Category		Title
NFR:	2.D.3.a	Domestic solvent use including fungicides
SNAP:	060408 060411	Domestic solvent use (other than paint application) Domestic use of pharmaceutical products
ISIC:		
Version	Guidebook 2019	

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Contents

1 Overview

This chapter addresses non-methane volatile organic compounds (NMVOCs) and certain other pollutant emissions from the domestic use of solvent-containing products. An overview of the main sub-categories for domestic solvent use is provided in section 0 of this chapter. Many of these products are also used in industry and commerce. It is not always possible to differentiate between domestic and industrial/professional use, but whenever possible this differentiation should be emphasised in the reporting. This section does not include the use of decorative paints, which is covered in Chapter 2.D.3.d 'Coating application' of this guidebook. If the distinction between domestic and industrial/commercial application cannot be made, it is good practice to report the emissions in the domestic use emission source category and document this in the informative inventory report (IIR).

Earlier versions of this guidebook were based on studies from the early 1990s that covered the United States (USEPA, 1995), the UK (Atlantic Consulting, 1995) and Canada (UNECE, 1990). In 2013, a new version was developed, which emphasises the utilisation of country-specific data and assesses the comparability between countries, which improved completeness and transparency as well as uncertainty estimates. In this 2013 version, emission factors were adopted from specific national inventories, which were selected based on high- quality data, characterised by a high degree of completeness, accuracy and transparency, and include nation-specific estimates that are independent of other inventories or previous guidebook data. These countries represent western Europe and have detailed mass balances that rely on, for example, national production, import and export statistics, and information from industries and trade organisations. The methods used by the different countries vary greatly, because the category comprises a large number of products and pollutants that are categorised as NMVOCs, and because use patterns may vary considerably.

In 2016, this latest revision of the chapter was completed. In this updated chapter, additional emission factors from national inventories have been included, and the existing methods and emission factors have been revised. Furthermore, information from a separate inventory, which was made available by the solvent industry (European Solvents Industry Group (ESIG)) to support emission inventory development, has also been assessed and included.

For the current chapter, several data sources were used to get as complete and comprehensive a picture as possible, in order to allow inventory compilers to select the information they need to improve their emissions estimates. The data sources include those outlined below.

- Specific information from several European national emissions inventories, including from the UK, Norway, Germany and Italy, was included.
- Data supplied by the ESIG in recent years, based on solvent production data in the European Union, was included.
- Information was included from a US survey on consumer and commercial solvent use (USEPA, 1995), some data from which were also included in the previous version of the guidebook. This survey is comprehensive and, for many product categories, it includes formulation data for practically all products sold within that category. The overall quality of the US emission factors is likely to be good.
- United Nations Economic Commission for Europe (UNECE) data for Canada (UNECE, 1990) were included.

- International Institute for Applied Systems Analysis (IIASA) data (personal communication, 2011) with emission factors for EMEP regions from the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model in 2010 for the total domestic sector (DOM_OS) for the EU-15 plus Iceland, Norway and Switzerland, and for the EU-12 and the 12 Eastern Europe, Caucasus and Central Asia (EECCA) countries.
- Information from a Greek study by Tzanidakis et al. (2012) was included.

The ideal case would be to have access to activity data as 'used amount of product', as well as to know the solvent content of these products, and measurements and/or estimates of emission factors for solvent species under the given conditions of product use (the amount of solvent that evaporates). On the basis that not all data are available and that assumptions are necessary, in this version of the guidebook different methodologies are distinguished to estimate emissions from the domestic use of solvents, based on the different types of activity data that may be available. Because the availability of activity data is often the limiting factor in estimating emissions from domestic solvent use, we present different methods for use with different types of activity data, as described below.

1. Tier 1 method: This is the default approach. It provides a per-capita emission factor, which is to be applied in cases only if no alternative information is available for the application of one of the other approaches described below.
2. Tier 2a method: This approach involves building the inventory based on the amount of solvents used, combined with emission factors (in g/kg solvent used) for the release of NMVOCs from these solvents. One of the options in this approach is to use data supplied by ESIG (only for EU-27 Member States). This latter approach can be applied if activity data are not available at all.
3. Tier 2b method: This approach involves building the inventory from existing statistics on the use of solvent-containing products. This requires information on the solvent content of the products, as well as the emission factor for the release of NMVOCs. These two are combined in an emission factor expressed as g/kg product used. For both parameters, this chapter provides guidance and default values that can be used.

Emission factors are uncertain parameters and are represented by a single number (mean value) with 95 % confidence interval limits, based on all values. If only one or two figures defined an emission factor, the uncertainty was assessed using expert judgement, typically representing the 95 % confidence interval as '– mean value/(2 to 10); + mean value × (2 to 10)', unless more reliable information was available. If more than two figures defined an emission factor, the mean value and 95 % confidence interval was calculated based on these figures. In some cases, the upper and lower intervals were set to the minimum and maximum values, respectively, from the available dataset.

2 Description of sources

2.1 Process description

NMVOCs are used in a large number of products sold for use by the public. These can be divided into a number of categories. The main categories that can be distinguished in the domestic use of solvents are outlined in Table 2.1.

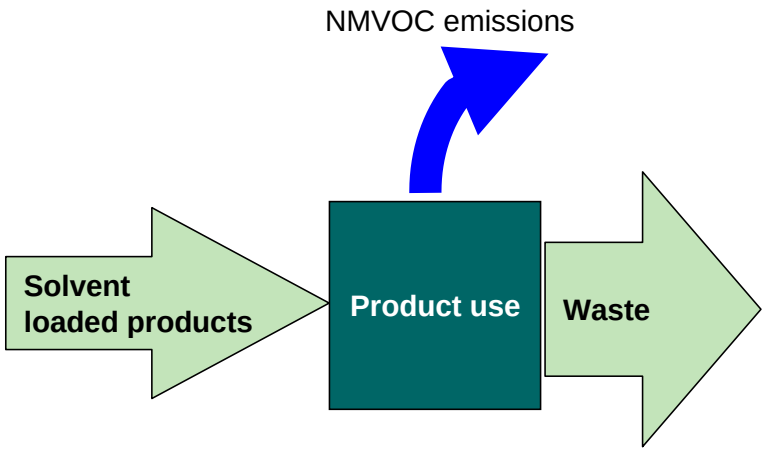
Table 2.1 Main categories with regard to the domestic use of solvents

Category	Description
Cosmetics and toiletries	Products for the maintenance or improvement of personal appearance, health or hygiene
Household products	Products used to maintain or improve the appearance of household durables
Construction/DIY	Products used to improve the appearance or the structure of buildings such as adhesives and paint remover. This sector would also normally include coatings; however, these products fall outside the scope of this section and are therefore omitted
Car care products	Products used for improving the appearance of vehicles to maintain vehicles, or winter products such as antifreeze
Pesticides	Pesticides, such as garden fungicides, herbicides and insecticides, and household insecticide sprays may be considered as consumer products. Most agrochemicals, however, are produced for agricultural use and fall outside the scope of this section

A further distinction is made between aerosol and non-aerosol products.

The domestic use of pharmaceutical products and the emissions of other pollutants, such as mercury (Hg), are also included in this chapter.

Figure 2.1 Process scheme for source category 2.D.3.a Domestic solvent use



2.2 Techniques

NMVOCs are mainly present in consumer products as solvents. In aerosols, NMVOCs such as butane and propane are also used as propellants. Propellants generally act as solvents as well. Aerosols are mainly included in cosmetics and paints, and are therefore not included separately in order to avoid double counting. Switching from an aerosol to a non-aerosol form of a product will not necessarily reduce the proportion of solvent used in the product.

2.3 Emissions

Emissions occur because of the evaporation of the NMVOCs contained in products during their use. For most products, all of the NMVOC will be emitted to the atmosphere. However, in some products the NMVOC will be lost mainly in wastewater.

There are only limited data available on the NMVOC species present in consumer products. A breakdown of NMVOC emissions from all consumer products was given by a Swiss study (ATAL, 1992) as summarised in Table 2.2.

Table 2.2 Breakdown of NMVOC emissions from all consumer products

VOC compound class	Total emission (t/a)	% of total emission
Aliphatic hydrocarbons	3 200	22
Alcohols	7 300	50
Amines	210	1
Ketones	70	1
Esters	140	1
Ethers	2 780	19
Aromatic hydrocarbons	450	3
Chlorinated hydrocarbons	190	1
Organic acids	190	1

In this study, the NMVOCs used were stated to include propane, butane, ethanol, isopropanol, ethyl acetate and butyl acetate. A breakdown of the emissions resulting from the use of aerosols is given in Passant (1993) and is also summarised in Table 2.3.

Table 2.3 Breakdown of emissions resulting from the use of aerosols

Compound	% wt
Alkanes	60
Alcohols	35
111-trichloroethane	2
Esters and ketones	1
Dimethylether	2

The alkanes present in emissions are predominantly butane and propane propellants. Ethanol is likely to be the most commonly used alcohol. The most widely used solvent in cosmetics and toiletries is ethanol and, in the absence of more detailed information, it is recommended that all emissions from non-aerosol cosmetics and toiletries are assumed to be ethanol. The second most important constituent is expected to be turpentine.

2.4 Controls

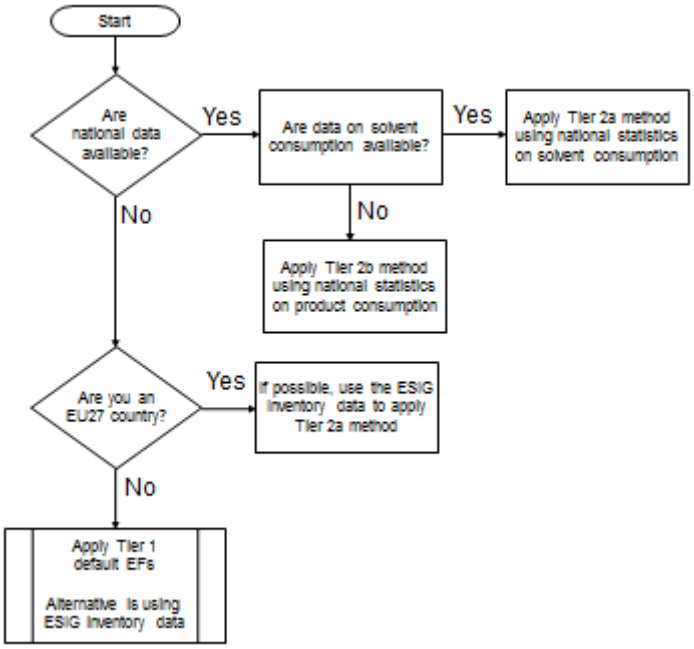
The control of emissions resulting from the use of consumer products can be achieved only through the reformulation of products so that they contain less NMVOCs or through measures that promote the use of NMVOCs with lower vapour pressure.

3 Methods

Figure 3.1 presents the procedure for selecting the methods to use to estimate emissions from the domestic use of solvents. The basic idea is outlined as follows.

- If detailed information is available, use it. For this source category, however, facility-level data will not be available. Therefore, the Tier 3 method using facility data cannot be used for this chapter.
- If the source category is a key category, a Tier 2 method must be applied, and detailed input data must be collected. The decision tree recommends that, in such cases, the user adopts the Tier 2 method.

Figure 3.1 Decision tree for source category 2.D.3.a Domestic solvent use



This chapter distinguishes between Tier 2a and Tier 2b methodologies, and either one of the two may be chosen depending on the type of activity data available. These two methods are explained in separate sections below, along with the Tier 1 method.

Specifically, for domestic solvent use, if no country-specific (activity) data are available for the application of an approach beyond Tier 1, the use of ESIG inventory data (as described in the Tier 2a approach) is encouraged if possible for your country. In principle, this approach is given preference over the Tier 1 approach, especially if domestic solvent use is a key source.

3.1 Tier 1 default approach

3.1.1 Algorithm

For domestic solvent use (including fungicides), the default Tier 1 approach is to multiply the population of the country with a typical emission factor. The general equation is:

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \quad (1)$$

where '$E_{pollutant}$' is the emission of the specified pollutant; '$AR_{production}$' is the activity rate for the coating application (in this case the population); and '$EF_{pollutant}$' is the emission factor for this pollutant.

This equation is applied at the national level, using annual national total figures for the population. The Tier 1 emission factors assume an average or typical range of products used in the domestic sector, and are representative for the domestic solvent use sector as a whole.

It should be noted that this Tier 1 method has limitations with regard to its applicability, as it is calculated using population data, and thus has no direct link to the actual use of products and, as such, does not reflect changes in the amount of products used or changes in their chemical composition, which may affect emission factors. Therefore, this factor should only be used if no other alternative is available

3.1.2 Default emission factors

Table 3.1 presents the default emission factor for NMVOC emissions from the domestic use of solvents. Emissions are estimated based on the population size of a country, since it is difficult to find another common activity parameter, which is readily available for all countries, to characterise emissions from this sector. To account for the differences between countries, typical emission factors are presented for the different country groups. The emission factors are based on an assessment of data from the IIASA GAINS model for the years 2000 and 2010. It should be noted that there is quite a lot of inter-country variation; therefore, it is recommended that this Tier 1 approach be used only if no alternative data sources are available.

In addition to the emission of NMVOC, emissions of Hg could arise from the use of fluorescent tubes. These emissions may, however, be accounted for elsewhere in the inventory e.g. under waste where emissions arising from breakage of these tubes might be an issue. Due to the uncertainty around these releases, this source is currently not considered in the Guidebook. However, it is recommended that countries review the available information to what extent this source could be estimated. Additional information on this source can be found in Climate and Pollution Agency, (2012).

Table 3.1 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use including fungicides

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
Not applicable	NO_x, CO, SO_x, NH_3, BC, Pb, Cd, As, Cr, Cu, Ni, Se, Zn, HCH, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	$PM_{2.5}$				
Pollutant	**Value**	**Unit**	**95 % confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC — western Europe ([a])	1.8	kg/capita	0.6	3.0	Assessment of available sources (described below)
NMVOC — other countries	1.2	kg/capita	0.5	1.7	Assessment of available sources (described below)

([a]) In this table, western Europe refers to the EU Member States as of 1 January 1995 plus Iceland, Norway and Switzerland.

In previous guidebook versions, the Tier 1 emission factor varies a lot. An assessment of the reporting of NMVOC emissions from domestic solvent use since 2000 shows large variations between countries, as described below.

- In the EU-15 plus Norway, Switzerland and Iceland, the implied emission factor (IEF) per capita ranged from 0.8 to 5.1 kg/capita in the year 2000 (with a weighted average of 2.5), and in the year 2013 it ranged from 0.8 to 2.8 kg/capita (average 1.6 kg/capita).
- For other EU Member States, an average IEF of around 1.5 kg/capita is seen for all years, ranging from 0.2 kg/capita to more than 6 kg/capita depending on the country and year.

- For other countries, reporting in 2013 shows IEFs of between 0.8 and 2.7 kg/capita, while for earlier years no estimate could be derived.

Other estimates include the following:

- IIASA estimates emissions from domestic solvent use to be around 1.6 kg/capita for western Europe and 0.7 kg/capita for eastern Europe. However, these figures are in turn partly based on an assessment of the reported data by the countries, while especially for non-EU countries, a default 0.5 kg/capita has been assumed.
- In the 2013 version of the guidebook, a factor of 2.7 kg/capita is proposed based on the reported emissions in selected countries. However, more recent reporting by countries suggests that this emission factor may be an overestimation.
- The ESIG inventory (ESIG, 2015) suggests an emission factor of 1.2 kg/capita for the EU-27 (EU Member States up to 30 June 2013).
- The Italian inventory (ISPRA, 2012) uses a default emission factor of 1.81 kg/capita.
- The Swiss inventory (FOEN, 2012) uses a default emission factor of 1.5 kg/capita.
- A Greek study by Tzanidakis et al. (2012) suggests a factor of between 1.8 and 5.4 kg/capita.

3.1.3 Based on the estimates described above, it was decided to adopt a default factor of 1.8 kg/capita for western EU Member States and 1.2 kg/capita for other countries. As shown by the range in values given by the different sources, the uncertainty in this estimate is rather high and this is reflected in the 95 % confidence interval.Activity data

The basic activity statistics required for use of the Tier 1 emission factor are national population figures that are available from national statistics offices.

3.2 Tier 2 technology-specific approach

For the Tier 2 approach to estimating emissions from domestic solvent use, two separate methodologies are available. Either one of these two methods may be chosen depending on the type of activity data available at the national level, as follows:

- for the Tier 2a method, emissions of NMVOCs from domestic solvent use are estimated based on the amounts of solvent used;
- for the Tier 2b method, emissions of NMVOCs from domestic solvent use are estimated based on the amounts of product used.

This section presents the emission factors for the Tier 2a and Tier 2b methods. Both methodologies are based on the same algorithm, but use a different aggregation level (either products or solvents).

When applying the Tier 2a methodology, with no activity data available, it may be possible to use the ESIG inventory as a basis, which is described in sub-section 3.2.3.

3.2.1 Algorithm

For the Tier 2a approach, activity data on the amount of solvent consumed are relevant, as it is contained in specific product types. To apply the Tier 2 approach, both activity data and emission factors are stratified according to the specific product or solvent types that are part of the domestic use of solvents.

The general approach for applying the Tier 2 methods is to sub-divide the domestic use of solvents into different products or product groups, and to apply specific emission factors for these products. Therefore, the Tier 2 method can, in general, be expressed with the following formula:

$$E_{NMVOC} = \sum_{products} AR_{product} \times EF_{product,NMVOC} \quad (2)$$

In the Tier 2a method, the activity rate ('*AR*') will be the amount of solvent consumed through the use of different products, while the Tier 2b method builds on the actual amounts of each product used. If, in some cases, activity data are lacking for specific products, it may be possible to estimate these from other data that might reflect the relative amount used of each solvent (i.e. the use of proxy data).

Sub-sections 3.2.2 to 3.2.4 describe the methodology in detail with default emission factors, while sub-section 3.2.6 contains more information on the activity data needed for the Tier 2 methodology.

3.2.2 Tier 2a: Solvent-based technology-specific emission factors

To apply the solvent-based approach, emission factors are available from various sources. These describe emission factors of solvent categories using different classifications. In Table 3.2, different types of aggregations with regard to the subsector detail are included to allow the inventory compiler to calculate emissions based on the level of detail in which the solvent consumption data are available at national level.

Table 3.2 NMVOC emission factors for source category 2.D.3.a Domestic solvent use including fungicides for different solvent types/applications

Tier 2 emission factors					
	Code	Name			
NFR source category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	N/A				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/practices	Various, see below				
Region or regional conditions					
Abatement technologies	N/A				
Not applicable	NO_x, CO, SO_x, NH_3, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	$PM_{2.5}$				
Subsector	**Value (NMVOC)**	**Unit**	**95 % confidence interval**		**Reference**
			Lower	**Upper**	
Agrochemical uses	1 000	g/kg solvent	950	1 000	ESIG (2015)
Blowing agents	1 000	g/kg solvent	950	1 000	ESIG (2015)
De-icing	1 000	g/kg solvent	950	1 000	ESIG (2015)
Binder and release agents	1 000	g/kg solvent	950	1000	ESIG (2015)
Professional consumer cleaning	500	g/kg solvent	300	700	ESIG (2015)
Industrial, professional and consumer coatings	750	g/kg solvent	500	1 000	ESIG (2015)
Road and construction	950	g/kg solvent	950	1 000	ESIG (2015)
Other consumer uses (households, aerosols, cosmetics)	950	g/kg solvent	700	1 000	ESIG (2015)

Cosmetics and toiletries (general)	830	g/kg solvent	800	950	USEPA (1995)
Cosmetics and toiletries (hair sprays)	950	g/kg solvent	750	1 000	German inventory (2016)
Cosmetics and toiletries (toilet waters)	950	g/kg solvent	750	1 000	German inventory (2016)
Cosmetics and toiletries (after shaves)	950	g/kg solvent	750	1 000	German inventory (2016)
Cosmetics and toiletries (perfumes)	950	g/kg solvent	750	1 000	German inventory (2016)
Cosmetics and toiletries (face care)	950	g/kg solvent	750	1 000	German inventory (2016)
Cosmetics and toiletries (personal deodorants and antiperspirants)	950	g/kg solvent	750	1 000	German inventory (2016)
Cosmetics and toiletries (body care)	950	g/kg solvent	750	1 000	German inventory (2016)
Household products (all)	650	g/kg solvent	500	800	USEPA (1995), SMED (2006)
Household products (soaps: liquid or paste)	950	g/kg solvent	750	1 000	German inventory (2016)
Household products (polishes and creams for floors)	950	g/kg solvent	750	1 000	German inventory (2016)
Household products (show polishes and creams)	950	g/kg solvent	750	1 000	German inventory (2016)
Car care products (all)	940	g/kg solvent	920	960	USEPA (1995), SMED (2006)
Car care products (antifreeze agents in windscreen wiper systems)	500	g/kg solvent	300	700	German inventory (2016)
Do it yourself (DIY)/buildings (all)	950	g/kg solvent	950	1 000	SMED (2006)
Do it yourself (DIY)/buildings (adhesives)	950	g/kg solvent	950	1 000	SMED (2006)
Do it yourself (DIY)/buildings (paint/varnish removers and solvents)	950	g/kg solvent	930	1 000	SMED (2006)
Do It Yourself (DIY)/buildings (sealants, filling agents)	975	g/kg solvent	950	1 000	USEPA (1995), SMED (2006)
Pesticides	865	g/kg solvent	800	930	USEPA (1995), Climate and Pollution Agency (2012)

If, for some specific products, only product-based statistics are available, the default factors in Table 3.3 may be used to calculate the solvent consumption from the product consumption.

Table 3.3 Default solvent content for specific products in domestic solvent use

Product	Default solvent content (%)	Source
Cosmetics and toiletries, Hair sprays	90	German Inventory (2016)
Car care products, Antifreeze agents in windscreen wiper systems	50	German Inventory (2016)
Cosmetics and toiletries, Toilet waters	80	German Inventory (2016)
Pharma, domestic use of pharmaceutical products	20	German Inventory (2016)
Household products, Soaps (liquid, paste)	5	German Inventory (2016)
Household products, Polishes and creams for floors	80	German Inventory (2016)
Cosmetics and toiletries, After shave	80	German Inventory (2016)

Cosmetics and toiletries, Perfumes	80	German Inventory (2016)
Cosmetics and toiletries, Face care	10	German Inventory (2016)
Cosmetics and toiletries, Personal deodorants and antiperspirants	50	German Inventory (2016)
Cosmetics and toiletries, Body care	10	German Inventory (2016)
Household products, Shoe polishes and creams	45	German Inventory (2016)
DIY/buildings, Application of glues and adhesives — DIY	75	German Inventory (2016)
DIY/buildings, Thinners	100	German Inventory (2016)

3.2.3 Special case of Tier 2a: use of ESIG data and methodology

For the Tier 2a method, one of the options is to make use of the activity data from the ESIG inventory in your national inventory. This inventory has been prepared by ESIG to support the emission inventory community. The methodology is described in detail in ESIG, 2015.

It should be noted, however, that this dataset has some important limitations for the inventories, namely the activity data:

- are available for only a limited number of years;
- are available for only the EU-27 countries (thus excluding Croatia), and some of the countries have been aggregated to country groups for confidentiality reasons;
- are categorised using the REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) sector classification, which is different from the NFR (Nomenclature for Reporting) classifications used in emission inventories;
- cover chemical compounds used as solvents and omit other relevant VOCs used as, for example, propellants;
- may not reflect the correct import and export for each country, as the underlying data represent the production of solvents in the EU-27.

To estimate emissions from the years for which data are missing, interpolation and/or extrapolation may be used. In addition, a conversion between the REACH and CRF/NFR category definitions should be made. However, the link between these two is not a simple one-to-one relationship in all cases. In the UK, an attempt has been made to link the subsectors underlying the NFR in the national UK inventory to the REACH sectors.

It must be ensured that a part of a country's used amount is not 'lost' because the linking of categories is not exact. Therefore, the total use amount must, of course, be recovered in the REACH categories. Given the uncertainty in linking the sectors, it is recommended that if ESIG data are used as the basis for the inventory of solvent NMVOC emissions, that this is done for all product use source categories (i.e. NFR 2.D.3.*) to avoid NMVOC emissions being missed or double counted because different methodologies are applied for different subsectors.

The full link table between REACH and NFR, as it is proposed, is provided in the annex to this chapter.

As mentioned above, when applying the ESIG methodology, it needs to be taken into account that reporting is based on product use rather than solvent use. However, the activity data from ESIG only include data on solvents and not the non-solvent product components, such as propellants, that

lead to volatile organic compound (VOC) emissions. In this methodology, this is taken into account by applying a correction factor for non-solvent VOC emissions. Some default factors describing a typical solvent content for different product groups are given in this chapter, which enables a conversion between product use and solvent use.

When deciding whether or not to use the ESIG activity data, it is proposed that the REACH sectors shown in the annex are taken into account, and that the following formula is applied:

$$E_{NMVOC} = C' \; F' \sum_{subsector} AR_{subsector} \; EF_{NMVOC,subsector} \qquad (3)$$

where '*C*', the correction factor for the non-solvent NMVOC emissions, is equal to 1.11; '*F*', the fraction of solvents not considered in the ESIG methodology, is equal to 1.11; '$AR_{subsector}$' is the amount of solvent used for a particular subsector; and '$EF_{NMVOC,subsector}$' is the emission factor for NMVOCs for the subsector.

The default values for *C* and *F* are given above. The rationale for choosing these default values for these parameters is as follows.

- The estimate of *C* is based on an estimation, in the emissions inventories of the UK and Denmark, of the emissions resulting from propellants (propane and butane), and how these VOC emissions contribute to the overall emissions from solvent use. It should be noted that this factor is likely to differ between countries. If country-specific information is available on the proportion of non-solvent VOCs in the inventory for product use, the use of this information is encouraged in order to improve the default factor of 1.11 presented here. It should be noted that the 11 % additional NMVOC emissions from non-solvent product use is a weighted average for the sector product use, given that, only for domestic solvent use, could non-solvent VOCs account for 30–40 % of the emissions, according to the UK emissions inventory.
- The estimate of *F* is based on the assumption (made by ESIG) that 95 % of the solvent producers in the EU-27 are included in the solvent emissions inventories of these Member States. The factor 1.05 corrects for the missing 5 % of production. In addition, from the Danish inventory, an *F* value of 1.17 is found, which gives a mean *F* value of 1.11.

The correction factor *C* also takes into account the uncertainty in import/export estimates to some extent. It must be recognised that, overall for the EU-27, the ESIG figures may be correct, but obtaining accurate figures for specific countries is a difficult exercise. Therefore, this factor will vary from country to country and may also be smaller in many cases; thus, the use of country-specific knowledge to improve this factor is encouraged.

With regard to the activity data, the ESIG inventory already provides the actual NMVOC emissions estimates for the different REACH sectors. This, therefore, represents the *AR* multiplied by *EF* from the formula above for each of the subsectors. However, this does not yet take into account the correction factors *C, F* and $IE_{country}$. Therefore, to calculate the emissions from the ESIG inventory, the emission values should be multiplied by these factors.

Finally, it should be emphasised once again that to reduce the uncertainties when using the ESIG methodology, investigating the share of non-solvent VOC emissions, the import/export of solvents and other parameters is encouraged. This way, the default parameters presented here can be replaced with actual data that will improve the quality of the emissions estimates.

3.2.4 Tier 2b: Product-based technology-specific emission factors

Studies such as those carried out in the United States are useful for providing an extensive list of consumer products that contain NMVOCs. However, the bulk of NMVOC emissions will be as a result of the use of a relatively small number of consumer products, and it is good practice to give these products priority in developing detailed estimates. Based on US and UK data and country specific inventories, the products listed in the following box may contribute significantly to emissions.

Box 1. Examples of solvent-containing products

Cosmetics and toiletries
Aerosols, all types
Styling aids, pumps
Styling gels
Other hair care, pumps
Antiperspirants/deodorants, pumps
Perfumes
After shave
Nail-polish remover
Astringent
Healthcare products, external
Rubbing alcohol

Car care products
Aerosols, all types
Antifreeze
Brake fluids
Car waxes and polishes
De-icer pumps
Engine degreasers
Windscreen washing fluid

Household products
Aerosols, all types
General purpose cleaners
Glass cleaner
Air freshener, slow release
Toilet blocks
Disinfectants
Waxes and polishes

DIY/buildings
Carpet/tile adhesives
Pipe cements
Construction adhesives
Paint thinners
Paint remover
Solvents

The use of pesticides and pharmaceutical products is also included in this category; furthermore, cooling liquid (ethylene glycol) may be an important contributor to the national total emissions from this source category.

The proportion of solvent contained in a product that is actually emitted to the atmosphere will vary depending on the manner in which the product is used. A US survey (USEPA, 1995) assumed that 100 % of NMVOCs are emitted to the atmosphere, except for products that are either used diluted in water (i.e. dishwasher detergents, fabric detergents, bleach, etc.), in which case it was generally assumed that 1 % of NMVOCs would be emitted to the atmosphere, and products that are removed with water after performing their function (i.e. shampoos, soaps, toothpaste, household cleaners, etc.), for which it was assumed that between 5 % and 50 % of NMVOCs would be emitted to the atmosphere. The quality of estimates made using the detailed method will depend upon the quality and quantity of the data used. In theory, it may be possible to obtain estimates deserving of an 'A rating' (refer to the General Guidance, Chapter 5, Uncertainties, for an explanation of the quality ratings).

Table 3.4 presents default emission factors based on product consumption data, from a variety of literature sources. Emission factors are presented at different product aggregation levels to account for the different levels for which statistical data on consumption of products may be available in each country.

Table 3.4 Tier 2 NMVOC emission factors for source category 2.D.3.a Domestic solvent use including fungicides for different products and product types

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	N/A				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/practices	Various, see below				
Region or regional conditions					
Abatement technologies					
Not applicable	NO_x, CO, SO_x, NH_3, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	$PM_{2.5}$				
Sector	**Value (NMVOC)**	**Unit**	**95 % confidence interval**		**Reference**
			Lower	**Upper**	
Cosmetics and toiletries (all)	127	g/kg product	60	250	ISPRA (2012), USEPA (1995)
Cosmetics and toiletries (non-aerosol)	85	g/kg product	50	120	ISPRA (2012), Passant et al. (2012)
Cosmetics and toiletries (aerosol)	270	g/kg product	140	540	ISPRA (2012)
Household products (all)	16	g/kg product	8	33	USEPA (1995), ISPRA (2012)
Household products (non-aerosol)	10	g/kg product	7	15	Passant et al. (2012), ISPRA (2012)
Car care products (all)	180	g/kg product	100	340	ISPRA (2012), USEPA (1995)
Car care products (non-aerosol)	250	g/kg product	125	500	Passant et al. (2012)
Do it yourself (DIY)/buildings (adhesives)	66	g/kg product	5	130	Passant et al. (2012), USEPA (1995)
Do it yourself (DIY)/buildings (sealants, filling agents)	45	g/kg product	20	100	USEPA (1995)
Pesticides	150	g/kg product	140	160	Passant et al. (2012), USEPA (1995)
Pharmaceutical products	600	g/kg product	250	950	ISPRA (2012), Umweltbundesamt (2012)

Table 3.5 presents additional emission factors for product use. However, these are per-capita emission factors. It is recommended that these be used in only specific cases, for instance if the product statistics for the use of the Tier 2b approach are not complete in terms of the product types covered by domestic solvent use.

Table 3.5 Tier 2 NMVOC emission factors for source category 2.D.3.a Domestic solvent use including fungicides for different products and product types

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	N/A				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Various, see below				
Region or regional conditions					
Abatement technologies					
Not applicable	NO_x, CO, SO_x, NH_3, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	$PM_{2.5}$				
Sector	**Value (NMVOC)**	**Unit**	**95 % confidence interval**		**Reference**
			Lower	**Upper**	
Household products (aerosol)	200	g/person	130	270	Passant et al. (2012), ISPRA (2012), UNECE (1990)
Household (cleaning) products — aerosol	201	g/person	130	270	Passant et al. (2012), UNECE (1990), ISPRA (2012)
Household (cleaning) products — non aerosol	252	g/person	150	350	Passant et al. (2012), UNECE (1990), ISPRA (2012)
Car care product — aerosol	161	g/person	40	280	Passant et al. (2012), UNECE (1990)
Car care product — non aerosol	303	g/person	150	450	Passant et al. (2012), UNECE (1990)
Cosmetics and toiletries — aerosol	355	g/person	250	450	Passant et al. (2012), UNECE (1990), ISPRA (2012)
Cosmetics and toiletries — non aerosol	494	g/person	250	750	Passant et al. (2012), UNECE (1990), ISPRA (2012)
DIY/buildings — adhesives	76	g/person	15	140	Climate and Pollution Agency (2012), Passant et al. (2012), USEPA (1995), UNECE (1990)
DIY/buildings — paint thinner	205	g/person	50	360	Passant et al. (2012)
DIY/buildings — paint and varnish removers, solvents	68	g/person	15	120	Climate and Pollution Agency (2012), FOEN (2012)
DIY/buildings — sealants, filling agents	23	g/person	13	33	Climate and Pollution Agency (2012), USEPA (1995)
Pharmaceutical products	48	g/person	16	100	FOEN (2012), ISPRA (2012)
Pesticides	76	g/person	60	90	Climate and Pollution Agency (2012), Passant et al. (2012)

3.2.5 Abatement

Abatement options are not available for this source category.

3.2.6 Activity data

For the Tier 2 method, basic activity statistics on the amount of solvent used or the amount of products containing solvents used in your country are required, as described below.

- For the Tier 2a method, statistics on the amount of solvent contained in products used in the domestic use sector are required. An overview of the typical products covered by domestic use is given in Box 1 and preceding tables.
- For the Tier 2b method, statistics on the consumption of different products that are part of domestic use are required. Alternatively, product consumption may be calculated from statistics on the production of these products, provided that import and export data are available to recalculate from production to consumption. If only production data are available for a certain product and import/export data are not available for that same product, import/export data on a related (chemical) product could be used as a proxy to estimate the use of this product.

The Tier 2b method (described in section 3.3) provides a list of the typically largest contributors to NMVOC emissions from domestic solvent use. If activity data are lacking, it may be possible to use the data from ESIG for the activity data (see Section 3.2.3).

3.3 Tier 2 technology-specific approach: Tier 2b

3.3.1 Algorithm

The Tier 2b approach for domestic solvents is similar to the Tier 2a approach: only the activity data used are different since the Tier 2b method builds on activity data regarding product consumption rather than solvent consumption. Therefore, activity data on the consumption of different solvent-containing products, which are part of the domestic use of products, are relevant for the Tier 2b approach.

The general approach for applying both Tier 2 approaches is explained in sub-section 3.2.1.

3.3.2 Abatement

Abatement options are not available for this source category.

3.3.3 Activity data

Basic activity statistics are solvent consumption and/or quantity of products used for the detailed methodology.

3.4 Tier 3 emissions modelling and use of facility data

Tier 3 is not applicable for this source.

4 Data quality

4.1 Completeness and transparency

Care should be taken to include all emissions from solvent use. There could be overlaps with other (solvent-related) NFR source categories. Indeed, it is good practice to check that all emissions are

included. This applies especially if using the ESIG methodology, as the sectors used are very different from the NFR source categories. Therefore, if the ESIG methodology is used for domestic solvent use, it is recommended that this methodology be also used for the other solvent sectors using the guidance provided in this chapter.

Consistency and continuity between Tier 1 and Tier 2 categories is important. The Tier 1 emission factor includes all the main products in the domestic sector. The four large aggregated categories ('Household products', 'Car care', 'Cosmetics' and 'DIY/buildings') plus 'Pharmaceuticals' and 'Various' are presented separately in the Tier 2 approach.

However, the data are compiled from different sources, and it is often difficult, if not impossible, to define the exact product groups that are included in all categories, since literature sources typically use different product groupings. For instance, the information from ESIG comprises different source categories making a direct comparison difficult.

There are no data sources that comprise emission factors for all categories and sub-categories that are provided in this guidebook. Therefore, the emission factor tables are aggregates of all available reliable data. This implies that the same references cannot always be found in all categories and associated sub-categories. However, this approach reflects the most reliable and comparable estimates to be used for other countries.

4.2 Avoiding double counting with other sectors

Care should be taken not to double count emissions from solvent use. There could be overlap with other NFR source categories. Indeed, it is good practice to check that no emissions are double counted. Extra care should be taken if activity data from different sources are combined, in order to ensure that no product uses are, in fact, double counted, and also, on the other hand, that no product uses are missing.

4.3 Verification

Verification of emissions estimates can be carried out in a number of ways. It is good practice to carry out the most detailed methods in cooperation with product manufacturers who may be able to provide formulation data and production statistics. Estimates derived using the detailed method could be cross-checked against estimates made for other countries. It is good practice to keep in mind, however, that there may be significant differences in the use of NMVOCs in consumer products from country to country. Estimates may also be compared with estimates of the quantity of solvent sold to manufacturers of consumer products; this information could perhaps be derived in consultation with solvent suppliers. Formulation data, if obtained from manufacturers, could be verified through the analysis of products.

If activity data allow, a comparison between the different methodologies (especially between Tier 2a and Tier 2b) can be useful for verification purposes.

In 2002, a study for the European Commission identified many products and emissions that are important for this source category (EC, 2002). This report can be very useful for the verification of emissions.

4.3.1 Best Available Technique emission factors

Information on the best available techniques are available from the *Reference document on best available techniques on surface treatment using organic solvents* (BREF STS) (EC, 2007). However, there is limited information with regard to domestic solvent use.

4.4 Developing a consistent time series and recalculation

Temporal allocation of emissions can be derived from monthly consumption statistics and from information on operating schedule, work-shifts, weekend intervals, etc. If these data are not available, it is good practice to assume constant operation.

4.5 Uncertainty assessment

4.5.1 Emission factor uncertainties

The simple Tier 1 method relies upon a per-person emission factor, whereas the detailed Tier 2 method relies on access to activity data on the amount of product used and/or data on the solvent content of products, and measurements and/or estimates of emission factors for solvent species under the given conditions of product use. Tier 1 and 2 emission factors were derived from emissions estimates for European countries with high-quality independent data, and for the United States and Canada. The estimates for Europe and the United States are likely to be relatively accurate (i.e. +/–20 %). In the case of the United States, since data on the NMVOC content has been obtained for products representing most products on the US market, the largest uncertainty is the proportion of NMVOCs in some products that are actually emitted to air. It is good practice to note that the per-capita emission factor is likely to vary considerably between countries, particularly between western and eastern European countries. There are likely to be differences in the per-person consumption of products as the formulations used from country to country vary because of economic, geographical and cultural reasons. The overall level of uncertainty of estimates may, therefore, be high (i.e. as much as +/–50 %). The use of the detailed method will remove one of the uncertainties that affects the simpler method. Depending on the quantity of data that can be obtained relating to formulations, there is no reason why the detailed method should not give an accuracy of perhaps +/–20 %. As with the US data, the largest uncertainty may relate to the proportion of NMVOCs that are emitted to air.

4.5.2 Activity data uncertainties

Activity data may vary between countries in relation to the amounts and types of solvents in products. In order to implement the emission factors in this guidebook in the most accurate way, there should be an emphasis on obtaining country-specific information on the solvent content of products from, for example, producers, manufacturers or importers.

For this source category, activity data are the most uncertain, as the domestic use of products is typically not recorded in statistics. Some countries with detailed product registers (e.g. the Nordic countries) have production statistics, which are combined with import/export data to estimate consumption. However, in some cases, these detailed import/export data are not available, which adds uncertainty to consumption estimates (e.g. if using ESIG production data from solvent manufacturers and estimating solvent use based on those data).

4.6 Inventory quality assurance/quality control (QA/QC)

The weakest aspect of the Tier 1 method is the use of per-person emission factors. There are likely to be differences in the use of consumer products in different countries because of, for instance, differences in car ownership, household size, wealth, lifestyle, product formulation, environmental awareness and climate. It is good practice to feedback emissions estimates from other countries derived using the Tier 2 or Tier 3 methods into the Tier 1 method, in order to improve the emission factors. The adoption of a range of factors to reflect geographical and economic factors could be considered.

The Tier 2 method should provide reasonably accurate estimates depending upon the quantity of data on product NMVOC content that is available. More information is required on the NMVOC contents of consumer products, especially those products that contribute most to emissions. If the formulations used are comparable in different countries, then default emission factors could be developed for use in the detailed method. The proportion of NMVOCs in a product actually emitted to the atmosphere may be considerably less than 100 % for some products. Further research may be necessary to determine the fate of NMVOCs contained in such products.

4.7 Gridding

It is good practice to disaggregate national emissions by population.

4.8 Reporting and documentation

There are no specific issues with regard to reporting and documentation.

5 Glossary

Consumption	Refers to sales of products in the country concerned
Decorative paints	Paints applied to internal walls, ceilings, woodwork, etc. As well as being decorative, they also provide protection against moisture penetration and consequent damage
DIY	'Do it yourself', that is home decoration by the general public
Domestic	Refers to the use of products by members of the public in their own homes. These products will usually have been purchased from retail stores
Formulation	The substances from which a product is manufactured. For aerosols, this includes the propellant and solvent. It does not include the packaging materials
Industrial use	Refers to the use of products by firms engaged in business. It includes products used for cleaning and maintaining buildings and vehicles, as well as those used in the production process itself. Many products are used in industry and by households. There is almost a complete overlap with most of the products used by the construction industry and sold to the DIY market
Production	Refers to the amount of product manufactured in the country concerned. In many cases, production statistics have to be used instead of consumption statistics. They are, however, less appropriate and, if they are used, the resulting emissions will have to be assigned a lower data quality
Propellant	A compressed gas present in the headspace of an aerosol can. Until recently, chlorofluorocarbons (CFCs) were used for this purpose, but now hydrocarbons such as butane are often used. Propellants are chosen to be liquid under pressure, so that when propellant vapour is lost from the headspace on discharge of the aerosol, it is replenished by evaporation of the liquid. The liquid propellant is intimately mixed with the active ingredients and can also act as a solvent, thereby blurring the distinction between propellant and solvent. If the propellant were replaced by a mechanical pump, extra solvent would be needed
Solvent	A liquid present in an aerosol can to dissolve solid active ingredients
NMVOC content	The NMVOC content of a product such as a coating can be inferred from its formulation or measured by evaporation tests. The latter are more accurate, but such data are unlikely to be available

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7 Point of enquiry

Enquiries concerning this chapter should be directed to the relevant leader(s) of the Task Force on Emission Inventories and Projection's (TFEIP's) expert panel on combustion and industry. Please refer to the TFEIP website (www.tfeip-secretariat.org/) for the contact details of the current expert panel leaders.

Annex 1 Mapping: REACH to NFR

This Annex presents a default link table (Table A1.1) between the REACH classification, as used in the ESIG inventory, and the NFR14 categories, used for emissions inventory reporting to the UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP) and under the EU National Emission Ceilings Directive.

For most sectors, a one-to-one link (100 %) between REACH end-use sector and NFR has been assumed. However, for some specific REACH sectors a distribution over the NFR sectors is proposed. The information in this table is partly based on a comparison between the ESIG inventory and the UK inventory, including the more detailed subsectors underlying the NFR source categories. The link has been reviewed and refined by inventory experts from Denmark and the Netherlands.
It should be stressed that this is a default link table and, whenever country-specific information is available, it should be used to improve these mappings.

Table A1.1 Mapping table: REACH to NFR

REACH end-use sector	2D3a	2D3b	2D3c	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i
Agrochemical uses	100 %								
Blowing agents									100 %
De-icing	50 %								50 %
Binder and release agents									100 %
Cleaning industrial and leather treatment					100 %				
Cleaning — professional consumer	100 %								
Coatings — industrial and adhesives, inks				80 %				15 %	5 %
Coatings — professional/consumer and thinners, paint industry	30 %			70 %					
Functional solvents (including solvents used in chemical processes, e.g. process aids, intermediates, extraction, dewaxing agents)							100 %		
Metal working/rolling oils/lubricant uses									100 %
Oil field chemicals, drilling, mining, extraction									100 %
Polymers processing (including rubber-tyre production) and industrial resins, synthetic rubber, process							100 %		
Road and construction		100 %							
Use as fuel/combustion and fuel additives									100 %
Water treatment									100 %
Other consumer uses (household, aerosols, cosmetics)	100 %								
Pharmaceuticals manufacturing							100 %		
Others — please specify below									100 %

Chlorinated solvents (not ventilated by sector)							100 %		