.4	113.6	113.9	113.2	114.9	114.7	97.7	49.6	49.7	50.3	108.2
ex Knock	198.8	198.8	198.8	198.8	198.8	198.8	198.8	198.8	198.8	198.8	198.8	198.8	198.8	198.8	182.9	186.2	231.3	231.1	217.9	180.9	161.5	151.2	233.5	226.5	354.5	290.5
ex Kerry	339.6	339.6	339.6	339.6	339.6	339.6	339.6	339.6	339.6	339.6	339.6	339.6	339.6	339.6	137.1	151.2	150.1	141.9	370.3	714.9	712.0	469.0	122.1	118.0	117.7	118.7
ex Waterford	141.4	141.4	141.4	141.4	141.4	141.4	141.4	141.4	141.4	141.4	141.4	141.4	141.4	141.4	78.9	83.2	79.2	205.3	293.1	109.4	140.8	115.7	74.1	50.0	57.3	49.6
ex Other	132.8	132.8	132.8	132.8	132.8	132.8	132.8	132.8	132.8	132.8	132.8	132.8	132.8	132.8	147.4	142.4	132.3	154.4	118.7	116.8	117.8	142.3	113.9	99.4	120.3	120.6
Weighted average	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**498.3**	**446.0**	**490.7**	**568.2**	**494.5**	**508.2**	**515.5**	**453.8**	**336.8**	**328.9**	**289.3**	**293.0**	**341.3**

IEF kg NO_x/LTO	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	6.9	7.3	8.7	7.3	7.2	6.8	6.1	5.2	5.6	4.8	4.6	5.1
ex Cork	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	2.1	2.4	4.1	4.0	4.4	5.1	5.3	4.2	1.8	1.8	1.8	2.5
ex Shannon	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	21.8	23.0	23.0	20.5	21.1	19.8	16.9	11.9	12.7	10.1	10.8	13.5
ex Galway	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.0	1.1	1.1	1.3	1.5	1.2	1.1	1.0	0.8	0.5	NA	0.3
ex Sligo	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.3	0.3	0.3	0.3
ex Donegal	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.3	0.3	0.3	0.9
ex Knock	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.8	1.9	2.5	2.4	2.2	1.8	1.5	1.4	2.3	2.2	3.5	2.9
ex Kerry	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	1.3	1.4	1.4	1.4	3.6	7.1	7.1	4.6	1.1	1.0	1.0	1.1
ex Waterford	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.6	0.6	0.6	1.5	2.2	1.0	1.3	1.1	0.6	0.3	0.4	0.3
ex Other	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	0.9	1.1	0.8	0.8	0.8	1.0	0.8	0.7	0.8	1.2
Weighted average	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.2**	**6.9**	**7.9**	**6.4**	**6.4**	**6.2**	**5.4**	**4.0**	**4.4**	**3.8**	**3.8**	**4.5**

Table C.16 Domestic LTO IEFs by airport (continued)

IEF g HC/LTO	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	486.4	486.4	486.4	486.4	486.4	486.4	486.4	486.4	486.4	486.4	486.4	486.4	486.4	486.4	498.7	545.8	518.1	464.7	519.9	461.3	396.1	355.6	362.0	327.7	328.9	258.0
ex Cork	367.2	367.2	367.2	367.2	367.2	367.2	367.2	367.2	367.2	367.2	367.2	367.2	367.2	367.2	229.1	259.4	416.3	372.8	378.7	425.7	488.3	410.7	221.1	236.1	283.3	447.7
ex Shannon	1467.9	1467.9	1467.9	1467.9	1467.9	1467.9	1467.9	1467.9	1467.9	1467.9	1467.9	1467.9	1467.9	1467.9	1844.2	1844.1	1435.3	1338.5	1571.7	1205.1	1036.1	692.2	700.8	596.5	529.8	766.8
ex Galway	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	12.4	16.7	14.8	65.2	126.1	9.8	10.0	33.9	166.0	251.2	NA	36.6
ex Sligo	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	18.9	16.9	9.8	9.0	16.8	7.1	5.6	73.9	195.4	201.2	201.2	201.2
ex Donegal	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	9.3	15.1	8.5	4.7	10.6	4.0	4.1	60.6	201.2	200.6	202.3	22.2
ex Knock	248.7	248.7	248.7	248.7	248.7	248.7	248.7	248.7	248.7	248.7	248.7	248.7	248.7	248.7	173.4	334.4	379.7	296.5	250.5	150.8	155.8	250.4	429.9	415.8	587.0	493.5
ex Kerry	240.3	240.3	240.3	240.3	240.3	240.3	240.3	240.3	240.3	240.3	240.3	240.3	240.3	240.3	36.6	62.1	57.9	44.1	292.5	595.0	593.8	397.9	30.2	32.3	52.6	36.3
ex Waterford	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	232.8	169.6	158.5	180.2	429.1	505.6	98.8	87.8	36.9	127.3	199.4	213.3	201.2
ex Other	321.4	321.4	321.4	321.4	321.4	321.4	321.4	321.4	321.4	321.4	321.4	321.4	321.4	321.4	339.7	335.2	315.1	349.2	299.7	303.5	307.2	342.6	295.7	278.7	311.7	283.4
Weighted average	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**465.7**	**481.7**	**544.3**	**507.4**	**438.3**	**490.9**	**425.9**	**366.7**	**285.4**	**316.8**	**294.8**	**292.6**	**266.7**

IEF g CO/LTO	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	5616.1	5616.1	5616.1	5616.1	5616.1	5616.1	5616.1	5616.1	5616.1	5616.1	5616.1	5616.1	5616.1	5616.1	4772.5	5011.0	5754.5	5419.5	6206.2	6401.4	5747.6	4239.6	3199.9	2796.3	2666.0	2816.8
ex Cork	5389.0	5389.0	5389.0	5389.0	5389.0	5389.0	5389.0	5389.0	5389.0	5389.0	5389.0	5389.0	5389.0	5389.0	2618.6	3142.8	5724.7	5545.8	6066.5	7108.6	7515.8	5941.7	2468.9	2536.4	2824.7	4120.1
ex Shannon	13360.8	13360.8	13360.8	13360.8	13360.8	13360.8	13360.8	13360.8	13360.8	13360.8	13360.8	13360.8	13360.8	13360.8	15486.7	15727.4	13951.0	12686.2	14136.5	11681.8	9855.9	6080.6	6106.7	5075.6	4591.1	6688.1
ex Galway	1092.6	1092.6	1092.6	1092.6	1092.6	1092.6	1092.6	1092.6	1092.6	1092.6	1092.6	1092.6	1092.6	1092.6	902.4	894.4	890.9	1344.6	1870.4	877.2	868.4	859.1	1137.8	1326.3	NA	749.0
ex Sligo	865.7	865.7	865.7	865.7	865.7	865.7	865.7	865.7	865.7	865.7	865.7	865.7	865.7	865.7	881.5	865.4	869.4	857.2	866.6	859.3	860.1	821.3	752.3	749.0	749.1	749.1
ex Donegal	865.9	865.9	865.9	865.9	865.9	865.9	865.9	865.9	865.9	865.9	865.9	865.9	865.9	865.9	870.3	867.8	871.8	860.3	869.3	861.0	860.9	842.0	749.0	749.4	761.3	850.7
ex Knock	2495.3	2495.3	2495.3	2495.3	2495.3	2495.3	2495.3	2495.3	2495.3	2495.3	2495.3	2495.3	2495.3	2495.3	2246.9	2756.5	2939.7	3218.3	2719.8	1941.7	1644.1	1976.2	3753.1	3646.7	5401.0	4527.9
ex Kerry	4291.6	4291.6	4291.6	4291.6	4291.6	4291.6	4291.6	4291.6	4291.6	4291.6	4291.6	4291.6	4291.6	4291.6	1109.5	1305.4	1217.9	1068.6	4846.7	10266.2	10226.5	6569.8	1026.8	994.2	1024.5	929.9
ex Waterford	1891.3	1891.3	1891.3	1891.3	1891.3	1891.3	1891.3	1891.3	1891.3	1891.3	1891.3	1891.3	1891.3	1891.3	986.0	977.6	1004.6	3381.6	4637.5	979.9	1271.5	868.9	797.3	749.8	882.5	749.0
ex Other	2170.1	2170.1	2170.1	2170.1	2170.1	2170.1	2170.1	2170.1	2170.1	2170.1	2170.1	2170.1	2170.1	2170.1	2426.0	2340.1	2166.0	2504.7	1933.5	1897.7	1922.5	2336.7	1838.1	1605.3	1966.5	1618.6
Weighted average	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**5363.0**	**4603.3**	**5091.6**	**5633.5**	**5140.3**	**5832.6**	**5936.2**	**5199.7**	**3410.5**	**2746.0**	**2455.0**	**2389.2**	**2723.7**

Table C.17 International LTO IEFs by airport

IEF kg fuel/LTO	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	781.5	781.5	781.5	781.5	781.5	781.5	781.5	781.5	781.5	781.5	781.5	781.5	781.5	781.5	790.1	786.4	770.7	772.2	789.7	791.8	770.0	771.8	766.0	745.1	735.0	734.4
ex Cork	622.6	622.6	622.6	622.6	622.6	622.6	622.6	622.6	622.6	622.6	622.6	622.6	622.6	622.6	580.4	623.4	640.7	586.3	653.6	652.1	622.2	600.8	597.4	588.2	555.0	539.9
ex Shannon	960.4	960.4	960.4	960.4	960.4	960.4	960.4	960.4	960.4	960.4	960.4	960.4	960.4	960.4	997.9	939.4	955.7	1011.1	948.8	940.1	929.6	868.5	775.3	766.4	724.6	653.6
ex Galway	139.5	139.5	139.5	139.5	139.5	139.5	139.5	139.5	139.5	139.5	139.5	139.5	139.5	139.5	121.4	172.5	134.5	142.2	143.5	135.2	127.5	128.3	256.4	191.7	NA	167.4
ex Sligo	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	67.5	49.6	49.6	49.6	109.3	115.1	50.0	49.6	88.0	49.2	128.9	49.5	122.2
ex Donegal	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	100.6	107.6	90.1	88.6	85.1	105.2	94.5	96.6	75.1	87.2	86.7	106.0
ex Knock	732.0	732.0	732.0	732.0	732.0	732.0	732.0	732.0	732.0	732.0	732.0	732.0	732.0	732.0	619.6	732.5	761.0	760.2	751.8	751.7	747.3	724.0	633.8	627.5	661.9	701.0
ex Kerry	578.8	578.8	578.8	578.8	578.8	578.8	578.8	578.8	578.8	578.8	578.8	578.8	578.8	578.8	629.1	588.2	574.5	560.5	566.2	581.8	551.1	555.2	595.0	614.8	604.7	590.7
ex Waterford	162.2	162.2	162.2	162.2	162.2	162.2	162.2	162.2	162.2	162.2	162.2	162.2	162.2	162.2	164.4	168.2	182.6	173.6	177.5	137.1	131.9	120.0	123.6	157.4	170.2	133.2
ex Other	245.7	245.7	245.7	245.7	245.7	245.7	245.7	245.7	245.7	245.7	245.7	245.7	245.7	245.7	249.0	213.2	279.7	236.8	299.3	233.5	208.1	214.2	198.9	206.2	204.9	209.6
Weighted average	**772.5**	**768.5**	**771.1**	**777.4**	**774.0**	**774.6**	**772.9**	**768.0**	**771.4**	**772.0**	**770.2**	**766.8**	**762.8**	**760.3**	**766.5**	**763.1**	**756.9**	**752.6**	**764.8**	**771.3**	**743.6**	**739.6**	**728.5**	**717.7**	**707.0**	**702.8**

IEF kg NO_x/LTO	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	8.6	9.1	9.2	9.2	9.5	9.6	9.4	9.4	9.4	9.2	9.0	8.9
ex Cork	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	6.4	7.2	7.5	6.6	7.7	8.0	7.6	7.3	7.2	6.9	6.5	6.3
ex Shannon	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	13.0	12.1	12.4	13.5	12.1	12.0	12.5	11.8	10.0	9.8	9.1	7.7
ex Galway	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.1	1.5	1.3	1.4	1.4	1.3	1.2	1.2	1.9	1.4	NA	1.2
ex Sligo	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.3	1.0	1.1	0.3	0.3	0.7	0.3	0.9	0.3	0.9
ex Donegal	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.7	0.7	0.9	0.8	0.8	0.5	0.6	0.6	0.9
ex Knock	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	6.7	7.8	8.2	8.1	7.7	7.8	7.8	7.6	6.7	6.6	6.9	7.4
ex Kerry	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	6.0	5.6	5.5	5.4	5.5	5.7	5.4	5.4	5.9	6.0	5.9	5.8
ex Waterford	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.6	1.5	1.5	1.3	1.2	1.1	1.1	1.6	1.8	1.3
ex Other	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.5	2.1	1.7	2.2	1.7	1.5	1.6	1.4	1.5	1.5	1.5
Weighted average	**9.3**	**9.3**	**9.3**	**9.4**	**9.3**	**9.3**	**9.3**	**9.2**	**9.3**	**9.3**	**9.2**	**9.2**	**9.1**	**9.1**	**8.6**	**8.9**	**9.1**	**9.1**	**9.2**	**9.4**	**9.1**	**9.1**	**8.9**	**8.8**	**8.6**	**8.4**

Table C.17 International LTO IEFs by airport (continued)

IEF g HC/LTO	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	1319.4	1319.4	1319.4	1319.4	1319.4	1319.4	1319.4	1319.4	1319.4	1319.4	1319.4	1319.4	1319.4	1319.4	1273.9	1417.0	1391.7	1314.4	1250.9	1276.9	1311.2	1370.5	1276.5	1242.2	1184.5	1134.2
ex Cork	1222.0	1222.0	1222.0	1222.0	1222.0	1222.0	1222.0	1222.0	1222.0	1222.0	1222.0	1222.0	1222.0	1222.0	1023.4	1118.4	1244.1	1067.4	1326.7	1400.3	1373.6	1286.5	1233.3	1218.5	1177.1	1094.8
ex Shannon	3191.1	3191.1	3191.1	3191.1	3191.1	3191.1	3191.1	3191.1	3191.1	3191.1	3191.1	3191.1	3191.1	3191.1	4805.3	2983.4	2614.7	3200.3	2871.8	2790.7	3071.6	2857.9	1800.2	1719.1	1558.0	1518.8
ex Galway	183.4	183.4	183.4	183.4	183.4	183.4	183.4	183.4	183.4	183.4	183.4	183.4	183.4	183.4	398.3	306.8	297.1	36.4	208.2	18.9	18.2	157.0	3254.3	4031.9	NA	1647.1
ex Sligo	161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4	201.2	201.2	201.2	38.0	86.0	201.2	201.2	168.9	178.9	3025.0	183.1	4239.9
ex Donegal	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	44.9	23.3	53.3	51.9	60.4	27.6	44.2	300.2	221.6	312.1	193.1	37.9
ex Knock	810.9	810.9	810.9	810.9	810.9	810.9	810.9	810.9	810.9	810.9	810.9	810.9	810.9	810.9	916.7	882.6	870.8	747.2	713.3	767.2	778.8	735.3	701.5	691.8	772.9	772.7
ex Kerry	3984.7	3984.7	3984.7	3984.7	3984.7	3984.7	3984.7	3984.7	3984.7	3984.7	3984.7	3984.7	3984.7	3984.7	6263.7	5648.8	4898.5	4953.0	3729.6	1293.6	1105.4	1205.8	1054.0	1418.5	1418.0	1309.3
ex Waterford	1316.0	1316.0	1316.0	1316.0	1316.0	1316.0	1316.0	1316.0	1316.0	1316.0	1316.0	1316.0	1316.0	1316.0	1504.4	2115.8	2816.1	1755.4	709.7	278.6	31.8	165.4	178.9	501.3	678.5	876.5
ex Other	5006.8	5006.8	5006.8	5006.8	5006.8	5006.8	5006.8	5006.8	5006.8	5006.8	5006.8	5006.8	5006.8	5006.8	2756.7	3075.0	5958.6	5696.2	7627.5	6377.7	3556.0	3756.7	2865.2	2727.0	2693.6	3649.3
Weighted average	**1757.7**	**1722.9**	**1706.9**	**1712.3**	**1667.1**	**1689.8**	**1683.3**	**1626.3**	**1644.6**	**1658.7**	**1652.5**	**1617.3**	**1567.5**	**1569.4**	**1705.9**	**1634.3**	**1601.7**	**1579.0**	**1483.9**	**1450.2**	**1458.2**	**1480.3**	**1292.8**	**1273.6**	**1213.9**	**1165.1**

IEF g CO/LTO	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	12251.0	12251.0	12251.0	12251.0	12251.0	12251.0	12251.0	12251.0	12251.0	12251.0	12251.0	12251.0	12251.0	12251.0	10630.9	11609.4	12621.3	12572.8	12710.2	12941.2	12671.4	12734.7	12669.3	12335.8	12060.4	11860.7
ex Cork	11136.8	11136.8	11136.8	11136.8	11136.8	11136.8	11136.8	11136.8	11136.8	11136.8	11136.8	11136.8	11136.8	11136.8	9498.5	10716.1	11365.1	10090.7	11886.4	12436.9	11963.6	11325.4	11267.2	10915.1	10368.0	10112.6
ex Shannon	14169.3	14169.3	14169.3	14169.3	14169.3	14169.3	14169.3	14169.3	14169.3	14169.3	14169.3	14169.3	14169.3	14169.3	13639.4	12646.8	12761.6	14364.8	15086.6	15232.3	15453.7	14151.2	11564.6	11593.1	10929.8	10561.0
ex Galway	1185.6	1185.6	1185.6	1185.6	1185.6	1185.6	1185.6	1185.6	1185.6	1185.6	1185.6	1185.6	1185.6	1185.6	1157.2	1936.6	1132.0	1004.8	1207.3	935.3	925.9	1113.4	5986.6	5594.4	NA	3617.6
ex Sligo	780.3	780.3	780.3	780.3	780.3	780.3	780.3	780.3	780.3	780.3	780.3	780.3	780.3	780.3	749.0	749.0	749.0	841.7	875.1	749.0	749.0	985.8	759.2	3927.8	806.3	4631.2
ex Donegal	836.8	836.8	836.8	836.8	836.8	836.8	836.8	836.8	836.8	836.8	836.8	836.8	836.8	836.8	837.8	850.1	836.3	837.9	826.6	835.2	834.0	1062.7	446.7	645.0	548.6	813.4
ex Knock	11012.3	11012.3	11012.3	11012.3	11012.3	11012.3	11012.3	11012.3	11012.3	11012.3	11012.3	11012.3	11012.3	11012.3	9888.0	10655.4	11771.8	10851.1	10958.1	11455.4	11506.5	10954.4	9499.5	9453.9	10027.6	10744.2
ex Kerry	10738.7	10738.7	10738.7	10738.7	10738.7	10738.7	10738.7	10738.7	10738.7	10738.7	10738.7	10738.7	10738.7	10738.7	12959.6	12094.1	11259.5	11243.2	10368.5	8933.1	8313.1	8452.7	8941.9	9482.0	9375.3	9094.9
ex Waterford	2470.9	2470.9	2470.9	2470.9	2470.9	2470.9	2470.9	2470.9	2470.9	2470.9	2470.9	2470.9	2470.9	2470.9	2826.7	3126.3	3832.4	2987.0	2319.7	1232.1	972.4	1060.9	1056.7	1476.8	1758.7	1619.3
ex Other	7153.7	7153.7	7153.7	7153.7	7153.7	7153.7	7153.7	7153.7	7153.7	7153.7	7153.7	7153.7	7153.7	7153.7	5645.7	5344.5	8370.4	7484.4	9785.0	7871.5	5574.7	5784.7	4858.8	4968.9	4920.8	5637.8
Weighted average	**12120.7**	**12080.9**	**12092.6**	**12136.9**	**12096.7**	**12109.9**	**12095.5**	**12041.2**	**12070.9**	**12080.2**	**12065.6**	**12029.4**	**11983.1**	**11967.1**	**10617.5**	**11324.8**	**12131.4**	**12023.5**	**12420.2**	**12715.3**	**12381.8**	**12288.2**	**12036.0**	**11870.7**	**11596.1**	**11450.9**

Table C.18 Domestic Cruise IEFs by airport

IEF kg fuel/Cruise	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	494.8	494.8	494.8	494.8	494.8	494.8	494.8	494.8	494.8	494.8	494.8	494.8	494.8	494.8	442.3	459.8	537.6	496.4	510.5	526.2	490.8	409.1	390.2	359.3	348.4	394.5
ex Cork	394.2	394.2	394.2	394.2	394.2	394.2	394.2	394.2	394.2	394.2	394.2	394.2	394.2	394.2	245.3	266.9	399.9	410.7	439.8	494.8	501.9	394.4	173.2	168.7	188.6	256.9
ex Shannon	979.8	979.8	979.8	979.8	979.8	979.8	979.8	979.8	979.8	979.8	979.8	979.8	979.8	979.8	1010.3	1055.9	1059.3	978.1	990.0	938.6	826.5	625.6	655.3	549.0	573.7	710.4
ex Galway	167.3	167.3	167.3	167.3	167.3	167.3	167.3	167.3	167.3	167.3	167.3	167.3	167.3	167.3	159.4	160.3	158.5	176.9	196.1	160.5	159.2	147.9	124.7	102.8	NA	89.6
ex Sligo	165.7	165.7	165.7	165.7	165.7	165.7	165.7	165.7	165.7	165.7	165.7	165.7	165.7	165.7	164.2	164.1	166.9	165.6	163.6	167.6	168.0	143.7	108.2	97.6	92.5	91.6
ex Donegal	213.7	213.7	213.7	213.7	213.7	213.7	213.7	213.7	213.7	213.7	213.7	213.7	213.7	213.7	212.1	210.6	213.8	215.2	212.4	216.0	215.6	191.0	126.4	127.0	127.4	208.0
ex Knock	214.5	214.5	214.5	214.5	214.5	214.5	214.5	214.5	214.5	214.5	214.5	214.5	214.5	214.5	192.6	202.7	242.8	244.8	230.1	201.6	186.8	176.0	240.2	232.3	323.4	276.9
ex Kerry	421.1	421.1	421.1	421.1	421.1	421.1	421.1	421.1	421.1	421.1	421.1	421.1	421.1	421.1	246.7	247.8	247.0	242.4	452.1	757.9	753.8	533.6	242.7	240.6	229.9	229.6
ex Waterford	158.9	158.9	158.9	158.9	158.9	158.9	158.9	158.9	158.9	158.9	158.9	158.9	158.9	158.9	104.8	109.8	105.5	210.1	287.0	130.4	164.8	151.2	101.9	72.7	88.4	87.5
ex Other	150.6	150.6	150.6	150.6	150.6	150.6	150.6	150.6	150.6	150.6	150.6	150.6	150.6	150.6	160.2	157.6	148.5	165.4	139.9	140.7	141.8	159.7	138.0	128.0	143.8	136.8
Weighted average	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**454.5**	**402.0**	**433.5**	**492.9**	**451.1**	**467.0**	**485.6**	**440.6**	**334.9**	**326.7**	**298.9**	**303.9**	**354.8**

IEF kg NO_x/Cruise	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	9.2	10.6	8.9	9.0	8.3	7.2	5.9	6.2	5.3	5.0	5.7
ex Cork	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	2.9	3.2	5.1	4.9	5.3	6.0	6.2	5.0	2.2	2.1	2.5	3.7
ex Shannon	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	25.2	26.6	26.5	23.3	24.6	22.2	18.5	11.7	12.4	9.3	9.9	12.9
ex Galway	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.5	1.5	1.6	1.8	2.1	1.6	1.5	1.4	1.2	0.9	NA	0.7
ex Sligo	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.5	1.4	1.5	1.5	1.5	1.3	0.8	0.7	0.7	0.7
ex Donegal	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.7	0.9	1.0	1.0	1.8
ex Knock	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.2	2.5	3.2	3.2	2.8	2.3	2.0	2.0	3.3	3.1	4.5	4.0
ex Kerry	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	2.6	2.8	2.8	2.7	5.4	9.2	9.2	6.3	2.2	2.2	2.2	2.2
ex Waterford	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	0.9	1.0	1.0	2.4	3.5	1.4	1.8	1.5	0.8	0.5	0.7	0.7
ex Other	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.7	1.6	1.5	1.8	1.4	1.4	1.4	1.7	1.3	1.2	1.4	1.6
Weighted average	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.9**	**7.7**	**8.5**	**9.5**	**7.8**	**7.9**	**7.5**	**6.4**	**4.7**	**5.0**	**4.2**	**4.3**	**5.1**

Table C.18 Domestic Cruise IEFs by airport (continued)

IEF g HC/Cruise	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	226.6	226.6	226.6	226.6	226.6	226.6	226.6	226.6	226.6	226.6	226.6	226.6	226.6	226.6	248.8	250.3	286.7	229.5	233.4	187.5	150.2	137.3	178.0	142.6	148.1	80.3
ex Cork	78.3	78.3	78.3	78.3	78.3	78.3	78.3	78.3	78.3	78.3	78.3	78.3	78.3	78.3	38.4	49.5	85.9	80.5	85.8	95.1	112.9	104.7	63.2	76.6	87.4	125.2
ex Shannon	790.9	790.9	790.9	790.9	790.9	790.9	790.9	790.9	790.9	790.9	790.9	790.9	790.9	790.9	842.0	888.3	911.3	789.6	845.9	720.7	538.7	245.7	255.8	136.1	153.7	212.0
ex Galway	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	7.8	11.1	10.2	21.8	36.4	6.5	6.5	25.1	96.9	144.3	NA	145.0
ex Sligo	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	14.9	14.6	10.4	10.3	13.9	5.8	4.4	58.7	164.0	158.0	149.7	148.3
ex Donegal	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	10.7	16.3	10.4	6.4	9.5	4.1	4.2	60.4	204.6	204.5	205.2	22.5
ex Knock	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.5	39.4	104.1	113.6	59.9	72.0	47.9	63.7	110.0	157.0	166.6	186.6	198.2
ex Kerry	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.9	19.4	23.0	25.9	22.3	94.8	158.8	159.1	120.8	14.5	21.7	42.3	30.8
ex Waterford	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	110.3	108.1	105.6	116.5	172.0	169.9	60.4	39.3	23.0	74.3	116.7	135.1	141.6
ex Other	170.8	170.8	170.8	170.8	170.8	170.8	170.8	170.8	170.8	170.8	170.8	170.8	170.8	170.8	178.0	173.6	175.8	179.6	168.2	159.8	160.9	165.4	158.0	156.9	160.9	157.1
Weighted average	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**209.0**	**218.9**	**243.4**	**270.0**	**205.8**	**212.3**	**173.5**	**137.6**	**109.7**	**154.5**	**127.7**	**137.0**	**89.6**

IEF g CO/Cruise	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ex Dublin	1970.0	1970.0	1970.0	1970.0	1970.0	1970.0	1970.0	1970.0	1970.0	1970.0	1970.0	1970.0	1970.0	1970.0	1934.1	1918.7	1968.0	1960.0	1936.5	2037.0	2035.7	1831.1	1901.7	1869.0	1786.3	2065.4
ex Cork	1706.3	1706.3	1706.3	1706.3	1706.3	1706.3	1706.3	1706.3	1706.3	1706.3	1706.3	1706.3	1706.3	1706.3	1521.9	1626.5	1563.0	1742.6	1758.8	1894.4	1836.8	1476.1	990.8	964.5	985.2	1069.5
ex Shannon	2335.6	2335.6	2335.6	2335.6	2335.6	2335.6	2335.6	2335.6	2335.6	2335.6	2335.6	2335.6	2335.6	2335.6	2276.0	2381.3	2546.1	2400.7	2341.4	2305.5	2098.6	1778.2	1860.3	1696.9	1761.5	1916.1
ex Galway	1370.2	1370.2	1370.2	1370.2	1370.2	1370.2	1370.2	1370.2	1370.2	1370.2	1370.2	1370.2	1370.2	1370.2	1501.4	1453.5	1334.4	1332.7	1265.4	1326.2	1377.5	1266.7	928.3	831.1	NA	857.1
ex Sligo	1624.9	1624.9	1624.9	1624.9	1624.9	1624.9	1624.9	1624.9	1624.9	1624.9	1624.9	1624.9	1624.9	1624.9	1625.9	1628.8	1650.2	1643.8	1582.6	1615.1	1628.1	1357.5	1014.7	933.8	884.8	876.3
ex Donegal	2109.3	2109.3	2109.3	2109.3	2109.3	2109.3	2109.3	2109.3	2109.3	2109.3	2109.3	2109.3	2109.3	2109.3	2116.3	2084.2	2115.6	2131.8	2087.3	2114.0	2116.1	1842.1	1209.3	1215.1	1212.0	2054.1
ex Knock	1350.8	1350.8	1350.8	1350.8	1350.8	1350.8	1350.8	1350.8	1350.8	1350.8	1350.8	1350.8	1350.8	1350.8	1358.6	1225.5	1278.9	1450.2	1398.1	1397.3	1347.3	1085.9	1042.9	1065.7	1115.8	1102.3
ex Kerry	1927.2	1927.2	1927.2	1927.2	1927.2	1927.2	1927.2	1927.2	1927.2	1927.2	1927.2	1927.2	1927.2	1927.2	1914.6	1646.1	1632.7	1623.5	1889.4	2400.6	2383.5	2163.3	2240.6	2263.8	2071.6	1941.3
ex Waterford	951.1	951.1	951.1	951.1	951.1	951.1	951.1	951.1	951.1	951.1	951.1	951.1	951.1	951.1	931.2	936.0	877.4	903.9	1006.4	953.2	1049.3	1231.4	996.4	700.0	791.9	836.9
ex Other	936.9	936.9	936.9	936.9	936.9	936.9	936.9	936.9	936.9	936.9	936.9	936.9	936.9	936.9	967.8	948.4	968.3	958.8	934.5	890.3	890.3	901.2	890.9	883.2	888.3	911.2
Weighted average	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1850.8**	**1813.4**	**1824.9**	**1854.3**	**1844.2**	**1818.3**	**1926.5**	**1868.3**	**1617.5**	**1677.7**	**1631.9**	**1620.6**	**1881.4**

Table C.19 Other Aviation EFs (SO_2, PM, Heavy Metals and POPs)

Emission Factors						
	Code	Name				Inventory Year
NFR Source Category	1.A.3.a	Civil Aviation & International Aviation				2015
	Gasoline			**Kerosene**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
SO_x	0.800	kg/LTO	Guidebook	0.970	kg/LTO	Guidebook
TSP	0.150	kg/LTO	CEPMEIP	0.150	kg/LTO	CEPMEIP
PM_{10}	0.150	kg/LTO	CEPMEIP	0.150	kg/LTO	CEPMEIP
$PM_{2.5}$	0.150	kg/LTO	CEPMEIP	0.150	kg/LTO	CEPMEIP
Pb	191.714	mg/Mg	CS	0.080	mg/Mg	EMEP/EEA 2013
Cd	0.242	mg/Mg	EMEP/EEA 2013	0.006	mg/Mg	EMEP/EEA 2013
Hg	0.195	mg/Mg	EMEP/EEA 2013	0.120	mg/Mg	EMEP/EEA 2013
As	0.007	mg/Mg	EMEP/EEA 2013	0.030	mg/Mg	EMEP/EEA 2013
Cr	0.359	mg/Mg	EMEP/EEA 2013	0.200	mg/Mg	EMEP/EEA 2013
Cu	0.942	mg/Mg	EMEP/EEA 2013	0.220	mg/Mg	EMEP/EEA 2013
Ni	0.292	mg/Mg	EMEP/EEA 2013	0.008	mg/Mg	EMEP/EEA 2013
Se	0.004	mg/Mg	EMEP/EEA 2013	0.110	mg/Mg	EMEP/EEA 2013
Zn	48.509	mg/Mg	EMEP/EEA 2013	29.000	mg/Mg	EMEP/EEA 2013
PCDD/F (I-TEQ)	NE			NE		
Benzo[a]pyrene	NE			NE		
Benzo[b]fluoranthene	NE			NE		
Benzo[k]Fluoranthene	NE			NE		
Indeno[1,2,3-cd]pyrene	NE			NE		
Total 4 PAHs	NE			NE		
HCB	NA			NA		

Table C.20 Emission Factors for NFR 1A3. (c and d)

Emission Factors			
	Code	Name	Inventory year
NFR Source Category	1.A.3.c	Railways	2015
Fuel	**Gasoil**		
Pollutant	**Value**	**Unit**	**Reference**
NO_x	1209.931	g/GJ	EMEP/EEA 2013
SO_x	15.885	g/GJ	CS
NMVOC	107.370	g/GJ	EMEP/EEA 2013
CO	247.066	g/GJ	EMEP/EEA 2013
NH_3	0.162	g/GJ	EMEP/EEA 2013
TSP	35.097	g/GJ	EMEP/EEA 2013
PM_{10}	33.250	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	31.634	g/GJ	EMEP/EEA 2013
BC	0.650	f-TSP	EMEP/EEA 2013
Pb	NE		EMEP/EEA 2013
Cd	0.010	g/t	EMEP/EEA 2013
Hg	NE		EMEP/EEA 2013
As	NE		EMEP/EEA 2013
Cr	0.050	g/t	EMEP/EEA 2013
Cu	1.700	g/t	EMEP/EEA 2013
Ni	0.070	g/t	EMEP/EEA 2013
Se	0.010	g/t	EMEP/EEA 2013
Zn	1.000	g/t	EMEP/EEA 2013
PCB	NE		EMEP/EEA 2013
PCDD/F (I-TEQ)	NE		EMEP/EEA 2013
Benzo[a]pyrene	0.030	g/t	EMEP/EEA 2013
Benzo[b]fluoranthene	0.050	g/t	EMEP/EEA 2013
Benzo[k]Fluoranthene	NE		EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	NE		EMEP/EEA 2013
Total 4 PAHs	0.080	g/t	EMEP/EEA 2013
HCB	NE		EMEP/EEA 2013

Emission Factors						
	Code	Name	Inventory year			
NFR Source Category	1.A.3.d	National Navigation	2015			
Fuel	**Gasoil**			**Fuel Oil**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	1812.587	g/GJ	EMEP/EEA 2013	1923.087	g/GJ	EMEP/EEA 2013
SO_x	32.325	g/GJ	CS	223.084	g/GJ	CS
NMVOC	64.653	g/GJ	EMEP/EEA 2013	65.477	g/GJ	EMEP/EEA 2013
CO	170.868	g/GJ	EMEP/EEA 2013	179.456	g/GJ	EMEP/EEA 2013
NH_3	NA		EMEP/EEA 2013	NA		EMEP/EEA 2013
TSP	34.635	g/GJ	EMEP/EEA 2013	150.355	g/GJ	EMEP/EEA 2013
PM_{10}	34.635	g/GJ	EMEP/EEA 2013	150.355	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	32.326	g/GJ	EMEP/EEA 2013	135.804	g/GJ	EMEP/EEA 2013
BC	0.310	f-TSP	EMEP/EEA 2013	0.120	f-TSP	EMEP/EEA 2013
Pb	0.130	g/t	EMEP/EEA 2013	0.180	g/t	EMEP/EEA 2013
Cd	0.010	g/t	EMEP/EEA 2013	0.020	g/t	EMEP/EEA 2013
Hg	0.030	g/t	EMEP/EEA 2013	0.020	g/t	EMEP/EEA 2013
As	0.040	g/t	EMEP/EEA 2013	0.680	g/t	EMEP/EEA 2013
Cr	0.050	g/t	EMEP/EEA 2013	0.720	g/t	EMEP/EEA 2013
Cu	0.880	g/t	EMEP/EEA 2013	1.250	g/t	EMEP/EEA 2013
Ni	1.000	g/t	EMEP/EEA 2013	32.000	g/t	EMEP/EEA 2013
Se	0.100	g/t	EMEP/EEA 2013	0.210	g/t	EMEP/EEA 2013
Zn	1.200	g/t	EMEP/EEA 2013	1.200	g/t	EMEP/EEA 2013
PCB	0.038	mg/t	EMEP/EEA 2013	0.570	mg/t	EMEP/EEA 2013
PCDD/F (I-TEQ)	0.130	µg/t	EMEP/EEA 2013	0.470	µg/t	EMEP/EEA 2013
Benzo[a]pyrene	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
Benzo[b]fluoranthene	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
Benzo[k]Fluoranthene	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
Total 4 PAHs	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
HCB	0.080	mg/t	EMEP/EEA 2013	0.140	mg/t	EMEP/EEA 2013

Table C.21 Emission Factors for NFR 1A3e

Emission Factors				
	Code	Name		Inventory year
NFR Source Category	1.A.3.e	Pipeline compressors		2015
Fuel	**Gasoil**			
Pollutant	**Value**	**Unit**	**Reference**	
NO_x	48.000	g/GJ	EMEP/EEA 2013	
SO_x	0.079	g/GJ	CS	
NMVOC	1.600	g/GJ	EMEP/EEA 2013	
CO	4.800	g/GJ	EMEP/EEA 2013	
NH_3	NA			
TSP	0.200	g/GJ	EMEP/EEA 2013	
PM_{10}	0.200	g/GJ	EMEP/EEA 2013	
$PM_{2.5}$	0.200	g/GJ	EMEP/EEA 2013	
BC	0.025	f-$PM_{2.5}$	EMEP/EEA 2013	
Pb	0.0015	mg/GJ	EMEP/EEA 2013	
Cd	0.00025	mg/GJ	EMEP/EEA 2013	
Hg	0.100	mg/GJ	EMEP/EEA 2013	
As	0.120	mg/GJ	EMEP/EEA 2013	
Cr	0.00076	mg/GJ	EMEP/EEA 2013	
Cu	0.000076	mg/GJ	EMEP/EEA 2013	
Ni	0.00051	mg/GJ	EMEP/EEA 2013	
Se	0.011	mg/GJ	EMEP/EEA 2013	
Zn	0.0015	mg/GJ	EMEP/EEA 2013	
PCB	NE		EMEP/EEA 2013	
PCDD/F (I-TEQ)	0.500	ng/GJ	EMEP/EEA 2013	
Benzo[a]pyrene	0.560	µg/GJ	EMEP/EEA 2013	
Benzo[b]fluoranthene	0.840	µg/GJ	EMEP/EEA 2013	
Benzo[k]Fluoranthene	0.840	µg/GJ	EMEP/EEA 2013	
Indeno[1,2,3-cd]pyrene	0.840	µg/GJ	EMEP/EEA 2013	
Total 4 PAHs	3.080	µg/GJ	EMEP/EEA 2013	
HCB	NE		EMEP/EEA 2013	

Table C.22 Emission Factors for NFR 1A4a

Emission Factors												
	Code	Name				Inventory Year						
NFR Source Category	1.A.4.a	Commercial/Institutional				2015						
Fuel	**Coal**			**Anthracite & Ovoids**			**Lignite**			**Sod Peat**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	173.000	g/GJ	EMEP/EEA 2013	173.000	g/GJ	EMEP/EEA 2013	173.000	g/GJ	EMEP/EEA 2013	173.000	g/GJ	EMEP/EEA 2013
SO_x	301.407	g/GJ	CS	574.110	g/GJ	CS	900.000	g/GJ	EMEP/EEA 2013	900.000	g/GJ	EMEP/EEA 2013
NMVOC	88.800	g/GJ	EMEP/EEA 2013	88.800	g/GJ	EMEP/EEA 2013	88.800	g/GJ	EMEP/EEA 2013	88.800	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	931.000	g/GJ	EMEP/EEA 2013	931.000	g/GJ	EMEP/EEA 2013	931.000	g/GJ	EMEP/EEA 2013
NH_3	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
TSP	124.000	g/GJ	EMEP/EEA 2013	124.000	g/GJ	EMEP/EEA 2013	124.000	g/GJ	EMEP/EEA 2013	124.000	g/GJ	EMEP/EEA 2013
PM_{10}	117.000	g/GJ	EMEP/EEA 2013	117.000	g/GJ	EMEP/EEA 2013	117.000	g/GJ	EMEP/EEA 2013	117.000	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	108.000	g/GJ	EMEP/EEA 2013	108.000	g/GJ	EMEP/EEA 2013	108.000	g/GJ	EMEP/EEA 2013	108.000	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.064	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Peat Briquettes**			**Kerosene**			**Fuel Oil**			**LPG**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	173.000	g/GJ	EMEP/EEA 2013	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013
SO_x	900.000	g/GJ	EMEP/EEA 2013	8.959	g/GJ	CS	223.084	g/GJ	CS	0.670	g/GJ	EMEP/EEA 2013
NMVOC	88.800	g/GJ	EMEP/EEA 2013	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2009	23.000	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013
NH_3	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
TSP	124.000	g/GJ	EMEP/EEA 2013	27.500	g/GJ	EMEP/EEA 2009	27.500	g/GJ	EMEP/EEA 2009	0.780	g/GJ	EMEP/EEA 2013
PM_{10}	117.000	g/GJ	EMEP/EEA 2013	21.500	g/GJ	EMEP/EEA 2009	21.500	g/GJ	EMEP/EEA 2009	0.780	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	108.000	g/GJ	EMEP/EEA 2013	16.500	g/GJ	EMEP/EEA 2009	16.500	g/GJ	EMEP/EEA 2009	0.780	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Gasoil**			**Petroleum Coke**			**Natural Gas**			**Biomass**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	100.000	g/GJ	EMEP/EEA 2009	100.000	g/GJ	EMEP/EEA 2009	74.000	g/GJ	EMEP/EEA 2013	91.000	g/GJ	EMEP/EEA 2013
SO_x	15.885	g/GJ	CS	968.297	g/GJ	CS	0.079	g/GJ	CS	11.000	g/GJ	EMEP/EEA 2013
NMVOC	10.000	g/GJ	EMEP/EEA 2009	10.000	g/GJ	EMEP/EEA 2009	23.000	g/GJ	EMEP/EEA 2013	300.000	g/GJ	EMEP/EEA 2013
CO	40.000	g/GJ	EMEP/EEA 2009	40.000	g/GJ	EMEP/EEA 2009	29.000	g/GJ	EMEP/EEA 2013	570.000	g/GJ	EMEP/EEA 2013
NH_3	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	37.000	g/GJ	EMEP/EEA 2013
TSP	27.500	g/GJ	EMEP/EEA 2009	27.500	g/GJ	EMEP/EEA 2009	0.780	g/GJ	EMEP/EEA 2013	150.000	g/GJ	EMEP/EEA 2013
PM_{10}	21.500	g/GJ	EMEP/EEA 2009	21.500	g/GJ	EMEP/EEA 2009	0.780	g/GJ	EMEP/EEA 2013	143.000	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	16.500	g/GJ	EMEP/EEA 2009	16.500	g/GJ	EMEP/EEA 2009	0.780	g/GJ	EMEP/EEA 2013	140.000	g/GJ	EMEP/EEA 2013
BC	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.560	f-$PM_{2.5}$	EMEP/EEA 2013	0.040	f-$PM_{2.5}$	EMEP/EEA 2013	0.280	f-$PM_{2.5}$	EMEP/EEA 2013

Table C.23 (a) Emission Factors for NFR 1A4a (Heavy Metals and Persistent Organic Pollutants)

Emission Factors (Heavy Metals and POPs)												
	Code	Name				Inventory Year						
NFR Source Category	1.A.4.a	Commercial/Institutional				2015						
Fuel	Coal			Anthracite & Ovoids			Lignite			Sod Peat		
Pollutant	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference
Pb	134.00	mg/GJ	EMEP/EEA 2013	134.00	mg/GJ	EMEP/EEA 2013	134.00	mg/GJ	EMEP/EEA 2013	134.00	mg/GJ	EMEP/EEA 2013
Cd	1.80	mg/GJ	EMEP/EEA 2013	1.80	mg/GJ	EMEP/EEA 2013	1.80	mg/GJ	EMEP/EEA 2013	1.80	mg/GJ	EMEP/EEA 2013
Hg	7.90	mg/GJ	EMEP/EEA 2013	7.90	mg/GJ	EMEP/EEA 2013	7.90	mg/GJ	EMEP/EEA 2013	7.90	mg/GJ	EMEP/EEA 2013
As	4.00	mg/GJ	EMEP/EEA 2013	4.00	mg/GJ	EMEP/EEA 2013	4.00	mg/GJ	EMEP/EEA 2013	4.00	mg/GJ	EMEP/EEA 2013
Cr	13.50	mg/GJ	EMEP/EEA 2013	13.50	mg/GJ	EMEP/EEA 2013	13.50	mg/GJ	EMEP/EEA 2013	13.50	mg/GJ	EMEP/EEA 2013
Cu	17.50	mg/GJ	EMEP/EEA 2013	17.50	mg/GJ	EMEP/EEA 2013	17.50	mg/GJ	EMEP/EEA 2013	17.50	mg/GJ	EMEP/EEA 2013
Ni	13.00	mg/GJ	EMEP/EEA 2013	13.00	mg/GJ	EMEP/EEA 2013	13.00	mg/GJ	EMEP/EEA 2013	13.00	mg/GJ	EMEP/EEA 2013
Se	1.80	mg/GJ	EMEP/EEA 2013	1.80	mg/GJ	EMEP/EEA 2013	1.80	mg/GJ	EMEP/EEA 2013	1.80	mg/GJ	EMEP/EEA 2013
Zn	200.00	mg/GJ	EMEP/EEA 2013	200.00	mg/GJ	EMEP/EEA 2013	200.00	mg/GJ	EMEP/EEA 2013	200.00	mg/GJ	EMEP/EEA 2013
PCB	170.00	µg/GJ	EMEP/EEA 2013	170.00	µg/GJ	EMEP/EEA 2013	170.00	µg/GJ	EMEP/EEA 2013	170.00	µg/GJ	EMEP/EEA 2013
PCDD/F (I-TEQ)	203.00	ng/GJ	EMEP/EEA 2013	203.00	ng/GJ	EMEP/EEA 2013	203.00	ng/GJ	EMEP/EEA 2013	203.00	ng/GJ	EMEP/EEA 2013
Benzo[a]pyrene	45.50	mg/GJ	EMEP/EEA 2013	45.50	mg/GJ	EMEP/EEA 2013	45.50	mg/GJ	EMEP/EEA 2013	45.50	mg/GJ	EMEP/EEA 2013
Benzo[b]fluoranthene	58.90	mg/GJ	EMEP/EEA 2013	58.90	mg/GJ	EMEP/EEA 2013	58.90	mg/GJ	EMEP/EEA 2013	58.90	mg/GJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	23.70	mg/GJ	EMEP/EEA 2013	23.70	mg/GJ	EMEP/EEA 2013	23.70	mg/GJ	EMEP/EEA 2013	23.70	mg/GJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	18.50	mg/GJ	EMEP/EEA 2013	18.50	mg/GJ	EMEP/EEA 2013	18.50	mg/GJ	EMEP/EEA 2013	18.50	mg/GJ	EMEP/EEA 2013
Total 4 PAHs	146.60	mg/GJ	EMEP/EEA 2013	146.60	mg/GJ	EMEP/EEA 2013	146.60	mg/GJ	EMEP/EEA 2013	146.60	mg/GJ	EMEP/EEA 2013
HCB	0.62	µg/GJ	EMEP/EEA 2013	0.62	µg/GJ	EMEP/EEA 2013	0.62	µg/GJ	EMEP/EEA 2013	0.62	µg/GJ	EMEP/EEA 2013

Emission Factors (Heavy Metals and POPs)												
	Code	Name				Inventory Year						
NFR Source Category	1.A.4.a	Commercial/Institutional				2015						
Fuel	Peat Briquettes			Fuel Oil			LPG			Gasoil		
Pollutant	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference
Pb	134.00	mg/GJ	EMEP/EEA 2013	0.08	mg/GJ	EMEP/EEA 2013	0.011	mg/GJ	EMEP/EEA 2013	0.08	mg/GJ	EMEP/EEA 2013
Cd	1.80	mg/GJ	EMEP/EEA 2013	0.006	mg/GJ	EMEP/EEA 2013	0.0009	mg/GJ	EMEP/EEA 2013	0.01	mg/GJ	EMEP/EEA 2013
Hg	7.90	mg/GJ	EMEP/EEA 2013	0.12	mg/GJ	EMEP/EEA 2013	0.540	mg/GJ	EMEP/EEA 2013	0.12	mg/GJ	EMEP/EEA 2013
As	4.00	mg/GJ	EMEP/EEA 2013	0.03	mg/GJ	EMEP/EEA 2013	0.100	mg/GJ	EMEP/EEA 2013	0.03	mg/GJ	EMEP/EEA 2013
Cr	13.50	mg/GJ	EMEP/EEA 2013	0.20	mg/GJ	EMEP/EEA 2013	0.013	mg/GJ	EMEP/EEA 2013	0.20	mg/GJ	EMEP/EEA 2013
Cu	17.50	mg/GJ	EMEP/EEA 2013	0.22	mg/GJ	EMEP/EEA 2013	0.0026	mg/GJ	EMEP/EEA 2013	0.22	mg/GJ	EMEP/EEA 2013
Ni	13.00	mg/GJ	EMEP/EEA 2013	0.008	mg/GJ	EMEP/EEA 2013	0.013	mg/GJ	EMEP/EEA 2013	0.008	mg/GJ	EMEP/EEA 2013
Se	1.80	mg/GJ	EMEP/EEA 2013	0.11	mg/GJ	EMEP/EEA 2013	0.058	mg/GJ	EMEP/EEA 2013	0.11	mg/GJ	EMEP/EEA 2013
Zn	200.00	mg/GJ	EMEP/EEA 2013	29.00	mg/GJ	EMEP/EEA 2013	0.730	mg/GJ	EMEP/EEA 2013	29.00	mg/GJ	EMEP/EEA 2013
PCB	170.00	µg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
PCDD/F (I-TEQ)	203.00	ng/GJ	EMEP/EEA 2013	1.400	ng/GJ	EMEP/EEA 2013	0.52	ng/GJ	EMEP/EEA 2013	1.40	ng/GJ	EMEP/EEA 2013
Benzo[a]pyrene	45.50	mg/GJ	EMEP/EEA 2013	1.900	mg/GJ	EMEP/EEA 2013	0.72	mg/GJ	EMEP/EEA 2013	1.90	mg/GJ	EMEP/EEA 2013
Benzo[b]fluoranthene	58.90	mg/GJ	EMEP/EEA 2013	15.000	mg/GJ	EMEP/EEA 2013	2.90	mg/GJ	EMEP/EEA 2013	15.00	mg/GJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	23.70	mg/GJ	EMEP/EEA 2013	1.700	mg/GJ	EMEP/EEA 2013	1.10	mg/GJ	EMEP/EEA 2013	1.70	mg/GJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	18.50	mg/GJ	EMEP/EEA 2013	1.500	mg/GJ	EMEP/EEA 2013	1.08	mg/GJ	EMEP/EEA 2013	1.50	mg/GJ	EMEP/EEA 2013
Total 4 PAHs	146.60	mg/GJ	EMEP/EEA 2013	20.100	mg/GJ	EMEP/EEA 2013	5.80	mg/GJ	EMEP/EEA 2013	20.10	mg/GJ	EMEP/EEA 2013
HCB	0.62	µg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013

Table C.23 (b) Emission Factors for NFR 1A4a (Heavy Metals and Persistent Organic Pollutants)

Emission Factors (Heavy Metals and POPs)									
	Code	Name				Inventory Year			
NFR Source Category	1.A.4.a	Commercial/Institutional				2015			
Fuel	**Petroleum Coke**			**Natural Gas**			**Biomass**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
Pb	0.08	mg/GJ	EMEP/EEA 2013	0.011	mg/GJ	EMEP/EEA 2013	27.000	mg/GJ	EMEP/EEA 2013
Cd	0.006	mg/GJ	EMEP/EEA 2013	0.0009	mg/GJ	EMEP/EEA 2013	13.000	mg/GJ	EMEP/EEA 2013
Hg	0.12	mg/GJ	EMEP/EEA 2013	0.540	mg/GJ	EMEP/EEA 2013	0.560	mg/GJ	EMEP/EEA 2013
As	0.03	mg/GJ	EMEP/EEA 2013	0.100	mg/GJ	EMEP/EEA 2013	0.190	mg/GJ	EMEP/EEA 2013
Cr	0.20	mg/GJ	EMEP/EEA 2013	0.013	mg/GJ	EMEP/EEA 2013	23.000	mg/GJ	EMEP/EEA 2013
Cu	0.22	mg/GJ	EMEP/EEA 2013	0.0026	mg/GJ	EMEP/EEA 2013	6.000	mg/GJ	EMEP/EEA 2013
Ni	0.01	mg/GJ	EMEP/EEA 2013	0.013	mg/GJ	EMEP/EEA 2013	2.000	mg/GJ	EMEP/EEA 2013
Se	0.11	mg/GJ	EMEP/EEA 2013	0.058	mg/GJ	EMEP/EEA 2013	0.500	mg/GJ	EMEP/EEA 2013
Zn	29.00	mg/GJ	EMEP/EEA 2013	0.730	mg/GJ	EMEP/EEA 2013	512.000	mg/GJ	EMEP/EEA 2013
PCB	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	0.060	µg/GJ	EMEP/EEA 2013
PCDD/F (I-TEQ)	1.400	ng/GJ	EMEP/EEA 2013	0.520	ng/GJ	EMEP/EEA 2013	100.000	ng/GJ	EMEP/EEA 2013
Benzo[a]pyrene	1.900	mg/GJ	EMEP/EEA 2013	0.720	mg/GJ	EMEP/EEA 2013	10.000	mg/GJ	EMEP/EEA 2013
Benzo[b]fluoranthene	15.000	mg/GJ	EMEP/EEA 2013	2.900	mg/GJ	EMEP/EEA 2013	16.000	mg/GJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	1.700	mg/GJ	EMEP/EEA 2013	1.100	mg/GJ	EMEP/EEA 2013	5.000	mg/GJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	1.500	mg/GJ	EMEP/EEA 2013	1.080	mg/GJ	EMEP/EEA 2013	4.000	mg/GJ	EMEP/EEA 2013
Total 4 PAHs	20.100	mg/GJ	EMEP/EEA 2013	5.800	mg/GJ	EMEP/EEA 2013	35.000	mg/GJ	EMEP/EEA 2013
HCB	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	5.000	µg/GJ	EMEP/EEA 2013

Table C.24 Emission Factors for NFR 1A4b

Emission Factors												
	Code	Name			Inventory Year							
NFR Source Category	1.A.4.b	Residential			2015							
Fuel	**Coal**			**Anthracite & Ovoids**			**Lignite**			**Sod Peat**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	110.000	g/GJ	EMEP/EEA 2013	110.000	g/GJ	EMEP/EEA 2013	110.000	g/GJ	EMEP/EEA 2013	110.000	g/GJ	EMEP/EEA 2013
SO_x	301.407	g/GJ	CS	574.110	g/GJ	CS	756.000	g/GJ	CS	300.000	g/GJ	EMEP/EEA 2013
NMVOC	484.000	g/GJ	EMEP/EEA 2013	484.000	g/GJ	EMEP/EEA 2013	484.000	g/GJ	EMEP/EEA 2013	484.000	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	931.000	g/GJ	EMEP/EEA 2013	931.000	g/GJ	EMEP/EEA 2013	931.000	g/GJ	EMEP/EEA 2013
NH_3	0.300	g/GJ	EMEP/EEA 2013	0.300	g/GJ	EMEP/EEA 2013	0.300	g/GJ	EMEP/EEA 2013	0.300	g/GJ	EMEP/EEA 2013
TSP	444.000	g/GJ	EMEP/EEA 2013	444.000	g/GJ	EMEP/EEA 2013	444.000	g/GJ	EMEP/EEA 2013	444.000	g/GJ	EMEP/EEA 2013
PM_{10}	404.000	g/GJ	EMEP/EEA 2013	404.000	g/GJ	EMEP/EEA 2013	404.000	g/GJ	EMEP/EEA 2013	404.000	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	398.000	g/GJ	EMEP/EEA 2013	398.000	g/GJ	EMEP/EEA 2013	398.000	g/GJ	EMEP/EEA 2013	398.000	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.064	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Peat Briquettes**			**Kerosene**			**LPG**			**Gasoil**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	110.000	g/GJ	EMEP/EEA 2013	51.000	g/GJ	EMEP/EEA 2013	42.000	g/GJ	EMEP/EEA 2013	51.000	g/GJ	EMEP/EEA 2013
SO_x	280.000	g/GJ	EMEP/EEA 2013	8.959	g/GJ	CS	1.300	g/GJ	EMEP/EEA 2013	15.885	g/GJ	CS
NMVOC	484.000	g/GJ	EMEP/EEA 2013	0.690	g/GJ	EMEP/EEA 2013	1.800	g/GJ	EMEP/EEA 2013	0.690	g/GJ	EMEP/EEA 2013
CO	931.000	g/GJ	EMEP/EEA 2013	57.000	g/GJ	EMEP/EEA 2013	22.000	g/GJ	EMEP/EEA 2013	57.000	g/GJ	EMEP/EEA 2013
NH_3	0.300	g/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	NA		EMEP/EEA 2013	NE		EMEP/EEA 2013
TSP	444.000	g/GJ	EMEP/EEA 2013	1.900	g/GJ	EMEP/EEA 2013	0.200	g/GJ	EMEP/EEA 2013	1.900	g/GJ	EMEP/EEA 2013
PM_{10}	404.000	g/GJ	EMEP/EEA 2013	1.900	g/GJ	EMEP/EEA 2013	0.200	g/GJ	EMEP/EEA 2013	1.900	g/GJ	EMEP/EEA 2013
$PM_{2.5}$	398.000	g/GJ	EMEP/EEA 2013	1.900	g/GJ	EMEP/EEA 2013	0.200	g/GJ	EMEP/EEA 2013	1.900	g/GJ	EMEP/EEA 2013
BC	0.064	f-$PM_{2.5}$	EMEP/EEA 2013	0.085	f-$PM_{2.5}$	EMEP/EEA 2013	0.054	f-$PM_{2.5}$	EMEP/EEA 2013	0.085	f-$PM_{2.5}$	EMEP/EEA 2013
Fuel	**Petroleum Coke**			**Natural Gas**			**Biomass**					
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	51.000	g/GJ	EMEP/EEA 2013	42.000	g/GJ	EMEP/EEA 2013	80.000	g/GJ	EMEP/EEA 2013			
SO_x	968.297	g/GJ	CS	0.079	g/GJ	CS	11.000	g/GJ	EMEP/EEA 2013			
NMVOC	0.690	g/GJ	EMEP/EEA 2013	1.800	g/GJ	EMEP/EEA 2013	600.000	g/GJ	EMEP/EEA 2013			
CO	57.000	g/GJ	EMEP/EEA 2013	22.000	g/GJ	EMEP/EEA 2013	4000.000	g/GJ	EMEP/EEA 2013			
NH_3	NA		EMEP/EEA 2013	NA		EMEP/EEA 2013	70.000	g/GJ	EMEP/EEA 2013			
TSP	1.900	g/GJ	EMEP/EEA 2013	0.200	g/GJ	EMEP/EEA 2013	800.000	g/GJ	EMEP/EEA 2013			
PM_{10}	1.900	g/GJ	EMEP/EEA 2013	0.200	g/GJ	EMEP/EEA 2013	760.000	g/GJ	EMEP/EEA 2013			
$PM_{2.5}$	1.900	g/GJ	EMEP/EEA 2013	0.200	g/GJ	EMEP/EEA 2013	740.000	g/GJ	EMEP/EEA 2013			
BC	0.085	f-$PM_{2.5}$	EMEP/EEA 2013	0.054	f-$PM_{2.5}$	EMEP/EEA 2013	0.100	f-$PM_{2.5}$	EMEP/EEA 2013			

Table C.25 (a) Emission Factors for NFR 1A4b (Heavy Metals and Persistent Organic Pollutants)

Emission Factors (Heavy Metals and POPs)												
	Code	Name		Inventory Year								
NFR Source Category	1.A.4.b	Residential		2015								
Fuel	Coal			Anthracite & Ovoids			Lignite			Sod Peat		
Pollutant	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference
Pb	130.000	mg/GJ	EMEP/EEA 2013	130.000	mg/GJ	EMEP/EEA 2013	130.000	mg/GJ	EMEP/EEA 2013	130.000	mg/GJ	EMEP/EEA 2013
Cd	1.500	mg/GJ	EMEP/EEA 2013	1.500	mg/GJ	EMEP/EEA 2013	1.500	mg/GJ	EMEP/EEA 2013	1.500	mg/GJ	EMEP/EEA 2013
Hg	5.100	mg/GJ	EMEP/EEA 2013	5.100	mg/GJ	EMEP/EEA 2013	5.100	mg/GJ	EMEP/EEA 2013	5.100	mg/GJ	EMEP/EEA 2013
As	2.500	mg/GJ	EMEP/EEA 2013	2.500	mg/GJ	EMEP/EEA 2013	2.500	mg/GJ	EMEP/EEA 2013	2.500	mg/GJ	EMEP/EEA 2013
Cr	11.200	mg/GJ	EMEP/EEA 2013	11.200	mg/GJ	EMEP/EEA 2013	11.200	mg/GJ	EMEP/EEA 2013	11.200	mg/GJ	EMEP/EEA 2013
Cu	22.300	mg/GJ	EMEP/EEA 2013	22.300	mg/GJ	EMEP/EEA 2013	22.300	mg/GJ	EMEP/EEA 2013	22.300	mg/GJ	EMEP/EEA 2013
Ni	12.700	mg/GJ	EMEP/EEA 2013	12.700	mg/GJ	EMEP/EEA 2013	12.700	mg/GJ	EMEP/EEA 2013	12.700	mg/GJ	EMEP/EEA 2013
Se	1.000	mg/GJ	EMEP/EEA 2013	1.000	mg/GJ	EMEP/EEA 2013	1.000	mg/GJ	EMEP/EEA 2013	1.000	mg/GJ	EMEP/EEA 2013
Zn	220.000	mg/GJ	EMEP/EEA 2013	220.000	mg/GJ	EMEP/EEA 2013	220.000	mg/GJ	EMEP/EEA 2013	220.000	mg/GJ	EMEP/EEA 2013
PCB	170.000	μg/GJ	EMEP/EEA 2013	170.000	μg/GJ	EMEP/EEA 2013	170.000	μg/GJ	EMEP/EEA 2013	170.000	μg/GJ	EMEP/EEA 2013
PCDD/F (I-TEQ)	800.000	ng/GJ	EMEP/EEA 2013	800.000	ng/GJ	EMEP/EEA 2013	800.000	ng/GJ	EMEP/EEA 2013	800.000	ng/GJ	EMEP/EEA 2013
Benzo[a]pyrene	0.230	μg/GJ	EMEP/EEA 2013	0.230	μg/GJ	EMEP/EEA 2013	0.230	μg/GJ	EMEP/EEA 2013	0.230	μg/GJ	EMEP/EEA 2013
Benzo[b]fluoranthene	0.330	μg/GJ	EMEP/EEA 2013	0.330	μg/GJ	EMEP/EEA 2013	0.330	μg/GJ	EMEP/EEA 2013	0.330	μg/GJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	0.130	μg/GJ	EMEP/EEA 2013	0.130	μg/GJ	EMEP/EEA 2013	0.130	μg/GJ	EMEP/EEA 2013	0.130	μg/GJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	0.110	μg/GJ	EMEP/EEA 2013	0.110	μg/GJ	EMEP/EEA 2013	0.110	μg/GJ	EMEP/EEA 2013	0.110	μg/GJ	EMEP/EEA 2013
Total 4 PAHs	0.800	μg/GJ	EMEP/EEA 2013	0.800	μg/GJ	EMEP/EEA 2013	0.800	μg/GJ	EMEP/EEA 2013	0.800	μg/GJ	EMEP/EEA 2013
HCB	0.620	μg/GJ	EMEP/EEA 2013	0.620	μg/GJ	EMEP/EEA 2013	0.620	μg/GJ	EMEP/EEA 2013	0.620	μg/GJ	EMEP/EEA 2013

Emission Factors (Heavy Metals and POPs)												
	Code	Name		Inventory Year								
NFR Source Category	1.A.4.b	Residential		2015								
Fuel	Peat Briquettes			Kerosene			LPG			Gasoil		
Pollutant	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference
Pb	130.000	mg/GJ	EMEP/EEA 2013	0.012	mg/GJ	EMEP/EEA 2013	0.0015	mg/GJ	EMEP/EEA 2013	0.012	mg/GJ	EMEP/EEA 2013
Cd	1.500	mg/GJ	EMEP/EEA 2013	0.001	mg/GJ	EMEP/EEA 2013	0.00025	mg/GJ	EMEP/EEA 2013	0.001	mg/GJ	EMEP/EEA 2013
Hg	5.100	mg/GJ	EMEP/EEA 2013	0.120	mg/GJ	EMEP/EEA 2013	0.680	mg/GJ	EMEP/EEA 2013	0.120	mg/GJ	EMEP/EEA 2013
As	2.500	mg/GJ	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013	0.120	mg/GJ	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013
Cr	11.200	mg/GJ	EMEP/EEA 2013	0.200	mg/GJ	EMEP/EEA 2013	0.00076	mg/GJ	EMEP/EEA 2013	0.200	mg/GJ	EMEP/EEA 2013
Cu	22.300	mg/GJ	EMEP/EEA 2013	0.130	mg/GJ	EMEP/EEA 2013	0.000076	mg/GJ	EMEP/EEA 2013	0.130	mg/GJ	EMEP/EEA 2013
Ni	12.700	mg/GJ	EMEP/EEA 2013	0.005	mg/GJ	EMEP/EEA 2013	0.00051	mg/GJ	EMEP/EEA 2013	0.005	mg/GJ	EMEP/EEA 2013
Se	1.000	mg/GJ	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013	0.011	mg/GJ	EMEP/EEA 2013	0.002	mg/GJ	EMEP/EEA 2013
Zn	220.000	mg/GJ	EMEP/EEA 2013	0.420	mg/GJ	EMEP/EEA 2013	0.0015	mg/GJ	EMEP/EEA 2013	0.420	mg/GJ	EMEP/EEA 2013
PCB	170.0	μg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
PCDD/F (I-TEQ)	800.0	ng/GJ	EMEP/EEA 2013	5.90	ng/GJ	EMEP/EEA 2013	1.500	ng/GJ	EMEP/EEA 2013	5.90	ug/TJ	EMEP/EEA 2013
Benzo[a]pyrene	230.0	mg/GJ	EMEP/EEA 2013	0.08	μg/GJ	EMEP/EEA 2013	0.00	μg/GJ	EMEP/EEA 2013	0.08	g/TJ	EMEP/EEA 2013
Benzo[b]fluoranthene	330.0	mg/GJ	EMEP/EEA 2013	0.04	μg/GJ	EMEP/EEA 2013	0.00	μg/GJ	EMEP/EEA 2013	0.04	g/TJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	130.0	mg/GJ	EMEP/EEA 2013	0.07	μg/GJ	EMEP/EEA 2013	0.00	μg/GJ	EMEP/EEA 2013	0.07	g/TJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	110.0	mg/GJ	EMEP/EEA 2013	0.16	μg/GJ	EMEP/EEA 2013	0.00	μg/GJ	EMEP/EEA 2013	0.16	g/TJ	EMEP/EEA 2013
Total 4 PAHs	800.0	mg/GJ	EMEP/EEA 2013	0.35	μg/GJ	EMEP/EEA 2013	0.003	μg/GJ	EMEP/EEA 2013	0.35	g/TJ	EMEP/EEA 2013
HCB	0.620	μg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013

Table C.25 (b) Emission Factors for NFR 1A4b (Heavy Metals and Persistent Organic Pollutants)

Emission Factors (Heavy Metals and POPs)									
	Code	Name			Inventory Year				
NFR Source Category	1.A.4.b	Residential			2015				
Fuel	Petroleum Coke			Natural Gas			Biomass		
Pollutant	Value	Unit	Reference	Value	Unit	Reference	Value	Unit	Reference
Pb	0.012	mg/GJ	EMEP/EEA 2013	0.0015	mg/GJ	EMEP/EEA 2013	27.000	mg/GJ	EMEP/EEA 2013
Cd	0.001	mg/GJ	EMEP/EEA 2013	0.00025	mg/GJ	EMEP/EEA 2013	13.000	mg/GJ	EMEP/EEA 2013
Hg	0.120	mg/GJ	EMEP/EEA 2013	0.680	mg/GJ	EMEP/EEA 2013	0.560	mg/GJ	EMEP/EEA 2013
As	0.002	mg/GJ	EMEP/EEA 2013	0.120	mg/GJ	EMEP/EEA 2013	0.190	mg/GJ	EMEP/EEA 2013
Cr	0.200	mg/GJ	EMEP/EEA 2013	0.00076	mg/GJ	EMEP/EEA 2013	23.000	mg/GJ	EMEP/EEA 2013
Cu	0.130	mg/GJ	EMEP/EEA 2013	0.000076	mg/GJ	EMEP/EEA 2013	6.000	mg/GJ	EMEP/EEA 2013
Ni	0.005	mg/GJ	EMEP/EEA 2013	0.00051	mg/GJ	EMEP/EEA 2013	2.000	mg/GJ	EMEP/EEA 2013
Se	0.002	mg/GJ	EMEP/EEA 2013	0.011	mg/GJ	EMEP/EEA 2013	0.500	mg/GJ	EMEP/EEA 2013
Zn	0.420	mg/GJ	EMEP/EEA 2013	0.0015	mg/GJ	EMEP/EEA 2013	512.000	mg/GJ	EMEP/EEA 2013
PCB	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	0.060	µg/GJ	EMEP/EEA 2013
PCDD/F (I-TEQ)	5.900	ng/GJ	EMEP/EEA 2013	1.500	ug/TJ	EMEP/EEA 2013	800.000	ng/GJ	EMEP/EEA 2013
Benzo[a]pyrene	0.080	µg/GJ	EMEP/EEA 2013	0.001	g/TJ	EMEP/EEA 2013	121.000	mg/GJ	EMEP/EEA 2013
Benzo[b]fluoranthene	0.040	µg/GJ	EMEP/EEA 2013	0.001	g/TJ	EMEP/EEA 2013	111.000	mg/GJ	EMEP/EEA 2013
Benzo[k]Fluoranthene	0.070	µg/GJ	EMEP/EEA 2013	0.001	g/TJ	EMEP/EEA 2013	42.000	mg/GJ	EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	0.160	µg/GJ	EMEP/EEA 2013	0.001	g/TJ	EMEP/EEA 2013	71.000	mg/GJ	EMEP/EEA 2013
Total 4 PAHs	0.350	µg/GJ	EMEP/EEA 2013	0.003	g/TJ	EMEP/EEA 2013	345.000	mg/GJ	EMEP/EEA 2013
HCB	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013	5.000	µg/GJ	EMEP/EEA 2013

Table C.26 Emission Factors for NFR 1A4c

Emission Factors						
	Code	Name	Inventory year			
NFR Source Category	1.A.4.c	Agriculture/Forestry/Fishing	2015			
Fuel	**Gasoil**			**Gasoil**		
	Stationary (1 A 4 c i)			**Mobile (1 A 4 c ii)**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	100.000	g/GJ	EMEP/EEA 2009	485.501	g/GJ	Danish Inventory (Winther and Nielsen, 2006)
SO_x	15.885	g/GJ	CS	3.848	g/GJ	CS
NMVOC	10.000	g/GJ	EMEP/EEA 2009	36.193	g/GJ	Danish Inventory (Winther and Nielsen, 2006)
CO	40.000	g/GJ	EMEP/EEA 2009	181.178	g/GJ	Danish Inventory (Winther and Nielsen, 2006)
NH_3	NE		EMEP/EEA 2013	0.183	g/GJ	Danish Inventory (Winther and Nielsen, 2006)
TSP	27.500	g/GJ	EMEP/EEA 2009	18.489	g/GJ	Danish Inventory (Winther and Nielsen, 2006)
PM_{10}	21.500	g/GJ	EMEP/EEA 2009	18.489	g/GJ	Danish Inventory (Winther and Nielsen, 2006)
$PM_{2.5}$	16.500	g/GJ	EMEP/EEA 2009	18.382	g/GJ	Danish Inventory (Winther and Nielsen, 2006)
Pb	0.080	mg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013
Cd	0.006	mg/GJ	EMEP/EEA 2013	0.010	mg/kg	EMEP/EEA 2013
Hg	0.120	mg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013
As	0.030	mg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013
Cr	0.200	mg/GJ	EMEP/EEA 2013	0.050	mg/kg	EMEP/EEA 2013
Cu	0.220	mg/GJ	EMEP/EEA 2013	1.700	mg/kg	EMEP/EEA 2013
Ni	0.008	mg/GJ	EMEP/EEA 2013	0.070	mg/kg	EMEP/EEA 2013
Se	0.110	mg/GJ	EMEP/EEA 2013	0.010	mg/kg	EMEP/EEA 2013
Zn	29.000	mg/GJ	EMEP/EEA 2013	1.000	mg/kg	EMEP/EEA 2013
PCDD/F (I-TEQ)	1.400	ng/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013
Benzo[a]pyrene	1.900	µg/GJ	EMEP/EEA 2013	30.000	µg/kg	EMEP/EEA 2013
Benzo[b]fluoranthene	15.000	µg/GJ	EMEP/EEA 2013	50.000	µg/kg	EMEP/EEA 2013
Benzo[k]Fluoranthene	1.700	µg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013
Indeno[1,2,3-cd]pyrene	1.500	µg/GJ	EMEP/EEA 2013	NE		EMEP/EEA 2013
Total 4 PAHs	20.100	µg/GJ	EMEP/EEA 2013	80.000	µg/kg	EMEP/EEA 2013
HCB	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013

Table C.27 Tier 2 Implied Emission Factors for NFR 1A4cii

		Implied Emission Factors																									
Pollutant	**Unit**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NOx	kg/TJ	796.90	824.66	850.67	874.95	897.47	918.25	937.30	955.19	971.88	987.08	1001.13	1007.82	980.62	943.49	906.18	870.59	829.30	785.66	743.31	703.76	668.53	631.78	596.58	563.87	527.28	485.55
NMVOC	kg/TJ	147.13	142.70	138.55	134.68	131.08	127.77	124.73	121.88	119.22	116.69	114.36	111.32	104.48	97.67	91.26	85.36	79.44	73.62	67.98	62.82	58.08	53.38	48.51	43.98	39.86	36.20
CO	kg/TJ	388.47	381.14	374.28	367.87	361.92	356.42	351.38	346.65	342.24	338.00	334.08	328.00	311.91	296.70	282.45	269.28	256.80	245.16	233.94	223.91	214.63	206.44	199.02	192.37	186.36	181.19
PM_{10}	kg/TJ	98.86	93.69	88.85	84.33	80.13	76.26	72.71	69.38	66.27	63.37	60.68	57.92	54.07	50.30	46.81	43.65	40.73	37.93	35.25	32.75	30.43	28.10	25.43	22.93	20.60	18.49
$PM_{2.5}$	kg/TJ	98.86	93.69	88.85	84.33	80.13	76.26	72.71	69.38	66.27	63.37	60.68	57.92	54.07	50.30	46.81	43.65	40.73	37.93	35.25	32.75	30.43	28.10	25.43	22.93	20.60	18.38
TSP	kg/TJ	98.86	93.69	88.85	84.33	80.13	76.26	72.71	69.38	66.27	63.37	60.68	57.92	54.07	50.30	46.81	43.65	40.73	37.93	35.25	32.75	30.43	28.10	25.43	22.93	20.60	18.49

Table C.28 Emission Factors for NFR 1A4ciii

Emission Factors				
	Code	Name		Inventory year
NFR Source Category	1.A.4.c iii	Fishing		2015
Fuel	**Gasoil**			
Pollutant	**Value**	**Unit**	**Reference**	
NO_x	1812.587	g/GJ	EMEP/EEA 2013	
SO_x	15.885	g/GJ	CS	
NMVOC	64.653	g/GJ	EMEP/EEA 2013	
CO	170.868	g/GJ	EMEP/EEA 2013	
NH_3	NA		EMEP/EEA 2013	
TSP	34.635	g/GJ	EMEP/EEA 2013	
PM_{10}	34.635	g/GJ	EMEP/EEA 2013	
$PM_{2.5}$	32.326	g/GJ	EMEP/EEA 2013	
BC	0.310	f-TSP	EMEP/EEA 2013	
Pb	130.000	mg/Mg	NAEI	
Cd	10.000	mg/Mg	NAEI	
Hg	30.000	mg/Mg	NAEI	
As	40.000	mg/Mg	NAEI	
Cr	50.000	mg/Mg	NAEI	
Cu	880.000	mg/Mg	NAEI	
Ni	1000.000	mg/Mg	NAEI	
Se	100.000	mg/Mg	NAEI	
Zn	1200.000	mg/Mg	NAEI	
PCB	0.038	mg/t	EMEP/EEA 2013	
PCDD/F (I-TEQ)	0.130	µg/t	EMEP/EEA 2013	
Benzo[a]pyrene	NE		EMEP/EEA 2013	
Benzo[b]fluoranthene	NE		EMEP/EEA 2013	
Benzo[k]Fluoranthene	NE		EMEP/EEA 2013	
Indeno[1,2,3-cd]pyrene	NE		EMEP/EEA 2013	
Total 4 PAHs	NE		EMEP/EEA 2013	
HCB	0.080	mg/t	EMEP/EEA 2013	

Table C.29 Emission Factors for NFR 1A3di

Emission Factors						
	Code	Name		Inventory year		
NFR Source Category	1.A.3.d.(i)	International Navigation		2015		
Fuel	**Fuel Oil**			**Gasoil**		
Pollutant	**Value**	**Unit**	**Reference**	**Value**	**Unit**	**Reference**
NO_x	79.300	kg/t	EMEP/EEA 2013	78.500	kg/t	EMEP/EEA 2013
SO_x	223.084	g/GJ	CS	32.325	g/GJ	CS
NMVOC	2.700	kg/t	EMEP/EEA 2013	2.800	kg/t	EMEP/EEA 2013
CO	7.400	kg/t	EMEP/EEA 2013	7.400	kg/t	EMEP/EEA 2013
NH_3	NE		EMEP/EEA 2013	NE		EMEP/EEA 2013
TSP	6.200	kg/t	EMEP/EEA 2013	1.500	kg/t	EMEP/EEA 2013
PM_{10}	6.200	kg/t	EMEP/EEA 2013	1.500	kg/t	EMEP/EEA 2013
$PM_{2.5}$	5.600	kg/t	EMEP/EEA 2013	1.400	kg/t	EMEP/EEA 2013
Pb	292.483	mg/Mg	NAEI 2008	40.965	mg/Mg	NAEI 2008
Cd	515.924	mg/Mg	NAEI 2008	17.647	mg/Mg	NAEI 2008
Hg	23.453	mg/Mg	NAEI 2008	19.936	mg/Mg	NAEI 2008
As	292.483	mg/Mg	NAEI 2008	40.965	mg/Mg	NAEI 2008
Cr	566.868	mg/Mg	NAEI 2008	24.314	mg/Mg	NAEI 2008
Cu	693.432	mg/Mg	NAEI 2008	297.516	mg/Mg	NAEI 2008
Ni	31959.485	mg/Mg	NAEI 2008	2217.647	mg/Mg	NAEI 2008
Se	361.125	mg/Mg	NAEI 2008	266.280	mg/Mg	NAEI 2008
Zn	1205.584	mg/Mg	NAEI 2008	276.492	mg/Mg	NAEI 2008
PCDD/F (I-TEQ)	104.278	ug/TJ	NAEI 2006	23.090	ug/TJ	NAEI 2006
Benzo[a]pyrene	113.978	mg/TJ	NAEI 2006	108.525	mg/TJ	NAEI 2006
Benzo[b]fluoranthene	492.288	mg/TJ	NAEI 2006	468.736	mg/TJ	NAEI 2006
Benzo[k]Fluoranthene	97.003	mg/TJ	NAEI 2006	92.362	mg/TJ	NAEI 2006
Indeno[1,2,3-cd]pyrene	184.305	mg/TJ	NAEI 2006	175.487	mg/TJ	NAEI 2006
Total 4 PAHs	887.574	mg/TJ	NAEI 2006	845.109	mg/TJ	NAEI 2006
HCB	NE			NE		

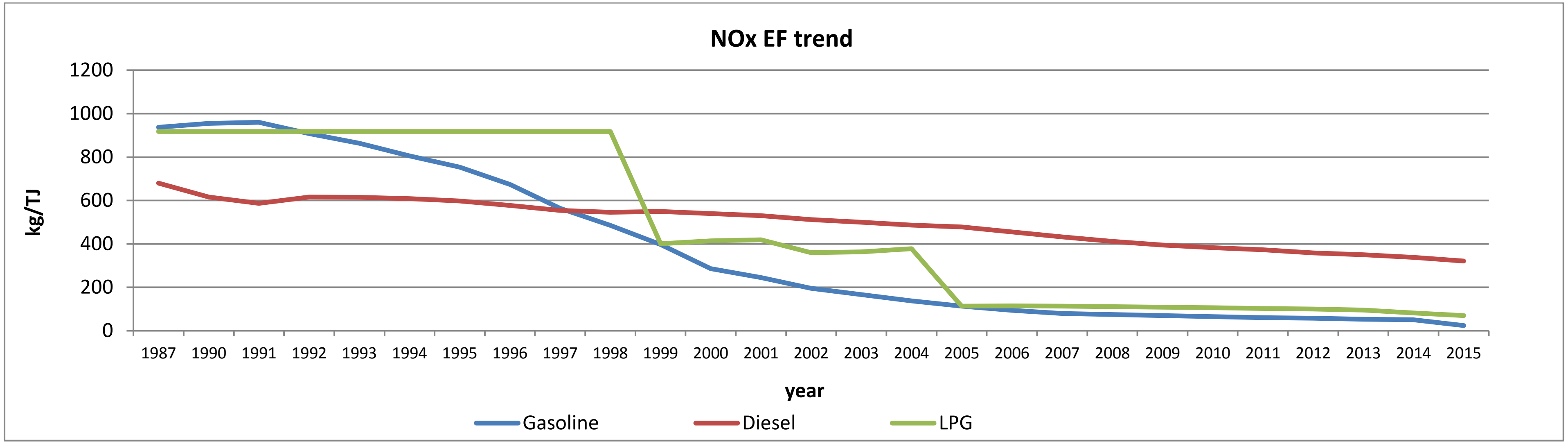

Figure C.1. Emission Factor Trends for Nitrogen Oxides in NFR 1A3b

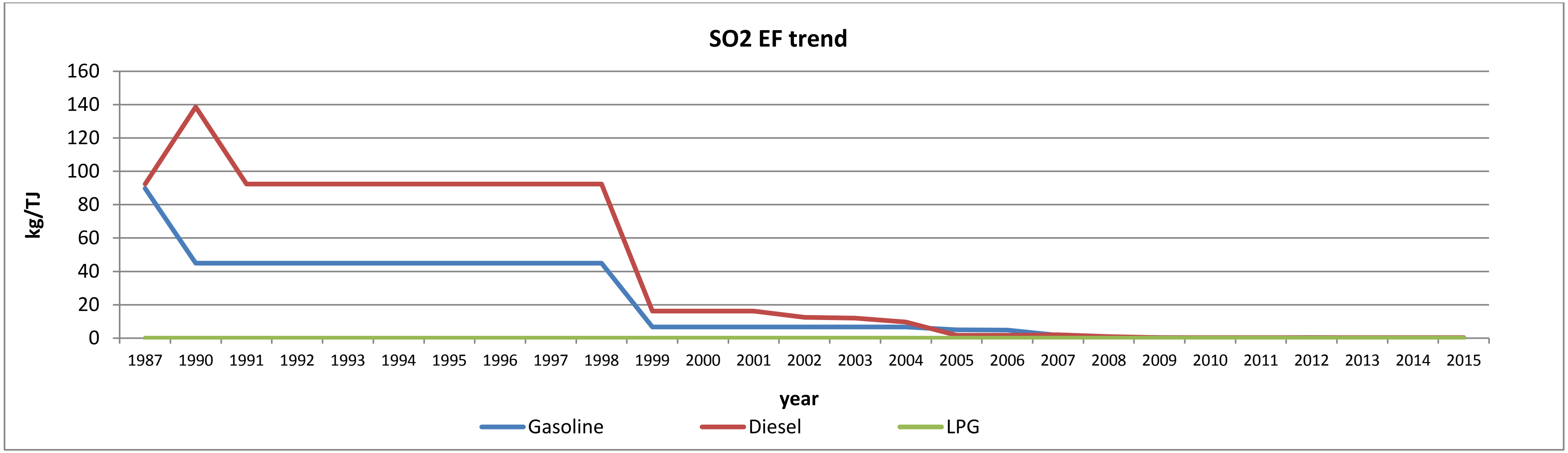

Figure C.2. Emission Factor Trends for Sulphur Dioxide in NFR 1A3b

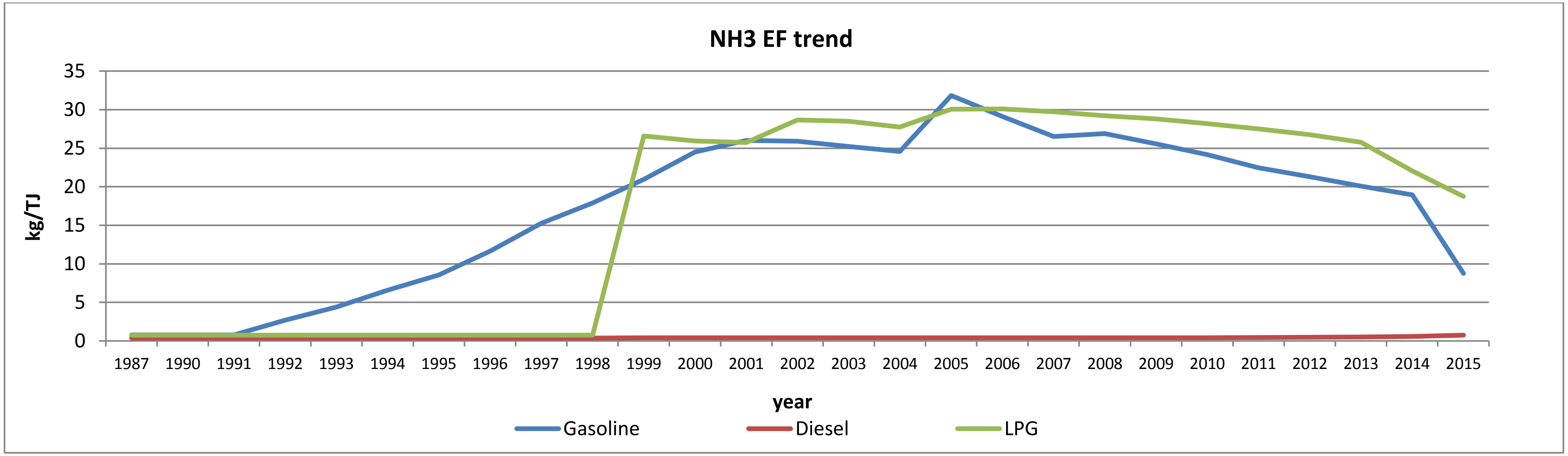

Figure C.3. Emission Factor Trends for Ammonia in NFR 1A3b

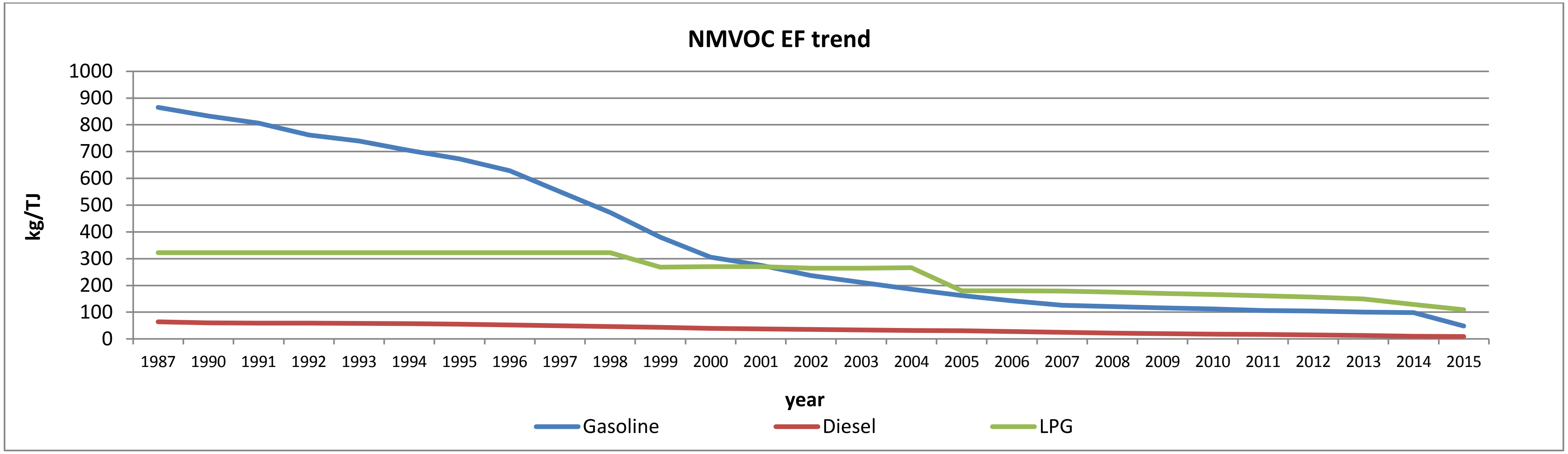

Figure C.4. Emission Factor Trends for Non-Methane Volatile Organic Compounds in NFR 1A3b

Annex D Emission Factors for Industrial Processes (NFR 2)

Table D.1 Emission Factors for NFR 2A

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	2	Industrial Processes	2015
NFR Source Category	**Cement Production (2A1)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F (I-TEQ)	0.05 to 5	µg I-TEQ / t	UNEP Toolkit (2005) & UNECE Guidebook (2006)
PCBs	1.000	µg / t	UNECE Guidebook (2006)
NFR Source Category	**Glass Production (2A3)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F (I-TEQ)	0.015 to 0.2	µg I-TEQ / t	UNEP Toolkit (2005)
NFR Source Category	**Glass Production (2A3) - Lead crystal**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	10.000	g/t	EEA/EMEP Guidebook 2013
PM_{10}	9.000	g/t	EEA/EMEP Guidebook 2013
$PM_{2.5}$	8.000	g/t	EEA/EMEP Guidebook 2013
BC	0.062	% of $PM_{2.5}$	EEA/EMEP Guidebook 2013
Pb	10.000	g/t	NAEI, 2003
Ni	0.175	g/t	NAEI, 2003
Zn	1.014	g / t	NAEI, 2003
NFR Source Category	**Glass Production (2A3) - Container**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	280.000	g/t	EEA/EMEP Guidebook 2013
PM_{10}	250.000	g/t	EEA/EMEP Guidebook 2013
$PM_{2.5}$	220.000	g/t	EEA/EMEP Guidebook 2013
BC	0.062	% of $PM_{2.5}$	EEA/EMEP Guidebook 2013
As	0.290	g/t	EEA/EMEP Guidebook 2013
Cd	0.120	g/t	EEA/EMEP Guidebook 2013
Cr	0.370	g/t	EEA/EMEP Guidebook 2013
Pb	2.900	g/t	EEA/EMEP Guidebook 2013
Ni	0.240	g/t	EEA/EMEP Guidebook 2013
Se	1.500	g/t	EEA/EMEP Guidebook 2013

Table D.1 Emission Factors for NFR 2A (continued)

NFR Source Category	Glass Production (2A3) - Glass wool		
Pollutant	**Value**	**Unit**	**Reference**
TSP	670.000	g/t	EEA/EMEP Guidebook 2013
PM_{10}	590.000	g/t	EEA/EMEP Guidebook 2013
$PM_{2.5}$	520.000	g/t	EEA/EMEP Guidebook 2013
BC	2.000	% of $PM_{2.5}$	EEA/EMEP Guidebook 2013
As	0.020	g/t	NAEI, 2003
Cd	0.028	g/t	NAEI, 2003
Cr	0.202	g/t	NAEI, 2003
Cu	0.202	g/t	NAEI, 2003
Pb	0.210	g/t	NAEI, 2003
Hg	0.069	g/t	NAEI, 2003
Ni	0.202	g/t	NAEI, 2003
Se	0.013	g/t	NAEI, 2003
Zn	2.355	g/t	NAEI, 2003
NFR Source Category	**Bricks and Ceramic Production (2A6)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F (I-TEQ)	0.110	µg I-TEQ / t	URS Dames and Moore (2000) & UNEP Toolkit (2005)
NFR Source Category	**Asphalt Production (2A6)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F (I-TEQ)	0.007 to 0.07	µg I-TEQ / t	UNEP Toolkit (2005)

Table D.2 Emission Factors for NFR 2B

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	2	Industrial Processes	2015
NFR Source Category	**Nitric Acid Production (2B2)**		
Pollutant	**Value**	**Unit**	**Reference**
NO_x	7.25 to 10.08	kg / t	Plant specific
NFR Source Category	**Storage, Handling & Transport of Fertilizers (2B10b)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	100.00	g / t	CORINAIR
PM_{10}	32.00	g / t	CORINAIR
$PM_{2.5}$	4.00	g / t	CORINAIR

Table D.3 Emission Factors for NFR 2C and NFR 2G

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	2	Industrial Processes	2015
NFR Source Category	**Iron and Steel Production (2C1)**		
Pollutant	**Value**	**Unit**	**Reference**
Cd	0.663	g / t	Plant specific
Cr	4.381	g / t	Plant specific
Pb	5.378	g / t	Plant specific
Ni	8.264	g / t	Plant specific
Zn	85.111	g / t	Plant specific
As	0.048	g / t	CORINAIR
Cu	0.550	g / t	CORINAIR
Hg	0.005	g / t	CORINAIR
Se	0.050	g / t	CORINAIR
PCDD/F (I-TEQ)	0.003	g I-TEQ / kt	EEA/EMEP Guidebook 2013
NFR Source Category	**Ferroalloys production (2C2)**		
Pollutant	**Value**	**Unit**	**Reference**
HCB	5	g / t	UNECE Guidebook
NFR Source Category	**Aluminium Production (2C3)**		
Pollutant	**Value**	**Unit**	**Reference**
Zn	2.725	g / t	UK NAEI
NFR Source Category	**Leakage from Electrical Equipment (2G)**		
Pollutant	**Value**	**Unit**	**Reference**
PCBs	0.060	g/kgfluid	UK NAEI
PCDD/F (I-TEQ)	83.500	µg I-TEQ / kg PCB	Dyke (1997)
NFR Source Category	**Fragmentisers & Shredders (2G)**		
Pollutant	**Value**	**Unit**	**Reference**
PCBs	0.004	g/capita/year	UNECE Guidebook (2000)

Annex E Agricultural Activity Data and Emission Factors (NFR 3)

Table E.1 Activity Data for Agriculture

Population (1000s)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Cattle	6822	6921	6973	6959	6965	7009	7282	7491	7592	7348	7012	7022	6961	6971	6973	6951	6925	6827	6828	6801	6555	6428	6691	6829	6840	6926
Dairy Cows	1341	1309	1262	1256	1247	1239	1241	1227	1216	1187	1165	1165	1146	1146	1139	1025	1054	1054	1060	1060	1039	1076	1101	1123	1177	1268
All Other Cattle	5481	5612	5711	5703	5718	5770	6041	6264	6376	6160	5847	5857	5814	5826	5834	5926	5872	5773	5768	5742	5516	5352	5590	5706	5663	5658
Other Cows	730	801	903	958	990	1022	1098	1183	1222	1192	1171	1178	1153	1166	1179	1121	1171	1185	1198	1169	1125	1103	1138	1118	1085	1065
Dairy Heifers	172	156	187	191	207	230	238	244	226	212	205	202	223	221	234	214	204	197	195	196	234	252	268	271	317	331
Other Heifers	80	71	106	116	104	123	134	149	128	121	133	140	142	139	142	191	193	212	180	156	170	202	181	149	174	188
Cattle < 1 yrs	1716	1765	1695	1738	1736	1746	1852	1938	1965	1821	1752	1824	1799	1761	1771	1962	1953	1941	1959	1889	1761	1846	2036	1969	1878	2042
Cattle < 1 yrs - male	903	919	889	914	904	915	974	1023	1055	965	919	955	953	922	930	958	951	947	969	918	827	892	1023	959	902	994
Cattle < 1 yrs - female	813	846	806	824	832	831	878	915	910	856	833	869	846	839	842	1005	1002	994	990	971	935	954	1013	1009	977	1048
Cattle 1 - 2 yrs	1663	1692	1638	1587	1586	1586	1639	1717	1783	1706	1517	1515	1593	1577	1535	1642	1506	1466	1496	1542	1408	1270	1376	1551	1469	1373
Cattle 1 - 2 yrs - male	986	981	982	958	952	964	996	1055	1086	1039	912	913	992	983	950	972	845	818	832	851	760	673	770	873	821	790
Cattle 1 - 2 yrs - female	677	711	656	630	634	622	643	662	697	667	605	602	601	594	585	670	661	648	664	690	647	597	606	678	648	583
Cattle > 2 yrs	1093	1099	1152	1078	1058	1023	1036	986	1002	1058	1016	941	845	902	911	734	782	715	687	738	772	640	554	609	701	628
Cattle > 2 yrs - male	826	798	830	773	740	712	732	690	708	737	722	642	560	599	605	537	565	510	476	501	506	426	361	388	456	424
Cattle > 2 yrs - female	266	301	322	305	318	311	304	296	294	321	295	299	284	303	305	197	217	206	211	237	265	214	193	221	245	204
Bulls	27	29	32	36	38	40	44	48	50	51	53	56	59	60	63	61	63	57	54	52	47	38	37	39	38	33
Total Sheep	8021	8484	8736	8977	8559	8364	8329	8051	8572	8547	7957	7455	6682	6481	6703	6431	6187	5656	5105	4727	4328	4429	4843	4918	5019	4870
Ewes Lowland	2397	2543	2622	2576	2511	2427	2369	2390	3056	2936	2814	2704	2637	2552	2464	2627	2414	2207	2057	1928	1920	1954	2036	2016	1978	1960
Ewes Upland	1961	2080	2145	2108	2055	1986	1938	1955	1310	1258	1206	1159	1130	1094	1056	657	604	552	514	482	480	489	509	504	494	490
Rams Lowland	64	67	70	69	67	66	62	64	81	79	77	75	73	72	70	77	74	69	63	58	59	59	61	62	60	60
Rams Upland	53	55	57	56	55	54	51	52	35	34	33	32	31	31	30	19	19	17	16	14	15	15	15	15	15	15
Other Sheep>1 - Lowland	164	96	89	99	107	113	106	118	172	153	143	128	129	144	140	124	122	109	112	103	96	101	116	112	97	110
Other Sheep>1 - Upland	134	79	73	81	88	92	86	97	74	66	61	55	55	62	60	31	31	27	28	26	24	25	29	28	24	27
Lambs - Lowland	1787	1960	2024	2194	2022	1994	2044	1856	2692	2815	2535	2312	1838	1768	2019	2317	2339	2140	1853	1693	1387	1429	1661	1745	1880	1766
Lambs - Upland	1462	1604	1656	1795	1654	1632	1672	1519	1154	1206	1086	991	788	758	865	579	585	535	463	423	347	357	415	436	470	442
Total Pigs	1222	1325	1404	1504	1514	1546	1643	1708	1810	1775	1727	1760	1791	1729	1704	1679	1632	1544	1486	1444	1508	1551	1532	1511	1530	1506
Gilts in Pig	21	22	25	23	22	24	25	27	26	25	21	23	20	20	22	20	22	21	21	20	19	19	20	19	20	20
Gilts not yet Served	12	14	15	14	15	18	17	18	19	16	18	19	20	18	19	20	19	16	16	17	15	15	15	15	15	15
Sows in Pig	83	90	96	101	99	100	103	108	109	109	110	107	110	104	102	100	96	96	91	89	92	90	84	82	83	82
Other Sows for Breeding	31	31	33	33	30	31	36	37	38	38	32	37	33	32	30	34	31	28	25	27	29	27	25	29	30	27
Boars	6	7	7	6	6	5	5	5	5	4	4	4	3	3	3	2	2	2	2	2	2	1	1	1	1	1
Pigs 20 Kg +	749	803	837	905	918	952	1016	1064	1144	1094	1038	1036	1062	1043	1028	1010	1034	939	932	911	953	965	960	926	941	934
Pigs Under 20 Kg	319	358	392	422	425	417	442	450	469	489	504	535	543	508	500	494	429	443	400	378	400	434	426	438	440	427
Total Poultry	11772	12698	13272	13072	14034	14438	15375	15548	15686	15490	15680	16024	15545	16152	17190	16573	15934	13324	13258	15277	15212	14947	15631	14989	15108	15429
Layer	1868	1800	2231	1832	1730	1371	1701	1580	1559	1537	1572	1676	1613	1907	1906	1950	1970	1813	1813	2145	2145	2060	2600	2828	2947	3268
Broiler	8035	8905	9067	9522	10393	11092	11730	12096	12287	12200	12426	12629	12322	12672	13375	12818	12360	9696	9696	11904	11904	11520	11520	10764	10764	10764
Turkey	1509	1633	1615	1358	1552	1616	1585	1513	1482	1393	1322	1358	1248	1209	1461	1274	1097	1330	1330	874	874	1078	1222	1125	1125	1125
Ducks	347	347	347	347	347	347	347	347	347	347	347	348	349	350	435	520	497	475	409	344	279	279	279	265	265	265
Geese	12	12	12	12	12	12	12	12	12	12	12	13	13	13	12	11	10	10	10	10	10	10	10	7	7	7
Horses	62	63	65	66	67	68	70	72	73	76	70	71	73	70	73	80	87	89	96	98	106	106	111	102	95	93
Mules	8	7	8	9	8	7	8	7	8	7	5	5	5	6	6	6	7	7	9	9	8	9	10	8	8	9
Goats	17	17	18	18	16	16	15	15	15	14	8	8	8	8	8	7	7	7	9	10	11	11	10	9	12	16
Farmed Deer	12	12	13	15	15	16	16	18	17	16	12	12	12	11	11	10	9	10	10	9	5	3	2	2	2	1
Mink	185	143	130	124	124	124	133	143	143	143	146	146	146	146	146	149	149	149	149	190	183	183	198	198	198	198
Fox	26	22	13	9	7	7	8	8	9	9	4	4	4	4	4	2	2	3	1	0	0	0	NO	NO	NO	NO
Fertiliser (1000's tonnes/N)	379.3	370.1	358.3	378.0	404.8	428.8	416.9	380.4	432.0	442.9	407.6	368.7	363.5	388.1	362.5	352.2	342.1	321.6	309.0	306.8	362.4	295.8	296.5	353.0	331.8	331.0

Table E.2.1 Input Data on Manure Management Practices - Cattle

Cattle	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number of days housed																										
Dairy Cows	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	118	117	117	117	117	117	117	117	117	117
Suckler Cows	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	142	141	141	141	141	141	141	142	141	141	142
Dairy Heifer	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128
Other Heifer	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139
Under1yr	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	222	222	222	223	223	227	224	224	223	222	221
Oneto2yrs	156	156	156	156	156	156	156	156	156	156	156	156	156	156	154	155	154	154	154	156	157	154	153	153	157	156
Over2yrs	23	23	23	23	23	23	23	23	23	23	23	23	23	23	25	26	24	26	23	26	26	23	21	22	22	26
Bulls	156	156	156	156	156	156	156	156	156	156	156	156	156	156	154	155	154	154	154	156	157	154	153	153	157	156
Number of days grazing																										
Dairy Cows	247	247	247	247	247	247	247	247	247	247	247	247	247	247	247	247	247	248	248	248	248	248	248	248	248	248
Suckler Cows	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	223	224	224	224	224	224	224	223	224	224	223
Dairy Heifer	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237	237
Other Heifer	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226
Under1yr	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	143	143	143	142	142	138	141	141	142	143	144
Oneto2yrs	209	209	209	209	209	209	209	209	209	209	209	209	209	209	211	210	211	211	211	209	208	211	212	212	208	209
Over2yrs	342	342	342	342	342	342	342	342	342	342	342	342	342	342	340	339	341	339	342	339	339	342	344	343	343	339
Bulls	209	209	209	209	209	209	209	209	209	209	209	209	209	209	211	210	211	211	211	209	208	211	212	212	208	209
Proportion to each AWMS																										
Liquid																										
Dairy Cows	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.28
Suckler Cows	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27	0.26	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Dairy Heifer	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Other Heifer	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Under1yr	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.42	0.41	0.42	0.42	0.42	0.42	0.42	0.42	0.41	0.41
Oneto2yrs	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.33	0.34	0.34	0.34	0.34	0.33	0.33	0.33	0.34	0.34
Over2yrs	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.04
Bulls	0.42	0.42	0.42	0.41	0.41	0.41	0.40	0.40	0.40	0.39	0.39	0.39	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Solid																										
Dairy Cows	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Suckler Cows	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Dairy Heifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Heifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Under1yr	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.18	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.19	0.19
Oneto2yrs	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Over2yrs	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.03
Bulls	0.14	0.14	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Pasture																										
Dairy Cows	0.66	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.68	0.68	0.68	0.68	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.70	0.70	0.69	0.69	0.69	0.70
Suckler Cows	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Dairy Heifer	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Other Heifer	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
Under1yr	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.38	0.39	0.39	0.39	0.39	0.39
Oneto2yrs	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.58	0.58	0.58	0.58	0.58	0.57	0.57	0.58	0.58	0.58	0.57	0.57
Over2yrs	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.93	0.94	0.93	0.93	0.94	0.94	0.94	0.94	0.93
Bulls	0.44	0.44	0.45	0.45	0.45	0.46	0.46	0.47	0.47	0.48	0.48	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49

Table E.2.2 Input Data on Manure Management Practices - Other Livestock

Animal Category	Days housed	% housed	% outwintered	Housing Type		Proportion to each AWMS		
				% Slurry based	% Straw based	Liquid	Solid	Pasture
Sheep								
Lowland Ewes	61.00	47.07	52.93	0.00	100.00	0.00	0.08	0.92
Upland Ewes	85.00	44.34	55.66	0.00	100.00	NA	0.10	0.90
Rams	85.00	22.34	77.66	0.00	100.00	NA	0.05	0.95
Lambs	58.00	16.88	83.12	0.00	100.00	NA	0.03	0.97
Other sheep	61.00	47.07	52.93	0.00	100.00	NA	0.08	0.92
Pigs								
Gilts in pig	365.00	100.00	0.00	100.00	0.00	1.00	0.00	0.00
Gilts not yet served	365.00	100.00	0.00	100.00	0.00	1.00	0.00	0.00
Sows in pig	365.00	100.00	0.00	100.00	0.00	1.00	0.00	0.00
Other sows for breeding	365.00	100.00	0.00	100.00	0.00	1.00	0.00	0.00
Boars	365.00	100.00	0.00	100.00	0.00	1.00	0.00	0.00
Pigs < 20 kg	365.00	100.00	0.00	100.00	0.00	1.00	0.00	0.00
Pigs > 20 kg	365.00	100.00	0.00	100.00	0.00	1.00	0.00	0.00
Poultry								
Layers	365.00	88.00	12.00	84.20	15.80	0.74	0.14	0.12
Broilers	365.00	100.00	0.00	0.00	100.00	0.00	1.00	0.00
Turkeys	365.00	100.00	0.00	0.00	100.00	0.00	1.00	0.00
Horses	143.00	100.00	0.00	0.00	100.00	0.00	0.39	0.61
Mules and Asses	143.00	100.00	0.00	0.00	100.00	0.00	0.39	0.61
Goats	0.00	0.00	100.00	0.00	0.00	0.00	0.00	1.00

Table E.3 Nitrogen excretion (kg/head/year)

N excretion (kg/head/year)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	N excretion values																									
Dairy Cows	95.5	95.9	96.3	96.6	97.0	97.3	97.7	98.0	98.4	98.7	99.1	99.5	99.8	100.2	100.0	102.1	102.0	101.7	100.7	99.6	102.3	102.4	100.8	100.9	100.4	101.4
Suckler Cows	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.6	76.6	76.6	76.8	77.7	76.7	75.7	77.2	75.3	75.5	76.5	77.8	75.6	76.1	74.5
Dairy Heifer	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4
Other Heifer	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4
Under 1yr	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
One to 2yrs	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4	63.4
Over 2yrs	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2
Bulls	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8
Ewes Lowland	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
Ewes Upland	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Rams - lowland	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Rams - upland	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Other Sheep>1- lowland	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Other Sheep>1- upland	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Lambs - lowland	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Lambs - upland	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Gilts in pig	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Gilts not yet served	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
Sows in pig	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Other breeding sows	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Boars	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Fatteners > 20 kg	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
Fatteners < 20 kg	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Laying hen per bird place	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Broiler per bird place	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Turkey per bird place	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Ducks	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Geese	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Horses	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4
Mules	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
Goats	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
Deer (red) 6 months - 2 years	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3
Deer (red) > 2 years	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
Deer (fallow) 6 months-2 years	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Deer (fallow) > 2 years	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3
Deer (sika) 6 months - 2 years	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Deer (sika) > 2 years	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Mink	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Fox	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1

Table E.4 Fertiliser Compound Statistics and Emission Estimates 1990-2015

Tonnes N/year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CAN	134,426	134,143	124,582	147,244	146,411	156,640	164,380	155,681	179,400	167,928	153,646	134,410	127,219	137,384	115,148	126,011	116,632	118,789	130,704	141,810	149,171	123,280	136,006	148,901	137,119	129,863
Urea	60,643	62,494	74,072	62,649	61,924	54,113	54,690	51,834	59,824	64,944	57,611	52,463	50,687	49,230	41,938	38,042	40,296	31,848	41,947	55,809	61,587	44,076	29,075	29,538	34,209	38,598
Ammonium sulphate	6,522	5,219	4,419	3,755	2,408	2,245	1,680	1,297	1,288	1,259	1,047	1,203	1,173	1,348	1,912	802	2,003	2,744	2,239	2,266	2,097	2,845	3,687	4,044	2,973	2,511
Other	177,720	168,264	155,229	164,337	194,068	215,828	196,168	171,538	191,487	208,789	195,293	180,590	184,434	200,118	203,527	187,310	183,206	168,172	134,069	106,920	149,540	125,595	127,767	170,535	157,480	160,167
Total	**379,311**	**370,121**	**358,302**	**377,985**	**404,811**	**428,826**	**416,918**	**380,350**	**431,999**	**442,920**	**407,597**	**368,666**	**363,513**	**388,080**	**362,525**	**352,165**	**342,137**	**321,553**	**308,959**	**306,805**	**362,395**	**295,796**	**296,535**	**353,018**	**331,781**	**331,139**

Tonnes NH3-N	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CAN	1,163	1,160	1,078	1,274	1,267	1,355	1,422	1,347	1,552	1,453	1,329	1,163	1,101	1,189	996	1,090	1,009	1,028	1,131	1,227	1,291	1,067	1,177	1,288	1,186	1,123
Urea	7,853	8,092	9,592	8,113	8,019	7,007	7,082	6,712	7,747	8,410	7,460	6,794	6,564	6,375	5,431	4,926	5,218	4,124	5,432	7,227	7,975	5,707	3,765	3,825	4,430	4,998
Ammonium sulphate	95	76	65	55	35	33	25	19	19	18	15	18	17	20	28	12	29	40	33	33	31	42	54	59	43	37
Other	1,537	1,456	1,343	1,422	1,679	1,867	1,697	1,484	1,657	1,806	1,690	1,562	1,596	1,731	1,761	1,620	1,585	1,455	1,160	925	1,294	1,087	1,105	1,475	1,362	1,386
	10,648	**10,785**	**12,077**	**10,863**	**10,999**	**10,262**	**10,226**	**9,562**	**10,974**	**11,687**	**10,494**	**9,536**	**9,277**	**9,314**	**8,215**	**7,648**	**7,841**	**6,647**	**7,755**	**9,412**	**10,590**	**7,902**	**6,101**	**6,647**	**7,022**	**7,544**

Table E.5 Timing of Slurry Spreading – Cattle

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Spring	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.52	0.52	0.52	0.52	0.52	0.52
Summer	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.36	0.36	0.36	0.36	0.36	0.36
Autumn	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.12	0.12	0.12	0.12	0.12	0.12
Winter	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00

Table E.6 NMVOC Emission Factors for NFR 3B

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	3	Agriculture	2015
NFR Source Category	**Manure management - cattle (3B1 a&b)**		
Pollutant	**Value**	**Unit**	**Reference**
NMVOC	0.0002002	kgNMVOC/kg MJ feed intake	Inventory Guidebook (2013) (silage feeding)
NMVOC	0.00005005	kgNMVOC/kg MJ feed intake	Inventory Guidebook (2013) (silage store)
NMVOC	0.0000353	kgNMVOC/kg MJ feed intake	Inventory Guidebook (2013) (house)
NFR Source Category	**Manure management - sheep (3B2)**		
Pollutant	**Value**	**Unit**	**Reference**
NMVOC	0.001614	kg VS excreted	Inventory Guidebook (2013) (House)
NMVOC	1.2326	kg VS excreted	Inventory Guidebook (2013) (Manure store ratio)
NMVOC	0.646584	kg VS excreted	Inventory Guidebook (2013) (Manure application ratio)
NMVOC	0.000023	kg VS excreted	Inventory Guidebook (2013) (Grazing)
NFR Source Category	**Manure management - pigs (3B3)**		
Pollutant	**Value**	**Unit**	**Reference**
NMVOC	0.001703	kgNMVOC/kgVS	Inventory Guidebook (2013) (Housing, gilts)
NMVOC	0.007042	kgNMVOC/kgVS	Inventory Guidebook (2013) (Housing, sows)
NMVOC	0.001703	kgNMVOC/kgVS	Inventory Guidebook (2013) (Housing, other pigs)
NFR Source Category	**Manure management - goats (3B4d)**		
Pollutant	**Value**	**Unit**	**Reference**
NMVOC	0.001614	kg VS excreted	Inventory Guidebook (2013) (House)
NMVOC	3.876	kg VS excreted	Inventory Guidebook (2013) (Manure store ratio)
NMVOC	2.033	kg VS excreted	Inventory Guidebook (2013) (Manure application ratio)
NMVOC	0.0000235	kg VS excreted	Inventory Guidebook (2013) (Grazing)
NFR Source Category	**Manure management - horses (3B4e)**		
Pollutant	**Value**	**Unit**	**Reference**
NMVOC	0.001614	kg VS excreted	Inventory Guidebook (2013) (House)
NMVOC	3.8758	kg VS excreted	Inventory Guidebook (2013) (Manure store ratio)
NMVOC	2.033	kg VS excreted	Inventory Guidebook (2013) (Manure application ratio)
NMVOC	0.0000235	kg VS excreted	Inventory Guidebook (2013) (Grazing)
NFR Source Category	**Manure management - mules & asses (3B4f)**		
Pollutant	**Value**	**Unit**	**Reference**
NMVOC	0.001614	kg VS excreted	Inventory Guidebook (2013) (House)
NMVOC	1.2326	kg VS excreted	Inventory Guidebook (2013) (Manure store ratio)
NMVOC	0.824	kg VS excreted	Inventory Guidebook (2013) (Manure application ratio)
NMVOC	0.0000235	kg VS excreted	Inventory Guidebook (2013) (Grazing)
NFR Source Category	**Manure management - poultry (3B4g)**		
Pollutant	**Value**	**Unit**	**Reference**
NMVOC	0.165	kg/AAP/yr	Inventory Guidebook (2013) (Layers)
NMVOC	0.108	kg/AAP/yr	Inventory Guidebook (2013) (Broilers)
NMVOC	0.489	kg/AAP/yr	Inventory Guidebook (2013) (Other poultry)
NFR Source Category	**Manure management - other animals (3B4h)**		
Pollutant	**Value**	**Unit**	**Reference**
NMVOC	0.045	kg/AAP/yr	Inventory Guidebook (2013) (Farmed Deer)
NMVOC	1.941	kg/AAP/yr	Inventory Guidebook (2013) (Mink & Fox)

Table E.7 TSP Emission Factors for NFR 3B

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	3	Agriculture	2015
NFR Source Category	**Manure management - cattle (3B1 a&b)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	1.810	kg/AAP/yr	Inventory Guidebook (2013) (Dairy cows - slurry)
TSP	0.940	kg/AAP/yr	Inventory Guidebook (2013) (Dairy cows - solid)
TSP	0.690	kg/AAP/yr	Inventory Guidebook (2013) (Other cattle - slurry)
TSP	0.520	kg/AAP/yr	Inventory Guidebook (2013) (Other cattle - solid)
TSP	0.340	kg/AAP/yr	Inventory Guidebook (2013) (Calves - slurry)
TSP	0.350	kg/AAP/yr	Inventory Guidebook (2013) (Calves - solid)
NFR Source Category	**Manure management - sheep (3B2)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	0.139	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - pigs (3B3)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	0.70	kg/AAP/yr	Inventory Guidebook (2013) (fattening pigs)
TSP	0.36	kg/AAP/yr	Inventory Guidebook (2013) (weaners)
TSP	1.36	kg/AAP/yr	Inventory Guidebook (2013) (sows)
NFR Source Category	**Manure management - goats (3B4d)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	0.139	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - horses (3B4e)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	0.48	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - mules & asses (3B4f)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	0.34	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - poultry (3B4g)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	0.119	kg/AAP/yr	Inventory Guidebook (2013) (Layers)
TSP	0.069	kg/AAP/yr	Inventory Guidebook (2013) (Broilers)
TSP	0.520	kg/AAP/yr	Inventory Guidebook (2013) (Turkeys)
TSP	0.240	kg/AAP/yr	Inventory Guidebook (2013) (Geese)
TSP	0.140	kg/AAP/yr	Inventory Guidebook (2013) (Ducks)
NFR Source Category	**Manure management - other animals (3B4h)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	0.018	kg/AAP/yr	Inventory Guidebook (2013) (Mink & Fox)

Table E.8 PM_{10} Emission Factors for NFR 3B

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	3	Agriculture	2015
NFR Source Category	**Manure management - cattle (3B1 a&b)**		
Pollutant	**Value**	**Unit**	**Reference**
PM_{10}	0.830	kg/AAP/yr	Inventory Guidebook (2013) (Dairy cows - slurry)
PM_{10}	0.430	kg/AAP/yr	Inventory Guidebook (2013) (Dairy cows - solid)
PM_{10}	0.320	kg/AAP/yr	Inventory Guidebook (2013) (Other cattle - slurry)
PM_{10}	0.240	kg/AAP/yr	Inventory Guidebook (2013) (Other cattle - solid)
PM_{10}	0.150	kg/AAP/yr	Inventory Guidebook (2013) (Calves - slurry)
PM_{10}	0.160	kg/AAP/yr	Inventory Guidebook (2013) (Calves - solid)
NFR Source Category	**Manure management - sheep (3B2)**		
Pollutant	**Value**	**Unit**	**Reference**
PM_{10}	0.0556	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - pigs (3B3)**		
Pollutant	**Value**	**Unit**	**Reference**
PM_{10}	0.31	kg/AAP/yr	Inventory Guidebook (2013) (fattening pigs)
PM_{10}	0.16	kg/AAP/yr	Inventory Guidebook (2013) (weaners)
PM_{10}	0.61	kg/AAP/yr	Inventory Guidebook (2013) (sows)
NFR Source Category	**Manure management - goats (3B4d)**		
Pollutant	**Value**	**Unit**	**Reference**
PM_{10}	0.0556	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - horses (3B4e)**		
Pollutant	**Value**	**Unit**	**Reference**
PM_{10}	0.22	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - mules & asses (3B4f)**		
Pollutant	**Value**	**Unit**	**Reference**
PM_{10}	0.16	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - poultry (3B4g)**		
Pollutant	**Value**	**Unit**	**Reference**
PM_{10}	0.119	kg/AAP/yr	Inventory Guidebook (2013) (Layers)
PM_{10}	0.069	kg/AAP/yr	Inventory Guidebook (2013) (Broilers)
PM_{10}	0.520	kg/AAP/yr	Inventory Guidebook (2013) (Turkeys)
PM_{10}	0.240	kg/AAP/yr	Inventory Guidebook (2013) (Geese)
PM_{10}	0.140	kg/AAP/yr	Inventory Guidebook (2013) (Ducks)
NFR Source Category	**Manure management - other animals (3B4h)**		
Pollutant	**Value**	**Unit**	**Reference**
PM_{10}	0.0081	kg/AAP/yr	Inventory Guidebook (2013) (Mink & Fox)

Table E.9 $PM_{2.5}$ Emission Factors for NFR 3B

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	3	Agriculture	2015
NFR Source Category	**Manure management - cattle (3B1 a&b)**		
Pollutant	**Value**	**Unit**	**Reference**
$PM_{2.5}$	0.540	kg/AAP/yr	Inventory Guidebook (2013) (Dairy cows - slurry)
$PM_{2.5}$	0.280	kg/AAP/yr	Inventory Guidebook (2013) (Dairy cows - solid)
$PM_{2.5}$	0.210	kg/AAP/yr	Inventory Guidebook (2013) (Other cattle - slurry)
$PM_{2.5}$	0.160	kg/AAP/yr	Inventory Guidebook (2013) (Other cattle - solid)
$PM_{2.5}$	0.100	kg/AAP/yr	Inventory Guidebook (2013) (Calves - slurry)
$PM_{2.5}$	0.100	kg/AAP/yr	Inventory Guidebook (2013) (Calves - solid)
NFR Source Category	**Manure management - sheep (3B2)**		
Pollutant	**Value**	**Unit**	**Reference**
$PM_{2.5}$	0.0167	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - pigs (3B3)**		
Pollutant	**Value**	**Unit**	**Reference**
$PM_{2.5}$	0.06	kg/AAP/yr	Inventory Guidebook (2013) (fattening pigs)
$PM_{2.5}$	0.03	kg/AAP/yr	Inventory Guidebook (2013) (weaners)
$PM_{2.5}$	0.11	kg/AAP/yr	Inventory Guidebook (2013) (sows)
NFR Source Category	**Manure management - goats (3B4d)**		
Pollutant	**Value**	**Unit**	**Reference**
$PM_{2.5}$	0.0167	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - horses (3B4e)**		
Pollutant	**Value**	**Unit**	**Reference**
$PM_{2.5}$	0.14	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - mules & asses (3B4f)**		
Pollutant	**Value**	**Unit**	**Reference**
$PM_{2.5}$	0.10	kg/AAP/yr	Inventory Guidebook (2013)
NFR Source Category	**Manure management - poultry (3B4g)**		
Pollutant	**Value**	**Unit**	**Reference**
$PM_{2.5}$	0.023	kg/AAP/yr	Inventory Guidebook (2013) (Layers)
$PM_{2.5}$	0.009	kg/AAP/yr	Inventory Guidebook (2013) (Broilers)
$PM_{2.5}$	0.070	kg/AAP/yr	Inventory Guidebook (2013) (Turkeys)
$PM_{2.5}$	0.030	kg/AAP/yr	Inventory Guidebook (2013) (Geese)
$PM_{2.5}$	0.020	kg/AAP/yr	Inventory Guidebook (2013) (Ducks)
NFR Source Category	**Manure management - other animals (3B4h)**		
Pollutant	**Value**	**Unit**	**Reference**
$PM_{2.5}$	0.0042	kg/AAP/yr	Inventory Guidebook (2013) (Mink & Fox)

Table E.10 Emission Factors for NFR 3D

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	3	Agriculture	2015
NFR Source Category	**Off-farm storage, handling and transport of bulk agricultural products (3Dd)**		
Pollutant	**Value**	**Unit**	**Reference**
TSP	100.00	g / t	CORINAIR
PM_{10}	25.00	g / t	CORINAIR
$PM_{2.5}$	4.00	g / t	CORINAIR
NFR Source Category	**Inorganic N-fertilizers (includes also urea application) (3Da1)**		
Pollutant	**Value**	**Unit**	**Reference**
NMVOC	0.86	kg/ha	Inventory Guidebook (2013)
PM_{10}	1.56	kg/ha	Inventory Guidebook (2013)
$PM_{2.5}$	0.06	kg/ha	Inventory Guidebook (2013)
TSP	1.56	kg/ha	Inventory Guidebook (2013) PM_{10} value

Annex F Emission Factors for Waste (NFR 5)

Table F.1 Emission Factors for NFR 5A and NFR 5C1

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	5	Waste	2015
NFR Source Category	Solid Waste Disposal on Land (5A)		
Pollutant	Value	Unit	Reference
NMVOC	5.65	g NMVOC/m3 landfill gas	2013 EMEP/EEA Guidebook
TSP	0.463	g/Mg	2013 EMEP/EEA Guidebook
PM_{10}	0.219	g/Mg	2013 EMEP/EEA Guidebook
$PM_{2.5}$	0.033	g/Mg	2013 EMEP/EEA Guidebook
PCDD/F (I-TEQ)	0.953	µg I-TEQ/tonne of escaping gas	UK NAEI
PCDD/F (I-TEQ)	0.614	µg I-TEQ/tonne of flared gas	UK NAEI
PCBs	0.0008	kg/ktonne of escaping gas	UK NAEI
NFR Source Category	Clinical Waste Incineration (5C1biii)		
Pollutant	Value	Unit	Reference
NOx	2.3	kg/Mg waste	2013 EMEP/EEA Guidebook
CO	0.190	kg/Mg waste	2013 EMEP/EEA Guidebook
NMVOC	0.700	kg/Mg waste	2013 EMEP/EEA Guidebook
SOx	0.540	kg/Mg waste	2013 EMEP/EEA Guidebook
TSP	17.000	kg/Mg waste	2013 EMEP/EEA Guidebook
PM10	11.900	kg/Mg waste	2013 EMEP/EEA Guidebook
PM2.5	6.800	kg/Mg waste	2013 EMEP/EEA Guidebook
BC	2.300	% of TSP	2013 EMEP/EEA Guidebook
As	0.100	g/tonne	CORINAIR
Cd	3.000	g/tonne	CORINAIR
Cr	0.400	g/tonne	CORINAIR
Cu	0.600	g/tonne	CORINAIR
Pb	364.000	g/tonne	CORINAIR
Hg	54.000	g/tonne	CORINAIR
Ni	0.300	g/tonne	CORINAIR
Zn	0.019	g/tonne	UK NAEI
PCDD/F	372.100	g-I-TEQ/mt burnt	UK NAEI
PCBs	0.77 - 3.15	kg/Mt burned	UK NAEI
HCB	0.5 - 2.053	kg/Mt burned	UK NAEI
Benzo[a]pyrene	0.7 - 2.875	kg/Mt burned	UK NAEI
Benzo[b]fluoranthene	3.15 - 12.937	kg/Mt burned	UK NAEI
Benzo[k]Fluoranthene	3.15 - 12.937	kg/Mt burned	UK NAEI

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	5	Waste	2015
NFR Source Category	Industrial (incl. Hazardous & Sludge) Waste Incineration (5C1bi-ii,iv)		
Pollutant	Value	Unit	Reference
NOx	0.87	kg/Mg waste	2013 EMEP/EEA Guidebook
CO	0.070	kg/Mg waste	2013 EMEP/EEA Guidebook
NMVOC	7.400	kg/Mg waste	2013 EMEP/EEA Guidebook
SOx	0.047	kg/Mg waste	2013 EMEP/EEA Guidebook
TSP	0.010	kg/Mg waste	2013 EMEP/EEA Guidebook
PM10	0.007	kg/Mg waste	2013 EMEP/EEA Guidebook
PM2.5	0.004	kg/Mg waste	2013 EMEP/EEA Guidebook
BC	3.500	% of PM2.5	2013 EMEP/EEA Guidebook
As	0.025	g/tonne	UK NAEI
Cd	0.010	g/tonne	UK NAEI
Cr	0.121	g/tonne	UK NAEI
Cu	0.085	g/tonne	UK NAEI
Pb	0.139	g/tonne	UK NAEI
Hg	0.018	g/tonne	UK NAEI
Ni	0.105	g/tonne	UK NAEI
Zn	1.449	g/tonne	UK NAEI
PCBs	1.223 - 4.83	kg/Mt burned	UK NAEI
HCB	0.5 - 1.975	kg/Mt burned	UK NAEI
Benzo[a]pyrene	0.15 - 0.592	kg/Mt burned	UK NAEI
Benzo[b]fluoranthene	0.65 - 2.567	kg/Mt burned	UK NAEI
Benzo[k]Fluoranthene	0.65 - 2.567	kg/Mt burned	UK NAEI
NFR Source Category	Crematoria (5C1bv)		
Pollutant	Value	Unit	Reference
NOx	0.825	kg/body	2013 EMEP/EEA Guidebook
CO	0.140	kg/body	2013 EMEP/EEA Guidebook
NMVOC	0.013	kg/body	2013 EMEP/EEA Guidebook
SOx	0.113	kg/body	2013 EMEP/EEA Guidebook
TSP	0.039	kg/body	2013 EMEP/EEA Guidebook
PM10	0.027	kg/body	2013 EMEP/EEA Guidebook
PM2.5	0.015	kg/body	2013 EMEP/EEA Guidebook
As	13.610	mg/cremation	2013 EMEP/EEA Guidebook
Cd	5.030	mg/cremation	2013 EMEP/EEA Guidebook
Pb	30.030	mg/cremation	2013 EMEP/EEA Guidebook
Cr	13.560	mg/cremation	2013 EMEP/EEA Guidebook
Ni	17.330	mg/cremation	2013 EMEP/EEA Guidebook
Hg	1.490	g/cremation	2013 EMEP/EEA Guidebook
Cu	12.430	mg/cremation	2013 EMEP/EEA Guidebook
PCDD/F	0.0270	ug - ITEQ/ cremation	2013 EMEP/EEA Guidebook
HCB	0.150	mg/cremation	2013 EMEP/EEA Guidebook
Benzo[a]pyrene	0.013	mg/cremation	2013 EMEP/EEA Guidebook

Table F.2 Emission Factors for NFR 5C2 and NFR 5E

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	5	Waste	2015
NFR Source Category	**Open Burning of Agricultural Wastes - Farm Plastics (5C2)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F	300.000	g-I-TEQ/Mt burned	UNEP Toolkit (2005)
PCBs	510.000	kg/Mt burned	UK NAEI
Benzo[a]pyrene	89.500	kg/Mt burned	UK NAEI
Benzo[b]fluoranthene	405.000	kg/Mt burned	UK NAEI
Benzo[k]Fluoranthene	405.000	kg/Mt burned	UK NAEI
NFR Source Category	**Accidental Vehicle Fires (5E)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F	94.000	ug I-TEQ/vehicle	UNEP Toolkit
PCBs	25.500	mg / vehicle fire	UK NAEI
Benzo[a]pyrene	0.060	mg / vehicle fire	UK NAEI
Benzo[b]fluoranthene	0.095	mg / vehicle fire	UK NAEI
Benzo[k]Fluoranthene	0.034	mg / vehicle fire	UK NAEI
Indeno[1,2,3-cd]pyrene	0.065	mg / vehicle fire	UK NAEI
NFR Source Category	**Accidental Buidling Fires (5E)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F	400.000	ug I-TEQ/t	UNEP Toolkit
PCBs	510.000	kg/Mt burned	UK NAEI
Benzo[a]pyrene	1.200	kg/Mt burned	UK NAEI
Benzo[b]fluoranthene	1.900	kg/Mt burned	UK NAEI
Benzo[k]Fluoranthene	0.670	kg/Mt burned	UK NAEI
Indeno[1,2,3-cd]pyrene	1.300	kg/Mt burned	UK NAEI

Emission Factors			
	Code	Name	Inventory Year
NFR Source Category	5	Waste	2015
NFR Source Category	**Domestic Bonfires (5E)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F	60.000	g-I-TEQ/Mt burned	UNEP Toolkit
PCBs	1.140	kg/Mt burned	UK NAEI
Benzo[a]pyrene	1300.000	kg/Mt burned	UK NAEI
Benzo[b]fluoranthene	1500.000	kg/Mt burned	UK NAEI
Benzo[k]Fluoranthene	500.000	kg/Mt burned	UK NAEI
Indeno[1,2,3-cd]pyrene	90.000	kg/Mt burned	UK NAEI
NFR Source Category	**Domestic Burning of Household Waste (5E)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F	173.000	g-I-TEQ/Mt burned	UK NAEI
PCBs	510.000	kg/Mt burned	UK NAEI
Benzo[a]pyrene	89.500	kg/Mt burned	UK NAEI
Benzo[b]fluoranthene	405.000	kg/Mt burned	UK NAEI
Benzo[k]Fluoranthene	405.000	kg/Mt burned	UK NAEI
NFR Source Category	**Wood Burining on Construction Sites (5E)**		
Pollutant	**Value**	**Unit**	**Reference**
PCDD/F	60.000	g-I-TEQ/Mt burned	UNEP Toolkit
PCBs	1.990	kg/Mt burned	UK NAEI
Benzo[a]pyrene	1300.000	kg/Mt burned	UK NAEI
Benzo[b]fluoranthene	1500.000	kg/Mt burned	UK NAEI
Benzo[k]Fluoranthene	500.000	kg/Mt burned	UK NAEI
Indeno[1,2,3-cd]pyrene	90.000	kg/Mt burned	UK NAEI

Annex G Uncertainty Analysis

A Tier 1 uncertainty analysis was conducted for NO_X, SO_2, NMVOC, NH_3, CO and PM_{10}. The method used was that specified in the IPCC Good Practice Guidance. This allows the calculation of an absolute uncertainty for the emissions in 2015, and the uncertainty in the trend between 1990 and 2015.

Uncertainty Associated with the Activity Data

The uncertainty values assigned to activity data in the combustion sectors (i.e. quantities of fuel) were taken from the Tier 1 uncertainty analysis of Greenhouse Gas emissions in Ireland's National Inventory Report. This was possible because the pollutants included here use the same activity data for combustion emissions. Uncertainties assigned to the activity data for sources not included in the carbon uncertainty analysis, i.e. process emissions, were determined by considering the variability in the trend of the activity data with time, and the extent to which recalculations had been made on data in previous years. In this way, it is possible to obtain a general assessment of how uncertain the data appears to be. This, combined with expert opinion, allowed a numerical value for the uncertainty in the activity data to be made.

Uncertainty Associated with Emission Factors

The EMEP/EEA Emissions Inventory Guidebook doesn't provide uncertainty information with each of the reported emission factors, but it does provide a guide as to the levels of uncertainty that are typically found by sector across the pollutants. Uncertainty ranges are used to give a general indication of how well emission factors are characterised.

This information was used as context when uncertainties were assigned to the emission factors. Expert judgement and knowledge of the inventory methodologies were also used, so that input datasets considered being higher or lower in uncertainty than the typical default levels could be reflected in the uncertainty value assigned to the relevant emission factor. Trends in the emission factor uncertainty across the sectors or fuel types were also incorporated to provide consistency in the approach across the pollutants. For example, in terms of the expected levels of uncertainty in emission factors the following relationship was assumed for the majority of cases:

Electricity Generation < Industrial Combustion < Commercial Combustion < Residential Combustion

Similar trends across the fuel were also generally used:

Gaseous Fuels < Petroleum Fuels < Coal < Peat

Uncertainty values were generally restricted to 10%, 20%, 50%, 100%, 300% and 500% (although other values were used on occasion).

This overall approach proves a good framework for populating the emission factor uncertainties in a consistent and transparent way.

The following tables show the contributions to the overall analysis for each pollutant by source sector.

Table G.1 Tier 1 Emissions Uncertainty Analysis NOx

IPCC Source Category	Gas	Emissions in 1990	Emissions in 2015	Activity Data (AD) Uncertainty	Emission Factor (EF) Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Emissions in 2015	Combined Emissions Uncertainty Squared	Type A Sensitivity	Type B Sensitivity	Uncertainty in Trend in Total Emissions due to AD	Uncertainty in Trend in Total Emissions due to EF	Combined Uncertainty in Trend in Total Emissions	Combined Trend Uncertainty Squared
		tonnes	**tonnes**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
1A1 Energy-Liquid	**NOx**	2766.3	330.2	1.0	10.0	10.05	0.04	0.00	-0.01	0.00	0.00	-0.09	0.09	0.01
1A1 Energy-Solid	**NOx**	34802.0	7405.0	1.0	10.0	10.05	0.94	0.88	-0.10	0.05	0.08	-0.95	0.96	0.91
1A1 Energy-Gas	**NOx**	9353.5	2021.4	1.0	10.0	10.05	0.26	0.07	-0.03	0.01	0.02	-0.25	0.26	0.07
1A1 Energy-Biomass & renewable waste	**NOx**	0.0	61.9	1.0	50.0	50.01	0.04	0.00	0.00	0.00	0.00	0.02	0.02	0.00
1A1 Energy-non-renewable waste	**NOx**	0.0	111.4	1.0	50.0	50.01	0.07	0.00	0.00	0.00	0.00	0.04	0.04	0.00
1A1 Energy-Landfill Gas	**NOx**	0.0	152.8	1.0	300.0	300.00	0.58	0.33	0.00	0.00	0.00	0.34	0.34	0.11
1A2 Industry-Liquid exc Pet Coke	**NOx**	3611.4	1914.3	10.0	20.0	22.36	0.54	0.29	0.00	0.01	0.20	-0.03	0.20	0.04
1A2 Industry-Coal + Biomass	**NOx**	2723.7	3066.3	2.0	50.0	50.04	1.93	3.72	0.01	0.02	0.06	0.54	0.55	0.30
1A2 Industry-Pet Coke	**NOx**	1409.9	4272.2	5.0	20.0	20.62	1.11	1.23	0.03	0.03	0.22	0.51	0.55	0.31
1A2 Industry-Gas	**NOx**	1182.9	1700.5	7.0	20.0	21.19	0.45	0.21	0.01	0.01	0.12	0.15	0.19	0.04
1A3a Transport-Oil-Aviation	**NOx**	1046.6	1039.4	1.0	7.5	7.57	0.10	0.01	0.00	0.01	0.01	0.02	0.03	0.00
1A3b Transport-Oil-Road	**NOx**	54000.5	37506.7	1.0	10.0	10.05	4.74	22.46	0.04	0.28	0.39	0.43	0.58	0.34
1A3c Transport-Oil-Rail	**NOx**	2198.5	1814.1	1.0	70.0	70.01	1.60	2.55	0.00	0.01	0.02	0.27	0.27	0.07
1A3d Transport-Oil-Navigation	**NOx**	2135.5	5426.1	1.0	40.0	40.01	2.73	7.45	0.03	0.04	0.06	1.23	1.23	1.51
1A3e Transport-Gas	**NOx**	54.2	119.4	1.0	50.0	50.01	0.08	0.01	0.00	0.00	0.00	0.03	0.03	0.00
1A4 Comm-Liquid	**NOx**	2523.1	1010.3	10.0	20.0	22.36	0.28	0.08	0.00	0.01	0.11	-0.07	0.13	0.02
1A4 Comm-Coal + Biomass	**NOx**	4.7	63.6	5.0	50.0	50.25	0.04	0.00	0.00	0.00	0.00	0.02	0.02	0.00
1A4 Comm-Peat	**NOx**	231.5	0.0	10.0	100.0	100.50	0.00	0.00	0.00	0.00	0.00	-0.10	0.10	0.01
1A4 Comm-Gas + Biogas	**NOx**	301.0	1295.0	2.5	20.0	20.16	0.33	0.11	0.01	0.01	0.03	0.16	0.17	0.03
1A4 Res-Liquid (excl Pet Coke)	**NOx**	764.2	2013.4	10.0	50.0	50.99	1.29	1.67	0.01	0.01	0.21	0.58	0.61	0.38
1A4 Res-Coal + Biomass	**NOx**	3031.8	1058.1	5.0	100.0	100.12	1.33	1.77	-0.01	0.01	0.06	-0.53	0.53	0.28
1A4 Res-Petcoke	**NOx**	41.2	13.9	5.0	50.0	50.25	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4 Res-Peat	**NOx**	3338.8	923.9	10.0	100.0	100.50	1.17	1.36	-0.01	0.01	0.10	-0.76	0.76	0.58
1A4 Res-Gas	**NOx**	206.2	976.1	2.5	20.0	20.16	0.25	0.06	0.01	0.01	0.03	0.13	0.13	0.02
1A4 Agric/Forestry/Fishing Liquid	**NOx**	8700.4	4431.5	10.0	100.0	100.50	5.60	31.35	0.00	0.03	0.46	-0.49	0.67	0.45
1B2 Fugitive emissions oil	**NOx**	433.0	801.5	5.0	300.0	300.04	3.02	9.14	0.00	0.01	0.04	1.21	1.21	1.47
2B2 Nitric Acid Production	**NOx**	960.0	0.0	1.0	100.0	100.00	0.00	0.00	0.00	0.00	0.00	-0.41	0.41	0.17
5C Incineration	**NOx**	34.0	15.6	25.0	50.0	55.90	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total NOx		**135855.0**	**79544.5**				**9.20**	**84.73**					**2.67**	**7.12**

Table G.2 Tier 1 Emissions Uncertainty Analysis SO2

IPCC Source Category		Gas	Emissions in 1990	Emissions in 2015	Activity Data (AD) Uncertainty	Emission Factor (EF) Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Emissions in 2015	Combined Emissions Uncertainty Squared	Type A Sensitivity	Type B Sensitivity	Uncertainty in Trend in Total Emissions due to AD	Uncertainty in Trend in Total Emissions due to EF	Combined Uncertainty in Trend in Total Emissions	Combined Trend Uncertainty Squared
			tonnes	tonnes	%	%	%	%	%	%	%	%	%	%	%
1A1	Energy-Liquid	SO2	20238.1	150.8	1.0	5.0	5.10	0.04	0.00	-0.01	0.00	0.00	-0.05	0.05	0.00
1A1	Energy-Solid	SO2	83802.0	5219.5	1.0	10.0	10.05	2.97	8.85	-0.02	0.03	0.04	-0.15	0.16	0.02
1A1	Energy-Gas	SO2	0.0	573.7	1.0	5.0	5.10	0.17	0.03	0.00	0.00	0.00	0.02	0.02	0.00
1A1	Energy-Biomass & renewable waste	SO2	0.0	7.3	1.0	50.0	50.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy-non-renewable waste	SO2	0.0	22.0	1.0	50.0	50.01	0.06	0.00	0.00	0.00	0.00	0.01	0.01	0.00
1A1	Energy-Landfill Gas	SO2	0.0	0.0	1.0	300.0	300.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Industry-Liquid exc Pet Coke	SO2	27831.5	503.9	10.0	5.0	11.18	0.32	0.10	-0.01	0.00	0.04	-0.06	0.07	0.00
1A2	Industry-Coal + Biomass	SO2	4599.8	993.6	2.0	20.0	20.10	1.13	1.28	0.00	0.01	0.02	0.06	0.06	0.00
1A2	Industry-Pet Coke	SO2	128.2	794.9	5.0	5.0	7.07	0.32	0.10	0.00	0.00	0.03	0.02	0.04	0.00
1A2	Industry-Gas	SO2	0.9	3.5	7.0	5.0	8.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A3a	Transport-Oil-Aviation	SO2	85.3	85.9	1.0	7.5	7.57	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A3b	Transport-Oil-Road	SO2	5386.0	46.9	1.0	5.0	5.10	0.01	0.00	0.00	0.00	0.00	-0.01	0.01	0.00
1A3c	Transport-Oil-Rail	SO2	251.5	23.8	1.0	5.0	5.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A3d	Transport-Oil-Navigation	SO2	1160.7	96.8	1.0	30.0	30.02	0.16	0.03	0.00	0.00	0.00	0.00	0.00	0.00
1A3e	Transport-Gas	SO2	0.1	0.2	1.0	5.0	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Comm-Liquid	SO2	10384.2	242.3	10.0	10.0	14.14	0.19	0.04	0.00	0.00	0.02	-0.04	0.04	0.00
1A4	Comm-Coal + Biomass	SO2	15.5	7.7	5.0	20.0	20.62	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Comm-Peat	SO2	1204.4	0.0	10.0	50.0	50.99	0.00	0.00	0.00	0.00	0.00	-0.03	0.03	0.00
1A4	Comm-Gas + Biogas	SO2	0.2	1.4	2.5	5.0	5.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Res-Liquid (excl Pet Coke)	SO2	1337.4	384.5	10.0	10.0	14.14	0.31	0.10	0.00	0.00	0.03	0.01	0.03	0.00
1A4	Res-Coal + Biomass	SO2	15199.7	3632.4	5.0	20.0	20.62	4.25	18.04	0.01	0.02	0.14	0.24	0.27	0.08
1A4	Res-Petcoke	SO2	1245.6	263.6	5.0	10.0	11.18	0.17	0.03	0.00	0.00	0.01	0.01	0.01	0.00
1A4	Res-Peat	SO2	8976.2	2458.6	10.0	50.0	50.99	7.11	50.55	0.01	0.01	0.19	0.43	0.47	0.22
1A4	Res-Gas	SO2	0.3	1.8	2.5	5.0	5.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Agric/Forestry/Fishing Liquid	SO2	1410.8	46.0	10.0	10.0	14.14	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.00
1B2	Fugitive emissions oil	SO2	1118.6	2070.5	5.0	300.0	300.04	35.23	1241.28	0.01	0.01	0.08	3.19	3.20	10.21
5C	Incineration	SO2	3.6	1.2	25.0	25.0	35.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total SO2		**184380.3**	**17632.9**				**36.34**	**1,320.43**					**3.25**	**10.55**

Table G.3 Tier 1 Emissions Uncertainty Analysis NMVOC

IPCC Source Category		Gas	Emissions in 1990	Emissions in 2015	Activity Data (AD) Uncertainty	Emission Factor (EF) Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Emissions in 2015	Combined Emissions Uncertainty Squared	Type A Sensitivity	Type B Sensitivity	Uncertainty in Trend in Total Emissions due to AD	Uncertainty in Trend in Total Emissions due to EF	Combined Uncertainty in Trend in Total Emissions	Combined Trend Uncertainty Squared
			tonnes	tonnes	%	%	%	%	%	%	%	%	%	%	%
1A1	Energy-Liquid	NMVOC	34.6	7.5	1.0	10.0	10.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy-Solid	NMVOC	152.6	130.9	1.0	10.0	10.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy-Gas	NMVOC	93.8	192.6	1.0	10.0	10.05	0.02	0.00	0.00	0.00	0.00	0.01	0.01	0.00
1A1	Energy-Biomass & renewable waste	NMVOC	0.0	2.4	1.0	50.0	50.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy-non-renewable waste	NMVOC	0.0	1.3	1.0	50.0	50.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy-Landfill Gas	NMVOC	0.0	4.5	1.0	300.0	300.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00
1A2	Industry-Liquid exc Pet Coke	NMVOC	305.0	199.9	10.0	20.0	22.36	0.04	0.00	0.00	0.00	0.02	0.00	0.02	0.00
1A2	Industry-Coal + Biomass	NMVOC	978.2	1616.2	2.0	20.0	20.10	0.32	0.10	0.01	0.01	0.03	0.13	0.13	0.02
1A2	Industry-Pet Coke	NMVOC	19.7	52.1	5.0	20.0	20.62	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00
1A2	Industry-Gas	NMVOC	367.7	998.3	7.0	20.0	21.19	0.21	0.04	0.01	0.01	0.07	0.10	0.12	0.02
1A3a	Transport-Oil-Aviation	NMVOC	184.2	142.0	1.0	7.5	7.57	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A3b	Transport-Oil-Road	NMVOC	34655.7	5355.8	1.0	15.0	15.03	0.79	0.63	-0.14	0.04	0.05	-2.03	2.03	4.12
1A3c	Transport-Oil-Rail	NMVOC	195.1	161.0	1.0	64.0	64.01	0.12	0.01	0.00	0.00	0.00	0.02	0.02	0.00
1A3d	Transport-Oil-Navigation	NMVOC	73.6	193.5	1.0	50.0	50.01	0.08	0.01	0.00	0.00	0.00	0.04	0.04	0.00
1A3e	Transport-Gas	NMVOC	1.8	4.0	1.0	10.0	10.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Comm-Liquid	NMVOC	258.8	106.2	10.0	20.0	22.36	0.02	0.00	0.00	0.00	0.01	-0.01	0.02	0.00
1A4	Comm-Coal + Biomass	NMVOC	2.4	8.4	5.0	20.0	20.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Comm-Peat	NMVOC	118.8	0.0	10.0	50.0	50.99	0.00	0.00	0.00	0.00	0.00	-0.03	0.03	0.00
1A4	Comm-Gas + Biogas	NMVOC	93.6	402.5	2.5	20.0	20.16	0.08	0.01	0.00	0.00	0.01	0.05	0.05	0.00
1A4	Res-Liquid (excl Pet Coke)	NMVOC	13.9	29.1	10.0	20.0	22.36	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Res-Coal + Biomass	NMVOC	13803.8	4541.9	5.0	50.0	50.25	2.25	5.07	-0.04	0.03	0.23	-1.85	1.87	3.49
1A4	Res-Petcoke	NMVOC	0.6	0.2	5.0	20.0	20.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Res-Peat	NMVOC	14690.9	4065.0	10.0	50.0	50.99	2.05	4.18	-0.04	0.03	0.40	-2.24	2.28	5.19
1A4	Res-Gas	NMVOC	8.8	41.8	2.5	20.0	20.16	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
1A4	Agric/Forestry/Fishing Liquid	NMVOC	1278.5	270.0	10.0	50.0	50.99	0.14	0.02	0.00	0.00	0.03	-0.22	0.23	0.05
1B1a	Fugitive emission from solid fuels: Co	NMVOC	20.0	0.0	5.0	300.0	300.04	0.00	0.00	0.00	0.00	0.00	-0.03	0.03	0.00
1B2	Fuel Extraction and Distribution	NMVOC	2130.8	2686.1	5.0	300.0	300.04	7.95	63.24	0.01	0.02	0.13	2.46	2.47	6.09
2D3a	Domestic solvent use including fungic	NMVOC	7926.6	10480.6	100.0	30.0	104.40	10.80	116.58	0.03	0.07	10.41	1.02	10.46	109.44
2D3b	Road paving with asphalt	NMVOC	35.2	30.4	33.0	30.0	44.60	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00
2D3d	Coating applications; paint applicatio	NMVOC	6046.9	3697.5	33.0	30.0	44.60	1.63	2.65	0.00	0.03	1.21	-0.13	1.22	1.49
2D3e	Degreasing	NMVOC	1743.5	1501.4	50.0	30.0	58.31	0.86	0.75	0.00	0.01	0.75	0.05	0.75	0.56
2D3f	Dry cleaning	NMVOC	281.8	44.1	50.0	30.0	58.31	0.03	0.00	0.00	0.00	0.02	-0.03	0.04	0.00
2D3g	Chemical products	NMVOC	3023.1	1340.5	100.0	30.0	104.40	1.38	1.91	-0.01	0.01	1.33	-0.17	1.34	1.80
2D3h	Printing	NMVOC	2912.0	1461.7	100.0	30.0	104.40	1.51	2.27	0.00	0.01	1.45	-0.13	1.46	2.13
2G4	Other product use	NMVOC	1793.7	1480.2	100.0	30.0	104.40	1.52	2.33	0.00	0.01	1.47	0.04	1.47	2.16
2H2	Food and beverage industry	NMVOC	9033.1	16440.8	33.0	30.0	44.60	7.24	52.35	0.07	0.12	5.39	2.11	5.79	33.49
3B1a	Dairy cattle	NMVOC	9164.6	8739.4	1.0	300.0	300.00	25.87	669.32	0.02	0.06	0.09	4.67	4.67	21.77
3B1b	Other cattle	NMVOC	22320.4	25371.3	1.0	300.0	300.00	75.11	5640.93	0.07	0.18	0.25	19.95	19.95	398.07
3B2	Sheep	NMVOC	560.6	340.4	1.0	300.0	300.00	1.01	1.02	0.00	0.00	0.00	-0.12	0.12	0.02
3B3	Swine	NMVOC	1018.1	2387.8	1.0	300.0	300.00	7.07	49.96	0.01	0.02	0.02	3.50	3.50	12.28
3B4d	Goats	NMVOC	2.4	2.1	1.0	300.0	300.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e	Horses	NMVOC	106.9	161.6	1.0	300.0	300.00	0.48	0.23	0.00	0.00	0.00	0.18	0.18	0.03
3B4f	Mules and asses	NMVOC	7.9	8.4	1.0	300.0	300.00	0.02	0.00	0.00	0.00	0.00	0.01	0.01	0.00
3B4g	Poultry	NMVOC	2089.9	2312.2	1.0	300.0	300.00	6.84	46.85	0.01	0.02	0.02	1.74	1.74	3.02
3B4h	Other animals	NMVOC	410.1	383.7	1.0	300.0	300.00	1.14	1.29	0.00	0.00	0.00	0.19	0.19	0.04
3D	Inorganic N-fertilizers	NMVOC	3361.4	3376.3	20.0	300.0	300.67	10.02	100.34	0.01	0.02	0.67	2.07	2.18	4.74
5A	Waste disposal to Land	NMVOC	833.9	470.1	200.0	300.0	360.56	1.67	2.80	0.00	0.00	0.93	-0.26	0.97	0.94
5C	Incineration	NMVOC	203.2	98.4	25.0	25.0	35.36	0.03	0.00	0.00	0.00	0.02	-0.01	0.03	0.00
	Total NMVOC		**142358.2**	**101342.2**				**82.25**	**6764.89**					**24.72**	**610.98**

Table G.4 Tier 1 Emissions Uncertainty Analysis NH3

IPCC Source Category		Gas	Emissions in 1990 tonnes	Emissions in 2015 tonnes	Activity Data (AD) Uncertainty %	Emission Factor (EF) Uncertainty %	Combined Uncertainty %	Combined Uncertainty as % of Emissions in 2015 %	Combined Emissions Uncertainty Squared %	Type A Sensitivity %	Type B Sensitivity %	Uncertainty in Trend in Total Emissions due to AD %	Uncertainty in Trend in Total Emissions due to EF %	Combined Uncertainty in Trend in Total Emissions %	Combined Trend Uncertainty Squared %
1A2	Industry-Biomass	NH3	94.1	264.5	1.0	200.0	200.00	0.49	0.24	0.00	0.00	0.00	0.32	0.32	0.10
1A3b	Transport-Oil-Road	NH3	41.0	870.1	1.0	20.0	20.02	0.16	0.03	0.01	0.01	0.01	0.16	0.16	0.02
1A3c	Transport-Oil-Railways	NH3	0.3	0.2	1.0	53.0	53.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Coal, Peat, Biomass	NH3	147.9	84.8	10.0	200.0	200.25	0.16	0.02	0.00	0.00	0.01	-0.13	0.13	0.02
1A4	Agric/Forestry/Fishing Liquid	NH3	1.3	1.0	10.0	100.0	100.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B2	Fugitive emissions oil	NH3	2.0	3.7	5.0	300.0	300.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B1a	Dairy cattle	NH3	13885.6	13890.0	1.0	50.0	50.01	6.43	41.40	0.00	0.13	0.19	-0.15	0.24	0.06
3B1b	Non-dairy cattle	NH3	27420.3	30668.7	1.0	50.0	50.01	14.21	201.81	0.02	0.29	0.41	1.23	1.30	1.69
3B2	Sheep	NH3	1731.6	1133.9	1.0	100.0	100.00	1.05	1.10	-0.01	0.01	0.02	-0.60	0.60	0.37
3B3	Swine	NH3	5859.2	6886.1	1.0	100.0	100.00	6.38	40.68	0.01	0.07	0.09	0.84	0.85	0.72
3B4d	Goats	NH3	40.5	36.3	1.0	100.0	100.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e	Horses	NH3	526.2	795.2	1.0	100.0	100.00	0.74	0.54	0.00	0.01	0.01	0.24	0.24	0.06
3B4f	Mules and asses	NH3	43.9	47.1	1.0	100.0	100.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4g	Poultry	NH3	1512.8	1548.7	1.0	100.0	100.00	1.43	2.06	0.00	0.01	0.02	0.00	0.02	0.00
3B4h	Other animals	NH3	570.9	403.4	1.0	100.0	100.00	0.37	0.14	0.00	0.00	0.01	-0.17	0.17	0.03
3D	Synthetic Fertilizer	NH3	12930.3	9160.5	11.2	200.0	200.31	17.00	288.86	-0.04	0.09	1.38	-7.71	7.83	61.28
3D	Organic fertiliser	NH3	40703.0	42144.5	11.2	200.0	200.31	78.19	6114.05	0.00	0.40	6.33	0.93	6.40	40.90
5B1	Biological treatment of waste - Comp	NH3	0.0	27.0	10.0	300.0	300.17	0.08	0.01	0.00	0.00	0.00	0.08	0.08	0.01
	Total NH_3		**105511.0**	**107965.7**				**81.80**	**6,690.69**					**10.25**	**105.15**

Table G.5 Tier 1 Emissions Uncertainty Analysis CO

IPCC Source Category		Gas	Emissions in 1990	Emissions in 2015	Activity Data (AD) Uncertainty	Emission Factor (EF) Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Emissions in 2015	Combined Emissions Uncertainty Squared	Type A Sensitivity	Type B Sensitivity	Uncertainty in Trend in Total Emissions due to AD	Uncertainty in Trend in Total Emissions due to EF	Combined Uncertainty in Trend in Total Emissions	Combined Trend Uncertainty Squared
			tonnes	**tonnes**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
1A1	Energy-Liquid	**CO**	232.1	49.9	1.0	10.0	10.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy-Solid	**CO**	18006.8	16211.9	1.0	10.0	10.05	1.49	2.23	0.03	0.05	0.07	0.30	0.31	0.10
1A1	Energy-Gas	**CO**	1354.9	2743.6	1.0	10.0	10.05	0.25	0.06	0.01	0.01	0.01	0.07	0.07	0.00
1A1	Energy-Biomass & renewable waste	**CO**	0.0	26.6	1.0	50.0	50.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy-non-renewable waste	**CO**	0.0	8.9	1.0	50.0	50.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy-Landfill Gas	**CO**	0.0	67.0	1.0	50.0	50.01	0.03	0.00	0.00	0.00	0.00	0.01	0.01	0.00
1A2	Industry-Liquid exc Pet Coke	**CO**	1057.0	520.6	10.0	20.0	22.36	0.11	0.01	0.00	0.00	0.02	0.01	0.02	0.00
1A2	Industry-Coal + Biomass	**CO**	9459.3	7378.5	2.0	50.0	50.04	3.38	11.45	0.01	0.02	0.06	0.63	0.64	0.40
1A2	Industry-Pet Coke	**CO**	78.9	208.4	5.0	20.0	20.62	0.04	0.00	0.00	0.00	0.00	0.01	0.01	0.00
1A2	Industry-Gas	**CO**	463.6	1258.7	7.0	20.0	21.19	0.24	0.06	0.00	0.00	0.04	0.06	0.07	0.01
1A3a	Transport-Oil-Aviation	**CO**	1307.0	1396.1	1.0	7.5	7.57	0.10	0.01	0.00	0.00	0.01	0.02	0.02	0.00
1A3b	Transport-Oil-Road	**CO**	249996.2	54325.8	1.0	15.0	15.03	7.48	56.01	-0.07	0.16	0.22	-1.01	1.03	1.07
1A3c	Transport-Oil-Rail	**CO**	448.9	370.4	1.0	65.0	65.01	0.22	0.05	0.00	0.00	0.00	0.04	0.04	0.00
1A3d	Transport-Oil-Navigation	**CO**	199.8	511.5	1.0	65.0	65.01	0.30	0.09	0.00	0.00	0.00	0.08	0.08	0.01
1A3e	Transport-Gas	**CO**	5.4	11.9	1.0	50.0	50.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Comm-Liquid	**CO**	1009.0	403.9	10.0	20.0	22.36	0.08	0.01	0.00	0.00	0.02	0.01	0.02	0.00
1A4	Comm-Coal + Biomass	**CO**	25.2	209.7	5.0	50.0	50.25	0.10	0.01	0.00	0.00	0.00	0.03	0.03	0.00
1A4	Comm-Peat	**CO**	1245.9	0.0	10.0	100.0	100.50	0.00	0.00	0.00	0.00	0.00	-0.11	0.11	0.01
1A4	Comm-Gas + Biogas	**CO**	118.0	507.5	2.5	20.0	20.16	0.09	0.01	0.00	0.00	0.01	0.03	0.03	0.00
1A4	Res-Liquid (excl Pet Coke)	**CO**	782.0	2212.1	10.0	50.0	50.99	1.03	1.07	0.01	0.01	0.09	0.28	0.30	0.09
1A4	Res-Coal + Biomass	**CO**	31876.9	10812.8	5.0	100.0	100.12	9.92	98.42	0.00	0.03	0.22	0.25	0.33	0.11
1A4	Res-Petcoke	**CO**	46.1	15.5	5.0	50.0	50.25	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Res-Peat	**CO**	28258.8	7819.3	10.0	100.0	100.50	7.20	51.85	0.00	0.02	0.32	-0.29	0.43	0.18
1A4	Res-Gas	**CO**	108.0	511.3	2.5	20.0	20.16	0.09	0.01	0.00	0.00	0.01	0.03	0.03	0.00
1A4	Agric/Forestry/Fishing Liquid	**CO**	3388.1	1211.0	10.0	100.0	100.50	1.12	1.24	0.00	0.00	0.05	0.04	0.07	0.00
1B2	Fugitive emissions oil	**CO**	162.4	300.6	5.0	300.0	300.04	0.83	0.68	0.00	0.00	0.01	0.21	0.21	0.05
5B1	Biological treatment of waste - Comp	**CO**	0.0	33.8	10.0	300.0	300.17	0.09	0.01	0.00	0.00	0.00	0.03	0.03	0.00
5C	Incineration	**CO**	2.9	1.6	25.0	50.0	55.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total CO		**349633.0**	**109128.8**				**14.94**	**223.28**					**1.43**	**2.03**

Table G.6 Tier 1 Emissions Uncertainty Analysis PM10

IPCC Source Category		Gas	Emissions in 1990	Emissions in 2015	Activity Data (AD) Uncertainty	Emission Factor (EF) Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Emissions in 2015	Combined Emissions Uncertainty Squared	Type A Sensitivity	Type B Sensitivity	Uncertainty in Trend in Total Emissions due to AD	Uncertainty in Trend in Total Emissions due to EF	Combined Uncertainty in Trend in Total Emissions	Combined Trend Uncertainty Squared
			tonnes	**tonnes**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
1A1	Energy-Liquid	PM_{10}	368.6	81.3	1.0	20.0	20.02	0.07	0.00	0.00	0.00	0.00	-0.06	0.06	0.00
1A1	Energy-Solid	PM_{10}	603.6	547.6	1.0	20.0	20.02	0.46	0.21	0.00	0.01	0.02	0.10	0.10	0.01
1A1	Energy-Gas	PM_{10}	32.1	66.0	1.0	20.0	20.02	0.06	0.00	0.00	0.00	0.00	0.02	0.02	0.00
1A1	Energy-Biomass & renewable waste	PM_{11}	0.0	11.7	1.0	50.0	50.01	0.02	0.00	0.00	0.00	0.00	0.01	0.01	0.00
1A1	Energy-non-renewable waste	PM_{10}	0.0	0.1	1.0	50.0	50.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A1	Energy-Landfill Gas	PM_{10}	0.0	1.5	1.0	50.0	50.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A2	Industry-Liquid exc Pet Coke	PM_{10}	493.0	199.5	10.0	50.0	50.99	0.43	0.18	0.00	0.00	0.07	-0.09	0.11	0.01
1A2	Industry-Coal + Biomass	PM_{10}	1213.2	1196.0	2.0	50.0	50.04	2.50	6.27	0.01	0.03	0.08	0.60	0.61	0.37
1A2	Industry-Pet Coke	PM_{10}	39.4	104.2	5.0	50.0	50.25	0.22	0.05	0.00	0.00	0.02	0.10	0.10	0.01
1A2	Industry-Gas	PM_{10}	12.4	33.7	7.0	50.0	50.49	0.07	0.01	0.00	0.00	0.01	0.03	0.03	0.00
1A3a	Transport-Oil-Aviation	PM_{10}	17.6	18.8	1.0	7.5	7.57	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A3b	Transport-Oil-Road	PM_{10}	2460.7	2140.2	1.0	10.0	10.05	0.90	0.81	0.02	0.05	0.07	0.18	0.19	0.04
1A3b	Transport-Road Abrasion	PM_{10}	213.4	550.3	1.0	50.0	50.01	1.15	1.33	0.01	0.01	0.02	0.51	0.51	0.26
1A3c	Transport-Oil-Rail	PM_{10}	60.4	49.9	1.0	169.0	169.00	0.35	0.12	0.00	0.00	0.00	0.06	0.06	0.00
1A3d	Transport-Oil-Navigation	PM_{10}	134.5	103.7	1.0	50.0	50.01	0.22	0.05	0.00	0.00	0.00	0.03	0.03	0.00
1A3e	Transport-Gas	PM_{10}	0.2	0.5	1.0	50.0	50.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Comm-Liquid	PM_{10}	536.1	212.2	10.0	50.0	50.99	0.45	0.20	0.00	0.00	0.07	-0.10	0.13	0.02
1A4	Comm-Coal + Biomass	PM_{10}	3.2	23.8	5.0	50.0	50.25	0.05	0.00	0.00	0.00	0.00	0.03	0.03	0.00
1A4	Comm-Peat	PM_{10}	156.6	0.0	10.0	50.0	50.99	0.00	0.00	0.00	0.00	0.00	-0.10	0.10	0.01
1A4	Comm-Gas + Biogas	PM_{10}	3.2	13.7	2.5	50.0	50.06	0.03	0.00	0.00	0.00	0.00	0.01	0.01	0.00
1A4	Res-Liquid (excl Pet Coke)	PM_{10}	24.5	72.9	10.0	100.0	100.50	0.31	0.09	0.00	0.00	0.02	0.14	0.14	0.02
1A4	Res-Coal + Biomass	PM_{10}	12007.1	3963.9	5.0	200.0	200.06	33.18	1100.72	-0.06	0.09	0.66	-12.98	12.99	168.84
1A4	Res-Petcoke	PM_{10}	1.5	0.5	5.0	100.0	100.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A4	Res-Peat	PM_{10}	12262.7	3393.1	10.0	300.0	300.17	42.61	1815.60	-0.08	0.08	1.13	-24.48	24.50	600.49
1A4	Res-Gas	PM_{10}	1.0	4.6	2.5	100.0	100.03	0.02	0.00	0.00	0.00	0.00	0.01	0.01	0.00
1A4	Agric/Forestry/Fishing Liquid	PM_{10}	861.9	149.8	10.0	100.0	100.50	0.63	0.40	-0.01	0.00	0.05	-0.78	0.78	0.62
1B1	Fugitive emission from solid fuels	PM_{10}	1.1	0.0	5.0	500.0	500.02	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.00
1B2	Fuel Extraction and Distribution	PM_{10}	17.9	33.1	5.0	100.0	100.12	0.14	0.02	0.00	0.00	0.01	0.05	0.05	0.00
2A3	Glass production	PM_{10}	20.1	0.0	5.0	300.0	300.04	0.00	0.00	0.00	0.00	0.00	-0.08	0.08	0.01
2B10	Handling of Chemicals	PM_{10}	57.4	44.7	10.0	500.0	500.10	0.93	0.87	0.00	0.00	0.01	0.15	0.15	0.02
2C2	Ferroalloys production	PM_{10}	60.0	0.0	10.0	500.0	500.10	0.00	0.00	0.00	0.00	0.00	-0.39	0.39	0.16
3B1a	Dairy cattle	PM_{10}	1059.8	1098.4	1.0	50.0	50.01	2.30	5.28	0.01	0.03	0.04	0.59	0.59	0.35
3B1b	Other cattle	PM_{10}	1246.2	1163.0	1.0	50.0	50.01	2.43	5.92	0.01	0.03	0.04	0.54	0.55	0.30
3B2	Sheep	PM_{10}	446.0	270.8	1.0	100.0	100.00	1.13	1.28	0.00	0.01	0.01	0.05	0.05	0.00
3B3	Swine	PM_{10}	365.0	435.5	1.0	100.0	100.00	1.82	3.32	0.01	0.01	0.01	0.54	0.54	0.29
3B4d	Goats	PM_{10}	1.0	0.9	1.0	100.0	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4e	Horses	PM_{10}	13.6	20.5	1.0	100.0	100.00	0.09	0.01	0.00	0.00	0.00	0.03	0.03	0.00
3B4f	Mules and asses	PM_{10}	1.3	1.4	1.0	100.0	100.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3B4g	Poultry	PM_{10}	1613.2	1703.0	1.0	100.0	100.00	7.12	50.76	0.02	0.04	0.06	1.87	1.87	3.51
3B4h	Other animals	PM_{10}	1.7	1.6	1.0	100.0	100.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3D	Inorganic N-fertilizers	PM_{10}	6097.5	6124.4	11.2	200.0	200.31	51.32	2634.18	0.06	0.14	2.28	12.67	12.88	165.79
3D	Handling of Farm Products	PM_{10}	49.1	65.9	10.0	500.0	500.10	1.38	1.90	0.00	0.00	0.02	0.45	0.45	0.20
5A	Solid waste disposal on land	PM_{10}	0.4	0.1	34.6	500.0	501.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C	Incineration	PM_{10}	47.8	0.2	25.0	100.0	103.08	0.00	0.00	0.00	0.00	0.00	-0.06	0.06	0.00
	Total PM_{10}		**42606.0**	**23902.9**				**75.03**	**5,629.60**					**30.68**	**941.34**

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL

Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú

Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:

- saoráidí dramhaíola *(m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola)*;
- gníomhaíochtaí tionsclaíocha ar scála mór *(m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta)*;
- an diantalmhaíocht *(m.sh. muca, éanlaith)*;
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe *(OGM)*;
- foinsí radaíochta ianúcháin *(m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha)*;
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil

- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce

- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol

- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil *(m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí)*.

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn

- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn.

Taighde agus Forbairt Comhshaoil

- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta

- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn *(m.sh. mórphleananna forbartha)*.

Cosaint Raideolaíoch

- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas

- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol *(m.sh. Timpeall an Tí, léarscáileanna radóin)*.
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta

- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil

Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:

- An Oifig um Inmharthanacht Comhshaoil
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Fianaise is Measúnú
- Oifig um Chosaint Radaíochta agus Monatóireachta Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

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