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Manual for air emissions accounts

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Contents

Preface

Air emissions accounts (AEA) are one of six modules of Regulation (EU) No. 691/2011 on European environmental economic accounts. AEA contribute directly to the Union's policy priorities on climate change, green growth and resource productivity by providing important information on air emissions in a way that is compatible with the international UN system of national accounts (SNA) and its European version (ESA). AEA record countries' economies air emissions broken down by emitting economic activity in line with the ESA methodology for national accounts. 'Air emission' means the physical flow of gaseous or particulate materials from the national economy (production or consumption processes) to the atmosphere (as part of the environmental system).

This AEA manual revises an earlier version ([1]). Major changes were made due to the revised NACE Rev. 2 classification and the introduction of new reporting formats for national emission inventories.

The 2015 version of the AEA manual has been prepared under the lead of Eurostat (Stephan Moll, Judita Horvathova and Maaike Bouwmeester) supported by an expert team from Statistics Sweden (Maria Lidén, Nancy Steinbach and Fredrik Kanlén) to whom Eurostat would like to express its gratitude. Eurostat would also like to thank Angelica Tudini (Istat) and Arturo de la Fuente (Eurostat) for their valuable comments and contributions. Furthermore, the authors and editors would like to thank many other experts who are not explicitly mentioned here for their positive feedback in the discussions.

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sustainable development

([1]) Eurostat 2009b.

Abbreviations

AEA	Air emissions accounts
BoP	Balance of Payments
CEIP	CLRTAP/EMEP Centre on Emission Inventories and Projections
CH4	Methane
CLRTAP	Convention on Long-range Transboundary Air Pollution
CO	Carbon monoxide
CO_2	Carbon dioxide
COICOP	Classification of Individual Consumption by Purpose
CPA	Statistical classification of products by activities
CRF	Common Reporting Framework (UNFCCC)
DTA	Domestic technology assumption
EEA	European Environment Agency
EE-IOA	Environmentally extended Input-Output analysis
EMEP	CLRTAP European Monitoring and Evaluation Programme
ESA	European System of Accounts
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse gases
GPG	Good Practice Guidance (IPCC guidelines)
GVA	Gross Value Added
HH	Private households
HFCs	Hydrofluorocarbons
IEA	International Energy Agency
IO	Input-output
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
KAU	Kind of activity unit
Kyoto protocol	International agreement under the UNFCCC
LTO	Landing and take-off

LULUCF	Land Use, Land Use Change and Forestry
N_2O	Nitrous oxide
NACE	Statistical classification of economic activities in the European Community
NEC	the EU National Emission Ceilings Directive
NF_3	Nitrogen trifluoride
NFR	Nomenclature For Reporting (CLRTAP)
NH_3	Ammonia
NMVOC	Non-methanic volatile organic compounds
NO_X	Nitrogen oxides
NSI	National statistical institute
OECD	Organization for Economic Cooperation and Development
PEFA	Physical Energy Flow Accounts
PFCs	Perfluorocarbons
PM10	Particulate matter < 10 micrometres
PM2.5	Particulate matter < 2.5 micrometres
POPs	Persistent organic pollutants
PSUT	Physical Supply and Use Tables
SDA	Structural Decomposition Analysis
SEEA-CF	System of Environmental Economic Accounting – Central Framework
SF_6	Sulphur hexafluoride
SIOT	Symmetric Input-Output tables
SNA	System of National Accounts
SNAP	Selected Nomenclature for Air Pollution
SO_2	Sulphur dioxide
SO_X	all sulphur compounds (expressed as sulphur dioxide ([2]))
SUIOT	Supply, Use and Input-Output Tables
TFEIP	UNECE's Task Force on Emission Inventories and Projections
TJ	Terajoule
Tkm	Tonne kilometres

([2]) As defined in the revised 2014 Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution).

TOE	Tonnes oil equivalents
TSA	Tourism Satellite Accounts
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change

1 Introduction

What are air emissions accounts?

1. Air emissions accounts (AEA) record the flows of gaseous and particulate materials from the national economy into the atmosphere. After joining the atmosphere, the emitted substances are out of any human control and become part of natural materials cycles and may induce several types of environmental impacts. AEA present air emissions in a breakdown by emitting economic activity; the latter comprise production and consumption activities.

2. The term 'air emission' is used in this manual to denote the physical flow of gaseous or particulate materials from the economic system (during production or consumption processes) to the atmosphere which is part of the environmental system. Air emissions comprise emissions of greenhouse gases as well as emission of air pollutants such as SO_2, NO_X, PM10 etc. (see Table 3 in section 3.1).

Residence principle

3. AEA record those emissions arising from the activities of resident units of a given national economy, regardless of where these emissions actually occur geographically.

4. AEA present data on air emissions in a way that is fully compatible with the concepts, principles and data of the national accounts ([3]). As such AEA have the same accounting principles and system boundaries as the national accounts and are also based on the same residence principle (see also chapter 2).

5. The national accounts concept of residence is based on the following principle: an economic unit is said to be a resident unit of a country when it has a centre of economic interest in the economic territory of that country, that is, when it engages for an extended period (1 year or more) in economic activities in that territory.

AEA versus national emission inventories

6. AEA's presentation broken down by emitting economic activities complements national emission inventories. National emission inventories have been established in the context of international conventions (UNFCCC ([4]), CLRTAP([5])) and are used to derive highly policy relevant indicators subject to quantitative policy targets.

7. National emission inventories present emissions of greenhouse gases and air pollutants in a breakdown by technically delineated processes and sources. In contrast to AEA, national emission inventories follow widely the territory principle, i.e. they include emissions originating from the geographic territory of a given country.

8. Note that AEA national totals differ from the totals as defined in emission inventories. The differences are due to (a) the differences between residence principle and territory principle, but also due to (b) the definition/scope of national totals as defined in emission inventories (e.g. emissions from international air transport are excluded from the totals in UNFCCC GHG inventories).

([3]) United Nations et. al. (2008): System of National Accounts (SNA 2008) and Eurostat (2010a): European System of Accounts (ESA 2010).
([4]) United Nations Framework Convention on Climate Change.
([5]) Convention on Long-range Transboundary Air Pollution.

9. In AEA these differences are made explicit through so-called 'bridging items' (see also section 6.4).

For whom is this manual?

10. This manual primarily addresses compilers of AEA but also the users of AEA who are interested in understanding more of the underlying statistical details.

What is in this manual?

11. The content of this manual can be broadly grouped into three parts. Chapters 2 and 3 form a rather theoretical part; chapter 2 presents the conceptual foundations of AEA and chapter 3 gives an overview of the legal reporting requirements (questionnaire etc.). Chapters 4 to 7 form a practical part providing compilation guidelines and possible data sources. The final chapter 8 shows the use/application of AEA.

12. Annexes to this manual provide further guidance and support for AEA compilers. Annex 1 – which is actually a separate EXCEL file available on Eurostat's website – provides a correspondence between CRF/NFR codes as used in national emission inventories and the NACE Rev. 2 classification used in AEA. Annex 2 presents the NACE Rev. 2 classification employed in the AEA questionnaire. Annex 3 provides detailed guidance on the bridging items, i.e. differences between AEA and national emission inventories. Annex 4 gives guidance on the calculation of aggregates of air emissions and uses of economic time series.

13. Any reference to NACE ([6]) made in this manual is to the most recent version NACE Rev. 2.

([6]) Eurostat (2008c): Statistical classification of economic activities in the European Community.

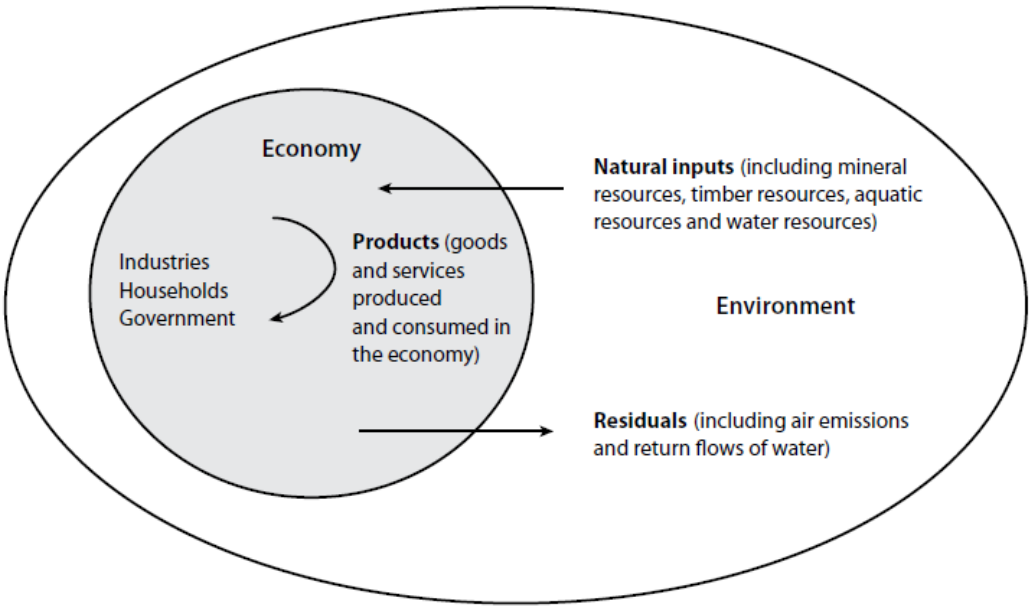
2 Conceptual foundations of air emissions accounts (AEA)

14. This chapter presents the conceptual foundations of air emissions accounts (AEA). Section 2.1 briefly explains how AEA are conceptually embedded in national and environmental accounts. Section 2.2 presents important accounting principles relevant for AEA. Section 2.3 provides a comparative overview of the concepts, principles and scope of national emission inventories vis-a-vis AEA.

2.1 AEA and the System of Environmental-Economic Accounting – Central Framework (SEEA-CF)

15. AEA are in line with the accounting structures and principles of the System of Environmental-Economic Accounting – Central Framework (SEEA-CF; UN et al. 2012) which is the internationally agreed standard for concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics on the environment and its relationship with the economy. The SEEA framework follows an accounting structure similar to the System of National Accounts (SNA) and uses concepts, definitions and classifications consistent with the SNA in order to facilitate the integration of environmental and economic statistics.

Figure 1: Natural inputs, products, and residuals as recorded in SEEA-CF physical flow accounts



16. AEA belong to the SEEA-CF main area of physical flow accounts (see SEEA-CF chapter 3, see also Figure 1). As such they aim at describing the physical flows of gaseous and particulate materials from the economy to the natural environment. The SEEA-CF lays out in its chapter 3 (and

parts of chapter 2) a general physical flow accounting framework and a set of accounting principles and boundaries making possible a consistent recording of all types of physical flows relating to economic activities.

17. In the context of the SEEA-CF framework, AEA constitute simplified physical supply tables recording the flow of residuals (see SEEA-CF sections 3.2, 3.3 and 3.6.3) originating from the various economic activities, namely industries' production activities and private households' consumption activities.

18. Air emissions are incidental and undesired outcomes of the economic system. Air emissions in AEA relate to those physical flows of gaseous or particulate materials that originate in the economic system (production, consumption and accumulation processes) and which are released into the atmosphere and remain suspended in the air for a substantial time period. Most of those residuals are in a gaseous state but small particulates (PM2.5 and PM10) and heavy metals are solids effectively suspended in the atmosphere for a substantial time and have certain behaviour similar to gases.

2.2 Accounting principles relevant for AEA

19. The following sections present various accounting principles, rules, and conventions most relevant for air emissions accounts (AEA). They are widely derived from national accounts – here references are made to the European version ESA 2010 – and the system for environmental-economic accounting (SEEA-CF).

2.2.1 Units and groupings of units in ESA 2010

20. National accounts define and use various statistical units and groupings of units that interact economically (see ESA 2010 §§ 1.54-1.56, 2.01-2.03). AEA assign emissions to producing entities termed *industries* (see below paragraphs 24ff.).

21. Perhaps the most central unit used in national accounts is the so-called ***institutional unit*** which is defined as 'an economic entity characterised by decision-making autonomy' (ESA 2010 §§ 1.57, 2.12). In particular larger *institutional units* producing goods and services are engaged in a variety of activities and hence are rather heterogeneous with regards to the type of their production activities. Their so-called 'principal activity' is the activity with the highest value added (ESA 2010 §§ 3.10 ff.). In addition *institutional units* may be engaged in 'secondary activities'. Institutional units are grouped into institutional sectors. The main institutional sectors are non-financial corporations, financial corporations, general government, households, non-profit institutions, and the rest of the world.

22. For the purpose of analysing production the national accounts suggest to portion/decompose *institutional units* into smaller units which are more homogenous with regards to the various activities. These more homogenous units are termed ***local kind-of-activity units – local KAU***([7]) (see ESA 2010 §§ 1.58, 2.144-2.149). *Local KAUs* form the smallest unit of economic entities in national accounts. Note that *local KAU* do not necessarily have decision-making autonomy as they are part of a larger *institutional unit*.

23. In principle, it is recommended to register as many *local KAUs* as there are secondary

([7]) Termed ***establishments*** in SNA 2008.

activities performed by the *institutional unit*. However, if the accounting documents (data sources) needed to describe such details are not available the compilers are not able to decompose *institutional units* into as many homogenous *local KAUs* undertaking only one activity. Hence in practice *local KAUs* may have – beside their principal activity – also one or several secondary activities. The homogeneity of *local KAUs* vary across countries depending on primary data sources compilers may have at hand.

24. *Local KAUs* are grouped to ***industries***. An *industry* consists of a group of *local KAUs* engaged in the same or similar kind-of-activity (see ESA §§ 1.59, 2.150-2.152). *Local KAUs* as well as *industries* are units suited to analyse production processes and technico-economic relationships (see ESA 2010 § 2.03).

25. AEA assign emissions to *industries* as these are delineated in national supply and use tables (SUTs) and thus there are close links between AEA and ESA supply tables. AEA use the same industry breakdown level (NACE A*64) as supply and use tables (SUTs) delivered to Eurostat.

26. The supply and use tables constitute an appropriate way of portraying in detail the production and consumption activities of a given national economy ([8]). The supply table is a product (row-wise) by industry (column-wise) table (see Figure 2). It shows which industries produce what products (goods and services). In addition, the supply table shows what products are imported (i.e. supplied by the rest of the world economy).

Figure 2: Simplified scheme of a supply table

<table>
<tr><td>Industries
Products</td><td colspan="3">Industries</td><td rowspan="2">Imports</td><td rowspan="2">Total</td></tr>
<tr><td></td><td>Agriculture</td><td>Manufacturing, mining, etc.</td><td>Service activities</td></tr>
<tr><td>Agricultural products</td><td colspan="3" rowspan="3">Output by product and industry</td><td rowspan="3">Imports by product</td><td rowspan="3">Total supply by product</td></tr>
<tr><td>Products from manufacturing</td></tr>
<tr><td>Services</td></tr>
<tr><td>Total</td><td colspan="3">Total output by industry</td><td>Total imports</td><td>Total supply</td></tr>
</table>

Source: based on Eurostat (2008b)

27. Industries are classified using NACE ([9]); products are classified using CPA ([10]). Both classifications have correspondence at 2-digit level. E.g. the industry 'manufacture of coke and refined petroleum products' (NACE code 19) produces typically the products 'coke and refined petroleum products' (CPA code 19). This is termed output from 'principal activity' production. In the ESA supply table the output from principal activities is shown on the diagonal. E.g. NACE grouping 19 produces CPA product 19; NACE grouping 24 produces CPA product 24 etc.

28. Theoretically (see above paragraphs 21-24) the *industries* in the ESA supply table should be rather homogenous, ideally producing only their typical product because all the *local KAUs* in the same *industry* have the same principal activity.

([8]) ESA 2010 paragraphs 1.06 and 9.01 ff..
([9]) Statistical classification of economic activities in the European Community.
([10]) Statistical classification of products by activities.

29. In practice however, *local KAUs* and hence *industries* can have one or several 'secondary activities' (see paragraph 23). E.g. the chemical industry (NACE code 20) may produce electricity and heat (CPA code 35). In the ESA supply table outputs from secondary activities of industries are recorded off the diagonal.

30. It is of utmost importance that each NACE grouping in AEA is defined and delineated exactly in the same way as in the national ESA supply table. Compilers of AEA are advised to contact their colleagues in national accounts in order to find out how exactly industries are compiled in their respective national SUTs (see also section 7). This concerns in particular the recording of secondary activities.

31. For example, let's assume that the waste management industry produces as a secondary activity electricity and heat (e.g. from waste incinerators) and this secondary output is recorded in the waste management industry's column in the ESA supply table. Then, the air emissions associated with the secondary activity, i.e. electricity and heat production, also have to be recorded under the waste management industry in the AEA.

2.2.2 AEA residence principle

32. The residence principle is one important feature as it defines the scope of the national economy and thus what is included in the accounts.

33. AEA uses the same residence principle as national accounts. In national accounts a *resident unit* is defined as an *institutional unit* (see paragraphs 21 above) that has its centre of economic interest on the economic territory of that country (see further ESA 2010, §§ 1.61, 2.04). The national economy is defined as the entity including all activities of resident *institutional units*. Note that this definition of the national economy does not exactly correspond to the economic activities in the national territory.

34. Therefore, AEA record air emissions (see paragraphs 1-2 above) arising from activities of ***resident units*** constituting a given national economy, regardless of where these emissions actually occur.

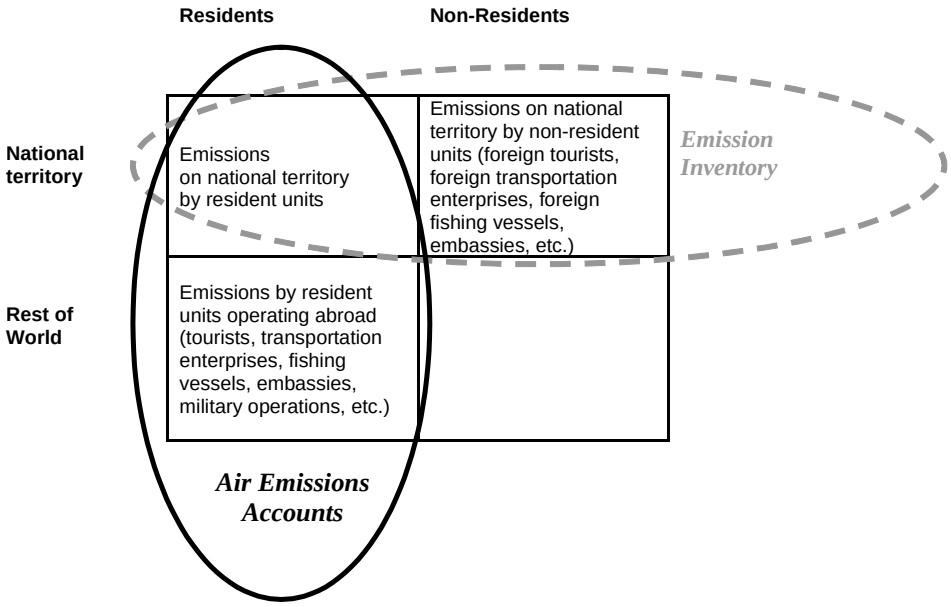
35. This implies that e.g. emissions by resident airlines are recorded in AEA regardless of where the emissions actually occur. An example: Ryanair is a big airline company which is a resident unit of Ireland. The emissions originating from a Ryanair operated flight between Frankfurt and New York are to be recorded in the Irish AEA because Ryanair's profit generated through this flight is contributing to the Irish GDP.

36. Usually the majority of air emission national totals are emitted from resident units' activities on the territory of the respective country. However, especially in smaller economies (e.g. Luxembourg, Malta, and Cyprus) the emission relevant activities of non-residents on the territory and the emission relevant activities of residents abroad may be significant in comparison to the national totals.

37. It is important to note that national emission inventories under the international conventions CLRTAP and UNFCCC and the underlying activity data (e.g. energy statistics) do not follow the residence principle as applied in national accounts. National emission inventories rather follow a territory principle. I.e. they record emissions arising from the territory of a given country regardless of who is emitting (i.e. resident units or non-residents).

38. Figure 3 illustrates the differences between the residence principle followed in AEA (vertical ellipse) and the rather territory oriented principle as widely applied in national emission inventories (dotted vertical ellipse). The latter count all emissions occurring on the territory originating from activities of resident units and non-residents. The residence principle calls for recording all emissions by resident unit on the territory but also outside, i.e. in the rest of the world.

Figure 3: Geographic and economic (resident) definition of a country



39. Whenever national emission inventories and/or energy statistics are used to compile AEA, the compiler will have to make certain adjustments to take into account the conceptual differences between territory and residence principle. These ***residence adjustments*** are explicitly presented in the so-called bridging items. The bridging items show the differences between AEA totals and national totals in UNFCCC and CLRTAP emission inventories. International transport is the main source for differences (see also chapter 6 and Annex 3).

2.2.3 Transport emissions – AEA assign emissions to operators

40. One of the most important AEA accounting conventions is related to transport emissions: AEA assign emissions to the ***operator*** of transport vehicles and other mobile sources of emissions (such as e.g. diesel-compressors used in construction, mobile generators of electricity). All industries and private households operate motor vehicles and other mobile sources and hence obtain assignments of transport emissions in AEA. Transport emissions from cars operated by tourists are attributed to the country of residence of the operator (in this case, the driver of the car), whether the car is owned by the driver or hired from a car rental firm. (SEEA-CF §3.129).

41. In contrast national emission inventories under CLRTAP and UNFCCC assign emissions to a source category termed 'transport' which is defined from a rather technical/engineering point of view. Also energy statistics use various technically defined 'transport' categories. In particular the category 'road transport' in energy statistics does not provide sufficient information about the operator.

42. If the compilers of AEA use national emission inventories or energy statistics they need to assign/distribute certain single category items over a range of industries and private households in AEA. This manual gives practical guidance how to do this (see chapter 7).

2.2.4 Private households' consumption activities by purpose

43. The economic activities in AEA also include consumption activities by private households. Households are regarded in national accounts, and correspondingly in AEA, as consumers (see further ESA 2010, §§ 2.118) and thus are reported separately from the industries, which are groupings of producer units. Recording of air emissions by households must indicate when household consumption is *directly* responsible for air emissions, avoiding any double counting with activities by industries. Private households constitute significant origins of *direct* air emissions.

44. In AEA, consumption activities by private households are divided into three sub-classes, reflecting the relevance with regards to air emissions (see also section 7.7):

- Transport
- Heating/cooling
- Other

2.3 Comparative overview: national emissions inventories (UNFCCC, CLRTAP) vis-a-vis AEA

45. National emission inventories and derived national totals provide well established data used to monitor quantitative policy targets in the domains of climate change (UNFCCC ([11])) and clean air (CLRTAP ([12]), NEC ([13])). There are some conceptual differences between UNFCCC inventories and CLRTAP inventories as well as between the former and AEA.

46. Differences concern the following aspects: (1) the range of emissions sources taken into account and the underlying principles, (2) the coverage of substances, and (3) – most importantly with regards to monitoring of policy targets – the way how national totals are derived/defined. This section provides a comparative overview along those aspects.

47. It has to be noted that in all three data frameworks emissions are usually estimated (i.e. calculated) and not metered (see section 4.1).

2.3.1 Range of emission sources taken into account and underlying principles

48. All three frameworks focus on the recording of anthropogenic emissions, i.e. human made emissions to the atmosphere. Emissions from natural sources (e.g. volcanos, forest fires etc.) are excluded in general.

(11) United Nations Framework Convention on Climate Change
(12) Convention on Long-range Transboundary Air Pollution
(13) EU National Emissions Ceilings Directive

49. Differences exist however as regards the geographical range of emission sources taken into account. The principle of national emission inventories is to account for human made emissions originating from the national territory ('territory principle'). Whereas AEA record human made emissions in relation to the national economy which is defined as the total of economic activities of resident units, independent of where these emissions geographically occur because some resident units may emit abroad ('residence principle', see also section 2.2.2).

UNFCCC inventories

50. The IPCC 2006 Guidelines specify two important concepts with regards to the coverage of emission sources taken into account in UNFCCC inventories ([14]):

— **Anthropogenic emissions and removals:**
Anthropogenic emissions and removals mean that greenhouse gas emissions and removals included in national inventories are a result of human activities. The distinction between natural and anthropogenic emissions and removals follows straightforwardly from the data used to quantify human activity. In the Agriculture, Forestry and Other Land Use (AFOLU) Sector, emissions and removals on managed land are taken as a proxy for anthropogenic emissions and removals, and interannual variations in natural background emissions and removals, though these can be significant, are assumed to average out over time.

— **National territory:**
National inventories include greenhouse gas emissions and removals taking place within national territory and offshore areas over which the country has jurisdiction. There are some special issues that are described in Section 8.2.1 of Volume 1 of the IPCC 2006 Guidelines. For example, emissions from fuel use in road transport is included in the emissions of the country where the fuel is sold and not where the vehicle is driven, as fuel sale statistics are widely available and usually much more accurate.

51. The first bullet point relates to the characteristic of the emission sources which are taken into account. It implies that UNFCCC inventories include only greenhouse gas emissions caused by human activities and excludes any emissions originating from natural sources. This concept for UNFCCC inventories coincides with AEA which only take into account emission flows from the national economy to the environment (see section 2.1). The national economy is defined as all resident units' economic activities, i.e. human activities. Like in UNFCCC inventories, emissions from natural sources (e.g. volcanos) are not considered in AEA.

52. It is important to note that in UNFCCC inventories emissions from managed land are considered anthropogenic emissions. They are accounted for in the inventories, however not included in the national totals (see also section 2.3.3).

53. Further it has to be noted that CO_2 emissions from biomass combustion are recorded as memo item in UNFCCCC inventories. They are not taken into account for deriving national totals (see also section 2.3.3 and Table 1).

54. The second bullet point in paragraph 50 relates to the geographical scope of emission sources

([14]) IPPC 2006 Guidelines - Volume 1: General Guidance and Reporting: section 1.1 'Concepts'.

taken into account. In principle UNFCCC inventories count all anthropogenic emissions on the national territory ('territory principle'). In contrast AEA follow the residence principle and take into account all emissions by resident units, independent of whether these occur on the territory or outside (see section 2.2.2).

55. It is important to note that – for practical reasons of data availability – UNFCCC inventories may deviate from the 'territory principle' by using fuel sale statistics. The latter may be used as activity variables to calculate emissions (see section 4.1). In other words, emissions from combustion of fuels are assigned to the country where the fuel was sold.

56. However, emissions arising from combustion of fuel sold on the territory must not exclusively occur on the territory, e.g. in the case of transport. Partly, transport fuel sold on the national territory is used for trips outside the national territory. In effect those emissions actually occur outside the country to which emissions are assigned. In particular big vehicles – such as trucks, ships, or airplanes – fuelling in one country may emit in other countries. Quantitatively, this effect can be huge for certain countries.

CLRTAP inventories

57. Article 1 of the Convention on Long-range Transboundary Air Pollution (CLRTAP) ([15]) includes the following definitions:

— 'Air Pollution' means the introduction by man, directly or indirectly, of substances or energy into the air resulting in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems and material property and impair or interfere with amenities and other legitimate uses of the environment, and 'air pollutants' shall be construed accordingly.

— 'Long-range transboundary air pollution' means air pollution whose physical origin is situated wholly or in part within the area under the national jurisdiction of one State and which has adverse effects in the area under the jurisdiction of another State at such a distance that it is not generally possible to distinguish the contribution of individual emission sources or groups of sources.

58. The first bullet point relates to the characteristic of the emission sources which are taken into accounts. Similar as in UNFCCC inventories as well as in AEA it implies that only those emissions are accounted for that are made by humans. Note that the questionnaire used for CLRTAP data collection includes as memo item emissions from natural sources, namely volcanos and forest fires (see also Table 2).

59. The second bullet in paragraph 57 relates to the geographical scope of CLRTAP inventories. Like in UNFCCC inventories the 'territory principle' is applied in general. I.e. human made emissions originating from the national territory are accounted for.

60. The EMEP/EEA air pollutant emission inventory guidebook 2013 – which is also the methodological reference for reporting under the EU National Emission Ceilings (NEC) Directive – does not provide further specifications as regards the geographical scope.

61. Compilers of CLRTAP inventories may use – in the one or the other form – fuel use statistics

([15]) http://www.unece.org/env/lrtap/lrtap_h1.html

as activity variables (see section 4.1). Fuel use statistics relate to fuel sales on the territory leading to the possible deviations from the 'territory principle' as described in paragraph 55 above.

AEA

62. Like inventories, AEA in principle account for anthropogenic, i.e. human made, air emissions. These include theoretically all emissions arising from economic activities (production, consumption, accumulation). Emissions from natural sources are excluded from AEA.

63. Note that cultivated plants and forests belong to the national economy as they are produced assets. Also humans and domesticated animals are part of the national economy. In contrast, soils under plants and forests are part of the natural environment.

64. Mostly due to practical reasons some conventions have been introduced in AEA that deviate slightly from the general principle mentioned in the previous paragraph 62. These specific cases are presented in the section 2.3.4.

2.3.2 Coverage of substances

65. UNFCCC inventories cover emissions of greenhouse gases. CLRTAP inventories include a wide range of air pollutants. AEA cover also greenhouse gas emissions and a selection of most important air pollutants.

66. All three frameworks exclude respiratory CO_2 emissions made by humans and animals. Oxygen (O_2) flows – e.g. from cultivated plants to the atmosphere – are excluded from all three frameworks, as well as any human made flows of water vapour to the atmosphere (see also section 2.3.4 below).

UNFCCC inventories

67. UNFCCC inventories cover six greenhouse gases, respectively groupings thereof, for which quantitative targets exist: CO_2, N_2O, CH_4, HFCs, PFCs, and SF_6. The former three are single substances whereas the latter three are groupings of substances – so-called F-gases. Since 2015 another grouping has been added which is not yet included in AEA: NF_3.

68. Emissions of all greenhouse gases can be aggregated together according to their potential global warming effect (see also Annex 4). The various greenhouse gases are converted using specific global warming factors which express their global warming potential in CO_2-equivalents. Quantitative policy targets have also been formulated for the aggregate of all greenhouse gases.

69. CO_2 emissions from biomass are recorded as memo item in UNFCCC inventories. They are not taken into account in national totals (see also section 2.3.3).

70. Note that UNFCCC inventories also include emissions of NO_x, CO, NMVOC and SO_2 rather for information only. They are not used for monitoring any policy targets. The policy relevant recording of these substances is in the CLRTAP inventories.

CLRTAP inventories

71. CLRTAP inventories cover a wide range of substances: 5 air pollutants (NO_X, CO, NMVOC, SOx, NH_3), 9 heavy metals, and a selection of persistent organic pollutants (POPs). In addition they include two forms of particulate matter (PM2.5 and PM10).

72. Quantitative policy targets exist for four pollutants mainly responsible for acidification, eutrophication and ground-level ozone pollution: sulphur (SO_2), nitrogen oxides (NO_X), volatile organic compounds (VOCs) and ammonia (NH_3).

73. The various air pollutants can be aggregated according to their potential contribution to the three aforementioned environmental themes (see also Annex 4). However, quantitative policy targets have not been formulated for those theme aggregates.

AEA

74. AEA include a selection of substances (see also section 3.1):

— Six greenhouse gases (CO_2, N_2O, CH_4, HFCs, PFCs, and SF_6), plus CO_2 emissions from biomass as a separate item.
Note that the UNFCCC inventories are the reference for these greenhouse gases when comparing AEA totals with inventory totals.

— Five air pollutants: NO_X, CO, NMVOC, SOx, NH_3.
Note that the CLRTAP inventories form the reference for these air pollutants when AEA totals are compared with inventory totals.

— Two forms of particulate matter: PM10 and PM2.5.
Note that the CLRTAP inventories form the reference for these particulate materials when AEA totals are compared with inventory totals.

2.3.3 Definitions of national totals in national emission inventories and the classifications of emissions sources

75. National emission inventories enable the derivation of totals which are considered national totals, i.e. representing single countries. These national totals have a high importance as they are linked to internationally agreed quantitative policy target. The policy targets are of a political nature as is the definition of the national totals – i.e. what is included and what is not.

76. National totals in UNFCCC inventories (see Table 1) are defined slightly different than national totals in CLRTAP inventories (see Table 2). The differences are articulated via so-called memo-items, which are emission sources for which emissions are reported in the inventory but not included in the aggregation of national totals. For instance, UNFCCC totals include only emissions from domestic aviation while those from international aviation are excluded. CLRTAP totals consider both, emissions from domestic and international aviation, but only those arising from the landing and take-off (LTO) stages whilst emissions at cruise stage are excluded (see Table 1 and Table 2; see also Annex 3).

77. In national emissions inventories emissions sources are classified according to specific classifications. UNFCCC inventories use the CRF ([16]) classification. CLRTAP inventories use the NFR ([17]) classification. With a few exceptions both classifications coincide. Both classifications have a hierarchical structure. Sectors form the highest hierarchy level; followed by categories and sub-categories. The coding has up to 6 digits, i.e. 6 hierarchical levels:

— (Sector) Numerical code: 1, 2, 3, 4, 5, 6

([16]) Common Reporting Format.
([17]) Nomenclature for Reporting.

— (Category) Upper case alphanumerical codes: A, B, C, D, E etc.

— (Sub-category) Numerical code: 1, 2, 3 etc.

— Lower case alphanumerical code: a, b, c, d etc.

— Roman numerical code: i, ii, iii, iv etc.

— Roman numerical code in brackets: (i), (ii), (iii), (iv) etc.

78. Table 1 provides an overview of the CRF sectors and categories as employed in UNFCCC inventories. It also shows what is included (and not) in UNFCCC national totals.

79. CRF item 1.A.3 'Transport (excl. international aviation and navigation)' includes GHG emissions deriving from fuel combustion related to domestic aviation, road transportation, railways, and domestic navigation. Explicitly excluded from CRF item 1.A.3 are GHG emissions deriving from fuel combustion associated with international aviation and international navigation. The latter are recorded as memo item "international bunkers' and not included in the UNFCCC national totals.

80. CRF item 1.C 'CO_2 transport and storage' records CO_2 leakage to atmosphere from the transport, injection, and geological storage of CO_2. It refers to technologies/activities of carbon capture and storage (CCS). These CO_2 leakages are included in UNFCCC national totals. Note that emissions resulting from fossil fuels used for capture, compression, transport, and injection of CO_2, are not included in CRF item 1.C; those are reported as GHG emissions from energy use in the appropriate stationary or mobile energy use categories – CRF code 1.A and its sub-items.

81. The amounts of CO_2 that are long term stored through CCS technologies are recorded as memo item 'CO_2 captured' and obviously excluded from UNFCCC national totals.

82. Note that the memo item 'CO_2 emissions from biomass' is excluded from UNFCCC national totals.

Table 1: CRF classification and definition of national totals in UNFCCC inventories

CRF code			Incl. in national totals	Label
Sector	Category			
1			yes	Energy
	A		yes	Fuel combustion
		1	yes	Energy industries
		2	yes	Manufacturing industries and construction
		3	yes	Transport (excl. international aviation and navigation)
		4	yes	Other sectors
		5	yes	Other
	B		yes	Fugitive emissions from fuels
		1	yes	Solid fuels
		2	yes	Oil and natural gas and other emissions from energy production
	C		yes	CO_2 transport and storage
2			yes	Industrial processes and product use
3			yes	Agriculture
4			no	Land use, land-use change and forestry (LULUCF)
5			yes	Waste (CO_2 only for non-biogenic and inorganic waste)
6			yes	Other
			no	Memo item: International bunkers: aviation, navigation
			no	Memo item: Multilateral operations
			no	Memo item: CO_2 emissions from biomass
			no	Memo item: CO_2 captured
			no	Memo item: Long-term storage of C in waste disposal sites

83. Table 2 provides an overview of the NFR sectors (for sector 1 also the categories and subcategories) as employed in CLRTAP inventories. It also shows what is included (and not) in CLRTAP national totals.

84. NFR item 1.A.3 'Transport (excl. aviation at cruise stage and international maritime navigation)' includes all emissions deriving from fuel combustion associated with road transport, railways, international and domestic aviation – here only landing and take-offs (LTO), and navigation on inland waterways. NFR item 1.A.3 is included in CLRTAP national totals.

85. Emissions from fuel combustion associated with international and domestic aviation at cruise stage are reported as memo item and hence excluded from CLRTAP national totals. The same applies for emissions from fuel combustion associated with international maritime navigation.

Table 2: NFR classification and definition of national totals in CLRTAP inventories

NFR code			Incl. in national totals	Label
Sector	Category			
1			yes	Energy
	A		yes	Fuel combustion
		1	yes	Energy industries
		2	yes	Manufacturing industries and construction
		3	yes	Transport (excl. aviation at cruise stage and international maritime navigation)
		4	yes	Other sectors
		5	yes	Other
	B		yes	Fugitive emissions from fuels
		1	yes	Solid fuels
		2	yes	Oil and natural gas and other emissions from energy production
2			yes	Industrial processes and product use
3			yes	Agriculture
4			n.a., no	The sector 'Land use, land-use change and forestry' is not applied in CLRTAP inventories
5			yes	Waste
6			yes	Other
	1A3ai(ii)		no	Memo item: International aviation at cruise stage
	1A3aii(ii)		no	Memo item: Domestic aviation at cruise stage
	1A3di(i)		no	Memo item: International maritime navigation
	1A5c		no	Memo item: Multilateral operations
	6B		no	Other not included in national total of the entire territory
	11A		no	Volcanoes
	11B		no	Forest fires
	11C		no	Other natural emissions (please specify in the IIR)

2.3.4 Specific cases: what is included in AEA and what not

86. AEA theoretically record all emissions related to human activities (see section 2.3.1). There are some specific cases presented in the following, that slightly deviate from the theoretical principles of national accounts and SEEA-CF as far as the coverage of emissions sources is concerned.

Respiratory emissions from humans and domesticated animals

87. Human bodies are part of the economy and hence emissions arising from human bodies should be accounted for according to the principles of national accounts and SEEA-CF (see SEEA-CF § 3.58). Human bodies are the source of respiratory emissions of water (evapotranspiration) – which is a substance excluded from AEA – and carbon dioxide (CO_2). Respiratory CO_2 emissions are not accounted for in AEA.

88. Domesticated animals belong to the economy. Emissions of gaseous substances originating from domesticated animals are flows from the economy to the environment which should in principle be recorded in AEA. Emissions by domesticated animals comprise water (evapotranspiration), carbon dioxide and methane from enteric fermentation taking place in the digestive system of ruminant animals. The former two are excluded from AEA. Only methane emissions from ruminant animals are accounted for in AEA as data are available in emission inventories.

Emissions (and uptakes) from (by) cultivated plants, as the latter belong to the national economy

89. According to national accounts principles cultivated biological resources such as plantations and livestock are part of the economy (see SEEA-CF §§ 19 and 3.54 ff.). Consequently, cultivated plants, forests, and cultivated animals are part of the economic system and air emissions originating from these produced assets should theoretically be included in AEA as they constitute flows from the economy to the environment.

90. Oxygen (O_2) and water (H_2O), which are emitted from cultivated plants and forests (photosynthesis), are substances not considered in AEA (see section 2.3.2), nor in national emission inventories.

91. Cultivated forests emit significant amounts of NMVOC. They may be accounted for in CLRTAP inventories as a memo item, i.e. they are not included in the totals. This is one of the reasons why these NMVOC emissions are excluded from AEA. Another reason is the quantitative uncertainty related to the estimation of these NMVOC emissions from trees.

92. Following the SEEA logic, uptake (absorption) of gaseous substances by cultivated plants and forests (i.e. CO_2 through photosynthesis) constitute flows from the environment to the national economy. However, flows from environment to economy are not subject to AEA.

93. In other words, carbon sequestration in forests is not to be subtracted from the total emissions to air by forestry.

Emissions of gaseous substances from soils

94. Emissions from managed soils are theoretically excluded from AEA because the SEEA-CF draws the functional system boundary between the economy and the environment at the root of the

cultivated plant. I.e. the soil under e.g. crops and forests is considered a part of the natural environment while the cultivated plant is part of the economy. Notably, UNFCCC inventories consider emissions from managed soils as man-made (see paragraph 52 above), i.e. they are recorded in UNFCCC inventories but not included in the national totals.

Emission of gaseous substances from soil cultivation

95. Emissions from soil cultivation in a wider sense such as fertiliser and manure applications, and animal excreta, are clearly to be included in AEA. They are resulting from production activities.

96. Note that these emissions from soil cultivation are recorded in national emission inventories and also included in the national totals of UNFCCC and CLRTAP inventories.

Emissions from waste landfills that go to atmosphere

97. Emissions to the atmosphere of methane (CH_4) from controlled landfills are considered a flow from the economy to the environment and hence to be recorded in AEA (see e.g. SEEA-CF §§ 19, 3.31, 3.237). Note that amounts of methane captured are excluded as they stay within the economy (see also paragraph 100).

98. Data on emissions from controlled landfills are available from national emission inventories.

Flaring and venting

99. The flaring and venting of residual gaseous and particulate materials into the air is recorded in emission inventories and takes place in conjunction with certain economic activities, namely, in oil refineries, chemical industries, and oil extraction. Hence, flaring and venting is also recorded in AEA (see SEEA-CF § 3.245).

Gaseous substances captured

100. Gaseous substances captured for further processing (e.g. methane at landfills) or gaseous substances captured for storage (e.g. CO_2 or carbon storage) are excluded from AEA. According to the SEEA-CF (e.g. §§ 3.74, 3.89, 3.234, 3.248) these are internal material flows within the national economy and not a flow from economy to environment.

3 Reporting AEA to Eurostat

101. Since 2013, Member States are to submit air emissions accounts (AEA) to Eurostat through a mandatory annual data collection ([18]). The data collection includes an electronic questionnaire and a quality report.

3.1 The AEA questionnaire

102. The AEA questionnaire is an MS Excel workbook. There are 14 spreadsheets (see Table 3), one for each greenhouse gas or air pollutant.

Table 3: Gaseous or particulate substances included in Eurostat's questionnaire for air emissions accounts

Code	Gaseous or particulate substances	Measurement unit
CO_2	Carbon dioxide without emissions from biomass	1000 metric tonnes
biomass CO_2	Carbon dioxide from biomass used as fuel	1000 metric tonnes
N_2O	Nitrous oxide	Metric tonnes
CH_4	Methane	Metric tonnes
HFC	Hydrofluorocarbons	Metric tonnes CO_2-equivalents
PFC	Perfluorocarbons	Metric tonnes CO_2-equivalents
SF_6	Sulphur hexafluoride	Metric tonnes CO_2-equivalents
NO_X	Nitrogen oxides	Metric tonnes NO_2-equivalents
SO_X	Sulphur oxides	Metric tonnes SO_2-equivalents
NH_3	Ammonia	Metric tonnes
NMVOC	Non-methane volatile organic compounds	Metric tonnes
CO	Carbon monoxide	Metric tonnes
PM10	Particulate matter<10 micrometres	Metric tonnes
PM2.5	Particulate matter<2.5 micrometres	Metric tonnes

103. Emissions of CO_2 are reported in 1000 metric tonnes while all other substances are reported in metric tonnes.

104. Note that the table for CO_2 is excluding CO_2 emissions from biomass because the latter are not included in UNFCCC inventory totals. In AEA, CO_2 emissions from biomass are treated as a separate substance. Hence the AEA totals for the ordinary CO_2 emissions do not include any CO_2 emissions from biomass.

([18]) According to Annex I of Regulation (EU) No 691/2011 of the European Parliament and of the Council of 6 July 2011 on European environmental economic accounts.

105. Each of the three groupings of F-gases (HFC, PFC, and SF_6) includes several compounds with differing global warming potentials. For this reason, these three groupings are reported in metric tonnes CO_2-equivalents (see also Annex 4) in order to make them comparable.

106. Nitrogen oxides (NO_X) means nitric oxide and nitrogen dioxide, expressed as nitrogen dioxide (NO_2).

107. Sulphur oxides (SO_X) comprise all sulphur compounds expressed as sulphur dioxide (SO_2) (including sulphur trioxide (SO_3), sulphuric acid (H_2SO_4), and reduced sulphur compounds, such as hydrogen sulphide (H_2S), mercaptans and dimethyl sulphides, etc.).

108. Particulate matter (PM) is an air pollutant consisting of a mixture of particles suspended in the air. These particles differ in their physical properties (such as size and shape) and chemical composition.

109. NMVOCs means all organic compounds of an anthropogenic nature, other than methane, that are capable of producing photochemical oxidants by reaction with nitrogen oxides in the presence of sunlight.

110. CO_2 from biomass includes emissions from wood and wood waste, charcoal, bio-alcohol, black liquor, landfill gas, household waste, etc. used as fuel.

111. Each spread sheet of the AEA questionnaire has an outline as shown in Figure 4. Column-wise it includes the reference years for which air emissions are reported. Row-wise the reporting table presents economic activities from which air emissions are originating and the so-called bridging items.

Figure 4: General scheme of data sheet in Eurostat's AEA questionnaire

<table>
<tr><th>Air pollutant:</th><th>1995</th><th>1996</th><th>…</th><th>2013</th><th>2014</th></tr>
<tr><td>Industries</td><td colspan="5" rowspan="2">Air emissions by industries</td></tr>
<tr><td>NACE based industry classification</td></tr>
<tr><td>Household, total</td><td colspan="5" rowspan="3">Air emissions by households</td></tr>
<tr><td>Transport</td></tr>
<tr><td>Heating</td></tr>
<tr><td>Other</td><td colspan="5" rowspan="5">Bridging items</td></tr>
<tr><td>Totals (AEA)</td></tr>
<tr><td>Less national residents abroad</td></tr>
<tr><td>Plus non-resident on the territory</td></tr>
<tr><td>Less/plus other</td></tr>
<tr><td>National Totals according to UNFCCC or CLRTAP excluding LULUCF</td></tr>
</table>

Source: AEA questionnaire

112. There is one column for each year, starting from 1995 and ranging up to *n*-2 (with *n* being the year when the data collection takes place). The AEA questionnaire includes the entire time series because national emission inventories – which may form an important data source for compiling AEA – are potentially revised for the entire period (see section 5.1).

113. Row-wise, the data sheets of the AEA questionnaire include the economic activities (in a detailed breakdown) from which emissions are originating and so-called bridging items:

— Emissions by industries are broken down by 64 groupings of the 88 divisions of the NACE Rev. 2 classification (NACE A*64);

— Emissions by households are broken down by three sub-classes (purposes);

— Bridging items explicitly show the differences between the AEA totals and national totals as reported in national emission inventories (see section 6.4).

114. The SEEA-CF recommends recording flows of air emissions in a combined physical supply and use table ([19]). The Eurostat AEA questionnaire format is slightly different as it only includes a physical supply table in the annual questionnaire. No accumulation column exists.

115. The allocation of production activities by industries and household consumption by purpose is further described in chapter 7. Annex 2 shows a complete NACE classification list as included in Eurostat's AEA questionnaire.

3.2 Confidential data

116. In the AEA questionnaire NSIs have to report confidential data to Eurostat whilst flagging them accordingly. Eurostat guarantees that reported data flagged as confidential are protected, i.e. not published.

117. One of Eurostat's main duties is to disseminate data for European Union aggregates (EU totals). The Commission needs these statistics in order to develop and monitor EU policies. They also meet an increasing demand from users outside the Commission: national administrations and private businesses. In order to make data useful for users, EU aggregates should be available to the maximum extent possible while guaranteeing that no confidential national data is disclosed. If one cell is flagged as confidential at the most detailed level of the NACE dimension, there are two consequences:

— For a given country it forces to flag the cell on the next superior hierarchical NACE level also confidential. This is usually done by the reporting country.

— For the EU aggregate the cell at the most detailed level as well as the cell at the next superior hierarchical level is to be flagged as confidential.

118. The value added of AEA is the detailed breakdowns of certain dimensions (mostly economic activity of the emitter). AEA data are not useful for integrated economic analyses if the breakdown by NACE A*64 is incomplete. Estimates of carbon footprints on the basis of input-output modelling are only possible if the full breakdown by NACE A*64 is given. Likewise decomposition analyses become impossible or at least the value of their results is significantly limited.

([19]) United Nations et. al. (2014): SEEA-CF Table 3.7.

119. As a matter of principle, Eurostat wants to avoid any discrepancy between Eurostat publications and national publications by NSIs. Eurostat cannot remove any (primary and/or secondary) confidentiality-flag reported by the NSI. Eurostat may encourage the NSI to make sure that confidentiality is really justified and Eurostat may ask the NSI to provide evidence for a given confidentiality flag.

120. To ensure proper use of environmental accounts, it is necessary to reduce the number of cells that cannot be published to a minimum. For this purpose, NSIs should undertake the following steps before sending AEA questionnaires with confidential cells:

Step 1: Unreliable data are not to be flagged confidential

121. Lack of faith/confidence in the accuracy of data does not justify setting a confidentiality flag! In those cases the NSI is asked to remove the confidentiality flag and to add a footnote stating that the data is less reliable.

Step 2: Check whether data is published elsewhere

122. If data is publicly available (i.e. published elsewhere) there is no confidentiality to be flagged.

Data obtained from sources lawfully available to the public and which remain available to the public according to national legislation shall not be considered confidential for the purpose of dissemination of statistics obtained from those data ([20]).

If a cell is confidential, the compiler of AEA is advised to check whether concerned data is maybe published (publicly available) elsewhere. Potential sources in the case of AEA are:

- National emission inventories
- National ministries and agencies on environment
- European environment agency (EEA)
- UNFCCC

Step 3: Consider changing methodology to allow disclosure

123. If the confidentiality flag is justified by national rules, the NSI could consider changing the compilation method for the concerned cell. E.g. instead of using micro data NSI may make an estimate (and add estimated flag).

Last option: Setting secondary confidentiality flags

124. NSIs can set secondary confidentiality flags in a way that enables – according to the national confidentiality rules – disclosure of hierarchically superior cells (see examples in Figure 5). This facilitates Eurostat to publish at least EU totals for more aggregated NACE levels.

125. If a frequency rule with a threshold of 3 exists: Flag two additional cells on the same hierarchical level (usually the most detailed NACE A*64 level) in order to enable disclosure of the hierarchically superior cell. This last option bears the risk of inconsistent publication: data published nationally by NSIs may be hidden (flagged confidential) in Eurostat's publication. The country should make sure that the two publications are aligned.

([20]) Regulation (EC) No 223/2009 of the European Parliament and of the Council, Article 25.

Figure 5: Examples of using primary confidentiality (flag = 'c') and secondary confidentiality (flag = 'd')

Air emissions by industry		2008	2009	2010
H	Transportation and storage	5,028.00	4,526.00	4,514.00
H49	Land transport and transport via pipelines	4,800.00	4,300.00	4,310.00
H50	Water transport	80.00 c)	70.00 c)	68.00 c)
H51	Air transport	45.00 c)	75.00 d)	49.00 c)
H52	Warehousing and support activities for transportation	55.00 d)	50.00 d)	52.00 c)
H53	Postal and courier activities	48.00	31.00	35.00
I	Accommodation and food service activities	91.58	81.12	83.61
J	Information and communication	37.07	35.22	33.10
J58-J60	*Publishing, motion picture, video, television programme production; sound recording, programming and broadcasting activities*	*8.11*	*6.55*	*5.50* d)
J58	Publishing activities	3.50 c)	2.30 d)	1.70 d)
J59_J60	Motion picture, video, television programme production; programming and broadcasting activities	4.61 c)	4.25 c)	3.80 d)
J61	*Telecommunications*	*17.26*	*16.82*	*16.32* c)
J62_J63	*Computer programming, consultancy, and information service activities*	*11.70*	*11.84*	*11.28* d)

Source: AEA questionnaire

3.3 The quality report

126. As part of the transmission obligations of the Regulation (EU) No 691/2011, Article 7, paragraph 2, each submission of data has to be accompanied by a quality report. The most recent quality report template for AEA is available on Eurostat's website. The quality report was developed by Eurostat and follows the guidelines of the European Code of Practice ([21]). The report covers:

— Relevance

— Accuracy

— Timeliness and punctuality

— Accessibility and clarity

— Comparability and coherence.

([21]) European Statistical System Committee (2011).

4 The general emission model and overview on compilation approaches for AEA

127. This chapter gives a general overview related to the compilation of air emissions accounts (AEA). More detailed and more practical compilation guidance is provided in chapter 5 (data sources), chapter 6 (adjusting original data for residence principle) and chapter 7 (allocating data to NACE groupings).

128. Like most environmental accounts, AEA are compiled from a variety of existing data (e.g. national emission inventories, energy statistics, trade statistics, transport statistics). This requires a conversion and re-arranging process: the original data has to be made consistent with the AEA-specific accounting rules, definitions and requirements which were presented in chapter 2.

129. When choosing primary data and methodologies for AEA compilation, priority should be given to datasets and compilation techniques that give the best quality and highest precision for the AEA, taking into account data availability, national circumstances and available resources. AEA compilers are invited to 'cherry-pick', that is to choose and combine datasets and methodologies in a way that is preferable given the national circumstances. AEA compilers are advised to make sure that no omission or double counting occurs when doing so. And regardless of the approach chosen, emissions should be reported for the time when the emissions take place.

130. In principle air emissions are estimated and not directly measured/metered. The general emission model to calculate emissions is presented in section 4.1. The basic idea is to multiply certain activity data with specific emission factors.

131. For compiling AEA, three compilation approaches can be distinguished:

- the inventory-first approach (see section 4.2)
- the energy-first approach (see section 4.3)
- a multi-purpose data system approach (see section 4.4)

In practice these three compilation approaches are often mixed.

4.1 The general emission model to estimate air emissions

132. Air emissions at the level of national economies are not metered or measured – they need to be estimated. The basic idea is to calculate air emissions using technology specific emission factors which are multiplied with a given activity variable (e.g. use of a certain fuel). A general emission model can be expressed as:

$$Emissions\ (E) = Activity\ Data\ (AD) \times Emission\ Factor\ (EF)$$

133. Statistics on energy use constitute by far the majority of activity variables employed. In Europe up to about 90% of most prominent air emissions (e.g. CO_2, SO_X, NO_2) are due to combustion of fossil and renewable fuels. For some pollutants, non-energy born air emissions are also quantitatively significant, e.g. methane (CH_4) emissions from agriculture and NMVOC emissions from industrial processes. For air emissions not related to energy a variety of statistics may be used as activity variable; e.g. number of livestock, production volumes etc. Many of these

potential activity data are official statistics ([22]). Hence cooperation of inventory experts and producers of official statistics is useful.

134. Please note that in some cases, in particular for transport emissions, the calculation is likely to be much more complex than the above basic model may suggest. Activity data (energy use) need to be decomposed by e.g. power plant type, fuel type, combustion technology, vehicle class, and abatement technologies (e.g. catalytic converters, filters on power plants and waste incinerators). The energy data may then be combined with corresponding emission factors. Emissions factors are pollutant-specific and specific for each of the aforementioned dimensions (i.e. fuel type, combustion technology, vehicle class etc.).

135. The guidelines for compilers of national emissions inventories describe in detail the specific emission models for each of the CRF/NFR source codes. For UNFCCC inventories see e.g. IPCC (2006) (see also section 5.1.1 for further references) and for CLRTAP inventories see EMEP/EEA (2013).

136. Compilers of AEA should make sure that activity data is converted to a unit compatible with the emission factors applied. For energy data it is often necessary to convert the physical units into energy content because many emission factors are based on energy units (TJ or TOE). Conversion factors should be available within the energy statistics.

137. As far as possible, compilers of AEA should use the same emission factors as used in the national emission inventories. Otherwise a systematic error will occur when trying to "bridge" from AEA totals to national emission inventory totals (see section 6.4).

138. National and international emission factors are regularly updated as knowledge improves and the composition of fuels and combustion techniques change over time. For the most up-to-date emission factors, it is advisable to study the most recent reports accompanying the national emission inventories ([23]) and cooperate with national experts on emission inventories. Other data sources for emission factors are the IPCC Emission Factor Database ([24]), the Air Pollutant Emission Factor Library ([25]), and default emission factors provided by the guidelines for national emission inventories mentioned above in paragraph 135.

139. If energy activity data is used, special attention must be given to the use of fuels for non-energy purpose, for example as catalysts in industrial processes (i.e. all energy activity variables used beyond CRF/NFR code 1A). The accurate amount of energy needs to be separate and subtracted from the data set. This could be a very complicated process and it is highly recommended to cooperate closely with staff in charge of the national emission inventories to assure that no double counting, omission or other systematic errors are introduced into the AEA.

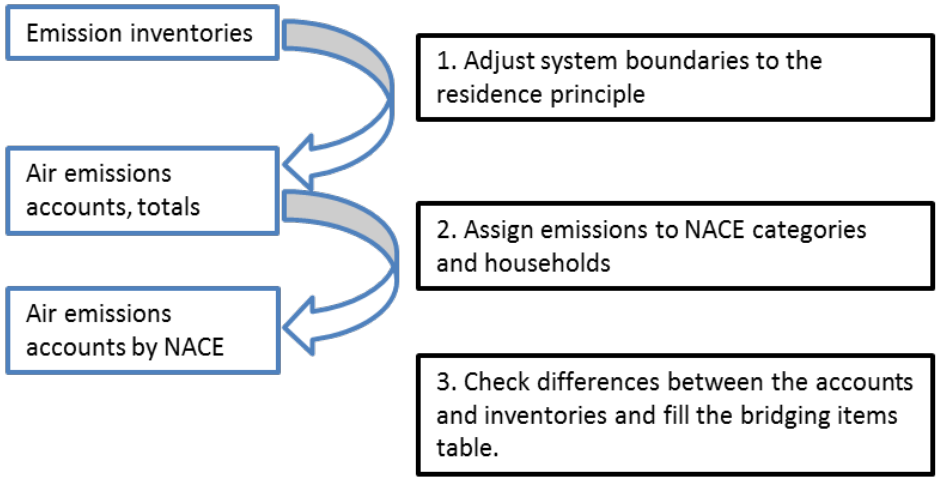
140. Fugitive emissions (CRF/NFR code 1B) arise from fuel uses and inventories. Note that energy statistics usually only provide data on fuel uses. National circumstances need to be investigated carefully with national compilers of energy statistics and emission inventories to make sure that all fugitive emissions from fuel uses and fuel inventories/stocks are taken into account in AEA.

([22]) Eurostat (2010b).
([23]) Available at UNFCCC website (greenhouse gases) and EMEP/CEIP website (air pollutants).
([24]) http://www.ipcc-nggip.iges.or.jp/EFDB/find_ef_main.php
([25]) http://www.apef-library.fi/

4.2 The inventory-first approach

141. The inventory-first approach (Figure 6) starts from existing national emission inventories reported to UNFCCC and CLRTAP and adjusts and re-arranges those data to the AEA format. Expressed in a simplified way, in this approach the AEA compiler takes the existing inventory data and re-arranges them.

Figure 6: Schematic overview of the inventory-first approach



142. In a first step it is recommended to adjust the system boundaries in order to obtain the AEA totals. National emission inventories follow the territory principle whereas AEA follows the residence principle (see section 2.2.2 and chapter 6).

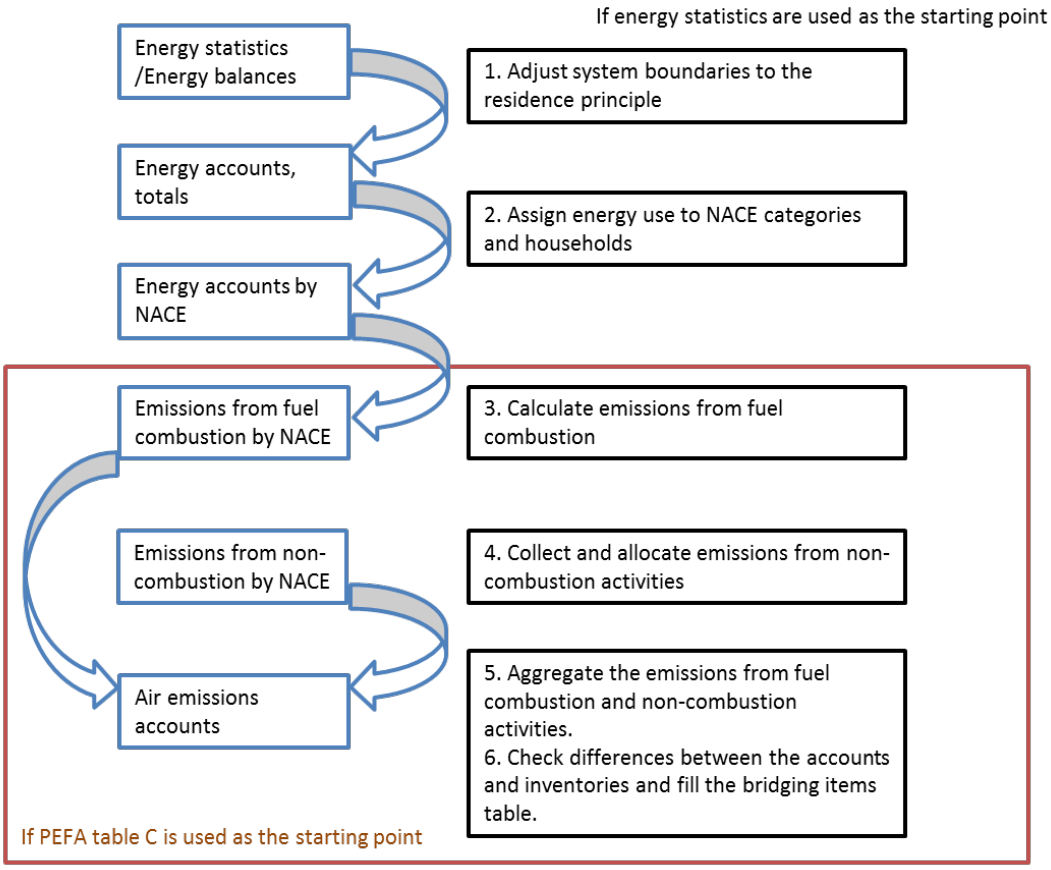
143. In a second step each inventory source category (CRF/NFR source code) needs to be assigned to the emitting production activity (i.e. NACE grouping) and/or private household consumption activity (see chapter 7 and Annex 1).

144. In a third step the differences between inventory totals (territory principle) and AEA totals (residence principle) are determined in detail and assigned to the bridging items (see also section 6.4). Step 3 and step 1 are strongly interrelated.

4.3 The energy-first approach

145. Some countries use energy statistics/balances as the starting point for compiling AEA. A schematic overview of this energy-first approach is shown in Figure 7. Please note that the order of the steps in the compilation process may vary.

Figure 7: Schematic overview of the energy first approach



146. Put in a simplified way, the AEA compiler first adjusts and re-arranges energy data according to national accounts principles and rules to arrive at energy accounts. First the adjustment is done for the economy total; secondly energy use data are broken down by NACE groupings and private households' consumption activities. The resulting energy accounts by NACE are very similar to physical energy flow accounts (PEFA).

147. Physical energy flow accounts (PEFA) constitute re-arranged energy statistics following the accounting principles and rules of national accounts. Eurostat's PEFA questionnaire includes Table C 'Emission-relevant use table' which shows the emission-relevant use of energy products and residuals in a breakdown by NACE groupings and private households. PEFA Table C is the most suitable data source for the energy first approach. In case PEFA Table C is available, steps 1 and 2 in Figure 7 are obsolete.

148. In a third step, emissions from the use of energy products are calculated using the general emission model (see section 4.1) employing specific emission factors. For this step it is crucial to apply the same emission factors as employed by compilers of national emission inventories.

149. Note that in a strict sense the energy-first approach is only valid for estimating emissions arising from the combustion of energy products (CRF/NFR codes starting with 1.A 'emissions from fuel combustion activities' ([26])). Hence step 4 concerns the non-combustion emissions. The non-combustion emissions (industrial processes, agriculture, waste etc.) are most likely taken from the national emission inventories and assigned to economic activities in the same manner as in the inventory first approach.

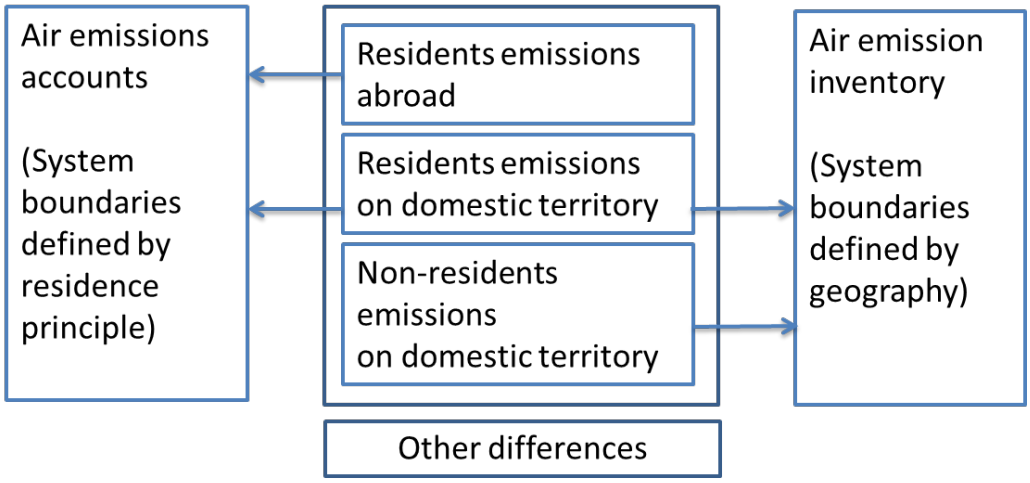
150. Step 5 combines both, fuel combustion and non-combustion emissions.

151. In a sixth step the differences between inventory totals (territory principle) and AEA totals (residence principle) are checked in detail and assigned to the bridging items (see also section 6.4). Note that step 6 and step 1 are closely related.

4.4 Multi-purpose data system approach

152. Some countries ([27]) have developed a multi-purpose data system approach. As illustrated in Figure 8, a central data system (e.g. databases) with all kinds of emission data at very detailed level is used to populate both: national emission inventories and AEA.

Figure 8: Schematic overview of the multi-purpose data approach for developing air emission inventories and air emissions accounts



153. This data arrangement allows combining different parts of the databases depending on *whether a territory-based system boundary definition is used (for national emission inventories) or* whether the system boundaries are defined by the national accounts' residence principle (see also section 2.2.2).

154. If each of the entries in the data system has breakdowns by NACE (and households) the process of developing air emissions accounts according to standard NACE groupings can be relatively straight forward.

([26]) In the case of UNFCCC inventories also including CRF codes starting with 1.D
([27]) According to quality reports submitted together with the 2013 questionnaire, countries using this approach include Germany, France and Norway.

5 Getting access to data

155. Air emissions accounts (AEA) are compiled from a wide range of already existing data. The data sources can be quite diverse depending on which compilation approach or combination of compilation approaches is chosen (see chapter 4). Evidently the range of potentially useful data sources also strongly depends on the national circumstances; relevant primary data and statistics are differently organised across countries. This chapter provides an overview on mainly international data sources which might be of interest for AEA compilers.

5.1 National emission inventories

156. There is significant policy interest in air emissions, particularly carbon dioxide and other greenhouse gas emissions but also air pollutants. In many countries national data for air emissions are available annually in form of so-called national emission inventories. There are two national emission inventories established under two international conventions and including different groupings of substances emitted to the atmosphere:

— **UNFCCC** ([28]) **greenhouse gas inventories**: primarily ([29]) CO_2, N_2O, CH_4, HFCs, PFCs, SF_6 and NF_3;,

— **CLRTAP** ([30]) **air pollutant inventories**: NO_X, CO, NMVOC, SO_X, NH_3, particulate matter, 9 heavy metals, 17 persistent organic pollutants (POPs).

157. Both national emission inventories usually become available in spring.

158. UNFCCC inventories follow the CRF ([31]) classification and CLRTAP inventories use the NFR ([32]) classification. Please note that the CRF and NFR nomenclature are very similar but NOT identical! For this reason AEA compilers need to treat CRF and NFR as separate variables in their AEA compilation system. A correspondence table between CRF, NFR and NACE is provided in Annex 1.

159. National emission inventories are detailed and elaborated data systems including a huge variety of emission sources and sinks for numerous substances. They provide an excellent data source for AEA compilers in particular for the so-called 'inventory-first-approach' (see chapter 4). Close cooperation between AEA compilers and the producers of national emission inventories is important and beneficial for both parties.

160. For each annual submission the entire time series in national emission inventories are provided because often the entire time series are revised due to e.g. improved estimation methods. For this reason the annual AEA questionnaire (see section 3.1) also includes the entire time series accommodating potential revisions of the time series. It is recommended to use data not only for the most recent year but to actually replace data for all years using data from the latest submission of national emission inventories.

([28]) United Nations Framework Convention on Climate Change.
([29]) See paragraph 70.
([30]) Convention on Long-range Transboundary Air Pollution.
([31]) Common Reporting Format.
([32]) Nomenclature for Reporting.

5.1.1 Greenhouse gas emission inventories (UNFCCC)

161. Greenhouse gas (GHG) inventories report emissions data under the United Nations Framework Convention on Climate Change (UNFCCC). They record emissions and sinks of greenhouse gases by categories. The principles and methodology to compile GHG inventories are laid down in several guidelines developed by the Intergovernmental Panel on Climate Change (IPCC). The sources are classified according to the Common Reporting Format (CRF). Each annual submission includes an updated and consistent time series from 1990 onwards.

162. GHG inventories reported in 2014 (and earlier) under the first commitment period of the Kyoto protocol (covering 1990-2012) follow the UNFCCC reporting guidelines ([33]), the revised IPCC 1996 Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines, 1996) ([34]), the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC GPG, 2000) ([35]) and the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC GPG-LULUCF, 2003) ([36]).

163. The second commitment period starting from the 2015 submission introduced several changes. Most importantly, the 2006 IPCC Guidelines ([37]) replace earlier guidelines published in 1996, 2000 and 2003. The UNFCCC reporting guidelines and – most importantly – the CRF classification have been updated ([38]). Emissions of NF_3 are added to the reporting. Data submitted in 2015 and the coming years will for each year include an updated and consistent time series starting in 1990.

164. There are several ways of accessing GHG inventory data:

Nationally

165. GHG inventory data are always published nationally. The layout and accessibility varies across countries and it may matter for easy processing into AEA. The best option is to establish contact with your national GHG inventory producer and agree on a procedure for annual deliveries of or, even better, constant access to databases for the AEA compilers. Cooperation with the GHG inventory producers is beneficial both for the AEA and the GHG inventory, because inventory compilers are heavy users of official statistics.

European Environment Agency (EEA)

166. The European Environment Agency (EEA) coordinates the collection of national GHG inventories and publishes them. The EEA also compiles a GHG inventory for the aggregated EU. At the EEA website national (and EU-wide) GHG inventories can be downloaded in two formats:

- Access database (mdb)
- Flatfile or Excel format, respectively (csv)
- Note 1: Rows where the variable “Pollutant name” is named “All greenhouse gases - (CO_2 equivalent)” provides a summary of all greenhouse gases for given CRF categories. Using both data for individual greenhouse gases and “All greenhouse gases -

([33]) UNFCCC (2006): FCCC/SBSTA/2006/9.
([34]) IPCC (1996).
([35]) IPCC (2000).
([36]) IPCC (2003).
([37]) IPCC (2006).
([38]) UNFCCC (2013).

(CO_2 equivalent)" will introduce double counting of GHG emissions into the AEA and should be avoided.

— Note 2: CO_2 emissions from combustion of biomass (CRF category 1) are reported as a memo item to the UNFCCC. This is however not included in the dataset provided at the EEA website. CO_2 emissions from combustion of biomass are part of the AEA questionnaire, treated as a separate substance.

UNFCCC

167. The raw GHG data as submitted from countries to UNFCCC are also available and accessible through the UNFCCC website. The format is CRF reporter (EXCEL questionnaire) and as such, not really suitable for processing. The EEA database is much more suited for data processing. However, the original CRF reporter (EXCEL questionnaire) might be of value to look up certain details, e.g. which activity data, such as energy use are used by the producers of GHG inventories.

5.1.2 Air pollutant inventories (CLRTAP)

168. National emission inventories for air pollutants report emission data under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP) and the EU National Emission Ceilings Directive (NEC) ([39]). The principles and methodology to estimate air pollutant inventories are laid down in the EMEP/EEA air pollutant emission inventory guidebook ([40]). The European Environment Agency (EEA) publishes the Guidebook, with the UNECE's Task Force on Emission Inventories and Projections (TFEIP) having responsibility for the technical content.

169. Air pollutant emission inventories record the emissions of a wide range of substances from sources classified according to the Nomenclature for Reporting (NFR). Recently (starting with 2015 submissions) the NFR has been revised from NFR09 to NFR14. The NFR14 is - as far as relevant - aligned to the new CRF used in UNFCCC inventories (see above section 5.1.1).

170. There are several ways of getting access to air pollutant inventory data:

Nationally

171. Air pollutant inventory data are always published nationally. The layout and accessibility to published detailed data that easily can be processed into AEA varies across countries. The best option is to establish contact with the producers of national air pollutant inventories and to agree on a procedure for annual deliveries of data or access to databases for the AEA compilers. Cooperation with the air pollutant inventory producer is beneficial both for the AEA and the air pollutant inventory.

European Environment Agency (EEA)

172. For EU member states, EEA coordinates the collection of national air pollutant inventories. It also compiles the data and publishes aggregated EU figures. Data are available at the EEA website in two data formats:

— Access database (mdb)

— Flat file or Excel format, respectively (csv)

([39]) Directive 2001/81/EC.
([40]) EMEP/EEA (2013).

173. Please note that the unit varies for different air pollutants.

Centre on Emission Inventories and Projections (CEIP):

174. Air pollutant emission inventory data are also accessible through the CEIP website. Always choose the most recent submission. Select your country and click/download NFR tables. The tables are in MS Excel format. Obtaining data from CEIP website might be useful, but primarily using the data published by EEA is recommended.

5.2 Energy data

175. Combustion of fossil fuels and biomass and the handling of energy products are major sources for emissions of air pollutants and greenhouse gases. Energy data form an indispensable data source for calculating/estimating air emissions (see section 4.1).

176. There are various ways of accessing energy data and the best one for the precision and quality of your AEA will depend on your national circumstances. Please note that if energy data based on the residence principle (e.g. PEFA) is used, adjusting the system boundaries (chapter 6) will not be necessary.

177. At international level energy statistics have been harmonised/standardised through a joint annual questionnaire operated by the International Energy Agency (IEA), Eurostat, and the UN. Nevertheless the way how national data, statistics, and in particular balances are organised and presented vary considerably across countries. Most national energy balances have different formats (and concepts) compared to those of IEA and Eurostat.

5.2.1 National energy statistics

178. Energy statistics are always published nationally. The layout and accessibility to detailed data nationally published which can easily be processed into AEA varies across countries. The best option is to establish contact with producers of national energy statistics and agree on a procedure for annual deliveries of energy data. The best of all solutions is to get constant access to your national energy databases. Cooperation with the producers of energy statistics is beneficial for both, the AEA and the energy statistics.

5.2.2 Eurostat - energy statistics and energy balances

179. Annual energy statistics are reported to Eurostat using the joint IEA/Eurostat/UN questionnaires. Eurostat processes the reported energy statistics in a standardised format called Eurostat's energy balances. Note that Eurostat's energy balances are different from national energy balances and the IEA energy balances due to historic reasons: concepts and formats of national balances were developed before Eurostat and IEA established their balances. Eurostat's energy balances are published on its website.

5.2.3 Eurostat – physical energy flow accounts (PEFA)

180. Energy accounts are a module of Regulation (EU) No. 691/2011 on European environmental economic accounts as amended by Regulation (EU) NO. 538/2014 ([41]) in 2014. Physical energy flow accounts (PEFA) have been developed by Eurostat according to the accounting structures and

([41]) Regulation (EU) No 691/2011 of the European Parliament and of the Council of 6 July 2011 on European environmental economic accounts as amended on 16 April 2014.

principles of the SEEA-CF and belong to the main area of SEEA-CF physical flow accounts ([42]).

181. The aim of PEFA is to describe the physical flows of energy within the economy and between the natural environment and the economy. Energy inputs, energy products and energy residuals are recorded in physical supply and use tables (PSUT). The conceptual foundations, the PEFA questionnaire, and general compilation guidelines are described in detail in the PEFA manual ([43]).

182. Until 2016, reporting is on a voluntary basis. Mandatory PEFA reporting will start in September 2017 and data will be published on the Eurostat website in 2018. PEFA covers energy flows for reference year t-2 (i.e., the energy flows for the reference year 2015 will be reported in 2017). There are two options on how to use PEFA for compiling the AEA – you can choose the option most suitable for your national circumstances:

— Use PEFA to adjust and assign (distribute) emission inventory data to detailed NACE groupings and private households.

— Calculate emissions by multiplying PEFA emission-relevant energy use data (table C) with fuel-specific emission coefficients (see also section 4.3).

([42]) United Nations et. al. (2014): System of Environmental-Economic Accounting – Central Framework: Chapter 3.
([43]) Eurostat (2014b).

6 Adjusting original source data to AEA residence principle

183. Air emissions accounts (AEA) follow the national accounts residence principle (see section 2.2.2) whilst the original source data based on which AEA are compiled – namely national emission inventories and/or energy statistics – most often follow a kind of territory principle. The compilers of AEA need to adjust the original data to the residence principle – this is referred to as 'residence adjustments'. This chapter provides guidance for this.

184. National emission inventories in principle report the emission originating from the territory regardless of whether the emitter is a resident unit or non-resident unit (territory principle). E.g. transport emissions from non-residents operating motor vehicles on the territory (e.g. transit) are included in national emission inventories. Note that emissions may be calculated based on transport fuel sales statistics; in which case emissions may occur outside the country to which emissions are assigned (see section 2.3.1 paragraphs 55-56 and 61).

185. Energy statistics report the supply and use of energy products related to a given country; here the energy use corresponds to all sales on the territory regardless of whether the purchaser is a resident unit or non-resident unit. E.g. kerosene sold at a domestic airport to a non-resident – e.g. a foreign airline company – operating a domestic flight is included in energy statistics.

186. AEA follow the residence principle – a common principle in national accounts (see section 2.2.2) – i.e. all air emissions by resident units are accounted regardless of the geographical location. E.g. emissions by a resident airline operating an international flight between two foreign airports are included in AEA.

187. Converting original source data from the territory to the residence principle is one fundamental step when AEA is compiled using national emission inventories and/or energy statistics. It is recommended to start the residence adjustment for the national total – in the cases of the inventory first approach (see section 4.2) as well as in the case of the energy-first approach if PEFA Table C is not available (see section 4.3). A residence adjustment is not necessary when compilation departs from PEFA Table C as the latter already follows the residence principle.

188. The residence adjustment of national air emission inventories means:

– deducting the emissions due to non-resident units operating on the national territory and

+ adding the air emissions due to resident units operating abroad.

Typically these necessary adjustments relate to international transport – land, water and air - as well as to tourism and fishing vessels (see sections 6.2 and 6.3). The relative importance of these activities in the overall adjustment depends on the size and structure of the respective economy (see also section 6.1).

189. The reader finds additional relevant and detailed information in Annex 3. Chapter 7 also provides guidance as techniques used to allocate emissions to economic activities are often useful also for the residence adjustment.

6.1 Prioritising the residence-adjustments to be made

190. It is important to focus on adjusting for the quantitatively big items and not spend too much time and resources on tackling items that are theoretically correct but quantitatively of minor importance. Adjustments of minor importance could be addressed in coming years as time and resources allow.

191. Looking at the structure of the national economy, the taxation system, transportation, fishing and tourism statistics plus the geographic location of a country helps to identify the relevance of various residence adjustment issues. The size and development trends of different industries are important, e.g. for industries such as water transport (NACE 50), land transport and transport via pipelines (NACE 49), air transport (NACE 51) and fishing and aquaculture (NACE 03). If these industries are large and/or growing, they should be prioritised.

192. Examples of residence adjustment items that may be important are presented in Table 4 (list is not exhaustive). Corrections to ensure consistency with the national accounts' residence principle are most important for emissions from transport.

193. It is preferable to make specific estimates for each item. Estimates are most likely to be based on auxiliary data, particularly energy use and transport statistics (see sections 6.2 to 6.3.7 below). Detailed knowledge on how estimates in the emission inventory are produced is necessary for choosing the most appropriate auxiliary data and estimation methods.

194. Detailed balance of payments (BoP) statistics may provide auxiliary information to undertake residence adjustments particularly in the area of international transport (road, water and air). The balance of payments provides information about expenditure of residents abroad and expenditure of non-residents on the territory. Detailed balance of payments statistics might provide the purchase of transport fuels by resident units operating abroad which should be separately identified as imported intermediate goods. Likewise fuel sales to non-residents should be recorded as exports in BoP statistics. These monetary data may be used to estimate corresponding emissions.

195. National accounts data may provide useful information on residents' consumption expenditure abroad as well as non-residents consumption expenditure on the territory.

196. Statistics on imports/exports in combination with energy statistics may also provide auxiliary data useful for making resident adjustments. According to the guidelines for European foreign trade statistics ([44]) fuels delivered to foreign aircrafts and vessels at domestic airports and harbours shall be included in exports. On the other hand, energy statistics report these amounts as domestic use. A comparison of foreign trade statistics and energy statistics can reveal the amount delivered to foreign aircrafts and vessels.

197. If there are taxes or tax exemptions on transports in your country, check if (background data or statistics regarding) any of these may be applicable for developing a methodology for residence adjustment. Tourism statistics or the tourism satellite accounts (TSA) in Europe ([45]) may help to evaluate adjustments for tourism activities especially since there is country specific information.

([44]) Eurostat (2014c).
([45]) Eurostat (2013b).

Table 4: Issues likely requiring residence adjustments

Issue requiring residence adjustment	Countries for which residence adjustments may be particularly relevant for the respective issue
International water transport	Countries with large ocean transport fleets: e.g. Norway, Greece, Denmark, the Netherlands, United Kingdom.
International air transport	Most countries but especially those with big airport 'hubs': e.g. Netherlands, UK, Germany, Italy, France, Denmark.
International road transport	Countries where companies operate transport services abroad (mostly lorries and coaches).
Fishing vessels	Countries whose fishing vessels are active in areas far from national fishing areas: e.g. Portugal, Spain, Norway, Ireland, Iceland.
Tourism (private car driving) (non-resident units on national territory)	Countries that attract comparably large numbers of foreign tourists: e.g. Malta, Cyprus, Spain, France, Italy, Switzerland, Austria, UK.
Tourism (private car driving) (resident units operating abroad)	Countries whose residents often leave the national territory for holidays using their own vehicles: e.g. Belgium, Luxembourg, The Netherlands, Slovenia.
'Fuelling tourism' (often induced by differences in tax levels)	Countries where non-residents prefer to purchase gasoline and diesel due to significant lower fuel prices: e.g. Luxembourg, Sweden and Denmark (from Norway). It is useful to check differences in fuel prices and taxes in neighbouring countries to determine the relevance of this effect.
Transportation in pipelines	When pipelines are located in international territories – such as the sea floor there may be some issues related to residence and how the energy use in the pipelines is recorded. The energy use in the non-resident pipelines should be coordinated with how this is treated in the National Accounts. Relevant for Norway, the Netherlands, and potentially Denmark and Iceland in the future.

6.2 Road transport

198. AEA record road transport emissions caused by resident units for domestic ([46]) as well as international ([47]) journeys. In contrast national emission inventories and energy statistics provide data related to the territory – more precisely fuel sales on the territory (including fuel sales to resident as well as non-resident units). E.g. if national emission inventory data is used, emissions of non-resident units fuelling on the domestic territory need to be excluded. Emissions caused by resident units operating transport services abroad (mostly lorries and coaches) and resident units driving their cars abroad e.g. for tourism, need to be added.

199. How to do this in practice depends on what data are available in your country that can be used as auxiliary information sources.

([46]) A domestic journey starts and ends on the domestic territory.
([47]) An international journey starts from one country and ends in another country.

6.2.1 Using statistics on energy consumption as auxiliary data

200. If data on total consumption of each fuel type for road transport on the national territory can be split by residents and non-residents, the share of emissions due to non-resident units driving in the country can be assumed to be equal to the share of non-residents' fuel consumption of each fuel type for road transport on the national territory as related to total consumption for the same fuel type.

201. If fuel purchases for road transport purposes abroad by resident units are known, the corresponding emissions could be estimated by a similar equation.

6.2.2 Using road transport statistics as auxiliary data

202. Road transport statistics (in passenger kilometres or tonne kilometres) could be used to estimate the components to be added/subtracted as a proportion of the inventories' emissions.

203. The first step is to split data on road transport emissions into passenger transport and freight transport. This can be partially derived from the emission inventories (see Table 5). An estimation of buses versus other heavy duty vehicles needs to be made, preferably by contacting the producers of national emission inventories, other relevant national experts or using some kind of transport statistics.

Table 5: Transportation type for different vehicle categories as delineated in emission inventories

Passenger transport	Freight transport
passenger cars	light duty vehicles
heavy duty vehicles and buses for part "buses"	heavy duty vehicles and buses for part "heavy duty vehicles"
mopeds and motorcycles	

Freight road transport

204. Emissions may be assumed to be proportional to the corresponding volumes ([48]) expressed in tonne kilometres (Tkm) of freight road transport (see Eurostat's transport statistics). Calculations can be performed for each component as shown in Table 6. Select Road transport/Road freight transport measurement ([49]). The data can be used as shown in

([48]) Based on the assumption that the transport volumes by vehicles registered in the reporting country correspond to fuel purchases on the territory.
([49]) Note that the basis for this statistics are vehicles registered in the reporting country.

205. Table **7**.

206. Emissions from resident units are to be included in the AEA.

Table 6: Components for calculating road transport emissions for freight transport

		Residents	**Non-residents – to be subtracted**
Included in emission inventories and energy statistics	Domestic journeys	A: transport of goods by residents within national territory	B: transport of goods by non-residents within national territory
	International journeys leaving from the country	C: transport of goods by residents for international journeys leaving from the country	D: transport of goods by non-residents for international journeys leaving from the country
To be added	International journeys bound to the country	E: transport of goods by residents for international journeys leaving from a foreign country and bound to the country	
	International journey entirely abroad	F: transport of goods by residents for international journeys operating entirely abroad	

Table 7: Eurostat statistics on freight road transport suitable as auxiliary data for AEA residence adjustments

Letter mentioned in Table 6	Eurobase	Variable selection
A	National annual road transport by group of goods and type of transport	Reporting country: Your country Group of goods: total Type of transport: total
B	Road cabotage transport by country in which cabotage takes place	Partner: Your country
C	International annual road freight transport – goods loaded in reporting country by type of transport	Reporting country: Your country Type of transport: total Unload: all countries of the world
D	International annual road freight transport by country of loading and unloading and by reporting country	Load: Your country Unload: all countries of the world Reporting country: all excluding your country
E	International annual road freight transport – goods unloaded in reporting country by type of transport	Reporting country: Your country Type of transport: total Load: all countries of the world
F	Road cabotage by hauliers from each reporting country Quarterly cross-trade road freight transport by type of transport	Reporting country: Your country Reporting country: Your country Type of transport: total Load: all countries of the world Unload: all countries of the world

Passenger road transport

207. Distributing emissions from road passenger transport may be very difficult. Depending on national circumstances, try for example methods indicated below.

208. National database: there might be a database of registered cars in your country, including information on the car owner (e.g. vehicle fleet model). Databases with information on mileage for different cars and other vehicles types might also exist. Such information might be provided through car inspection authorities etc.

209. Using auxiliary data from Eurostat: A variety of transport data is published by Eurostat.

210. Coefficients from similar countries: this option is to be used only if no other data are available.

6.3 Other transport modes

6.3.1 Railways

211. If there are substantial operations of domestic train companies operating internationally or non-resident trains on the national territory, an adjustment for the resident principle may be relevant.

6.3.2 Pipelines

212. The amount of energy used in transporting petroleum, natural gas and water in pipelines is substantial. Although these are fixed installations there may be some unclear issues regarding residence when pipelines are located in international waters as well as import or export issues regarding the energy used to move products in the pipeline.

6.3.3 Fishing

213. In emission inventories and energy statistics, national fishing includes all fuel supplied to commercial fishing activities in the country. Emissions stemming from foreign fishing vessels, which purchase their fuel on national territory, need to be excluded and emissions of national fishing vessels purchasing fuel abroad need to be included.

214. For countries in which international fishing is a significant activity of the resident fleet (for example Spain, Ireland, United Kingdom, Denmark and Norway), it is likely that national fishing emissions need to be complemented by the estimated emissions related to overseas activities of resident units operating fishing vessels abroad.

6.3.4 Domestic navigation

215. Emissions from domestic navigation refer to emissions from shipping vessels between two ports of the same country, irrespective of flag or nationality of the vessel. In order to be consistent with the national accounts' residence principle, only emissions from resident units' shipping vessels should be included. Statistics to look for in order to derive resident units' emissions are presented below. (Check the consistency between the definition of resident units in the available statistics and the national accounts definition).

216. Fuel use statistics: if data on total use for domestic navigation of each fuel type can be broken down by resident units and non-residents, air emissions can be assigned with the same respective shares.

217. Tax rates: In some countries there are different tax rates on maritime fuels so the tax revenues and tax rates can be used to distinguish the resident/non-resident fuel purchases.

218. Transport statistics: if primary data or statistics on domestic water transport include a breakdown by nationality of the operator, emissions can be assigned with the same respective shares.

6.3.5 International navigation

219. Emissions from international navigation refer to emissions from shipping vessels' bunkering on the territory for journeys between a domestic port and a foreign port; i.e. related to journeys originating from domestic ports.

220. In order to be consistent with the national accounts' resident principle, resident's emissions need to be singled out. Also, emissions caused by shipping vessels operated by resident units and bunkering fuel abroad for international journeys need to be added.

221. Possible sources and methods in order to derive non-residents' emissions are presented below. In order for any of these methods to be applied, the consistency between the definition of resident units in the available statistics and the national accounts definition should be checked.

222. Fuel use statistics: if data on the total use of bunker fuel (by fuel type) for international navigation can be broken down by residents and non-residents, air emissions can be assigned with the same respective shares. In addition, emissions from shipping vessels operated by resident units bunkering fuel abroad for international water traffic could also be calculated on the basis of resident units' fuel bunkering abroad, if available.

223. Transport statistics: if statistics on international water transport (e.g. in tonne kilometres) include a break down by nationality of the operators, air emissions can be assigned with the same respective shares.

6.3.6 Households' water transport

224. In many countries, private households' use of leisure boats is usually within the national territorial waters so there is no need to adjust for the residence principle for households – or the adjustment would be very minor.

6.3.7 Air transport

225. For domestic aviation, it might be the case that domestic flights are run by resident companies only. If so, they can be included as such in the AEA (this may be an assumption particularly for the first years of the emissions time series). If domestic flights are operated both by resident and non-resident companies, emissions due to domestic flights operated by resident units only need to be singled out. It is preferable, whenever possible, to use energy-based estimates. Alternatively, if transport statistics allow for a distinction between flights operated by resident companies and by foreign/non-resident companies, the share of emissions due to resident units out of total domestic air traffic emissions can be assumed to be equal to the share of domestic flights run by resident companies out of total flights ([50]). Where data on km exist, it is preferably to use them. In order to be consistent with the national accounts it is also relevant to check with national accounts whether or not foreign companies performing domestic flights are regarded as resident units.

226. For international aviation, similarly to the case of domestic air transport, if no data on energy use, passengers or tonne-kilometres are available, the share of energy or emissions due to resident companies out of total international air traffic emissions can also be assumed to be equal to the share of international flights run by resident companies out of total international flights ([51]).

6.4 Filling the bridging items

227. The so-called 'bridging items' section can be found at the bottom of each pollutant sheet in Eurostat's electronic questionnaire. The 'bridging items' were developed to explicitly show for each pollutant the differences between AEA total and national totals as reported by the country to UNFCCC and CLRTAP.

228. There are two main causes for these differences: The first is the conceptual difference between the residence principle and the territory principle (see section 2.2.2). The second cause is

([50]) Based on the very crude assumption that each domestic flight has an equal amount of emissions.
([51]) Based on the very crude assumption that each international flight has an equal amount of emissions.

the scope/definition of the totals in national emission inventories (see section 2.3); e.g. international aviation is completely excluded from totals in UNFCCC inventories. Annex 3 provides a detailed description of the potential differences between AEA totals and national emission inventories' totals for each transport mode and inventory type (UNFCCC versus CLRTAP).

229. Reporting bridging items is important for users as it helps to understand the causes and the magnitude of differences between two official statistics on air emissions. Bridging items also help in making international comparisons. E.g. in the case of Luxembourg the national emission inventory totals are much higher than the AEA totals due to significant 'fuelling tourism'.

230. Table 8 shows and explains the bridging items as they appear in Eurostat's electronic questionnaire. Annex 3 presents for each transport mode the differences in coverage between AEA totals and UNFCCC/CLRTAP totals providing practical indications to compilers.

Table 8: Bridging items for each air pollutant

Bridging item	Description
Air emissions accounts totals (industry + households)	This covers the emissions of resident units, both emissions from production activities and household consumption. Emissions caused by residents' activities operating abroad are included and emissions caused by non-residents on the territory are excluded. Note that AEA totals for CO_2 exclude CO_2 from biomass which is treated as a separate substance in AEA (see also paragraph 104).
Less national residents abroad - National fishing vessels - Land transport - Water transport - Air transport	Emissions by resident units abroad – broken down by transport mode – are deducted. See Annex 3 for further detailed guidance.
Plus non-residents on the territory + Land transport + Water transport + Air transport	All emissions by non-resident units on the territory need to be added as long as they are taken into account in the national emission inventory totals (i.e. UNFCCC and CLRTAP totals). Note that UNFCCC and CLRTAP totals exclude partly international aviation and international water transport emissions, so that only the difference needs to be recorded here. See Annex 3 for further detailed guidance.
(+ or -) Other adjustments and statistical discrepancy	As appropriate, report additional differences. This could be for example the use of emission factors different from those used within the national emission inventory (see section 4.1) or certain allocation issues.
= 'Total emissions as reported to UNFCCC/CLRTAP	The totals as reported in national emission inventories and submitted to UNFCCC/CLRTAP. See Annex 3 for detailed description of what is included in UNFCCC totals and CLRTAP totals. Note that CO_2 totals in UNFCCC inventories exclude CO_2 emissions from biomass (see also paragraph 104).
Year of submission to UNFCCC/CLRTAP	Submission year of the UNFCCC/CLRTAP inventory used to fill the previous field. Usually the same year in which the AEA questionnaire is completed.

Net reporting of bridging items

231. It may be the case that AEA compilers can only determine the following two residence adjustment items on a net basis:

— Less national residents abroad

— Plus non-residents on the territory

In such a case it is recommended to record the net amounts under 'Less national residents abroad' and to report a zero for the 'Plus non-residents on the territory'. Please add footnotes to both explaining that the residence adjustments are reported net.

7 Assigning emissions and energy use to economic activities

232. In air emissions accounts (AEA) data are broken down by emitting economic activities (see also section 3.1 and Figure 4). Emissions from production activities are broken down by NACE A*64 level and emissions from households' consumption activities are broken down by three purposes (see also Annex 2 for the classification of economic activities applied in AEA).

233. The most common original data source to compile AEA – namely, national emission inventories and energy statistics – are organised differently, i.e. have data structure excluding a NACE dimension. Hence, the original source data need to be assigned and distributed to the economic activities in AEA (NACE groupings and households, see Annex 2).

234. This chapter starts with an overview of three general steps recommended for assigning emissions to economic activities (section 7.1). Section 7.2 explains the correspondence between CRF/NFR sources and NACE groupings. Section 7.3 gives some general guidance for using energy statistics followed by some specific issues related to road transport (section 7.4), emissions of F-gases (section 7.5), solvents use (section 7.6), and household emissions (section 7.7).

7.1 Three general assignment steps

235. The original source data used to create AEA – most notably national emission inventories and energy statistics – have their specific data structures and classification systems, which are not the same as the classification system for economic activities as applied in national and environmental accounts (i.e. NACE).

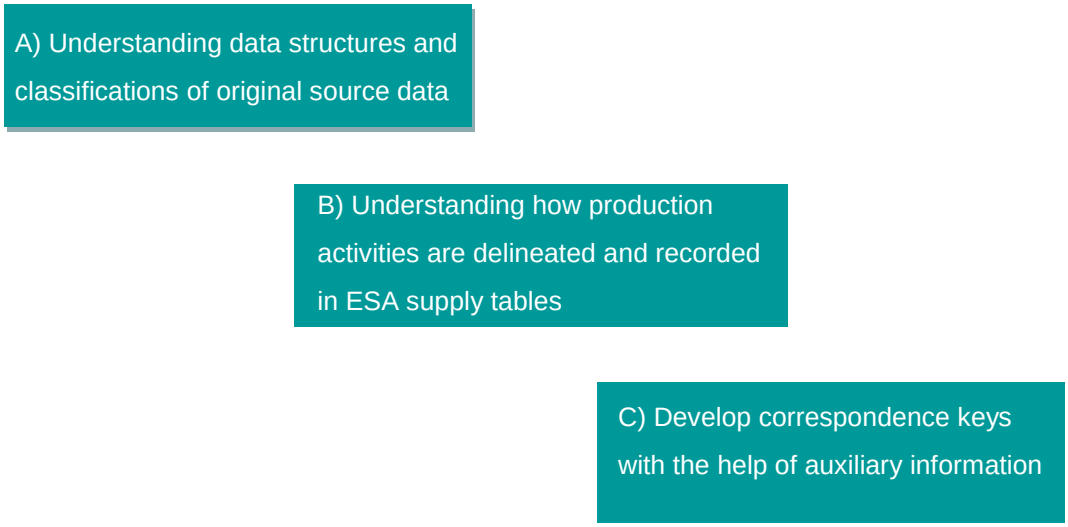
236. Compilers of AEA need to undertake a kind of conversion process that assigns the original source data to the AEA data structures, in particular NACE groupings. Three generic steps are recommended for this kind of conversion and assignment process (see Figure 11):

A) First, the compiler of AEA needs to understand the classification of the original source data.

B) Secondly, the AEA compiler needs to understand how national industries' production activities are delineated and recorded in the ESA supply tables.

C) Thirdly, AEA compilers need to develop a specific correspondence key ideally based on some appropriate auxiliary information.

Figure 9: Three steps to assign original source data to AEA's economic activities



7.1.1 Step A): Understanding data structures and classifications of original source data

237. It is essential that the compiler of AEA studies sufficiently all kinds of meta information related to the original source data with the aim to understand the concepts, principles, data structures and classifications. E.g. the CRF/NFR classification used in national emission inventories; or the categories of energy use applied in energy statistics.

238. The EMEP/EEA guidelines are a good source to study the exact meaning/scope of CRF/NFR categories. Sections 5.1 and 7.2 provide further details on data structures and classifications of national emission inventories and how they can be assigned to NACE groupings.

239. To understand energy statistics classification of energy use it is recommended to obtain a first overview from the Energy Statistics Manual and to study in detail the reporting instructions associated to the annual IEA/Eurostat/UN energy questionnaires provided on Eurostat's website. Sections 174 and 7.3 provide further information.

7.1.2 Step B): Understanding how economic activities are delineated in ESA supply tables (SUTs)

240. In AEA, emissions are recorded in a breakdown by economic activities including industries' production activities classified with NACE Rev. 2. Note that production activities (i.e. NACE groupings) in AEA must be delineated in the very same way as in the ESA supply table ([52]). Hence it is essential that the AEA compiler also understands how industries' production activities are delineated and recorded in the ESA supply tables (see also section 2.2.1).

241. At this point it is important to identify output from possible secondary production activities. More detailed information may be found in ESA 2010 and Eurostat's Manual of Supply, Use and Input-Output Tables.

([52]) In short, the supply table shows the domestic production of products (rows) by industries (columns).

242. For example, assume that the waste management industry – as a secondary activity – produces electricity and heat (e.g. from waste incinerators) and this secondary output is recorded in the waste management industry's column in the ESA supply table. In this case the air emissions associated with this secondary activity, i.e. electricity and heat production, also have to be recorded under the waste management industry in the AEA. AEA compilers should be aware of this.

243. The share of secondary outputs varies from industry to industry. Some industries may only have outputs from principal activity, while others will have a considerable amount of outputs from secondary activity (see also section 2.2.1). Secondary outputs have usually smaller value than primary outputs.

244. The ESA supply tables of all EU countries can be consulted via Eurostat's website. It is important to note that the degree of secondary output presented in national ESA supply tables varies considerable across countries. Some countries show almost no secondary activity output in their supply tables – implying that the compilers managed to delineate rather homogenous industries. Other countries show a lot of secondary activity output.

245. It is important that AEA compilers consult their national ESA supply tables to find out how much secondary activity output has been recorded. The following cases of possible secondary activity output are of significant emission-relevance:

— Iron & steel industry (NACE 24) producing coke (CPA 19) and coke oven gas (CPA 35);

— Production of electricity and heat (CPA 35) may occur as secondary activity in a wide range of industries (basically all NACE groupings). These cases are also referred to as so-called 'autoproducer production' in energy statistics.

7.1.3 Step C): Develop correspondence keys with the help of auxiliary information

246. Compilers of AEA need to develop certain correspondences to convert (i.e. assign, distribute) the original source data's classifications to NACE groupings and the three purposes for household's emissions. In general, two types of correspondences can be distinguished:

— a *one-to-one* correspondence between an original data source category and AEA category (i.e. NACE groupings and households);

— a *one-to-several* correspondence between an original data source category and a number of AEA categories.

247. For many categories of the source data there might be a simple straightforward one-to-one correspondence between the original source data category and the NACE categories. However, for several source data categories there is a one-to-several correspondence and some auxiliary information is needed to distribute the original source data over several NACE groupings.

248. One example is transport: in national emission inventories and energy statistics, transport is broken down by transport modes and technologies. In AEA transport-related emissions are to be assigned to the resident unit (i.e. NACE grouping or private household) undertaking the transport activity. Basically all industries as well as households undertake road transport. Significant efforts are required to allocate/distribute the original road transport source data to the AEA format, i.e. all industries and households. Allocating road transport is one of the most difficult parts of compiling AEA and calls for extra attention.

249. Additional auxiliary statistics may be useful to create correspondence keys for the re-allocation of original source data to the AEA format. Auxiliary data may comprise physical data (e.g. energy use or vehicle ownership), employment data and/or monetary data that provide additional information that helps to make a correspondence key. Various national accounts aggregates may also be used such as e.g. output and value added (here, preferably the supply tables should be used; see also previous section 7.1). National accounts data are available at Eurostat's website.

7.2 Correspondence between CRF/NFR and NACE Rev. 2

250. Annex 1 of this manual (separate EXCEL workbook available on Eurostat's website) is a correspondence table that links the CRF/NFR classification to NACE Rev. 2. Annex 1 is subject to on-going revisions.

251. In national emission inventories, emissions are reported by categories of the technical process-oriented classifications CRF and NFR, respectively. The first step to make the reallocation required for the AEA is to use the correspondence table provided in Annex 1:

- For some categories, Annex 1 will be enough to assign emissions to economic activities.
- For some categories, Annex 1 will provide a selection of economic activities that might be appropriate. However, additional information is also required.
- For some categories, Annex 1 will not be able to provide any guidance because the allocation to economic activities is too country specific.

252. The following sections 7.2.1 to 7.2.10 give specific guidelines related to the main chapters of the CRF/NFR classification.

7.2.1 Fuel combustion activities – energy industries (CRF/NFR code 1.A.1)

253. 'Public electricity and heat production' can be clearly allocated to NACE grouping C35. Note that in your national supply table also other industries may supply electricity and heat – so-called 'autoproducers' of electricity and heat.

254. 'Petroleum refining' can be clearly allocated to NACE grouping C19 'Manufacture of coke and refined petroleum products'.

255. 'Manufacture of solid fuels and other energy industries' is mainly referring to NACE grouping C19. However, it may happen that your national supply table allocates the production of coke as a secondary activity output to NACE grouping C24 'Manufacture of basic metals' ([53]) (see section

([53]) Including iron and steel manufacturing which as a by-product may produce coke.

7.1.2). If this is the case, the related emissions are also to be allocated to NACE C19. Also this CRF/NFR code may include combustion in oil and gas extraction which relates to NACE D.

7.2.2 Fuel combustion activities – manufacturing industries and construction (CRF/NFR code 1.A.2)

256. The following relations exist between the CRF/NFR codes and the AEA classification of production activities (NACE rev. 2):

- Iron and steel = C24
- Non-ferrous metals = C24
- Chemicals = C20 and C21
- Pulp, paper and print = C17 and C18
- Food processing, beverages and tobacco = C10-C12
- Non-metallic minerals = C23
- Manufacturing of machinery = C28
- Manufacturing of transport equipment = 29_C30
- Mining (excluding fuels) and quarrying = B
- Wood and wood products = C16
- Construction = F
- Textile and leather = C13-C15
- Off-road vehicles and other machinery = country specific
- Other (please specify) = potentially all not mentioned: C21, C22, C23, C26_27, C31_32, C33

7.2.3 Fuel combustion activities – transport (CRF/NFR code 1.A.3)

257. For road transport please see separate section 7.4.

258. Emissions from railways and pipeline transport are allocated only to NACE grouping H49.

259. All emissions from water transport in general are allocated to the shipping industry, i.e. NACE H50. However, emission inventories classify households own use of water transport means in national navigation. Private boats used by households needs to be separated from transport carried out as economic activity.

260. All emissions from aviation are allocated to NACE grouping H51. Military aviation (corresponding to NACE section O) should be specified if it is possible to estimate, using for example emission inventories, category 1A5b and memo item 'Multilateral operations'. If this information is reported as confidential, other available sources of information should be used or emissions should be allocated to civil aviation. Households' own use of aircraft is so minimal that is it is not worth the effort adjusting for this activity. For this reason, it can be assumed that all emissions from aviation are allocated to industries H51 and O.

7.2.4 Fuel combustion activities – Other sectors (CRF/NFR code 1.A.4)

261. CRF/NFR code 1.A.4 reports fuel combustion emissions (stationary combustion and off-road vehicles and other machinery) by other sectors. Other sectors include:

— 'Commercial/institutional' (1.A.4.a): This subsector includes a wide range of in particular service industries. The corresponding NACE groupings are provided in Annex 1. Distribution is difficult and compilers of AEA will need to be a bit creative and find some national data (e.g. energy use, employment, output) that may be used as a proxy for distributing the emissions to NACE.

— 'Residential' (1.A.4.b): This subsector relates one-to-one to households in the AEA questionnaire.

— 'Agriculture/forestry/fishing' (1.A.4.c): This sector includes emissions by NACE divisions 01 (agriculture), 02 (forestry), and 03 (fishing). The distribution of emissions across these three NACE groupings requires some auxiliary data such as e.g. fuel purchases. UNFCCC and CLRTAP emissions reported for fishing include non-resident units and hence require residence adjustments in AEA (see Annex 3).

7.2.5 Fuel combustion activities – Other stationary and mobile sources (CRF/NFR code 1.A.5)

262. This item mainly includes emissions from the military which is assignable to NACE grouping O (Public administration and defence; compulsory social security). Please not that the UNFCCC/CLRTAP emissions under this item include non-resident military fuelling on the territory which makes necessary residence adjustments in AEA (see Annex 3).

7.2.6 Fugitive emissions from fuels (CRF/NFR code 1.B)

263. Fugitive emissions refer mainly to venting and flaring. Annex 1 shows the correspondence between CRF/NFR classifications and NACE. With regards to fugitive emissions they mainly stem from mining of coal (NACE section B) and production/distribution of natural gas and oil (NACE sections B and D). If the assignment to NACE is not obvious, experts from the national emission inventory may have a solution. It is not worth spending too long on addressing very small emissions.

7.2.7 Total industrial processes (CRF/NFR code 2.)

264. Industrial processes are generally easy to identify by NACE since the producer unit often must report these point emissions to Pollution Control Authorities. The industry classification must somehow be associated with the reporting unit through a business register number or other identification.

265. There are many industrial processes but often there is a one-to-one correspondence between the economic activity of the emitter and the NACE classification. A close cooperation with the emissions inventory experts will facilitate allocation to NACE. The most important NACE groupings hosting relevant industrial processes are:

— NACE C23: including cement production.

— NACE C20: all sorts of chemical production processes.

— NACE C24: processes of metal production.

7.2.8 Agriculture (CRF/NFR code 3.)

266. This CRF/NFR category includes all non-combustion related emissions of the agriculture industry such as e.g. enteric fermentation (methane from animals), manure management etc.

267. The entire CRF/NFR category 3 is to be assigned to the agricultural industry (NACE 01).

268. In some countries, households may have substantial agricultural production for own final use. In that case the production would need to be divided between the agriculture industry (NACE 01) and the household sector. Households may also differ in their manure management so emissions calculations for this may also differ. But again, if households have substantial production for own-use, the air emissions inventory experts will probably have the necessary knowledge for calculating and assigning this correctly.

7.2.9 LULUCF (CRF/NFR code 4.)

269. Emissions from land use and land use change are excluded from the emission inventory totals as well as from AEA.

7.2.10 Waste (CRF/NFR code 5.)

270. Emissions from landfills are estimated based on the type of waste, landfill construction and other factors. These emissions are assigned to those who operate the waste disposal sites. NACE grouping E37-E39 does this as a principal activity. In some countries municipalities (NACE O) may be the operator; check in your national accounts' supply table who (which NACE groupings) is producing these services (CPA divisions 37 to 39) and assign emissions accordingly.

7.3 General guidance when using energy statistics and/or accounts

271. Compilers of AEA may use energy databases, energy statistics and/or energy accounts. This section provides some practical guidelines.

272. Compilers of AEA may have access to detailed national energy databases. In case those energy databases have a NACE breakdown (i.e. characterise the NACE code for a certain energy data item) they may constitute a rich pool of auxiliary information for the AEA compiler. Compilers of AEA are advised to explore the possible use of national energy databases for the purpose of AEA. The main benefit may lay in the possible derivation of more or less detailed distribution keys by NACE groupings (and private households). I.e. certain shares which can be used to assign air emissions to the emitting economic activities.

273. If already available, physical energy flow accounts (PEFA) may serve as an excellent source for AEA compilers (starting from 2017, energy accounts reporting will be obligatory). In particular PEFA Table C 'emission relevant energy use' is an excellent source of auxiliary information. PEFA Table C records the use of various energy products by industries (NACE A*64). The industry breakdown in PEFA Table C is the very same as in AEA.

274. PEFA Table C may be used in two ways:

- The emission-relevant use of a given product by a given industry can be multiplied with substance-specific emission factors to obtain the amount of air emissions emitted by the respective industry. Like this PEFA Table C is used as 'activity data' to calculate/estimate emissions for AEA.

- The row-vector of emission-relevant use of a given energy product may be used to derive shares for the 64 industries. Like this PEFA Table C is used to derive a distribution key that can be used to distribute/assign certain emission inventory data over industries. E.g. emission inventories provide just one single category for all service industries together which could be distributed via such a distribution key. Or, e.g. the emission relevant use of motor gasoline – as recorded in PEFA Table C) could be used to assign/distribute road transport emissions (as provided as single category item in national emission inventories) over all industries and private households.

275. Energy statistics are basically five annual questionnaires jointly collected by Eurostat, International Energy Agency (IEA) and UN. They constitute an internationally harmonised framework of aggregated energy data. Energy statistics are further aggregated to energy balances. Note that energy balances still vary across countries; the e.g. the national energy balance may differ from Eurostat's energy balance. In addition Eurostat energy balances are slightly different from IEA energy balances.

276. Eurostat's energy statistics/balance provide a quite detailed product breakdown by some 50 products. AEA compilers may use it as auxiliary information for e.g. making a split between energy-use versus non-energy-use.

277. Eurostat's energy statistics and balances provide a quite detailed breakdown of inputs and outputs of a range of so-called transformation sectors which might be an auxiliary data source for AEA compilers. The following Table 9 provides a correspondence between energy sectors (as defined in Eurostat/IEA/UN energy statistics) and NACE groupings (codes).

Table 9: Transformation sectors – as included in energy statistics – and their correspondence to NACE groupings

Transformation sector Label as in IEA/Eurostat questionnaires	NACE code	Comment
Main activity producer electricity plants	D35	
Main activity producer CHP plants	D35	
Main activity producer heat plants	D35	
Autoproducer electricity plants	all (potentially)	
Autoproducer CHP plants	all (potentially)	
Autoproducer heat plants	all (potentially)	
Patent fuel plants	C19	
Coke ovens	C19	
Gas works	D35	
BKB / PB plants	C19	
Coal liquefaction plants	C19	
Blast furnaces	C24	
Gas-to-liquids (GTL) plants	C19	
For blended natural gas	D35	
For blending to motor gasoline/diesel	C19	
Charcoal production plants	C20	

278. Eurostat's energy statistics/balances also provide a detailed breakdown by manufacturing industries which correspond with groupings of NACE divisions (see Table 10).

Table 10: Final energy use sectors – as included in energy statistics – and their correspondence to NACE groupings and groupings thereof

Final energy use sector Label as in IEA/Eurostat questionnaires	NACE groupings	Comment
Iron and steel	C24	
Chemical (including petrochemical)	C20, C21	
Non-ferrous metals	C24	
Non-metallic minerals	C23	
Transport equipment	C29-C30	
Machinery	C25, C26, C27, C28	
Mining and quarrying	B05-B09	
Food, beverages and tobacco	C10-C12	
Paper, Pulp and Printing	C17, C18	
Wood and Wood Products	C16	
Construction	F41-F43	
Textiles and Leather	C13-C15	
For transport see next table		
Commercial and Public Services	C33, E36, E37-E39, G45, G46, G47, H52, H53, I55-I56, J58, J59-J60, J61, J62-J63, K64, K65, K66, L68, M69-M70, M71, M72, M73, M74-M75,N77, N78, N79, N80-N82, O84, P85, Q86, Q87-Q88, R90-R92, R93, S94, S95, S96, T97-T98, U99	
Residential	Private households	(no NACE code)
Agriculture/Forestry	A01-A02	
Fishing	A03	

279. Eurostat's energy statistics/balances include several items related to transport. Table 11 provides the correspondence between transport items in energy statistics and NACE groupings.

Table 11: Transport related items as included in energy statistics and their correspondence to NACE groupings

Transport related items Label as in IEA/Eurostat questionnaires	NACE groupings	Comment
International marine bunkers	H50	Note that this item records the fuel delivered to all ships in domestic ocean ports (operated by resident units and non-residents).
Rail	H49	
International aviation	H51	Note that this item records the fuel delivered to all airplanes in domestic airports (operated by resident units and non-residents).
Domestic aviation	H51	Note that this item records the fuel delivered to all airplanes in domestic airports (operated by resident units and non-residents).
Road	all incl. H49	potentially
Domestic navigation	H50	Note that this item records the fuel delivered to all ships in domestic ocean ports (operated by resident units and non-residents).

7.4 Specific issues related to road transport

280. Basically all industries as well as households undertake some road transport activities. Significant efforts are required to allocate/distribute the original road transport source data to the AEA format, i.e. by industries and households. Allocating road transport data is one of the most difficult parts of compiling AEA and it calls for extra attention.

281. The assignment of road transport emissions can only be done with the help of auxiliary data. The availability of the latter depends on your country specific situation. Hence, it is difficult to provide practical guidance so unfortunately, the following description remains rather abstract.

282. Allocation of emissions should be made separately for each vehicle category as shown in emission inventories: passenger cars, light duty vehicles, heavy duty vehicles and buses, mopeds and motorcycles. For each vehicle category, first make a split between private households and industries. Then, industry emissions can be allocated to land transport industry (NACE grouping 49) and other industries (NACE groupings 01 to 99, excl. 49).

283. Several allocation approaches are possible, depending on the auxiliary information available in your country. Approaches can be combined as appropriate:

7.4.1 National emission models for road transport

284. This works best if there is one or more national road transport data system or model that allows making all splits required.

285. In many countries, emissions from road transport in the emission inventories are estimated using a model. Common models are COPERT, ARTEMIS and HBEFA. These are very complex

models taking into account a variety of aspects that affect the emissions, not only the amount of fuel consumed but also the type of engine and how the vehicles are driven. Certain variables in the emission models may be very useful when distributing emissions to various NACE groupings and households.

286. If your national transport statistics system contains information on the ownership of road transport vehicles and respective number of kilometres driven, this allows to roughly split between private and commercial transport, i.e. between private households and industries.

287. If physical energy flow accounts (PEFA) are available, they might show the use of different energy commodities by NACE groupings. The use of diesel and gasoline may be used to distribute road transport emissions over industries.

288. Contact your national accountants. They may maintain some type of energy use monetary data. Often, national accountants maintain comprehensive use tables for internal use only – typically the use of 1000+ commodities broken down by industries. For each industry/households, the fuel use (differentiated by fuel type) could be assigned to vehicle categories by employing certain auxiliary information such as mileages. The resulting percentage shares could be used to distribute emissions accordingly.

289. Using the split of another country is also a possibility if none of the above information is available. You can use shares from a country with similar economic structures as yours.

7.5 Specific issues related to F-gases

290. Emissions of fluorinated gases occur only in CRF chapter 2 'Industrial Processes'. By far the majority of F-gas emissions take place in CRF category 2.F 'Consumption of Halocarbons and SF6' in which CRF code 2.F.1 'Refrigeration and Air Conditioning Equipment' is the main contributor.

291. Manufacturing of commercial and industrial refrigerators and freezers, as well as room air-conditioners are included in NACE class 27.51 'Manufacture of electric domestic appliances'. Manufacture of non-domestic cooling and ventilation equipment is included in NACE class 28.25. Installation of air-conditioning systems is part of NACE division 33 'Repair and installation of machinery and equipment'. Air conditioning supply is part of NACE division 35 'Electricity, gas, steam and air conditioning supply'. Installation of air-conditioning systems is included in NACE division 43 'Specialised construction activities'.

292. Compilers of UNFCCC inventories most often use data on chemical sales and usage pattern by sub-application such as refrigeration and air conditioning, foam blowing agents, fire protection, aerosols, metered dose inhalers, and others. Compilers of AEA are advise to contact their national inventory compilers to find out in how far their data can be linked to NACE activities..

293. One possible way is to make a database inquiry to the emission inventory F-gas model used in your country – if available. For example emissions from manufacturing, use and disposal of refrigeration equipment may be modelled separately and totalled for the inventory. If so, take the separately modelled totals and assign them to the relevant NACE classification. Where this does not offer sufficient disaggregation engage with producers of national emission inventories in order to identify appropriate proxy data, or elicit expert judgement, for the NACE split. Proxy data may be for example employment data as a weighting for some element of the split.

294. Another option is to distribute emissions by products from the emission inventory applying the detailed monetary use tables from national accounts (if available). There are often only a few products the use of which in aforementioned applications (see paragraphs 291 and 292) may be associated with emissions of F-gases (contact your national inventory compilers)). An approximate solution is to create a distribution key by determining the share of each industry's use in the total domestic use of the respective relevant product (the same can be done for private household consumption).

7.6 Specific issues related to the use of solvents and other volatile organic products

295. The use of solvents and other volatile organic products is emission relevant (see CRF/NFR code 2.D).

296. Frequently, emissions from the use of solvents and other volatile organic products are estimated/approximated using the sales amounts of these products. Information to allocate these emissions to NACE groupings and households typically comes from surveys of industries or from sales data obtained from producers. In any event, solvent use needs to be distributed using some type of distribution key – information about these products may be available from the supply and use tables or input-output tables of the national accounts.

7.7 Specific issues related to private households' emissions

297. Air emissions are allocated to private households only when those are actually emitting. Households themselves carry out certain activities causing air emissions; e.g. fuel combustion when heating homes, or petrol combustion when driving a car. The associated air emissions are to be reported under the relevant household consumption activity.

298. In AEA, consumption activities by private households are divided into three sub-categories, reflecting three emission relevant purposes of activities:

299. **Transport:** This category includes actual air emissions by households related to the combustion of fuels for transportation purposes. Transport emissions are allocated to private households only when they arise from the private use of motor vehicles; emissions caused by public transport are to be assigned to the respective transportation industry. Emissions from households' use of private leisure boats and aircrafts should also be classified under this purpose category.

300. **Heating/cooling** (incl. cooking): This category covers actual air emissions by private households that derive from the combustion of fuels for heating/cooling houses and flats as well as from the fuel combustions for cooking and producing hot water. Heating/cooling emissions are allocated to private households when they use the fuels themselves, e.g. gas for central heating boilers and cooking ovens. Emissions from the production of electricity purchased by households are not allocated to private households but to the electricity producers/suppliers.

301. **Others**: This category relates to direct air emissions by private households for other purposes than transport and heating. It includes e.g. solvent emissions from paints, aerosols from sprays and emissions from open fires (for leisure or burning garden refuse). Emissions from off road vehicles and working machinery such as for example lawn mowers, hedge clippers and other gardening equipment are also included.

302. Air emissions actually caused by private households are closely linked to the consumption of certain products, most importantly fuels. Hence, actual air emissions by private households can also be related to economic classifications. In ESA use tables, products purchased by households (for final use) are classified using the CPA, the European standard statistical classification of products by activity. In addition, private households' consumption activities can be categorised according to different purposes. Here the statistical system offers a classification called Classification of Individual Consumption by Purpose (COICOP) ([54]).

303. Consumption activities by private households can be cross-classified using both classifications. The result is a matrix product-by-purpose, showing which products have been purchased by private households for which purposes. In a matrix cross-classified this way, the three categories of household consumption applied in AEA can be clearly defined:

— Transport emissions by private households relate to the purchase of 'refined petroleum products' (CPA code 19.20) for the purpose of 'fuels and lubricants for personal transport equipment' (COICOP code 07.2.2).

— Heating/cooling emissions by private households relate to the purchase of 'refined petroleum products' (CPA code 19.20) and 'fuel wood' (CPA code 02.10.1) for the purpose of 'electricity, gas and other fuels' (COICOP code 04.5).

— Other emissions by private households relate to the purchase of all products for all kinds of purposes, except the ones mentioned above for transport and heating.

304. In AEA as well as in national emission inventories air emissions are estimated based on use of fuels and other products rather than purchases, an assumption is made that items purchased are also used. In other words, households are assumed not to build up stocks to any significant extent.

([54]) United Nations et. al. (2000).

8 Uses of air emissions accounts

305. This chapter provides an overview of the possible uses of air emissions accounts (AEA) as input to analysis, research and policy making.

306. AEA can be used to analyse environmental implications (in the domains of climate change and air pollution) of European production and consumption patterns. The general analytical added value of AEA is its consistency with national accounts enabling integrated environmental and economic analyses, in particular the detailed breakdown of air emissions by causing production activities (at NACE A*64). Furthermore, AEA can be directly linked to any data that is represented in this unified framework at NACE A*64 detail, such as environmental taxes or the physical energy flow accounts (PEFA).

307. With regards to the analytical possibilities of AEA a general distinction can be made between a production perspective and a consumption perspective. The former considers all the direct air emissions arising from domestic production and distinguishes and compares the environmental performance of different industries (see Section 8.1). The consumption perspective considers the direct and indirect air emissions arising along the international production chains of all products consumed domestically, and compares the air emissions caused by the final demand of different product groups or broadly compares across the different categories of final demand such as consumption, investments and exports. Consumption-based accounts of air emissions result from modelling and are also known as (carbon) 'footprints' (see Section 8.2).

308. To analyse changes over time in emissions, these changes can be decomposed into changes in the underlying factors. Emission intensities can be decomposed into intra-industry intensity changes and inter-industry structural change within the economy (see Section 8.3.1). Changes over time in the consumption-based estimates of greenhouse gas emissions can be looked at in more detail by applying structural decomposition analysis. Using this technique, consumption-based estimates can be decomposed in the underlying factors; emission intensities of the various industries, production technologies and the structure of final demand (see Section 8.3.2).

8.1 Descriptive analyses of air emission accounts

309. A wide array of information can be extracted from AEA. This section gives examples of descriptive analyses of AEA. The examples follow on the questions:

1) How much do the various economic activities (industries' production activities and private households' consumption activities) contribute to total national air emissions? Has the structure/composition changed over the years?

2) How does my country compare with other EU countries? Does the structure of air emissions (i.e. contributions by various industries and private households) vary across countries?

3) How much do single industries contribute to total air emissions and totals of socio-economic parameters such as e.g. value added and employment?

4) Are the emissions changing relative to economic growth? Is there a decoupling of air emissions from economic growth?

5) Which industries are most (least) intensive in emitting air emissions per unit output (or gross value added)?

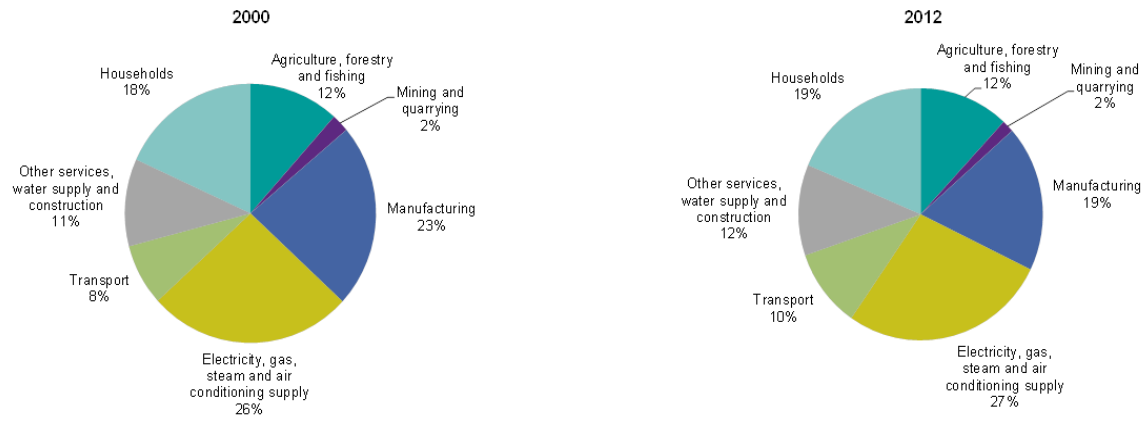
8.1.1 Air emissions by economic activity and structural changes over time

310. AEA data for a given country and a given time comprise several types of air emissions broken down by direct emitters (i.e. industries' production activities (NACE codes) and private households' consumption activities). Thereof, the direct emissions by industries, i.e. excluding direct air emissions by private households, relate to the production system of the given country's national economy and characterises the latter with regards to directly induced environmental pressures.

This allows investigating the question "How much do economic production activities (industries and private households) contribute to total national air emissions?"

The data can be presented in a pie chart displaying the top 10 industries (if we work with A*64). The remaining 54 categories of NACE A*64 can be grouped together. Another option is to group the 64 industries to 7-10 bigger groupings (see Figure 10)

Figure 10: Greenhouse gas emissions (CO_2, N_2O, CH_4) by economic activities and private households, EU-27, 2000 and 2012 (% of total emissions in CO_2 equivalents)



Source: Eurostat (2015) Statistics Explained: Greenhouse gas emissions by industries and households

8.1.2 Air emissions by economic activity and by country

311. Across the EU Member States, the contributions by the various economic activities and households to total national greenhouse gas emissions differ. These differences are, in part, due to different economic structures and different mixes of non-renewable and renewable energy sources.

312. First, one may be interested in how much a single industry is responsible for national emissions and compare these shares across countries. For instance, in most EU countries the industry supplying electricity is among the largest contributors of direct greenhouse gas emissions. It might be of interest to know which country's electricity industry is contributing higher shares to national totals and which country's electricity industry is contributing lower shares to respective national totals.

313. Secondly, one may be interested to know how the EU-wide direct air emissions of a particular industry is composed by looking at single EU country contributions, e.g. which country's electricity industries contribute most to total EU emissions by electricity industry?

314. In most Member States the activity concerning the supply of energy, gas, steam and air conditioning was the main producer of greenhouse gases in 2012, followed by manufacturing (see Table 12). The most notable exceptions are Ireland and Latvia where agriculture, forestry and fishing were the main source of emissions; Denmark, Luxemburg and Malta where transport service industry was the main source; and France where households are the main source.

Table 12: Greenhouse gas emissions (CO_2, N_2O, CH_4) by economic activity. EU-28, Norway and Switzerland, 2012 (1000 tonnes of CO_2 equivalents)

	All economic activities	Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Electricity, gas, steam and air conditioning supply	Transport	Other services, water supply and construction	Households
EU-28	3 802 402	556 596	73 571	877 818	1 278 293	501 509	514 614	870 641
EU-27	3 781 388	552 513	73 041	871 553	1 273 004	499 225	512 051	865 526
Belgium	88 931	11 505	32	31 008	18 479	9 633	18 274	26 738
Bulgaria	53 659	5 208	461	6 063	33 678	6 344	1 906	6 918
Czech Republic	107 813	9 203	7 567	18 037	53 459	8 803	10 744	8 140
Denmark	82 176	11 913	1 845	5 887	13 699	42 495	6 337	8 137
Germany	811 653	77 135	11 495	179 908	356 855	83 167	103 093	183 833
Estonia	18 169	1 392	107	1 577	12 696	1 479	918	1 163
Ireland	45 755	18 907	169	5 202	12 381	3 034	6 061	11 788
Greece	90 741	13 230	63	10 012	52 077	7 941	7 418	14 575
Spain	270 941	43 590	3 106	78 989	77 509	38 422	29 325	61 699
France	341 250	101 623	1 058	98 058	32 157	40 141	68 212	126 576
Croatia	21 014	4 083	530	6 264	5 289	2 284	2 563	5 115
Italy	356 607	41 997	2 177	100 352	112 451	51 068	48 563	101 845
Cyprus	7 397	900	41	1 024	3 560	539	1 333	1 944
Latvia	10 365	2 904	40	1 589	2 023	2 261	1 548	1 859
Lithuania	21 702	5 221	28	6 137	3 449	5 449	1 417	3 696
Luxembourg	7 512	723	7	1 426	1 183	3 049	1 122	1 537
Hungary	48 870	9 972	414	9 184	17 128	2 649	9 524	14 559
Malta	5 586	107	11	71	2 065	3 149	182	349
Netherlands	185 568	25 692	3 135	43 911	49 220	31 442	32 168	40 362
Austria	60 440	9 015	1 356	27 192	9 253	6 453	7 171	15 424
Poland	352 093	53 026	13 985	65 961	156 210	24 588	38 322	47 102
Portugal	55 530	8 923	197	16 137	15 083	3 862	11 328	13 041
Romania	105 512	19 496	2 965	27 404	35 201	9 502	10 944	14 943
Slovenia	16 000	2 106	339	2 173	6 108	4 268	1 007	3 499
Slovakia	37 105	3 201	976	17 954	6 121	4 332	4 521	5 105
Finland	57 028	7 692	200	14 264	17 741	10 006	7 125	5 893
Sweden	55 106	10 007	878	15 582	7 497	12 836	8 306	9 652
United Kingdom	487 876	57 825	20 385	86 450	165 721	82 314	75 181	135 149
Norway	57 494	6 608	14 161	11 963	1 565	19 706	3 492	5 249
Switzerland	34 589	6 318	102	8 687	600	7 833	11 049	19 549
Turkey	334 862	36 160	3 554	101 210	121 902	20 140	51 896	99 047

Source: Eurostat (2015) Statistics Explained: Greenhouse gas emissions by industries and households

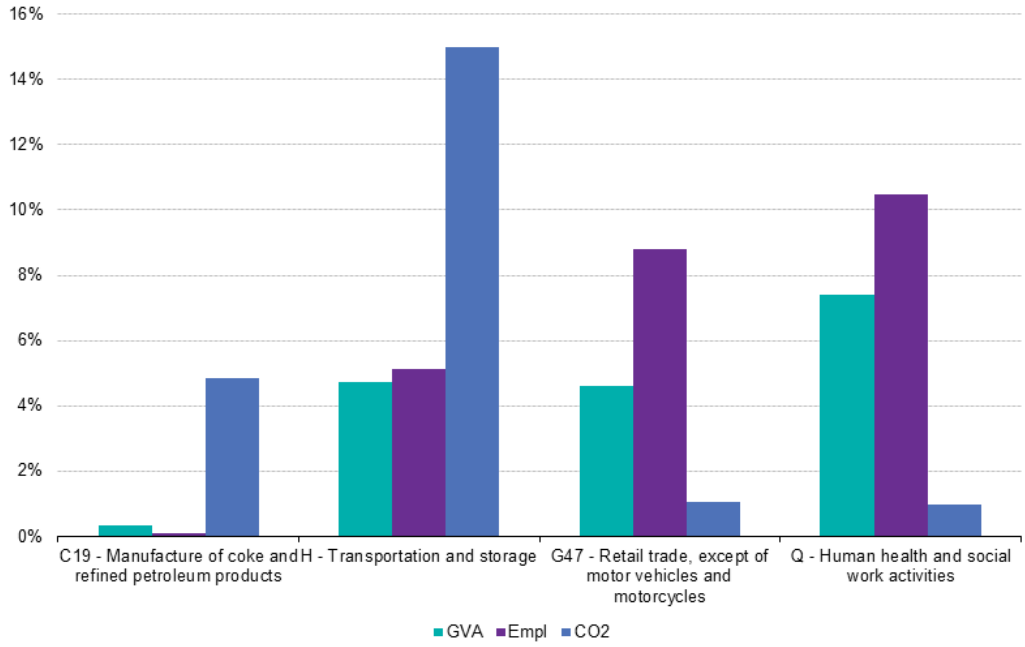
8.1.3 Environmental-economic profile

315. In so-called environmental-economic profiles both environmental and social-economic parameters can be presented jointly for selected industries or groupings of industries. Those profiles present the shares of respective industries in ***totals*** for a number of parameters, e.g. gross value added, production output, greenhouse gas emissions, number of engaged persons, environmental taxes, and more.

316. Please note that the ***totals*** may include only totals related to production activities (i.e. total of all NACE groupings). Private households are commonly excluded from totals in this kind of presentation.

317. Figure 11 shows environmental-economic profiles for selected industries (EU28, 2011). The industries covered are NACE groupings C19, H, G47 and Q. The economic and environmental parameters covered are gross value added, employment and greenhouse gas emissions.

Figure 11: Environmental-economic profiles of CO_2 emissions for selected industries in EU-28, 2011



Source: Produced from Eurostat data (GVA: nama_nace38_k, Empl: lfsa_egan2, CO_2 emissions: env_ac_ainah_r2)

318. The two left (green and purple) bars represent the role of the selected industries in the EU economy with regards to two important economic parameters: the share of gross value added and employment in EU 28 totals. The blue bars represent the share of CO_2 emissions in the EU 28 totals (here, all NACE groupings).

319. The first two industries (C19 'refineries' and H 'transport') significantly contribute to total CO_2 emissions whereas their socio-economic importance is rather small. On the other hand, the two industries on the right (G47 'retail' and Q 'health and social services') play a significant socio-economic role – particularly for employment - while their shares of CO_2 emissions are low.

8.1.4 Decoupling of air emissions from the economy

320. Decoupling of environmental pressures from economic growth denotes that – whilst economic growth is continuing – environmental pressures are declining (absolute decoupling) or at least growing at a lower rate than the economic parameter (relative decoupling).

321. Figure 12 presents an example of a decoupling graph: indexed CO_2 emissions and gross value added (GVA) are shown for the total economy as well as for the manufacturing industry (NACE section C) in the EU-28 over the period 2008 to 2012.

322. Note that time series of economic data have to be in constant prices or chained volume measures (see Annex 4).

Figure 12: Decoupling of air emissions from value added, EU-28 2008-2012, index 2008=100

Source: Produced from Eurostat data (GVA: nama_10_a10, CO_2 emissions: env_ac_ainah_r2)

8.1.5 Intensity analysis

323. AEA in combination with economic parameters (preferably production output) can be used to calculate production related air emission intensities of industries; these are the amounts of air emissions directly emitted per unit of output.

324. Such production-related and industry-specific air emission intensities can be used to

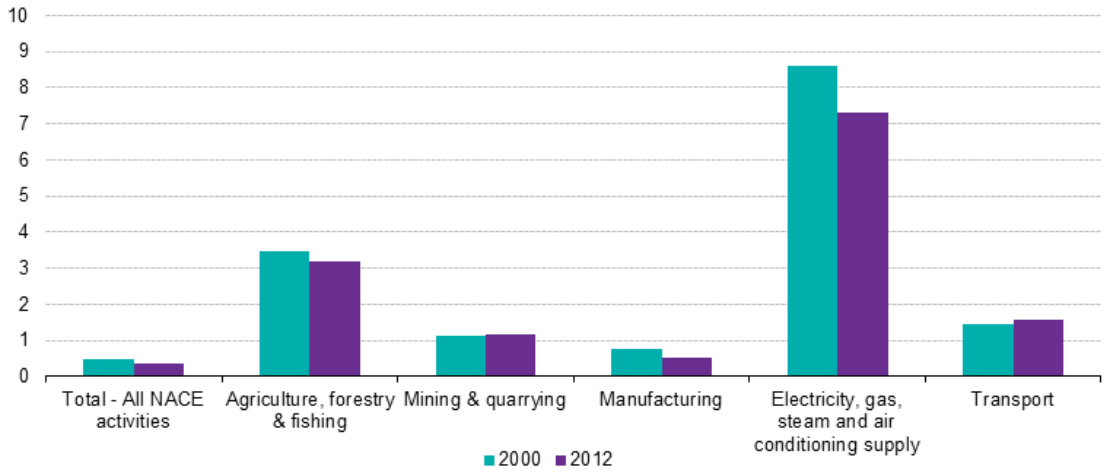
— compare industries within one national economy in order to identify most eco-efficient industries;

— compare across countries (for a given industry) in order to identify best performers; and

— monitor development over time in order to assess improvements in eco-efficiency, i.e. – for an enterprise, industry or even whole national economy – the generation of one unit of economic output with lower levels of environmental pressures and less use of natural resources.

325. The ratio of greenhouse gas emissions (in tonnes of CO_2 equivalents) to gross value added (in million euros) measures the greenhouse gas intensity of economic activities. Note that gross value added is calculated in basic prices, and the time series are compiled using chain-linked volumes to eliminate the effect of inflation.

Figure 13: Greenhouse gas emission intensities by economic activity, EU-27 2000 and 2012 (kg of CO_2 equivalents per euro of GVA)



Source: Eurostat (2015) Statistics Explained: Greenhouse gas emissions by industries and households

326. As shown in Figure 13, the GHG emission intensities can also be compared between years and groupings of NACE activities.

8.2 Consumption-based accounting of greenhouse gases

327. Here, the perspective is switched to the point of view of the final use of products, also referred to as the consumption side of the national economy. Examples of questions that can be answered with consumption-based accounting are:

- What are the air emissions induced by domestic final demand?
- How many emissions associated with domestic final demand are emitted abroad (in the rest of the world economy)?

328. Domestic final use of products by residents is shaped by domestic final demand from resident households, governments and businesses (in the form of final consumption expenditure) and gross capital formation (investments such as e.g. buildings, infrastructures, machinery). In national accounting, final use of products also includes the products that leave the national economy as exports.

329. Consumption-based accounting entails associating the final use of products with the amount of greenhouse gases or other pollutants that were emitted in order to produce these products. From this point of view, domestic final demand for products can be seen as triggering air emissions. Associating the final use of products by a national economy with the environmental pressure it generates in terms of air emissions is hence also referred to as (carbon) 'footprint' analysis.

330. All air emissions arising along the entire production chains of the final products need to be taken into account. Depending on the production chain, this can include both air emissions arising in the domestic production system as well as emissions arising in production systems of the rest of the world economy. All greenhouse gases emitted during the production of all intermediate inputs, their

intermediate inputs, and the inputs to those inputs, that are needed to meet domestic final demand, are to be accounted for in consumption-based accounts.

331. This perspective is possible through employing the technique of environmentally extended input-output analysis[55] which combines AEA data with input-output (IO) tables. IO tables contain economic data on intermediate deliveries between industries in monetary terms. The economic data in the input-output tables provides the link between the producing industries and the final use of products. With IO modelling air emissions can be attributed to the use of final products.

332. In a hypothetical economy without any imports and exports, the total amount of emissions by domestic industries will equal the total amount of emission triggered by the final use of products. Still the final use of product 'A' most likely will not equal the emissions by industry 'A', because some of the output of industry A is used as intermediate input in the production of another final product, and the production of final product 'A' will also require intermediate inputs from other industries. The consumption-based emissions of product 'A' hence will be a mix of emissions by all industries that are directly or indirectly involved in the production of product 'A'.

333. In an open economy, trade in products will cause a difference in the total amount of emissions by domestic industries and the total amount of emissions due to the final use of products by residents. Emissions 'embodied' in imports need to be included, and emissions 'embodied' in exports need to be excluded. In addition to unequal import/export flows, differences in emissions intensities and production technologies across countries will cause further divergence in the results.

334. To account for all emissions 'embodied' in trade, a multi-country IO table can be used, which also represents all intermediate and final deliveries across borders ([56]). This type of IO table allows the modeller to link the final use of products in a specific country, to the required inputs and related emissions in all countries involved in the production chain. However, constructing a multi-country IO table is very data intensive.

335. In case a multi-country IO table is not available, a national IO table is often used to estimate the emissions embodied in imports. However, this implies that the assumption is made that the technology in the country is equal to the technology used in the supplying countries to produce the imports. This assumption is generally referred to as the domestic technology assumption (DTA). Interpreting the estimates based on a model using DTA as consumption-based accounting of actual emissions needs to be done very cautiously. In this case, the modeller needs to defend why the DTA is an acceptable approximation for the production technology used abroad.

336. The estimate of emissions embodied in imports based on DTA is actually a measure of domestic emission avoided. Hence, IO models based on the DTA can be directly used to answer a slightly different question: What is the amount of emissions that would occur in the domestic economy if it were to produce the imported products itself[57]?

337. Policy makers may be interested in the amount of air emissions activated (triggered) by domestic final demand in order to design various environmental policies. For example:

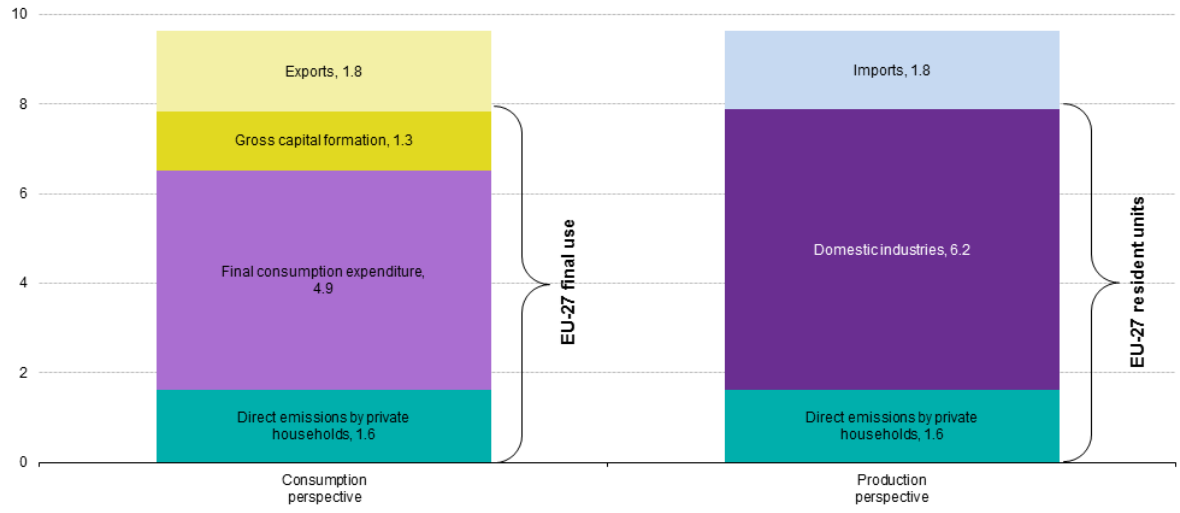
([55]) see e.g. Moll et al. 2007 pp. 66ff.; Miller/Blair 2009 chapter 10 pp. 446ff.; ten Raa 2005 chapter 11 pp. 139ff..
([56]) IO tables that include multiple countries are in the literature generally referred to as multi-regional input-output tables.
([57]) Assuming that this shift in production would not influence the domestic production processes used in any way.

— One can identify those product groups the domestic use of which bears the highest 'embodied' air emissions. In that case, the final uses of product groups are to be ranked according to their 'embodied' air emissions.

— Another interesting question is to analyse how much of indirect air emissions are activated by the different categories of final use, namely final consumption expenditure, gross capital formation, and particularly exports.

338. Figure 14 compares the results of analysing CO_2 emissions from a consumption perspective and a production perspective. EU-27 final use by resident units amounts to a total of 7.8 tonnes of CO_2 per capita emitted both domestically and abroad. This total consists of 4.9 tonnes per capita associated with final consumption expenditure on goods and services by households and governments, 1.3 tonnes per capita associated with gross capital formation, and 1.6 tonnes per capita of direct emissions by private households. Foreign demand for goods and services accounts for another 1.8 tonnes per capita of air emissions. The total amount of emissions associated with final use within a country, including exports, equals the total amount of emissions from a production perspective when the air emissions embodied in imports are also fully accounted for (see right-hand side of Figure 14)

Figure 14: Domestic and global CO_2 emissions — consumption and production perspective, EU-27, 2011, (tonnes CO_2 per inhabitant)



Source: Eurostat (2014a) Statistics Explained: Carbon dioxide emissions from final use of products

8.3 Decomposition analyses

339. The development of total production related air emissions over time is determined by various underlying factors. Hence, a decrease of total national air emissions can be due to eco efficiency improvements in the single industries (intra-industry efficiency increase). Or, an increase of air emissions can be due to overall economic growth. Economic structural change can be another reason for decreasing national air emissions if air emission intensive industries lose relative weight in the total economy due to the increasing importance of lower emissions intensive industries (inter-industry structural changes). The air emissions can also be affected by changes in trade patterns.

340. Decomposition analysis can be used to answer questions such as:

1) Are changes in the national air emission intensity driven by inter-industry structural changes or by changes in intra-industry emission intensities?

2) What are the drivers of changes in the emissions triggered by domestic final demand (e.g. consumption patterns)?

341. The first question can be answered using index decomposition analysis (IDA). This type of analysis is relatively simple and requires only limited data. The second question can be answered using structural decomposition analysis (SDA). This type of analysis requires the availability of input-output tables. Hoekstra and van der Bergh (2003) present a thorough comparison of structural and index decomposition analysis.

342. Comparing changes over time requires data in constant prices or previous year's prices in order to exclude the impact of mere changes in prices (e.g. inflation).

343. Several forms of decomposition analysis exist within both IDA and SDA. The differences between the methods are related to the way in which the change in a specific variable is isolated. As a kind of European standard, Eurostat recommends the method applied in a German pilot study (Destatis 2003). For example, the Laspeyres index method isolates the change in a variable by allowing that specific variable to change, while all other variables are fixed at their respective base year values. Dietzenbacher and Los (1998) showed that, because there are several ways to isolate a change, decomposition with n factors has $n!$ different decomposition forms. However, only $2^{(n-1)}$ forms are unique.

344. The change in an aggregate emissions intensity may be expressed as an additive decomposition (e.g. the total change = structural change + intensity change) or as a multiplicative decomposition (e.g. the total change = structural change × the intensity change). This holds both for IDA and SDA, although in the literature multiplicative SDA is rarely applied.

345. Some methods do not result in a complete decomposition, in the sense that the change in the total is not equal to the sum or multiplication of the structural and intensity component. This residual can be neglected when very small, interpreted as a separate interaction term, or combined with one of the other components.

346. The aggregation level heavily impacts the result of the decomposition analysis. Therefore, when the aggregation level and the influence of the economic variables chosen are very high, the results of decomposition analyses have to be presented with caution. These methodologies are useful but using the exact results – making statements such as, the changes in the economic structure of a country account for precisely 'x' per cent of the changes in the levels of emissions should perhaps be avoided. Decomposition analysis based on aggregated data is only appropriate when making more general observations and statements about the underlying reasons for the observed changes in the emissions levels.

8.3.1 Index decomposition analysis

347. In general, an index number is a ratio of a value of interest over a base or reference value. A price index, for example, represents an average price level in a certain year standardised by the average price level in a base year. Alternatively, an index can be a ratio of two different indicators.

For example, emission intensity is an index, because it is the ratio of total emissions over total output.

348. For an index decomposition analysis of total emissions over total output, i.e. emission intensity, only data on emissions by industry and output by industry are required at two different points in time. With this information, the change in the overall index can be decomposed into a structural component (the inter-industry change in the composition of all production activities) and an intensity component (the intra-industry change in the amount of emissions per industry).

349. Choosing a specific form and type (additive or multiplicative) of the decomposition analysis determines the decomposition formula that needs to be applied to the data at detailed level. Although performing the actual decomposition can be relatively straightforward, the difficulty lies with choosing the most suitable decomposition form.

350. A survey of techniques applied in the literature, including a discussion of the basic approaches, the classification of index decomposition techniques and method selection issues can be found in Ang and Zhang (2000).

8.3.2 Structural decomposition analysis of consumption-based air emissions

351. Structural decomposition analysis (SDA) is also referred to as input-output decomposition analysis. SDA uses the information contained in input-output tables to determine the impact of changes in technology. Data for at least two points in time is required.

352. SDA is more data intensive than IDA, but also provides more detail. In addition, SDA includes the indirect demand effects (consumption perspective), whereas IDA only includes the direct effects (production perspective).

353. For SDA there exist no theoretical arguments to prefer one decomposition form over the other, so in that sense they are all equal (Dietzenbacher and Los, 1998). However, the results may be rather different for the different forms applied. A straightforward solution is to average the outcome of all $n!$ decomposition forms that are possible (where n represents the number of factors). To reduce the computational demands of a decomposition with several factors, Statistics Denmark (2010) notes that a weighted average of the more limited set of $2^{(n-1)}$ forms is normally close to the average of all forms.

354. To show the variability in the results across the different decomposition forms, Dietzenbacher and Los (1998) also recommend publishing the range or standard deviations of the outcomes.

355. Statistics Denmark (2010) shows for SDA that the choice of base year in a series of constant price tables impacts the decomposition results of the change between the same set of years. Previous year's prices are preferred as they do not depend on a base year table which may represent a completely different economic structure.

356. Changes in consumption-based air emissions (i.e. indirect air emissions induced by domestic final use of product groups) as discussed in section 8.2 can also be analysed over time by decomposing the overall change into the changes in the underlying factors. In the basic case, the change in overall emissions can be decomposed into changes in the emission intensity, changes in the production technologies, and changes in final demand.

357. In more detail, with the help of SDA, the overall change can be decomposed into these underlying factors:

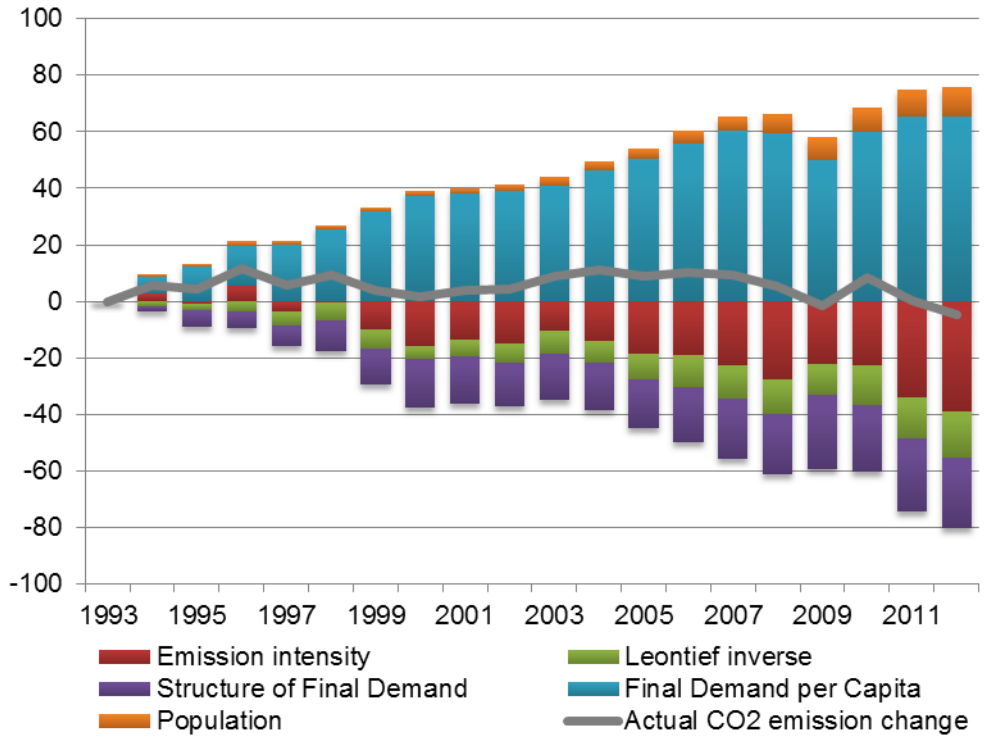
- Consumption level: This factor relates to the change in the level of total domestic final use and how this development influences the worldwide indirect air emissions associated with domestic final use; usually, total consumption increases more or less at the same pace as gross domestic product.
- Consumption mix: This factor relates to the change of composition of products consumed in a given economy and how it influences the worldwide indirect air emissions associated with domestic final use. For instance, one may assume that a shift from material goods towards a greater portion of services consumed should have a decreasing effect on the worldwide associated indirect air emissions.
- Production structure: This factor relates to the change in the structure of intermediate deliveries between industries. It is also referred to as the production technology change, or the structural change. If products are produced with more emission-intensive intermediate products, this will increase the overall air emissions associated with final use.
- Air emission intensities: This effect relates to changes in emission intensities of industries. When a certain industry can produce the same amount of output while emitting less greenhouse gases or other pollutants, this will, all else equal, reduce the total amount of emissions associated with final use.

The latter two effects can be interpreted together as the improvement in the eco-efficiency of the product chains. If the intensities of air emissions along the worldwide production chain are improving, this should have a decreasing effect on total air emissions associated with consumption.

358. An example of a more elaborate SDA is shown in Figure 15. In addition to the factors mentioned above, population size is also included as a factor. All else equal, when population increases, it is to be expected that consumption will also increase, which in turn will require more production and probably more emissions. Final demand per capita shows the consumption-level effect mentioned above. The purple bars show the structure of final demand, or consumption-mix factor. The factor indicated with Leontief inverse refers to the production structure factor and emission intensity to the air emission intensity by sector.

359. The actual CO_2 emission change is relatively stable compared to some of the changes in the underlying factors. Except for the first few years, emission intensities have been increasingly improving over the years due to changes in the fuel mix used. Also, over time production has shifted towards less carbon-intensive products, given that both types of structural effects, i.e. the production structure and the structure of final demand, have increasingly resulted in lower overall emissions. Unfortunately, these improvements in these three factors have been more than cancelled out by the additional emissions due to the increase in final demand per capita, in combination with some growth in population. Only from the start of the crisis, a real decline in total CO_2 emissions in Sweden can be observed, with a one-time increase in 2010.

Figure 15: Factors affecting CO_2 emissions in Sweden – a decomposition analysis, 1993-2012, in percentages.



Source: Statistics Sweden (2015)

360. More information on SDA can be found in Statistics Denmark (2010) and Destatis (2003) for example. Examples of SDA published in scientific journals are de Haan (2001) and Yamakawa and Peters (2011).

361. Eurostat intends to provide further guidance on SDA by publishing a recommendation before the end of 2016.

Annex 1: Correspondence between CRF/NFR and NACE Rev. 2

362. The actual correspondence table is provided as an EXCEL workbook on Eurostat's website.

363. The correspondence table relates the single items of the CRF/NFR classification (as used in national emission inventory reporting) to the NACE Rev. 2 classification (A*64 breakdown) as employed in Eurostat's AEA.

364. The following versions of the CRF/NFR classifications are included in Annex 1:

- CRF categories until submission 2014 ([58])
- CRF categories for sub 2015 onwards ([59])
- NFR09 ([60])
- NFR14 ([61])
- NACE Rev. 2 ([62])

365. The SNAP nomenclature is an older classification system which is still used in some countries for compiling national emission inventories. The SNAP nomenclature is not included in Annex 1 because no correspondence could be found between SNAP and the new (post-2015) CRF and NFR14 respectively.

366. NSI still using the SNAP nomenclature may combine the 2012 edition of this correspondence table ([63]) (correspondence between SNAP and old CRF/NFR09) and relate/integrate it with correspondences between old and new CRF/NFR.

([58]) FCCC/SBSTA/2006/9.
([59]) UNFCCC (2013).
([60]) NFR09.
([61]) NFR14.
([62]) Eurostat (2008c).
([63]) Eurostat (2012).

Annex 2: Classification of economic activities as included in Eurostat's questionnaire for air emissions accounts (AEA)

367. Table 13 shows the complete classification list of economic activities as employed for Eurostat's AEA, including air emissions by industry, household air emissions and bridging items.

- The hierarchical classification of production activities (industries) is based on NACE Rev. 2. The NACE breakdown employed in the AEA questionnaire is chosen to be in line with the ESA Supply and Use Tables. At the most detailed level it distinguishes 64 groupings of divisions (NACE A*64).
- The emissions by private households' consumption activities are broken down by three purposes (heating/cooling, transport activities, other).
- Bridging items are discussed in more detail in section 6.4 and Annex 3.
- Item 'National fishing vessels operating abroad' is included in bridging item 'Water transport'.

Table 13: Classification of economic activities (industries and households) and bridging items as included in Eurostat's questionnaire for air emissions accounts (AEA)

Level	Code	Label
Air emissions by industries		
1	**A_U 01-99**	**Total NACE industries**
A*21 A*38	**A**	**Agriculture, forestry and fishing**
A*64	A01	Crop and animal production, hunting and related service activities
A*64	A02	Forestry and logging
A*64	A03	Fishing and aquaculture
A*21 A*38 A*64	**B**	**Mining and quarrying**
A*21	**C**	**Manufacturing**
A*38 A*64	C10-C12	Manufacture of food products, beverages and tobacco products
A*38 A*64	C13-C15	Manufacture of textiles, wearing apparel and leather products
A*38	C16-C18	Manufacture of wood, paper, printing and reproduction
A*64	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
A*64	C17	Manufacture of paper and paper products
A*64	C18	Printing and reproduction of recorded media
A*38 A*64	C19	Manufacture of coke and refined petroleum products

Level	Code	Label
A*38 A*64	C20	Manufacture of chemicals and chemical products
A*38 A*64	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
*A*38*	*C22_C23*	*Manufacture of rubber and plastic products and other non-metallic mineral products*
A*64	C22	Manufacture of rubber and plastic products
A*64	C23	Manufacture of other non-metallic mineral products
A*38	C24_C25	Manufacture of basic metals and fabricated metal products, except machinery and equipment
A*64	C24	Manufacture of basic metals
A*64	C25	Manufacture of fabricated metal products, except machinery and equipment
A*64	C26	Manufacture of computer, electronic and optical products
A*38 A*64	C27	Manufacture of electrical equipment
A*38 A*64	C28	Manufacture of machinery and equipment n.e.c.
*A*38*	*C29_C30*	*Manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment*
A*60	C29	Manufacture of motor vehicles, trailers and semi-trailers
A*60	C30	Manufacture of other transport equipment
A*38	C31-C33	Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment
A*64	C31_C32	Manufacture of furniture; other manufacturing
A*64	C33	Repair and installation of machinery and equipment
A*21	**D**	**Electricity, gas, steam and air conditioning supply**
A*21 A*38	**E**	**Water supply; sewerage, waste management and remediation activities**
A*64	E36	Water collection, treatment and supply
A*64	E37-E39	Sewerage, waste management, remediation activities
A*21	**F**	**Construction**
A*21 A*38	**G**	**Wholesale and retail trade; repair of motor vehicles and motorcycles**
A*64	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
A*64	G46	Wholesale trade, except of motor vehicles and motorcycles
A*64	G47	Retail trade, except of motor vehicles and motorcycles
A*21 A*38	**H**	**Transportation and storage**
A*64	H49	Land transport and transport via pipelines
A*64	H50	Water transport
A*64	H51	Air transport

Level	Code	Label
A*64	H52	Warehousing and support activities for transportation
A*64	H53	Postal and courier activities
A*21 A*38 A*64	**I**	**Accommodation and food service activities**
A*21	**J**	**Information and communication**
A*38	J58-J60	Publishing, motion picture, video, television programme production; sound recording, programming and broadcasting activities
A*60	J58	Publishing activities
A*60	J59_J60	Motion picture, video, television programme production; programming and broadcasting activities
A*38 A*64	J61	Telecommunications
A*38 A*64	J62_J63	Computer programming, consultancy, and information service activities
A*21 A*38	**K**	**Financial and insurance activities**
A*60	K64	Financial service activities, except insurance and pension funding
A*60	K65	Insurance, reinsurance and pension funding, except compulsory social security
A*60	K66	Activities auxiliary to financial services and insurance activities
A*21 A*38 A*64	**L**	**Real estate activities**
	L68A	Of which: Imputed rents of owner-occupied dwellings
A*21	**M**	**Professional, scientific and technical activities**
A*38	M69-M71	Legal and accounting activities; activities of head offices; management consultancy activities; architectural and engineering activities; technical testing and analysis
A*64	M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities
A*64	M71	Architectural and engineering activities; technical testing and analysis
A*38 A64	M72	Scientific research and development
A*38	M73-M75	Advertising and market research; other professional, scientific and technical activities; veterinary activities
A*60	M73	Advertising and market research
A*60	M74-M75	Other professional, scientific and technical activities; veterinary activities
A*21 A*38	**N**	**Administrative and support service activities**
A*60	N77	Rental and leasing activities
A*60	N78	Employment activities
A*60	N79	Travel agency, tour operator reservation service and related activities
A*60	N80-N82	Security and investigation, service and landscape, office administrative and support activities

Level	Code	Label
A*21 A*38 A*64	**O**	**Public administration and defence; compulsory social security**
A*21 A*38 A*64	**P**	**Education**
A*21	**Q**	**Human health and social work activities**
A*38 A*64	Q86	Human health activities
A*38 A*64	Q87_Q88	Residential care activities and social work activities without accommodation
A*21 A*38	**R**	**Arts, entertainment and recreation**
A*64	R90-R92	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities
A*64	R93	Sports activities and amusement and recreation activities
A*21 A*38	**S**	**Other service activities**
A*60	S94	Activities of membership organisations
A*60	S95	Repair of computers and personal and household goods
A*60	S96	Other personal service activities
A*21 A*38 A*64	**T**	**Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use**
A*21 A*38 A*64	**U**	**Activities of extraterritorial organisations and bodies**
Household air emissions		
1	**HH**	**Total activities by households**
2	HH_HEAT	Heating/cooling
2	HH_TRA	Transport activities
2	HH_OTH	Other
Bridging items		
1		**Total air emissions accounts (industry + households)**
1		**Less national residents abroad**
2		- Land transport
2		- Water transport (including fishing vessels)
2		- Air transport
1		**Plus non-residents on the territory**
2		+ Land transport
2		+ Water transport (including fishing vessels)
2		+ Air transport
1		**(+ or -) Other adjustments and statistical discrepancy**
1		**= Total emissions of pollutant X as reported to UNFCCC / CLRTAP**

Annex 3: Deriving bridging items from national emission inventories

368. Air emissions accounts (AEA) include so-called bridging items reporting the differences between AEA totals and totals of national emission inventories (see section 3.1 and section 6.4).

369. The differences between AEA totals and inventory totals are due to two main determinants:

— Adjustment for the residence principle: AEA follow the residence principle whereas national emission inventories follow more or less a territory principle.

— National totals are defined differently in national emission inventories regarding international transport, e.g. emissions from international air transport are excluded in UNFCCC inventory totals whereas they are partly included in CLRTAP inventory totals.

370. This technical note explains in detail the differences – i.e. bridging items – between AEA totals and the national totals in UNFCCC and CLRTAP inventories for the three main transport modes (see Table 14):

Table 14: Content overview of this technical note on bridging items

	Land transport	Water transport (including fishing vessels)	Air transport
UNFCCC inventories	paragraphs 372 ff.	paragraphs 390 ff.	paragraphs 416 ff.
CLRTP inventories	paragraphs 379 ff.	paragraphs 401 ff.	paragraphs 426 ff.

Land transport

371. Land transport refers to emissions from mobile sources engaged in road and off-road transport, railways and pipeline transport. In general, the AEA totals include emissions from land transport activities operated by resident units irrespective of where these emissions are emitted (on the domestic territory or in the rest of world).

UNFCCC totals – land transport

372. AEA totals are bridged to UNFCCC totals for the six greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6. Categories in UNFCCC GHG inventories relevant for land transport are shown in Table 15.

Table 15: CRF categories (UNFCCC inventories) relevant for land transport

CRF (old)	CRF (new)	CRF-label	Definition
1.A.3.b	1.A.3.b	Road Transportation	All combustion and evaporative emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on paved roads.
1.A.3.b	1.A.3.b.i	Cars	Emissions from automobiles so designated in the vehicle registering country primarily for transport of persons and normally having a capacity of 12 persons or fewer.
1.A.3.b	1.A.3.b.ii	Light-duty Trucks	Emissions from vehicles so designated in the vehicle registering country primarily for transportation of lightweight cargo or which are equipped with special features such as four-wheel drive for off-road operation. The gross vehicle weight normally ranges up to 3500-3900 kg or less.
1.A.3.b	1.A.3.b.iii	Heavy-duty Trucks and Buses	Emissions from any vehicles so designated in the vehicle registering country. Normally the gross vehicle weight ranges from 3500-3900 kg or more for heavy duty trucks and the buses are rated to carry more than 12 persons.
1.A.3.b	1.A.3.b.iv	Motorcycles	Emissions from any motor vehicle designed to travel with not more than three wheels in contact with the ground and weighing less than 680 kg.
1.A.3.c	1.A.3.c	Railways	Emissions from railway transport for both freight and passenger traffic routes.
1.A.3.e	1.a.3.e	Other transportation	Combustion emissions from all remaining transport activities including pipeline transportation, ground activities in airports and harbours, and off-road activities not otherwise reported under 1.A.4.c Agriculture or 1.A.2. Manufacturing Industries and Construction.
1.A.3.e	1.A.3.e.i	Pipeline Transport	Combustion related emissions from the operation of pump stations and maintenance of pipelines. Transport via pipelines includes transport of gases, liquids, slurry and other commodities via pipelines.
1.A.3.e	1.A.3.e.ii	Other	Combustion emissions from all remaining transport activities including ground activities in airports and harbours, and off-road activities not otherwise reported under 1 A 4 c Agriculture or 1 A 2. Manufacturing Industries and Construction.
1.A.5.b	1.A.5.b.iii	Non-specified: Mobile (Other)	All remaining emissions from mobile sources not included elsewhere.

Source: Annex 1 and 2006 IPCC Guidelines for GHG Inventories

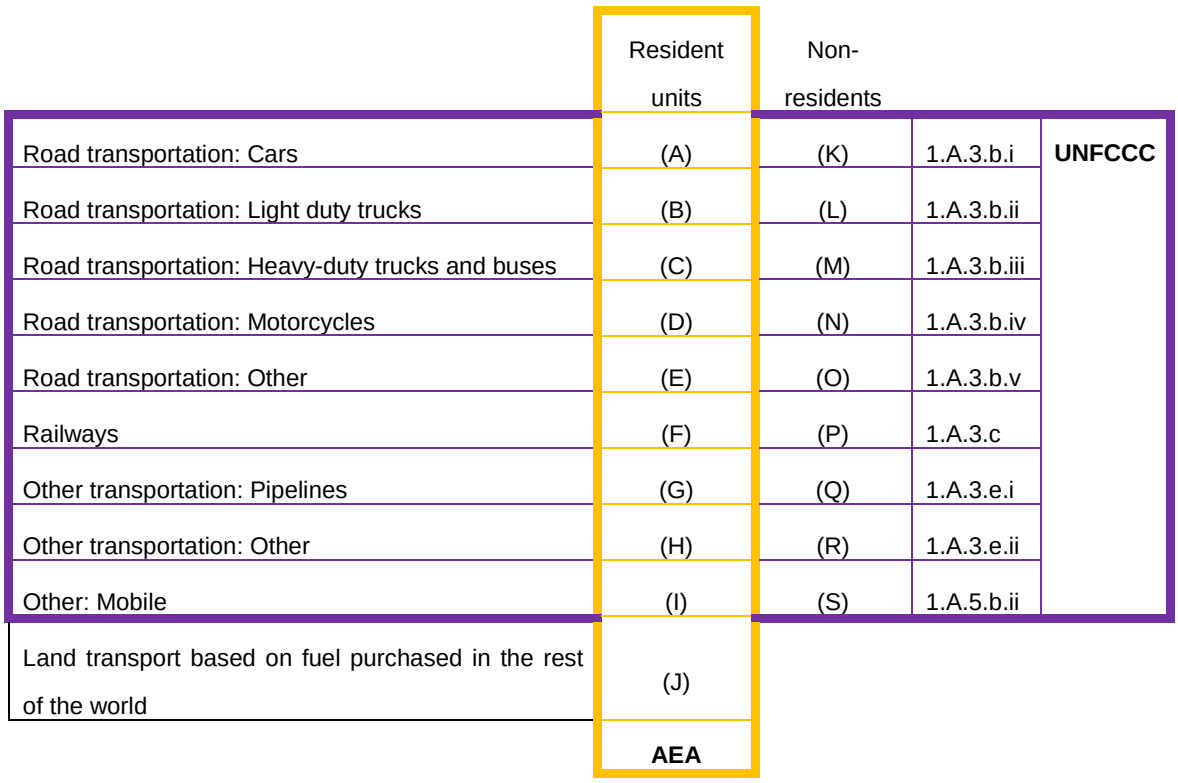
373. CRF categories in Table 15 are based on fuel sold on the domestic territory to resident units as well as to non-residents. Hence all CRF categories have a resident component as well as a non-resident component. This is represented by the 2nd and 3rd column in Figure 16.

374. Figure 16 provides an overview of what elements of land transport related emissions are included in UNFCCC totals (blue) and what elements are included in AEA totals (yellow/orange).

375. AEA totals related to land transport include all resident components reported in UNFCCC

inventories (elements (A) to (I)). In addition AEA totals include land transport emissions by resident units based on fuel purchased outside the domestic territory (element (J).

Figure 16: Land transport emissions in UNFCCC inventories and AEA



376. Table 14 describes the bridging items between AEA totals and UNFCCC totals for land transport with reference to element letters in Figure 16.

377. GHG emissions by resident units operating land transport based on fuel purchases in the rest of the world are deducted from the AEA totals (J) to arrive at UNFCCC totals. This is the only element to be considered under the AEA-bridging item *'Less national residents abroad – land transport'* in the AEA questionnaire (see Table 16).

378. GHG emissions by non-resident units operating land transport based on fuel purchases on domestic territory are added to the AEA totals. These elements (K) to (S) (see Table 16) make up the AEA-bridging item *'Plus non-residents on the territory – land transport'* in the AEA questionnaire.

Table 16: Bridging items for land transport for UNFCCC totals

Bridging item	Description	Element in Figure 16
AEA total [TOT_NACE_HH]	Includes all GHG emissions from land transport undertaken by resident units based on fuel purchases on domestic territory as well as based on fuel purchases in the rest of the world.	
Less national residents abroad: land transport [NRA_LAND]	Deduct: All GHG emissions from land transport by resident units based on fuel purchases in the rest of the world.	(J)
Plus non-residents on the territory: land transport [NRES_LAND]	Add: All GHG emissions from land transport undertaken by non-resident units based on fuel purchases on domestic territory.	(K) to (S)
Other adjustments and statistical discrepancies [ADJ_OTH]	Any other differences.	
UNFCCC totals [TOT_CONV]	Includes all GHG emissions from land transport undertaken by resident units and non-residents based on fuel purchases on domestic territory.	

CLRTAP totals – land transport

379. AEA totals are bridged to CLRTAP totals for the following 7 air pollutants: SO_X, NO_X, NH_3, NMVOC, CO, PM10 and PM2.5. Categories in CLRTAP emission inventories relevant for land transport are shown in Table 17.

380. NFR categories in Table 17 are based on fuel sold on the domestic territory to resident units as well as to non-residents. Hence all NFR categories have a resident component as well as a non-resident component. This is represented by the 2nd and 3rd column in Figure 17.

Table 17: NFR categories (CLRTAP inventories) relevant for land transport

NFR14	NFR label	Definition
1.A.3.b	Road transport	
1.A.3.b.i	Road transport: Passenger cars	Emissions from vehicles used for the carriage of passengers and comprising not more than eight seats in addition to the driver's seat.
1.A.3.b.ii	Road transport: Light duty vehicles	Emissions from vehicles used for the carriage of goods and having a maximum weight not exceeding 3.5 tonnes.
1.A.3.b.iii	Road transport: Heavy duty vehicles and buses	Emissions from vehicles used for the carriage of goods and having a maximum weight exceeding 3.5 tonnes. Emissions from vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat.
1.A.3.b.iv	Road transport: Mopeds & motorcycles	Emissions from: Light two-wheel powered vehicles with an engine cylinder capacity not exceeding 50 cm^3 and a maximum design speed not exceeding 45 km/h and a maximum continuous or net power ≤ 4000 W Three-wheel mopeds maximum design speed not exceeding 45 km/h, a maximum continuous rated or net power ≤ 4000 W and mass in running order ≤ 270 kg. Two-wheel motorcycles with an engine cylinder capacity exceeding 50 cm^3 or a design speed exceeding 45 km/h, or a maximum continuous or net power exceeding 4000 W Two-wheel motorcycle with side-car with a maximum of four seating positions including the driver on the motorcycle with side car and a maximum of two seating positions for passengers in the side car.
1.A.3.b.v	Road transport: Gasoline evaporation	Evaporative emissions of NMVOCs from gasoline vehicles
1.A.3.b.vi	Road transport: Automobile tyre and brake wear	Emissions of particulate matter (PM) which are due to road vehicle tyre and brake wear
1.A.3.b.vii	Road transport: Automobile road abrasion	Emissions of particulate matter (PM) which are due to road surface wear
1.A.3.c	Railways	Exhaust emissions from railways arise from the combustion of liquid fuels in diesel engines, and solid or liquid fuels in steam engines to provide propulsion
1.A.3.e.i	Pipeline transport	Emissions of pipeline compressors, which is mainly important for greenhouse gases (methane leaks).
1.A.3.e.ii	Other	n.a.
1.A.5.b	Other, Mobile (including military, land based and recreational boats)	n.a.

Source: Annex 1 and EMEP/EEA air pollutant emission inventory guidebook 2013

381. Figure 17 provides an overview of which elements of land transport related emissions are included in CLRTAP totals (blue) and which elements are included in AEA totals (yellow/orange).

382. AEA totals related to land transport include all resident components reported in CLRTAP inventories (elements (A) to (K). In addition AEA total includes transport emissions by resident units based on fuel purchased outside the domestic territory (L).

Figure 17: Land transport emissions in CLRTAP inventories and AEA

	Resident units	Non-residents		
Road transportation: Passenger cars	(A)	(M)	1.A.3.b.i	**CLRTAP**
Road transportation: Light duty vehicles	(B)	(N)	1.A.3.b.ii	
Road transportation: Heavy-duty vehicles and buses	(C)	(O)	1.A.3.b.iii	
Road transportation: Mopeds & motorcycles	(D)	(P)	1.A.3.b.iv	
Road transportation: Gasoline evaporation	(E)	(Q)	1.A.3.b.v	
Road transportation: Automobile tyre and break wear	(F)	(R)	1.A.3.b.vi	
Road transportation: Automobile road abrasion	(G)	(S)	1.A.3.b.vii	
Railways	(H)	(T)	1.A.3.c	
Other transportation: Pipelines	(I)	(U)	1.A.3.e.i	
Other transportation: Other	(J)	(V)	1.A.3.e.ii	
Other: Mobile	(K)	(X)	1.A.5.b.ii	
Land transport based on fuel purchased in the rest of the world	(L)			
	AEA			

383. Table 18 describes bridging items between AEA totals and CLRTAP totals for land transport with reference to element letters in Figure 17.

384. Emissions of air pollutants by resident units operating land transport based on fuel purchases in the rest of the world are deducted from the AEA totals (L) to arrive at CLRTAP totals. This is the only element to be considered under the AEA-bridging item *'Less national residents abroad – land transport'* in the AEA questionnaire.

385. Emissions of air pollutants by non-residents operating land transport based on fuel purchases on domestic territory are added to the AEA totals. These elements (M) to (X) (see Figure 17) make up the AEA-bridging item *'Plus non-residents on the territory – land transport'* in the AEA questionnaire.

Table 18: Bridging items for land transport for CLRTAP totals

Bridging item	Description	Element in Figure 17
AEA total [TOT_NACE_HH]	Includes all emissions of air pollutants by resident units from land transport based on fuel purchases on domestic territory as well as based on fuel purchases in the rest of the world.	
Less national residents abroad: land transport [NRA_LAND]	Deduct: All emissions of air pollutants from land transport by resident units based on fuel purchases in the rest of the world.	(L)
Plus non-residents on the territory: land transport [NRES_LAND]	Add: All emissions of air pollutants from land transport undertaken by non-resident units based on fuel purchases on domestic territory. (AEA totals are bridged to CLRTAP totals for NO_X, SO_X, NH_4, NMVOC, CO, PM10 and PM2.5. Categories in CLRTAP inventories relevant for water transport are shown in Table 17)	(M) to (X)
Other adjustments and statistical discrepancies [ADJ_OTH]	Any other differences.	
CLRTAP totals [TOT_CONV]	Includes all emissions of air pollutants by resident units and non-residents from land transport activities based on fuel purchases on domestic territory.	

Water transport

386. Water transport refers to all water-born navigation with watercrafts (ships, fishing vessels, boats etc.) driven primarily by diesel engines, and occasionally by steam or gas turbines. The fuel combustion associated with the latter cause emissions to the atmosphere. In general, the AEA totals include emissions from water transport operated by resident units irrespective of where these emissions are emitted (on domestic territory or in the rest of the world).

387. There are three NACE groupings the activities of which may involve water navigation as principal, secondary or ancillary production activity: A.03 Fishing and aquaculture, H.50 Water transport and O.84 Public administration and defence. In addition private households operate watercrafts for non-commercial purposes (consumption activity).

388. In the context of UNFCCC and CLRTAP emission inventories a certain terminology is applied:

— First, a distinction is made between *international* versus *domestic* transport. International transport relates to journeys between two ports located in two different countries. Domestic transport relates to journeys between two ports located in the same country.

— Secondly, a distinction is made between (a) *sea*, (b) *coastal waters*, and (c) *inland lakes and water ways*. The water body type is obviously the criterion used for this distinction.

389. National totals are differently defined in UNFCCC and CLRTAP. With regards to water

transport emissions there is an important difference: The UNFCCC total excludes any emissions from international water-born navigation. The CLRTAP total makes a difference between international water-born navigation undertaken on sea and coastal waters 1.A.3.d.i(i) and international navigation undertaken on inland waterways 1.A.3.d.i.(ii). The latter is included in CLRTAP totals whereas the former is excluded.

UNFCCC totals – water transport

390. AEA totals are bridged to UNFCCC totals for the six greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6. Categories in UNFCCC inventories relevant for water transport are shown in Table 19.

Table 19: CRF categories (UNFCCC inventories) relevant for water transport

CRF (old)	CRF (new)	CRF label	Definition
1.A.3.d	1.A.3.d	Domestic navigation	Emissions from fuels used to propel water-borne vessels, including hovercraft and hydrofoils, but excluding fishing vessels. The international/domestic split should be determined on the basis of port of departure and port of arrival.
1.A.4.c	1.A.4.c.iii	Agriculture/Forestry/Fishing: Fishing	Emissions from fuels combusted for inland, coastal and deep-sea fishing. Fishing should cover vessels of all flags that have refuelled in the country.
1.A.5.b	1.A.5.b	Other Mobile (Water-borne Component)	All remaining water-borne emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the country's military not otherwise included separately in 1.A.3.d.i as well as fuel delivered within that country but used by militaries of other countries that are not engaged in multilateral operation pursuant to the Charter of the United Nations.
Memo item: 1.C.1.B	Memo item: 1.D.2	International bunkers / Navigation	Emissions from fuels used by vessels of all flags that are engaged in international navigation. The international navigation may take place at sea, on inland lakes and waterways and in coastal waters. Includes emissions from journeys that depart in one country and arrive in a different country. Emissions from international military water-borne navigation can be included provided that the same definitional distinction is applied and data are available to support the definition.
Memo item: 1.C.2	*Memo item: 1.D.3*	Multilateral operations (Water-borne Component)	Emissions from military water-borne operations abroad using fuel bunkered domestic.

Source: Annex 1 and 2006 IPCC Guidelines for GHG Inventories

391. CRF categories in Table 19 are in principle based on fuel sold on the domestic territory to resident units as well as to non-residents. Hence all CRF categories have a resident component as well as a non-resident component. This is represented by the 2nd and 3rd column in Figure 18.

392. Please note that emissions from international bunkers represent fuel sold at domestic ports and not necessary emissions emitted on the journey from the departing port to the next port. Watercrafts may carry fuel from port to port and bunker in those ports where full is cheapest.

393. Also, it could be noted that it is not possible to determine what parts of 1.A.5.b '*Other mobile'* and '*Multilateral operations'* are water-borne, air-borne or land transport in the emission inventory. Some kind of assumption needs to be made when allocating emissions in the bridging table.

394. Figure 18 provides an overview of what elements of water transport related emissions are included in UNFCCC totals (bold blue horizontal) and what elements are included in AEA totals (yellow/orange vertical).

395. UNFCCC totals include domestic navigation, fishing and military navigation, for resident units (elements (A)-(C)) as well as non-residents (elements (G)-(I)). International bunkers and multilateral operations are not included in the UNFCCC total but provided as a memo item (elements (D), (E), (J) and (K)).

396. AEA totals related to water transport include all resident components reported in UNFCCC inventories (elements (A) to (E)). Note that elements (D) and (E) are reported as memo items only, i.e. not considered in UNFCCC totals.

397. In addition AEA totals include water transport emissions by resident units based on fuel purchased outside the domestic territory (element (F).

Figure 18: Water transport emissions in UNFCCC inventories and AEA

	Resident units	Non-residents		
Domestic navigation	(A)	(G)	1.A.3.d	**UNFCCC totals**
Agriculture/Forestry/Fishing: Fishing	(B)	(H)	1.A.4.c.iii	
Other Mobile (Water-borne Component)	(C)	(I)	1.A.5.b	
International bunkers / Navigation	(D)	(J)	1.D.2	UNFCCC Memo item
Multilateral operations (Water-borne Component)	(E)	(K)	1.D.3	
Water transport based on fuel purchased in the rest of the world (incl. resident fishing vessels)	(F)			
	AEA			

398. Table 20 describes the bridging items between AEA totals and UNFCCC totals for water transport with reference to element letters in Figure 18.

Table 20: Bridging items for water transport for UNFCCC totals

Bridging item	Description	Element in Figure 18
AEA total [TOT_NACE_HH]	Includes all GHG emissions by resident units from domestic and international water-born navigation based on bunkering in domestic ports as well as navigation based on bunkering in the rest of the world.	
Less national residents abroad: national fishing vessels operating abroad [NRA_FISH]	Deduct: All GHG emissions from resident fishing vessels **bunkering in the rest of the world**.	(F)
Less national residents abroad: water transport [NRA_WATER]	Deduct: All GHG emissions from international navigation and multilateral operations (water-borne part) undertaken by resident units **bunkering in domestic ports**.	(D), (E)
Less national residents abroad: water transport [NRA_WATER]	Deduct: All GHG emissions from international navigation and multilateral operations (water-borne part) undertaken by resident units **bunkering in the rest of the world**.	(F)
Plus non- residents on the territory: water transport [NRES_WATER]	Add: All GHG emissions from domestic navigation undertaken by non-resident units bunkering at domestic ports.	(G)
	Add: All GHG emissions from non-residents' fishing vessels bunkering at domestic ports.	(H)
	Add: All GHG emissions from non-residents' military bunkering at domestic ports.	(I)
Other adjustments and statistical discrepancies [ADJ_OTH]	Any other differences.	
UNFCCC totals [TOT_CONV]	Includes all GHG emissions by resident units and non-residents from domestic water-born navigation based on bunkering in domestic ports.	

399. Less national residents abroad: GHG emissions by resident units operating international water-born navigation or multilateral operations bunkering fuel at domestic ports are deducted from the AEA totals (element (D) and (E)). Also, GHG emissions by resident units operating international water-born navigation, fishing vessels or multilateral operations bunkering fuel in the rest of the world (F) are deducted from the AEA totals.

400. Plus non-residents on the territory: GHG emissions by non-resident units operating domestic water-born navigation that departs from domestic ports and for which assumingly fuel was bunkered at domestic ports are added to the AEA totals (G). Also, GHG emission by non-resident fishing vessels bunkering at domestic ports are added (H). Thirdly, GHG emissions by non-resident military operating water-born navigation that departs from domestic ports and for which assumingly fuel was bunkered at domestic ports are also added to AEA totals (I).

CLRTAP totals – water transport

401. AEA totals are bridged to CLRTAP totals for the following 7 air pollutants: SO_X, NO_X, NH_3, NMVOC, CO, PM10 and PM2.5. Categories in CLRTAP emission inventories relevant for water transport are shown in Table 21.

Table 21: NFR categories (CLRTAP inventories) relevant for water transport

NFR14	NFR label	Definition
Memo item: 1.A.3.d.i(i)	International maritime navigation	International water-born navigation taking place at sea and in coastal areas.
1.A.3.d.i(ii)	International inland waterways	International water-born navigation taking place on inland lakes and waterways.
1.A.3.d.ii	National navigation (shipping)	Emissions from fuels used by vessels of all flags that depart and arrive in the same country. Note that this may include journeys of considerable length between two ports in a country (e.g. San Francisco to Honolulu). Includes small leisure boats whilst fishing vessels are excluded.
1.A.4.c.iii	Fishing (mobile combustion)	Emissions from fuels combusted for inland, coastal and deep-sea fishing. Fishing should cover vessels of all flags that have refuelled in the country (include international fishing).
1.A.5.b	Other Mobile (water-borne component)	All remaining water-borne mobile emissions from fuel combustion that are not specified elsewhere. Includes military water-borne navigation emissions from fuel delivered to the country's military not otherwise included, as well as fuel delivered within that country but used by the military of external countries that are not engaged in multilateral operations.
Memo item: 1.A.5.c	Multilateral operations (Water-borne Component)	Emissions from military water-borne operations abroad using fuel bunkered domestically.

Source: Annex 1 and EMEP/EEA air pollutant emission inventory guidebook

402. NFR categories in Table 21 are in principle based on fuel sold on the domestic territory to resident units as well as to non-residents. Hence all NFR categories have a resident component as well as a non-resident component. This is represented by the 2nd and 3rd column in Figure 19.

403. Please note that emissions from international bunkers represent fuel sold at domestic ports and not necessary emissions emitted on the journey from the departing port to the next port. Watercrafts may carry fuel from port to port and bunker in those ports where full is cheapest.

404. Also, it could be noted that it is not possible to determine what parts of 1.A.5.b '*Other mobile'* are water-borne, air-borne or land transport in the emission inventory. Some kind of assumption needs to be made when allocating emissions in the bridging table.

405. Figure 19 provides an overview of what elements of water transport related emissions are included in CLRTAP totals (bold blue horizontal) and what elements are included in AEA totals (yellow/orange vertical).

406. CLRTAP totals include international navigation on inland waterways, national navigation, fishing and military navigation, for resident units (elements (A)-(D)) as well as non-residents (elements (H)-(K)). International maritime navigation and multilateral operations – undertaken by both, resident units and non-residents – are not included in the CLRTAP total but provided as a memo item (elements (E), (F), (L) and (M)).

407. AEA totals related to water transport include all resident components reported in CLRTAP inventories (elements (A) to (F)). Note that elements (E) and (F) are reported as memo items only, i.e. not considered in CLRTAP totals. In addition AEA totals include navigation emissions by resident units bunkering abroad (G).

Figure 19: Water transport emissions in CLRTAP inventories and AEA

	Resident units	Non-residents		
International inland waterways	(A)	(H)	1.A.3.di(ii)	
National navigation (shipping)	(B)	(I)	1.A.3.dii	**CLRTAP totals**
Agriculture/Forestry/Fishing: National fishing	(C)	(J)	1.A.4.c.iii	
Other Mobile (Water-borne Component)	(D)	(K)	1.A.5.b	
International maritime navigation	(E)	(L)	1.A.3.d.i(i)	CLRTAP Memo item
Multilateral operations (Water-borne Component)	(F)	(M)	1.A.5.c	
Water transport based on fuel purchased in the rest of the world	(G)			
	AEA			

408. Table 22 describes the bridging items between AEA totals and CLRTAP totals for water transport making reference to the element-letters in Figure 19.

Table 22: Bridging items for water transport for CLRTAP totals

Bridging item	Description	Element in Figure 19
AEA total [TOT_NACE_HH]	Includes all emissions of air pollutants by resident units from domestic and international water-born navigation based on bunkering in domestic ports as well as navigation based on bunkering in the rest of the world.	
Less national residents abroad: fishing vessels operating abroad [NRA_FISH]	Deduct: All emissions of air pollutants from resident fishing vessels bunkering in ports in the rest of world.	(G)
Less national residents abroad: water transport [NRA_WATER]	Deduct: All emissions of air pollutants by resident units from international maritime navigation and multilateral operations based on **bunkering in domestic ports**.	(E) (F)
	Deduct: All emissions of air pollutants by resident units from navigation (incl. military) based on **bunkering in ports in the rest of the world.**	(G)
Plus non-residents on the territory: water transport [NRES_WATER]	Add: All emissions of air pollutants by non-residents from international inland waterways navigation based on bunkering at domestic ports.	(H)
	Add: All emissions of air pollutants by non-residents from domestic navigation based on bunkering at domestic ports.	(I)
	Add: All emissions of air pollutants by non-residents' fishing vessels based on bunkering in domestic ports.	(J)
	Add: All emissions of air pollutants from non-residents' military bunkering in domestic ports.	(K)
Other adjustments and statistical discrepancies [ADJ_OTH]	Any other differences.	
CLRTAP totals [TOT_CONV]	Includes all emissions of air pollutants by resident units and non-residents from international inland waterways navigation and domestic water-born navigation based on bunkering in domestic ports.	

409. Less national residents abroad: Emissions of air pollutants by resident units operating international maritime navigation and multilateral operations based on bunkering in domestic ports are deducted from the AEA totals ((E), (F)). Also, Emissions of air pollutants by resident units operating navigation (incl. fishing vessels and military) or multilateral operations based on bunkering fuel in the rest of the world are deducted from the AEA totals (G).

410. Plus non-residents on the territory: Emissions of air pollutants by non-residents operating international inland waterways navigation based on bunkering at domestic ports (H) needs to be added to AEA totals. Also, emissions by non-residents undertaking domestic navigation based on bunkering at domestic ports (I) need to be added. Thirdly, emissions of air pollutants by non-residents' fishing vessels based on bunkering in domestic ports (J) need to be added. Fourthly, emissions of air pollutants from non-resident military's navigation based on bunkering in domestic ports (K) need to be added.

Air transport

411. Air transport relates to the operation of aircrafts (aviation). Aircraft engines combust fuels that cause direct emissions of materials to the atmosphere. In general, the AEA totals include emissions from air transport activities operated by resident units irrespective of where these emissions actually take place on or above the domestic territory or in the rest of world.

412. There are two NACE groupings which may be involved in operating aircrafts as primary, secondary, and ancillary production activity: H.51 Air transport and O.84 Public administration and defence.

413. Under NACE grouping H.51 the AEA should record the emissions of resident units producing (as output of their principal activity) air transport services (transport of passengers or freight by air or via space). Air transport services may also be undertaken by the resident military which is part of NACE grouping O.84. In addition private households operate aircrafts for non-commercial purposes (consumption activity).

414. For air transport there are significant differences between UNFCCC and CLRTAP with regards to what is included in national totals:

— The focus under CLRTAP is air pollution, which may be local. Therefore it is necessary to distinguish between emissions from the LTO phase and the cruise phase of a flight. Emissions at a low altitude tend to stay local while emissions at a high altitude may travel far away with the winds. Emissions from LTO are because of this included in the national total also for international flights leaving the country. Emissions from the cruise phase are excluded from the national total also for domestic flights, and reported as memo item.

— The focus under UNFCCC is climate change, which is global. It is not necessary to distinguish between emissions at a high or low altitude. International aviation departing from the reporting country's airports is however excluded from UNFCCC totals whereas all domestic aviation is included.

415. Emissions related to international aviation bunkers are based on fuel sold at domestic airports. Aircrafts usually avoid any unnecessary weight, so emissions refer to the flight to the next airport.

UNFCCC totals – air transport

416. AEA totals are bridged to UNFCCC totals for the six greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs and SF_6. Categories in UNFCCC inventories relevant for air transport related emissions are shown in Table 23.

Table 23: CRF categories (UNFCCC inventories) relevant for air transport

CRF (old)	CRF (new)	CRF label	Definition
1.A.3.a	1.A.3.a	Domestic Aviation	Emissions from civil domestic passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.), including take-offs and landings for these flight stages. Note that this may include journeys of considerable length between two airports in a country (e.g. San Francisco to Honolulu).
1.A.5.b (partly)	1.A.5.b (partly)	Other Mobile (Aviation Component)	Aviation emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the country's military.
Memo item:1.C.1.a	Memo item:1.D.1	International bunkers / Aviation	Emissions from flights that depart in one country and arrive in a different country. Include take-offs and landings for these flight stages. Emissions from international military aviation can be included as a separate sub-category of international aviation provided that the same definitional distinction is applied and data are available to support the definition.
Memo item: 1.C.2	Memo item: 1.D.3	Multilateral operations (Aviation Component)	Emissions from military air-bourne operations abroad using fuel bunkered domestic.

Source: Annex 1 and 2006 IPCC Guidelines for GHG Inventories

417. CRF categories in Table 23 are in principle based on fuel sold on the domestic territory to resident units as well as to non-residents. Hence all CRF categories have a resident component as well as a non-resident component. This is represented by the 2nd and 3rd column in Figure 20.

418. It could be noted that it is not possible to determine what parts of 'Other mobile' and 'Multilateral operations' are water-borne, air-borne or land transport in the emission inventory. Some kind of assumption needs to be made when allocating emissions in the bridging table.

419. Figure 20 provides an overview of what elements of air transport related emissions are included in UNFCCC totals (bold blue horizontal) and what elements are included in AEA totals (yellow/orange vertical).

420. UNFCCC totals include domestic aviation and other mobile (aviation component) for resident units (elements (A) and (B)) as well as non-residents (elements (F) and (G)). International aviation bunkers and multilateral operations are not included in UNFCCC totals but provided as a memo item (elements (C), (D), (H) and (I)).

421. AEA totals related to air transport include all resident components reported in UNFCCC

inventories (elements (A) to (D)). Note that elements (C) and (D) are reported as memo items only, i.e. not considered in UNFCCC totals.

422. In addition AEA totals include air transport emissions by resident units based on fuel purchased outside the domestic territory (element (E)).

Figure 20: Air transport emissions in UNFCCC inventories and AEA

	Resident units	Non-residents		
Domestic aviation	(A)	(F)	1.A.3.a	**UNFCCC**
Other Mobile (Aviation Component)	(B)	(G)	1.A.5.b	
International bunkers / Aviation	(C)	(H)	1.D.1	UNFCCC Memo item
Multilateral operations (Aviation Component)	(D)	(I)	1.D.3	
Air transport based on fuel purchased in the rest of the world	(E)			
	AEA			

423. Table 24 describes the bridging items between AEA totals and UNFCCC totals for air transport making reference to the element-letters in Figure 20.

Table 24: Bridging items for air transport for UNFCCC totals

Bridging item	Description	Element in Figure 20
AEA total [TOT_NACE_HH]	Includes all GHG emissions from domestic and international aviation as well as aviation in the rest of the world undertaken by resident units (airlines and military).	
Less national residents abroad – air transport [NRA_AIR]	Deduct: All GHG emissions from international aviation undertaken by resident units (airlines and maybe military).	(C), (D), (E)
Plus non-residents on the territory – air transport [NRES_AIR]	Add: All GHG emissions from domestic aviation undertaken by non-resident units (airlines) bunkering on domestic airports.	(F)
	Add: All GHG emissions from domestic and international aviation undertaken by non-resident military bunkering on domestic airports.	(G)
Other adjustments and statistical discrepancies [ADJ_OTH]	Any other differences.	
UNFCCC totals [TOT_CONV]	Includes all GHG emissions from domestic aviation undertaken by resident units and non-residents bunkering on domestic airports.	

424. Less national residents abroad: GHG emissions by resident airlines operating international aviation that departs from domestic airports and for which fuel was bunkered on domestic airports are deducted from the AEA totals (C). Also, GHG emissions by resident military operating international aviation that depart from domestic airports and for which fuel was bunkered on domestic airports are also deducted from AEA totals (D). Thirdly, GHG emissions by resident airlines operating international aviation that departs from domestic airports and for which fuel was bunkered in the rest of the world are deducted from the AEA totals (E).

425. Plus non-residents on the territory: GHG emissions by non-resident airlines operating domestic aviation that departs from domestic airports and for which fuel was bunkered on domestic airports are added to the AEA totals (F). Also, GHG emissions by non-resident military operating international aviation that departs from domestic airports and for which the fuel was bunkered on domestic airports are also added to AEA totals (G).

CLRTAP totals – air transport

426. AEA totals are bridged to CLRTAP totals for seven air pollutants: SO_X, NO_X, NH_3, NMVOC, CO, PM10 and PM2.5. Categories in CLRTAP emission inventories relevant for air transport are shown in Table 25.

Table 25: NFR categories (CLRTAP inventories) relevant for air transport

NFR14	NFR label	Definition
1.A.3.a.i(i)	International aviation LTO (civil)	Emissions from mobile sources that concerns the movement of people and/or freight by air. The scope of the emissions to be included comprises civil commercial use of airplanes, including scheduled and charter traffic for passengers and freight, air taxiing and general aviation. The international/ domestic split should be determined on the basis of departure and landing locations for each flight stage and not by the nationality of the airline. LTO cycles are all movements below 3000 ft (914 m) and Cruise movements above.
Memo item: 1.A.3.a.i(ii)	International aviation cruise (civil)	
1.A.3.a.ii(i)	Domestic aviation LTO (civil)	
Memo item: 1.A.3.a.ii(ii)	Domestic aviation cruise (civil)	
1.A.5.b	Other mobile (including military)	Mobile emissions from vehicles and other machinery, maritime and aviation (not included elsewhere). Includes emissions from fuel delivered to the country's military as well as fuel delivered within the country and used by the military of other countries.
Memo item: 1.A.5.c	Multilateral operations (Aviation Component)	In case military aviation is split into civilian, national and international aviation, the international military emissions may be reported under International Aviation (i.e. 1.A.3.a.i).

Source: Annex 2 and EMEP/EEA air pollutant emission inventory guidebook 2013

427. CRF categories in Table 25 are in principle based on fuel sold on the domestic territory to resident units as well as to non-residents. Hence all CRF categories have a resident component as well as a non-resident component. This is represented by the 2nd and 3rd column in Figure 21.

428. It could be noted that it is not possible to determine what parts of 'Other mobile' and 'Multilateral operations' are water-borne, air-borne or land transport in the emission inventory. Some kind of assumption needs to be made when allocating emissions in the bridging table.

429. Figure 21 provides an overview of what elements of air transport related emissions are included in CLRTAP totals (blue) and what elements are included in AEA totals (orange).

430. CLRTAP total include emissions from landing and take-off (LTO) related to international and domestic aviation departing from domestic air ports and undertaken by resident and non-residents units (elements (A), (B), (H), and (I)). Further the CLRTAP total includes other mobile (aviation component) by residents and non-residents (element (C) and (J). Emissions from aviation at cruise stage are excluded from CLRTAP totals (elements (D), (E), (K) and (L). So are emissions from multilateral operation (elements (F) and (M)).

431. AEA totals include related to air transport include all resident components reported in CLRTAP inventories (elements (A) to (F)). Note that elements (D), (E) and (F) are reported as memo items only, i.e. not considered in CLRTAP totals. In addition CLRTAP total include

emissions from air transport operated by resident unit based on fuel purchased in the rest of the world (element (G)).

Figure 21: Air transport emissions in CLRTAP inventories and AEA

	Resident units	Non-residents		
International aviation – LTO	(A)	(H)	1A3ai(i)	**CLRTAP**
Domestic Aviation – LTO	(B)	(I)	1A3aii(i)	
Other Mobile (Aviation Component)	(C)	(J)	1.A.5.b	
International aviation – Cruise	(D)	(K)	1A3ai(ii)	CLRTAP Memo item
Domestic aviation – Cruise	(E)	(L)	1A3aii(ii)	
Multilateral operations (Aviation Component)	(F)	(M)	1.A.5.c	
Air transport based on fuel purchased in the rest of the world	(G)			
	AEA			

432. Table 26 describes the bridging items between AEA totals and CLRTAP totals for air transport making reference to the letters in Figure 21.

Table 26: Bridging items for air transport for CLRTAP totals

Bridging item	Description	Element in Figure 21
AEA total [TOT_NACE_HH]	Includes all emissions from domestic and international aviation as well as aviation in the rest of the world undertaken by resident units (airlines and military).	
Less national residents abroad – air transport [NRA_AIR]	Deduct: All emissions from international aviation at cruise stage undertaken by resident units and where the fuel is bunkered on domestic airports (implicit: flights departing from domestic airports).	(D)
	Deduct: All emissions deriving from domestic aviation at cruise stage undertaken by resident units (implicit: fuel must be bunkered on domestic airports).	(E)
	Deduct: All emissions by resident units from multilateral operations based on bunkering at domestic airports.	(F)
	Deduct: All aviation emissions by resident units deriving from fuel bunkered on airports in the rest of the world	(G)
Plus non-residents on the territory – air transport [NRES_AIR]	Add: All emissions deriving from international aviation at LTO stage undertaken by non-residents and departing from domestic airports (implicit: fuel must be bunkered on domestic airports).	(H)
	Add: All emissions from domestic aviation at LTO stage undertaken by non-residents (implicit: fuel must be bunkered on domestic airports).	(I)
	Add: Aviation born emissions from other mobile sources such as e.g. foreign military bunkering on domestic airports.	(J)
Other adjustments and statistical discrepancies [ADJ_OTH]	Any other differences.	
CLRTAP totals [TOT_CONV]	Includes all emissions from domestic and international aviation LTO where the fuel is bunkered on domestic airports.	

433. Less national residents abroad: Emissions of air pollutants by resident units operating international aviation at cruise stage departing from domestic airports (D) are deducted from AEA totals. Also, emissions by resident airlines operating domestic aviation at cruise stage (E) are deducted. Thirdly, emissions from resident units undertaking multilateral operations (aviation part) (F) are deducted. Finally, all emissions related to aviation by resident units departing from and implicit bunkering at airports in the rest of the world (G) are deducted.

434. Plus non-residents on the territory: Emissions of air pollutants by non-residents operating international aviation at LTO stage departing from domestic airports (H) are added to AEA totals. Also, emissions of air pollutants by non-residents operating domestic aviation at LTO stage (I) are added. Thirdly, emissions by non-resident military undertaking aviation departing from domestic airports (J) are added.

Annex 4: Calculating aggregates and uses of economic time series

Aggregation of air emissions to environmental themes

435. In order to assess the potential aggregated impact of a number of different air emissions on the same environmental theme it is possible to aggregate several air emissions to aggregated numbers introducing conversion factors. This is also done by Eurostat ([64]).

436. Three environmental impact categories are derivable by NACE from 8 air emissions of Eurostat's AEA:

— Global Warming Potentials (CO_2, N_2O, CH_4)

— Acidification (SO_X, NO_X, NH_3)

— Tropospheric Ozone Formation Potential (NO_X, NMVOC, CO, CH_4)

437. The impact categories are derived through aggregating several air emissions to one number applying internationally agreed weighing factors. Table 27 presents the weighing factors applied by Eurostat:

Table 27: Weighting factors applied for aggregating air emissions to environmental themes

Impact category (environmental theme)	Unit	Air emission	Weighting factor
Global Warming Potential (GWP)after 100 years	CO_2-equivalents	CO_2	1.0
		N_2O	298
		CH_4	25
Acidification (ACID)	SO_2-equivalents	SO_X	1.0
		NO_X	0.7
		NH_3	1.9
Tropospheric Ozone Forming Potential (TOFP)	NMVOC-equivalents	NO_X	1.22
		NMVOC	1.0
		CO	0.11
		CH_4	0.014

Source: Eurostat and UNFCCC ([65])

([64]) Eurostat (2015a) and Eurostat (2015b).
([65]) Ibid and UNFCCC (2013). Data in the table refers to: GWP: UNFCCC (2013), Table 2.14; ACID: based on Adriaanse (1993) and EEA (2002), chapter 10 p. 83; TOFP: EEA (2002), chapter 10 p. 84.

Chained volume measures for economic time series

438. Economic variables such as production output and gross value added are expressed in monetary units. It is the monetary value of goods and services which is actually measured ([66]). The problem when using the monetary unit as a measuring unit is that it is neither a stable nor an international standard.

439. In economic analyses across countries and over time, it is frequently necessary to distinguish, in the value changes for certain economic aggregates, the changes arising solely from price changes from the remainder which is called the change in 'volume'. The value (v) can be thus decomposed in two elements: unit price (p) multiplied with the quantity unit (q):

$$v = p \cdot q$$

440. The values of goods and services as recorded in the System of National Accounts bear a volume dimension and a price dimension, which – if needed – has to be decomposed. For analyses of time series, it is recommended to use volume measures only, i.e. measurement units where the price dimension (inflation, changes in relative prices) has been deducted.

441. The ESA has introduced chained volume measures to report economic aggregates in volume terms in their annual and quarterly accounts. Chained volume measures are replacing former 'constant prices' that were used to express development in volume terms. Eurostat offers four forms of chained volume measures:

- growth rates,
- (chain) index (year 2010 = 100),
- chained level series (reference year 2010), and
- levels at prices of the previous year.

442. Growth rates: For annual series year-on-year growth rates are shown. For quarterly series, the growth rate compared to the previous quarter as well as the growth rate compared to the same quarter of the previous year is given.

443. Indices: Chained volume measure series will be expressed as an index in which the series is scaled to a value of 100 in one year, which is called the reference year. In 2015, Eurostat uses the year 2010 as reference year for the chain indices. The choice of the reference year has no impact on the movements in the series.

444. Chained level series: Chained volume measure series will also be shown and referenced onto the year 2010. These level series are obtained by multiplying the chain index by the current price figures in the reference year.

445. Level at prices of the previous year: These figures are intended as input for advanced users to allow them building their own aggregations and derived measures. It must be noted that, as the price base changes every year, the figures do not constitute a homogeneous time series, so in particular growth rates cannot be derived directly from them.

([66]) For more details see SNA2008 chapter 15, Eurostat (2010a) chapter 10, and Eurostat (2008 b) SUIOT Manual chapter 9.

446. Users who want to work with the chained level series must be aware that chain-linking results in the **loss of additivity** of volume data (except for the data relating to the reference year and the one following the reference year): The chained level of an aggregate is not equal to the sum of the chained components. This means, for example, that in the chained level series the components of GDP do not add up to GDP. This loss of additivity also applies to geographical aggregations (such as euro area, EU15, EU25 and EU27). Non-additivity arises for purely mathematical reasons; the discrepancies cannot and should not be interpreted as indications of quality. Additivity however remains in data expressed at previous year's prices and in the data expressed at current prices. Hence it is also given in the chained level series for the reference year and the year following the reference year.

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