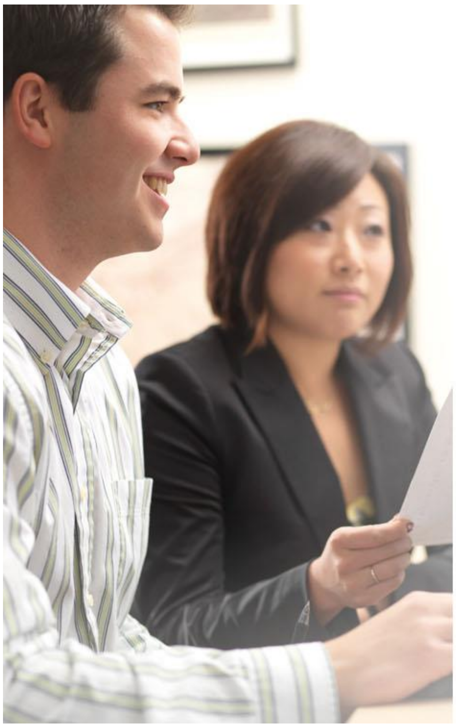
European Commission (DG Environment)

Service contract for assessing the potential emission reductions delivered by BAT conclusions adopted under the directive on industrial emissions (IED)

Final Report (3rd Revision)



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Amec Foster Wheeler Environment & Infrastructure UK Limited

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Report for

EUROPEAN COMMISSION,
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Unit C.4 – Industrial Emissions

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European Commission (DG Environment)

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Executive Summary

Introduction

This report presents the overall findings of a project on "assessing the potential emission reductions delivered by BAT conclusions adopted under the Directive on Industrial Emissions". The work was split into four main tasks:

- Task 1: Develop an overview/ baseline of industrial emission trends in recent years.
- Task 2: Develop a methodology for estimating the potential reductions of emissions to air and water from the implementation of BAT conclusions adopted under the IED.
- Task 3: Test the model implementing the developed methodology.
- Task 4: Summarise the findings in a report including recommendations on further needs and ways to address these.

The overall objective of this project was to improve the available knowledge concerning the potential for emission reduction due to the implementation of the BAT conclusions under the IED. The main aim was to develop a methodology that can be used to estimate the potential emission reductions delivered by the BAT conclusions adopted under the IED and which can be used for IED sectors that are covered by BREFs.

The report presents the historical emission trends for the IED industrial sectors and more specifically for the seven sectors[1] with adopted BAT conclusions that were used to test the model. It also provides a comprehensive description of the developed methodology and the model along with limitations/ issues identified during the course of the study. The implementation of the method in the future, with high-quality and reliable data, could be used to prioritise (or de-prioritise) sectors, processes and pollutants for further action and provide a basis for policy evaluation.

Developed methodology and model

A methodology was developed and the model implementing the methodology was tested in order to ensure that it can be used in the future for different IED sectors that are covered by BREFs, taking into account the different parameters affecting emissions and the implementation of the BAT conclusions. The model is expected to be a useful tool for estimating the possible emission reductions triggered by the BAT-AELs in the BAT conclusions. However, the validity of the model is highly dependent on the quality of input data, and this will need to be improved if the approach is to be used for policy purposes.

[1] The sectors used to test the model are: Cement and lime sectors, Glass sector, Iron and Steel sector, Chlor-alkali sector, Tanneries, Refineries and Pulp and paper sector.

The main characteristics of the model are:

- **Robustness:** The developed model was tested in 7 industrial sectors[2] using readily available data from the BREFs, E-PRTR and the GAINS model, as well as other data sources. The model works well for all the sectors that were analysed. However, in order for the model to provide accurate results, it is considered that collection of more robust data would be needed[3] through a bespoke data collection exercise for each sector.

- **Flexibility:** The model provides a high degree of flexibility. The model parameters can be easily be changed through a user "control panel".

- **Two calculation approaches**: The model includes two different calculation approaches –a simple approach and one which takes into account replacement of older installations by newer ones –for the assessment of changes in emissions (reduction or increase) due to the implementation of the BAT conclusions adopted under the IED.

- **Flexible level of analysis**: The model allows assessment of the potential impacts of the BAT conclusions upon emissions both at EU level and at Member State level. It can take into account different types of plants or sub-processes within a sector. The model can also be used for a specific sub-sector within an industrial sector.

Data availability

The availability and quality of existing data for the IED activities is the main limitation identified in this project.

During the testing of the model it was observed that there is not a single existing source that can provide consistent and high quality data for the IED sectors and indeed even combining existing data sets is not sufficient. E-PRTR and GAINS contain useful data for the IED industrial sectors but several uncertainties/ limitations were identified. In the future, it will be important to focus on obtaining specific, up-to-date data about industrial activities being assessed. This includes in particular information on:

- The level of industrial activity per type of sectors and process;

- The split of emissions between the different sub-processes;

- The extent of uptake of BAT for different industrial activities and sub-processes within an activity, and the (quantified) extent of deviation from BAT; and

[2] Eight in reality since cement and lime are different sectors even though they are covered by the same BREF.

[3] For example, the model relies on estimating the share of emissions from different processes in different (types of) plants within a sector, but currently there are relatively few data to be able to estimate these shares accurately. Such data would need to be collected as part of detailed surveys of the industry sectors concerned. Likewise information on the proportion of installations currently applying and not applying BAT is usually uncertain (as is the range of emissions across different installations). The likely agreement of derogations from the BAT conclusions is also a key uncertainty.

- The performance of installations including complete and accurate reporting of the base year emissions to air and water.

Consistent and accurate data sources and Member State specific data will help the Commission to better understand the potential emission reductions resulting from the BAT conclusions.

Suggestions for improvement of the model and next steps

We have identified a series of steps that can be adopted in order to improve the model and the results that can be obtained from it.

- **Detailed pilot study**: As a next step in the development and testing of the methodology, a more detailed pilot study would be proposed for one of the IED industrial sectors for which the BREFs are currently under review by the IPPC Bureau. The aim of this pilot study would be to conduct an in-depth review of the sector so as to obtain a better, more accurate and complete dataset to run the model by collecting the necessary Member State and sectoral level data through engagement with the relevant trade associations and companies of the industrial sector selected, as well as Member States and other experts.

- **Further improvement of the model:**

  - The emission split between different industrial processes could be differentiated between the base year and the target years in order to take into account technical progress in specific processes.

  - The current model considers that in the base year all plants are "existing". An improvement in the model would be to consider both existing and new plants for the base year.

  - The model could include a cost module which would help the Commission to estimate the associated costs of emission reductions in the target years.

Contents

1. Introduction

1.1 This report

Amec Foster Wheeler was contracted by the European Commission to undertake a study "assessing the potential emission reductions delivered by BAT conclusions adopted under the Directive on Industrial Emissions" (contract number 070307/2013/667622/SER/ENV.C.3).

This report presents the overall findings of the project which was split into four main tasks:

- Task 1: Develop an overview/ baseline of industrial emission trends in recent years;
- Task 2: Develop a methodology for estimating the potential reductions of emissions to air and water from the implementation of BAT conclusions adopted under the IED;
- Task 3: Test the model implementing the developed methodology; and
- Task 4: Summarise the findings in a report including recommendations on further needs and ways to address these.

1.2 Study context

1.2.1 Industrial Emissions Directive (IED)

Industrial activities play an important role in the economic well-being of Europe, contributing to sustainable growth and providing high quality jobs. However, industrial activities also have significant impacts on the environment. The need to further control industrial emissions led to the adoption of the Directive on industrial emissions (IED 2010/75/EU) that recast seven Directives[4] related to industrial emissions into a single clear and coherent legislative instrument. The IED seeks to prevent and control air, water and soil pollution by industrial installations. It regulates emissions of a wide range of pollutants, including sulphur and nitrogen compounds, dust particles and heavy metals. It clarifies and strengthens the role of Best Available Techniques (BAT) and contains the new concept of "*BAT conclusions"* which are formally adopted by the Committee.

The IED requires Member States to set permit limits based on prescribed emission limit values. All permit conditions for installations falling under IED are to be reconsidered and, if necessary, updated to ensure compliance with the BAT conclusions within four years of their publication. Operators of the installations are required to comply with those updated permit conditions.

[4] The titanium dioxide industry related directives (78/176/EEC, 82/883/EEC, 92/112/EEC), the IPPC Directive (96/61/EC, codified version 2008/1/EC), the Solvent Emission Directive (1999/13/EC), the Waste Incineration Directive (2000/76/EC) and the LCP Directive (2001/80/EC).

1.2.2 BAT Conclusions and BAT-AELs

The IPPC Bureau has the responsibility to co-ordinate the exchange of information process in order to determine what constitutes BAT. It is a complex consensus-building exercise with numerous stakeholders, underpinned by sound techno-economic information that has now been enshrined into Union legislation:

- The Industrial Emissions Directive (2010/75/EU) itself; and
- Commission Implementing Decision 2012/119/EU laying down rules concerning guidance on the collection of data and on the drawing up of BAT reference documents and on their quality assurance referred to in Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions (also known as "the Guidance" within TWGs).

This process results in the adoption of the BAT conclusions and publication of BAT Reference Documents (so-called BREFs). The BAT conclusions set out what BAT should be for a particular sector and provide BAT-Associated Emission Levels (BAT-AELs). Regulatory authorities in each Member State must use these Conclusions as the basis for setting or revising permit conditions including Emission Limit Values (ELVs). The IED makes it much harder to deviate from applying BAT-AELs than was possible under the IPPC Directive.

BAT conclusions provide a reference for setting and revising the permit conditions of IED installations and offer information on the best available techniques for a specific sector, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures.

The first series of 33 BREFs were completed in 2006, and the IPPC Bureau is currently reviewing and updating them under the IED. The objective of the BREF review process is not to re-write the entire existing BREF documents but to review those parts closely linked to BAT Conclusions such as cutting-edge techniques and also emerging techniques. The IPPC Bureau has to collect and take into account new information that could result in a revised BREF document and BAT conclusions. Data and information are key to the update process, especially new and relevant information that includes techniques that have been developed since the last review of the BREF.

So far, BAT conclusions have been adopted in seven Commission Implementing Decisions and two more are expected soon. These are on:

- Tanning of hides and skins (adopted in February 2013);
- Glass manufacturing (March 2012);
- Cement, lime and magnesium oxide production (March 2012);
- Iron and steel production (April 2013);
- Chlor-alkali (December 2013);
- Pulp and paper manufacturing (September 2014); and

- Mineral oil and gas refining (October 2014).

The adoption procedure has also started for the common waste water and wood based panels BREFs with the submission of the final drafts to the Article 13 Forum for its opinion (status January 2015).

1.3 Study aims and objectives

The objectives of this project were to improve the available knowledge concerning the potential for emission reduction due to the implementation of the BAT conclusions under the IED.

The main aim of the project was to develop a methodology that can be used to estimate the potential emission reduction delivered by the BAT conclusions adopted under the IED and test the model implementing the methodology in order to ensure that it can then be used in the future for IED sectors that are covered by the BREFs.

The methodology is intended to be flexible enough in order to cover all different levels of disaggregation (EU level, Member State level) and new data as this emerges.

1.4 Structure of this report

This report provides an overview of the findings of the study along with recommendations on further needs and ways to address them. The report is structured as follows:

- Section 2 presents the methodology to develop the industrial emissions trends since 2000 (part of Task 1);
- Section 3 presents the developed methodology for estimating the potential emissions reductions from BAT conclusions adopted under the IED and also the model implementing the methodology (Task 2);
- Section 4 presents the sector scoping and historical emissions for the seven industrial sectors considered and a summary of the model testing (Task 1 and 3);
- Section 5 presents the limitations and the uncertainties of the study;
- Section 6 presents the conclusions of the study and recommendations on further needs (Task 4).

2. Industrial Emission Trends

2.1 Overview

In this section, the methodology for carrying out Task 1 'Develop an overview/ baseline of industrial emission trends in recent years is presented'. The aim of Task 1 was to set the context against which possible future reductions of emissions to air and water could be assessed and specifically to estimate the evolution of industrial emissions to water and air since the year 2000, which was the transposition deadline for the IPPC Directive. This task provided a high-level overview of the emissions trends for all main IPPC sectors and all key pollutants.

Key to this approach was the development of the historical and base year emissions database, and then using available activity data to estimate future changes in emissions.

As agreed with the Commission during the Inception meeting, the analysis in Task 1 was undertaken at an aggregated level and not at an installation level. The historical emission trends (were estimated based on aggregated emissions in each activity type. The estimation of pollutant emissions from E-PRTR data has to be done at the level of appropriate sub-category within the main Annex I activity level.

In a few cases NACE main economic activity has been used in order to disaggregate E-PRTR data and create the required categories (e.g. pulp and paper and wood-based panels).

2.2 Development of the Industrial Emission Trends

2.2.1 Methodology

The work of Task 1 was broken down to two distinct sub-tasks that involved the following elements:

- Task 1.1 – Development of base year emissions estimates; and
- Task 1.2 – Estimation of historical emissions.

2.2.2 Data Sources

The E-PRTR database was used to define the baseline (year 2010) of air and water emissions. The E-PRTR database covers 2007-2011 emissions data. The years 2010 or 2011 were the two possible starting point options for estimating baseline emissions, as the most recent years for which data are available in E-PRTR. Use of data from 2011 has the advantage of being more up-to-date and reflecting the most recent changes in emissions controls. However the 2011 data had not undergone any further correction round at the time of extraction, unlike the 2010 emissions (corrections to historical errors in May 2013). Use of 2010 data would provide greater consistency with activity and emission forecasts that would be used in estimating future and potentially historical emissions (e.g. GAINS activity data, which includes estimates for 5-year intervals at 2010, 2015, 2020, etc.). Taking into account the abovementioned points, it was agreed with the Commission to use 2010 as the base year for estimating baseline emissions. The EPER database was used to define historical emissions before 2007. The main reporting years for the EPER were 2001 and 2004. The coverage of the EPER is smaller than the E-PRTR, as it covers EU-15 and Norway and Hungary for 2001 and EU-25 for 2004. There are also fewer activities and pollutants reported in the EPER than the E-PRTR.

The objective of Task 1 was to provide a high-level overview of the emission trends based on readily available data and for this objective it was considered that EPER and E-PRTR were the most complete and readily available data sources, despite of their identified limitations (see Section 5.2)

2.2.3 Selected pollutants

Amec Foster Wheeler has compiled and agreed with the Commission two lists of pollutants to be analysed under Task 1, one for air emissions and the other for water emissions. The starting point for the development of the lists was the pollutants included in the E-PRTR and in Waterbase (for water pollutants) and the pollutants analysed in the study looking at the contribution from industry to emissions to air and water, in order to achieve consistency between the two projects. The list was further refined by adding pollutants that are relevant to IED activities (those where BAT-AELs are defined) but which were not included in a related study[5] or removing pollutants that were not relevant to the present study (e.g. pollutants that do not have BAT-AELs).

Table 2.1 and Table 2.2 present the agreed pollutants for air and water to be covered in Task 1.

[5] Amec Foster Wheeler, Contribution of industry to pollutant emissions to air and water, report prepared for the European Commission, 2013 (https://circabc.europa.eu/sd/a/c4bb7fee-46df-4f96-b015-977f1cca2093/Contribution%20of%20Industry%20to%20EU%20Pollutant%20Emissions-Amec Foster Wheeler%20Final%20Report%2013298i5.pdf)

Table 2.1 Air Pollutants proposed for Task 1 Analysis

Pollutant
Ammonia (NH_3)
Arsenic and compounds
Cadmium and compounds
Carbon monoxide
Chlorine and inorganic compounds (HCl)
Dust / particulate matter
Lead and compounds
Mercury and compounds
Nickel and compounds
Non Methane Volatile Organic Compounds (NMVOC)
Oxides of nitrogen (N) and other nitrogen compounds (NOX/NO2)
PCDD + PCDF (dioxins + furans) (as Teq)
Sulphur dioxide and other sulphur compounds (SO2/SOX)

Table 2.2 Water Pollutants proposed for Task 1 Analysis

Pollutant
Arsenic and compounds (as As)
Cadmium and compounds (as Cd)
Chlorides (as total Cl)
Chromium and compounds (as Cr)
Copper and compounds (as Cu)
Cyanides (as total CN)
Fluorides (as total F)
Halogenated organic compounds (as AOX)
Lead and compounds (as Pb)
Mercury and compounds (as Hg)
Nickel and compounds (as Ni)
Phenols (as total C)
Total nitrogen
Total organic carbon (TOC) (as total C or COD/3)
Total phosphorus
Zinc and compounds (as Zn)

For the IED sectors that already had adopted BAT conclusions at the beginning of the project, a more sector-specific scoping was performed during the testing of the model which is presented separately in Section 4 along with the historical emissions.

2.2.4 Mapping of IED Activities and Categories used in the Analysis

The categories reported in the EPER and the E-PRTR were matched with the activities listed in Annex I of the IED. For categories where the description in the databases was different to the description in the IED, the sub-level of NACE main economic activity name[6] was used to select the emissions sources that were relevant for each IED category. For example, pulp and paper and wood-based panels are reported under the same E-PRTR activity. In this case the NACE code for wood-based panels (i.e. 16.21) was used in order to disaggregate the E-PRTR data and create two separate files for pulp and paper and wood-based panels. It was important to closely match the activities reported under the E-PRTR with those in the IED in order to ensure, as far as practicable, that only emissions from IED activities were retained[7].

The mapping of the EPER and the E-PRTR found that emissions data are available for most of the IED activities (although no assessment is made in the current task of the completeness or accuracy of that data). Some partial matches between the datasets of EPER and E-PRTR and the activities listed in Annex I of the IED have been identified, such as for activity 5.3.b: “Recovery or a mix of recovery and disposal, of non-hazardous waste”. EPER and E-PRTR only include disposal of non-hazardous waste and not the recovery part which is covered by the IED activity 5.3.b.

2.2.5 Base Year

The E-PRTR database has been used as the primary data source for estimating the base year emissions. It includes reported emissions to air and water of a wide range of different pollutants, from individual installations, and for the years 2007 to 2011. Emissions data were processed using Excel to derive a summary-level database of emissions which includes:

- A breakdown of all IED Annex I activities and appropriate sub-categories within the main Annex I activity level;
- Emissions to air/ water of the selected pollutants covered by E-PRTR;
- Total emissions at EU level;
- Emission data breakdown for each Member State; and
- Emission data breakdown for NACE codes and Member States.

[6] Eurostat, 2008, NACE Rev.2 - Statistical classification of economic activities in the European Community.

[7] Taking into account the uncertainties of the E-PRTR as discussed in Section 5.4.1.

2.2.6 Estimating Historical Emissions

One objective of this project is to improve the understanding of the extent to which emissions of key pollutants have been reduced in the period since transposition of the IPPC Directive (2000) to a time when the majority of the changes required under that directive should have been implemented (i.e. 2010). It is expected that a comparison of these emissions reductions (taking into account changes in levels of activity) with expected additional reductions through the uptake of the BAT-conclusions will highlight the additional value of the BAT conclusions in reducing emissions compared to the original IPPC Directive. However, to obtain these results it is important to understand the extent to which the original IPPC Directive was responsible for reducing emissions, at a Member State level to take into account differences in implementation. This step is undertaken through the estimation of historical emissions for 2001 and 2004 from all activity types and selected pollutants (these are the two years for which data are available in EPER).

The key source of information for estimating actual emissions is data from EPER and this has been used to establish the database of historical industrial emissions. It should be noted that the coverage of EPER is less than that of E-PRTR, in terms of geographical coverage[8], as well as in terms of pollutants and (in some cases) activities.

The estimation of historical trends was undertaken on an aggregated level and not an installation level and it was based on aggregated emissions in each activity type. The EPER data (years 2001 and 2004) have been incorporated in a database with the base year data (2010). The resulting database presents historical emissions data based on the following breakdown:

- For each of the Member States[9] (15 Member States for 2001, 25 Member States for 2004 and 27 Member States for 2010);
- For water and air emissions;
- For the years 2001, 2004 and 2010;
- For each selected pollutant; and
- For each Annex I activity and appropriate sub-categories within the main Annex I activity level.

2.3 Industrial emissions trends

Two databases have been prepared. The baseline database (Excel) sets out the base year emissions and the historical emissions for air and water. The databases have been provided as separate files to the Commission along with this report. The results of Task 1 for the seven sectors that already have adopted BAT conclusions are discussed in Section 4 which is related to the testing of the model implementing the developed methodology. These

[8] EPER covered the EU-15 plus Norway and Hungary for 2001 and the EU-25 for 2004.

[9] Historical data for Croatia that joined EU in 2013 are not available.

include the analysis of historical emissions for the seven sectors for the EU-27 as well as for the EU-15 and newer Member States. More specifically, for the results of the individual sectors please refer to the following sections:

- **Cement, lime and glass sectors:** see section 4.3.2.
- **Iron and steel sector:** see section 4.6.2.
- **Tanneries sector:** see section 4.7.2.
- **Chlor-alkali sector:** see section 4.8.2.
- **Refineries sector:** see section 4.9.2.
- **Pulp and paper sector:** see section 4.10.2.

The historical data show that for many industrial sectors (e.g. cement, lime, glass, iron and steel, pulp and paper, refineries) significant reductions in total emissions were observed during the period 2001 – 2010 based on the data reported by Member States in EPER (2001, 2004) and E-PRTR (2010). The reductions observed during that period may be due to a number of different factors such as (non-exhaustive list):

- Implementation of the IPPC Directive (and other sectoral Directives where relevant) by the Member States;
- Additional measures taken at national level;
- Changes in sector activity levels; and
- Economic crisis in Europe.

For the period 2001 to 2004 the picture related to emission changes is mixed. There are cases of industrial sectors where the emissions increased or decreased during the period 2001 – 2004. The increases observed in emissions during the 2001-2004 period may be due to the reporting of the new EU Member States but also due to improved reporting from the old EU Member States.

Historical emissions data (as reported in EPER and E-PRTR) also revealed that the majority of emissions in the period 2001 – 2010 were reported from the EU15 Member States and only small percentages of the total emissions were reported by the new EU Member States. However, in some cases (e.g. refineries sector) the contribution of the new Member States to the total EU emissions was much higher than their contribution to the total EU production capacity. This could be an indication that the environmental performance of the plants in the new Member States was not as good as that of plants in the old EU Member States during the period 2001 – 2010.

3. Methodology for Estimating the Potential Emission Reductions from BAT Conclusions Adopted under the IED

3.1 Methodology overview

3.1.1 Introduction

This section provides a general overview of the methodology developed under Task 2 to estimate the emission reduction that can be delivered by the implementation of BAT conclusions adopted under the IED in comparison to the use of BAT under IPPC. A detailed description of the methodology and of the model developed to implement it are presented in Section 3.2.

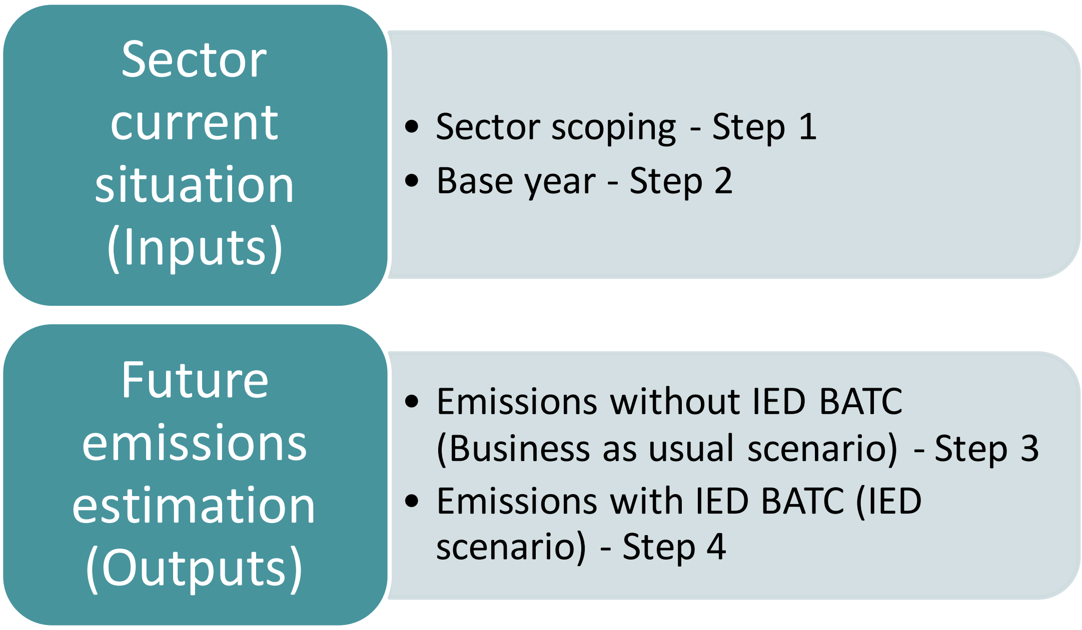
3.1.2 Approach

The general approach of the methodology is that emission data (input data at sector/ Member state level) from a selected base year (to be chosen when setting up the analysis framework) are projected to the target years (to be chosen when setting up the analysis framework) with the purpose of comparing the sector's future emissions with or without the IED BAT conclusions (BATC). The methodology can be split into two main parts:

- A part that describes the current situation of the sector under analysis (the Inputs part); and
- A part that estimates the future emissions in the sector with or without the IED BAT conclusions (the Outputs part).

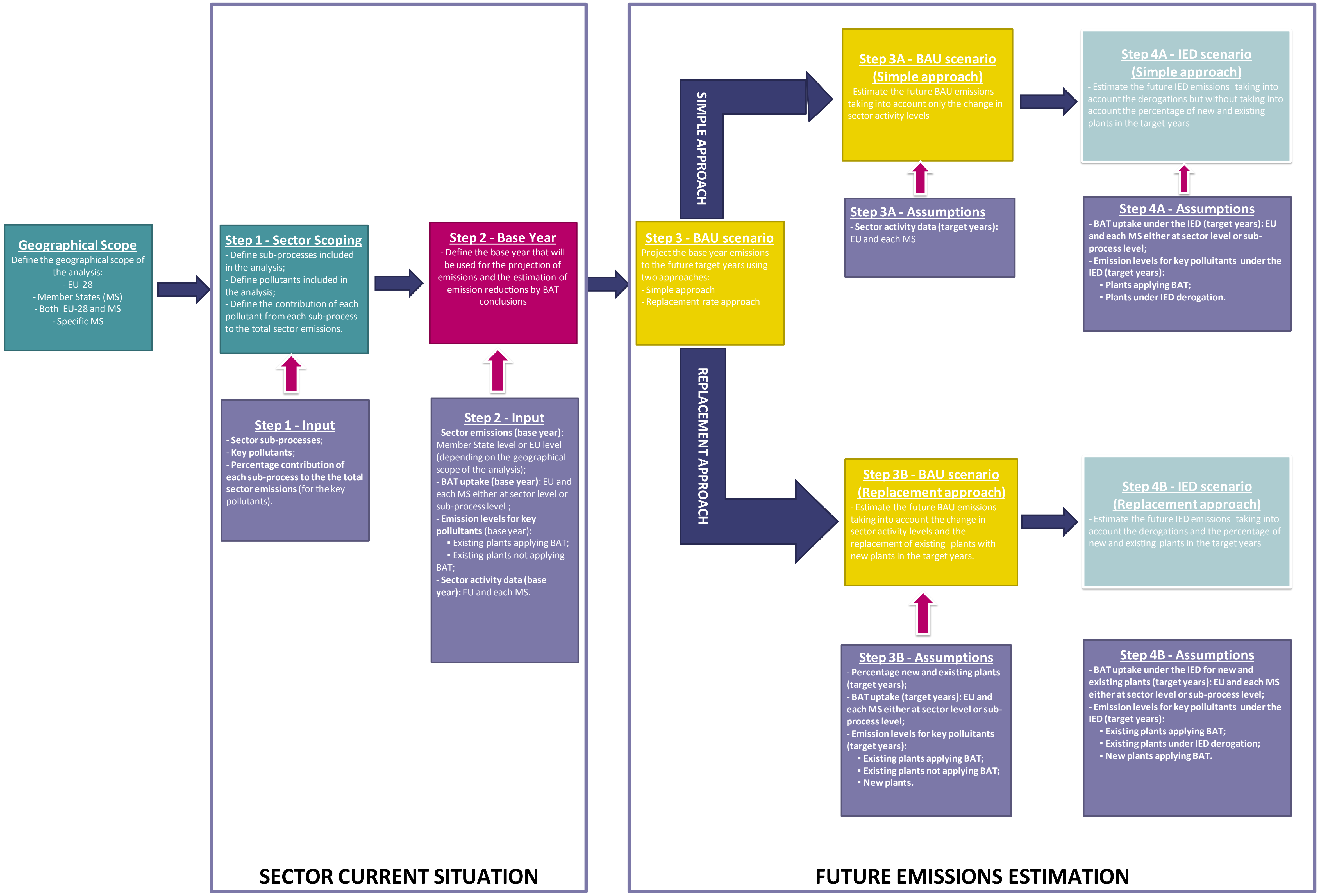
Figure 3.1 presents the main parts of the methodology and the steps included in each of the two parts.

Figure 3.1 Main parts of the methodology



An overview of the methodology and how the different steps interact is provided in Figure 3.2. It must be highlighted that the methodology requires specific inputs (based on empirical data or assumptions) in each step in order to produce the required results. The input or assumptions that are required in each step are described in the following sections but also in Figure 3.2.

Figure 3.2 Methodology overview



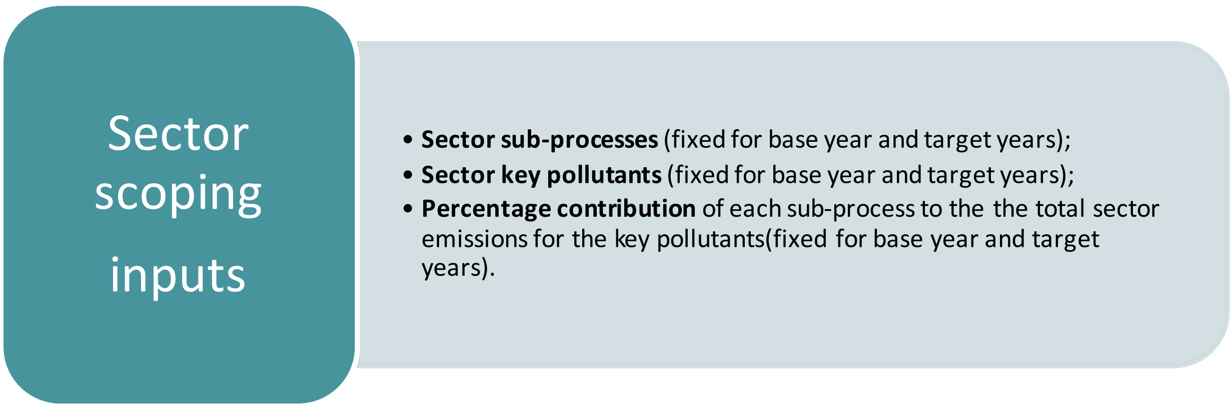
3.1.3 Sector current situation (methodology inputs)

The first two steps of the methodology aim to describe the current situation of the sector under analysis and set up the analysis framework. These two steps are necessary inputs in order to perform the analysis and estimate the future emissions (outputs).

Sector scoping - Step 1

The processes used in an industrial sector can be broken down to various smaller processes (sub-processes)[10]. Sub-processes contribute to the total emissions of the sector. Within the sector under analysis, the key sub-processes and pollutants (air and water) that will be included in the analysis have to be defined along with the percentage contribution of each sub-process to the total sector emissions. The inputs that are required in this step are provided in Figure 3.3.

Figure 3.3 Important Sector scoping required inputs



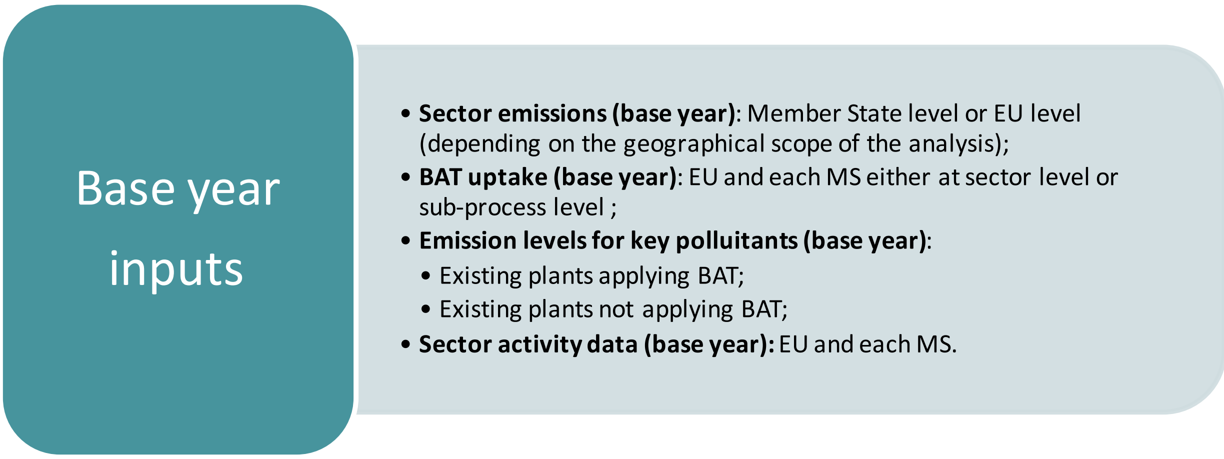
Once the above parameters are defined then they are fixed throughout the specific analysis and cannot be changed between the base years and the target years or between the different future emission scenarios.

Base year – Step 2

A base year needs to be selected for the sector under analysis. Once the base year is defined then all required inputs, as presented in Figure 3.4, need to be collected in order to define the sector situation in the base year. This will be the starting point for the projection of emissions to the target years for both the BAU and the IED scenario. It is a very important step of the methodology and should represent as closely as possible the sector situation in each Member State.

[10] For example for cement sector the BAT conclusions break down the cement production process to three key sub-processes which have BAT-AELs: 1. Kiln firing; 2. Cooling and milling processes; 3. Other dusty operations.

Figure 3.4 Important Base year required inputs



This step requires significant effort in data collection if it is to yield high quality and realistic results. It must be mentioned that in the base year the methodology considers that at all plants are existing plants[11].

3.1.4 Future emissions estimation (methodology outputs)

Using the input from Steps 1 and 2 along with assumptions (described in the following sections) for the target years, the future emission can be estimated under the BAU and the IED scenarios. The emission projections are calculated using two different approaches. These are:

- **Simple approach:** This approach does not take into account the proportion of new and existing plants that might exist in the target years and the potentially different emission levels and BAT uptake that the new plants might have; and

- **Replacement approach**: This approach considers that a number of plants will be replaced between the base year and target years. New plants are expected to implement state-of-the-art abatement technologies which can achieve lower emissions compared to the existing plants. This approach takes into account the proportions of new and existing plants in the target years and the differences in emission levels and BAT uptake.

The simple approach is a quick way to estimate the potential emission reductions when a detailed assessment is not required. The replacement approach is considered more precise and complete in order to support, for example, an impact assessment of potential future changes to the IED.

Business as usual (BAU) scenario - Step 3

This step is an output of the methodology as it provides the estimation of future emissions without IED BAT conclusions. Under this scenario it is assumed that the IED does not exist and that the IPPC Directive would have continued to be applicable. The base year (as defined in Step 1) emissions are projected to the target years taking

11 According to the definitions used in adopted BAT conclusions, new plant is a plant introduced on the site of the installation following the publication of the BAT conclusions or a complete replacement of a plant on the existing foundations of the installation following the publication of the BAT conclusions. Existing plant is a plant that is not new.

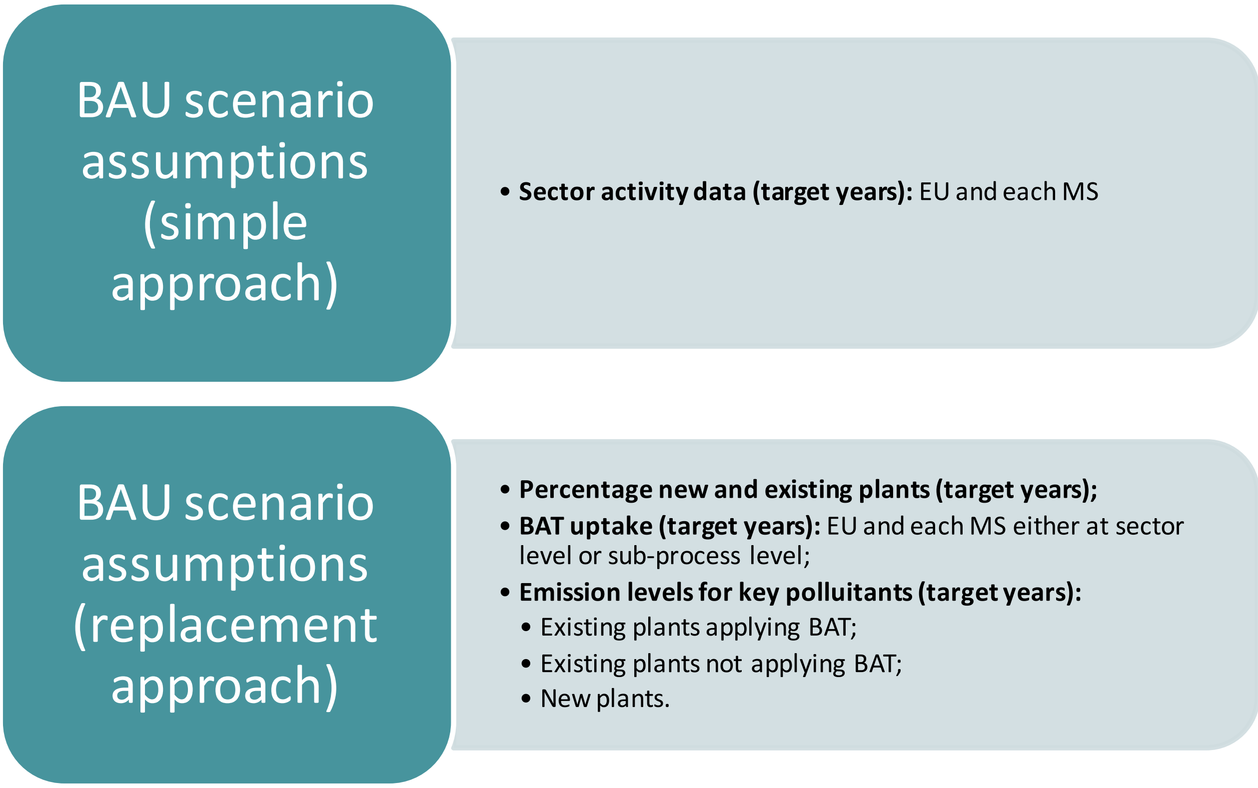
into account only the provisions of the IPPC Directive. The base year emissions (Step 2) are projected to the target years based on:

- The change in the sector's activity (simple approach); or
- The sector's activity change and change in sector's emission levels due to new plants replacing existing ones (replacement approach).

In order to define the sector emission levels in the target years using the replacement approach, assumptions for parameters affecting emission levels need to be made

The inputs required in this step are provided in Figure 3.5.

Figure 3.5 Important BAU scenario required assumptions



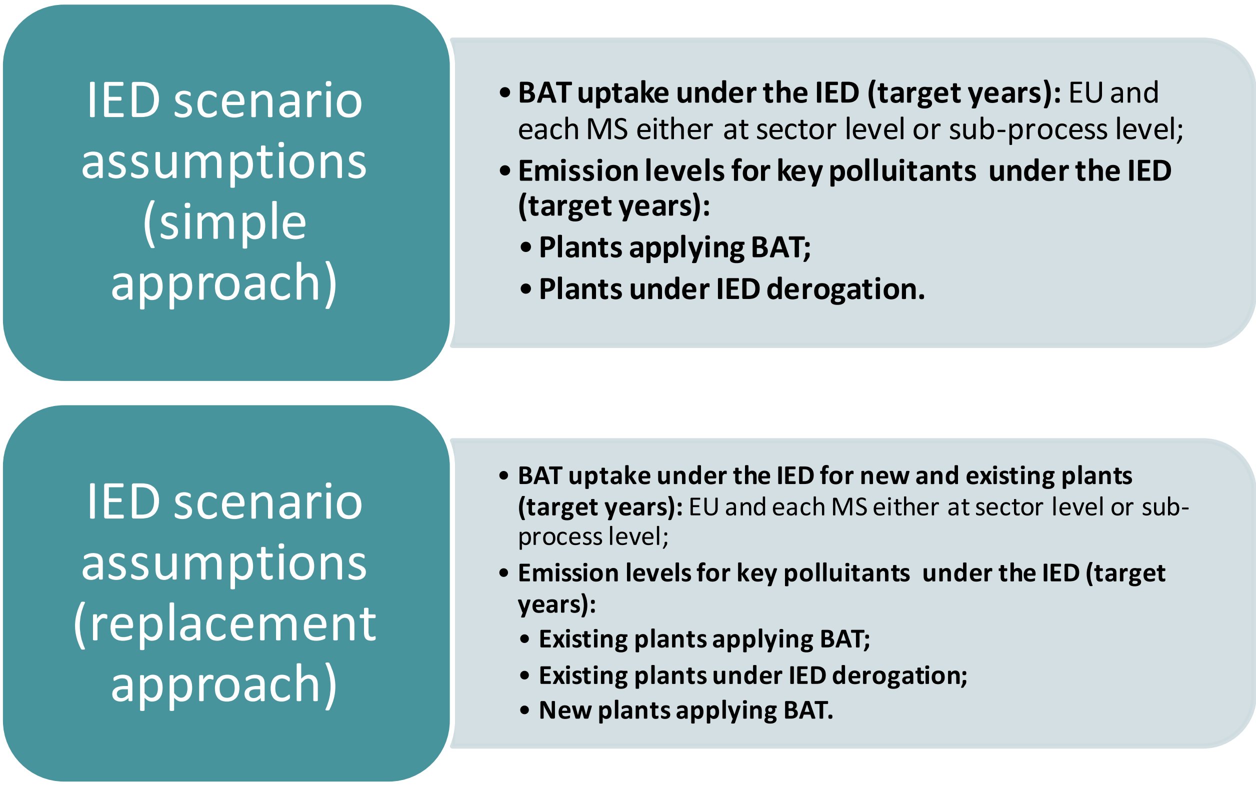
IED scenario – Step 4

Under this scenario it is assumed that the IPPC Directive has been replaced by the IED. The base year emissions are projected to the target years taking into account the provisions of the IED (i.e. BAT conclusions, BAT-AELs and derogations).

The emissions in the target years are calculated using the BAU scenario emissions and the change in emission levels of the sector between the BAU scenario and the IED scenario in the target years. The simple approach does not take into account the replacement of existing plants with new plants in the target years while the replacement approach does.

This step requires significant effort in defining the scenario assumptions if it is to give high quality and realistic results. The assumptions that are required in this step are presented in Figure 3.6 for both the simple approach and the replacement approach. Note that the assumptions from Step 3 about the sector's activity and percentage of new and existing plants in the target years are also used in this step. In the methodology it is assumed that new plants under the IED can comply with the BAT conclusions.

Figure 3.6 Important IED scenario required assumptions



3.1.5 Model implementing the methodology

Amec Foster Wheeler developed a model which implements the methodology described in the previous sections. The main characteristics of the model along with what results that the model can produce are presented in the following sections.

Geographical coverage

The developed model can perform analysis for each of the 28 Member State and EU-28 level. The user can select and change easily the geographical scope of the analysis including for example only EU-28 level, Member State level or only selected Member States.

Timeframe of the analysis

The base year and the target years can be selected when the analysis framework is defined. The model implementing the methodology does not have a restriction on the years that will be used (as long as the required input data and assumptions are fed into the model) and can generate results for two different target years at the same time.

Sectoral coverage

The model can cover all IED sectors and is able to perform analysis at sector level, sub-process level or both. The model can even be run only for a specific sub-process of a specific sector.

Emission levels units

The model can use emission levels in different units according to the units included in the BAT-AELs of the BAT conclusions adopted under the IED.

Sector activity

The model requires input about the sector's activity in the base year but also assumptions about the sector's activity in the target years. The data input for sector activity can be the production data for the sector (e.g. Mt product per year or PJ per year for energy production) or number of animals for agricultural sectors or amount of waste handled per year for waste facilities.

Limitations of the model

The model is able to handle a maximum of 40 different sub-processes, 30 pollutants, 200 BATs and 28 Member States plus EU level. This is expected to be enough for the vast majority of industrial sectors.

How the model works

The model implements the methodology described in 3.1. For each pollutant included in the analysis of a sector the model:

- Establishes for each sub-process within the sector and for the sector as a whole the emission level in the base year (using the input data from Steps 1 and 2);
- Calculates the emission level for each sub-process for the target years under the BAU (Step 3) and IED (Step 4) scenarios,
- Aggregates projected emission levels from sub-processes according to their contribution to the emissions of that pollutant within the sector (using input data from Step 1), obtaining the sector emission level;
- Compares sector emission levels between the base year and target years (BAU scenario – Step 3) or between the BAU and IED scenarios for the target years (IED scenario – Step 4) and, based on that, calculates the total emissions either in the BAU or IED scenario target years; and
- Compares the emissions and specific emissions (e.g. tonnes of emissions per unit of activity or fuel use) between the BAU scenario and the IED scenario in order to establish the potential emission reduction.

What are the outputs of the model?

The aim of the methodology and of the associated model is to estimate the potential emission reductions delivered by BAT conclusions adopted under the IED. The potential emission reduction is the difference between the estimated future emissions under the IED scenario and those under the BAU scenario. Apart from that, the model can also estimate the potential reduction in specific emissions (t pollutant/Mt product) which can provide a better understanding of the impacts of the IED and the improvement of the environmental performance of the sector. More specifically for a given industrial sector, set of pollutants and geographical scope (e.g. NO_X emissions from the cement sector at EU level), the model calculates:

- Projections for the target years under the BAU scenario (i.e. IPPC) of:
  - Total emissions (tonnes per year);
  - Emission levels (in the units that the user defines when setting up the model);
  - Specific emissions (tonnes of pollutant per Mt of product);
- Projections for target years under the IED scenario:
  - Total emissions (tonnes per year);
  - Emission levels (in the units that the user defines when setting up the model);
  - Specific emissions (tonnes of pollutant per Mt of product);
- Relative change of the above parameters between the BAU and the IED scenario.

Importance of input data and assumptions

The methodology takes into account several parameters which can influence the emission of the IED sectors. The most important parameters that require input/ assumptions in each step of the methodology were presented in Sections 3.1.3 and 3.1.4 and Figure 3.2 . The input data or assumptions that will be used for each of the important parameters can affect to a different degree the results of the model and could lead to incorrect estimation of emission reductions if the data included in the model are not reliable.

Particular attention should be paid during the setup of the model and the collection of the input data and assumptions, as these should represent the specific IED sector as closely as possible. To give the most reliable and most precise results, Member State specific data and assumptions should be used in the model in order to reflect the specificities of each sector in the different Member States. It was observed during the testing of the model that Member State specific data is not readily available. In order to run the model, it would be necessary to undertake a specific data collection exercise including consultation with stakeholders (i.e. Member States and the affected industry sector) about the assumptions that have to be made and the data that can be generated. This could ensure that high quality data and realistic assumptions are included in the model and that the estimated emission reductions actually reflect the impacts of the IED and the BAT conclusions in the industrial sectors. A suitable mechanism for collecting such data might be through the data collection undertaken for the regular review of the BREFs.

3.2 Detailed description of the model

3.2.1 Introduction

This section illustrates in detail the model developed in the project (Task 2) in order to estimate the potential emission reduction that can be delivered by the BAT conclusions adopted under the IED in comparison with the use of the BAT under the IPPC Directive. The section describes the different steps of the model including definition of the baseline (emissions, sector activity, BAT uptake and future BAU emission estimation), estimation of potential emission reductions associated with BAT conclusions and application of Article 15(4) derogations.

In the description, the assumptions and hypotheses critical for the methodology to produce sound estimation of potential emission reduction are highlighted.

Data presented in this section are purely indicative and reported only for illustrative purposes and for clarifying the description of the methodology. A number of abbreviations/ terms are used within this section and summarised in the table below for reference.

IPPC BAT	BAT as set out in the original BREFs developed under the IPPC Directive
IED BAT	BAT as set out in the revised BREFs and included in the BAT Conclusions under the IED
Existing plant	In this note the term is not used with the legal definition of IPPC or IED but it is used for plants that were in operation in the base year (2010)
EL	Emission level of a pollutant
SEL_{2010}	Sector emission level for a pollutant in 2010
AC_x	Sector activity for a given year
$SFEL_x$	Sector future emission level for a given year
EPEL	Existing plant emission level
NPEL	New plant emission level
NPELC	New plant emission level change

3.2.2 Step 1 – Sector scoping

The aim of this step is to establish important background data on the sector in which the whole analysis will be based. It sets up the framework of the model and delimits the scope of the modelling exercise. It is the most important step as all projections will be based on the data used and assumptions made in this step.

Step 1 – Sector Scoping	Example Sector – Dust Emissions
Step 1.1 (Input step) Identification of **key emitting processes** for the sector	• Process A; • Process B; • Process C.
Step 1.2 (Input step) Identification of **key air pollutants** for analysis based on significance of emissions and presence of BAT-AELs in the BAT Conclusions. Pollutants for which BAT-AELs are defined the IED BAT conclusions shall be included in the list. Additionally the list could potentially include pollutants with BAT-APLs.	Key air pollutants for the 'anonymous' sector: • Dust; • NO_X ; • SO_X ; • HCl ; • HF. These pollutants have BAT-AELs in the IPPC BREF and in the IED BAT conclusions.
Step 1.3 (Input step) Identification of **key water pollutants** for analysis based on significance of emissions and presence of BAT-AELs in BAT Conclusions Pollutants for which BAT-AELs are defined in the IED BAT conclusions shall be included in the list. Additionally the list could potentially include pollutants with BAT-APLs. It should be mentioned that the analysis of the water and air pollutants is not linked to each other and one can be done separately from the other in separate files (if necessary).	No key water pollutants. Emissions to water are considered insignificant in the BREF (both IPPC and IED) and there are no BAT-AELs in the BAT conclusions.
Step 1.4 (Input step) Split of emissions to the different processes identified in Step 2.2 using factors from BREFs or generic factors from literature (depending on availability of data) This is a critical step and allocation of emissions to the different processes of the sectors requires sound knowledge of the processes and sector	Split of emissions to different processes (sector scoping matrix): (see table below)

Process	Dust	NO_X	SO_X	HCl	....
Process A	50%	100%	100%	100%	.....
Process B	45%				
Process C	5%				

Sector scoping is a key step in setting the data and assumptions used for further calculations and the estimation of the potential emission reductions that can be delivered by the adopted BAT conclusions. The sector scoping matrix must include all the key processes that contribute to the total sector emissions and the contribution of each process to the total sector emissions must be based to realistic data that describe what actually happens in the sector. Information from literature sources such as the BREF, but more importantly consultation with stakeholders (e.g. Member States, industrial associations and NGOs) or literature review should be used in order to prepare the scoping matrix. The parameters included in Step 1 that are critical for the methodology to produce sound estimation of potential emission reduction are:

Table 3.1 Important parameters/ data for Step 1

Parameter	Importance/ comments
Sector sub-processes	The key sub-process that are responsible for a proportion of the total emissions of any pollutant of the specific sector must be defined in as much detail as possible in order to allow the disaggregation of the total sector emissions and matching these with the BAT conclusions and BAT-AELs. The tool accepts a maximum of 40 sub-processes which should be sufficient for even the bigger and more complex sectors such as refineries or iron and steel.
Sector key pollutants	For the sector to be analysed the key pollutants for each release medium (air and water) have to be defined. If necessary, pollutants can be assigned to both air and water. Identification of the key air pollutants can be based on significance of emissions and presence of BAT-AELs in BAT Conclusions. The pollutants for which BAT-AELs in the IED BAT conclusions should be included in the list.
Sub-processes contribution to the total sector emissions	The percentage contribution of each sub-process to the total sector emissions has to be defined. Practically this means creating a matrix with sub-processes (vertical axis) and pollutants (horizontal axis) which will contain the contribution in percentage of each sub-process to the total emissions of that specific pollutant in the whole sector. The sum of all contributions must be 100%.

3.3 Step 2 - Base year

The aim of this step is to define the base year which will then be used to project the emissions in the target years both for the BAU and the IED scenarios. It is an important step in setting up the model as it should represent as closely as possible the sector situation in each Member State. This step requires significant effort in data collection if the results of the model are to be realistic.

Step 2	Example Sector – Dust Emissions
Step 2.1 (Input step) Collection of **activity data** for the sector **for the base year**, at MS and EU level.	Example sector activity level in 2010 (AC_{2010}) = 6.99 Mt (Million tonnes produced) (EU level)
Step 2.2 (Input step) Collection of **emission data for the base year**, at EU and MS level. Depending on the sector data might be found in E-PRTR database, LRTAP or other sector-specific air emission database.	Dust emissions in 2010 = 11.176 Kt (EU level)
Step 2.3 (input step) Collection of **BAT-AELs from existing BREFs** (adopted under IPPC Directive)	BAT-AELs in the IPPC BREF: (see table below)
Step 2.4 (Input step) Definition of **BAT uptake** for each pollutant and MS **in the base year**. The model has been designed to enable the input of BAT uptake data either at EU level or MS level. This however is a critical step as it might be difficult to get detail information on BAT uptake at MSs level. In the absence of readily available information on BAT uptake for each MS , the EU average can be applied, limiting however the precision of the results obtained	BAT uptake and percentage of plants not applying BAT: (see table below)

BAT-AELs in the IPPC BREF:

Process	**BAT-AEL for dust emissions (mg/Nm³)**	
	Lower level	**Upper level**
Process A	<10	20
Process B	<10	20
Process C		<10

BAT uptake and percentage of plants not applying BAT:

Process	**Dust**		**NO_x**		**....**	
	BAT application	**Not BAT**	**BAT application**	**Not BAT**	**BAT application**	**Not BAT**
Process A	60%	40%	85%	15%	....	.....
Process B	60%	40%				
Process C	60%	40%				

Step 2	**Example Sector – Dust Emissions**

Step 2.5 (Input step)
Definition of **emission levels for the plants applying BAT**,

If this information is not provided by MSs, the emission levels can be based on BAT-AELs for existing plants in the BREFs adopted under IPPC.

Depending on the pollutant under analysis, the emission levels (EL) defined can be expressed either in concentration (mg/l or mg/Nm^3) or in load (tonnes/tonne product). In the cases where there were no BAT-AEL(s) in the IPPC BREF but there are BAT-AEL(s) in the BAT Conclusions under the IED, base year emissions level might be derived based on other sources (e.g. sector reports).

Where BAT is defined as more than one technology for a particular process and pollutant:

- The analysis can be broken down to different technologies if emission level and BAT uptake data is available for each Member State;
- An average sector emission level can be chosen based on information included in the BREF or preferably specific data collection, which represents a more reliable and up-to-date source;
- Choose an emission level based on the most commonly used technology.

When data on sector emission levels is not available, the methodology includes the possibility to apply as an emission level:

- the lower, upper or midpoint emission level of the BAT-AELs (if expressed as a range);
- A percentage lower than the upper BAT-AEL level.

The tool also allows for flexibility in switching between the different values described above.

Emission levels for plants applying BAT:

Process	**Emission levels for dust in the base year (m/Nm^3)**
Process A	15
Process B	18
Process C	8

Step 2.6 (Input step)

Definition of **emission levels for plants not applying BAT**

In absence of detailed emission level data from MSs assumptions need to be made in order to perform the analysis but this might affect the precision of the results.

If assumptions need to made, one path might be to assume a percentage of higher emissions compared to the upper level of the BAT-AEL, alternatively different data sources (e.g. data from BREF documents, implementation reports or sector studies) need to be collected. Ideally specific, up-to-date data should be collected.

As for the BAT emission levels described above, the methodology allows some flexibility in terms of what is assumed for plants not applying BAT.

Emission levels for plants not applying BAT:

Process	**Emission levels for dust in the base year (mg/Nm^3)**
Process A	25
Process B	23
Process C	15

Step 2	Example Sector – Dust Emissions
Step 2.7 (Output step) Using data from the steps 2.1-to 2.6 it is possible now to calculate the **sector emission level** (SEL_{2010}) **for base year.** The result is a weighted average of the emission levels for the various processes and the BAT uptake. Using the example figures, for process A the emission level will be calculated based on the emission levels of the plants applying and not applying BAT and the percentage of the plants in each category (based on the BAT uptake): (60% * 15 mg/Nm^3) + (40% * 25 mg/Nm^3) = 19 mg/Nm^3 SEL_{2010} is then calculated by weighting the emission levels of the processes according to the split of the total emissions between the different processes: (19 mg/Nm^3 * 50%) + (20 mg/Nm^3 * 45%) + (10.8 mg/Nm^3 * 5%) = 19.04 mg/Nm^3 The model calculates the sector emission level for each Member State which is then used in later steps for the projection of emissions in the target years (both in the BAU and IED scenario).	Dust emission levels for the sector in the base year:

Process	Emission levels for dust in the base year (mg/Nm^3)
Process A	19
Process B	20
Process C	10.8
Example sector dust emission level (SEL_{2010})	***19.04***

All assumptions and input data must be defined based on reliable and realistic sector-specific data in order for the tool to offer valid and reliable results. The data used is the most critical part of the methodology in order to obtain realistic estimates of the potential emission reductions in the target years.

Ideally installation and Member State specific data should be used for all the input parameters in order to take into account the specificities of the sector in each Member State. If Member State specific data is not available then EU level data may be used (this feature is included in the model) in order to run the analysis. However this could lead to an analysis that may not totally represents the situation of the sector in the specific Member States. The important parameters and input data in this step in which the data collection should focus are:

Table 3.2 Important parameters/ data for Step 2

Parameter	Importance/ comments
Emission data (base year)	Data on emissions for each considered pollutant and Member State need to be collected for the base year. A suitable and reliable database (e.g. E-PRTR LRTAP) has to be selected for the specific IED sector which correctly represents the base year emissions of the sector. It should be agreed for each sector which database is the most suitable and should be used in the analysis. This step is critical because the same sector might be differently described in the various datasets and comparison among datasets is not straightforward in most cases.
Sector activity data (base year)	The model uses sector activity data in order to project the base year emissions to the target years. Depending on the sector data sources such as GAINS, PRIMES data can be used. Another option would be Member State specific data provided by the Member States or industry associations.

Parameter	**Importance/ comments**
BAT Uptake (base year)	The uptake of BATs for each pollutant and MS must be defined for the base year in order to estimate the percentage of plants applying BAT and plants not applying BAT. The data should be either at sector or sub-process level. For a more detailed analysis sub-process specific BAT uptake data would be required for each Member State. If this data is not available then the model can run with sector BAT uptake in each Member State or even EU level BAT uptake in the worst case that none of the previous data is available. Including BAT uptake data at EU level would limit the precision of the results obtained. The best option would be to use Member State specific BAT uptake data for each sub-process and pollutant defined. This data could be provided by industry or Member State experts that have knowledge of the IED sectors in their Member States (e.g. regulatory authorities with knowledge of specific installations).
Emission levels for plants applying BAT	For the plants applying BAT, emission levels should be defined for the base year for each sub-process and pollutant under analysis. The definition of the emission levels in the base year (but also in the target years in the steps to follow) is a very important issue that input from Member States and industry will be essential for obtaining realistic and precise results from the model. Ideally the emission levels should be defined at Member State level but if data is not available then general EU emission levels can be defined and used in the analysis. The model gives the user the following possibilities related to the emission levels: ✓ Specify a specific emission level value (e.g. based on data collection from stakeholders); ✓ Specify an emission level as a % <u>under</u> the maximum emission level associated with the use of BAT ; ✓ Specify an emission level based on a specific point (lower end of the range, midpoint or upper end of the range) from emission levels associated with the use of BAT.
Emission levels for plants not applying BAT	For the plants not applying BAT, emission levels should also be defined for the base year for each sub-process and pollutant under analysis. Information about the emission levels of the plants not applying BAT in the base year might not be readily available so data has to be provided by the stakeholders or assumptions must be made based on other data source (e.g. literature). Input from Member States and industry will be essential for obtaining realistic results from the model. Ideally the emission levels should be defined at Member State level but if data is not available then general EU emission levels can be defined and used in the analysis. The model gives to the user the following possibilities related to the emission levels: ✓ Specify a specific emission level value (e.g. based on data collection from stakeholders); ✓ Specify an emission level as a % <u>over</u> the maximum emission level associated with the use of BAT.

3.4 Step 3 - BAU scenario

The aim of this step is to calculate the "Business as usual" (BAU) future emission projections. Under this scenario it is assumed that the IPPC Directive still exists in the target years i.e. that it was not replaced by the IED. The base year (e.g. 2010) emissions are projected to the target years (i.e. 2010 and 2025) taking into account only the provisions of the IPPC Directive. As mentioned in the methodology overview (see Section 3.1), the model includes two calculation approaches for estimation of the emission reductions through application of the BAT conclusions under the IED. These are:

- **Simple approach**: The base year emissions are projected to the target years based on the change in the sector activity, without taking into account changes in the proportion of new and existing plants and potentially differing emission levels and BAT uptake; and

- **Replacement approach:** Base year emissions are projected to the target years taking into account the change in proportions of new and existing plants and any differences in emission levels and BAT uptake.

In the following sections, the methodology described in Step 3A refers to the simple approach while the methodology described in Step 3B refers to the replacement approach. The simple approach is a quick and rough estimation of the potential emission reduction by the application of the BAT conclusions while the replacement approach is a more detailed calculation approach which can provide more realistic and precise results (if the required input data is available).

3.4.1 Step 3A - BAU scenario (simple approach)

This step describes the relatively simple approach for the estimation of future BAU emissions.

Step3A	Example Sector – Dust Emissions
Step 3A.1 (Input step) Collection of **activity data for the sector in the target years.** Activity data projections need to be collected for the sector at MS and EU level. Where this data is not available assumptions need to be made.	**Example sector activity level in 2020 (AC_{2020})**: 8.82 Mt **Example sector activity level in 2025 (AC_{2025})**: 8.97 Mt
Step 3A.2 (Output step) Calculation of the ***sector activity change between the target years and the base year.*** The activity data in the base year are compared with the activity data projections for the target years. $\text{Activity change}_{2020} = \frac{AC_{2020}}{AC_{2010}}$ $\text{Activity change}_{2025} = \frac{AC_{2025}}{AC_{2010}}$	Calculation of activity change for the example sector: **Activity change in 2020 (compared to base year)**: 1.26 **Activity change in 2025 (compared to base year)**: 1.28

Step3A	Example Sector – Dust Emissions
Step 3A.3 (Output step) Calculation of **BAU emissions in the target years**. The change in activity between the base year and the target years (calculated as a factor) is applied to base year emissions in order to project them to the target years (e.g. 2020 and 2025) under the BAU scenario: $BAU\ emissions_{2020} = Activity\ change_{2020} * Emissions_{2010}$ $BAU\ emissions_{2025} = Activity\ change_{2025} * Emissions_{2010}$	Dust emissions projections for example sector: **BAU dust emissions in 2020**: 14.102 Kt **BAU dust emissions in 2025**: 14.342 Kt

Note: It should be highlighted again that the simple approach assumes that that there is no change in emission levels of the target years compared to the base year scenario and there is only activity change.

The important parameters and assumptions in this step in which consultation with industry/ regulator stakeholders should focus are:

Table 3.3 Important parameters/ assumptions for Step 3A

Parameter	Importance/ comments
Sector activity data (target years)	Activity data projections for the sector in the target years are key elements in the calculations of this step. The model uses the change in sector activity between the base year and the target years in order to project the base year emissions to the target years. It might be difficult to obtain future sector activity data especially on Member State level. The primary source of data should be the stakeholder (e.g. Member States or industry associations). If data is not available then assumptions need to be made which will affect the reliability and precision of the results.

3.4.2 Step 3B - BAU scenario (replacement rate approach)

This step describes the more detailed replacement approach for estimation of the BAU emissions in the target years. As mentioned previously, in addition to activity change, this approach also considers the number of existing plants that will be replaced by new (better performing) plant between the base year and target years.

All assumptions must be made taking into account sector specific data in order for the model to provide valid and reliable results.

Ideally Member State specific assumptions (based on plant-by-plant data) should be made for all the parameters in order to take into account the specificities of the sector in each Member State. If Member State data are difficult to identify then EU level assumptions could be used (this feature is included in the model) in order to run the analysis. However this could lead to an analysis that may not totally represents the situation of the sector in the specific Member States of interest.

Step 3B	**Example Sector – Dust Emissions**
Step 3B.1(Input step) Define the **percentage of new and existing plants in target year.**	100% existing plants in the base year (2010)
The methodology assumes that in the base year there were 100% of existing plants while in the target future years there will be a mix of new and existing plants (as older plants are replaced and new plants potentially come on line to meet increased demand). The new plants might be able to achieve lower emission levels compared to the existing plants and this can be reflected in the methodology by setting different (lower) emission levels for new plants compared to the emission levels of the existing plants applying BAT (see steps 3B.2 and 3B.3) The proportion of existing plants versus new plants is a key element in the calculations and it might be difficult to get reliable data on this. Ideally the percentage of existing /new plants shall be provided by each MSs or through data collection with the industry concerned. In case these data are not available the percentages of new and existing plants in the target years might be estimated by applying an assumed lifetime of plants in the sector and calculating annual turnover (e.g. if an average plant lifetime is assumed to be 25 years then this equates to a 4% turnover of plants per year). An alternative approach to estimating the percentage of existing vs new plants could be to use PRIMES GVA data (preferably in a GAINS format) which can serve as an indicator of a sector's growth or decline (or we simply use the underlying activity data itself that will be applied for projecting emissions). For example, if GVA for a sector is projected to increase by 20% from the base year then all of this growth could be assumed to be met by new installations. Recognising that some existing plants could probably meet a small increase in demand a threshold (e.g. 5%) can be included over which it will be assumed that new plants have to be built.	Percentage of new and existing plants in 2020 and 2025:

	2020	**2025**
Existing plants	85%	80%
New plants	15%	20%

Step 3B	**Example Sector – Dust Emissions**

Step 3B.2(Input step)

Definition of BAT uptake for existing plants **in target years**

Assumptions on the BAT uptake in the target year should be based on realistic data for the sector in each Member State. The assumptions should be defined in consultation with the stakeholders (i.e. Member States and industry).

The model allows different BAT uptakes to be assumed between the base year and the target years if this reflects a realistic situation for the sector. However in this example for existing plants the BAT uptake levels have been assumed to be the same as in Step 2.

Existing plant s BAT uptake under IPPC:

Process	**Dust**		**NO_X**		**....**	
	BAT application	**Not BAT**	**BAT application**	**Not BAT**	**BAT application**	**Not BAT**
Process A	60%	40%	85%	15%	....	.....
Process B	60%	40%				
Process C	60%	40%				

Step 3B.3 (Input step)

Definition of **emission levels for existing plants in target year.**

In this step the emission levels of existing plants applying BAT and not applying BAT are defined for the target years. These have to be based on assumptions which could be made in consultation with the stakeholders (i.e. Member States and industry).

It should be highlighted that in the example for existing plants the emission levels have been assumed to be the same as in Step 2 – Base year.

Emission levels for existing plants applying BAT under IPPC:

Process	**Emission levels for dust (mg/Nm^3)**
Process A	15
Process B	18
Process C	8

Emission levels for existing plants not applying BAT under IPPC:

Process	**Emission levels for dust (mg/Nm^3)**
Process A	25
Process B	23
Process C	15

Step 3B.4 (Input step)

Definition of **BAT uptake** for new plants **in target years.**

Assumptions on the BAT uptake in the target year should be based on realistic data for the sector in each MS. The assumptions should be defined in consultation with the stakeholders (i.e. Member States and industry).In this example for new plants regulated under IPPC 100% BAT uptake has been assumed and different (lower) emission levels have been defined based on the BAT-AELs in the BREFs adopted under IPPC.

New plant BAT uptake under IPPC:

Process	**Dust**		**NO_X**		**....**	
	BAT application	**Not BAT**	**BAT application**	**Not BAT**	**BAT application**	**Not BAT**
Process A	100%	0%	100%	0%	....	.....
Process B	100%	0%				
Process C	100%	0%				

Step 3B	**Example Sector – Dust Emissions**

Step 3B.5 (Input step)

Definition of emission levels **for new plants in target year**

In this step the emission levels of new plants are defined for the target years. These have to be based on assumptions which could be made in consultation with the stakeholders (i.e. Member States and industry).

Emission levels for new plants under IPPC:

Process	**Emission levels for dust (mg/Nm^3)**
Process A	12
Process B	15
Process C	5

Step 3B.6 (Output step)

Calculation of **existing plants emission level and emissions** in **the target years** (assuming 100% existing plants).

This step involves the calculation of existing plants' emission levels in the target year based on the assumptions made in Steps 3B.2 and 3B.3.

In the example the existing plants emission level (EPEL) and emissions in the target years will be the same as the Sector emission level calculated in Step 2 for the base year scenario (assuming 100% existing plants) as the same assumptions as in Step 2 have been made. However the model can handle different assumptions for existing plants between the base year and the target years.

In this particular example we have the following assumptions were made:

$$\mathrm{EPEL} = \mathrm{SEL}_{2010}$$

$$\text{Existing plants BAU emissions}_{2020}(\text{assuming 100\% existing plants}) = \text{BAU emissions}_{2020}$$

$$\text{Existing plants BAU emissions}_{2025}(\text{assuming 100\% existing plants}) = \text{BAU emissions}_{2025}$$

The results for existing plants' dust emission levels and emissions are:

Existing plants emission level (EPEL) (assuming 100% existing plants)	19.04 mg/Nm^3

Existing plants dust emissions in 2020 (assuming 100% existing plants)	14.102 Kt
Existing plants dust emissions in 2025 (assuming 100% existing plants)	14.342 Kt

Step 3B.7 (Output step)

Calculation of **new plants emission level and emissions** in **the target years** (assuming 100% new plants).

In this step the new plant emission level (NPEL) is calculated as a weighted average of the new plant emission levels for the various processes.

(i.e. 50% emissions from process A 12 mg/Nm^3, 45% from process B 5 mg/Nm^3, etc.). It should be noted that the emission split as defined in Step 2 is used.

It should be noted that the emission split is the same for new and existing plants, and also the same for the base year and the target years.

New plants emission level (NPEL)	13.0 mg/Nm^3

Step 3B	**Example Sector – Dust Emissions**

New plant emission level (NPEL) is compared with the sector emission level for the base year (SEL_{2010}) and the difference is applied to base year emissions along with the activity change in order to calculate the new plant emissions in the target years (assuming 100% new plants):

$$\text{New plant emission level change (NPELC)} = \frac{\text{NPEL}}{\text{SEL}_{2010}}$$

$$\text{New plant BAU emissions}_{2020}\ (\text{100\% new plants}) = \text{NPELC} * \text{Activity change}_{2020} * \text{Emissions}_{2010}$$

$$\text{New plant BAU emissions}_{2025}\ (\text{100\% new plants}) = \text{NPELC} * \text{Activity change}_{2025} * \text{Emissions}_{2010}$$

New plants emission level change (NPELC)	0.68

New plants BAU dust emissions in 2020 (assuming 100% new plants)	9.628 Kt
New plants BAU dust emissions in 2025 (assuming 100% new plants)	9.792 Kt

Step 3B.8 (Output step)

Calculation of **sector BAU emission levels** and **BAU dust emission** in the **target years**.

In this step the sector BAU emission level is calculated based on the BAU emission levels for existing and new plants (as calculated in steps 3B.6 and 3B.7) in combination with the percentage of new and existing plants in the target years (as defined in step 3B.1)

The sector future BAU emission levels and emissions are calculated as a weighted average of new and existing plants as follows:

$$Sector\ future\ BAU\ emission\ level_{2020} = Existing\ plants_{2020}\ (\%) * EPEL + New\ plants\ _{2020}(\%) * NPEL$$

$$Sector\ future\ BAU\ emission\ level_{2025} = Existing\ plants_{2025}\ (\%) * EPEL + New\ plants\ _{2025}(\%) * NPEL$$

$$Sector\ future\ BAU\ emissions\ _{2020} = Existing\ plants_{2020}\ (\%) * Existing\ plants\ BAU\ emissions_{2020} + New\ plants\ _{2020}(\%) * New\ plants\ BAU\ emissions_{2020}$$

$$Sector\ future\ BAU\ emissions\ _{2025} = Existing\ plants_{2025}\ (\%) * Existing\ plants\ BAU\ emissions_{2025} + New\ plants\ _{2025}(\%) * New\ plants\ BAU\ emissions_{2025}$$

Sector future BAU dust emission level in 2020	18.13 mg/Nm^3
Sector future BAU dust emission level in 2025	17.83 mg/Nm^3

Sector future BAU dust emissions in 2020	13.431 Kt
Sector future BAU dust emissions in 2025	13.432 Kt

The important parameters that require assumptions in this step and in which consultation with stakeholders should focus are:

Table 3.4 Important parameters/ assumptions for Step 3B

Parameter	Importance/ comments
Percentage of new and existing plants (target years)	The replacement approach takes into account the percentages of new and existing plants in the target years. Assumptions about the percentages of new and existing plants in the target years have to be made and are very critical for the results of the model as they can significantly affect the potential emission reduction that can be achieved in a sector by the implementation of the adopted BAT conclusions.
BAT Uptake of new and existing plants (target years)	The uptake of BATs for each pollutant and Member State must be defined for the new and existing plants in the target years in order to estimate the percentage of existing plants applying BAT and plants not applying BAT. The data should be either at sector or sub-process level as the model can perform the analysis in both cases depending on data availability. For a more detailed analysis sub-process specific BAT uptake data would be required for each Member State. If this data is not available then the model can run with sector BAT uptake in each Member State or even EU level BAT uptake in the worst case where none of the above data is available. Including BAT uptake data at EU level would limit the precision of the results obtained. The best option would be to use Member State specific BAT uptake data for each sub-process and pollutant defined. This data could be provided by industry or Member State experts (e.g. permitting authorities) that have data on of the IED sectors in their Member States.
Emission levels for existing plants applying BAT (target years)	For the existing plants applying BAT, emission levels should be assumed for the target years for each sub-process and pollutant under analysis. This data point has a significant effect on the model results. Ideally the emission levels should be defined at Member State level but if data is not available then general EU emission levels can be defined and used in the analysis. The model gives the user the following possibilities related to the existing plants emission levels: ✓ Define a specific emission level value (e.g. based on consultation with stakeholders); ✓ Define an emission level as a % under the maximum emission level associated with the use of BAT ; ✓ Define an emission level based on a specific point (lower end of the range, midpoint or upper end of the range) from emission levels associated with the use of BAT.
Emission levels for existing plants not applying BAT (target years)	For the existing plants not applying BAT, emission levels should also be assumed for the target years for each sub-process and pollutant under analysis. Assumptions should ideally be made based on consultation with the stakeholders... Ideally the emission levels assumptions should be made at Member State level but general EU emission levels can also be used. The model gives the user the following possibilities related to the emission levels: ✓ Define a specific emission level value (e.g. based on data collection from stakeholders); ✓ Define an emission level as a % over the maximum emission level associated with the use of BAT.
Emission levels for new plants (target years)	For new plants, emission levels should be assumed in the target years for each sub-process and pollutant under analysis. The assumptions can be made either by expert judgment or combined with stakeholder consultation. The model gives the user the following possibilities related to the emission levels of new plants: ✓ Define a specific emission level value (e.g. based on consultation with stakeholders); ✓ Define an emission level as a % under the maximum emission level associated with the use of BAT ; ✓ Define an emission level based on a specific point (lower end of the range, midpoint or upper end of the range) from emission levels associated with the use of BAT.

3.5 Step 4 – IED scenario

The aim of this step is to calculate the IED scenario emission projections for the target years. Under this scenario it is assumed that the IPPC Directive has been replaced by the IED. The base year emissions are projected to the target years taking into account the provisions of the IED (i.e. BAT conclusions, BAT-AELs, derogations).

As mentioned before, the model includes two calculation approaches (see Section 3.1.2) for estimation of the emission reductions through application of the BAT conclusions under the IED:

- Simple approach; and
- Replacement approach.

In the following sections, Step 4A refers to the simple approach while Step 4B refers to the replacement approach.

3.5.1 Step 4A - IED scenario (simple approach)

This step describes the simple approach for the estimation of future IED emissions without taking into account the percentage of new and existing plants in the target years.

<table>
<tr><th>Step 4A</th><th>Example Sector – Dust Emissions</th></tr>
<tr>
<td>Step 4A.1 (Input step)
BAT-AELs from BAT conclusions (adopted under the IED) need to be collected. Some BAT-AELs included in the IED BAT conclusions may be different for new and existing plants. In that case the percentages of new and existing plants calculated in Step 3B can be used in the calculations.
In the example provided it is assumed that there is one BAT-AEL for all types of plants (new and existing).</td>
<td>BAT-AELs for dust in the BAT conclusions:
<table>
<tr><th rowspan="2">Process</th><th colspan="2">BAT-AEL for dust emissions (mg/Nm^3)</th></tr>
<tr><th>Lower level</th><th>Upper level</th></tr>
<tr><td>Process A</td><td><10</td><td>20</td></tr>
<tr><td>Process B</td><td><10</td><td>20</td></tr>
<tr><td>Process C</td><td></td><td><10</td></tr>
</table>
</td>
</tr>
</table>

Step 4A	**Example Sector – Dust Emissions**

Step 4A.2 (Input step)

Definition of **future BAT uptake and derogations** for each pollutant and for each MS with the implementation of BAT conclusions **under the IED**.

Even though all plants should comply with the BAT conclusions, a number of plants will apply for derogations in order to have higher emission levels than the BAT-AELs in the BAT conclusions.

Potential derogations are calculated based on the assumed BAT uptake under the IED:

$$Percentage\ (\%) derogations = 100\% - Percentage\ (\%) BAT\ uptake$$

The model has an extra built-in functionality that can take into account a maximum percentage of plants operating under IED derogation. This functionality is intended for the cases of Member States with very low estimated BAT uptake, which with the IED is expected to increase or for cases where derogation data is not available and a general assumption has to be made. The functionality can be de-activated if the user does not provide specific values.

The assumption on the proportion of plants that will comply with the BAT conclusions and the plants under derogation is difficult to derive as data about IED derogations are not available at the moment and in many Member States the derogation process has not yet been used. The assumptions that will be included in the model should be made in consultation with the Member States and industry in order to reflect as closely as possible the expected situation in each Member State.

BAT uptake under the IED:

Process	**Dust**			
	2020		**2025**	
	Compliance with BAT conclusions	**Derogations**	**Compliance with BAT conclusions**	**Derogations**
Process A	90%	10%	95%	5%
Process B	90%	10%	95%	5%
Process C	90%	10%	95%	5%

Step 4A	**Example Sector – Dust Emissions**

Step 4A.3 (Input step)

Definition of **emission levels for plants complying with BAT conclusions** under the IED.

Based on BAT-AELs in the BAT conclusions, future emission levels have to be defined for each process for the plants that comply with the BAT conclusions. Different emission levels can be defined in case of different BAT-AELs for new and existing plants.

Where BAT is defined as more than one technology for a particular process and pollutant:

- The analysis can be broken down to different technologies if emission level and BAT uptake data is available for each Member State;
- An average sector emission level can be chosen based on information included in the BREF or other reliable source;
- Choose an emission level based on the most commonly used technology.

When specific data on sector emission levels is not available, the methodology includes the possibility to apply as the emission level:

- The lower, upper or midpoint emission level of the BAT-AELs (if expressed as a range);
- A percentage lower than the upper BAT-AEL level.

The tool also allows for flexibility in switching between the different values described above.

The assumptions about the emission levels of the plants complying with BAT are very critical for the results of the model and their reliability. The decision about the assumptions made for each sector should be made in consultation with the relevant stakeholders (i.e. Member States and industry).

Emission levels for plants that comply with BAT conclusions:

Process	**Emission levels for dust with the application of BAT conclusions (mg/Nm^3)**
Process A	12
Process B	10
Process C	5

Step 4A.4 (Input step)

Definition of **emission levels for plants under IED derogation**.

Different future emission levels have to be assumed for plants under derogation. The assumptions can be based on expert knowledge in combination with consultation with stakeholders (i.e. Member States and industry) in order to reflect as closely as possible the situation in each Member State.

Alternatively, if specific data is not available, the model provides the possibility to define the emission levels as a percentage higher compared to the upper level of the BAT-AELs.

In this specific example it is assumed that the emission levels for plants under derogation are 10% higher than the upper level of the BAT-AEL.

Emission levels for plants under derogation (10% higher than the upper level of BAT-AEL in this case:

Process	**Emission levels for dust for plants under derogation (mg/Nm^3)**
Process A	22
Process B	22
Process C	11

Step 4A — **Example Sector – Dust Emissions**

Step 4A.5 (Output step)

Calculation of **sector future emission level (SFEL) for target years**.

In this step the SFEL is calculated as weighted average of future emission levels for the various processes, BAT uptake and the percentage of plants complying with BAT conclusions or having a derogation.

For example, for Process A, this has been calculated as (based on data from steps A4.2, A4.3, A4.4):

(90% * 12 mg/Nm^3) + (10% * 22 mg/Nm^3) = 13 mg/Nm^3

$SFEL_{2020}$ has been then calculated by weighting the emission levels according to the split of emissions to different processes (see step 1.4):

(13 mg/Nm^3 * 50%) + (11.2 mg/Nm^3 * 45%) + 5.6 mg/Nm^3 * 5%).

It should be noted that the emission split as defined in Step 1 was used. The emission split is the same for new and existing plants, and also the same for the base year and the target years.

Emission levels for the sector in 2020 under the IED:

Process	**Emission levels for dust in 2020 (mg/Nm^3)**
Process A	13
Process B	11.2
Process C	5.6
Sector dust emission level ($SFEL_{2020}$)	11.82

Emission levels for the sector in 2025 under the IED:

Process	**Emission levels for dust in 2025 (mg/Nm^3)**
Process A	12.5
Process B	10.6
Process C	5.3
Sector dust emission level ($SFEL_{2025}$)	11.29

Step 4A.6 (Output step)

Calculation of the **emission level change** and calculation of the future emissions and specific emissions under the IED:

$$Sector\ emission\ level\ change = \frac{Sector\ future\ emission\ level\ (BAT\ conclusions)}{Sector\ emission\ level\ (IPPC\ Directive)}$$

The sector emission level change between the base year and the target year is then applied to the BAU future emissions calculated in Step 3A.3 in order to estimate the future emissions with application of BAT conclusions:

$$Emissions_{2020} = Sector\ emission\ level\ change * BAU\ Emissions_{2020}$$

$$Emissions_{2025} = Sector\ emission\ level\ change * BAU\ Emissions_{2025}$$

Sector dust emission level change between 2020 and base year	0.62
Sector dust emission level change between 2025 and base year	0.59

Dust emissions projections under IED:

Dust emissions 2020	8.754 Kt
Dust emissions 2025	8.500 Kt

<table>
<tr><th>Step 4A</th><th>Example Sector – Dust Emissions</th></tr>
<tr><td>Estimation of specific emissions reduction (emissions per unit of production) based on the estimated total emissions and the relevant activity data:
$$Specific\ emissions_{2010} = \frac{\mathrm{Emissions}_{2010}}{\mathrm{AC}_{2010}}$$
$$Specific\ emissions_{2020} = \frac{\mathrm{Emissions}_{2020}}{\mathrm{AC}_{2020}}$$
$$Specific\ emissions_{2025} = \frac{\mathrm{Emissions}_{2025}}{\mathrm{AC}_{2025}}$$
$$Specific\ emissions\ reduction_{2010-2020} = Specific\ emissions_{2020} - Specific\ emissions_{2010}$$
$$Specific\ emissions\ reduction_{2010-2025} = Specific\ emissions_{2025} - Specific\ emissions_{2010}$$</td>
<td>
<table>
<tr><th></th><th>2010</th><th>2020</th><th>2025</th></tr>
<tr><td>Specific dust emissions (kt emissions/Mt product)</td><td>1.599</td><td>0.992</td><td>0.948</td></tr>
<tr><td>Specific dust emissions reduction (kt emissions/Mt product)</td><td></td><td>-0.606</td><td>-0.651</td></tr>
<tr><td>Percentage change (%)</td><td></td><td>-37.9%</td><td>-40.7%</td></tr>
</table>
</td></tr>
</table>

The important parameters that require assumptions in this step and in which consultation with stakeholders should focus are:

Table 3.5 Important parameters/ assumptions for Step 4A

<table>
<tr><th>Parameter</th><th>Importance/ comments</th></tr>
<tr><td>BAT Uptake under the IED (target years)</td><td>The uptake of BATs for each pollutant and MS must be defined for the plants under the IED. The data should be either at sector or sub-process level. For a more detailed analysis sub-process specific BAT uptake data would be required for each Member State. If this data is not available then the model can run with sector BAT uptake in each Member State or even EU level BAT uptake in the worst case that none of the above data is available. Using EU level BAT uptake data would limit the precision of the results obtained. The best option would be to use Member State specific BAT uptake data for each sub-process and pollutant defined. This data could best be provided by the industry sector or Member State regulators for the sector.</td></tr>
<tr><td>Emission levels for plants applying BAT under the IED (target years)</td><td>For plants applying BAT, emission levels under the IED should be assumed for the target years for each sub-process and pollutant under analysis. Ideally the emission levels should be defined at Member State level but if data is not available then general EU emission levels can be defined and used in the analysis. The model gives the user the following possibilities related to the existing plants; emission levels:
✓ Define a specific emission level value (e.g. based on consultation with stakeholders);
✓ Define an emission level as a % <u>under</u> the upper end of the BAT-AEL ;
✓ Define an emission level based on a specific point of the BAT-AEL (lower end of the range, midpoint or upper end of the range).</td></tr>
</table>

Parameter	**Importance/ comments**
Emission levels for plants under IED derogation (target years)	For the plants under IED derogation, emission levels should also be assumed for the target years for each sub-process and pollutant under analysis. Assumptions have to be made either by expert judgement or consultation with stakeholders. Input from Member States and industry will be essential for making assumptions that would be considered representative for the sector. Ideally the emission levels assumptions should be made at Member State level but general EU emission levels can also be used. The model gives the user the following possibilities related to the emission levels: ✓ Define a specific emission level value (e.g. based on data collection from stakeholders); ✓ Define an emission level as a % over the upper end of the BAT-AEL.

3.5.2 Step 4B - IED scenario (replacement rate approach)

Step 4B	Example Sector – Dust Emissions

Step 4B.1 (Input step)

BAT-AELs from BAT conclusions (adopted under the IED) need to be collected (Similarly to step 4A.1).

BAT-AELs for dust in the BAT conclusions:

Process	**BAT-AEL for dust emissions for new and existing plants** (mg/Nm^3)	
	Lower level	**Upper level**
Process A	<10	20
Process B	<10	20
Process C		<10

Step 4B.2 (Input step)

Define the **percentage of new and existing plants in target years.**

Percentages of new and existing plants, as calculated in Step 3B.1, have been taken into account.

Percentages of new and existing plants in 2020 and 2025:

	2020	**2025**
Existing plants	85%	80%
New plants	15%	20%

Step 4B.3 (Input step)

Definition of **future BAT uptake** for each pollutant and for each MS with the implementation of BAT conclusions under the IED **(Existing plants)**.

For existing plants, the percentage of derogations has been taken into account (similarly to Step 4A.2).

The model assumes that all new plants apply BAT and comply with the BAT-AELs from the BAT conclusions.

BAT uptake for new plants under IED:

Process	**Dust**	
	2020	**2025**
Process A	100%	100%
Process B	100%	100%
Process C	100%	100%

BAT uptake for existing plants under the IED:

Process	**Dust**			
	2020		**2025**	
	Compliance with BAT conclusions	**Derogations**	**Compliance with BAT conclusions**	**Derogations**
Process A	90%	10%	95%	5%
Process B	90%	10%	95%	5%
Process C	90%	10%	95%	5%

Step 4B	**Example Sector – Dust Emissions**

Step 4B.4 (Input step)

Definition of **emission levels for plants complying with BAT conclusions** under the IED (new and existing).

Based on BAT-AELs in the BAT conclusions, future emission levels need to be defined for each process for the plants that comply with the BAT conclusions (disaggregated for new and existing plants).

Emission levels for new plants under the IED:

Process	**Emission levels for dust with the application of BAT conclusions (mg/Nm3)**
Process A	10
Process B	8
Process C	3

Emission levels for existing plants that comply with BAT conclusions under the IED:

Process	**Emission levels for dust with the application of BAT conclusions (mg/Nm^3)**
Process A	12
Process B	10
Process C	5

Step 4B.5 (Input step)

Definition of **emission levels for existing plants** under IED derogation.

Different future emission levels also need to be defined for plants under derogation. The model provides three options for defining the emission levels of the plants under derogation:

- Define that the plant will continue to operate at base year emissions level;
- Define a new emission level;
- Define the emission level as a percentage (%) higher compared to the upper level of the BAT-AELs.

Emission levels for existing plants under derogation:

Process	**Emission levels for dust for plants under derogation (mg/Nm^3)**
Process A	22
Process B	22
Process C	11

Step 4B	**Example Sector – Dust Emissions**

Step 4B.6 (Output step)

Calculation of **sector future emission level (SFEL) for target years**.

In this step the SFEL is calculated as weighted average of future emission levels for the various processes, BAT uptake, proportions of new and existing plants and proportions of plants complying with BAT conclusions or having derogation.

For example, for Process A this has been calculated as:

(85%*((90% * 12 mg/Nm^3) + (10% * 22 mg/Nm^3)))+(15%*100%*10 mg/Nm^3) = 12.55 mg/Nm^3

$SFEL_{2020}$ has been then calculated by weighting the emission levels according to the split of emissions according to different processes:

(12.55 mg/Nm^3 * 50%) + (10.72 mg/Nm^3 * 45%) + (5.21 mg/Nm^3 * 5%).

Emission levels for the sector in 2020 under the IED:

Process	**Emission levels for dust 2020 (mg/Nm3)**
Process A	12.55
Process B	10.72
Process C	5.21
Sector dust emission level (SFEL2020)	11.36

Emission levels for the sector in 2025 under the IED:

Process	**Emission levels for dust in 2025 (mg/Nm^3)**
Process A	12
Process B	10.08
Process C	4.84
Cement sector dust emission level (SFEL2025)	10.78

Step 4A.6 (Output step)

Calculation of the **emission level change** and calculation of the future emission s and specific emissions under the IED.

The SFEL (2020 and 2025) is compared with sector future BAU emission level calculated in Step 3B.8:

$$Sector\ emission\ level\ change = \frac{Sector\ future\ emission\ level\ (BAT\ conclusions)}{Sector\ future\ BAU\ emission\ level\ (IPPC\ Directive)}$$

Sector emission level change between the future BAU scenario under IPPC and the future scenario under the IED will then be applied in the BAU future emissions calculated in Step 3B.8 in order to estimate the future emissions with application of BAT conclusions:

$$Emissions_{2020} = Sector\ emission\ level\ change * BAU\ Emissions_{2020}$$

$$Emissions_{2025} = Sector\ emission\ level\ change * BAU\ Emissions_{2025}$$

Sector emission levels change:

Sector dust emission level change in 2020 between sector future emission levels under IED and sector future BAU emission level under IPPC	0.63
Sector dust emission level change in 2025 between sector future emission levels under IED and sector future BAU emission level under IPPC	0.60

Dust emissions projections under the IED:

Dust emissions 2020	8.413 Kt
Dust emissions 2025	8.118 Kt

Step 4B	**Example Sector – Dust Emissions**
Finally the specific emissions reduction (emissions per unit of production) is estimated based on the estimated total emissions and the relevant activity data: $$Specific\ emissions_{\ 2010} = \frac{\mathrm{Emissions}_{2010}}{\mathrm{AC}_{2010}}$$ $$Specific\ emissions_{\ 2020} = \frac{\mathrm{Emissions}_{2020}}{\mathrm{AC}_{2020}}$$ $$Specific\ emissions_{2025} = \frac{\mathrm{Emissions}_{2025}}{\mathrm{AC}_{2025}}$$ $$Specific\ emissions\ reduction_{2010-2020} = Specific\ emissions_{2020} - Specific\ emissions_{2010}$$ $$Specific\ emissions\ reduction_{2010-2025} = Specific\ emissions_{2025} - Specific\ emissions_{2010}$$	See table below

	2010	**2020**	**2025**
Specific dust emissions (kt emissions/Mt product)	1.599	0.954	0.905
Specific dust emissions reduction between target and base year (k emissions/Mt product)		-0.645	-0.694
Percentage change (%)		-40.3%	-43.4%

The important parameters that require assumptions in this step and in which consultation with stakeholders should focus are:

Table 3.6 Important parameters/ assumptions for Step 4A

Parameter	**Importance/ comments**
BAT Uptake under the IED for new and existing plants (target years)	The uptake of BATs for each pollutant and MS must be assumed for new and existing plants under the IED. The assumptions should be either at sector or sub-process level. For a more detailed analysis, sub-process-specific BAT uptake assumptions would be required for each Member State. If these assumptions are difficult to make then the model can run with sector-level BAT uptake data (assumptions) in each Member State or even EU level BAT uptake in the worst case that none of the above data is available. Using EU level BAT uptake assumptions would limit the precision of the results obtained. The best option would be to use Member State specific BAT uptake assumptions for each sub-process and pollutant defined.
Emission levels for existing plants applying BAT under the IED (target years)	For existing plants applying BAT, emission levels under the IED should be assumed for the target years for each sub-process and pollutant under analysis. The model gives the user the following possibilities related to the existing plants emission levels: ✓ Define a specific emission level value (e.g. based on consultation with stakeholders); ✓ Define an emission level as a % under the upper end of the BAT-AEL ; ✓ Define an emission level based on a specific point of the BAT-AEL (lower end of the range, midpoint or upper end of the range).
Emission levels for existing plants under IED derogation (target years)	For the plants under IED derogation, emission levels should also be assumed for the target years for each sub-process and pollutant under analysis. Assumptions have to be made either by expert judgement or consultation with the stakeholders.

Parameter	Importance/ comments
	Input from Member States and industry will be essential for making assumptions that would be considered representative for the sector. Ideally the emission levels assumptions should be made at Member State level but general EU emission levels can also be used. The model gives the user the following possibilities related to the emission levels: ✓ Define a specific emission level value (e.g. based on data collection from stakeholders); ✓ Define the same emission level as for existing plants not applying BAT in the BAU scenario; ✓ Define an emission level as a % over the upper end of the BAT-AEL.
Emission levels for new plants (target years)	For the new plants, emission levels should be assumed in the target years for each sub-process and pollutant under analysis. The assumptions can be made either by expert judgment or combined with stakeholder consultation. The model gives the user the following possibilities related to the emission levels of new plants: ✓ Define a specific emission level value (e.g. based on consultation with stakeholders); ✓ Define an emission level as a % under the maximum emission level associated with the use of BAT ; ✓ Define an emission level based on a specific point (lower end of the range, midpoint or upper end of the range) from emission levels associated with the use of BAT.

4. Sectoral Scoping and historical Emissions

4.1 Introduction

The model implementing the methodology presented in Section 3 has been tested under Task 3 in order to see how well it works (robustness) and if it can be applied in principal to different industrial sectors. The seven industrial sectors that had adopted BAT conclusions in the beginning of the project were used to test the robustness of the model and identify any problematic issues.

The testing of the model allowed the identification and fixing of bugs and proved its robustness. It also allowed its limitations to be identified.

The results of the testing are not presented here as the data used for the testing are not considered sufficiently accurate and a more extensive and specific data collection will be required in the future in order to run the model properly for the IED sectors.

This Section therefore presents some general observations about the testing and information on the sector scoping, and historical emissions. More observations regarding model testing are provided in Section 5.5.

The seven sectors considered in this study are:

- Glass sector.
- Iron and steel sector.
- Tanneries sector.
- Cement and lime sectors.
- Chlor-alkali sector.
- Refineries sector.
- Pulp and paper sector.

4.2 General observations on model testing

Emissions data from E-PRTR have been used in order to test the model. E-PRTR data presented some issues already identified in however, within the timeframe and the budget of this project for testing the model it was proposed and selected as the most complete data source that included emissions data for all sectors and the EU27 Member States. Other data sources suitable for specific sectors can be used in the future to run the model such as emissions data from LRTAP (for refineries), LCP emission inventories and/ or data from industry associations(e.g. for the chlor-alkali sector and tanneries). However, these data sources also might present some limitations. For each industrial sector the most reliable and comprehensive data source should be identified and selected for running the model.

4.3 Cement sector

4.3.1 Sector scoping

The first step in testing the model was the initial sector scoping. This involved the identification of key sub-processes and key pollutants for the sector, and mapping these with the available emission data from E-PRTR. Based on the information in the CLM BREF and taking into account the sub-processes with BAT-AELs in the BAT conclusions, the following key sub-processes and pollutants were considered in the testing of the model in the cement sector:

Key sub-processes

- Kiln firing;
- Cooling and milling processes; and
- Other dusty operations.

Key pollutants

Table 4.1 Overview of pollutants included in the testing

Air pollutants	Water pollutants
Dust (E-PRTR includes only data on particulate matter (PM_{10}) and this data was used in the analysis)	No key water pollutants were identified for the cement sector. Emissions to water are considered insignificant in the BREF (both IPPC and IED) and there are no BAT-AELs in the BAT conclusions.
NO_X	
SO_X	
HCl	
HF	
PCDD/F	
Hg	
Σ (Cd, Tl)	
Σ (As, Sb, Pb, Cr, Co, Cu, Mn, Ni, V)	

From all pollutants that were included in the testing, NOx, SOx and dust (as PM10) are presented in this section as they are the most important for the sector.

4.3.2 Historical emissions

In the EPER database, data are split according to similar categories as those in E-PRTR, but in some cases categories are aggregated together within EPER. This is the case for the cement sector which is included with the lime, glass, mineral substances and ceramics sectors under one category in EPER:

- 3.1/3.3/3.4//3.5 – Installations for the production of cement clinker (>500 t/day), lime (>50 t/day), glass (> 20 t/day), mineral substances (>20 t/day) or ceramic products (>75 t/day).

It was not possible to split the emissions of the aggregated EPER category based on the available data and for that reason the historical data analysis was only possible only at the EPER aggregation activity level. For the base year (2010) the relevant E-PRTR categories were aggregated in order to have all data at the same aggregation level and to allow an analysis across the EU. All historical emission data for all pollutants and all Member States for the abovementioned sectors are included in the historical emissions database.

Graphs are presented below for the main pollutants that were analysed for the cement sector (NO_X, SO_X and PM_{10}). As discussed above, the results for all pollutants that were analysed are included in the workbook with historical emissions that was submitted along with the report. The analysis is at the EU level which is more useful than the member state level for the observation of historical emissions trends.

The total NO_X, SO_X and PM_{10} emissions from the production of cement clinker, lime, glass, mineral substances and ceramic products as reported by 27 Member States for the years 2001, 2004 and 2010 are shown below in plots (a), (b) and (c) respectively of Figure 4.1. The figures also illustrate the split between emissions from the old EU-15 Member States and the new EU Member States which entered the EU from 2004 onwards. Figure 4.1 (d) shows the indexed trends of total emissions of each pollutant from the abovementioned sectors in the EU-27 over the period 2001-2004-2010, indexed to 2001 emission levels (i.e. values below 1 indicate a reduction in emissions since 2001 while values above 1 indicate an increase in emissions). The data clearly show an increase in total *reported* emissions of all pollutants between 2001 and 2004 while in 2010 a substantial decrease in all emissions can be observed[12]. Similar trends were observed for all other pollutants. It should be noted that much higher reductions in dust emissions were observed compared to NOx and SOx in the period 2004 – 2010 which may be due to the application of dust abatement techniques by the industry.

From the data it can also be observed that the EU15 Member States are the ones with the highest contribution to the total EU historical emissions. Even in 2010 when all 27 Member States have reported emissions it can be observed that the contribution of the older 15 Member States in the total EU emission is significant (i.e. 82% for NO_X, 87% for SO_X and 47% for PM_{10}).

The changes observed in total emissions through the period 2001 to 2010 may be due to a number of different reasons such as (non-exhaustive list):

- Improvement in the reporting under EPER/E-PRTR by Member States;

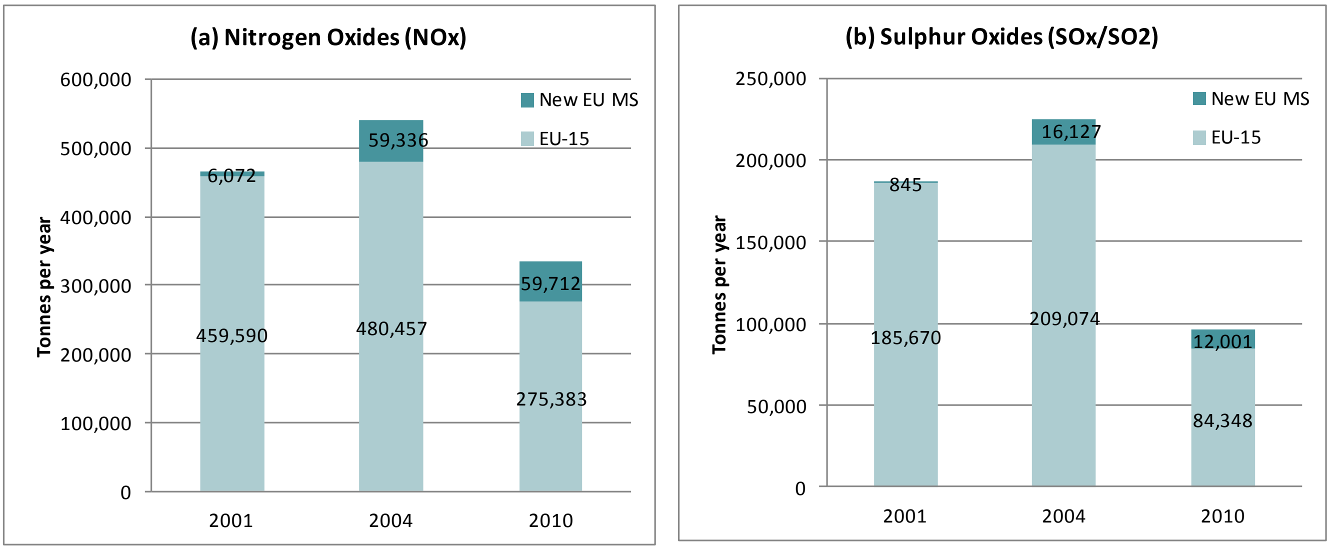
[12] By way of example, the top 10 NO_x emitters in 2004 (EPER) accounted for 54kt with emissions ranging from 4.4 to 8.1kt per installation. In 2010, the top 10 NO_x emitters (E-PRTR) accounted for 30kt, with emissions ranging from 2.6 to 3.5kt per installation.

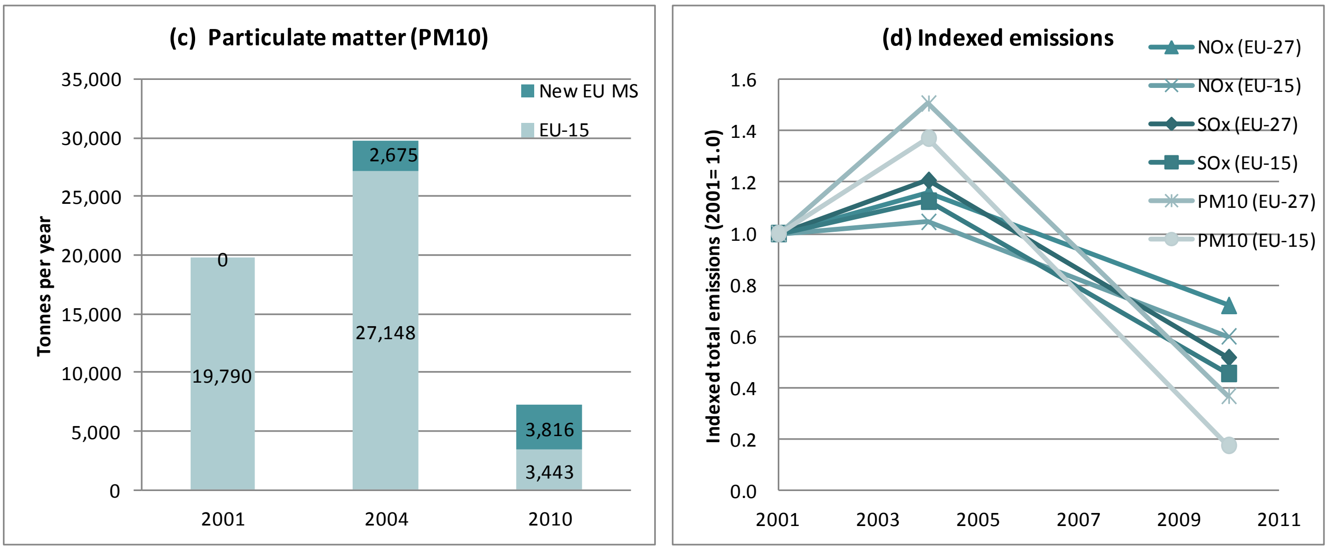
- Implementation of IPPC Directive by the Member States;
- Additional measures taken at national level;
- Changes in sector activity levels; and
- Economic crisis in Europe.

As a number of reasons are likely to have played a role in the change in total emissions it is not possible to isolate and estimate the net effect of the IPPC Directive during that period.

In the sectoral analysis, activity data from GAINS has been looked at for calculating the specific emissions of the sectors (t pollutant/Mt product). Unfortunately in the case of the aggregated sectors presented here for historical emissions, GAINS data was not available for the ceramic sector, so it was not possible to calculate the specific emissions for the aggregated category for the historical years.

Figure 4.1 (a) NO_X (b) SO_X and (c) PM_{10} emissions from EU-15 and newer EU Member States from 2001 to 2010. Plot (d) shows total emissions for each pollutant for EU-15 and EU-27 indexed to 2001 emissions





4.4 Lime sector

4.4.1 Sector scoping

The first step in the testing of the model in the lime sector was the initial sector scoping. This involved the identification of key sub-processes and key pollutants for the sector, and mapping these with the available emission data from E-PRTR. CLM BREF identifies the calcinations process (kiln firing) as the major source of air emissions (e.g. NOx, SO2, dust, CO). NOx and SO2 are mainly generated by kiln firing while channelled dust emissions can also be generated by other sources such as lime hydration, crushing, storage, grinding and handling of materials. All processes apart from kiln firing are included under one category (Dusty operations – Other than kiln firing) in the BAT conclusions for lime. Based on the information in the CLM BREF and the sub-processes identified in the BAT conclusions with BAT-AELs, the following key sub-processes and pollutants were considered in the methodology testing:

Key sub-processes

- Kiln firing.
- Dusty operations - other than kiln firing.

Key pollutants

Table 4.2 Overview of pollutants included in the testing

Air pollutants	Water pollutants
Dust (E-PRTR includes only data on particulate matter (PM_{10}) and this data was used in the analysis)	No key water pollutants were identified for the lime sector. Emissions to water are considered insignificant in the BREF (both IPPC and IED) and there are no BAT-AELs in the BAT conclusions.
NO_X	
SO_X	
CO	
TOC	
HCl	
HF	
PCDD/F	
Hg	
Σ (Cd, Tl)	
Σ (As, Sb, Pb, Cr, Co, Cu, Mn, Ni, V)	
NH_3	

4.4.2 Historical emissions

In the EPER database, data are split according to similar categories as those in E-PRTR, but in some cases categories are aggregated together within EPER. This is the case for the lime sector which is included with the cement, glass, mineral substances and ceramics sectors under one category in EPER:

- 3.1/3.3/3.4//3.5 – Installations for the production of cement clinker (>500 t/day), lime (>50 t/day), glass (> 20 t/day), mineral substances (>20 t/day) or ceramic products (>75 t/day).

It was not possible to split the emissions of the aggregated EPER category based on the available data and for that reason the historical data analysis was only possible at the EPER aggregation activity level. The historical emission analysis for this category can be found in the cement sector analysis (see Section 4.3.2).

4.5 Glass sector

4.5.1 Sector scoping

Taking into account the sub-processes with BAT-AELs in the BAT conclusions, the glass sector encompasses the manufacture of the following glass products:

- Container glass.
- Flat glass.
- Continuous filament glass fibre.
- Domestic glass.
- Special glass.
- Mineral wool.
- High temperature insulation wool.[13]
- Frits.

Key sub-processes

Based on the information in the GLS BREF (2012), the following key sub-processes were considered in the testing of the methodology in the glass sector. The sub-processes have been defined in accordance with the BAT-AELs; some of which are defined for specific pollutants (e.g. melting furnace with oxy-fuel melting is a sub-process for NO_X emissions) which explain why some sub-processes seem similar or overlapping. A distinction is made between emissions from melting activities (i.e. product forming stage) and from downstream activities (i.e. all processes after the product forming stage such as coating and binders).

Container glass manufacture:

- Melting furnace.
- Melting furnace with combustion modification.
- Melting furnace with electric melting.
- Melting furnace with oxy-fuel melting.
- Melting furnace with secondary techniques.
- Downstream processes in container glass manufacture.

Flat glass manufacture:

- Melting furnace.
- Melting furnace with combustion modifications and/ or Fenix process.
- Melting furnace with oxy-fuel melting.

[13] Note that in the 2001 BREF, this sector is referred to as 'Ceramic Fibre'

- Melting furnace with secondary techniques.
- Downstream processes in flat glass manufacture.

Continuous filament glass fibre manufacture:

- Melting furnace.
- Melting furnace with combustion modification.
- Melting furnace with oxy-fuel melting.
- Downstream processes in continuous filament glass fibre manufacture.

Domestic glass:

- Melting furnace.
- Melting furnace with combustion modification and/ or special furnace design.
- Melting furnace with electric melting.
- Melting furnace with oxy-fuel melting.
- Downstream processes in domestic glass manufacture.

Special glass:

- Melting furnace.
- Melting furnace with combustion modification.
- Melting furnace with electric melting.
- Melting furnace with oxy-fuel melting.
- Melting furnace with secondary techniques.
- Downstream processes in special glass manufacture.

Mineral wool:

- Melting furnace.
- Melting furnace for manufacture of glass wool with fuel/ air and electric furnaces.
- Melting furnace for manufacture of glass wool with oxy-fuel melting.
- Melting furnace for manufacture of stone wool (all types of furnaces).

- Melting furnace for manufacture of glass wool with gas-fired and electric furnaces.
- Melting furnace for manufacture of stone wool with gas-fired and electric furnaces.
- Melting furnace for manufacture of stone wool with cupola furnaces, no briquettes or slag recycling.
- Melting furnace for manufacture of stone wool with cupola furnaces, with cement briquettes or slag recycling.
- Downstream processes in manufacture of mineral wool.

High temperature insulation wool:

- Melting furnace.
- Downstream processes in manufacture of high temperature insulation wool.

Frit manufacture:

- Melting furnace.
- Melting furnace with oxy-fuel firing, without nitrates.
- Melting furnace with oxy-fuel firing, with use of nitrates.
- Melting furnace with fuel/ air, fuel/ oxygen-enriched air combustion, without nitrates.
- Melting furnace with fuel/ air, fuel/ oxygen-enriched air combustion, with use of nitrates.
- Downstream processes in frit manufacture process.

Key pollutants

Whilst the GLS BREF (2012) BAT conclusions include BAT-AELs for emissions from several pollutants, not all of these have been included in the testing due to limited data availability. The table below presents the pollutants to air and water selected.

It is important to note that whilst BAT-AELs are included for water pollutants, the GLS BREF states that ‘emissions to the water environment are relatively low and there are few major issues that are specific to the glass industry’ and one set of BAT-AELs has been defined for water pollutants to apply across all the categories of glass products (i.e. container glass, flat glass, domestic glass etc.).

Table 4.3 Overview of pollutants included in the testing

Air pollutants	Water pollutants
Dust (E-PRTR includes only data on particulate matter (PM_{10}) and this data	The BAT-AELs cover the following pollutants: ammonia,

Air pollutants	**Water pollutants**
was used in the testing)	arsenic, cadmium, copper, fluorides, lead, nickel, phenols and zinc. No emissions of ammonia, copper, chromium and fluorides were reported for the glass sector in the E-PRTR. **The testing thus focused on Arsenic, Cadmium, Lead, Nickel, Phenols and Zinc.**
Nitrogen oxides	
Sulphur oxides	
Carbon Monoxide	
Hydrogen chloride	
Hydrogen floride	
Sum of metals (arsenic, copper, nickel, cadmium, selenium and chromium)[14]	
Total volatile organic compounds	

4.5.2 Historical emissions

The historical emissions for the glass sector are included in the aggregated category presented in section 4.3.2.

[14] E-PRTR does not include information on emissions of selenium from glass. For emission data we summed the emission data reported for all these pollutants except selenium.

4.6 Iron and steel sector

4.6.1 Sector scoping

Based on the information in the adopted BAT conclusions and the I&S BREFs, the following key sub-processes and pollutants were considered in the testing of the methodology in the iron and steel sector:

Key sub-processes

- Sinter plant – Production (Air and water pollutants).
- Sinter plant - Sinter strand discharge, sinter crushing, cooling, screening and conveyor transfer points (Air).
- Pelletisation plant – Production (Air and water pollutants).
- Coke oven plant - Coke oven underfiring (Air).
- Coke oven plant - Coking and COG (Water).
- Blast furnace – Loading (Air).
- Blast furnace - Hot blast stove (Air).
- Blast furnace – waste water treatment (WWT) from gas treatment (Water).
- Basic oxygen furnace - Gas recovery[15] (Air).
- Basic oxygen furnace - Secondary dedusting (Air).
- Basic oxygen furnace - Continuous casting (Water).
- Electric Arc Furnace – Production[16] (Air).
- Electric Arc Furnace - Continuous casting (Water).

There are numerous sub-processes included in the adopted BAT conclusions. Not all of these processes have been included in the testing for various reasons, such as the difficulty of aggregating the emissions arising from all of them and others explained below:

[15] This refers to the BAT-AELs for dust in basic oxygen furnace (BOF) gas recovery during suppressed combustion. During oxygen blowing, converter gas is released from the converter. When suppressed combustion is applied, carbon monoxide combustion in the flue-gas duct is suppressed and the carbon monoxide can be recovered. The absence of nitrogen (given that air is excluded) means higher oxygen blowing speeds are possible and thus process time is reduced. This recovered gas contains dust and needs to be de-dusted prior to being combusted. As a result, BAT-AELs have been provisioned in the BAT conclusions for this process.

[16] The BAT-AELs for this refers to electric arc furnaces primary and secondary de-dusting (including scrap preheating, charging, melting, tapping, ladle furnace and secondary metallurgy)

- **Coke ovens (air emissions): coal grinding, storage and handling, charging systems, coke pushing, coke quenching, coke grading and handling:** All of these sub-processes have BAT-AELs only for one pollutant (dust). Some of the emissions arising from these processes are very difficult to measure (e.g. storage and handling, charging) and the emission level data is very limited. Because of this and given the fact that the IED BREF states (p. 14) that coke oven underfiring accounts for most of the emissions, the rest of the processes were not included.

- **Blast furnaces (air emissions): Casting house (tap holes, runners, torpedo ladles charging points, skimmers).** This sub-process was not included in the testing, whereas loading and hot blast stoves have been. The reasoning behind this was a better aggregation and simplification of the testing following a calculation of the proportion of dust emissions arising from loading, casting and hot blast stoves using typical emissions data from these sub-processes included in the IED BREF.

- **Basic oxygen furnaces (BOF) (air emissions): Gas recovery during oxygen blowing in full combustion, re-ladling of hot metal from the torpedo ladle to the charging ladle, hot metal pre-treatment, BOF-related processes, secondary metallurgy and continuous casting, on-site slag processing.** The BAT conclusions include BAT-AELs for dust in all these sub-processes. A category called "Gas recovery" has been chosen as being representative for this group of sub-processes and the BAT-AELs and information about "Suppressed combustion" has been considered. This has been decided because the BAT-AELs are the same for both gas recovery options, and the IED BREF states (p. 411) that there is a tendency towards gas suppression systems, mainly because of logistic advantages compared to full combustion processes. A single category for all secondary emissions has been included for a better integration in the testing.

- **Electric arc furnaces (EAF) (air emissions): On-site slag processing.** This sub-process was not included due to the limited information available to identify emission levels arising from this as well as for calculating the relative proportion of emissions within all the sub-processes present in electric arc furnaces. Furthermore, according to the IED BREF (p. 430), primary off-gases represent approximately 95% of total emissions from an EAF.

Finally, the rest of the downstream processes of the I&S sector have been excluded, as they are not included in the provisions of the BAT conclusions.

Key pollutants

As a general rule, the pollutants present in the BAT conclusions relevant to this sector have been included in the testing. However, there have been some exceptions:

- **Fe (Water):** The data on emissions of iron to water is limited, as iron is not one of the pollutants included in E-PRTR.

- **Suspended solids, COD, BOD_5, sulphides [easily released], and SCN^- (water):** E-PRTR does not consider these pollutants. The information on these is also very limited in the BREFs.

- **PAHs and phenols (Water):** The emissions of these pollutants have not been deemed relevant and have not been included in the assessment, as they were very low and only a small number of Member States had reported emissions.

- **Total HCs (Water):** It is difficult to determine what has been considered within this group and to match it with what is reported in E-PRTR (total organic carbon), which posed an insurmountable obstacle, as there was no equivalence under E-PRTR. It was decided that total hydrocarbons would not be included in the analysis.

- **Kjeldahl Nitrogen and the ∑ NH_4^+-N, NO_2^--N, NO_3^--N. (Water):** (AEL for pelletisation plants and coke ovens respectively) have been expressed as "Total N" as expressed in E-PRTR.

- The IED BAT conclusions include in some cases environmental performance levels (BAT-APLs, such as for H_2S in coke ovens) that are not BAT-AELs and have not been included in the testing. The reason for this was that the BAT-APLs are not legally binding in the same way as the BAT-AELs/ BAT Conclusions, which creates difficulties in estimation of BAT-uptake for these pollutants. When the sector analysis is properly run, more comprehensive information will be needed in order for these sub-processes and pollutants to be included in the analysis. Although the estimation of emission reductions in the model is currently built upon emission levels, performance levels could also be used for estimating the emission reduction with small modifications to the workbook.

Table 4.4 below presents the air and water pollutants that have been included in the testing:

Table 4.4 Overview of pollutants included in the testing

Air pollutants	Water pollutants
Dust (E-PRTR includes only data on particulate matter (PM_{10}) and this data was used in the testing)	Kjeldahl Nitrogen and ∑ NH_4^+-N, NO_2^--N, NO_3^--N (E-PRTR includes only data on total N and this data was used in the testing).
NO_X	CN- easily released
SO_X	Pb
Hg	Zn
PCDD/F	Ni
HF	Cr
HCl (E-PRTR includes data on chlorine and inorganic compounds expressed as HCl, and this data was used in the testing)	Σ As, Cd, Cr, Cu, Hg, Ni, Pb, Zn (For sinter plants and pelletisation plants)[17]

4.6.2 Historical emissions

In the EPER database, data are split according to similar categories as those in E-PRTR, but in some cases categories are aggregated together within EPER. This is the case for the iron and steel sector, where there is an aggregated category for the primary and secondary production of metals. This aggregation does not include coke ovens, which have a separate category in both EPER and E-PRTR. Therefore, the EPER categories included in the analysis of historical emissions have been:

[17] The sum of these heavy metals has been included as a separate pollutant as they were expressed as a sum in the BAT-AELs for sinter and pelletisation plants in the adopted BAT conclusions. However, Pb, Zn, Ni and Cr have also been included individually as they had individual AELs for some of the other processes in this sector.

- 1.3 – Coke ovens.
- 2.1/2.2/2.3/2.4/2.5/2.6 – Primary and secondary metal production or sinter plants (Other waste management) and characteristic processes in the manufacture of metals and metal product (Metal industry).

It was not possible to split the emissions of the aggregated EPER category based on the available data and for that reason the historical data analysis was possible only at the EPER aggregation activity level. Emissions from coke ovens have been added to the aggregated category for a comprehensive analysis of the sector. For the base year (2010) the relevant E-PRTR categories were aggregated in order to have all data at the same aggregation level and to allow an analysis across the EU. All historical emission data for all pollutants and all Member States for the abovementioned sectors are included in the historical emissions database.

Graphs are presented below for some of the main pollutants that were analysed for the iron and steel sector (NO_X, SO_X, and PM_{10}). HCl has also been included for comparison as it will be analysed in the sections below due to the issue with the higher BAT-AEL levels compared to IPPC EL associated with BAT commented below. The analysis is at the EU level which is more useful than the member state level for the observation of historical emissions trends.

The total NO_X, SO_X, PM_{10} and HCl emissions from the primary and secondary metal production or sinter plants; characteristic processes in the manufacture of metals and metal products; and coke ovens as reported by 27 Member States for the years 2001, 2004 and 2010 are shown below in plots (a), (b), (c) and (d) respectively of Figure 4.2. The figures also illustrate the split between emissions from the EU-15 Member States and the Member States which entered the EU from 2004 onwards. Figure 4.2 (e) and (f) show the indexed trends of total emissions of each pollutant from the abovementioned sectors in the EU-27 over the period 2001-2004-2010, indexed to 2001 emission levels (i.e. values below 1 indicate a reduction in emissions since 2001 while values above 1 indicate an increase in emissions). It is worth noting that the Member States that joined from 2004 onwards did not have the obligation to report emissions data before joining the EU (i.e. in EPER in 2001). Although some of them have submitted emissions data for this year on a voluntary basis once they joined, this has not been consistent for all these Member States, which should be taken into account when comparing reported emissions data from 2001 and the rest of the years included in this analysis. The data show different trends for the total *reported* emissions of the selected pollutants between 2001 and 2004. For NO_X, there is an increase of 12% whereas for PM_{10} the increase is more significant (37%). On the other hand, the total reported emissions of SO_X and HCl in this sector decreased slightly from 2001 to 2004. However, the trend from 2004 to 2010 shows a substantial decrease in the emissions of all pollutants[18].

From the data it can also be observed that the EU-15 Member States are the highest contributors to the total EU historical emissions. Even in 2010 when all 27 Member States have reported emissions it can be observed that the

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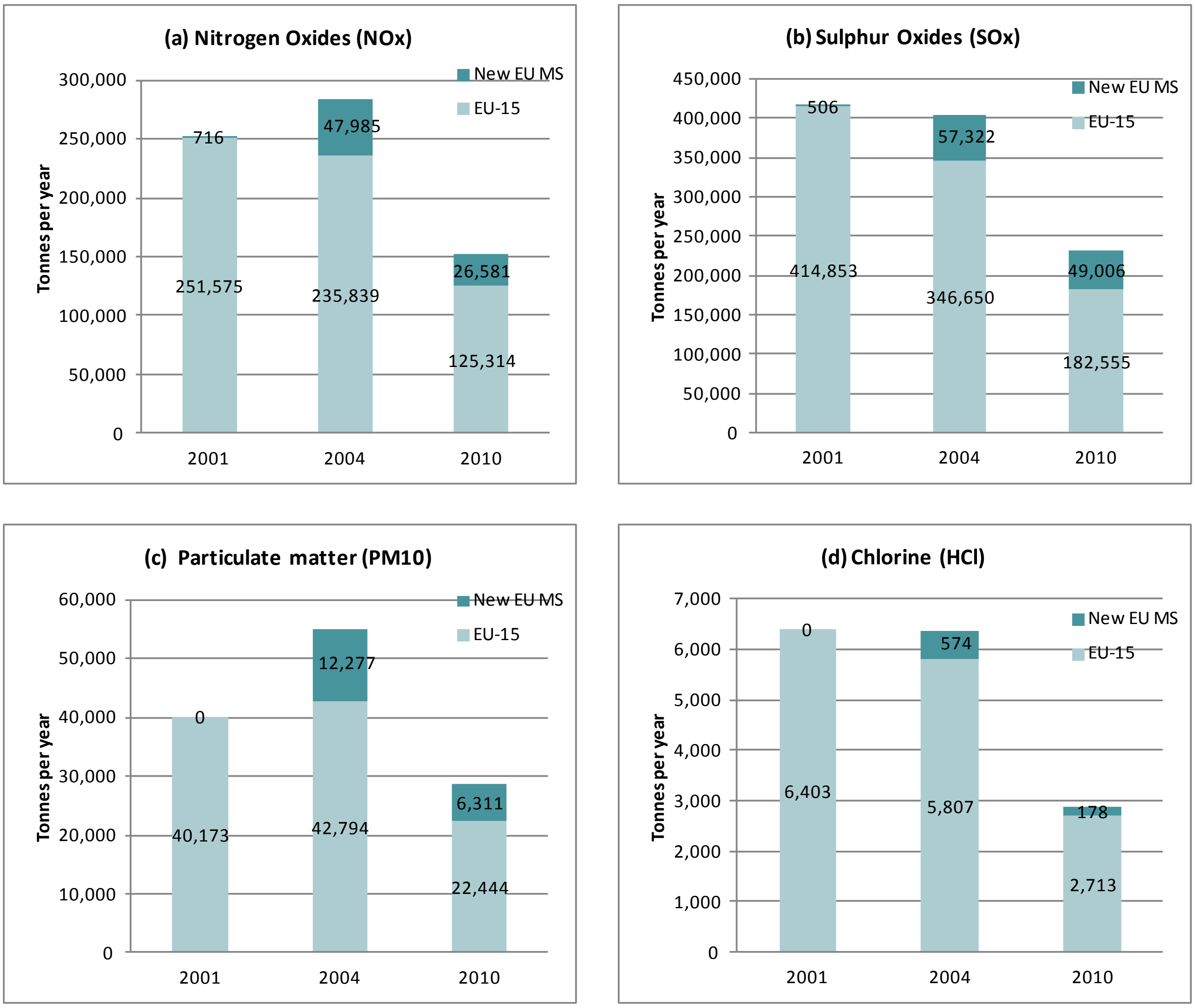
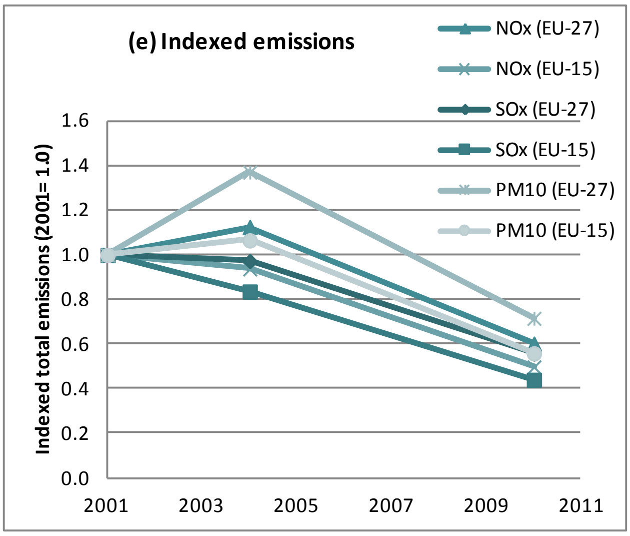
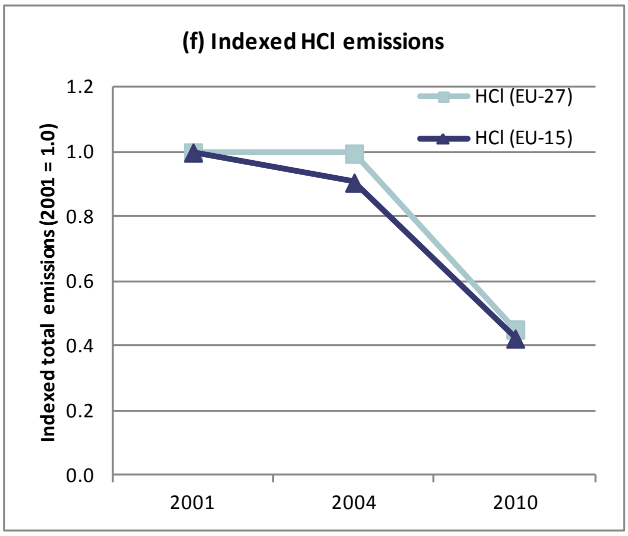
[18] This decrease may have been caused by the differences in reporting procedures in EPER and E-PRTR, which have affected the quantity of reported emissions from coke ovens. Emissions from NOx, SOx and PM_{10} differ substantially, whereas there are no emissions of HCl for this sector in E-PRTR. These emissions may have been reported under other processes given the characteristics of the integrated iron and steel works and how this is influenced by the reporting rules in E-PRTR.

contribution of the EU-15 Member States in the total EU emission is significant (i.e. 83% for NO_X, 79% for SO_X, 78% for PM_{10} and 94% for HCl).

Figure 4.2 **(a)-(d) shows Emissions from EU-15 and newer EU Member States from 2001 to 2010; (e) and (f) show total emissions for each pollutant for EU-15 and EU-27 indexed to 2001 emissions**







The general decreases of the sectoral emissions in the studied period (2001-2010) have been of 28%, 40%, 44% and 55% for PM, NOx, SOx and HCl respectively.

In the testing of the methodology, activity data from GAINS was looked at for calculating the specific emissions of the sectors (t pollutant / Mt product). Unfortunately, as it was not possible to split the data for the relevant categories in the case of the aggregated sectors presented here for historical emissions. It was not possible to use GAINS activity data for the calculation of specific emissions as they do not include all the categories included in EPER.

4.7 Tanneries sector

4.7.1 Sector scoping

The tables below present the BAT-AELs for emissions to water and air from the key processes of the tanneries sector.

Table 4.5 Key processes and emissions levels in BAT conclusions for water emissions

Pollutant	BAT-AELs (in mg/l)
For direct discharges of waste water after treatment	
COD	200-500
BOD 5	15-25
Suspended solids	<35

Pollutant	**BAT-AELs (in mg/l)**
Ammoniacal nitrogen (as N)	<10
Total chromium (as Cr)	<0.3-1
Sulphide (S)	<1
Indirect discharges of waste water from tanneries in urban waste water treatment plants	
Total chromium (as Cr)	<0.3-1
Sulphide (S)	<1

Table 4.6 Key processes and solvent use level and BAT-AELs for VOC emissions

Solvent used	**Type of production**	**BAT-associated levels (g/m^2) average values per unit of finished leather**
Water-borne coatings used in combination with an efficient application system	Upholstery and automotive leather	10-25
	Footwear, garment and leathergoods leathers	40-85
	Coated leathers (coating thickness >0.15 mm)	115-150
Extraction ventilation and abatement system used as an alternative to the use of water-borne finishing materials	VOC emissions	9-23

Based on the information in the TAN BREF and the sub-processes identified in the BAT conclusions with BAT-AELs, the following key sub-processes and pollutants were included in the testing of the model:

Key sub-processes

- Direct discharges of waste water after treatment[19].
- Finishing: Solvent based coating (air emissions) .[20]

[19] This applies to direct waste water discharges from tanneries' on-site waste water treatment plants to receiving water courses.

[20] The BREF TAN (2013) indicates that emissions of VOC are also generated from water-based coating, however it states that 'Water-based finishes exist which have low or near-zero concentrations of organic solvents.' As a result we have assumed that all the emissions of VOC are from solvent-based finishing processes.

It must be mentioned that TAN BREF also includes BAT-AELs for indirect discharges into urban waste water treatment plants but these were not included in the.

Key pollutants

The TAN BREF (2013) includes BAT-AELs for water and air emissions, several of these pollutants were excluded from the testing of the model because either E-PRTR does not cover the specific pollutants or data is not reported by the Member States[21]. Due to the limited information reported in the EPER and E-PRTR related to water emissions, in combination with the limited water pollutants that have BAT-AELs in the TAN BREF, the selection of pollutants was restricted and only chromium was included in the testing of the model. BAT-AELs also exist for COD, BOD_5, suspended solids, ammoniacal nitrogen and sulphide (as S). For air emissions the TAN BREF only includes a BAT-AEL for VOC emissions. The pollutants selected for the testing of the model are:

- Air pollutants: VOC[22].
- Water pollutants: Chromium.

4.7.2 Historical emissions

In the EPER database, emissions data from the tanning of hides and skins is reported under category 6.3: Plants for tanning of hides and skins over 12 tonnes per day.

Data is reported for air emissions of VOC[23], however this data is reported by only two Member States: Italy in 2001, 2004 and 2010 and France in 2004. The total VOC emissions are presented in the table below for 2001 and 2010. The information presented should not be considered to be realistic or representative of the sector due to limited data on emissions reported in the EPER and E-PRTR.

Table 4.7 VOC emissions 2001, 2004 and 2010 (tonnes per year)

	2001	2004	2010
EU	396	496	443
FR	-	101	-
IT	396	395	443

[21] For air, emissions from dust were not included in the analysis because no Member States have reported emissions from tanneries. For water emissions the following pollutants were excluded as they are either not covered by E-PRTR or no emissions were reported from tanneries: COD, BOD, suspended solids, ammoniacal nitrogen and sulphide.

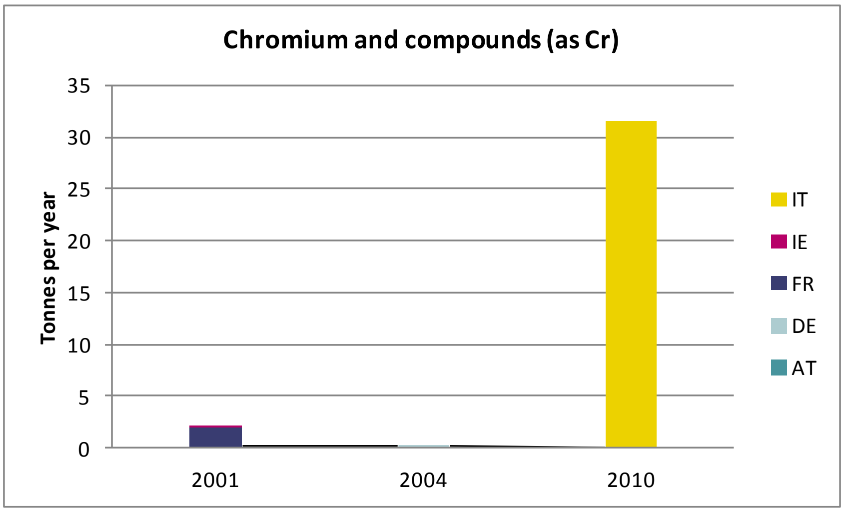
[22] The E-PRTR reports emissions of NMVOC that were used for this sector's analysis.

[23] Reported data in E-PRTR are emissions of NMVOC

For water emissions, historical emissions of chromium are presented in the figure below. Direct emissions were reported by 3 Member States in 2001 (Austria, France and Ireland), 2 Member States in 2004 (Austria, France and Germany) and 2 Member States in 2010 (Germany and Italy).

The chart below presents the emissions of chromium to water from tanneries. It shows that between 2001 and 2004, the total reported emissions of chromium have decreased significantly. However, the emissions reported have increased between 2004 and 2010. This is due to the reporting of emissions from Italy in 2010, which did not reported emissions in 2001 or 2004. The TAN BREF indicates that in 2007, Italy generated 60% of the production with around 1,400 tanneries installations. The BREF also indicates that since 2000, the activity has been slowing down with installations closing down especially in Germany and in the UK but also in Italy. As a result, the increase of emissions between 2004 and 2010 is considered to be an increase of reported emissions but not an actual increase of emissions due to the sectors' activity.

Figure 4.3 Emissions of chromium to water from tanneries between 2001 and 2010



For both emissions of VOC to air and chromium to water, the number of tanneries reporting data in EPER and E-PRTR is very limited. Furthermore the installations reporting emissions are not the same for the different years (maybe due to the reporting thresholds of E-PRTR). For these reasons, the historical trends presented cannot be considered as providing a realistic picture of the situation for the tanneries sector. To fill these gaps and get a more realistic representation of the tanneries sector better data are required. One possible source of data would be through interaction with tanneries industry representatives and a bespoke data collection exercise (e.g. Euroleather, COTANCE).

In the testing of the model, activity data from GAINS were looked up and used to calculate the specific emissions of the sectors (t pollutant/Mt product). Unfortunately, GAINS activity data is not available for the tanneries sector, so it was not possible to calculate the specific emissions for the historical years.

4.8 Chlor-alkali sector

4.8.1 Sector scoping

The first step in the testing of the model in the sector was the sector scoping. This involved the identification of key sub-processes and key pollutants for the sector, and mapping these with the available emission data from E-PRTR. For the purposes of the testing, the main types of chlor-alkali production plants have been identified, along with the key sub-processes that lead to air and water pollution in each of them. Based on the information in the BREF and the sub-processes identified in the BAT conclusions with BAT-AELs, the following key sub-processes and pollutants were considered in the testing of the model in the chlor alkali sector:

Key types of chlor alkali production plants and sub-processes

- Membrane plants - Processing of chlorine (Air emissions).
- Membrane plants - Chlor alkali production (Water emissions).
- Mercury plants - Processing of chlorine (Air emissions).
- Mercury plants - Chlor alkali production (Water emissions).
- Other plants (including diaphragm cell plants and other techniques) - Processing of chlorine (Air emissions).
- Other plants (including diaphragm cell plants and other techniques) - Chlor alkali production (Water emissions).

Key pollutants

Table 4.8 Overview of key pollutants included in the testing

Air pollutants	Water pollutants
Chlorine and chlorine dioxide (E-PRTR includes only data on "Chlorine and inorganic compounds (as HCl)" and this data was used in the testing)	Free chlorine (E-PRTR includes only data on "Chlorides (as total Cl)" and this data was used in the testing)
	Additionally Hg is included in the testing as it is a significant pollutant which had emissions in 2010. However, Hg emissions from chlor-alkali production are expected to cease in 2020 and 2025 with the decommissioning of mercury cell plants.

Even though mercury emissions to air are perhaps the most important pollutant issue for the sector, since the BAT conclusions state that the mercury cell technique cannot be considered BAT under any circumstances it is considered that mercury emissions to air will be eliminated before 2020 as the mercury plants will have to close or be converted to another technology. Additionally, the IPPC BREF and the current BAT conclusions do not include BAT-AELs about mercury emissions to air so the specific pollutant was not included in the testing.

Finally it should be mentioned that the BREF does not include BAT-AELs for any other pollutants and thus only this limited number of pollutants was included in the testing of the model. No other pollutants were included in the testing because the BAT conclusions do not include BAT-AELs for any other pollutants. The BAT conclusion include BAT-AELs for chlorine and chlorides and then for mercury when decommissioning plants. Furthermore, while the EPER data include emissions from other pollutants, these include indiscriminately several inorganic chemical sector, including fertilisers.

4.8.2 Historical emissions

In the EPER database, data are split according to similar categories as those in E-PRTR, but in some cases categories are aggregated together within EPER. This is the case for the chlor-alkali sector, which is included within one EPER category that refers to the whole inorganic chemicals and fertilisers production sector:

- 4.2/4.3 - Production of inorganic chemicals and production of P-, N-, K-based fertilisers.

It was not possible to split the emissions of the aggregated EPER category based on the available data and for that reason the historical data analysis was only possible only at the EPER aggregation activity level. For the base year (2010) the relevant E-PRTR categories were aggregated in order to have all data at the same aggregation level and to allow an analysis across the EU. All historical emission data for all pollutants and all Member States for the abovementioned sectors are therefore included in the historical emissions database.

Graphs are presented below for the three pollutants that were analysed for the chlor alkali sector. E-PRTR includes data on "Chlorine and inorganic compounds (as HCl)" for emissions to air and "Chlorides (as total Cl)" for emissions to water. This data were used in the analysis. The analysis is at the EU level which is more useful than the member state level for the observation of historical emissions trends.

The chlorine (Air), chlorides (Water), and Hg (Water) emissions from the production of inorganic chemicals and of P-, N-, K-based fertilisers as reported by 27 Member States for the years 2001, 2004 and 2010 are shown below in plots (a), (b) and (c) respectively of Figure 4.4. The figures also illustrate the split between emissions from the old EU-15 Member States and the new EU Member States which entered the EU from 2004 onwards.

Figure 4.4 (d) shows the indexed trends of total emissions of each pollutant from the abovementioned sectors in the EU-27 over the period 2001-2004-2010, indexed to 2001 emission levels (i.e. values below 1 indicate a reduction in emissions since 2001 while values above 1 indicate an increase in emissions). The data clearly show different trends for the pollutants released to air and to those released to water. For chlorine released to air, the data show a decrease of almost 30% in total reported emissions from 2001 to 2004[24]; and an increase up to values similar to those of 2001 from 2004 to 2010. On the other hand, there is a substantial increase of emissions of water pollutants

[24] The observed decrease might be due either to a real reduction in emissions or a reporting/data issue. We do not have sufficient information to determine which applies.

from 2001 to 2004 (45% and 144% increases for chlorides and Hg respectively). Then, emissions decrease from 2004 to 2010 (13% and 63% for chlorides and Hg respectively). For Hg emissions the increase between 2001 and 2004 is due to the reporting of the new EU MS.

From the data it can be observed that the EU-15 Member States are the main contributors to the total EU historical emissions of chlorine and chlorides. This is particularly relevant in the case of chlorine released in air, as the EU-15 Member States accounted for all the reported emissions in 2010.

It is important to note that while the EPER data include emissions from other pollutants (including ammonia, SOx and NOx), this is because the reporting category under the EPER includes the whole inorganic chemical sector, including fertilisers. The chlor-alkali BAT conclusions, include BAT-AELs only for chlorine and chlorides and additionally for Hg emissions from decommissioning of mercury cell plants. For that reason only these pollutants were included in the analysis.

In the sectoral analysis, activity data from GAINS were looked up and used to calculate the specific emissions of the sectors (t pollutant/Mt product). Activity data for the inorganic chemicals sector from GAINS are only available for the following sub-sectors: "Chlorine and caustic soda production by electrolysis using mercury cells"; "Industrial Process: Nitric acid"; and "Industrial Process: Sulphuric acid". These categories do not represent the whole inorganic chemicals sector so using them to calculate specific emissions would be inaccurate. As a result, no specific emissions have been calculated for the historical emissions arising from the sector.

Figure 4.4 (a) Chlorine (Air) (b) Chlorides (Water) and (c) Mercury (Hg) emissions from EU-15 and newer EU Member States from 2001 to 2010. Plot (d) shows total emissions for each pollutant for EU-15 and EU-27 indexed to 2001 emissions

4.9 Refineries sector

4.9.1 Sector scoping

Based on the information in the REF IED BREF (2013) [25] and taking into account the sub-processes with BAT-AELs in the BAT conclusions, the following key sub-processes and pollutants were considered in the testing of the model in the refinery sector. The sub-processes have been defined in accordance with the BAT-AELs. The full list of key sub-processes used in the analysis is presented below. It should be mentioned that some sub-processes (e.g. sulphur recovery units) were not included in the testing as the BAT conclusions do not contain BAT-AELs but BAT associated performance levels which are not binding in the same way as the BAT-AELs. Since they are not binding for the industry, this creates problems related to the assumed BAT uptake in the IED scenario. In the future when the sector analysis is properly run, appropriate data for those sub-sectors need to be collected and included in the model. Although the estimation of emission reduction in the model is currently built upon emission levels, performance levels could also be used for estimating the emission reduction with small modifications to the workbook.

Key sub-processes

Fluid catalytic cracking:

- Full combustion mode (NO_X, SO_X, PM).
- Partial combustion mode (NO_X, SO_X, PM, CO).

Coking processes (PM)

Combustion units:

- Gas turbines including CCGT and IGCC (NO_X);
- Gas firing units except gas turbines (NO_X);
- Multi fuel firing units except gas turbines (NO_X, PM);
- Refinery Fuel Gas (RFG) firing units except gas turbines (SO_X);
- Multi fuel firing units except gas turbines and stationary gas engines (SO_X); and
- All combustion units (CO)[26].

[25] European Commission, Joint Research Centre, “Best Available Techniques Reference (BAT) Document for the Refining of Mineral Oil and Gas (Final Draft)”, 2013,

[26] In the workbook analysis is mentioned as combustion processes

Waste gas treatment (NH_3)

Waste water treatment (N, Pb, Cd, Ni, Hg,)

Storage and handling (NMVOC)

Key pollutants

Air pollutants	Water pollutants
Dust (E-PRTR includes only data on particulate matter (PM_{10}) and this data was used in the testing)	N
NO_X	Heavy metals: N, Pb, Cd, Ni, Hg
SO_X	
NH_3	
CO	
NMVOC	

4.9.2 Historical emissions

The EPER database contains data on historical emissions for the refinery sector, with activity 7 within EPER corresponding to the sector. Within E-PRTR the relevant category is 1 (a). These two data sources were proposed and agreed with the Commission to be used for Task 1 in order to examine the trends in historical emissions. For specific sectors such as the refineries sector there might be more complete and comprehensive data sources (such as LRTAP or NEC) for that sector. The aim in this project was to develop and test the methodology. .

From all pollutants that were included in the testing, NOx, SOx, and PM10 historical emissions to air and historical emissions of mercury to water are presented in this section as they are the most important for the sector.

Total emissions

Graphs are presented below for the main pollutants which were analysed for the refinery sector. These include NO_X, SO_X and PM_{10} emissions to air and Mercury (Hg) to water. The analysis is at the EU level which is more useful than the Member State level for the observation of historical emissions trends, given the quality of the historical data (data is not available for all countries).

For **air pollutants**, the total NO_X, SO_X and PM_{10} emissions from the refinery sector as reported by 27 Member States (no data available for Croatia) for the years 2001, 2004 and 2010 are shown below in plots (a), (b) and (c) respectively of Figure 4.5. The figures also illustrate the split between emissions from the old EU15 Member States and the newer EU12 Member States which entered the EU from 2004 onwards.

Figure 4.5 (d) shows the trends of total emissions of each pollutant from the abovementioned sectors in the EU27 over the period 2001-2004-2010, indexed to 2001 emission levels (i.e. values below 1 indicate a reduction in emissions since 2001 while values above 1 indicate an increase in emissions).

For SO_X and PM the data shows a decreasing trend between 2001 and 2004, and again between 2004 and 2010. For NO_X, there is a slight increase in reported emissions between 2001 and 2004, and a decrease between 2004 and 2010. Activity data for these years shows a slight increase in sector activity in 2004 compared to 2001, and a decrease in 2010 (with 2010 and 2001 activity data broadly similar). Activity data in the analysis takes into account the fact that the EU12 countries did not report emissions data until 2004, and in some cases until 2010 (2010 is the first year for which activity data is based on the EU 27 Member States).

The changes observed in total emissions in the period 2001 to 2010 may be due to a number of different reasons such as (non-exhaustive list):

- Improvement in the reporting under EPER/E-PRTR by Member States;
- Implementation of IPPC Directive by the Member States;
- Additional measures taken at national level;
- Changes in sector activity levels; and
- The economic crisis in Europe.

As many reasons play a role in the change in total emissions it is not possible to estimate the net effect of the IPPC Directive during that period.

From the data it can also be observed that the EU15 Member States provide the highest contribution to total EU historical emissions for NO_X, SO_X and PM in 2010 (the first year for which all 27 Member States submitted emissions data). The production capacity of the new EU Member States represents 11-16%[27] of total EU production in the 2001-2010 period. Specifically in 2010 when all Member States reported data for the E-PRTR and when the IPPC Directive was already implemented, the production capacity of the new Member States represented 12% of the total EU production capacity while the reported PM, NOx and SOx emissions represented 37%, 29% and 31% of the total EU emissions respectively. This is a possible indication of better environmental performance of installations in the EU15 Member States compared to the new EU Member States and show a potential for total EU emission reduction in the future if their environmental performance is improved.

For **water pollutants**, emissions of Mercury are shown in plot (a) of Figure 4.6, in which plot (b) shows indexed emissions of Mercury. Total emissions of Mercury decreased between 2001 and 2004, and increased in 2010 (to levels above those of 2001). It can also be seen from the graph that there are no reported emissions from EU12 Member States (which joined the EU in 2004) for Mercury until 2010, at which point they account for a third of total Mercury emissions.

[27] Calculated based on GAINS activity data.

Figure 4.5 (a) NO_X (b) SO_X and (c) PM_{10} emissions from EU-15 and newer EU Member States from 2001 to 2010. Plot (d) shows total emissions for each pollutant for EU-15 and EU-27 indexed to 2001 emissions

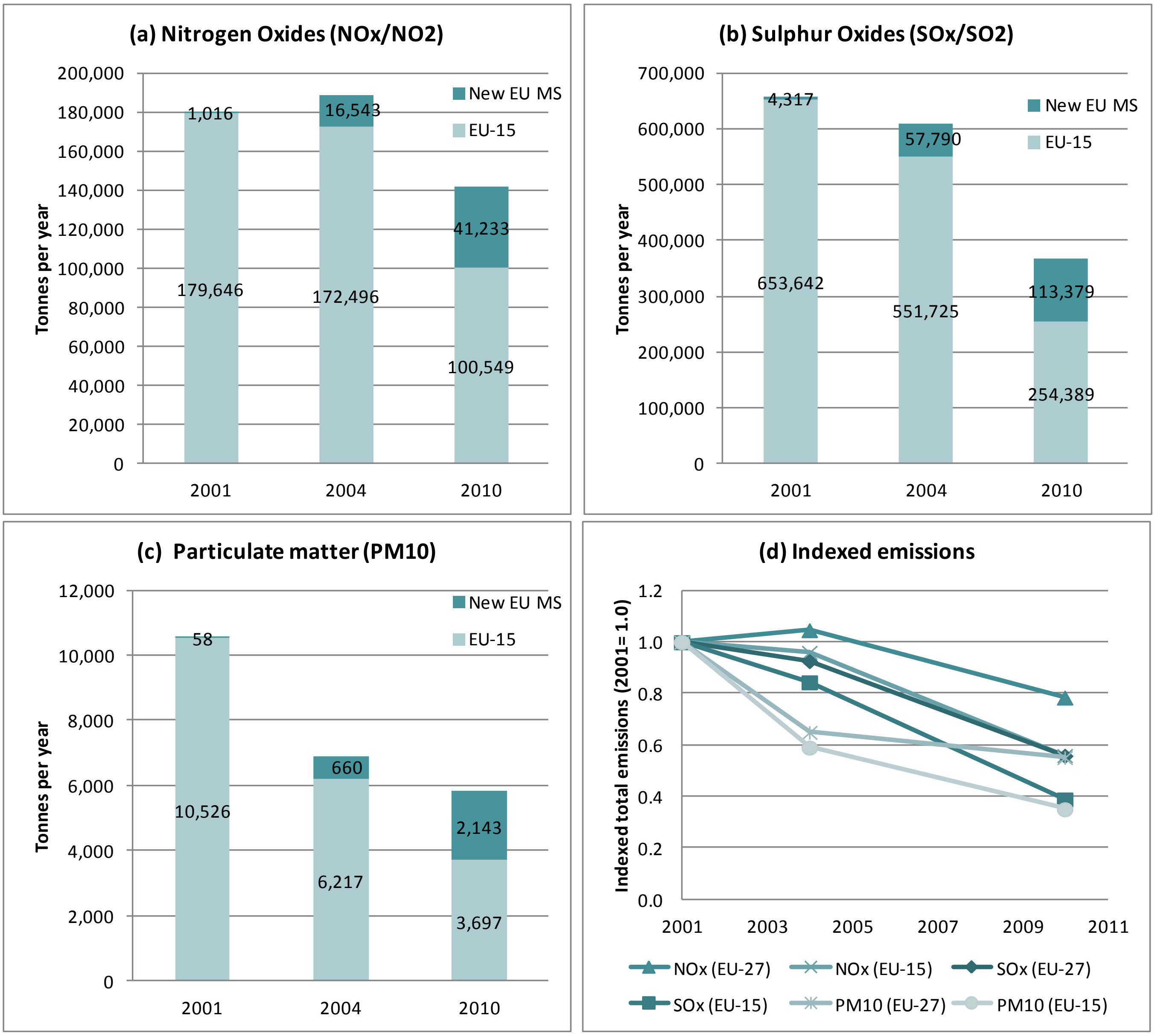
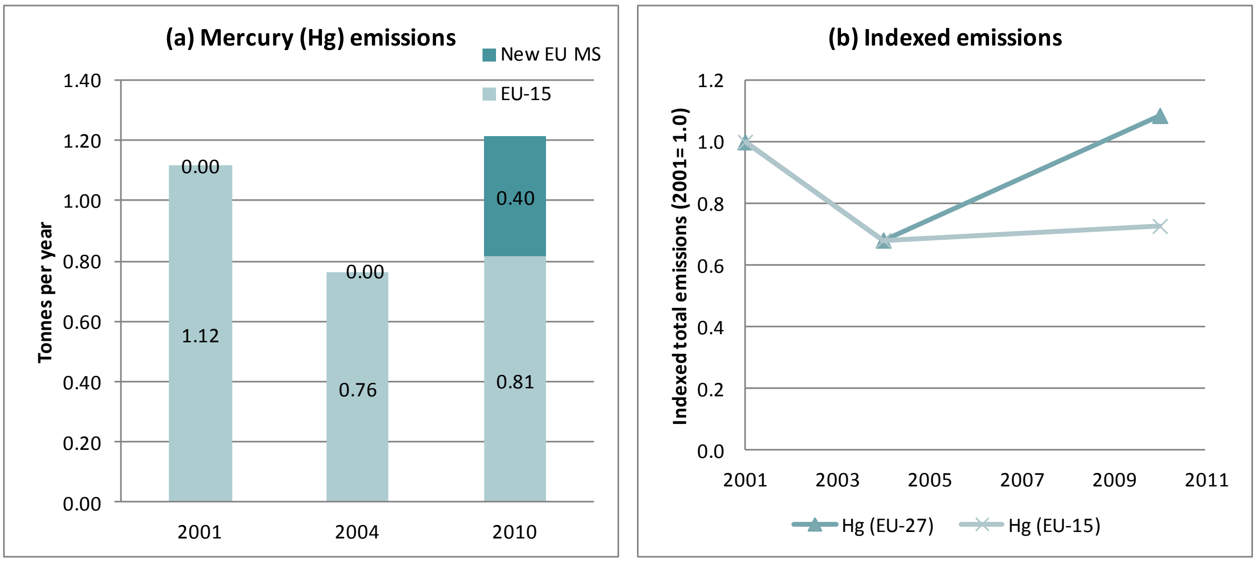


Figure 4.6 **(a) Emissions of Mercury (Hg), (b) total emissions for Mercury (Hg) pollutant for EU15 and EU27 indexed to 2001 emissions**



Specific emissions

In the sectoral analysis, activity data from GAINS (for the years 2000 up to 2030, with 5 year intervals) have been used to calculate the specific emissions of the sectors (t pollutant/Mt crude oil and other products - input to refineries). Since activity data from GAINS is available for 2000 and 2005, in order to calculate specific emissions for 2001 and 2004, linear interpolation has been used in order to achieve an estimate of the sector activity in 2001 and 2004.

Figure 4.7 below shows historical specific emissions for NO_X, SO_X and PM_{10} emissions to air (plots a, b, c), and the indexed specific emissions (plot d, indexed to 2001).

For water pollutants, Figure 4.8 shows specific emissions of Mercury (plot a) and indexed specific emissions of Mercury (plot b), indexed to 2001.

Specific emissions of SO_X and PM decrease between 2001 and 2004, and again between 2004 and 2010, more significantly for PM emissions. Specific emissions of NO_X show a small increase in 2004 compared to 2001, and a decrease in 2010. The decrease of specific emissions between 2001 and 2010 shows an improvement of the environmental performance of refineries which may be due to the installation and use of abatement techniques in the refineries associated with the implementation of the IPPC directive[28].

Specific emissions of mercury show a decrease between 2001 and 2004, and an increase between 2004 and 2010.

[28] Progress made in reducing emissions from refineries was shown in a previous study: Assessment of the implementation of the IPPC directive, final report for the European Commission DG Environment, Entec UK Limited (now Amec Foster Wheeler), ARCADIS and REC, February 2010

Figure 4.7 Specific emissions for (a) NO_X, (b) SO_X, (c)PM_{10}, for the EU-27. Plot (d) shows indexed specific emission, indexed to 2001 emissions

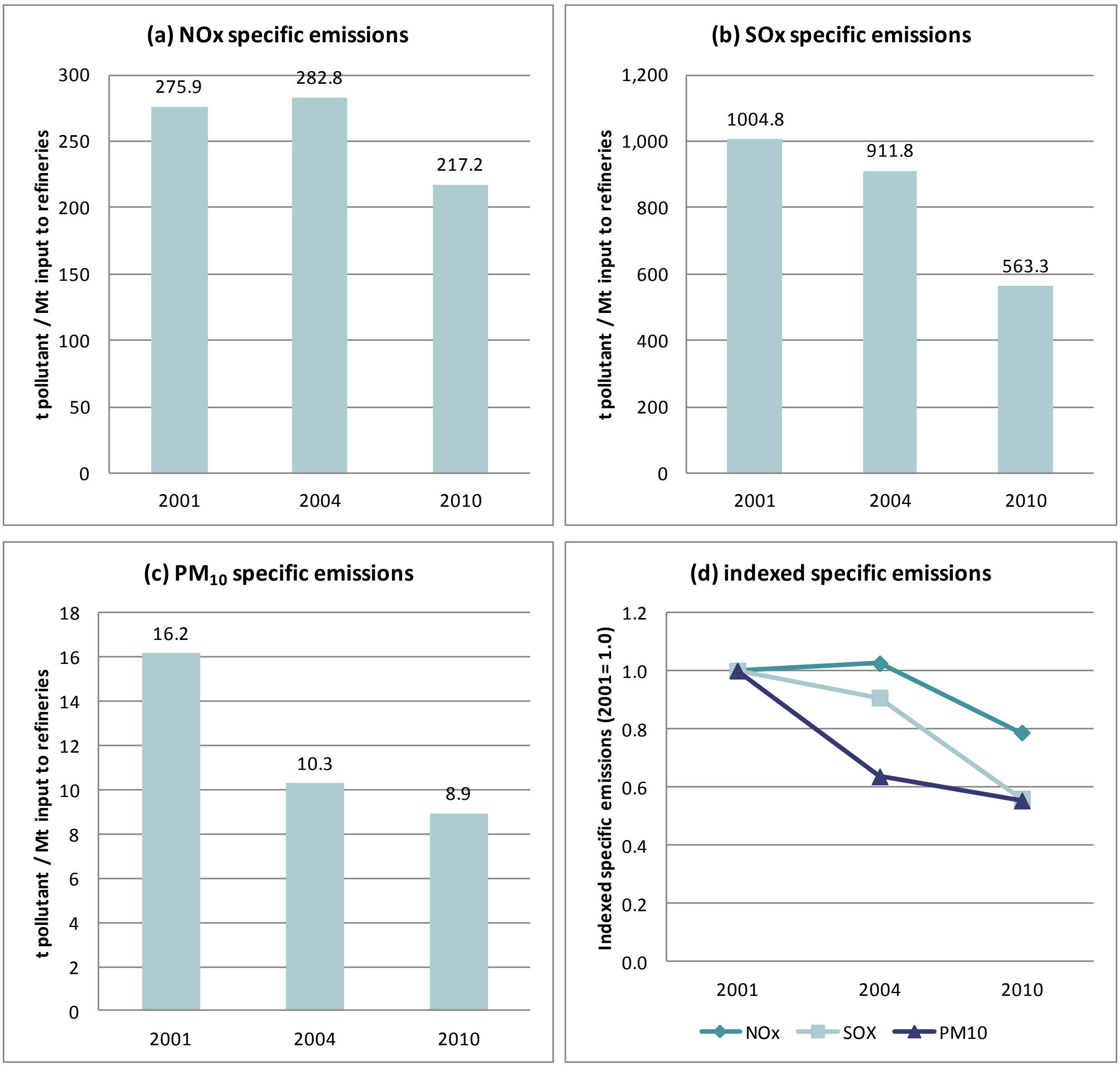
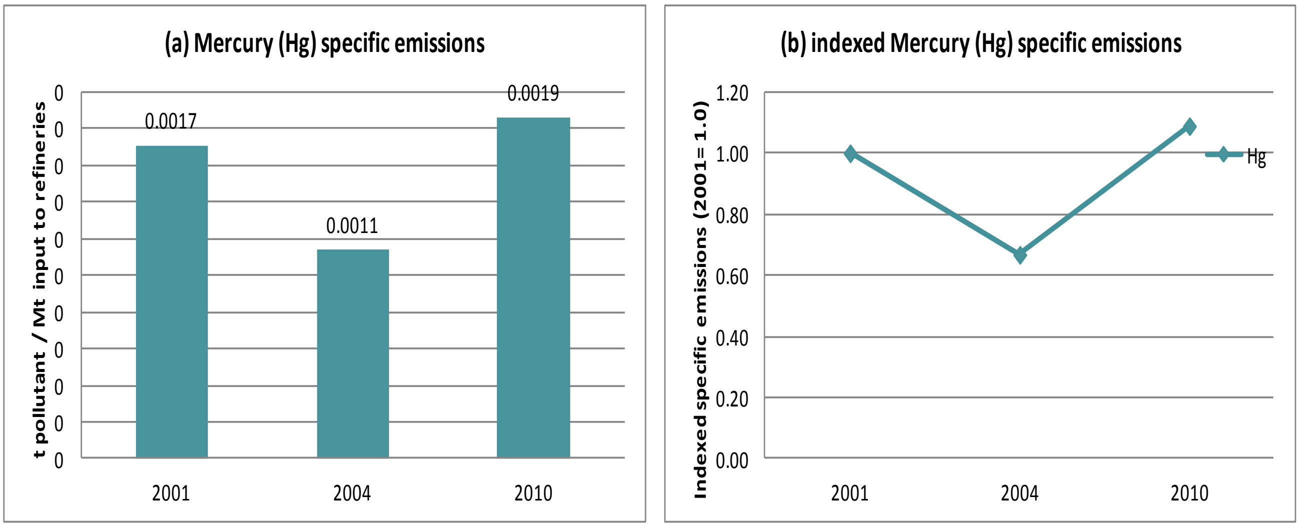


Figure 4.8 Specific emissions of (a) Mercury (Hg), and (b) specific emissions of Mercury (Hg) indexed to 2001 emissions



4.10 Pulp and paper sector

4.10.1 Sector scoping

Based on the information in the PP BREF (2013), the following key sub-processes and pollutants were considered in the testing of the model in the pulp and paper sector. The sub-processes have been defined in accordance with the draft BAT conclusions and the pollutants that include BAT-AELs.

Key sub-processes

For some processes the PP BREF (2013) identified a number of sub-processes, however there was not readily available data to carry out the testing at that level of disaggregation. In these cases we have carried out the testing at the higher sub-process level. This occurred in the following instances:

- Kraft pulp: The PP BAT conclusions distinguish between Bleached and Unbleached Kraft mill. One category was used in the testing due to lack of data on the split emissions (a common issue throughout the testing of the model). The BAT-AELs for Bleached Kraft mill have been used in the testing as it is the more conservative of the two BAT-AELs.

- Sulphite pulp: For emissions to water, the PP BAT conclusions distinguish between three types of sulphite pulping sub-process: bleached sulphite paper grade pulp production, magnefite pulping, and NSSC pulp production. Due to lack of available data only one category was included in the testing, for which the BAT-AEL for Bleached sulphite paper grade pulp production was used. The BAT-AELs for the three different types of sulphite pulp are broadly comparable with small differences.

- Mechanical and chemimechanical pulp: The PP BAT conclusions differentiates mechanical and chemimechanical pulping into two sub-sectors for the purposes of water pollutants: (a) integrated production of paper and board, and (b) CTMP and CMP pulp mills. Due to a lack of available data only one category was used in the testing, for which the BAT-AELs for Mechanical pulping integrated production were used (BAT-AELs for Total N and Total P that are included in the testing of the model for the two types of mills are broadly comparable).

- Processing of paper for recycling: The PP conclusions split the Processing paper for recycling sector into two sub-sectors: (a) without deinking, (b) with deinking. Additionally specific BAT-AELs for emissions from tissue paper mills were identified for three pollutants only (Total suspended solids, Total Phosphorus and Total Nitrogen). Due to a lack of available data to split the emissions it was not possible to carry out the testing of the model at this level of disaggregation, therefore one category was included. The BAT-AELs for processing paper for recycling with deinking were used in the testing of the model. BAT-AELs for the three subsectors were broadly comparable for Total N and Total P that were included.

- Papermaking: The PP BAT conclusions split the Papermaking sector into three sub-sectors: (a) non-integrated paper mills (Excluding speciality), (b) non-integrated paper mills. A separate BAT-AEL for emissions of from tissue paper production (for Total Nitrogen only) was also identified. Due to a lack of available data in order to split emissions it was not possible to carry out the testing of the model at this level of disaggregation. One category for Papermaking was included and the BAT-AELs for non-integrated paper mills (excluding specialty) were used.

The issues mentioned above highlight that an appropriate emission split and a reliable database are crucial for the modelling of the sectors.

The list of key sub-processes used in the testing of the model is as follows:

<u>For Kraft pulping:</u>

- Bleached Kraft mills.
- Dedicated TRS (Total Reduced Sulphur) burners.
- Lime kilns.
- Recovery boilers.

<u>For Sulphite pulping:</u>

- Production of Bleached sulphite paper grade pulp.
- Recovery boilers.

<u>For Mechanical and Chemimechanical Pulping:</u>

- Mechanical Pulping – integrated production.

<u>For processing paper for recycling:</u>

- Processing paper for recycling – with de inking.

Papermaking and related processes:

- Papermaking and related processes – non-integrated paper mills.

Key pollutants

From the pollutants that have BAT-AELs in the BAT conclusions gaseous Sulphur (air), COD (water) and TSS (water) were excluded from the testing due to lack of available emission data in E-PRTR. The pollutants included in the testing of the model are:

Air pollutants	Water pollutants
Dust (E-PRTR includes only data on particulate matter (PM_{10}) and this data was used in the testing)	Total Phosphorus (Total P)
NO_2	Total Nitrogen (Total N)
SO_2	Absorbable Organic Halides (AOX)
NH_3	

4.10.2 Historical emissions

The EPER database contains data on historical emissions (2001 and 2004) for the pulp and paper sector, which within EPER is:

- Activity 31: Manufacture of pulp and paper products (whole group).

For the base year (2010) the relevant E-PRTR categories were aggregated in order to have all data at the same aggregation level and to allow an analysis across the EU. All historical emission data for all pollutants and all Member States for the abovementioned sectors are included in the historical emissions database.

Under E-PRTR pulp and paper is split into two activities:

- 6.1.a Production of pulp from timber and other fibrous materials.
- 6.1.b production of paper, cardboard and wood-based panels.

In order to obtain data for the pulp and paper sector, values for the production of wood-based panels were removed from the 6.1.b data, and the remaining values added to the values for production of pulp (6.1.a).

Total emissions

Graphs are presented below for the main pollutants which were analysed for the pulp and paper sector (NO_X, SO_X and PM_{10} emissions to air, and Total Phosphorus and Total Nitrogen emissions to water). The analysis is at the EU level which is more useful than the member state level for the observation of historical emissions trends.

For **air pollutants**, the total NO_X, SO_X and PM_{10} emissions from the production of pulp and paper as reported by 27 Member States (no data available for Croatia) for the years 2001, 2004 and 2010 are shown below in plots (a), (b) and (c) respectively of Figure 4.9. The figures also illustrate the split between emissions from the old EU15 Member States and the newer EU12 Member States which entered the EU from 2004 onwards.

Figure 4.9 (d) shows the indexed trends of total emissions of each pollutant from the abovementioned sectors in the EU27 over the period 2001-2004-2010, indexed to 2001 emission levels (i.e. values below 1 indicate a reduction in emissions since 2001 while values above 1 indicate an increase in emissions). The data clearly show an increase in total *reported* emissions of NO_X (5% increase) and PM_{10} (22% increase) pollutants between 2001 and 2004, while in 2010 a substantial decrease in these emissions can be observed with a 21% decrease of emissions of NOx reported and 70% less emissions of PM10 reported. Emissions of SO_X decreased slightly between 2001 and 2004 (9%), and more significantly between 2004 and 2010 (59% less emissions reported in 2010 than in 2004). From the data it can also be observed that the EU15 Member States are the countries with the highest contribution to the total EU historical emissions.

Emissions of **pollutants to water** (Total N and total P) are show in plots (a) and (b) of Figure 4.10 respectively. These figures also illustrate the split between emissions from the old EU15 Member States and the new EU Member States which entered the EU from 2004 onwards. Emissions data reported vary significantly between Member States and also within the reporting period. However, for nitrogen emissions, the top emitters are consistent in 2001 and in 2010 with Sweden, Finland and France reporting the highest amount of N emissions to water. Figure 4.10 (c) shows the indexed trends of total emissions, indexed to 2001 emissions levels.

The data for emissions to water show a decrease in reported emissions between 2001 and 2004, and again between 2004 and 2010. The EU 15 have the highest contribution to total historical emissions, showing the preponderance of the pulp and paper industry in the EU15 countries, with the new Member States contributing in a limited manner. This can be particularly observed in 2010 when all Member States have reported emissions. The emissions reported from new Member States accounted for 10% of Total Nitrogen emissions in 2010, and 14.4% of Total Phosphorus emissions in 2010. Generally, Pulp and Paper sector has reduced significantly the emissions of Total N and Total P in the last 20 years as is also mentioned in the PP. In most cases nitrogen and phosphorous do not arise from the production process but they have to be added in the WWTP for the correct operation of the biological treatment[29]. The exceptions are very specific cases, for example the processing of eucalyptus pulp which has a higher nutrient content.

[29] See Pulp and Paper draft BREF (p.97)

Figure 4.9 (a) NO_X (b) SO_X and (c) PM_{10} emissions from EU15 and newer EU Member States from 2001 to 2010. Plot (d) shows total emissions for each pollutant for EU15 and EU27 indexed to 2001 emissions

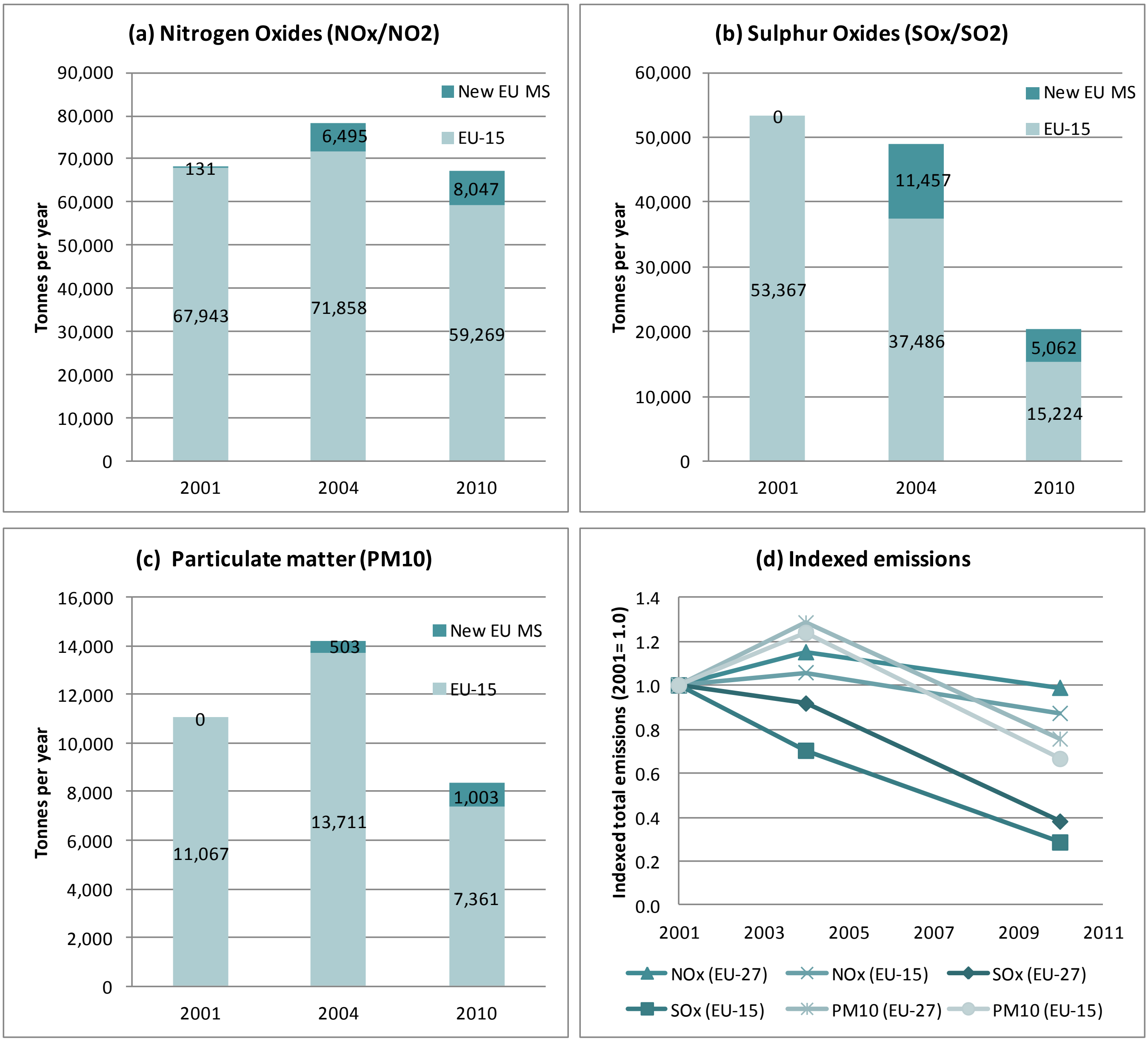
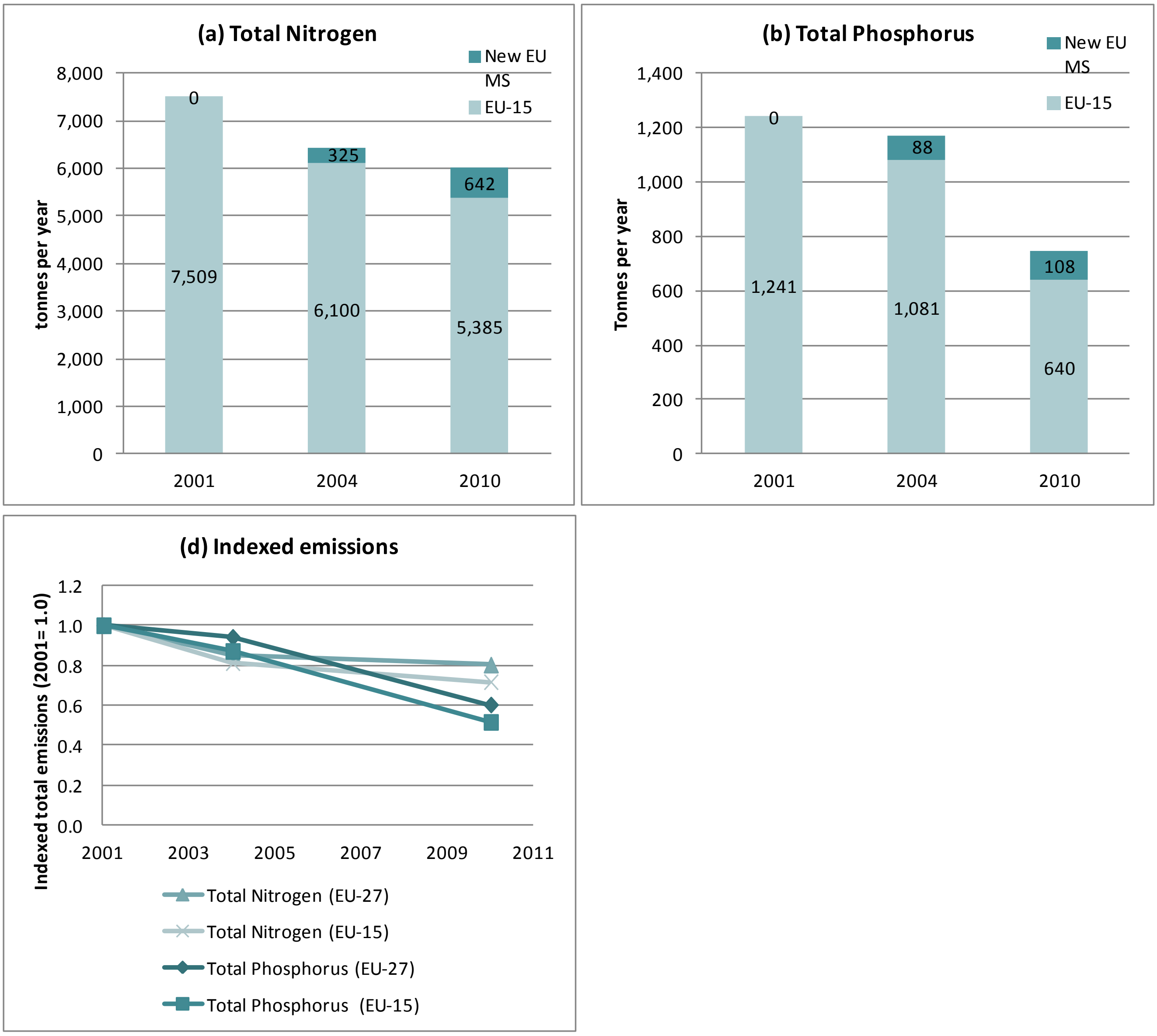


Figure 4.10 (a) Total Phosphorus, (b) Total Nitrogen, (c) total emissions for each pollutant for EU15 and EU27 indexed to 2001 emissions



Specific emissions

In the sectoral analysis, activity data from GAINS are used to calculate the specific emissions of the sectors (t pollutant/Mt product). Since activity data from GAINS is available for 2000 and 2005 years, in order to calculate specific emissions for 2001 and 2004, linear interpolation has been used in order to achieve an estimate of the sector activity in 2001 and 2004.

Figure 4.11 below shows historical specific emissions for NO_X, SO_X and PM_{10} emissions to air (plots a, b, c), and the indexed specific emissions (plot d, indexed to 2001). It is noticeable that NOx and PM specific emissions increase in 2004. The reasons for this increase are not clear but it could be due to an improvement in reporting from Member States or reporting from new EU Member States with higher specific emissions

Figure 4.12 shows historical specific emissions for Total Nitrogen and Total Phosphorus to water (plots a and b), and indexed emissions for these (plot c).

Specific emissions for NO_X and PM_{10} emissions show an increase between 2001 and 2004, and a decrease in 2010 while the specific emissions for SO_X decreased from 2001 onwards.

Specific emissions to water of Total Phosphorus and Total Nitrogen decrease gradually from 2001 and 2010. Pulp and paper sector has decreased significantly the Total N and Total P emissions the last 20 years as it is also reported in the PP BREF. Nitrogen and phosphorus are usually added in the WWTP in order to enhance the operation of the biological treatment as the waste water of the sector have very low nitrogen and phosphorus.

Figure 4.11 Specific emissions for (a) NO_X, (b) SO_X, (c)PM_{10}, for the EU-27 Plot (d) shows indexed specific emission, indexed to 2001 emissions.

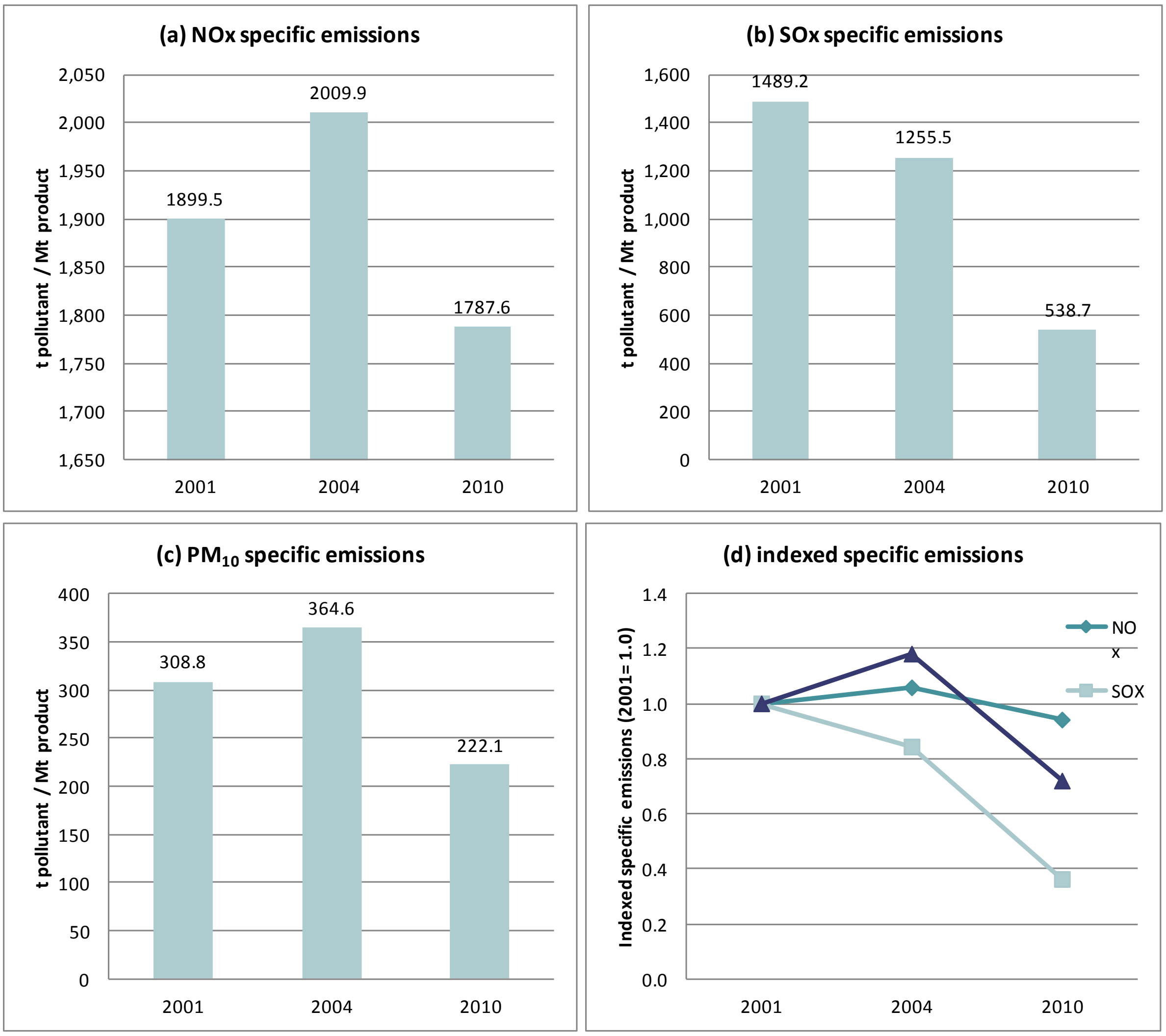
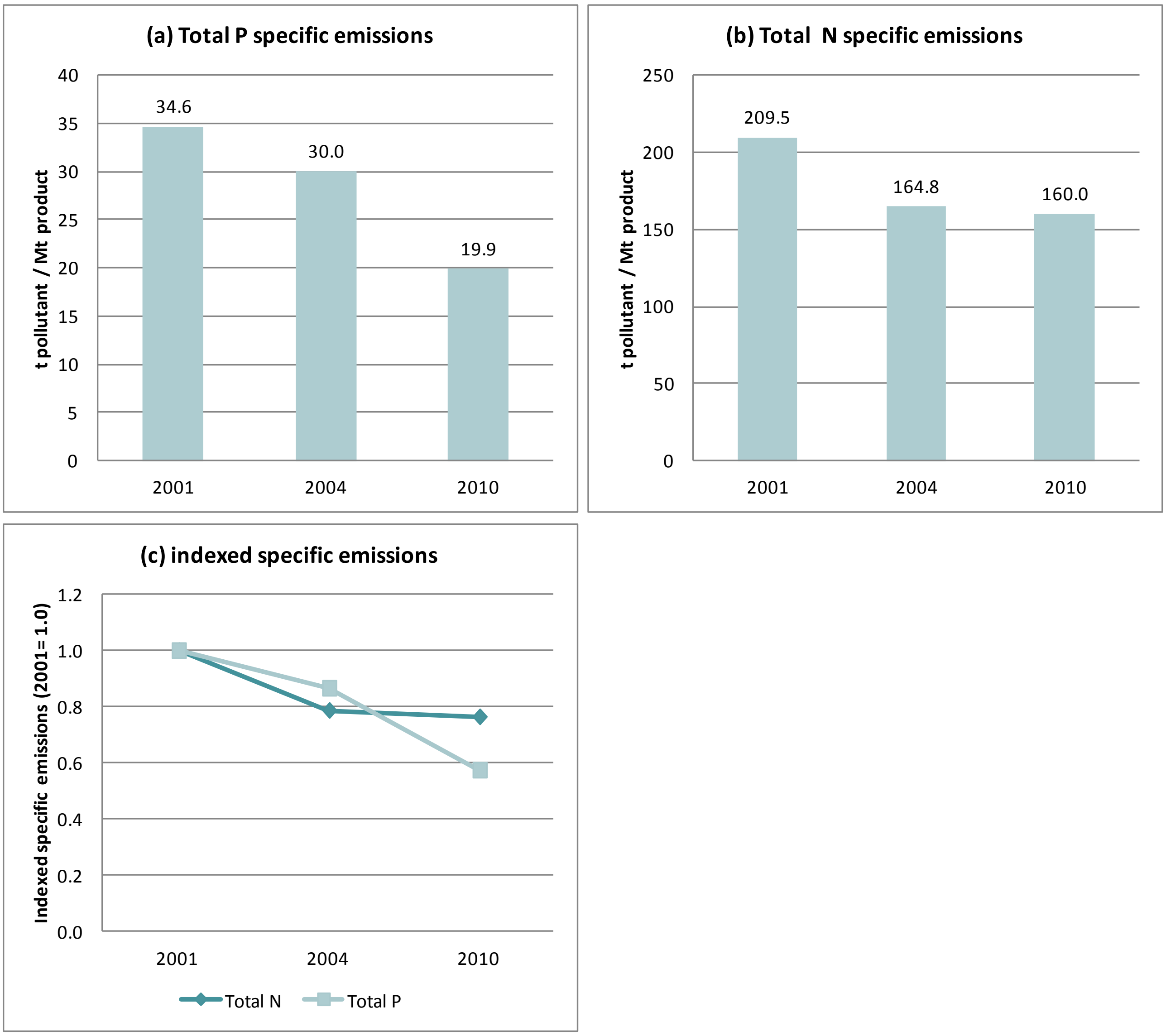


Figure 4.12 Specific emissions for (a) Total N, (b) Total P, for the EU-27 Plot (c) shows indexed specific emissions, indexed to 2001 emissions



5. Limitations and uncertainties of the study

5.1 Introduction

This section describes the limitations of the study and the uncertainties that were identified during the progress of the project. The limitations and uncertainties broadly fall into four categories:

- Limitations/ uncertainties related to the historical emissions;
- Limitations of the methodology during the project;
- Limitations/ uncertainties of the main data sources used in testing the methodology; and
- Other limitations/ uncertainties identified during the testing of the methodology.

The identified limitations/ uncertainties are described in more detail in the following sections.

5.2 Limitations/ uncertainties of historical emissions

5.2.1 Different Geographical Coverage of EPER and E-PRTR Databases

For the development of the historical emissions database, data from EPER was used for the years 2001 and 2004 and data from E-PRTR for 2010. However EPER and E-PRTR have different geographical coverage due to the expansion of EU. The 2001 EPER data covers the 15 Member States while the 2004 data covers 25 Member States (after the expansion of EU in 2004). Finally the 2010 E-PRTR data covers 27 Member States. Croatia joined the EU in 2013 and is not included in the historical database as data is not available. The difference in the geographical coverage affects the total emissions at EU level. In the historical emission graphs presented in this report, there is a differentiation between the emissions from the EU15 Member States and EU-27 including the newer Member States that joined the EU from 2004 onwards. Therefore, it is possible to extract results about trends in emissions in the original EU15 where data is available from 2001, but not for the current composition of the EU.

5.2.2 Lack of Data for some IED Activities compared to EPER and E-PRTR Activities

EPER and E-PRTR data is limited for some activities, such as, for example, some of the new activities adopted under the IED[30]. Issues with the availability of data were observed for the following IED activities:

- 3(1)(c): Production of magnesium oxide in kilns with a production capacity exceeding 50 tonnes per day;

[30] Activities 3(1)(c), 6.1 (c), 6.10

- 5(3)(b): Recovery or a mix of recovery and disposal, of non-hazardous waste with a capacity exceeding 75 tonnes per day involving one or more of the following activities, and excluding activities covered by Directive 91/271/EEC:

  (i) Biological treatment;

  (ii) Pre-treatment of waste for incineration or co-incineration;

  (iii) Treatment of slags and ashes; and

  (iv) Treatment in shredders of metal waste, including waste electrical and electronic equipment and end-of-life vehicles and their components.

- 5.5: Temporary storage of hazardous waste not covered under point 5.4 pending any of the activities listed in points 5.1, 5.2, 5.4 and 5.6 with a total capacity exceeding 50 tonnes, excluding landfills of inert waste;

- 5.6: Underground storage of hazardous waste with a total capacity exceeding 50 tonnes;

- 6(1)(c): Production in industrial installations of one or more of the following wood-based panels: oriented strand board, particleboard and fibreboard with a production capacity exceeding 600 m3 per day;

- 6(4)(b)(iii): Animal and vegetable raw materials, both in combined and separate products, with a finished product production capacities in tonnes per day greater than: 75 if A is equal to 10 or more; or, [300-(22,5 x A)] in any other case, where A is the portion of animal material (in percent of weight) of the finished product productions capacity;

- 6(9): Capture of CO_2 streams from installations covered by [the] Directive for the purposes of geological storage pursuant to Directive 2009/31/EC; and

- 6(10): Preservation of wood and wood products with chemicals with a production capacity exceeding 75 m3 per day other than exclusively treating against sapstain.

There is very little data available on activities 6(1) (c) and 6(10). Activities 3(1) (c), 5(5) and 5(6) were not covered by EPER and E-PRTR, thus data is not available. For the magnesium oxide sector (3(1) (c)) the LRTAP data was additionally checked but no data was identified. The magnesium oxide sector is also small compared to the cement and lime sectors that are part of the same BREF (CLM) and the contribution of the sector to the IED 3(1) activity emissions is likewise expected to be small. For these reasons, it was agreed with the Commission not to include the magnesium oxide sector in the Task 3 analysis under the BAT conclusions for the Production of cement, lime and magnesium oxide.

EPER and E-PRTR include separate categories for animal and vegetable raw materials and not a combined category such as activity 6(4) (b) (iii) of the IED. This means that some installations that did not meet the separate thresholds for animal or vegetable raw material in the past might now meet the new threshold for the mixed category and will now be part of the IED.

Activity 5(3) (b) (recovery or a mix of recovery and disposal of non-hazardous waste) is only partly covered by EPER and E-PRTR (disposal of non-hazardous waste).

Since for the abovementioned sectors there is little or no data available, the sectors were excluded from the analysis of historical emission trends in Task 1. For those sectors it is not possible to estimate the importance of their contribution to total EU emissions due to the absence of data. It may be appropriate to update E-PRTR to take into account the activities and thresholds of the IED, in order for data from the new sectors to be collected in the future, and to provide an overview of the sectors' emissions and their importance.

5.2.3 Different Thresholds between EPER, E-PRTR and IED

During the mapping of the EPER with E-PRTR and the IED, it was observed that there were some activities where different thresholds existed between EPER, E-PRTR and IED. This means one of the following:

- Installations that are reported in EPER or E-PRTR might not be part of the IED anymore so the historical emissions might be higher than the emissions expected under the IED; and
- Installations that are now covered by the IED were not covered in the past by EPER and E-PRTR so emission data was not reported in 2010 and thus the emissions projections might be lower than would be the case if they were included.

These differences are described in the table on the following page.

Table 5.1 Activities with Different Reporting Thresholds in EPER and E-PRTR than the Annex I of the IED

EPER code	EPER name	Threshold	E-PRTR code	E-PRTR Name	Threshold	IED code	IED name	IED threshold	Comments
						1(4)(a)	Gasification or liquefaction of coal	-	
1.4	Coal gasification and liquefaction plants	-	1(b)	Installations for gasification and liquefaction	-	1(4)(b)	Gasification or liquefaction of other fuels in installations with a total rated thermal input of 20 MW or more	>20 MWth	Threshold in IED, not in EPER or E-PRTR
			7.a	Industrial plants for the production of pulp from timber or similar fibrous materials		6.1.a	Pulp from timber or other fibrous materials;		
6.1	Industrial plants for the production of pulp from timber or other fibrous materials and paper or board production	>20 tonnes paper/day				6.1.b	Paper or card board with a production capacity exceeding 20 tonnes per day;	>20 tonnes/day	
n/a			7.b	Industrial plants for the production of paper and board and other primary wood products (such as chipboard, fibreboard and plywood)	>20 tonnes paper/day	6.1.c	One or more of the following wood-based panels: oriented strand board, particleboard or fibreboard	>600 m3 per day.	Wood panels have a different threshold in IED

EPER code	EPER name	Threshold	E-PRTR code	E-PRTR Name	Threshold	IED code	IED name	IED threshold	Comments
			c	**Industrial plants for the preservation of wood and wood products with chemicals**	**>50 m3 per day**	**6.10**	**Preservation of wood and wood products with chemicals y other than exclusively treating against sapstain**	**>75 m3 per day**	**Threshold in E-PRTR is different**
6.4	Vegetable raw materials	>300 tonnes/day	105.03 b.ii	Vegetable raw materials	>300 tonnes/day	6.4.b.ii	Only vegetable raw materials	300 tonnes/day or 600 tonnes/day for less than 90 days operation	Different threshold in the IED for plants operating less than 90 days

5.2.4 EPER Data Aggregation Level for Specific Sectors

In the EPER database, data are split down to categories based on the IPPC Annex I activities but in some cases categories are aggregated together. In those cases it is not possible to identify the emissions of a specific sector within the aggregated category and hence it is not possible to compare the historical emissions with the current emissions of the sector (which is needed in order to identify the changes in the total and specific emissions, and the trends in the environmental performance of the sector in general). This is the case for the following EPER categories:

- 2.1/2.2/2.3/2.4/2.5/2.6 – Metal industry and metal ore roasting or sintering installations; installations for the production of ferrous and non-ferrous metals;
- 3.1/3.3/3.4//3.5 – Installations for the production of cement clinker (>500 t/day), lime (>50 t/day), glass (> 20 t/day), mineral substances (>20 t/day) off ceramic products (>75 t/day);
- 4.2/4.3 – Basic inorganic chemicals and fertilisers;
- 4.4/4.6 – Biocides and explosives;
- 5.1/5.2 – Installations for the disposal or recovery of hazardous waste (>10 t/day) or municipal waste (>3 t/day); and
- 5.2/5.4 – Installations for the disposal of non-hazardous waste (>50 t/day) and landfills (>10 t/day).

These EPER categories are further split down to NOSE-P processes [31] and NACE codes. However the NOSE-P processes do not match the IED sub-activities. Also, from the NACE codes it is not possible to split down the emissions of an EPER category such as 2.1/2.2/2.3/2.4/2.5/2.6, as a large variety of NACE codes are reported for that might be common to more than one IED sub-category.

Additionally, for the chemical industry, EPER includes the main chemical categories and does not include as many sub-categories as the IED.

Based on the above, the historical data analysis was possible only in the EPER aggregation activity level. For the base year (2010) the relevant E-PRTR categories were aggregated in order to have all data at the same aggregation level and to allow an analysis across the EU and by Member State.

5.3 Limitations of the methodology

As set out in the methodology agreed with the Commission (see Section 3), the split of emissions between the different types of plants or sub-processes in the model is the same throughout the years (2010, 2020, and 2025). The model does not envisage the possibility that these proportions could possibly change over time due to e.g.

[31] European Commission, 2000, Commission decision of 17 July 2000 on the implementation of a European pollutant emission register (EPER) according to Article 15 of Council Directive 96/61/EC concerning integrated pollution prevention and control (IPPC) 2000/479/EC).

technological evolution of the sectors or the shift from one type of process or fuel etc. to another. This limitation of the methodology has been identified during the testing of the methodology (Section 4).

This limitation is applicable to the chlor-alkali sector. The chlor-alkali sector has the peculiarity that one of the existing types of plants (i.e. mercury cell plants) is considered as not-BAT (under any circumstances) in the recently adopted BAT conclusions. This means that during the 4-year period that existing plants have to comply with the BAT conclusions, the mercury plants will have to be decommissioned. Hence, the split of emissions for the sector will be completely different in 2020 and 2025 compared to the base year. The agreed methodology and the model that was developed assumes that the split of emissions between different sub-process/ or sub-sectors stays the same throughout the analysis period (2010, 2020 and 2025). This limitation of the methodology can lead to an underestimation of the chlorine and chlorides emissions in the IED scenario since the model cannot re-allocate the emissions of mercury plants to another type of plant in 2020 and 2025. Similar problems could be observed for other sectors if there is a change to the emission split due to changes in the proportions of different types of plant in the sector, e.g. technological evolution of the sectors or a shift from one type of fuel to another. This has been identified as an area for improvement of the model.

5.4 Limitations/ uncertainties of data sources used in the testing of the methodology

5.4.1 E-PRTR limitations/ uncertainties

Reporting of emissions under the main Annex I activity

Under the E-PRTR, the operator of a facility must report annually on the amount of emissions to air and water. According to Article 2(4) of the E-PRTR regulation, “facility” means “one or more installations on the same site that are operated by the same natural or legal person”. The ‘same site’ means the same location and is a question of judgement for each facility[32]. A facility can include one or more installations which have different Annex I activities.

According to the E-PRTR guidance, all the emissions/ releases and off-site transfers of the facility must be reported under the main Annex I activity given by the operator. This reporting rule of E-PRTR means that emissions from Annex I activities other than the reported main activity might be included in the reported emissions (i.e. where they are not the main activity). Hence, in the E-PRTR data there will be cases of overestimation and underestimation of emissions for the various Annex I activities. For the estimation of total EU emissions, this reporting rule does not create a problem but it can lead to overestimation or underestimation of emissions when the analysis is carried out at Annex I activity level.

An example is the Iron and Steel sector. In most cases around Europe, the installations are integrated and include different Annex I activities e.g. 1(d) “Coke ovens” and 2(b) Installations for the production of pig iron or steel (primary or secondary melting) including continuous casting”. During the analysis of the emission trends of the

[32] E-PRTR guidance highlights that a site does not become two sites merely because two parcels of land are separated by a physical barrier such as a road, a railway or a river.

sector it was observed that very little data are reported under the 1(d) activity while the majority of the data is reported under 2(b). This can create problems in mapping the pollutants and emissions to the BAT-AELs in the Iron and Steel BAT conclusions. This might lead to an overestimation or underestimation of the emissions of the two activities and of the sector as a whole, given that there are pollutants with BAT-AELs in only one of the activities and not in the other.

Correct application of the facility-level reporting rule by Member States

It is not possible for Amec Foster Wheeler to check if Member States correctly applied the facility-level reporting rule or if they have reported the same emissions more than once (i.e. for each installation that is included within a facility). This would again lead to overestimation of emissions both for the Annex I activities and for EU as a whole.

Emissions of non-Annex I activities

When a facility carries out both Annex I and non-Annex I activities, the releases from non-Annex I activities can be excluded from the reported data. However, when it is not possible to separate and quantify the contributions of the non-Annex I activities, the operator can report the releases from non-Annex I activities together with those from Annex I activities. Again this reporting rule means that emissions from non-Annex I activities might be included in the E-PRTR and hence there might be an overestimation of emissions when using data reported in E-PRTR.

Mapping E-PRTR Emission Data with BREFs and BAT conclusions

E-PRTR contains categories similar to the IED activities. However, the BREF documents and the adopted BAT conclusions might include under their scope only specific activities within an IED activity or specific activities from two or more different IED activities. This is the case of the chemical industry where several BREFs cover the same IED activity. For example, the LVIC-AAF, CAK and SIC BREFs all cover activity 4.2.(a) of the IED which refers to the production of inorganic chemicals and specifically gases such as ammonia, chlorine or hydrogen chloride, fluorine or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide and carbonyl chloride. This mismatching between the IED/E-PRTR activities and the BREFs is problematic when undertaking analysis of the data for a specific sub-sector within the main activity. This is a general issue for the chemical sector where different BREFs cover the same IED activities but also might be relevant for other sectors too.

The abovementioned issue was observed in the case of the chlor-alkali sector, where the reported E-PRTR emission data had to be matched with the BAT-AELs from the chlor-alkali BREF in order to estimate the emissions reduction due to the implementation of the BAT conclusions. The chlor-alkali sector base year emissions had to be extracted from the main categories (i.e. 4(b) (i) and 4(b) (iii)) in order to match the chlor-alkali activity that is included in the BREF. An initial check was made of the NACE codes reported under the relevant E-PRTR activities. The reported NACE codes under those two categories were considered too general and do not provide the required information to extract the chlor-alkali sector emissions. More specifically the following NACE codes are reported:

- 20.13 - Manufacture of other inorganic basic chemicals;
- 20.15 - Manufacture of fertilisers and nitrogen compounds;
- 20.59 - Manufacture of other chemical products n.e.c.; and
- 26.11 - Manufacture of electronic components.

Since the chlor-alkali sector is relatively small and all plants were listed in the chlor-alkali BREF, an attempt was made to match the plants reported in the BREF with the plants reporting in categories 4(b)(i) and 4(b)(iii) of the E-PRTR (in combination with the key pollutants that are specific for the chlor-alkali sector). In that way emission data were identified for the chlor-alkali sector in the base year and were used for the estimation of emission reduction that can be achieved by the implementation of BAT conclusions. It should be noted that not all plants listed in the chlor-alkali BREF could be found in the E-PRTR database. This might be due to:

- Emissions below the reporting thresholds leading to some facilities being not reported in E-PRTR.
- Chlor-alkali plants that are part of a large, integrated chemical production facilities, where emissions have to be reported under the main Annex I activity.

5.5 Limitations/ uncertainties identified during the methodology testing

5.5.1 Split of emissions to different sub-processes or sub-products

Emissions are reported in the E-PRTR at the activity level. However an industrial activity encompasses several sub-sectors and sub-processes, some of which may emit more than others. In addition, the BAT-AELs specified in the BAT conclusions apply to specific sub-processes or sub-products, so to accurately estimate the reduction in emissions that these BAT-AELs could bring, it was important to identify as accurately as possible the sources of emissions for each pollutant analysed. The split of emissions is one of the major uncertainties in the analysis since in many cases data on the contribution of the different sub-processes or sub-sectors to the total emissions was not available. Collection of such data would require extensive industry surveys which were outside the scope of the current study.

For all sectors, the split of emissions was informed by a review of the information available in the literature (e.g. BREFs, sectoral review reports, benchmarking reports). In a few cases information can be found in the BREFs about the split of emissions, but this does not go down to the level of sub-sectors and sub-processes at which the BAT-AELs are set. Furthermore, BREFs sometimes only provide some information about the split (e.g. source X has a large percentage of dust emissions) without providing specific values. When specific data was available (e.g. production activity data), this was used in order to estimate the split of emissions. However, in many instances data was not available and assumptions without supporting information had to be made in order to test the model.

5.5.2 Multiple BAT-AELs in the BAT conclusions

Due to their legally-binding nature, the BAT-AELs adopted in the BAT conclusions have been defined in detail for a range of specific plants, products, fuels or operating conditions. For example, the BAT conclusions can include different BAT-AELs for different techniques or for new/ existing plants or for different fuels used or even operating conditions (e.g. different BAT-AELs according to percentage of dry solids in pulp and paper recovery boilers or according to fuel type used in glass melting activities). In order to include that level of detail in the analysis, an in-depth review and/ or understanding of each sector would be required, including detailed discussions with the industrial sector associations, Member State competent authorities and operators.

5.5.3 Lack of emission data in E-PRTR for pollutants with BAT-AELs

The testing of the methodology has been limited to pollutants for which emissions data was reported in the E-PRTR. It was observed that for several IED sectors, pollutant emission data were not available as they are not included in the list of pollutants that have to be reported in the E-PRTR, even though BAT-AELs existing in the BAT conclusions.[33] However, it is important to note that there are no cases where no data were available for a major pollutant. In the future if and when the methodology is implemented in the various IED sectors, E-PRTR or other more sector specific data sources should be identified in order to make sure that consistent and reliable data is used in the sector analysis.

5.5.4 Lack of data on the actual sectors emission levels

The model requires data on the emission levels for existing plants applying BAT, for those not applying BAT, for new plants and for those that are under derogation. During the testing of the methodology it was observed that there is not one source that can provide data on actual industrial emission levels. For testing the methodology, sector emissions levels were identified primarily from the BREFs and other literature such as benchmarking reports issued for the EU ETS or IPPC implementation reports. In most cases, BREF documents include data on reported emissions. In many cases, ranges are provided while in others graphs with plant reported data are included. From the graphs with reported plant data it is more straightforward to identify emission levels, while when just the range of emissions (minimum/ maximum) is available it is not so easy, especially given that the distribution of reported emissions is not provided in most cases.

In cases where it is difficult to make an assumption for a specific value or where no data is available, a percentage below or above the upper BAT-AEL can be assumed or a point within the BAT-AEL range (e.g. lower, midpoint, upper) when estimating emission levels within a sector. If the emission levels included in the analysis come from different data sources, are from different years or are simply assumptions based on expert judgement, this introduces a high level of uncertainty in the results of the analysis. The availability and quality of existing data for the IED activities is one of the main limitations identified in this project, to the extent that a key conclusion is that bespoke data collection would be needed to make the methodology yield meaningful results.

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[33] This point will be relevant for consideration as part of the REFIT evaluation of the E-PRTR which has recently started (December 2014).

5.5.5 Lack of data on BAT uptake

Ideally, detailed Member State information (based on plant-by-plant data) on the extent of BAT uptake would be required. As an alternative approach, other sources such as the GAINS model data can be used in order to calculate the BAT uptake under the baseline for the main air pollutants (NO_X, SO_X, PM and VOC) for several industrial sectors. However, data is not always available for all air pollutants and GAINS does not include data for water pollutants. For these, alternative information from BREFs can be used in order to derive assumptions on BAT uptake or more specific Member State uptake data if it is available. However, again the existing datasets are not sufficient to allow meaningful results to be derived without additional data generation, something which should be considered when taking this method forward.

5.5.6 Uncertainty on percentage of new/ existing plants in target years

Information on the split between new and existing plants is important, because they achieve different performance levels and because different BAT-AELs often apply. Based on existing literature, such as information available in the BREFs for each sector, an average lifetime of an installation could be derived. This can be used to derive the replacement rate and the percentage of new/ existing plants in the target years. This is an important parameter that can considerably affect the extent of emissions decrease in the target years. During its lifetime, an installation will undergo modifications and refurbishment, some of which may be difficult to distinguish from a replacement in terms of emission levels. The assumptions to be made during a sector analysis should be sector specific and should represent as accurately as possible the reality. Therefore, once again, existing literature sources such as the BREFs are unlikely to be sufficient on their own, and should be complemented with bespoke information collection.

5.5.7 Uncertainty on potential derogations under IED

Data about the likely extent of derogations under the IED are not available as considerations on derogations are still at a very early stage. The percentage of derogations for each pollutant need to be estimated based on the BAT uptake data for the target years (2020 and 2025)[34]. It is expected that, under the IED, there will be a limited percentage of plants that cannot meet the BAT-AELs in the BAT conclusions and will have to use the derogation process. Also it is expected that the percentage of derogations will decrease with time as existing plants implement BAT and improve their performance, as well as when existing plants that require derogation are closed and replaced by newer plants.

The model has a built-in functionality that can take into account a maximum percentage of plants operating under an IED derogation. This functionality is intended for the cases of Member States with very low estimated BAT uptake, which with the IED is expected to change. The functionality can be completely de-activated if the user does not provide specific values.

[34] % Derogations = 100% - % Plants complying with BAT (%BAT uptake).

5.5.8 Decision-making on parameter settings

In order to use the model, decisions have to be made with regard to various parameters used within the model, such as the uptake of BAT, split of emissions, emissions levels for existing and new plants, percentage of new and existing plants, etc. The decisions taken for each parameter affect, to different degrees, the model and thus the results. In some cases, the choice of parameters/ assumptions can distort the results significantly, which is particularly relevant in cases where data availability is poor. In order to reduce this uncertainty, sector specific data collection will be needed to better understand the specifics of these parameters across a specific sector (e.g. split of emissions between different processes). A lot of data required to run the model simply is not available at this stage. All the input parameters have an impact on the final results of the model but the degree that they affect the model (i.e. which ones are the most or least significant) depends on the specificities of each sector i.e. different sectors are more sensitive to different parameters.

6. Conclusions of the study

6.1 Overview

This section presents the overall conclusions of the study, as well as recommendations about metrics that could be used in order to better understand the potential emission reductions resulting from the BAT conclusions (Task 4).

Overall this study has shown that it is possible to develop and apply a method and model to assess the implications of the IED and BAT Conclusions on future emissions. However, a number of improvements to the model could be made (see Section 6.2.4) but, more importantly, the testing of the model showed that there are significant gaps in the available data for running the analysis for the IED sectors. Detailed data collection for specific sectors and consultation with the stakeholders would be needed in order to run the model and obtain reliable and accurate results.

The remainder of this section elaborates in more detail on the conclusions drawn, suggestions for improvements to the approach, as well as recommendations on how to take forward this approach in the future.

6.2 Conclusions

6.2.1 Industrial emissions trends

For many industrial sectors (e.g. cement, lime, glass, iron and steel, pulp and paper, refineries) significant reductions in total emissions were observed during the period 2001 to 2010 based on the data reported by Member States in EPER (2001, 2004) and E-PRTR (2010). The reductions observed during that period may be due to a number of different factors such as (non-exhaustive list):

- Implementation of the IPPC Directive by the Member States;
- Additional measures taken at national level;
- Changes in sector activity levels; and
- The economic crisis in Europe.

For the period 2001 to 2004, the picture related to emissions is mixed. There are cases of industrial sectors where the emissions decreased during the period 2001 to 2004 but also cases of sectors where increases in total emissions were observed. The increases may be due to the reporting of the new EU Member States but also due to increased emissions from the older EU Member States (IPPC Directive was not fully implemented in existing installations). Improvement in Member States reporting between 2001 and 2004 might be another reason that increases were observed during that period.

Historical emissions data (as reported in EPER and E-PRTR) revealed that the majority of emissions reported in the period 2001 to 2010 originated from the older EU-15 Member States and only small percentages were emitted by the new EU Member States. Historical emission trends also showed that in some cases the emissions per unit of production were higher in the new EU Member State compared to the old EU Member States which shows that there is potential for improvement of the environmental performance of the plants and further reduction of the total EU emissions.

The data in E-PRTR and EPER were a key source of information for the current study, and represent the best single (multi-sector) source of emissions data of this type in Europe. However, there are a number of data gaps, uncertainties and limitations with the E-PRTR data which have a critical effect on the reliability of the results for the current study. In order to improve the reliability of the results (see below) improved data on existing emission levels would be invaluable.

6.2.2 Developed methodology and model

The main aim of the project was to develop a methodology that can be used to estimate the potential emission reduction delivered by the BAT conclusions adopted under the IED and test the model implementing the methodology in order to ensure that it can then be used in the future for IED sectors that are covered by the BREFs. Amec Foster Wheeler developed a methodology and tested the model which can then be used in the future for IED sectors that are covered by BREFs taking into account the different parameters affecting the emissions and the implementation of the BAT conclusions. The model developed is expected to be a useful tool for the Commission in estimating the possible emission reductions triggered by the BAT-AELs in the BAT conclusions. However, as described elsewhere, its validity is highly dependent on the quality of input data. High quality and reliable data would be needed in order to run the analysis for the IED sectors. Expert knowledge of the sector that will be analysed is also required as a number of assumptions need to be made in the absence of concrete data and those assumptions can affect significantly the results of the model.

The IPPC Bureau in particular has a significant amount of very detailed data available at facility level that could be used to run the model with great accuracy. Additionally during a BREF review, data on BAT uptake for a sector can be easily requested by the Member States. BREF authors will also have access to information enabling gaps to be filled where data are not available for parameters such as split of emissions to different sub-sectors or percentages of new and existing plants.

The main characteristics of the model are:

- **Robustness:** The developed model was tested in 7 industrial sectors[35] using readily available data from the BREFs, E-PRTR and the GAINS model, as well as other data sources Problems/ bugs that were identified during the testing of the model were fixed and the model works and can handle almost all[36] the specificities of the sectors under analysis and is expected to be able to handle all specificities

[35] Eight in reality since cement and lime are different sectors even though they are covered by the same BREF.

[36] One limitation of the methodology was identified during the chlor-alkali sector analysis which can be fixed in the next versions of the model (see section 6.2.4)

of the other IED industrial sectors. Refineries, Glass and Iron and Steel sectors are sectors with a significant number of sub-processes and BAT-AELs for both air and water pollutants. The methodology and the model work well for all the sectors that were tested. However, in order for the model to provide accurate results, it is considered that collection of robust data would be needed[37] and such data would require bespoke data collection exercises, if the results are to be meaningful (e.g. data collection at Member State level about activity levels, BAT uptake, emissions levels of plants applying BAT and plants not applying BAT, as well as percentages of new/ existing plants).

- **Flexibility:** The model provides a high degree of flexibility. All the model parameters are included in a control tab which is the main switchboard of the model. It controls the parameters and assumptions that will used to run the analysis. A range of options are offered to the user in order to facilitate establishing values and making assumptions on emission levels of BAT techniques, BAT uptake, plants replacement rates and derogations. The control panel also allows the user to easily assign EU values to specific Member States if no information at Member State level is available.

- **Two calculations approaches**: The model includes two different calculation approaches (a simple and a replacement approach) for the assessment of changes in emissions (reduction or increase) due to the implementation of the BAT conclusions adopted under the IED. Under the simple approach, the base year emissions are projected to the target years based only on the expected change in the sector activity, without taking into account changes in the proportion of new and existing plants and potentially different emission levels and BAT uptake compared to the existing plants applying BAT. Under the replacement approach, the base year emissions are projected to the target years taking into account the expected change in proportions of new and existing plants and any differences in emission levels and BAT uptake compared to existing plants applying BAT.

- **Flexible level of analysis**: The model allows assessment of potential impacts of the BAT conclusions upon emissions both at EU level and at Member State level. It can take into account different types of plants or sub-processes within a sector. The model can also be used for a specific sub-sector within an industrial sector. The model was tested and can handle the specificities of each industrial sector. It is also flexible enough to cover different levels of disaggregation (EU level, Member State level) and different aspects that affect emission changes, and it can handle any new data as this might emerge in the future. The methodology achieves the aims of the project and can be easily used for the industrial sectors that are covered by the IED.

A limitation in the methodology and consequently the model was identified during the testing of the model. This limitation is related to the split of the input emissions to the different types of plants or sub-processes for the base year and the target years. Currently the model uses the same emission split in the base year and the target years and does not allow the use of a different emission split that might be necessary in some sectors e.g. due to technological progress. This is an area of where the model could be further improved, as discussed in more detail in Section 6.2.4.

[37] For example, the model relies on estimating the share of emissions from different processes in different (types of) plants within a sector, but currently there are relatively few data to be able to estimate these shares accurately. Such data would need to be collected as part of detailed surveys of the industry sectors concerned. Likewise information on the proportion of installations currently applying and not applying BAT is usually uncertain (as is the range of emissions across different installations). The likely agreement of derogations from the BAT conclusions is also a key uncertainty.

6.2.3 Data availability

The information provided in Section 5 show clearly that the availability and quality of existing data for the IED activities is the main limitation identified in this project. During the testing of the model it was observed that there is not a single source that can provide consistent and high quality data for the IED sectors, and many of the data needed are simply not published, so a bespoke data collection exercise would be required. The type of data that are required in order to run the developed model are:

- Emissions for a base year.
- Split of emissions according to different sub-sectors/ sub-processes within a sector.
- Sector activity data.
- Information on extent of BAT uptake.
- Percentage of new and existing plants and replacement rates.
- Emission levels of plants applying BAT, those not applying BAT and new plants.
- Percentage of derogations under the IED and how this is expected to change over time.

Emission data from E-PRTR have been used in order to test the model. E-PRTR might not be the best source of data due to all the uncertainties and limitations identified in Section 5.4.1 and also as in many cases it does not includes pollutants that have BAT-AELs in the BAT conclusions. However, it is best available database covering multiple sectors and member states, with real emissions data included. The main uncertainties and limitations of E-PRTR can be summarised as follows:

- For a facility including more than one Annex I activities, the reporting of emissions must be made under the main Annex I activity which can lead either to overestimation or underestimation of emissions for specific Annex I activities;
- There are might be variations on the correct application of this reporting rule at facility level in Member States;
- It is possible that emissions from non-Annex I activities are included in the reporting of emissions from a main Annex I activity, for example if the operator cannot distinguish monitoring for different processes;
- Difficulties in mapping E-PRTR Emission Data with BREFs and BAT conclusions; and
- E-PRTR present limited water emission data.

The abovementioned issues could be considered during the E-PRTR refit evaluation project that has recently launched by the Commission.

Data sources more suitable for specific sectors could be examined and used in the future to run the model such as emission data from LRTAP (for refineries) LCP emission inventories for the LCP sector or bespoke data collection exercises in collaboration with industry associations (e.g. For the chlor-alkali sector and tanneries). Databases included in LCA models might be another possible data source that could be examined in the future. For each industrial sector the most reliable and comprehensive data source should be identified and selected. GAINS includes some data about the IED industrial sectors that are useful for running the model (e.g. activity data or percentage unabated emissions). Industry is not the main focus of the GAINS model so issues have been identified regarding the percentages of unabated emissions or the abatement techniques that are used for each sector in the GAINS model.

Accurately estimating the emission reduction that will be delivered by the adoption of BAT conclusions requires reliable and high quality data; otherwise the analysis will have significant limitations and uncertainties. In the future, it will be important to focus on obtaining data about industrial activities that are required for the assessment. Consistent and accurate data sources will help the Commission to better understand the potential emission reductions resulting from the BAT conclusions and will also support any changes in the legislation in the future.

6.2.4 Suggestions for improvement of the model and next steps

Pilot study to improve data quality

As a next step in the development and testing of the methodology, a pilot study would be proposed for one of the IED industrial sectors for which the BREFs are currently under review by the IPPC Bureau. The aim of this pilot study should be to obtain an accurate and complete data set to run the model by collecting the necessary Member State level data. This pilot study could be implemented in collaboration with the IPPC Bureau as the IPPC Bureau can provide facility-level emission data and information about the BAT used which are available through the data collection for the BREF review. Further data collection from Member States would be necessary in order to collect Member State-level data about e.g. BAT uptake, percentages of new/ existing plants, emission split, and sector activity. In that way a complete dataset could be developed for one of the IED industrial sectors which could feed into the model and show accurately the expected effect of the BAT conclusions for that sector.

Further improvement of the model

Emission split

During the testing of the model a limitation in the methodology and the model was observed which can be improved on in the future. This limitation is related to the split of the input emissions to the different types of plants or sub-processes. The agreed methodology and the model developed consider that the split of emissions remains the same throughout the analysis period and does not allow a different emission split for different years). In the future an updated version of the model could provide this functionality to the user.

New/ existing plants

The methodology and the current version of the model assume that in the base year there is 100% existing plants. The reality is that in the base year there might be both new and existing plants. An upgrade of the model could be implemented in the future and help improve the accuracy of the projections.

Cost/ benefit module

The current model could be extended in the future to include a cost module which would help the Commission to estimate the associated costs of emission reductions from industrial emissions legislation in the target years.

The costs of emission reductions could be calculated using a simple approach with an average/ weighted cost per tonne of pollutant abated applied to the reductions estimated (based on the mix of abatement measures assumed to be applied). Alternatively, a more complex approach could involve the development of an integrated abatement cost module so that costs are estimated directly based on the specific measures assumed to be applied (over and above the baseline). Furthermore the benefits associated with the emission reductions could be estimated by applying appropriate damage cost functions such as those developed under the CAFE programme or any updated values derived as part of the recent review of the Thematic Strategy for Air Pollution. Cost/ benefit ratios could then be estimated.

6.3 Recommendations

As discussed above, the availability and quality of existing data for the IED activities considered in this study (and any others that may be considered in the future) is the main limitation for undertaking a robust ex-ante assessment. In particular, whilst there is relatively good emissions data from E-PRTR for each sector there is very limited data (at an EU level) on current BAT application and permit conditions (i.e. emission limits applied by each plant). Furthermore, estimating future emissions and BAT uptake in the absence of the BAT Conclusions is highly uncertain. Defining the baseline now and in future years is key for undertaking a robust ex-ante assessment i.e. to provide a baseline against which to compare an alternative scenario.

Conversely, to undertake a robust evaluation, the key is in defining the counterfactual i.e. what would have happened in the absence of a particular policy such as the IED and BAT Conclusions. The challenge is differentiating the impacts of the policy under consideration from other drivers such as related policies and measures. In reality, to undertake a comprehensive ex-post evaluation of industrial emissions legislation would involve a focussed assessment at a sectoral level in order to define a suitable counterfactual gathering sufficient sector specific data to enable the evaluation.

For both types of assessment, the following metrics (individually or in combination) would be of value for investigating the impacts of the IED and BAT Conclusions:

- Specific emissions (i.e. emissions of a particular pollutant per tonne of product/ output and/ or for combustion activities, energy input). If individual installations or Member States (perhaps to avoid confidentiality concerns) were to report average sector specific emissions each year, or according to an agreed frequency, then this would help to identify changes in emissions year-on-year, stripping out changes in activity. Whilst changes in average sector specific emissions between years could be due to factors other than the requirements of industrial emissions legislation (e.g. plant closures, product changes, energy efficiency improvements), they do provide a good indication of any major changes in process and/ or abatement equipment.

- Average, minimum and maximum sector permit conditions for each pollutant (weighted by activity or total emissions) i.e. emission limits in force for a sector or due to be in force in the future. If this information were to be provided at a national level, it would provide an understanding of current BAT application relative to the BAT-AELs (and future uptake if permit conditions are to apply in later years). It would enable a comparison to be made between current/ future permit conditions versus the BAT-AELs applied under the BAT Conclusions. Whilst this information should all be available within each Member State, it is often not stored centrally and so could entail a significant amount of work to collate (although as part of the application of the BAT Conclusions all Member States are required to review and revise, where necessary, the permit conditions of that particular sector so there is perhaps an opportunity to collate the information centrally).

BAT uptake would be valuable for understanding how the BAT-AELs could drive further reductions. However, as the BAT Conclusions are technology-neutral, and for many pollutants and sectors there are a wide range of techniques that could enable the emission levels to be met, this may not be very feasible. The permit conditions as described above would therefore provide a good proxy for current BAT uptake/ BAT-AEL compliance.

The two types of metrics described above include data that should already be available at a Member State level. However, it would require additional collation, analysis and reporting activities for most sectors. For combustion plants, a significant volume of data is already available at an EU level due to the existing requirements of the LCP Directive (and in the future the IED). This has included reporting on an annual basis (in three year batches) of data at a plant level including both emissions and fuel consumption. This allows for the calculation and comparison of emissions per unit of energy between plants, Member States and years. Furthermore, for those plants burning single fuels it has been possible in recent evaluations[38] to derive equivalent emission concentrations and compare these against the LCP Directive emission limit values and BAT-AELs.

[38] http://forum.eionet.europa.eu/x_reporting-guidelines/library/lcp_reporting/summary_report/summary-report-lcp-inventories-2007-2009