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Norwegian NMVOC emissions from sector 3: Solvent and other products use

Providing a basis for discussing the inclusion of new emission sources in the Guidebook

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Preface

In February 2010, members of the TFEIP Expert Panel on Combustion and Industry participated at a workshop in Utrecht where the needs and wishes with respect to updates of the chapters on solvent and other product use in the EMEP/EEA Guidebook were discussed. Solvent and other product use is a diffuse source of emissions and therefore difficult to regulate and estimate on a country basis. Reported emissions from 1990 onwards have shown only a small decrease in NMVOC emissions from the use of solvents, while EU legislation has been put in place to reduce these emissions more significantly. The question is to what extent the current methods for estimating NMVOC emissions from the use of solvents and other products are of sufficient quality to provide reliable and accurate estimates of the total emissions by country.

While the Guidebook revision of 2007/2008 made improvements to a number of sectors based on EGTEI methodologies, other sectors were not updated due to lack of new methodologies, especially the sources covered by 3.D *Other product use*. It is unclear which emission sources are covered by these source categories and methods differ significantly between countries. Therefore, the Expert Panel is trying to gather information to improve the emission calculation methods for these sectors, and check which are the most important emission sources that should be covered by these source categories.

As the compiler of the Norwegian Emission Inventory, Statistics Norway offered to provide the Expert Panel with information on emissions from 3.D *Other Product use*, based on the Norwegian model for estimation of NMVOC emissions from solvents and other product use. The aim is to help identify new emission sources that could be included in the Guidebook and making the first steps towards developing methodologies for these new emission sources. Thus, the purpose of the document is to provide as a basis for a discussion of whether the results of the Norwegian model should have implications for the Guidebook, and, if so, how the Guidebook should be supplemented.

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Abstract

Solvents and other product use (NFR sector 3) is the source of almost 30 per cent of the Norwegian emissions of non-methane volatile organic compounds (NMVOC). Between 80 and 90 per cent come from sector 3.D *Other product use*. This constitutes a per capita emission rate of around 8 kg. The results are based on a mass balance per substance, using data from the Norwegian Product Register. Products contributing to more than 10 per cent of the emissions from 3.D.2 and 3.D.3 are solvents, ensilage means and cleaning products. NMVOC emissions from solvents arise mainly in manufacture of transport equipment, miscellaneous productions and construction. Formic acid in ensilage means is emitted during production of fodder, while cleaning products are used mostly for car maintenance, including vehicle degreasing. Substances contributing to more than 10 per cent of emissions are ethanol, formic acid, different kinds of naphtha and ethylene glycol. When comparing the Norwegian inventory for 3.D with the activities described in the Guidebook, it is evident that the Guidebook does not cover all Norwegian emissions allocated to 3.D. Several important emission sources, like ensilage means, disinfectants, anti-freeze agents, windscreen washing agents, cosmetics and probably part of the solvents, are not covered by the methods given in the Guidebook.

The Norwegian model cannot be directly adopted by any other countries, as only the Nordic countries can obtain equivalent activity data. However, the Norwegian inventory for 3.D can be used as a basis for developing methods for estimating emissions from sources not yet covered by the Guidebook. Using the Norwegian results, potentially important sources currently omitted may be identified, and factors for solvent content and fractions emitted might be calculated for various types of activity data.

In order to use the Norwegian results to identify important emission sources not covered in the Guidebook, several questions need to be considered:

- Do the activities that generate the Norwegian emissions differ considerably between Norway and other countries?
- Are activity data available?
- Should values of photochemical ozone creation potential (POCP) be taken into account when deciding on which new sources to prioritize?
- How many new sources should be included?

If more activities are to be included in the Guidebook, it is probably necessary not to be too ambitious and focus only on a few, important products that are not covered. Taking into consideration the Norwegian use patterns, the possibility of obtaining accessible consumption figures and POCP-values, a first suggestion is to focus on disinfectants, cleaning products (especially windscreen cleaning agents) and cosmetics.

Contents

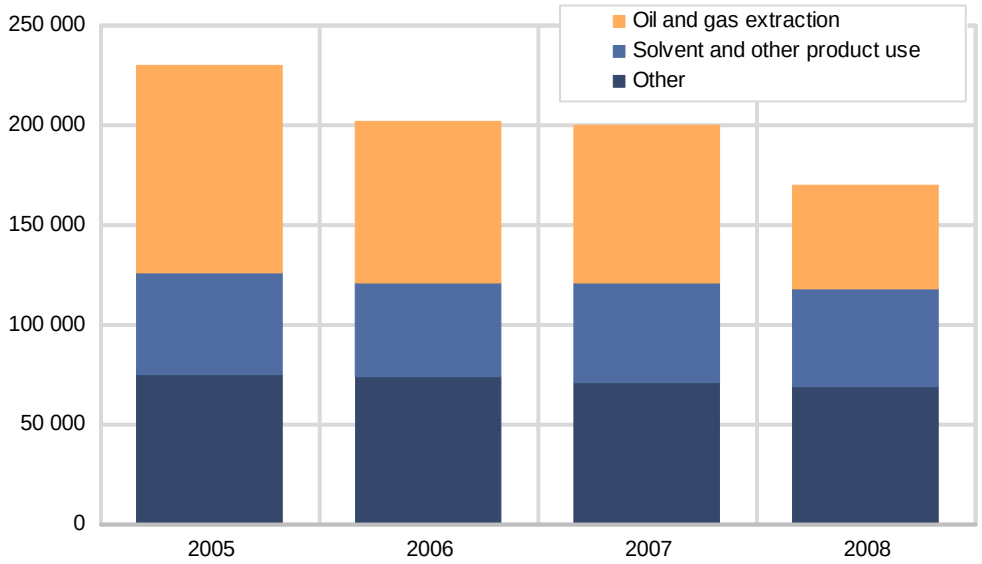
Abbreviations

CAS number	**C**hemical **A**bstract **S**ervices; A CAS number is an identification number for substances described in the literature, assigned by, a division of the American Chemical Society (American Chemical Society 2007). Most CAS numbers refer to individual substances, but some are mixtures, such as petroleum solvents, e.g. naphtha.
CLRTAP	**C**onvention on **L**ong-**R**ange **T**ransboundary **A**ir **P**ollution
CN	**C**ommon **N**omenclature
CORINAIR	**COR**e **IN**ventory **AIR** emissions
CPA	**C**lassification of **Pr**oducts by **A**ctivity
EEA	**E**uropean **E**nvironment **A**gency
EGTEI	**E**xpert **G**roup on **T**echno-**E**conomic **I**ssues
EMEP	**E**uropean **M**onitoring and **E**valuation **P**rogramme
EPA	**U.S. E**nvironmental **P**rotection **A**gency
KLF	**K**osmetikk**l**everandørenes **f**orening. Norwegian Association of Cosmetics, Toiletries and Fragrance Suppliers
NACE	**N**omenclature statistique des **A**ctivités économiques dans la **C**ommunauté **E**uropéenne. International nomenclature system for industrial classification (industrial sectors). Codes according to Statistics Norway's Standard Industrial Classification (Statistics Norway 2002b), based on EU's international industrial standard NACE Rev.1.1., 2002 update
NAEI	UK's **N**ational **A**tmospheric **E**missions **I**nventory
NFR	**N**omenclature **F**or **R**eporting. Category classification in which emissions should be reported under the convention on Long Range Transboundary Air Pollution (LRTAP) according to the Gothenburg protocol
NMVOC	**N**on-**M**ethane **V**olatile **O**rganic **C**ompound. The term "volatile organic compound" (VOC) refers to any organic compound having a vapour pressure of 0.01 kPa or more at 293.15 degrees K, or having a corresponding volatility under the particular conditions of use (European Commission 1999)
POCP	**P**hotochemical **O**zone **C**reation **P**otential
PRODCOM	**PROD**uction **COM**munautaire
SITC	**S**tandard **I**nternational **T**rade **C**lassification
SNAP	**S**ignificant **N**ew **A**lternatives **P**olicy; SNAP codes are industrial sectors defined under EPA's SNAP program
TFEIP	**T**ask **F**orce on **E**missions **I**nventories and **P**rojections
UCN	**U**se **C**ode **N**ordic. The Nordic Product Registers' classification system for products (Product Register 2007)
UNECE	**U**nited **N**ations **E**conomic **C**ommission for **E**urope
UNFCCC	**U**nited **N**ations **F**ramework **C**onvention on **C**limate **C**hange

1. Norwegian NMVOC emissions

The Norwegian emissions of NMVOC were just below 170 000 tonnes in 2008 (Figure 1).

Figure 1. Total NMVOC emissions in the Norwegian emission inventory, 2005-2008. Tonnes



Around 30 per cent were emitted from oil and gas extraction, a little under 30 per cent came from sector 3 *Solvent and other product use*.

2. Introduction to the Norwegian emission inventory for sector 3

The following is a short description of the Norwegian model for estimating NMVOC emissions from the sector 3. For more details, see Holmengen and Kittilsen 2009).

2.1. The model

The emissions of NMVOC from solvents and other product use are calculated using a simplified version of the detailed methodology described in chapter 6 of the EMEP/CORINAIR Guidebook 2007 (EEA 2007). It represents a mass balance *per substance*, where emissions are calculated by multiplying relevant activity data with an emission factor, according to the equation:

consumption = production + import - export
emission = consumption x emission factor (fraction emitted)

total emission (all substances) = sum of all emissions (per substance)

From 1995 to 2000 emissions were calculated using data on import, export and production of solvent-containing products. By the year 2000 this method was considered obsolete because essential assumptions about solvent content and emission factors were out of date. In 2007-2008 the model was revised and a new data source was adopted, namely the Norwegian Product Register.

2.2. Activity data

The Product Register is the Norwegian government's central register on chemical products that are subject to duty of declaration and labelling, such as paint, adhesives and cleaning products. Any person or company placing dangerous

chemicals on the Norwegian market for professional or private use has duties pursuant to these regulations. The duty of declaration applies annually to import, export and manufacturing. The only exception is when the amount of a given product placed on the market by a given importer/producer is less than 100 kg per year.

When a product is declared to the Product Register, information about the registrant and the product must be reported. Most importantly, the chemical composition and the appurtenant volume of individual components are disclosed to the Product Register. Statistics Norway is authorised to use the net quantity of import, export and manufacture of individual components, given by CAS number (classification by Chemical Abstract Services). The data used by Statistics Norway also includes information about the product type that the substance enters into and the industrial sector (NACE 2002) in which the product is used (including private households). A list of 678 substances satisfying the NMVOC criteria has been compiled, using substance lists from Sweden and the UK, and this substance list forms the basis for the data selection from the Product Register.

Because the data are given on a substance level, no assumptions about solvent content must be made. Furthermore, the information on use included in the data makes it possible to specify the emission factors for different combinations of product type and industrial sector (including private households). Also, the results can be presented on a substance level, distributed over product types, industrial sectors or a combination of both. As a consequence, the identification of specific substances, products or industrial sectors that have a major influence on the emissions is greatly facilitated.

2.3. Emission factors

The source of most of the emission factor values for volatile organic compounds is the Swedish model for estimating NMVOC emissions from solvent and other product use (Skårman *et al.* 2006). During several studies, Sweden has developed emission factors that take into account different application techniques, abating measures and alternative pathways of release (e.g. waste or water). These country-specific emission factors apply to 12 different industries or activities that correspond to sub-divisions of the four major emission source categories for solvents defined in the Guidebook (Internet version, 2007). It was deemed that the factors developed for Sweden are representative for Norwegian conditions. However, a few adjustments had to be made. The three most important adjustments were:

1. The emission factor for ensilage means was set specifically based on expert judgment, as the emission factor given in the Swedish model seemed unsuitable for describing the usage of ensilage in Norway.
2. The emission factor for anti-freezing agents from the Swedish model was only used for commercial land, water and air transport (NACE 2002: 60-62) (value of 0.1). The radiator in a car is a closed system. However, when anti-freezing agent must be refilled in a private car, this entails that some of it has evaporated or otherwise been emitted. Thus, the emission factor for anti-freezing agents was set higher industrial sectors and private households in the Norwegian model.
3. The emission factors for raw materials were applied to other product types assumed to be used as raw materials in the industrial sectors “Manufacture of chemicals and chemical products” (NACE 2002: 24) and “Manufacture of rubber and plastic products” (NACE 2002: 25).

In accordance with the Swedish model, emission factors were set to zero for a few products that are deemed to be completely converted through combustion processes, such as EP-additives, soldering agents, and welding auxiliaries. Emission factors may change over time, and such changes may be included in this model. However, all emission factors are constant for the 2005 to 2008 period.

Although emissions factors are specified to a large extent most of them are still rough and there is clearly a need for further differentiation. For instance, certain uses of biocides might have too high emission factors in the current model.

2.4. Supplementary model for cosmetics

The duty of declaration to the Product Register does not apply to all solvent-containing products. Some product groups are not covered by the regulations, while other product groups are covered only when the solvent content is above a certain level. Unless these solvent-containing products have been declared due to regulations concerning other ingredients than the solvent, these NMVOC quantities are not included in the activity data. Two product groups poorly covered by the Product Register were suspected to contain significant amounts of NMVOC: Cosmetics and water based paint and varnish. For these two product groups, estimates were calculated using manufacturing statistics, external trade statistics and assumptions on solvent content and emissions factors.

Estimates obtained revealed that cosmetics constitute a relatively large emission source, while emissions from water based paint and varnish were considered negligible, compared to the estimates for other product groups included in the Product Register data. Thus, a supplementary time series of NMVOC emissions from cosmetics was included in the reported NMVOC emissions.

Emissions from cosmetics were calculated using a combination of sales figures and turnover numbers: The Norwegian Climate and Pollution Agency (formerly the Norwegian Pollution Control Authority) calculated the consumption of cosmetics in 2004, based on sales figures (given in Norwegian kroner) from the Norwegian Association of Cosmetics, Toiletries and Fragrance Suppliers (KLF) and Swedish turnover numbers (given in tonnes) (Norwegian pollution control authority 2005). The consumption was calculated for product groups such as shaving products, hair dye, body lotions and antiperspirants. A consumption time series (in tonnes) from 2005 to 2008 was calculated from the relationship between consumption in Norwegian kroner and in tonnes in 2004, and consumption (in Norwegian kroner) from 2005 to 2008 from KLF (Norwegian Association of Cosmetics Toiletries and Fragrance Suppliers 2009). Figures on VOC content and emission factors for each product group were taken for the most part from a study in the Netherlands (IVAM 2005), with some supplements from the previous Norwegian solvent balance (the previous NMVOC model).

It is considered unlikely that other products containing only small amounts of solvents, i.e. not subject to the duty of declaration, and at the same time not covered by regulations on other ingredients, represent a large source of NMVOC emissions.

2.5. Uncertainty

The uncertainty of emission levels was estimated to be between 2.5 and 4.6 per cent for the years 2005-2007 (not including the side model for cosmetics).

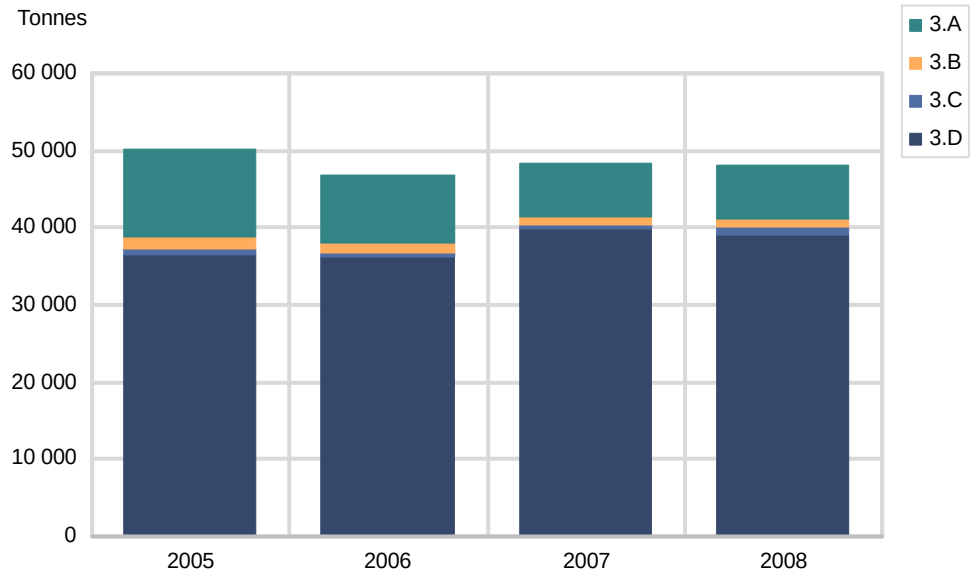
3. Results from the Norwegian model for sector 3

Note that during the finalization of this work, an error was found in the activity data. The source of the error is incorrect declaration to the Product Register of disinfectants used in chemical industry and miscellaneous manufacturing. As a result, annual emissions of ethanol from this source are overestimated by around 900 tonnes on average (the exact size of these figures are not yet known). In the figures presented below, 50 per cent of the contribution of ethanol in disinfectants used in chemical industry and miscellaneous manufacturing has been subtracted. Consequently, the figures presented in this report differ from the one that is part of the official Norwegian emission inventory, reported to the United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Economic Commission for Europe (UNECE) for the pollutants restricted by CLRTAP (Convention on Long-Range Transboundary Air Pollution). The official figure for NMVOC emissions from solvent use 2005-2008 will not be revised until February 2011.

3.1. Sector 3: Solvent and other product use

Estimated NMVOC emissions from source categories 3.A *Paint Application*, 3.B. *Degreasing and Dry Cleaning*, 3.C. *Chemical Products* and 3.D. *Other Product Use* 2005-2008 are given in figure 2.

Figure 2. NMVOC emissions from sector 3 in the Norwegian emission inventory, 2005-2008. Tonnes



Estimated emissions for the period 2005 -2008 range between approximately 46 700 tonnes to a little over 50 000 tonnes. Compared to the results from the previous model, emissions estimates for 2005-2008 increased by around 3 000 tonnes. Emissions from sector 3.D *Other product use* clearly dominate and 3.D is the sector where emissions estimates deviate most from the results of the previous model.

The population size of Norway and NMVOC emissions per capita from source categories 3 and 3.D. 2005-2008 are given in table 1.

Table 1. Population of Norway and Norwegian NMVOC emissions per capita from source categories 3 and 3.D, 2005-2008. kilograms/capita

	Unit	2005	2006	2007	2008
Population		4 606 363	4 640 219	4 681 134	4 737 171
3.A-3.D	Kg/capita	10.9	10.1	10.4	10.1
3.D	Kg/capita	7.9	7.8	8.5	8.2

Estimates of emissions per capita of 10-11 kilograms from sector 3 are among the highest in Europe. Of these, 80-90 per cent come from sector 3.D Other product use. Estimated NMVOC emissions from the NRF source categories with extensions are given in Table 2. Also given is the per cent contribution of each source to the mean annual emissions.

Table 2. NMVOC emissions from sector 3 (with extensions) in the Norwegian emission inventory, 2005-2008, and contribution to mean annual emissions. Tonnes and per cent

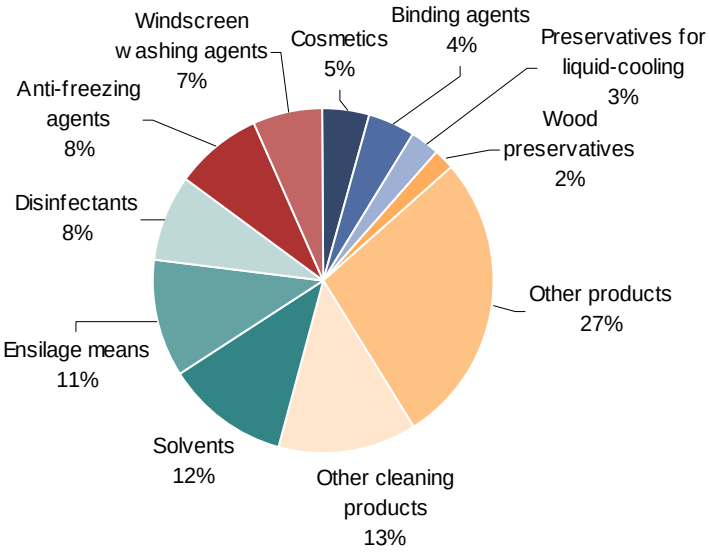
Code	2005	2006	2007	2008	Contribution in per cent
3.A.1	8 375	7 075	5 059	5 600	13.5
3.A.2	2 957	1 637	1 898	1 336	4.0
3.A.3	91	33	39	24	0.1
3.B.1	1 200	629	918	772	1.8
3.B.2	247	651	158	105	0.6
3.C	770	472	473	1 237	1.5
3.D.1	726	447	551	453	1.1
3.D.2	10 521	9 063	9 974	9 416	20.1
3.D.3	25 305	26 740	29 415	29 090	57.1
Total 3	50 191	46 746	48 485	48 034	100.0

Sector 3.D.3 *Other product use* (under 3.D. *Other product use*) is by far the greatest emissions source, contributing 57 per cent of the mean of the emissions in the period 2005-2008.

3.2. Source categories 3.D.2 and 3.D.3

Annual emissions from 3.D.2 and 3.D.3 are 37 400 tonnes on average, of which around 1/4 is allocated to *Domestic solvent use* (3.D.2). The percentage contribution to the 2005-2008 emissions from sector 3.D.2 and 3.D.3 from the most important products is given in figure 3. Note that because the Norwegian model does not yet handle hold up (i.e. storage effects), the mean of emissions during 2005-2008 are used in all the following figures and tables.

Figure 3. Dominant sources of NMVOC emissions from sector 3.D.2 and 3.D.3 in the Norwegian emission inventory, by product group. Contribution to mean annual emissions for the period 2005-2008. Per cent



Products contributing to more than 10 per cent of the emissions from 3.D.2 and 3.D.3 are solvents, ensilage means and cleaning products. “Other products” includes a wide range of products, such as construction materials, joint-less floors, insulation materials, heat transmission agents, adhesives, PH-regulating agents, filling agents, polishing agents, lubricants, anti-corrosion materials and colouring agents. Note that emissions from the use of ensilage means in production of fodder should probably be allocated to another sector than 3, e.g. 4.D.2a.

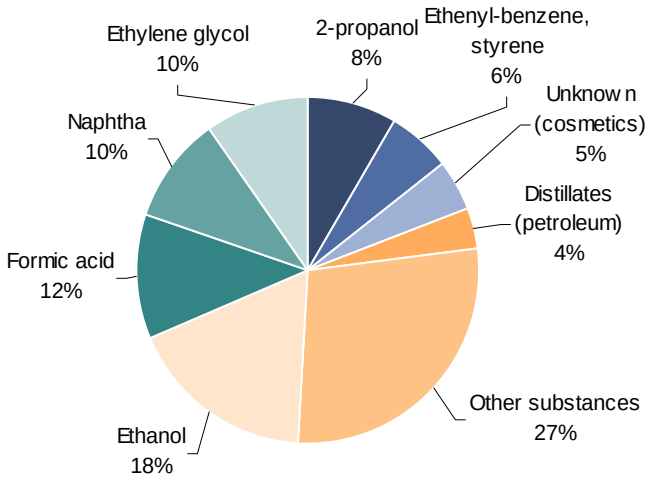
While solvents consist of a number of different substances, four of the most important product groups are dominated by one substance (see Table 3).

Table 3. Percentage substance composition of four important product groups

Product group	Substance composition
Ensilage means	99.9 formic acid
Anti-freezing agents	85.6 ethylene glycol
Windscreen washing agents	80.9 ethanol
Disinfectants	72.7 ethanol

The percentage contribution to the 2005-2008 emissions from sector 3.D.2 and 3.D.3 from the most important substances is given in figure 4.

Figure 4. Dominant substances in NMVOC emissions from sector 3.D.2 and 3.D.3 in the Norwegian emission inventory. Contribution to mean annual emissions for the period 2005-2008. Per cent



Ethanol is the most important substance among the NMVOC emitted due to "other product use". Not only does it constitute 18 per cent of emissions from products declared to the Product register, it is probably also the dominating NMVOC in emissions from cosmetics. In the report from which factors on VOC content and fractions emitted are taken, it is stated: "*Typically, a large fraction of all VOC emitted from household products consists of ethanol (Gent University 2002). When also substances such as formaldehyde, acetaldehyde, acetone, IPA and butylglycol are included, a large fraction of all VOC emissions is covered (DETIC 2004a); (Ponche 2000).*"(IVAM 2005). Other substances contributing to more than 10 per cent of emissions are formic acid, different kinds of naphtha and ethylene glycol. The group "Other substances" include 321 different CAS numbers.

The emissions allocated to 3.D.2 and 3.D.3 are spread over a wide range of industries (see Table 4).

Table 4. Dominant industries (given by NACE 2002) for the products contributing most to NMVOC emissions from sector 3.D.2 and 3.D.3 in the Norwegian emission inventory. Contribution to mean annual emissions for the period 2005-20081. Per cent

NACE 2002	Industry	Sol-vents	En-silage means	Dis-infectants	Anti-freezing agents	Windscreen washing agents	Other cleaning products	Binding agents	Preservatives for liquid-cooling and processing systems	Wood preser-vatives
1	Agriculture, hunting etc		46							
5	Fishing, fish farming etc		6							
11	Extraction of crude petroleum and natural gas								61	
15	Man. of food products and beverages (including production of fodder).....		48	13						
20	Man.of wood and of products of wood and cork.....									31
24	Man.of chemicals and chemical products.....			50					8	
26	Man. of other non-metallic mineral products							11		
27	Man. of basic metals.....							26		
35	Man. of other transport equipment	31						18		
36	Man. of furniture, manufacturing n.e.c.	12		16						
45	Construction	24						31		28
50	Sale, maintenance and repair of motor vehicles and motorcycles, retail sale of automotive fuel	7			53	21	36			
51	Wholesale trade and commission trade.....							6		
52	Retail trade. Repair of personal and household goods	7			19	26				6
60	Land transport; transport via pipelines.....				8					
74	Other business activities (including industrial cleaning)						5			
85	Health and social work.....			15						
93	Other service activities.....					10				
	Private households	9			9	41	46		30	33
	Other.....	10		6	10	3	12	8	1	2

[1] Only values of 5 per cent or more are given, except for under "Other".

Note that products that are assumed to be raw material/intermediates in industrial processes are either 1) not included (in industries where data on point source emissions are included) or 2) multiplied with a low emission factor. The figures do include products that are used in industrial processes but most likely not considered as raw material. We assume that emissions caused by such use would not be included elsewhere in the emission inventory. However, there is some uncertainty concerning whether or not all products used as raw materials are excluded, especially binding agents used in the manufacture of basic metals. There is also uncertainty associated with the emission factors. As mentioned earlier, the emission factor of 80 per cent for use of biocides, including disinfectants and preservatives in liquid-cooling and processing systems, may be too high. The emissions from binding agents used in construction may also be considerably overestimated, as the emission factor applied is 95 per cent. Note that the emission factors are applied on a substance level and therefore only apply to NMVOCs, not the whole product. Furthermore, the emission factors are taking the whole life-time of the product into account.

3.3. Details on emissions in sector 3.D.2 and 3.D.3

Domestic solvent use (3.D.2)

Any NMVOC emissions from products deemed to be used by private households are allocated to sector 3.D.2 *Domestic solvent use* in the Norwegian emission inventory. This assessment is based on the NACE codes to which the products are sold, according to the declarations in the Product Register. Substances in products registered as destined for retail sale of automotive fuel or retail trade, sporting activities or other recreational activities (NACE 2002: 50.5, 52, 92.6 and 92.7 respectively) are assumed to be used in private households. In addition, the Norwegian Product Register has extra codes for allocating sale to private households and public use. Products registered with these codes are also included in 3.D.2. Because of lack of sector distribution of cosmetics consumption, the emissions were divided equally between the sectors private households (no NACE) and "Other personal services" (NACE 2002: 93), where sectors such as hairdressers and beauty salons are included. Both of these are included in 3.D.2.

Products used for car maintenance are the largest sources of NMVOC emissions in private households (36 per cent). These products include windscreen washing agents, anti-freezing agents and car polish. Glass and window polish and other cleaning products make the second largest contribution to emissions (25 per cent), followed by the use of cosmetics (18 per cent).

Ethanol is the most important substance among the NMVOCs emitted due to "other product use" in private households, constituting 28 per cent of emissions from products for domestic use declared to the Product register. As mentioned earlier, it is probably also the dominating NMVOC in emissions from cosmetics. The second most important substance from domestic emissions is 2-propanol (20 per cent), followed by naphtha (12 per cent) ethylene glycol (11 per cent).

Other product use (3.D.3)

All products not covered by the other source code under sector 3, such as paint, degreasers and raw material, are allocated to 3.D.3. *Other product use*. This is the most important source of NMVOC emissions from product use in the Norwegian emission inventory (see Table 2). Emissions are consist of many different substances, used in a number of different product types and in a variety of different industrial sectors. The most important combinations of substance, product group and areas of use (industries) are given in Table 5.

Table 5. Most important combinations of substance, product group and industries (NACE 2002) in the NMVOC emissions from sector 3.D.3 in the Norwegian emission inventory. Contribution to mean annual emissions for the period 2005-2008. Per cent

Substance name	Product group	Areas of use (NACE 2002)	Percentage contribution
Formic acid	Ensilage means	1, 15.7	14.3
Ethenyl-benzene (styrene), naphtha, ethanol and ethyldimethylbenzene	Solvents	35, 36, 45	9.8
Ethanol	Disinfectants	24, 36	6.9
Ethylene glycol	Anti-freezing agents	50, 60	5.8
Naphtha, ethanol, distillates and 2-propanol	Cleanings products (incl. windscreen washing agents)	50.2	4.4

Formic acid makes up 95 per cent of the substances used as preservatives for feed and feedstock in agriculture and ensilage means in manufacture of prepared animal feeds (both termed ensilage means here). This combination contributes to 14 per cent of mean NMVOC emissions from 3.D.3 in 2005-2008. Solvents are the second largest contributor to emissions among the different product groups. When including the four most important substances and the three main industries where the solvents are used, 10 per cent of total emissions from 3.D.3 are covered. Another important combination is ethanol in disinfectants. Used in chemical

industry and miscellaneous manufacturing, it contributes to 7 per cent of Norwegian NMVOC emissions from 3.D.3 in 2005-2008.

Ethylene glycol used in anti-freezing agents in vehicles (and to some extent in trams and railways) makes up 6 per cent of NMVOC emissions from 3.D.3. Cleaning products have a widespread use, in which the most dominant as a source of NMVOC emissions is degreasing of vehicles. This is in accordance with the Guidebook, where this source is described explicitly. Naphtha, ethanol, petroleum distillates and 2-propanol in cleaning products used for maintenance and repair of motor vehicles (NACE 2002: 50.2) contribute to 4 per cent of the emissions from 3.D.3. In addition, a relatively large contribution is made by various products used in construction, such as solvents binding agents, flooring materials, construction materials, filling agents and adhesives.

4. Implications for the Guidebook

The Norwegian model cannot be directly adopted by other countries, as only the Nordic countries can obtain equivalent activity data. However, the Norwegian inventory for 3.D can be used as a basis for developing methods for estimating emissions from sources not yet covered by the Guidebook. Using the Norwegian results, potentially important sources currently omitted may be identified, and factors for solvent content and fractions emitted might be calculated for various types of activity data.

4.1. Comparison to the Guidebook

Activities included in sector 3.D in the EMEP/EEA Guidebook 2009 (EEA 2009) are given in Table 6, with indication of where guidance of emissions estimation is included.

Table 6. SNAP codes included under 3. D in the EMEP/EEA Guidebook 2009

SNAP	Description	Guidance on estimating emissions
060401	Glass wool enduction	
060402	Mineral wool enduction	
060404	Fat, edible and non-edible oil extraction	X
060405	Application of glues and adhesives	
060406	Preservation of wood	X
060407	Underseal treatment and conservation of vehicles	X
060408	Domestic solvent use (other than paint application)	
060409	Vehicles dewaxing	X
060411	Domestic use of pharmaceutical products	
060412	Other (preservation of seeds, etc.)	
060508	Other	
060601	Use of fireworks	
060602	Use of tobacco	X
060603	Use of shoes	

When comparing the Norwegian inventory for 3.D with the activities described in the Guidebook, it is evident that the Guidebook does not cover all Norwegian emissions allocated to 3.D. Although we have not tried to compare results from the Norwegian model with the results we would obtain using methods taken from the Guidebook, we assume that emissions that we estimate from wood-preservatives are well covered by SNAP 060406 “Preservation of wood”. Furthermore, solvents and other cleaning products are covered at least in part by SNAP 060407 “Underseal treatment and conservation of vehicles”, SNAP 060409 “Vehicle dewaxing” and perhaps SNAP 060404 “Fat, edible and non-edible oil extraction”.

(Emissions from products defined as extraction agents make up only a minor contribution in the Norwegian inventory). On the other hand, several important emission sources, like ensilage means, disinfectants, anti-freeze agents, windscreen washing agents, cosmetics and probably part of the solvents, do not seem to be covered by the methods given in the Guidebook.

4.2. Using the Norwegian results

In order to use the Norwegian results to identify important emissions sources not covered in the Guidebook, several questions need to be considered:

1. Do the activities that generate the Norwegian emissions differ considerably between Norway and other countries?
2. Are activity data available?
3. Should values of photochemical ozone creation potential (POCP) be taken into account when deciding on which new sources to prioritize?
4. How many new sources should be included?

Norwegian use patterns

For some products the Norwegian use pattern may not be representative for other countries. For instance, the consumption of formic acid used as ensilage means seems to be far higher in Norway than in Denmark and Sweden. The high consumption of ensilage means in Norway is due to the partiality towards acidified grass as winter forage. In Norway, almost 100 per cent of grass preserved as winter forage is silage (acidified grass), while this fodder type constitutes only one third of the winter forage in Denmark. The sugar content is considerably lower in the grass types used in Norway, which calls for a higher use of ensilage means, and at the same time the conditions for drying of forage are more unpredictable in Norway than in Sweden and Denmark (Selmer-Olsen 2006). In Sweden, wilting prior to ensiling is more common than in Norway, and this reduces the necessary amount of silage additives. Thus, more ensilage means is required in order to preserve the grass properly in Norway. The consumption of concentrated cattle feed is also traditionally lower in Norway, and thus the demand for good ensilage has been higher. In addition to this, the wet and cold climate makes the season for outdoor grazing shorter, and the need for preserved food increases (Å. T. Randby, Norwegian University of Life Sciences, pers. comm. 2008).

For climatic reasons, it is also likely that the consumption of anti-freezing agents is particularly high in Norway. Furthermore, products used in oil and gas extraction probably have a higher consumption rate than in many other countries. Note however, that the oil and gas themselves are not included in the emissions estimates for sector 3.

For many products, such as solvents, disinfectants, windscreen washing agents and other cleaning products, we have presently no reason to believe that the Norwegian use patterns are considerably different. However, the level of consumption in Norway may be relatively high, due to our high economic activity.

Activity data

In order to include more activities in the Guidebook, accessible activity data must be identified. If a link can be made to the data in the Norwegian model, factors for solvent content and fraction emitted might be based on Norwegian results.

Consumption data

When estimating emissions of NMVOC from other product use, using consumption data would be preferable. Most countries have trade and production statistics, and many have sales statistics produced by different associations and organisations.

With help from the Swedish Product Register (where products are registered with both product codes and common customs tariff codes), we have identified some

common customs tariff codes that might be used, given that the inventory makers have access to them. It's uncertain whether some of the most important product groups are declared as chemicals or products. Separate custom customs tariff numbers (Common Nomenclature; CN) exist for e.g. ethanol/ethyl alcohol (22.07.1090, 22.07.2000), formic acid (29.15.1100), ethylene glycol (29.05.3100), and styrene (29.01.5000). These can be difficult to use as activity data, since a large part of the amount imported is probably used as raw materials in processes covered elsewhere in the emission inventory. Furthermore, some product groups seem difficult to identify in the CN. However, disinfectants and anti-freezing agents have specific CN codes. In addition, it may be possible to identify the amount of formic acid (29.15.1100) that is imported as ensilage means. However, in the Swedish Product Register, those figures are confidential. The codes that so far have identified are given in Table 7, with corresponding CPA (Classification of Products by Activity), SITC (Standard International Trade Classification) and PRODCOM (PRODuction COMmunautaire) codes.

Table 7. Connection between product groups of the Product Register and codes used in trade and production statistics

Product groups:	Ensilage means	Disinfectants	Disinfectants	Anti-freezing agents
CN 2008	29151100 Formic acid	38085000 Goods containing one or more of ...	38089490 Disinfectants	38200000 Anti-freezing preparations and prepared de-icing fluids (excl. prepared additive...
CPA 2008	20.14.32 Saturated acyclic monocarboxylic acids and their derivatives	20.20.19 Other pesticides and other agrochemical products	20.20.14 Disinfectants	20.59.43 Hydraulic brake fluids; anti-freezing preparations and prepared de-icing fluids
PRODCOM	20.14.32.50 Formic acid, its salts and esters	20.20.19.30 Goods of HS 38.08, containing one or more of the following substances…	20.20.14.90 Disinfectants put up in forms or packings for retail sale or as preparations or articles	20.59.43.50 Anti-freezing preparations and prepared de-icing fluids
SITC 4	51 374	59 190	59 140	59 733

Proxy data

If obtaining consumption figures is not feasible, an alternative would be to use proxy data to deduce emission rate for the whole or parts of 3.D. For instance, per capita emission rates can be calculated based on the Norwegian results (Table 8).

Table 8. Examples of per capita emission rates for eight of the most important products, based on averages of emissions and population, 2005-2008. Kilograms/person/year

Emission rates	Per capita
Other cleaning products	1.07
Solvents	0.96
Ensilage means	0.90
Anti-freezing agents	0.69
Disinfectants	0.66
Windscreen washing agents	0.55
Cosmetics	0.37
Binding agents	0.36

In comparison, the Guidebook gives two per capita rates: 1.0 kg/person/year from 3.D.2 *Domestic solvent use* and 0.2 kg/person/year from *Underseal treatment and conservation of vehicles* under 3.D.3 *Other product use*.

Another option is to use some kind of economic statistics the may reflect the activities that give rise to NMVOC emissions, e.g. production figures. If such figures are used, it may be possible to make different emission factors for different industries and weigh them together using the distributions given in table 4.

POCP-values

POCP-value of NMVOC's is currently not taken into account in the reporting requirements under CLRTAP. However, if one is to choose between several emission sources to be included in the Guidebook, it may be relevant to consider that different substances make different contributions to the creation of tropospheric ozone (Table 9).

Table 9. Values for photochemical ozone creation potential (POCP) for 10 of the substances contributing most to the NMVOC emissions from sector 3.D in the Norwegian emission inventory[1]

Substance name	CAS number	POCP[2]
Ethanol	6 4-1 7-5	39.9
Formic acid	6 4-1 8-6	3.2
Ethylene glycol	10 7-2 1-1	37.3
2-propanol	6 7-6 3-0	18.8
Ethenyl-benzene, styrene	10 0-4 2-5	14.2
Formaldehyde	5 0-0 0-0	51.9
Benzenemethanol	10 0-5 1-6	46.9
Pentane	10 9-6 6-0	39.5
Acetic acid	6 4-1 9-7	9.7
4,4'-methylenediphenyl diisocyanate	10 1-6 8-8	51.3

[1] Note that POCP values are not known for all substances, especially complex petroleum compounds like naphtha and kerosene.
[2] POCP values supplied by UK's National Atmospheric Emissions Inventory (NAEI).

New sources in focus

If more activities are to be included in the Guidebook, it's probably necessary not to be too ambitious and focus only on a few, important products that are not covered. Taking into consideration the Norwegian use patterns, the possibility of obtaining accessible consumption figures and POCP-values, a first suggestion is to focus on disinfectants, cleaning products (especially windscreen cleaning agents) and cosmetics.

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