

Category		Title
NFR:	<b>2.A.2</b>	<b>Lime production</b>
SNAP:	<b>040614</b>	<b>Lime</b>
ISIC:	<b>2694</b>	<b>Manufacture of cement, lime and plaster</b>
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## Contents

1	Overview .....	3
2	Description of sources.....	3
2.1	Process description .....	3
2.2	Techniques .....	4
2.3	Emissions .....	4
2.4	Controls .....	5
3	Methods.....	6
3.1	Choice of method .....	6
3.2	Tier 1 default approach.....	7
3.3	Tier 2 technology-specific approach .....	8
3.4	Tier 3 emission modelling and use of facility data.....	11
4	Data quality .....	14
4.1	Completeness .....	14
4.2	Avoiding double counting with other sectors.....	14
4.3	Verification.....	15
4.4	Developing a consistent time series and recalculation .....	15
4.5	Uncertainty assessment .....	15
4.6	Inventory quality assurance/quality control (QA/QC) .....	15
4.7	Gridding .....	15
4.8	Reporting and documentation .....	15
5	Glossary .....	16
6	References.....	16
7	Point of enquiry.....	17

## 1 Overview

Lime (CaO) is the high-temperature product of the calcination of limestone. The production occurs in vertical and rotary kilns fired by coal, oil or natural gas. Calcium limestone contains 97–98 % calcium carbonate on a dry basis. The rest includes magnesium carbonate, aluminium oxide, iron oxide and silica. However, some limestone contains as much as 35–45 % magnesium carbonate and is classified as dolomite.

Atmospheric emissions in the lime manufacturing industry include particulate emissions from the mining, handling, crushing, screening and calcining of the limestone and emissions of air pollutants generated during fuel combustion in kilns. These emissions are not very significant on a global or even regional scale. However, lime works can be an important emission source of air pollutants on a local scale.

The production of lime causes emissions from both processes and combustion. This chapter only covers the process emissions. Emissions from combustion activities are addressed in chapter 1.A.2.f Manufacturing Industries and Construction (Combustion) — Other.

## 2 Description of sources

### 2.1 Process description

Two major types of processes can be considered within the lime work operations: quarrying, crushing, and size grading of minerals; and combustion of fuels in lime kilns. Limestone quarries are usually developed in a number of benches or lifts. For primary blasting of the limestone, holes are made by drills operated by compressed air (Parker, 1978). The excavated limestone is transferred for crushing and grinding. There are several types of crushing and grinding machines to produce limestone of sizes suitable for several designs of kilns. A schematic overview of the different processes occurring during the production of lime is shown in Figure 2.1.

During the kiln operations the limestone reaches temperatures as high as 900 °C, and carbon dioxide is driven off limestone to leave so-called quicklime. The quicklime descends through the cooling zone and is discharged at the base of the kiln. Obviously, various air pollutants are generated during combustion of fuels in the kiln.

Hydrated lime is made by adding water to crushed or ground quicklime and thoroughly mixing the quicklime and the water. Milk of lime can be produced either by slaking quicklime with an excess of water or by mixing hydrated lime with water.

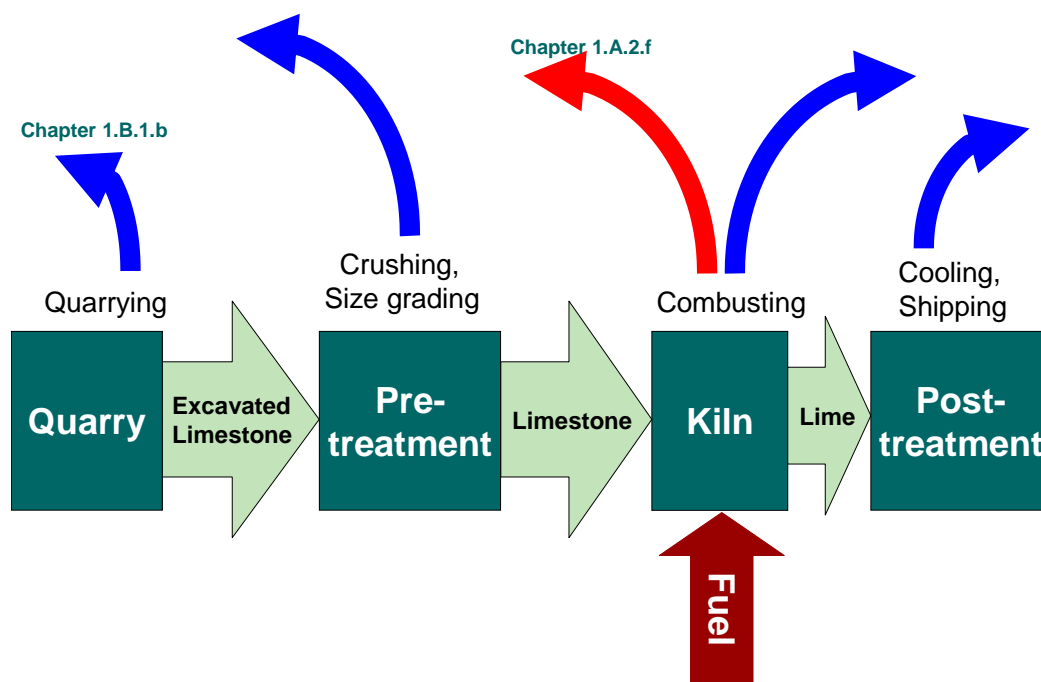


Figure 2.1 Process scheme for source category 2.A.2 Lime production.

## 2.2 Techniques

At present two major types of kilns are in use: vertical and rotary kilns. Because of larger size of charge material, lower air velocities and less agitation, vertical kilns emit lower amounts of particles but higher amounts of sulphur dioxide and carbon monoxide. However, in recent years there have been important developments in the design and use of rotary kilns. They require a more carefully classified and smaller size of limestone than for the vertical kilns.

## 2.3 Emissions

Pollutants released are sulphur oxides ( $\text{SO}_x$ ), nitrogen oxides ( $\text{NO}_x$ ), volatile organic compounds (non-methane VOC and methane ( $\text{CH}_4$ )), carbon monoxide ( $\text{CO}$ ), carbon dioxide ( $\text{CO}_2$ ), nitrous oxide ( $\text{N}_2\text{O}$ ) and particulate matter. According to CORINAIR90 the main relevant pollutants are  $\text{SO}_2$ ,  $\text{NO}_x$ ,  $\text{CO}$  and  $\text{CO}_2$  (Bouscaren, 1992). Fuel-based emissions are included under source category 1.A.2 Manufacturing Industries and Construction (Combustion) and not included here to prevent double counting.

Sulphur dioxide emissions are influenced by several factors, including the sulphur content of the fuel, the sulphur content and mineralogical form (metal sulphide such as pyrite, or sulphates such as gypsum) of the stone feed, the quality of lime being produced and the type of kiln. Due to variations in these factors, plant-specific  $\text{SO}_2$  emission factors are likely to vary significantly from the average emission factors presented here. The dominant source of sulphur emissions is the kiln's fuel, particularly coal and petroleum derived coke, where the levels of sulphur may be as high as 5 % by weight. The amount of sulphur present will vary widely according to the nature of the deposits used. During the calcining operation, sulphide and sulphates are decomposed to yield sulphur dioxide. On combustion of the fuel, the sulphur compounds present in the fuel are

oxidised to sulphur dioxide and pass through the burning zone of the kiln with the exhaust gases (US EPA, 1995; HSMO, 1992).

When sulphur-containing fuels are burnt, for practical purposes sulphur in the kiln exhaust may be assumed to be emitted as sulphur dioxide, although there is usually some sulphur trioxide formed. In the case of lime manufacture in shaft kilns, much of the sulphur re-combines with the burnt lime and the emissions of sulphur dioxide are subsequently reduced. In the case of rotary and rotating hearth kilns, combinations of process design and combustion conditions can be selected to ensure that most of the sulphur is expelled as sulphur dioxide in the kiln gases (HSMO, 1992).

The oxides of nitrogen are produced through the reaction of the nitrogen and oxygen in the air and through the oxidation of the nitrogen compounds contained in the fuel. There is a significant increase in the amount of oxides of nitrogen (mainly nitric oxide) which is formed at temperatures above 1 400 °C. The formation of nitric oxide is also a function of the excess air. When operating near to stoichiometric conditions in the kiln, there is localised generation of carbon monoxide. This acts as a reducing agent so that any nitric oxide which may be present is converted to nitrogen. Some oxides of nitrogen are also formed in electrostatic precipitators (HSMO, 1992).

Carbon dioxide and carbon monoxide are formed as main products of the combustion process. Carbon monoxide is formed by the incomplete combustion of carbonaceous fuels and even with good combustion control small amounts of carbon monoxide will be present in combustion gases.

The dissociation of limestone produces up to 0.75 tonnes of carbon dioxide (CO<sub>2</sub>) per tonne of quicklime, depending on the composition of the limestone and the degree of calcination. The amount of carbon dioxide produced by combustion depends on the chemical composition of the fuel and on the heat use per tonne of quicklime, generally it is in the range 0.2–0.45 tonnes CO<sub>2</sub> per tonne of quicklime (European Commission, 2001).

The heat of dissociation of calcium limestone is 3 200 MJ/tonne. The net heat use per tonne of quicklime varies considerably with kiln design. Rotary kilns generally require more heat than shaft kilns. The heat use tends to increase as the degree of burning increases. The net heat use varies between 3 600 and 7 500 MJ/Mg of lime for calcium quicklime and light- and hard-burned dolomite, and between 6 500 and 10 500 MJ/Mg of lime for dead-burned dolomite (European Commission, 2001).

## 2.4 Controls

Emissions of sulphur oxide can be reduced by using low sulphur fuels and by limiting the sulphur contents of the fuel and raw materials. Sulphur dioxide emissions may be further reduced if the polluting equipment is fitted to desulphurise the exhaust gases (e.g. by using a wet process) (US EPA, 1995; HMSO, 1992).

The design of kiln and combustion conditions may be selected to ensure that most of the sulphur is retained in the burnt lime. In most circumstances, especially in shaft kilns, only a small fraction of the sulphur dioxide generated within the kiln (whether originating from the raw materials or from the fuel) is released to atmosphere, since it is mainly incorporated into the lime by chemical combination (HSMO, 1992).

The following techniques can be reasonably applied to reduce oxides of nitrogen discharges to the atmosphere:

- the use of low-NO<sub>x</sub>-burners where practicable, which operate by avoiding localised hot spots;

- the use of very finely pulverised coal so that complete combustion can be achieved with low excess air.

Modern lime works are equipped with electrostatic precipitators that remove at least 98 % of the particulate matter from exhaust gases. Other control devices are also used including multiple cyclones, wet scrubbers and baghouses.

### 3 Methods

#### 3.1 Choice of method

Figure 3.1 presents the procedure to select the methods for estimating process emissions from the lime industry. The basic approach is as follows:

- If detailed information is available such that higher tiered methods can be employed: use it.
- If the source category is a key category, a Tier 2 or better method must be applied and detailed input data must be collected. The decision tree directs the user in such cases to the Tier 2 method, since it is expected that it is easier to obtain the necessary input data for this approach than to collect facility level data needed for a Tier 3 estimate.
- The alternative of applying a Tier 3 method, using detailed process modelling is not explicitly included in this decision tree. However, detailed modelling will always be done at the facility level and results of such modelling could be seen as ‘facility data’ in the decision tree.

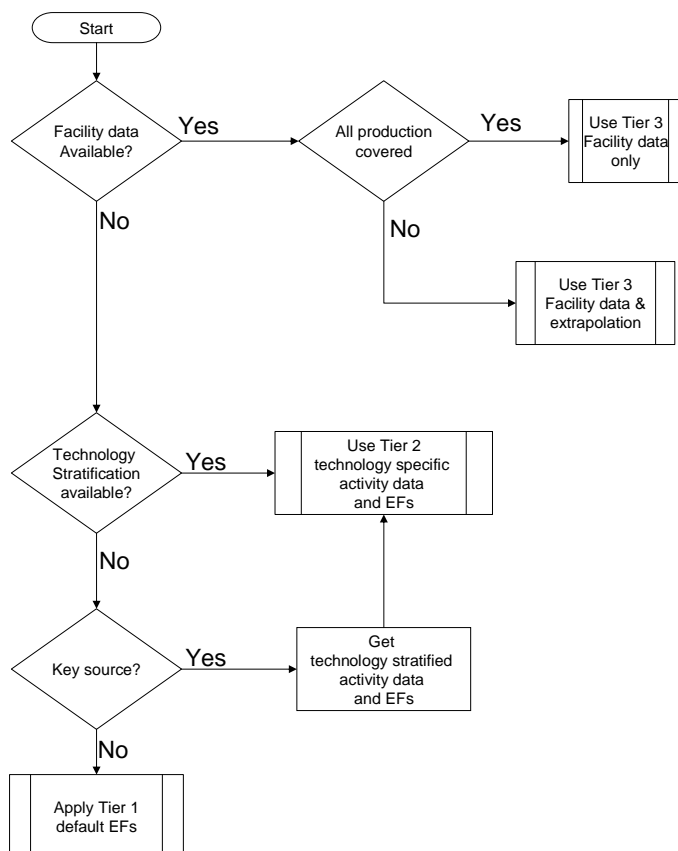


Figure 3.1 Decision tree for source category 2.A.2 Lime production.

## 3.2 Tier 1 default approach

### 3.2.1 Algorithm

The Tier 1 approach for process emissions from lime uses the general equation:

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

where:

$E_{\text{pollutant}}$	=	the emission of the specified pollutant
$AR_{\text{production}}$	=	the activity rate for the lime production
$EF_{\text{pollutant}}$	=	the emission factor for this pollutant

This equation is applied at the national level, using annual national total lime production data. Information on the production of lime, suitable for estimating emissions using the simpler estimation methodology (Tier 1 and 2), is widely available from United Nations statistical yearbooks or national statistics.

The Tier 1 emission factors assume an ‘averaged’ or typical technology and abatement implementation in the country and integrate all different sub-processes in the lime production between inputting raw materials into the process and the final shipment off the facilities.

In cases where specific abatement options are to be taken into account a Tier 1 method is not applicable and a Tier 2 or Tier 3 approach must be used.

### 3.2.2 Default emission factors

The Tier 1 approach needs emission factors for all relevant pollutants that integrate all sub-processes within the industry from inputting raw materials to the final shipment of the products off site. The default emission factor for total suspended particulates (TSP) as given in Table 3.1 has been extracted from the Best Available Techniques Reference (BREF) document for cement and lime production (European Commission, 2001) and represents worst case TSP emissions (i.e. uncontrolled process) during lime production (kiln, hydrating and grinding).

$PM_{10}$  and  $PM_{2.5}$  emission factors have been estimated using the particulates profile suggested in the Coordinated European Particulate Matter Emission Inventory Program (CEPMEIP) (Visschedijk *et al.*, 2004). The BC emission factor is based on Chow *et al.* (2011) and related to  $PM_{2.5}$ .

Emission factors in the BREF documents are mostly given in ranges. The range is interpreted as the 95 % confidence interval, while the geometric mean of this range is chosen as the value for the emission factor in the table below.

**Table 3.1 Tier 1 emission factors for source category 2.A.2 Lime production.**

Tier 1 default emission factors					
	Code	Name			
NFR source category	2.A.2	Lime production			
Fuel	NA				
Not applicable	NH <sub>3</sub> , As, Cr, Cu, Ni, Se, Zn, HCH, PCB, PCDD/F, Benzo(a)pyrene, Benzo(a)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	NO <sub>x</sub> , CO, NMVOC, SO <sub>x</sub> , Pb, Cd, Hg				
Pollutant	Value	Unit	95 % confidence interval		Reference
			Lower	Upper	
TSP	9 000	g/Mg lime	3 000	22 000	European Commission (2001)
PM <sub>10</sub>	3 500	g/Mg lime	1 000	9 000	Visschedijk et. (2004) applied on TSP
PM <sub>2.5</sub>	700	g/Mg lime	300	2 000	Visschedijk et. (2004) applied on TSP
BC	0.46	% of PM <sub>2.5</sub>	0.23	0.92	Chow et al. (2011)

Emission factors in Table 3.1 are provided for particulate fractions only. This does not imply that there are no process emissions for other pollutants but since it is very difficult to separate process and combustion emissions and we expect the majority of emissions for other pollutants (NO<sub>x</sub>, SO<sub>x</sub>, NMVOC, CO, cadmium (Cd), mercury (Hg) and lead (Pb)) to be due to the combustion of fuels. Emission factors for combustion-related emissions of NO<sub>x</sub>, CO and SO<sub>2</sub> are provided in chapter 1.A.2.f. Emissions of other heavy metals are assumed to be negligible.

### 3.2.3 Activity data

Information on the production of lime, suitable for estimating emissions using the simpler estimation methodology (Tiers 1 and 2), is widely available from United Nations statistical yearbooks or national statistics. National statistics are preferred if they are judged to be complete and representative of the sector.

Further guidance is provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 3 on Industrial Processes and Product Use (IPPU), chapter 2.3.1.3 'Choice of activity data' (IPCC, 2006).

## 3.3 Tier 2 technology-specific approach

### 3.3.1 Algorithm

The Tier 2 approach is similar to the Tier 1 approach. To apply the Tier 2 approach, both the activity data and the emission factors need to be stratified according to the different techniques that may occur in the country. With regard to the lime production, these techniques include the use of the various kilns:

- vertical shaft kiln;
- vertical double inclined kiln;
- parallel flow / counterflow regenerative kiln;
- annular kiln;
- rotary short kiln / air suspension preheater;
- rotary long kiln;
- calcimatic kiln.



The Tier 2 approach is as follows:

Stratify the lime production in the country to model the different product and process types occurring in the national industry into the inventory by:

- defining the production using each of the separate product and/or process types (together called ‘technologies’ in the formulae below) separately; and
- applying technology specific emission factors for each process type:

$$E_{\text{pollutant}} = \sum_{\text{technologies}} AR_{\text{production,technology}} \times EF_{\text{technology,pollutant}} \quad (2)$$

where:

$AR_{\text{production,technology}}$  = the production rate within the source category, using this specific technology

$EF_{\text{technology,pollutant}}$  = the emission factor for this technology and this pollutant

A country where only one technology is implemented will result in a penetration factor of 100 % and the algorithm reduces to:

$$E_{\text{pollutant}} = AR_{\text{production}} \times EF_{\text{technology,pollutant}} \quad (3)$$

where:

$E_{\text{pollutant}}$  = the emission of the specified pollutant

$AR_{\text{production}}$  = the activity rate for the lime production

$EF_{\text{pollutant}}$  = the emission factor for this pollutant

The emission factors in this approach will still include all sub-processes within the industry.

### 3.3.2 Technology-specific emission factors

The present subsection presents uncontrolled and controlled emission factors, which are taken from the BREF document for cement and lime production (European Commission, 2001). The BC emission factor is based on Chow et al. (2011) and related to  $PM_{2.5}$ . Emission factors are based on a typical exhaust gas volume of 4 000  $Nm^3/Mg$  lime for the calcining process. The gaseous effluent from hydrating plants is rather small in volume, estimated is 800  $m^3/Mg$  of hydrated lime.

During lime grinding, air is drawn through all of the grinding equipment to remove ground lime of the required particle size. The product is separated from air in bag filters, often preceded by clones. Thus, dust collection is an integral part of the process and therefore uncontrolled emission factors are not applicable to the process of lime grinding. The typical air flow during grinding is 1 500  $Nm^3/Mg$  lime.

The majority of the particulate emissions arise from the calcining of limestone. Other processes like hydrating and grinding are less important for the PM emissions. In the tables in this chapter, these emissions have been added up to get emission factors for the whole process.

Subsidiary operations, such as crushing, screening, conveying, slaking, storage and discharge are not included in the tables below. Emission factors for these processes are not available.

Emission factors in the BREF documents are mostly given in ranges. The range is interpreted as the 95 % confidence interval, while the geometric mean of this range is chosen as the value for the emission factor in the table below.

### 3.3.2.1 Uncontrolled emission factors

**Table 3.2 Tier 2 emission factors for source category 2.A.2 Lime production.**

Tier 2 default emission factors					
	Code	Name			
NFR source category	2.A.2	Lime production			
Fuel	NA				
SNAP (if applicable)	040614 Lime (decarbonizing)				
Technologies/Practices	Typical emissions from some types of lime kiln				
Region or regional conditions					
Abatement technologies	Uncontrolled				
Not applicable	NH <sub>3</sub> , As, Cr, Cu, Ni, Se, Zn, HCH, PCB, PCDD/F, Benzo(a)pyrene, Benzo(a)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	NO <sub>x</sub> , CO, NMVOC, SO <sub>x</sub> , Pb, Cd, Hg				
Pollutant	Value	Unit	95 % confidence interval		Reference
			Lower	Upper	
TSP	9 000	g/Mg lime	3 000	22 000	European Commission (2001)
PM <sub>10</sub>	3 500	g/Mg lime	1 000	9 000	Visschedijk et al. (2004) applied on TSP
PM <sub>2.5</sub>	700	g/Mg lime	300	2 000	Visschedijk et al. (2004) applied on TSP
BC	0.46	% of PM <sub>2.5</sub>	0.23	0.92	Chow et al. (2011)

### 3.3.2.2 Controlled emission factors

It is assumed that controlled rotary kilns are fitted with dust collection equipment, as are most controlled shaft kilns. Because of the wide range of exhaust gas conditions, a variety of dust collectors are used, including cyclones, wet scrubbers, fabric filters, electrostatic precipitators and gravel bed filters.

Furthermore, it is assumed that both wet scrubbers and bag filters are used to de-dust the emissions during lime hydrating.

**Table 3.3 Tier 2 emission factors for source category 2.A.2 Lime production.**

Tier 2 default emission factors					
	Code	Name			
NFR source category	2.A.2	Lime production			
Fuel	NA				
SNAP (if applicable)	040614 Lime (decarbonizing)				
Technologies/Practices	Typical emissions from some types of lime kiln				
Region or regional conditions					
Abatement technologies	Controlled				
Not applicable	NH <sub>3</sub> , As, Cr, Cu, Ni, Se, Zn, HCH, PCB, PCDD/F, Benzo(a)pyrene, Benzo(a)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	NO <sub>x</sub> , CO, NMVOC, SO <sub>x</sub> , Pb, Cd, Hg				
Pollutant	Value	Unit	95 % confidence interval		Reference
			Lower	Upper	
TSP	400	g/Mg lime	100	1 000	European Commission (2001)
PM <sub>10</sub>	200	g/Mg lime	60	400	Visschedijk et al. (2004) applied on TSP
PM <sub>2.5</sub>	30	g/Mg lime	10	80	Visschedijk et al. (2004) applied on TSP
BC	0.46	% of PM <sub>2.5</sub>	0.23	0.92	Chow et al. (2011)

### 3.3.3 Abatement

Abatement efficiencies are not provided for lime production. Tier 2 uncontrolled and controlled emission factors may be used.

### 3.3.4 Activity data

Information on the production of lime, suitable for estimating emissions using the simpler estimation methodology (Tiers 1 and 2), is widely available, preferably from national statistics or alternatively from United Nations statistical yearbooks.

Further guidance is provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 3 on Industrial Processes and Product Use (IPPU), chapter 2.3.1.3 ‘Choice of activity data’ (IPCC, 2006).

## 3.4 Tier 3 emission modelling and use of facility data

### 3.4.1 Algorithm

There are two different methods to apply emission estimation methods that go beyond the technology specific approach described above:

- detailed modelling of the lime production process;
- facility-level emission reports.

#### 3.4.1.1 Detailed process modelling

A Tier 3 emission estimate, using process details will make separate estimates for the consecutive steps in the lime production process:

- handling of raw materials;
- combustion in the kiln;
- after-treatment of the lime.

This process modelling will need to be done using a tailored toolkit or a system with input from experts in the industry. Where possible, process-specific emission factors will be needed to apply to each of the activities.

#### 3.4.1.2 Facility-level data

Where facility-level emissions data of sufficient quality (see the guidance chapter on data collection in Part A of the Guidebook) are available, it is good practice to use these data. There are two possibilities:

- the facility reports cover all lime production in the country;
- facility-level emission reports are not available for all lime plants in the country.

If facility-level data cover all lime production in the country, it is good practice to compare the implied emission factors (reported emissions divided by the national lime production) with the default emission factor values or technology specific emission factors. If the implied emission factors are outside the 95 % confidence intervals for the values given below, it is good practice to explain the reasons for this in the inventory report

If the total annual lime production in the country is not included in the total of the facility reports, it is good practice to estimate the missing part of the national total emissions from the source category, using extrapolation by applying:

$$E_{total,pollutant} = \sum_{Facilities} E_{facility,pollutant} + \left( Production_{total} - \sum_{Facilities} Production_{facility} \right) \times EF_{pollutant} \quad (4)$$

where:

$E_{\text{total,pollutant}}$	=	the total emission of a pollutant for all facilities within the source category
$E_{\text{facility,pollutant}}$	=	the emission of the pollutant as reported by a facility
$\text{Production}_{\text{total}}$	=	the production rate in the source category
$\text{Production}_{\text{facility}}$	=	the production rate in a facility
$EF_{\text{pollutant}}$	=	the emission factor for the pollutant

Depending on the specific national circumstances and the coverage of the facility-level reports as compared to the total national lime production, it is good practice to choose the emission factor ( $EF$ ) in this equation from the following possibilities, in decreasing order of preference:

- technology-specific emission factors, based on knowledge of the types of technologies implemented at the facilities where facility-level emission reports are not available;
- the implied emission factor derived from the available emission reports:

$$EF = \frac{\sum_{\text{Facilities}} E_{\text{Facility,pollutant}}}{\sum_{\text{Facilities}} \text{Production}_{\text{Facility}}} \quad (5)$$

- the default Tier 1 emission factor. This option should only be chosen if the facility-level emission reports cover more than 90 % of the total national production

### 3.4.2 Tier 3 emission factors and models

Lime production facilities are major industrial facilities and emissions data for individual plants might be available through a pollutant release and transfer registry (PRTR) or another emission reporting scheme. When the quality of such data is assured by a well developed QA/QC system and the emission reports have been verified by an independent auditing scheme, it is good practice to use such data. If extrapolation is needed to cover all lime production in the country either the implied emission factors for the facilities that did report, or the emission factors as provided above could be used (see subsection 3.3.2 above).

A model setting out TSP emission factors for sub-processes within the lime industry (Economopoulos, 1993) is presented in Table 3.4. It is a rather old model, which may be outdated, and should therefore be used with care.

**Table 3.4 Tier 3 emission factors for particulate emissions from lime production.**

Operation		Abatement (if applicable)	Emission factor [kg/Mg lime]
Coal storage	Open piles		0.5
	Semi-enclosed piles		0.25
	Compartments		0.1
	Silos		0.1
Coal crushing and		Uncontrolled	0.18

screening		Fabric filter	0.002
Coal grinding	(Semi) direct fired system		0.0
	Indirect fired system	Uncontrolled	10.0
		Fabric filter	0.1
Raw material storage			0.16
Crushing and screening		Uncontrolled	1.5
		Fabric filter	0.0005
Crushed material storage	Open piles		1.0
	Semi-enclosed piles		0.5
	Compartments		0.2
	Silos		0.2
Raw material conveying		Uncontrolled	1.2
		Fabric filter	0.01
Raw material calcining	Vertical shaft kiln	Uncontrolled	3.0
		Cyclone	1.0
		Multicyclones	0.75
	Vertical double Inclined kiln	Uncontrolled	10.5
		Cyclone	3.6
		Multicyclones	2.6
	Parallel flow / Counterflow Regenerative kiln	Uncontrolled	8.0
		Cyclone	2.8
		Multicyclones	2.0
	Annular kiln	Uncontrolled	12.0
		Cyclone	4.2
		Multicyclones	3.0
	Rotary short kiln / air suspension preheater	Uncontrolled	40.0
		Cyclone	14.0
		Multicyclones	9.0
		ESP	0.6
		Fabric filter	0.2
	Rotary long kiln	Uncontrolled	140.0
		Cyclone	49.0
		Multicyclones	35.0
		ESP	2.0
Fabric filter		0.4	
Calcimatic kiln	Uncontrolled	25.0	

		Cyclone	8.7
		Multicyclones	6.2
Lime cooling	Grate cooler	Uncontrolled	20.0
		Cyclone	4.0
		Multicyclones	2.0
		Fabric filters	0.1
	Planetary, rotary or vertical shaft coolers		0.0
Lime packaging / shipping			0.12
Lime hydration		Uncontrolled	35.0
		Scrubber	0.04

More information on the typical emissions from a lime production facility may also be found in the BREF document for the Cement and Lime industry (European Commission, 2001).

### 3.4.3 Activity data

Since PRTR generally do not report activity data, such data in relation to the reported facility level emissions are sometimes difficult to find. A possible source of facility-level activity might be the registries of emission trading systems.

The detailed methodology (Tier 3) requires more comprehensive information. For example, the quantities of lime produced by various types of industrial technologies employed in the lime industry at plant level. However, in most cases, no information is available from the statistical yearbooks on the quantities of lime produced in vertical and rotary kilns.

## 4 Data quality

### 4.1 Completeness

In cases where attempts are made to split the emissions from lime manufacturing between combustion emissions and non-emission combustions, care must be taken to include all emissions.

It is good practice to check whether the emissions reported as ‘included elsewhere’ (IE) under source category 2.A.2 are indeed included in the emissions reported under source category 1.A.2.f.

### 4.2 Avoiding double counting with other sectors

In cases where it is possible to split these emissions, it is good practice to do so. However, care must be taken that the emissions are not double counted.

It is good practice to check that the emissions reported under source category 2.A.2 are not included in the emission reported under source category 1.A.2.f.

## 4.3 Verification

### 4.3.1 Best Available Technique (BAT) emission factors

This section presents Best Available Technique emission factors. These are provided by the BREF document for this industry (European Commission, 2001), available at <http://eippcb.jrc.es/pages/FActivities.htm>. The BREF document discusses the process, current emission levels and provides Best Available Technique information but does not provide emission values associated with the use of BAT.

## 4.4 Developing a consistent time series and recalculation

For Tier 1 and Tier 2, activity data should be consistent across the time series. Where technology-specific emission factors are introduced for Tier 2 these must be applied so that they reflect the technology employed in the relevant years of the inventory calculation.

For Tier 3 using facility-level data, it might occur that a different selection of facility-level data is included in different years. This can lead to time series inconsistencies. Moreover, PRTR data generally are available for specific years only. Splicing such recent reported data under the European Pollutant Emission Register (EPER) and the European Pollutant Release and Transfer Register (E-PRTR) with historical data could be used to get consistent time series. Splicing could be used for both the activity data and the country-specific emission factors.

Unexpected discontinuities in time series can occur when specific lime works come into operation or are closed in specific years. If this happens, it is good practice to document such explanations clearly in the inventory archives.

## 4.5 Uncertainty assessment

It is rather difficult to assess current uncertainties of emission estimates for pollutants emitted during lime production. The uncertainties of sulphur dioxide emission estimates can be assessed in a similar way as the uncertainties of estimates for fossil fuel combustion (see chapter 1.A.2.f).

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

As discussed in the present chapter, emissions from lime production only include the emissions due to other causes than the combustion of fuels. Emissions from fuel combustion are to be reported under source category 1.A.2.f in the Industrial Combustion sub-sector. It is good practice to check whether the lime production data evaluated under the present chapter are consistent with the associated fuel use reported under chapter 1.A.2.f.

## 4.7 Gridding

It is good practice to consider lime production plants as point sources if plant-specific data are available. Otherwise national emissions should be disaggregated on the basis of plant capacity, employment or population statistics.

## 4.8 Reporting and documentation

No specific issues.

## 5 Glossary

$AR_{\text{production, technology}}$	the production rate within the source category, using a specific technology
$AR_{\text{production}}$	the activity rate for the lime production
$E_{\text{facility, pollutant}}$	the emission of the pollutant as reported by a facility
$E_{\text{pollutant}}$	the emission of the specified pollutant
$E_{\text{total, pollutant}}$	the total emission of a pollutant for all facilities within the source category
$EF_{\text{country, pollutant}}$	a country-specific emission factor
$EF_{\text{pollutant}}$	the emission factor for the pollutant
$EF_{\text{technology, abated}}$	the emission factor after implementation of the abatement
$EF_{\text{technology, pollutant}}$	the emission factor for this technology and this pollutant
$EF_{\text{technology, unabated}}$	the emission factor before implementation of the abatement
$\text{Penetration}_{\text{technology}}$	the fraction of production using a specific technology
$\text{Production}_{\text{facility}}$	the production rate in a facility
$\text{Production}_{\text{total}}$	the production rate in the source category
$\eta_{\text{abatement}}$	the abatement efficiency

## 6 References

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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 expert panel on combustion and industry. Please refer to the TFEIP website ([www.tfeip-secretariat.org](http://www.tfeip-secretariat.org)) for the contact details of the current expert panel leaders.