Plan d’assurance et de contrôle qualité (AQ/CQ) de l’inventaire des gaz à effet de serre (GES) 1990–2022 : Procédés industriels et utilisation des produits (PIUP)

ICAT Initiative for Climate Action Transparency

UN environment programme | copenhagen climate centre

Initiative pour la transparence de l'action climatique – ICAT

Plan d'assurance et de contrôle qualité (QA/QC) de l'inventaire des gaz à effet de serre (GES) 1990–2022 : Procédés industriels et utilisation des produits (PIUP)

Livrable 2.d

Auteur : Traute Köther, Consultante Indépendant, Novembre 2025

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L'Initiative pour la transparence de l'action climatique (ICAT), soutenue par l'Autriche, le Canada, l'Allemagne, l'Italie, et la Children's Investment Fund Foundation.

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PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF THE ENVIRONMENT AND QUALITY OF LIFE

QA/QC Plan
to the
GHG inventory 1990-2022
PIUP

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4 Industrial processes and product use (IPPU) (CRT sector 2)

4.1 Overview of the sector and background information

In the Sector Industrial Processes and Product Use (IPPU), emissions originating from industrial processes, from the use of greenhouse gases in products, and from non-energy uses of fossil fuel carbon are considered.

Emissions from the IPPU sector are the main source of GHGs in Algeria. In the year 2022, about 9.2% of national total GHGs emissions and 11.2% of national total CO2 emissions from Algeria originated from the IPPU sector.

4.2 Mineral Industry (CRT category 2.A)

Methodological issues

The CRT category 2.A comprises the process-related carbon dioxide (CO_2) emissions resulting from the use of carbonate raw materials such as limestone and dolomite in the production and use of a variety of mineral industry products. As described in the 2006 IPCC Guidelines, Vol. 3, Chap 1, there are two broad pathways for release of CO_2 from carbonates:

The primary process resulting in the **release of CO_2 is the calcination of carbonate compounds**, during which, through heating, a metallic oxide is formed. A typical calcination reaction, here shown for the mineral calcite or calcium carbonate, would be:

$$CACO_3 + heat \rightarrow CaO + CO_2$$

Acid-induced release of CO_2 as a result of small quantities of carbonate being present as an impurity in an acidification process to upgrade a non-carbonate material. The formation of CO_2 can be via an equation such as:

$$CACO_3 + H_2SO_4 \rightarrow CaSO4 + H_2O + CO_2$$

In the following table, an overview of the IPCC sub-categories included in this chapter is given and is provided information on the status of emission estimates of all subcategories. 2.A „✔" indicates that emissions from this sub-category have been estimated.

4.2.1.1 *Main Activity Mineral Industry* (CRT category 2.A)

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry		
File	2A1_Cement_DZA.xlsx 2A2_Lime_DZA.xlsx 2A3_Glass_DZA.xlsx		
NID CHAPTER	Mineral Industry (CRT category 2.A)		
ToDo	Check for updated reasons for trend in sectoral chapter Update GHG emissions and AD in tables & graphs from sheet Table2(I).A-H_AD_T Table2(I).A-H_GHG_T		
		AD	emissions

	Table	E-M	E-M
	Graph	L-P	
	Check for updated reasons for trend in chapter • Trend -> Industrial processes and product use (IPPU) • Executive Summary		

4.2.1.1.1 Category description .

CRT code	CRT category	CO_2		CH_4		N_2O	
2.A	**Mineral Industry**	**Estimated**	**Key Category**	**Estimated**	**Key Category**	**Estimated**	**Key Category**
2.A.1	Cement production	✔	✔	NA	-	NA	-
2.A.2	Lime production	✔	-	NA	-	NA	-
2.A.3	Glass Production	✔	-	NA	-	NA	-
2.A.4	Other Process Uses of Carbonates						
2.A.4.a	Ceramics	NE	-	NA	-	NA	-
2.A.4.b	Other Uses of Soda Ash	NE	-	NA	-	NA	-
2.A.4.c	Non Metallurgical Magnesia Production	NE	-	NA	-	NA	-
2.A.4.d	Other	NE	-	NA	-	NA	-
2.A.5	Other	NO	-	NA	-	NA	-

4.2.2 Cement production (CRT category 2.A.1)

4.2.2.1.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	**Key Category**	**Estimated**	**Key Category**	**Estimated**	**Key Category**
2.A.1	Cement production	✔	✔	NA	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.2.2.1.2 Methodological issues

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Cement_production
File	2A1_Cement_DZA.xlsx
Sheet	ChoiceMethology

This chapter includes the CO_2 emissions estimations from cement production. Process-related CO_2 emissions are released during clinker production. Cement Production is a key source with regards to CO_2 emissions.

In cement manufacture, CO_2 is produced during the production of clinker, a nodular intermediate product that is then finely ground, along with a small proportion of calcium sulfate [gypsum ($CaSO_4$,H_2O) or anhydrite ($CaSO_4$)], into hydraulic (typically portland) cement.

$CaCO_3 + heat \rightarrow CaO + CO_2$ … typical calcination reaction

$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$ … acid-induced release of CO_2

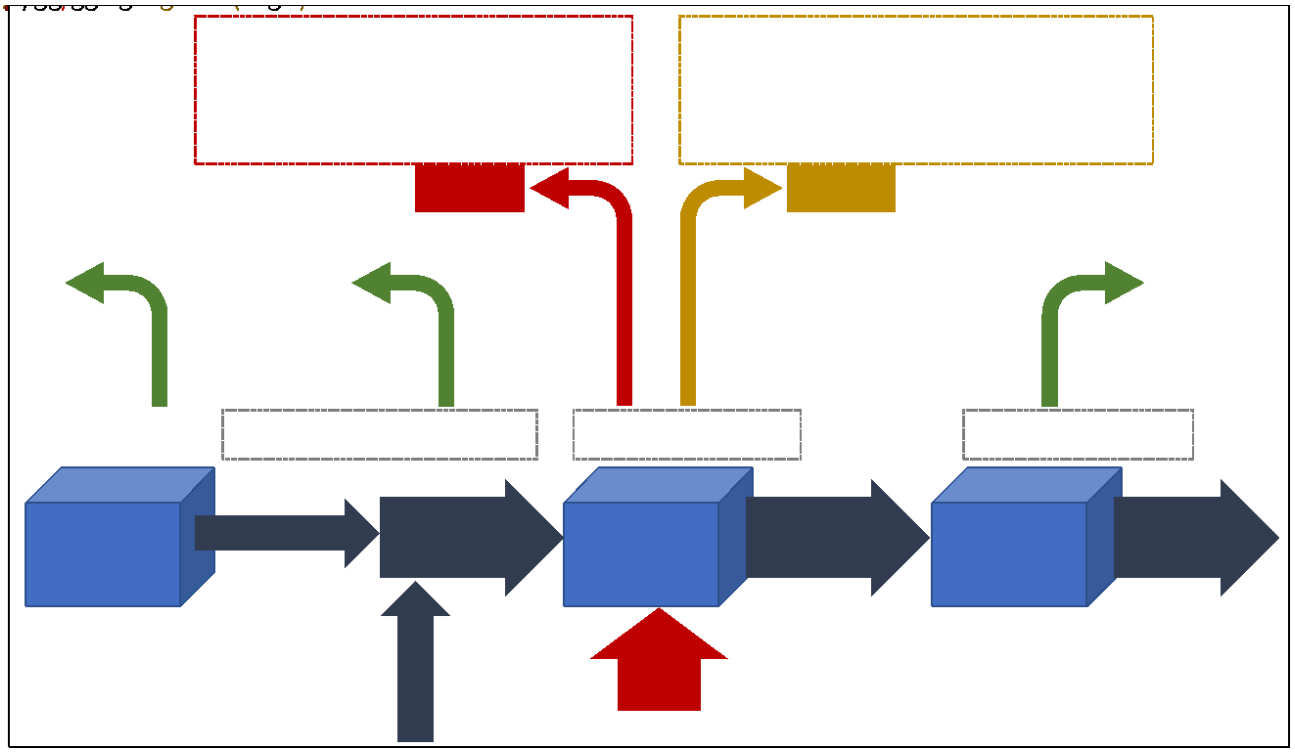
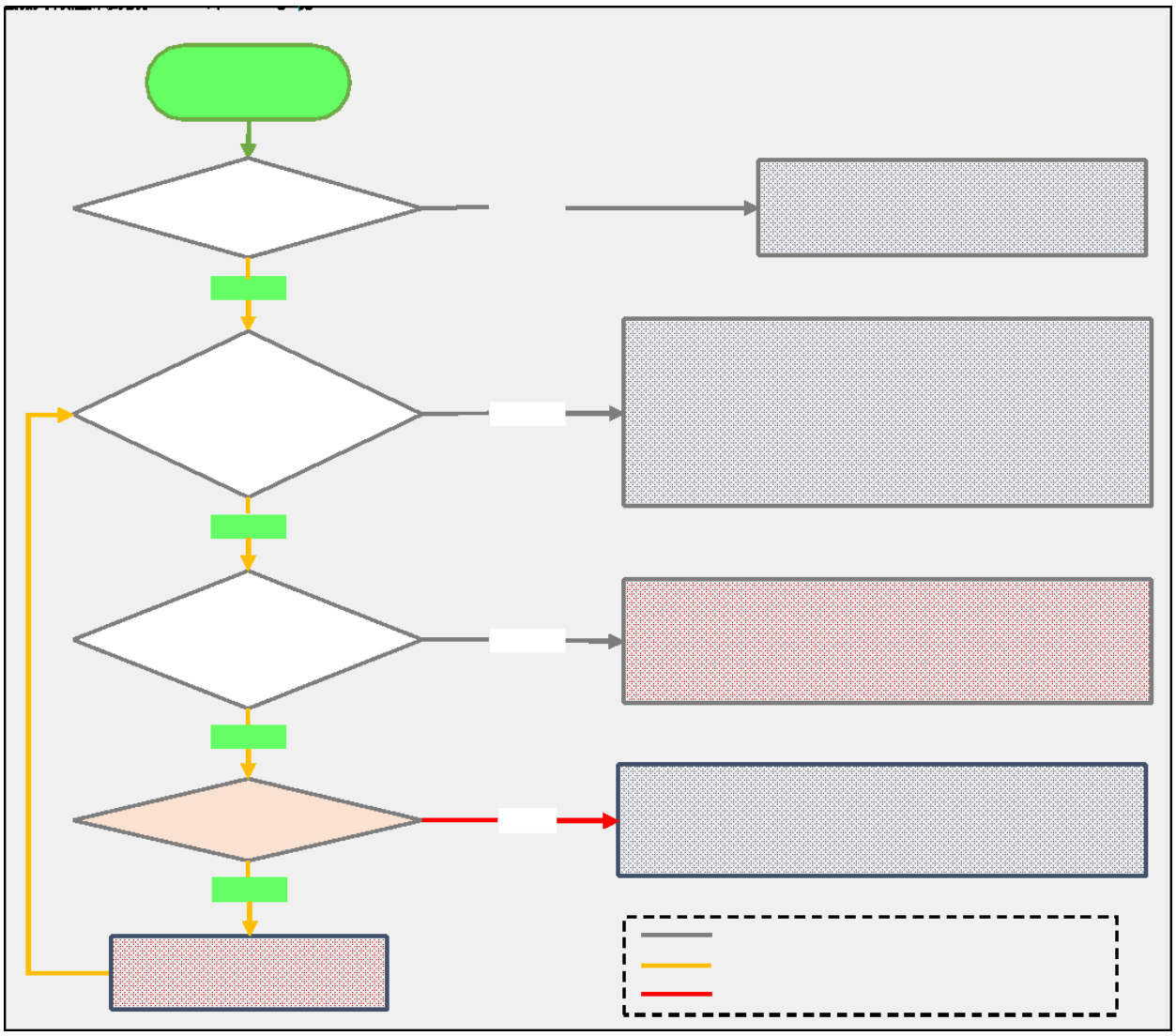


Figure 4-1 Schematic illustration of cement production and allocation of emissions

In the following figure is provided the decision tree and the decision (highlighted) for Tier 2 method for estimating CO_2 emissions from CRT category 2.A.1 *Cement production*

Figure 4-2 Decision tree for estimating GHG emission from CRT category 2.A.1 Cement production



4.2.2.1.3 Choice of methods

The 2006 IPCC Guidelines Tier 1 and Tier 2 approach[1] have been applied: CO_2 emissions are based on clinker production estimates inferred from cement production data, correcting for imports and exports of clinker.

Equation 2.1: Tier 1 - Emissions based on cement production (2006 IPCC GL. Vol. 3. Chap. 2.2.1.1)

$$CO_2\ emissions = \left[\sum_i (Mass_{ci}\ x\ ClFrac_{cl\,i}) - Imp + Exp\right] x\ EE_{cl\,i}$$

[1] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 2: Mineral Industry Emissions, Section 2.2 Cement Production

Where:

CO_2 Emissions = emissions of CO_2 from cement production in tons
$Mass_{cli}$ = weight (mass) of produced cement of type i in tons
$CFIrac_{cl\ i}$ = clinker fraction of cement of type i, fraction
Im = imports for consumption of clinker, tons
Ex = exports of clinker, tons
$EF_{cl\ i}$ = emission factor for clinker, tons CO_2/ton clinker

Equation 2.2: Tier 2 - Emissions based on cement production (2006 IPCC GL. Vol. 3. Chap. 2.2.1.1)

$$CO_2\ Emissions = M_{cl} \bullet EF_{cl} \bullet CF_{ckd}$$

Where:

CO_2 Emissions = emissions of CO_2 from cement production, tons
M_{cl} = weight (mass) of clinker produced , tons
$EF_{cl\ i}$ = emission factor for clinker, tons CO_2/ton clinker
CF_{ckd} = emissions correction factor for CKD

4.2.2.1.4 Choice of activity data

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Cement_production
File	AD_Cement_DZA.xlsx
based on	GES_AD_GICA_DZA.xlsx
	GES_AD_Lafarge.xlsx
	GES_AD_Biskria_DZA.xlsx
	GES_AD_Sarl_Amouda_Ciment.xlsx
	GES_AD_TimoKTANE.xlsx
	ONS.xlsx

Cement plants provide production data to estimate greenhouse gas emissions for the period 2010–2022.

4.2.2.1.4.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Cement_production
File	AD_Cement_DZA.xlsx
Sheet	EF_CS_DZA

For the period 2010 to 2022 we used the plant specific emission factor and completed the time series with average Plant Specific emission factor as shown in the next table.

Table 4-1 Plant Specific emission factor for CRT category 2.A.1 Cement production.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022

Average national emission factors for Clinker	0.53	0.53	0.52	0.53	0.53	0.53	0.53	0.54	0.54	0.54	0.54	0.55	0.55

We used the correction factor for CKD of 01 percent according to expert editor for cement plants.

4.2.2.2 Uncertainty assessment and time-series consistency

The uncertainties for activity data and emission factors used for CRT category 2.A.1 *Cement production* are presented in the following table.

4.2.2.2.1 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Cement_production
File	AD_Cement_DZA.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.A.1 cement Production are presented in the following table.

Uncertainty	**CO_2**	**Reference**
Activity data (AD)	2%	2006 IPCC GL. Vol. 3. Chap.2. Table 2.3 Default uncertainty values for cement production
Emission factor (EF)	2%	
Combined Uncertainty (U)	2%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

4.2.2.2.2 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Cement_production
File	AD_Cement_DZA.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed:

- Check of calculations by spreadsheets
  - documented sources.
  - use of units.
  - record keeping; use of write protection.
  - strictly defined interfaces between spreadsheets/calculation modules.
  - unique structure of sheets which do the same.

- unique use of formulas; special cases are documented/highlighted.
- quick-control checks for data consistency through all steps of calculation.

- time series consistency
  - plausibility checks of dips and jumps.
  - yearly public trend repeated values.
- cross-checked from different sources:
  - Plant specific data
  - National Statistic published by Office National des Statistics (ONS)[2] (several years): Annuaire statistique de l'Algérie: Chapitre XIII: Industrie et Energie

4.2.2.2.3 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Cement_production
File	AD_Cement_DZA.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.A.1	Application of TIER 2 and TIER 3 methodology	M	Accuracy	high
2.A.1	Revision of activity data (1990-2022): improvement of time series consistency by collection of plant specific activity data from all cement plants ● Production of clinker ● Production of cement per type ● Clinker fraction ● CaO composition of clinker and the MgO content ● CaO content of the raw material inputs	AD	Accuracy Transparency Completeness Consistency Comparability	high
2.A.1	Investigation on amount of cement kiln dust (CKD) which is recycled or not returned to the kiln	AD	Accuracy Transparency	High
2.A.1	Revision of activity data (1990-2022): improvement of time series consistency ● for imports for consumption of clinker ● exports of clinker	AD	Accuracy Transparency Comparability	high
2.A.1	Revision of Country specific national and plant specific	EF		Medium
2.A.1	Percentage share in cement kiln dust (CKD) which is recycled	AD	Accuracy Transparency Comparability	Medium

[2] https://www.ons.dz/spip.php?rubrique6 and https://www.ons.dz/IMG/pdf/CH8-ENERGIE.pdf; https://www.ons.dz/spip.php?rubrique127

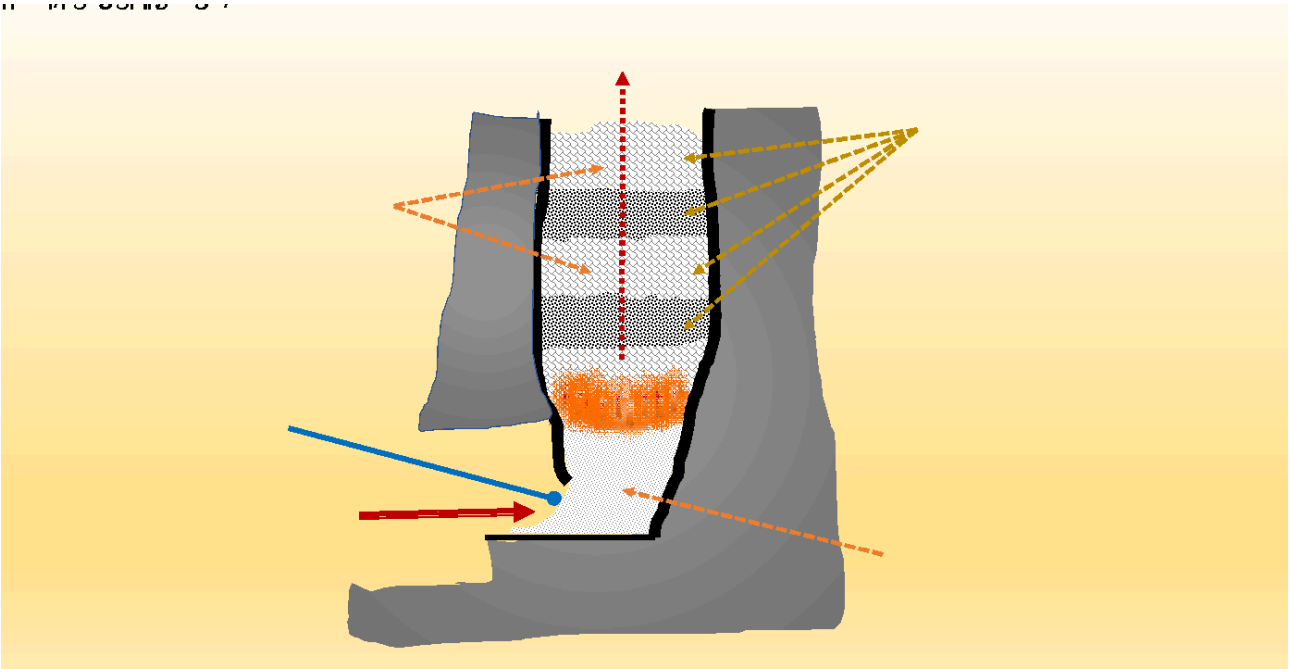
4.2.3 Lime production (CRT category 2.A.2)

4.2.3.1.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.A.2	Lime production	✔	-	NA	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.2.3.1.2 Methodological issues

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A2_Lime_production
File	2A1_Lime_DZA.xlsx
Sheet	ChoiceMethology



Process-related to CO_2 emissions are released during (quick) lime production. Calcium oxide (CaO) , also called as quicklime, is formed by heating limestone to decompose the carbonates. This is usually done in shaft or rotary kilns at high temperatures and the process releases CO_2. Depending on the product requirements (e.g., metallurgy, pulp and paper, construction materials, effluent treatment, water softening, pH control, and soil stabilization), primarily high calcium limestone (calcite) is utilized in accordance with the following reaction:

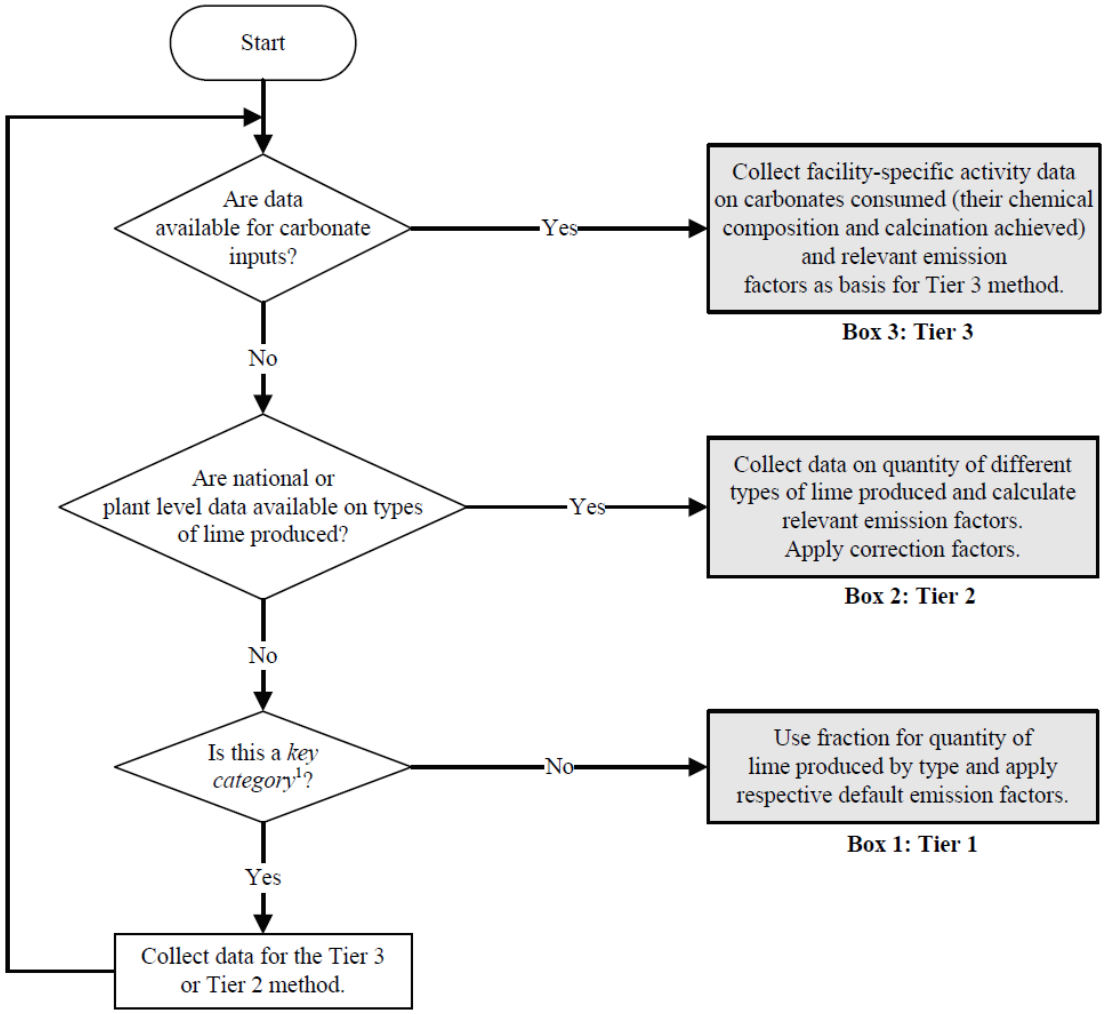
$$CaCO_3 \text{ (high-purity limestone)} + \text{heat} \rightarrow CaO \text{ (quicklime)} + CO_2$$

Dolomite and dolomitic (high magnesium) limestones may also be processed at high temperature to obtain dolomitic lime (and release CO_2) in accordance with the following reaction:

$$CaMg(CO_3)_2 \text{ (dolomite)} + \text{heat} \rightarrow CaO{\cdot}MgO \text{ (dolomitic lime)} + 2CO_2.$$

In the following figure is provided the decision tree and the decision (highlighted) for Tier 2 method for estimating CO2 emissions from CRT category 2.A.2 Lime production

Figure 4-3 Decision tree for estimating GHG emission from CRT category 2.A.1 Lime production



4.2.3.2 Methodological issues

4.2.3.2.1 Choice of methods

The 2006 IPCC Guidelines Tier 1 approach[3] has been applied on the period 1990 until 2005 and Tier 2 has been applied on the period 2006 until 2022, which is based on applying a default emission factor to national level lime production data.

Equation: Tier 1 - Emissions based on national lime production data

(2006 IPCC Guidelines, Vol. 3. Chapter 2. section 2.3.1.1)

$$CO_2\ emissions = Mass_{hydraled\ lime} \times Emission\ Factor_{hydroled\ lime} \times CF_{hydroled\ lime}$$

Where:

CO_2 Emissions = emissions of CO_2 from lime production (tons)

$Mass_{hydralic\ lime}$ = weight (mass) of hydraulic lime produced (tons)

$EF_{hydralic\ lime}$ = emission hydraulic factor for lime (tons CO_2/ton lime)

[3] Source: 2006 IPCC Guidelines, Volume 3: Industrial Processes and Product Use, Chapter 2: Mineral Industry Emissions, Section 2.3.1.1 Lime Production - Choice of method

$CF_{hydralic\ lime}$ = default correction factor for hydrated lime

It is not necessary for good practice to account for lime kiln dust (LKD) in Tier 1.

Equation 2.6: TIER 2: EMISSIONS BASED ON NATIONAL LIME PRODUCTION DATA BY TYPE (2006 IPCC Guidelines, Vol. 3. Chapter 2. section 2.3.1.1)

$$CO_2\ emissions = \sum\left(EF_{lime,i} * M_{l,i} * CF_{lkd,i} * C_{h,i}\right)$$

CO_2 Emissions = emissions of CO_2 from lime production (tons)
$EF_{lime,i}$ = weight (mass) of hydraulic lime produced (tons)
$M_{l,i}$ = emission hydraulic factor for lime (tons CO_2/ton lime)
$CF_{lkd,i}$ = correction factor for LKD for lime of type *i* of lime
$C_{h,i}$ = correction factor for hydrated lime of the type *i* of lime
i = each of the specific lime types listed

According to information provided by plants, the type of lime produced is:

- ✔ High-calcium lime
- ✔ Dolomitic lime
- ✔ Hydraulic lime.

4.2.3.2.2 Choice of activity data

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Lime_production
File	2A2_Lime_DZA.xlsx
based on	AD_Production_Chaux.xlsx
	AQS_AD_Production_Chaux.xlsx
	SIDER_AD_Production_Chaux.xlsx
	Tosyali-AD_Production_Chaux.xlsx

Cement plants provide production data to estimate greenhouse gas emissions for the period 2006–2022.

4.2.3.2.2.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Cement_production
File	2A2_Lime_DZA.xlsx
Sheet	EF_IPCC_2A2

4.2.3.2.3 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Lime_production
File	2A2_Lime_DZA.xlsx

Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.A.2 lime Production are presented in the following table.

Uncertainty	CO_2	Reference
Activity data (AD)	2%	based on 2006 IPCC GL. Vol. 3. Chap.2. Table 2.5 Default uncertainty values for lime production. page 2.25 and section 2.3.2.2. page 2.26.
Emission factor (EF)	15%	
Combined Uncertainty (U)	15%	$U_{Total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

4.2.3.2.4 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Lime_production
File	2A2_Lime_DZA.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed:

- Checked of calculations by spreadsheets
  - documented sources.
  - use of units.
  - record keeping; use of write protection.
  - unique use of formulas; special cases are documented/highlighted.
  - quick-control checks for data consistency through all steps of calculation.
- cross-checked from three sources:
  - national statistic ONS.
  - activity data from Plant
- time series consistency - plausibility checks of dips and jumps.

4.2.3.2.5 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\02_IPPU\2A_Mineral_Industry\2A1_Lime_production
File	2A2_Lime_DZA.xlsx
Sheet	PlannedImprovements

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.A.2	Application of Tier 2 method or higher	meth	Accuracy Comparability	Medium
2.A.2	Collection of production data for 1990 - 2022 ● plant specific production data ● types of lime produced. ● carbonates consumed including their chemical composition and calcination achieved	AD	Accuracy Comparability Consistency Completeness Transparency	Medium
2.A.2	Analysis of industries that produce non-marketed lime, e.g., sugar production, pulp and paper manufacturing facilities, metallurgy and water softeners.	AD	Accuracy Transparency	Medium
2.A.2	Investigation regarding lime kiln dust (LKD) production, its composition and use.	AD	Accuracy Transparency	Medium

4.2.4 Glass Production (CRT category 2.A.3)

4.2.4.1.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.A.3	Glass production	✔	-	NA	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.2.4.1.2 Methodological issues

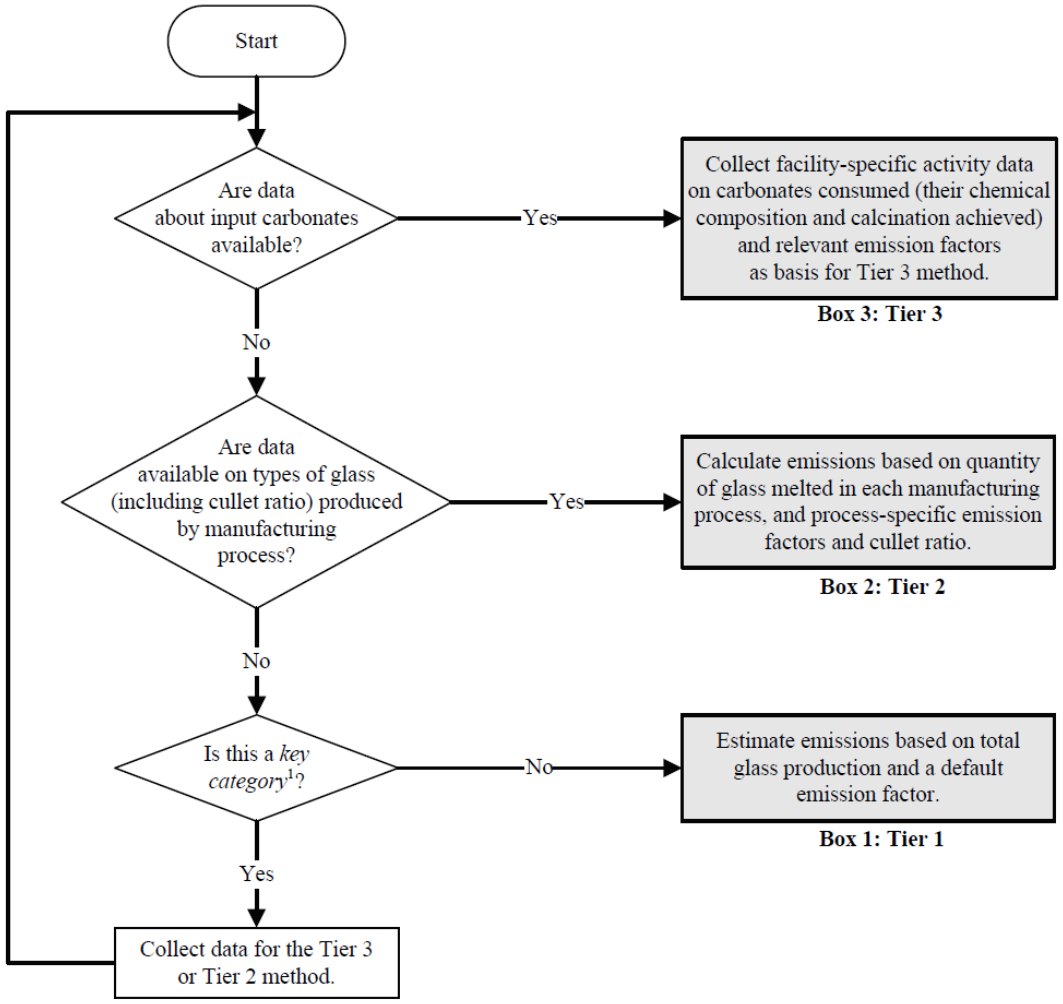
Folder	\06_Inventory\2024_submission\02_IPPU\ 2A_Mineral_Industry\2A3_Glass_Production
File	2A3_Glass_DZA.xlsx
Sheet	ChoiceMethology

As described in the 2006 IPCC guidelines[4], many kinds of glass articles and compositions are used commercially, but the glass industry can be divided into four main categories: containers, flat (window) glass, fibre glass, and specialty glass. The major glass raw materials which emit CO_2 during the melting process are limestone ($CaCO_3$), dolomite $CaMg(CO_3)_2$ and soda ash (Na_2CO_3). Where these materials are mined as carbonate minerals for their use in the glass industry, they represent primary CO_2 production and should be included in emissions estimates. Where carbonate materials are produced through the carbonation of a hydroxide, they do not result in net CO_2 emissions and should not be included in the emissions estimate. Minor CO_2-emitting glass raw materials are barium carbonate ($BaCO_3$), bone ash ($3CaO_2P_2O5 + XCaCO_3$), potassium carbonate (K_2CO_3) and strontium carbonate ($SrCO_3$). Additionally, powdered anthracite coal or some other organic material may be added to create reducing conditions in the molten glass and will combine with available oxygen in the glass melt to produce CO_2. The action of these carbonates in the fusion of glass is a complex high-temperature chemical reaction and is not to be directly compared to the calcination of carbonates to produce quicklime or burnt dolomitic lime. Nevertheless, this fusion (in the region of 1 500°C) has the same net effect in terms of CO_2 emissions.

In the following figure is provided the decision tree and the decision (highlighted) for Tier 1 method for estimating CO_2 emissions from CRT category 2.A.3 *glass production*

[4] Source: 2006 IPCC GL, Volume 3: Industrial Processes and Product Use, Chapter 2: Mineral Industry Emissions, Section 2.4 Glass production

Figure 4-4 Decision tree for estimating GHG emission from CRT category 2.A.3 Glass production



4.2.4.1.3 Choice of methods

The 2006 IPCC Guidelines Tier 1 approach[5] has been applied which is based on applying a default emission factor to national level glass production data.

Equation 2.10: TIER 1 emissions based on glass production
(2006 IPCC Guidelines, Vol. 3. Chapter 2. section 2.4.1.1)

$$CO_2\ emissions = Mass_{glass} \times EF_{glass} \times (1 - CR)$$

Where:

CO_2 Emissions = emissions of CO_2 from glass production (tonnes)

$Mass_{glass}$ = mass of glass produced (tonnes)

EF_{glass} = default emission factor for manufacturing of glass (tonnes CO_2/tonne glass)

CR = cullet ratio for process (fraction)

[5] Source: 2006 IPCC Guidelines, Volume 3: Industrial Processes and Product Use, Chapter 2: Mineral Industry Emissions, Section 2.3.1.1 Glass Production - Choice of method

4.2.4.1.4 Choice of activity data

Folder	\06_Inventory\2024_submission\02_IPPU\ 2A_Mineral_Industry\2A3_Glass_Production
File	2A3_Glass_DZA.xlsx
	ONS.xlsx

4.2.4.1.4.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\ 2A_Mineral_Industry\2A3_Glass_Production
File	2A3_Glass_DZA.xlsx
Sheet	EF_IPCC_2A3

4.2.4.1.5 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\ 2A_Mineral_Industry\2A3_Glass_Production
File	2A3_Glass_DZA.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.A.3 *Glass production* are presented in the following table.

Table 4-2 Uncertainty for CRT category 2.A.3 Glass production.

Uncertainty	CO_2	Reference
Activity data (AD)	5%	2006 IPCC GL. Vol. 3. Chap.2. section 2.4.2.
Emission factor (EF)	60%	
Combined Uncertainty (U)	60%	$U_{Total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

4.2.4.1.6 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\ 2A_Mineral_Industry\2A3_Glass_Production
File	2A3_Glass_DZA.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed:

- Checked of calculations by spreadsheets
  - documented sources.
  - use of units.
  - record keeping; use of write protection.
  - unique use of formulas; special cases are documented/highlighted.
  - quick-control checks for data consistency through all steps of calculation.
- cross-checked from two sources:
  - national statistic ONS.
  - international production statistics of UN statistics[6]
- time series consistency - plausibility checks of dips and jumps.

4.2.4.1.7 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\02_IPPU\ 2A_Mineral_Industry\2A3_Glass_Production
File	2A3_Glass_DZA.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements, including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

Table 4-3 Planned improvement for CRT category 2.A.3 Glass production

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.A.3	Application of Tier 2 methodology or higher	meth	Accuracy Comparability	Medium
2.A.3	Collection of production data for 1990 - 2022 ● plant specific production data ● types of glass produced ● carbonates consumed	AD	Accuracy Completeness Transparency	Medium
2.A.3	Investigation of glass production processes used in the country	AD	Accuracy Transparency	Medium
2.A.3	Investigation regarding cullet ratio (recycled glass)	AD	Accuracy Transparency	Medium

[6] United Nations - Department of Economic and Social Affairs - Statistics Division Statistics - Energy Statistics https://unstats.un.org/unsd/energystats/

4.3 Chemical Industry (CRT category 2.B)

The CRT category 2.B comprises the production of various inorganic and organic chemicals. The following tables provides information which of the chemical industries are occurrent in Algeria.

4.3.1.1 *Main Activity Mineral Industry* (CRT category 2.B)

Folder	06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry
File	2B1_Ammonia_Production.xlsx 2A2_Lime_DZA.xlsx 2A3_Glass_DZA.xlsx
NID CHAPTER	Chemical Industry (CRT category 2.B)
ToDo	Check for updated reasons for trend in sectoral chapter Update GHG emissions and AD in tables & graphs from sheet Table2(I).A-H_AD_T Table2(I).A-H_GHG_T

	AD	emissions
Table	E-M	E-M
Graph	L-P	

Check for updated reasons for trend in chapter

- Trend -> Industrial processes and product use (IPPU)
- Executive Summary

4.3.1.1.1 Category description.

CRT code	Description	Occurrent
2.B.1	Ammonia Production (*including Urea production*)	E
2.B.2	Nitric Acid Production	E
2.B.3	Adipic Acid Production	NO
2.B.4	Caprolactam, Glyoxal and Glyoxylic Acid Production	
2.B.4.a	Caprolactam	NO
2.B.4.b	Glyoxal	NO
2.B.4.c	Glyoxylic acid	NO
2.B.5	Carbide Production	
2.B.5.a	Silicon carbide	NO
2.B.5.b	Calcium carbide	NO
2.B.6	Titanium Dioxide Production	NO
2.B.7	Soda Ash Production	NO
2.B.8	Petrochemical and Carbon Black Production	
2.B.8.a	Methanol	E
2.B.8.b	Ethylene	E
2.B.8.c	Ethylene Dichloride and Vinyl Chloride Monomer	NO
2.B.8.d	Ethylene Oxide	NO
2.B.8.e	Acrylonitrile	NO

2.B.8.f	Carbon Black	NO
2.B.9	Fluor chemical Production	
2.B.9.a	By product emissions	NO
2.B.9.b	Fugitive Emissions	NO
2.B.10	Other – Urea production	
2.B.10.a	Hydrogen production	NO
2.B.10.b	Other - Urea production	E

4.3.2 Ammonia Production (CRT category 2.B.1)

4.3.2.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.B.1	Ammonia production	✔	LA 1990/2022 TA	NA	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.3.2.1.1 Methodological issues

Folder	\06_Inventory\2024_submission\ 02_IPPU\2B_Chemical_Industry\2B1_Ammonia_Production
File	2B1_Ammonia.xlsx
Sheet	ChoiceMethology

This chapter includes the process-related to CO_2 emissions estimations from ammonia production. Combustion re-related GHG emissions are allocated in 1.A.2.c Chemical industry. Ammonia production is a key source with regards to CO_2 emissions.

Algeria has two ammonia plants.

The process of ammonia production is based on the ammonia synthesis loop (also referred to as the Haber-Bosch process) reaction of nitrogen (derived from process air) with hydrogen to form anhydrous liquid ammonia. The hydrogen is derived from feedstock as natural gas (conventional steam reforming route). Anhydrous ammonia produced by catalytic steam reforming of natural gas (mostly CH_4) involves the following reactions with carbon dioxide produced as a by-product:

Primary steam reforming	$CH_4 + H2O \rightarrow CO + 3H_2$
	$CO + H2O \rightarrow CO_2 + H_2$
Secondary air reforming	$CH_4 + air \rightarrow CO + 2H_2 + 2N_2$
Overall reaction	$0.88\ CH_4 + 1.26\ Air + 1.24H_2O \rightarrow 0.88CO_2 + N_2 + 3H_2$
Ammonia synthesis	$N_2 + 3H_2 \rightarrow 2NH_3$
Secondary reformer	$CO + H_2O \rightarrow CO_2 + H_2$
Process gas shift conversion	

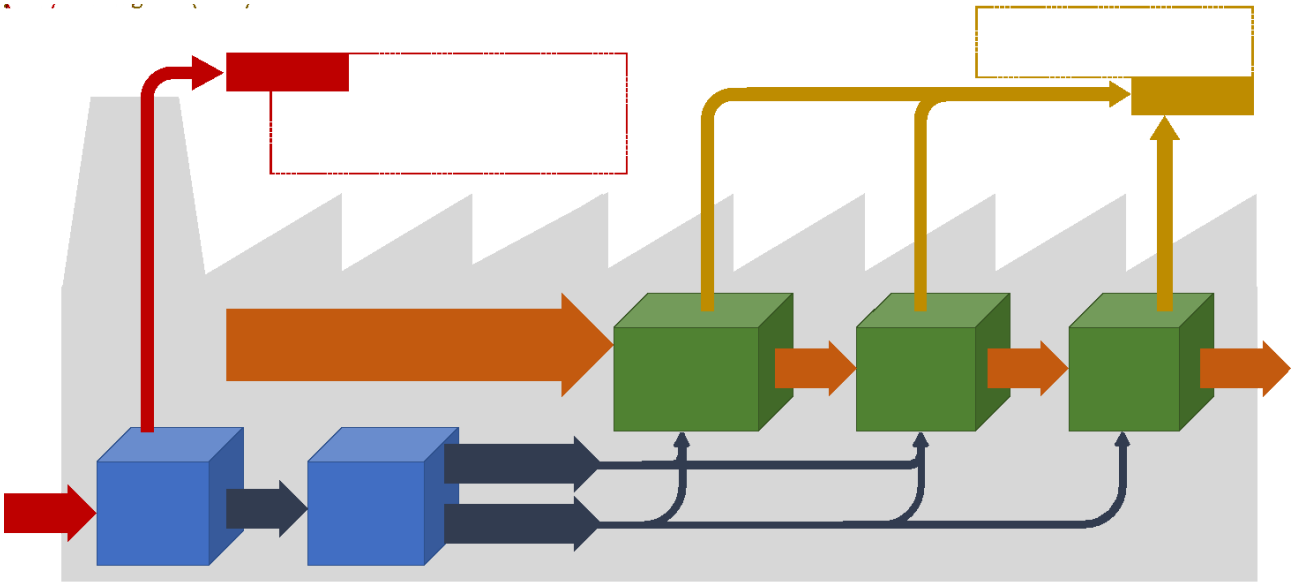
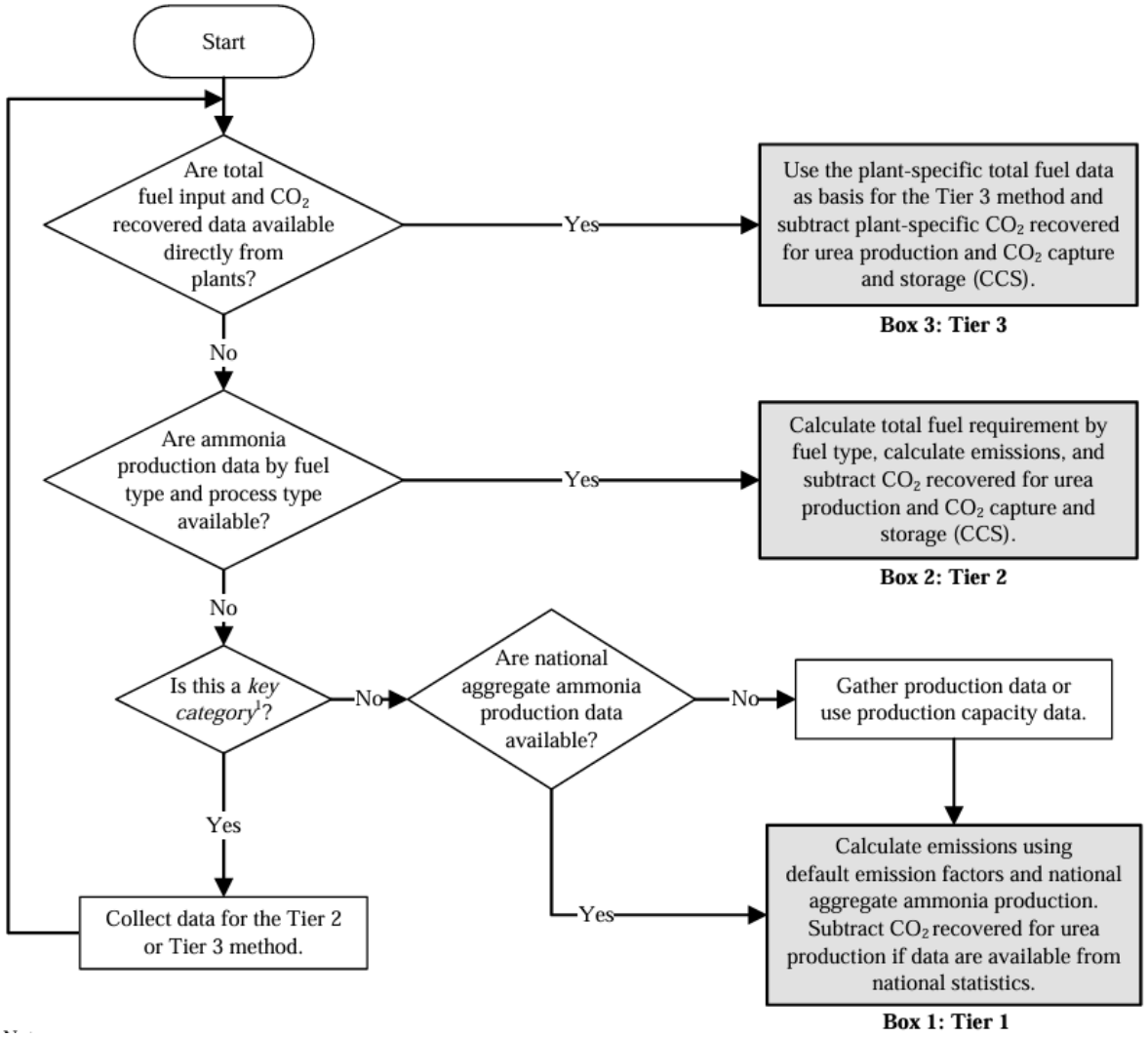


Figure 4-5 Schematic illustration of Ammonia production and allocation of emissions

In the following figure is provided the decision tree and the decision (highlighted) for Tier 1 method for estimating CO_2 emissions from CRT category 2.B.1 *ammonia production*

Figure 4-6 Decision tree for estimating GHG emission from CRT category 2.B.1 ammonia production



4.3.2.1.2 Choice of methods

For estimating the CO_2 emissions, the 2006 IPCC Guidelines Tier 1 approach[7] has been applied:

Equation 3.1: CO_2 emissions from ammonia production – TIER 1 (2006 IPCC GL. Vol. 3. Chap. 3)

$$Emissions_{CO_2} = AP \times EF_{CO_2} - R_{CO_2}$$

[7] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 3: Chemical Industry Emissions – 3.2.2.1 Choice of method

$$with\ EF_{CO_2} = FR \times CCF \times COF \times \frac{44}{12}$$

Where:

Emissions $_{CO2}$ = CO_2 emission (kg)
AP = ammonia production (tons)
EF_{CO2} = default CO_2 emission factor (tons CO_2/ton NH3)
FR = fuel requirement per unit of output (GJ/ton ammonia produced)
CCF = carbon content factor of the fuel (kg C/GJ)
COF = carbon oxidation factor of the fuel, fraction
44/12 = ratio of molecular weight of CO_2 (44) to the molecular weight of carbon (12)
R_{CO2} = CO_2 recovered for downstream use (urea production) (kg)

4.3.2.1.3 Choice of activity data

Folder	\06_Inventory\2024_submission\ 02_IPPU\2B_Chemical_Industry\2B1_Ammonia_Production
File	2B1_Ammonia.xlsx
based on	Canevas Production_ammoniaque_et_uree_Fertial.xlsx
	Canevas Production_ammoniaque_et_uree SORFERT.xlsx
	Canevas Production_ammoniaque_et_uree AOA.xlsx
	US-GS_Timeseries.xlsx

Ammonia plants provide production data to estimate greenhouse gas emissions for the period 2010–2022.

4.3.2.1.3.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\ 02_IPPU\2B_Chemical_Industry\2B1_Ammonia_Production
File	2B1_Ammonia.xlsx
Sheet	T1_Ammonia

For the Tier 1 method it is *good practice* to use the highest total fuel requirement per ton of ammonia.

Equation 3.1: CO_2 emissions from ammonia production – TIER 1 (2006 IPCC GL. Vol. 3. Chap. 3)

$$EF_{CO_2} = FR \times CCF \times COF \times \frac{44}{12}$$

Where:

EF_{CO2} = default CO_2 emission factor (tons CO_2/ton NH3)
FR = fuel requirement per unit of output (GJ/ton ammonia produced)
CCF = carbon content factor of the fuel (kg C/GJ)
COF = carbon oxidation factor of the fuel, fraction
44/12 = ratio of molecular weight of CO_2 (44) to the molecular weight of carbon (12)

Table 4-4 Default CO_2 emission factor for CRT category 2.B.1 *Ammonia production.*

Parameter	Unit	Value	Reference

FR	total fuel requirement	GJ(NCV)/ton NH3	37.5	Table 3.1. 2006 IPCC GL. Vol. 3 IPPU. Chapter 3
CCF	carbon content factor of the fuel	kg C/GJ	15.3	
COF	carbon oxidation factor of the fuel	fraction	1	
con	Conversion factor of carbon in carbon dioxide (44/12)	-	3.67	
EF_{CO_2}	**default CO_2 emission factor**	**tons CO_2/ton NH3**	**2.104**	

4.3.2.1.4 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\ 02_IPPU\2B_Chemical_Industry\2B1_Ammonia_Production
File	2B1_Ammonia.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.B.1 *Ammonia production* are presented in the following table.

Table 4-5 Uncertainty for CRT category 2.B.1 *Ammonia production.*

Uncertainty	N_2O	Reference
Activity data (AD)	±2%	2006 IPCC GL. Vol. 3. IPPU Chap. 3.3.3.2
Emission factor (EF)	±7%	Table 3.3. 2006 IPCC GL. Vol. 3 IPPU. Chapter 3
Combined Uncertainty (U)	7%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

4.3.2.1.5 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\ 02_IPPU\2B_Chemical_Industry\2B1_Ammonia_Production
File	2B1_Ammonia.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.

- cross-checked from different sources:
  - national statistic published by Office National des Statistiques (ONS)[8] and
  - US geological survey[9]
  - FAO[10]
  - UN statistics[11]
- cross checks with other relevant sectors (2.B.2. 2.B.10. 1.A.2.c) are performed to avoid double counting or omissions.

4.3.2.1.6 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\ 02_IPPU\2B_Chemical_Industry\2B1_Ammonia_Production
File	2B1_Ammonia.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

Table 4-6 Planned improvements for CRT category 2.B.1 *Ammonia production.*

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.B.1	Application of Tier 2 methodology or higher	meth	Accuracy	High
2.B.1	Collection of plant specific activity data (1990-2022): ● production capacity data per plant ● ammonia production per plant ● used fuel	AD	Accuracy Completeness Consistency Transparency	high
2.B.1	Collection of plant specific parameter ● fuel requirement per unit of output ● carbon content factor of the fuel ● carbon oxidation factor of the fuel	EF	Accuracy Transparency Consistency Completeness Comparability	High
2.B.1	Collection of information on CO_2 recovery for Urea and Methanol production and conversion of Calcium Nitrate. Collection of information on NH3 and HNO3 recovery for Ammonia Nitrate production.	AD	Accuracy	medium

4.3.3 Nitric Acid Production (CRT category 2.B.2)

4.3.3.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category

[8] https://www.ons.dz/spip.php?rubrique6 and https://www.ons.dz/IMG/pdf/CH8-ENERGIE.pdf; https://www.ons.dz/spip.php?rubrique127

[9] U.S. Geological Survey (several years): Algeria Minerals Yearbook.
Available (04.06.2022) on https://www.usgs.gov/search?keywords=Algeria%20Minerals%20Yearbook

[10] FAO – FAOSTAT – Land, Inputs and Sustainability – Inputs - Fertilizers by Product https://www.fao.org/faostat/en/#data/RFB

[11] United Nations Industrial Development Organization UNIDO - Statistical Databases INDSTAT
https://www.unido.org/researchers/statistical-databases

2.B.2	Nitric Acid Production	NA	-	NA	-	✔	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.3.3.1.1 Methodological issues

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B2_Nitric Acid_Production
File	2B2_NitricAcid_Tool.xlsx
Sheet	ChoiceMethology

Nitric acid is used as a raw material mainly in the manufacture of nitrogenous-based fertilizer. As described in the 2006 IPCC Guidelines[12], during the production of nitric acid (HNO3) , nitrous oxide (N_2O) is generated as an unintended by-product of the high temperature catalytic oxidation of ammonia (NH3). The amount of N_2O formed depends, inter alia, on combustion conditions (pressure, temperature), catalyst composition and age and burner design.

Nitric acid production involves three distinct chemical reactions that can be summarized as follows:

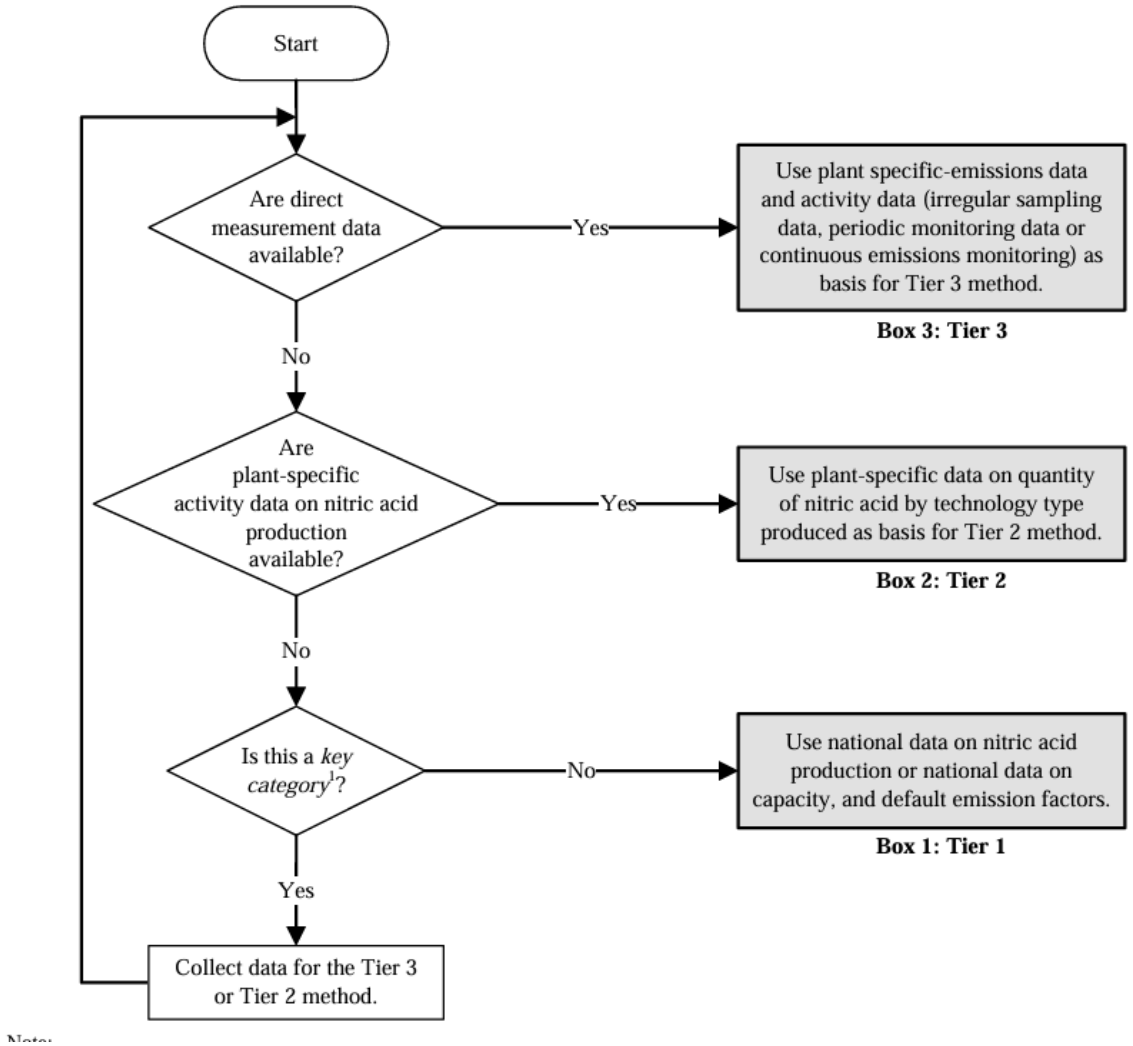
$$4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$$
$$2\ NO + O_2 \rightarrow 2\ NO_2$$
$$3\ NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$$

To produce nitric acid, ammonia (NH_3) is reacted with air over precious metal – normally a platinum-rhodium (Pt-Rh) alloy – catalyst gauze pack in the ammonia oxidation reactor of nitric acid plants. The main product of this reaction is NO, which is metastable at the conditions present in the ammonia oxidation reactor and therefore reacts with the available oxygen to form NO_2, which is later absorbed in water to form HNO_3 – nitric acid. Simultaneously, undesired side reactions yield nitrous oxide (N_2O), nitrogen and water.

In the following figure is provided the decision tree and the decision (highlighted) for Tier 1 method for estimating N_2O emissions from CRT category 2.B.2 Nitric acid production

[12] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 3: Chemical Industry Emissions, chapter 3.3 Nitric acid production

Figure 4-7 Decision tree for estimating GHG emission from CRT category 2.B.2 Nitric acid production



4.3.3.1.2 Choice of methods

The 2006 IPCC Guidelines Tier 1 approach[13] has been applied:

Equation 3.5: Tier 1 – N_2O emissions from nitric acid production – Tier 1 (2006 IPCC GL. Vol. 3. Chap. 3.3.2.1)

$$N_2O\ emissions = EF\ x\ NAP$$

Where:

N_2O emissions = emissions of N_2O from nitric acid production in kg

NAP = nitric acid production, tons

EF = N_2O emission factor (default), kg N_2O/ton nitric acid produced

4.3.3.1.3 Choice of activity data

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B2_Nitric Acid_Production
File	2B2_NitricAcid_Tool.xlsx

[13] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 3: Chemical Industry Emissions, chap. 3.3 Nitric acid production -3.3.2.1 choice of method

based on	AD_Nitric_acid_production_Fertial.xlsx
	NC1 and NC2.

4.3.3.1.3.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B2_Nitric Acid_Production
File	2B2_NitricAcid_Tool.xlsx
Sheet	T1_NitricAcid

Table 4-7 N_2O Emission Factor applied in CRT category 2.B.2 *Nitric Acid Production.*

Production Process	N_2O Emission Factor (relating to 100 percent pure acid)
Single high-pressure plants	9 kg N_2O/ton nitric acid
Source: 2019 Refinement to the 2006 IPCC Guidelines, Vol. 3 IPPU. Chapter 3: Chemical Industry Emissions. Chap. 3.3 Nitric acid production -3.3.2.2 Choice of emission factors. Table 3.3 (updated) Default factors for nitric acid production	

4.3.3.1.4 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B2_Nitric Acid_Production
File	2B2_NitricAcid_Tool.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.B.2 Nitric acid production are presented in the following table.

Uncertainty	N_2O	Reference
Activity data (AD)	±2%	2006 IPCC GL. Vol. 3. IPPU Chap. 3.3.3.2
Emission factor (EF)	±40%	Table 3.3 (updated). 2019 Refinement to the 2006 IPCC GL. Vol. 3 IPPU. Chapter 3
Combined Uncertainty (U)	40%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

4.3.3.1.5 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B2_Nitric Acid_Production
File	2B2_NitricAcid_Tool.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- cross checks with other relevant sectors (2.B.1) are performed to avoid double counting or omissions.

4.3.3.1.6 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B2_Nitric Acid_Production
File	2B2_NitricAcid_Tool.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.B.2	Collection of plant specific activity data (1990-2022): ● utilization factor per line ● nitric acid production per line	AD	Accuracy Completeness Transparency	high
2.B.2	Collection of plant-specific measurements: N_2O generation and destruction factors	Emi	Accuracy Transparency Consistency Completeness Comparability	High
2.B.2	Application of Tier 2 methodology or higher	meth	Accuracy	medium
2.B.2	Collection of information on HNO3 recovery for Ammonia nitrate and nitro phosphate plant production.			

4.3.4 Petrochemical and Carbon Black Production (CRT category 2.B.8)

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.B.8	Petrochemical and Carbon Black Production						
2.B.8.a	Methanol	✔	-	✔	-	NA	-

2.B.8.b	Ethylene	✔	-	✔	-	NA	-
2.B.8.c	Ethylene Dichloride and Vinyl Chloride Monomer	NO	-	NO	-	NA	-
2.B.8.d	Ethylene Oxide	NO	-	NO	-	NA	-
2.B.8.e	Acrylonitrile	NO	-	NO	-	NA	-
2.B.8.f	Carbon Black	NO	-	NO	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.3.4.1 Methanol Production (CRT category 2.B.8.a)

4.3.4.1.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.B.8.a	Methanol production	✔	-	✔	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.3.4.1.2 Methodological issues

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8a_Methanol.xlsx
Sheet	ChoiceMethology

As described in the 2006 IPCC Guidelines[14] worldwide almost all methanol is made by way of steam reforming of natural gas. The steam reforming and shift reaction produce 'synthesis gas' comprised of CO_2, carbon monoxide (CO) and hydrogen (H2). The natural gas to methanol production process produces methanol and by-product CO_2, CO, and H2 from the synthesis gas.

As described by the Methanol Institute (MI)[15] Methanol is a clear liquid chemical used in thousands of everyday products, including plastics, paints, cosmetics and fuels. Methanol is also an energy resource used in the marine, automotive, and electricity sectors and an emerging renewable energy resource.

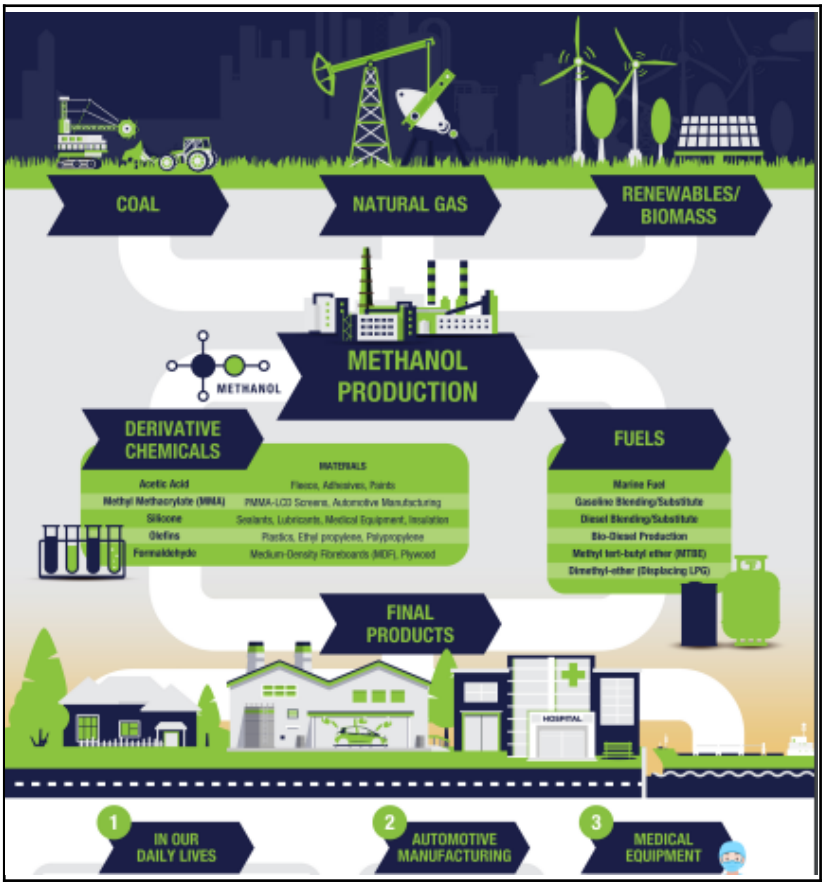


Figure 4-8 Essential Methanol Infographic

Source: Methanol Institute (MI)[Error! Bookmark not defined.]

[14] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 3: Chemical Industry Emissions – 3.9 Petrochemical and carbon black production 3.9.1 Introduction

[15] Methanol Institute (MI); available (20.07.2022) on https://www.methanol.org/about-methanol/

Figure 4-9 Decision tree for estimating of CO_2 emissions from petrochemical industry and carbon black industry

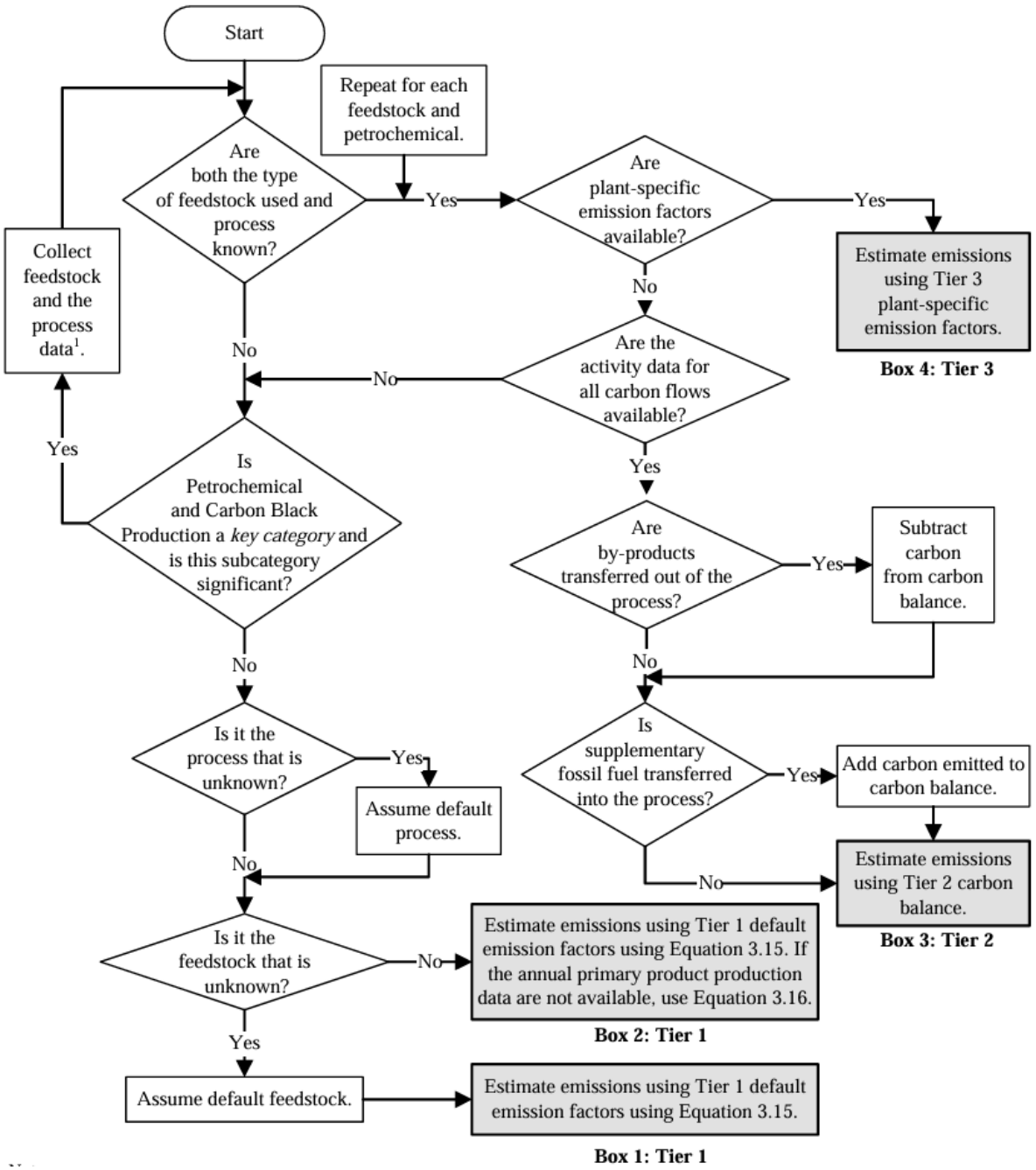
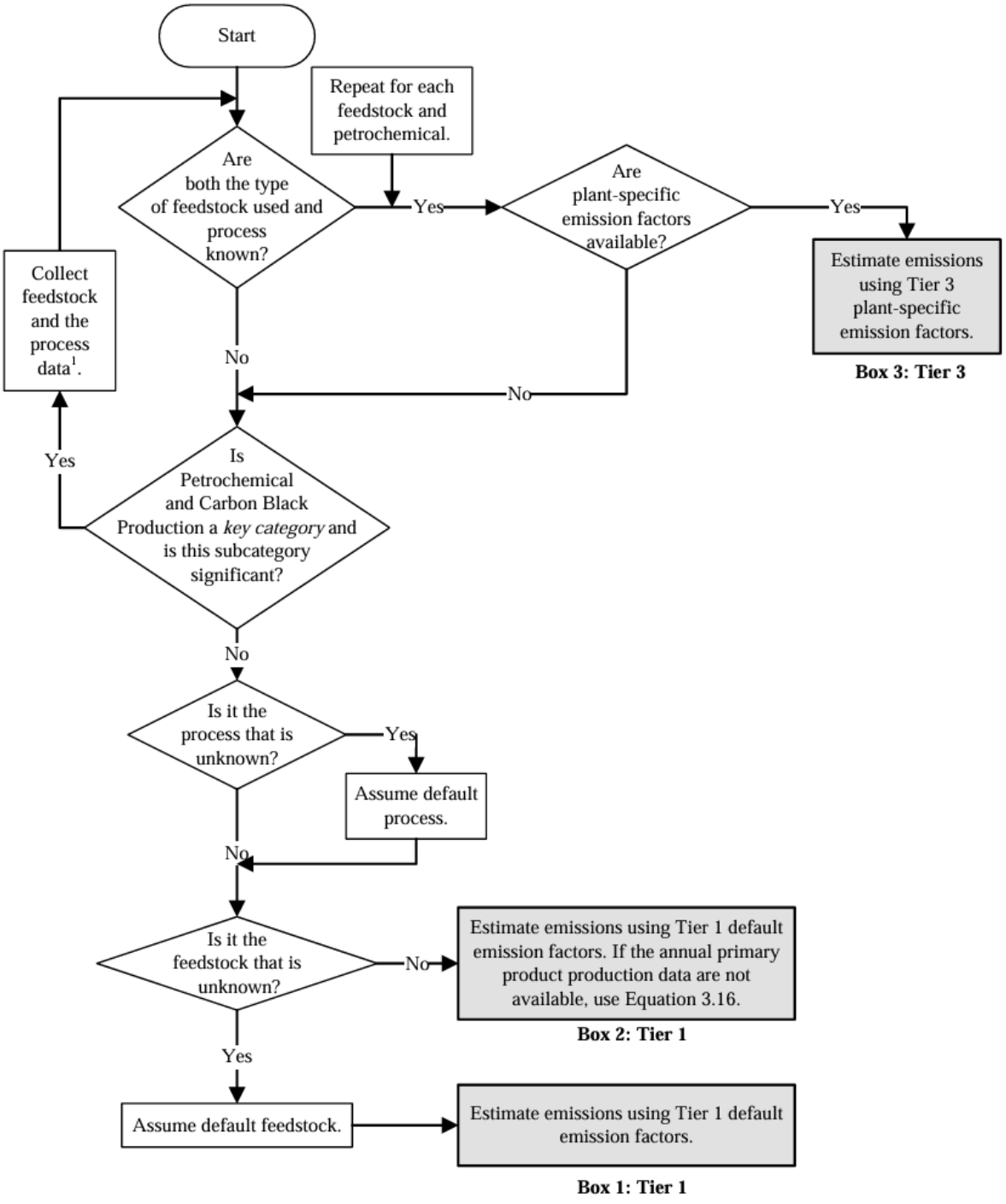


Figure 4-10 Decision tree for estimating of CH_4 emissions from petrochemical industry and carbon black industry



4.3.4.1.2.1 Choice of methods

For estimating the CO_2 emissions, the Tier 1 product-based emission factor method of the 2006 IPCC Guidelines[16] has been applied:

Equation 3.15: TIER 1 CO_2 emission calculation (2006 IPCC GL. Vol. 3. Chap. 3)

$$Emissions_{CO_2} = PF_{methanol} \times EF_{CO_2} \times \frac{GAF}{100}$$

[16] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 3: Chemical Industry Emissions – 3.9 Petrochemical and carbon black production 3.9.2.1 Choice of method

Where:

Emissions $_{CO2}$ = CO_2 emissions from production of petrochemical – methanol (tons)

PF $_{methanol}$ = annual production of petrochemical – methanol (tons)

EF_{CO2} = default CO_2 emission factor for petrochemical – methanol (tons CO_2/ton product produced)

For estimating the CH_4 emissions, the Tier 1 product-based emission factor method of the 2006 IPCC Guidelines has been applied, where CH_4 emissions from petrochemical processes may be fugitive emissions and/or process vent emissions. Fugitive emissions are emitted from flanges, valves and other process equipment. Emissions from process vent sources include incomplete combustion of waste gas in flare and energy recovery systems.

Equation 3.23: TIER 1 - CH_4 Fugitive emission calculation (2006 IPCC GL. Vol. 3. Chap. 3)

$$Emissions_{CH_4\,Fugitive} = PF_{methanol} \times EF_{CO_{2\,fugitive}}$$

Equation 3.24: TIER 1 - CH_4 Process vent emission calculation (2006 IPCC GL. Vol. 3. Chap. 3)

$$Emissions_{CH_4\,Vent} = PF_{methanol} \times EF_{CO_{2\,Vent}}$$

Equation 3.25: TIER 1 - CH_4 Total emissions calculation (2006 IPCC GL. Vol. 3. Chap. 3)

$$Emissions_{CH_4\,Total} = Emissions_{CH_4\,Fugitive} + Emissions_{CH_4\,Vent}$$

Where:

Emissions $_{CH4\ Total}$ = total emissions of CH_4 from production of petrochemical – methanol (tons).

Emissions $_{CH4\ Fugitive}$ = fugitive emissions of CH_4 from production of petrochemical – methanol (tons).

Emissions $_{CH4\ Vent}$ = process vent emissions of CH_4 from production of petrochemical – methanol (tons).

PF = annual production of petrochemical – methanol (tons).

$EF_{CH4\ Fugitive}$ = default CH_4 process vent emission factor for petrochemical – methanol (tons CH_4/ton product produced).

$EF_{CH4\ Vent}$ = default CH_4 process vent emission factor for petrochemical – methanol (tons CH_4/ton product produced).

4.3.4.1.3 Choice of activity data

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8a_Methanol.xlsx
based on	Canevas Methanol CP1Z 2024 (Projet BTR1 & BTR2).xlsx

Methanol plants provide production data to estimate greenhouse gas emissions for the period 1990–2022.

4.3.4.1.3.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8a_Methanol.xlsx
Sheet	EF

Methanol production CO_2 emission factors for Conventional Steam Reforming, without primary reformer, which is the default for process and natural gas default feedstock, was selected.

As no country specific EF for CH_4 was available, the default EF for CH_4 was applied Table 4-08 provides the default feedstocks and default processes for each petrochemical production process.

Table 4-8 Default CO_2 and CH_4 emission factors for CRT category 2.B.8.a *Methanol production.*

EF	Parameter	Unit	Value	Reference
EF CO_2	Conventional Steam Reforming without primary reformer (Default Process and Natural Gas Default Feedstock)	ton CO_2/ton methanol produced	0.67	Table 3.12. 2006 IPCC GL. Vol. 3 IPPU. Chapter 3
EF CH_4	CH_4 process vent emission factor for petrochemical	kg CH_4 / ton of methanol produced	2.3	

4.3.4.1.4 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8a_Methanol.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.B.8.a *Methanol production* are presented in the following table.

Uncertainty	CO_2	CH_4	Reference
Activity data (AD)	7%	7%	Based on 2006 IPCC GL. Vol. 3 IPPU Chap. 3.3.3.2
Emission factor (EF)	±30%	-80% to +30%%	Table 3.27. 2006 IPCC GL. Vol. 3 IPPU. Chapter 3
Combined Uncertainty (U)	31%	86%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

4.3.4.1.5 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8a_Methanol.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- cross-checked from different sources:
  - national statistic published by Office National des Statistiques (ONS)[17] and
  - information provided by SONATRACH - MEM.

4.3.4.1.6 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8a_Methanol.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.B.8.a	Application of Tier 2 methodology or higher and /or Preparation of a carbon mass balance calculations according to Tier 2 carbon mass balance flow diagram (Figure 3.10. 2006 IPCC GL. Vol. 3 IPPU. Chapter 3)	meth	Accuracy	medium
2.B.8.a	Collection of plant specific activity data (1990-2022): ● production capacity data per plant ● methanol production per plant ● feedstock used	AD	Accuracy Completeness Consistency Transparency comparability	medium
2.B.8.a	Collection of information related to process applied for methanol production including plant specific parameter	EF	Accuracy Transparenc y	medium

4.3.4.2 Ethylene production (CRT category 2.B.8.b)

4.3.4.2.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.B.8.b	Ethylene production	✔	-	✔	-	NA	-

[17] https://www.ons.dz/spip.php?rubrique6 and https://www.ons.dz/IMG/pdf/CH8-ENERGIE.pdf; https://www.ons.dz/spip.php?rubrique127

A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF

4.3.4.2.2 Methodological issues

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8b_Ethylene.xlsx
Sheet	ChoiceMethology

4.3.4.2.3 Choice of methods

For estimating the CO_2 emissions, the Tier 1 product-based emission factor method of the 2006 IPCC Guidelines[18] has been applied:

Equation 3.15: TIER 1 CO_2 emission calculation (2006 IPCC GL. Vol. 3. Chap. 3)

$$Emissions_{CO_2} = PF_{ethylenel} \times EF_{CO_2} \times \frac{GAF}{100}$$

Where:

Emissions $_{CO2}$ = CO_2 emissions from production of petrochemical – Ethylene (tons)
$PF_{Ethylene}$ = annual production of petrochemical – Ethylene (tons)
EF_{CO2} = default CO_2 emission factor for petrochemical – Ethylene (tons CO_2/ton product produced)
GAF = Geographic Adjustment Factor for Tier 1 CO_2 emission factors for ethylene production

For estimating the CH_4 emissions, the Tier 1 product-based emission factor method of the 2006 IPCC Guidelines has been applied. CH_4 emissions from petrochemical processes may be fugitive emissions and/or process vent emissions. Fugitive emissions are emitted from flanges, valves, and other process equipment. Emissions from process vent sources include incomplete combustion of waste gas in flare and energy recovery systems.

Equation 3.23: TIER 1 - CH_4 Fugitive emission calculation (2006 IPCC GL. Vol. 3. Chap. 3)

$$Emissions_{CH_4\,Fugitive} = PF_{ethylene} \times EF_{CO_{2\,fugitive}}$$

Equation 3.24: TIER 1 - CH_4 Process vent emission calculation (2006 IPCC GL. Vol. 3. Chap. 3)

$$Emissions_{CH_4\,Vent} = PF_{ethylene} \times EF_{CO_{2\,Vent}}$$

Equation 3.25: TIER 1 - CH_4 Total emissions calculation (2006 IPCC GL. Vol. 3. Chap. 3)

$$Emissions_{CH_4\,Total} = Emissions_{CH_4\,Fugitive} + Emissions_{CH_4\,Vent}$$

Where:

Emissions $_{CH4\ Total}$ = total emissions of CH_4 from production of petrochemical – Ethylene (tons)
Emissions $_{CH4\ Fugitive}$ = fugitive emissions of CH_4 from production of petrochemical – Ethylene (tons)
Emissions $_{CH4\ Vent}$ = process vent emissions of CH_4 from production of petrochemical – Ethylene (tons)
PF = annual production of petrochemical – Ethylene (tons)
$EF_{CH4\ Fugitive}$ = default CH_4 process vent emission factor for petrochemical – Ethylene (tons CH_4/ton product produced)
$EF_{CH4\ Vent}$ = default CH_4 process vent emission factor for petrochemical – Ethylene (tons CH_4/ton product produced)

[18] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 3: Chemical Industry Emissions – 3.9 Petrochemical and carbon black production 3.9.2.1 Choice of method

4.3.4.2.4 Choice of activity data

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8b_Ethylene.xlsx
	ONS.xlsx

4.3.4.2.4.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8b_Ethylene.xlsx
Sheet	T1_Calculation

The Tier 1 method allows for the selection of a 'default' feedstock and 'default' process in instances where activity data are not available to identify the feedstock or the process used to produce the petrochemical. Therefore, in the Ethylene production, CO_2 emission factors for Conventional Steam Reforming, without primary reformer, which is the default for process and natural gas default feedstock, was selected.

As no country specific EF for CH_4 was available, the default EF for CH_4 was applied Table 4-09 provides applied factors.

Table 4-9 Default CO_2 and CH_4 emission factors for CRT category 2.B.8.b *Ethylene production.*

	Parameter	**Unit**	**Value**	**Reference** 2006 IPCC GL. Vol. 3 IPPU. Chapter 3
EF CO_2	Steam cracking ethylene production Tier 1 CO_2 emission factors Feedstock: Ethylene (Total Process and Energy Feedstock Use)	ton CO_2/ton Ethylene produced	0.95	Table 3.14.
GAF	Default geographic adjustment factors	-	130%	Table 3.15
EF CH_4	CH_4 process vent emission factor for petrochemical for petrochemical	kg CH_4 per ton of Ethylene produced	6	Table 3.15

4.3.4.2.5 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8b_Ethylene.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter

	1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.B.8.b *Ethylene production* are presented in the following table.

Table 4-10 Uncertainty for CRT category 2.B.8.b *Ethylene production.*

Uncertainty	CO_2	CH_4	Reference
Activity data (AD)	7%	7%	Based on 2006 IPCC GL. Vol. 3 IPPU Chap. 3.3.3.2
Emission factor (EF)	±30%	±10%	Table 3.27. 2006 IPCC GL. Vol. 3 IPPU. Chapter 3
Combined Uncertainty (U)	31%	12%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

4.3.4.2.6 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8b_Ethylene.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed:

- Checked of calculations by spreadsheets
  - documented sources.
  - use of units and conversion factors.
  - strictly defined interfaces between spreadsheets/calculation modules.
  - unique structure of sheets which do the same.
  - record keeping, use of write protection.
  - unique use of formulas, special cases are documented/highlighted.
  - quick-control checks for data consistency through all steps of calculation.

4.3.4.2.7 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\02_IPPU\2B_Chemical_Industry\2B8_Petrochemical_and_Carbon_Black_Production
File	2B8b_Ethylene.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

Table 4-11 Planned improvements for CRT category 2.B.8.b *Ethylene production.*

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.B.8.b	Application of Tier 2 methodology or higher and /or Preparation of a carbon mass balance calculations according	meth	Accuracy	medium

GHG source & sink category	Planned improvement	Type of improvement		Priority
	to Tier 2 carbon mass balance flow diagram (Figure 3.10. 2006 IPCC GL. Vol. 3 IPPU. Chapter 3)			
2.B.8.b	Collection of plant specific activity data (1990-2022): ● Production capacity data per plant ● Ethylene production per plant ● Feedstock used.	AD	Accuracy Completeness Consistency Transparency comparability	medium
2.B.8.b	Collection of information related to the process applied for Ethylene production including plant specific parameter.	EF	Accuracy Transparenc y	medium

4.3.5 Other – Urea production (CRT category 2.B.10)

4.3.5.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.B.10	Other						
2.B.10.a.	Hydrogen production	NO	-	NO	-	NO	-
2.B.10.b	Other - Urea production	✔	-	NO	-	NO	-
2.B.10.c	Other – not specified	NO	-	NO	-	NO	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.3.5.1.1 Methodological issues

Folder	\06_Inventory\2024_submission\02_IPPU\ 02_IPPU\2B_Chemical_Industry\2B10_Other
File	2B10b__Urea.xlsx
Sheet	ChoiceMethology

Urea is produced commercially from synthetic ammonia and carbon dioxide, mainly in integrated chemical plants in downstream.

The urea production process consists of two main equilibrium reactions, with incomplete conversion of the reactants. The first is carbamate formation: the fast-exothermic reaction of liquid ammonia with gaseous carbon dioxide (CO_2) at high temperature and pressure to form ammonium carbamate (H2N-COONH4):

$$2NH_3 + CO_2 \rightleftharpoons H_2N\text{-}COONH_4$$

The second is urea conversion - the slower endothermic decomposition of ammonium carbamate into urea and water:

$$H_2N\text{-}COONH_4 \rightleftharpoons (NH_2)_2CO + H_2O$$

The overall conversion of NH3 and CO_2 to urea is exothermic, the reaction heat from the first reaction driving the second.

Methodological issues

4.3.5.1.2 Choice of methods

For estimating the CO_2 emissions, the 2006 IPCC Guidelines Tier 1 approach[19] has been applied:

Equation 3.1: CO_2 emissions from ammonia production – TIER 1

$$Emissions_{CO_2} = AP \times EF_{CO_2}$$

Where:

Emissions $_{CO2}$ = CO_2 emission for urea production
AP = urea production (tons)
EF_{CO2} = default CO_2 emission factor for urea production (tons CO_2/ton CO_2)

4.3.5.1.3 Choice of activity data

Folder	\06_Inventory\2024_submission\02_IPPU\ 02_IPPU\2B_Chemical_Industry\2B10_Other
File	2B10b__Urea.xlsx
based on	AD_DZA_Ammoniac_urée.xlsx

urea plants provide production data to estimate greenhouse gas emissions for the period 2013–2022.

4.3.5.1.3.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\ 02_IPPU\2B_Chemical_Industry\2B10_Other
File	2B10b__Urea.xlsx
Sheet	T1_Urea

Parameter		Unit	Value			Reference
			low	average	high	
EF_{CO2}	**default CO_2 emission factor**	tons CO_2/ ton of urea produced	2	**4.5**	7	Box 3.3. 2006 IPCC GL. Vol. 3 IPPU. Chapter 3

4.3.5.1.4 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\ 02_IPPU\2B_Chemical_Industry\2B10_Other
File	2B10b__Urea.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals

[19] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 3: Chemical Industry Emissions – 3.2.2.1 Choice of method

	11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.B.10 *Urea production* are presented in the following table.

Uncertainty	N_2O	Reference
Activity data (AD)	±2%	2006 IPCC GL, Vol. 3, IPPU Chap. 3.3.3.2
Emission factor (EF)	±7%	Table 3.3 2006 IPCC GL, Vol. 3 IPPU, Chapter 3
Combined Uncertainty (U)	7%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

The time-series are considered to be consistent as the capacity is used as activity data.

4.3.5.1.5 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\ 02_IPPU\2B_Chemical_Industry\2B10_Other
File	2B10b__Urea.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- cross-checked from different sources:
  - national statistic published by Office National des Statistiques (ONS)[20] and
  - US geological survey[21]
  - FAO[22]
  - UN statistics[23]
- cross checks with other relevant sectors (2.B.1, 2.B.2, 1.A.2.c) are performed to avoid double counting or omissions.

4.3.5.1.6 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\02_IPPU\ 02_IPPU\2B_Chemical_Industry\2B10_Other
File	2B10b__Urea.xlsx
Sheet	PlannedImprovements

[20] https://www.ons.dz/spip.php?rubrique6 and https://www.ons.dz/IMG/pdf/CH8-ENERGIE.pdf; https://www.ons.dz/spip.php?rubrique127

[21] U.S. Geological Survey (several years): Algeria Minerals Yearbook.
Available (04.06.2022) on https://www.usgs.gov/search?keywords=Algeria%20Minerals%20Yearbook

[22] FAO – FAOSTAT – Land, Inputs and Sustainability – Inputs - Fertilizers by Product https://www.fao.org/faostat/en/#data/RFB

[23] United Nations Industrial Development Organization UNIDO - Statistical Databases INDSTAT
https://www.unido.org/researchers/statistical-databases

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

Table 4-12 Planned improvements for CRT category 2.B.10 *Urea production.*

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.B.10	Collection of plant specific activity data (1990-2022): ● production capacity data per plant ● urea production per plant	AD	Accuracy Completeness Consistency Transparency Comparability	high
2.B.10	Collection of amounts of CO_2 used/recovered for downstream	AD	Accuracy	medium

4.4 Metal Industry (CRT category 2.C)

The CRT category 2.C comprises the production of various ferrous and non-ferrous producing industries, where GHG emissions are arising. In Algeria, steel, lead and zinc is produced. Iron and Steel Production (CRT category 2.C.1)

4.4.1.1 *Main Activity Metal Industry* (CRT category 2.c)

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry		
File	2C1_Iron_and_Steel 2C5_Lead_Production 2C6_Zinc_Production		
NID CHAPTER	*Metal* Industry (CRT category 2.C)		
ToDo	Check for updated reasons for trend in sectoral chapter Update GHG emissions and AD in tables & graphs from sheet Table2(I).A-H_AD_T Table2(I).A-H_GHG_T		
		AD	emissions
	Table	E-M	E-M
	Graph	L-P	
	Check for updated reasons for trend in chapter ● Trend -> Industrial processes and product use (IPPU) ● Executive Summary		

4.4.1.2 Category description

CRT code	Description	CO_2	CH_4	N_2O

		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.C.1	Iron and Steel Production						
2.C.1.a	Steel	√	-	NO	-	NO	-
2.C.1.b	Pig iron	√	-	NO	-	NO	-
2.C.1.c	Direct reduced iron	√	-	√	-	NO	-
2.C.1.d	Sinter	√	-	√	-	NO	-
2.C.1.e	Pellet	√	-	NO	-	NO	-
2.C.1.f.	Other	NO	-	NO	-	NO	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

The iron and steel industry is a highly material and energy-intensive industry. The production of iron and steel leads to emissions of carbon dioxide (CO_2) and methane (CH_4).

4.4.1.2.1 Methodological issues

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C1_Iron_and_Steel
File	2C1_Iron-Steel_DZA.xlsx
Sheet	ChoiceMethology

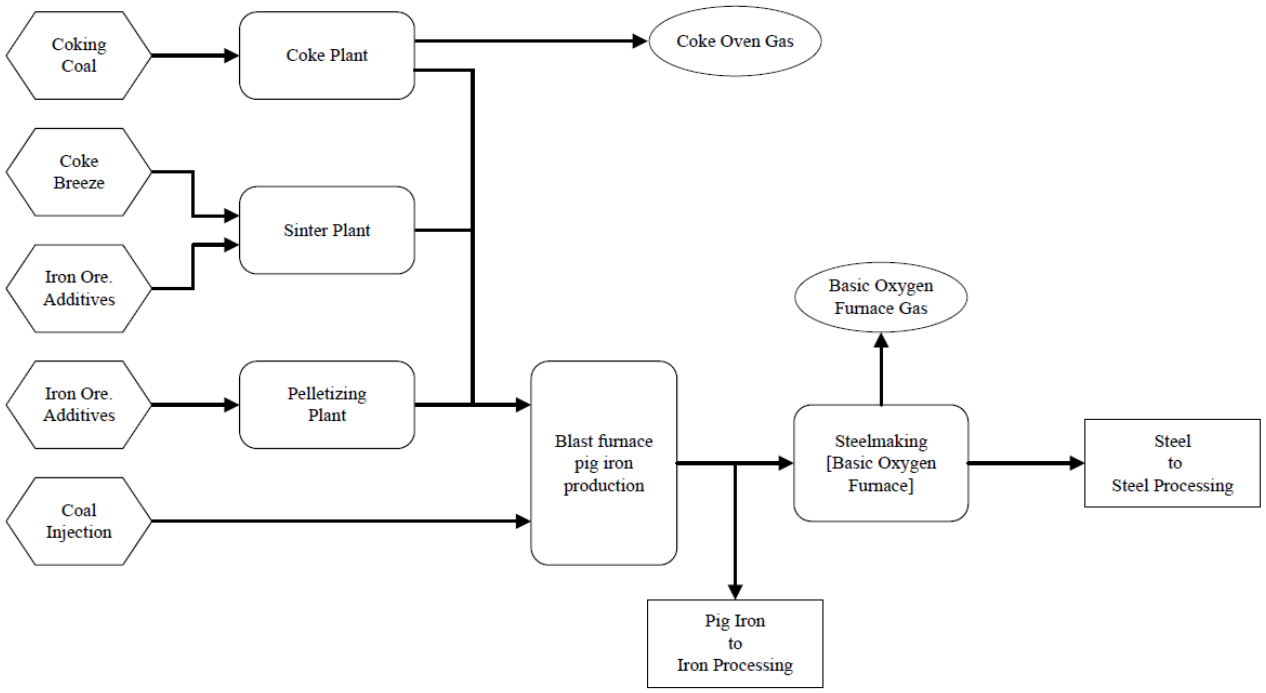


Figure 4-11 Figure 4.1 Illustration of main processes for integrated iron and steel[24]

[24] Source: 2019 Refinement to the 2006 IPCC Guidelines, Volume3: Industrial Processes and Product Use, Chapter 4: Metal Industry Emissions Figure 4.8d (New) Energy or IPPU CO_2 emissions allocation in an integrated iron and steel facility

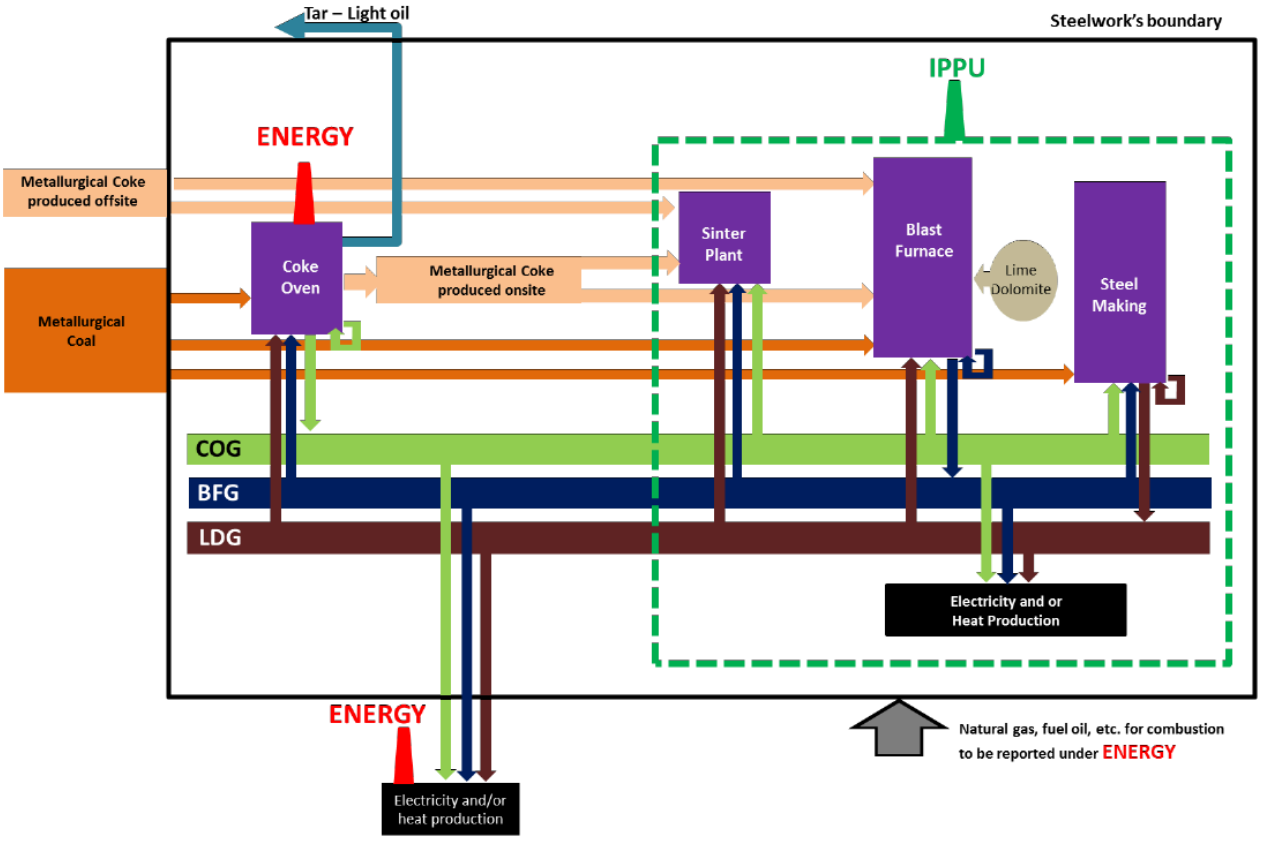


Figure 4-12 Energy or IPPU CO_2 emissions allocation in an integrated iron and steel facility.[25]

4.4.1.2.2 Choice of methods

For estimating the CO_2 and CH_4 emissions, the 2006 IPCC Guidelines Tier 1 approach[26] has been applied:

EQUATION 4.4
CO_2 EMISSIONS FROM IRON AND STEEL PRODUCTION (TIER 1)

$$\text{Iron \& Steel: } E_{CO_2,\,non-energy} = BOF \bullet EF_{BOF} + EAF \bullet EF_{EAF} + OHF \bullet EF_{OHF}$$

EQUATION 4.5
CO_2 EMISSIONS FROM PRODUCTION OF PIG IRON NOT PROCESSED INTO STEEL (TIER 1)

$$\text{Pig Iron Production: } E_{CO_2,\,non-energy} = IP \bullet EF_{IP}$$

[25] Source: 2019 Refinement to the 2006 IPCC Guidelines, Volume3: Industrial Processes and Product Use, Chapter 4: Metal Industry Emissions Figure 4.8d (New) Energy or IPPU CO_2 emissions allocation in an integrated iron and steel facility

[26] Source: 2006 IPCC Guidelines, Volume 2: Energy, Chapter 4: Metal Industry Emissions- 4.4.2 Methodological issues - Choice of method

EQUATION 4.6
CO_2 EMISSIONS FROM PRODUCTION OF DIRECT REDUCED IRON (TIER 1)

Direct Reduced Iron: $$E_{CO_2,\,non-energy} = DRI \bullet EF_{DRI}$$

EQUATION 4.7
CO_2 EMISSIONS FROM SINTER PRODUCTION (TIER 1)

Sinter Production: $$E_{CO_2,\,non-energy} = SI \bullet EF_{SI}$$

EQUATION 4.8
CO_2 EMISSIONS FROM PELLET PRODUCTION (TIER 1)

Pellet Production: $$E_{CO_2,\,non-energy} = P \bullet EF_{P}$$

EQUATION 4.8A (NEW)
CO_2 EMISSIONS FROM BFG AND LDG FLARING (TIER 1)

$$E_{CO_2,\,non-energy} = BFG \bullet (EF_{CO_2})_{BFG\ flaring} + LDG \bullet (EF_{CO_2})_{LDG\ flaring}$$

$$= BFG \bullet (R_{BFG\ flared} \bullet CC_{BFG} \bullet \frac{44}{12}) + LDG \bullet (R_{LDG\ flared} \bullet CC_{LDG} \bullet \frac{44}{12})$$

Where:

$E_{CO2.\ non\text{-}energy}$ = emissions of CO_2 to be reported in IPPU Sector, tons

BOF = quantity of Basic Oxygen Furnace (BOF) crude steel produced, tons

EAF = quantity of Electric Arc Furnace (EAF) crude steel produced, tons

OHF = quantity of Open Hearth Furnace (OHF) crude steel produced, tons

IP = quantity of pig iron production not converted to steel, tons

DRI = quantity of Direct Reduced Iron produced nationally, tons

SI = quantity of sinter produced nationally, tons

P = quantity of pellet produced nationally, tons

EFx = emission factor, tons CO_2/ton x produced

$(EFCO_2)_{BFG\ flaring}$ = emission factor, tons CO_2/tons of BFG produced

$(EFCO_2)_{LDG\ flaring}$ = emission factor, tons CO_2/tons of LDG produced

BFG = blast furnace gas produced nationally, tons

LDG = converter gas produced nationally, tons

RBFG flared = rate of BFG removed from the production steam and then flared. If this data is not available, a default value of 0.2 can be assumed (see Box 4.0)

RBFG flared = rate LDG removed from the production steam and then flared. If this data is not available, a default value of 1.0 can be assumed (see Box 4.0)

CCBFG = carbon content of blast furnace gas, tons C/ton CCLDG = carbon content of converter gas, tons C/ton

4.4.1.2.3 Choice of activity data

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C1_Iron_and_Steel
File	2C1_Iron-Steel_DZA.xlsx
based on	2C1_Iron-Steel_SIDER.xlsx
	2C1_Iron-Steel_AQS.xlsx
	2C1_Iron-Steel_Tosyali.xlsx

all plants provide production data to estimate greenhouse gas emissions for the period 1990–2022.

4.4.1.2.3.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C1_Iron_and_Steel
File	2C1_Iron-Steel_DZA.xlsx
Sheet	IPCC_default

Default emission factors for CO_2 and CH_4 were taken from the IPCC 2006 Guidelines and are presented in the following table.

2.C.1. Iron and steel production	CO_2	CH_4

	Unit	EF	Source	type	Unit	EF	Source	type
Sinter production	ton CO_2 per ton sinter produced	0.20	**TABLE 4.1**	**D**	kg CH_4 / ton sinter	**0.07**	**TABLE 4.2**	**D**
Coke Oven	ton CO_2 per ton coke produced	0.56		**D**	**NA**			
Iron Production	ton CO_2 per ton pig iron produced	1.35		**D**	**NA**			
Direct Reduced Iron production	ton CO_2 per ton DRI produced	0.70		**D**	kg CH_4 / TJ (on a net calorific basis)	**1**		**D**
Pellet production	ton CO_2 per tonne pellet produced	0,03		**D**	**NA**			
Steelmaking Method								
Basic Oxygen Furnace (BOF)	ton CO_2 per ton of steel produced	1.46	**TABLE 4.1**	**D**	**NA**		**TABLE 4.2**	
Electric Arc Furnace (EAF)	ton CO_2 per ton of steel produced	0.08		**D**	**NA**			
Open Hearth Furnace (OHF)	ton CO_2 per ton of steel produced	1.72		**D**	**NA**			
Global Average Factor (65% BOF, 30% EAF, 5% OHF)*	ton CO_2 per ton of steel produced	1.06		**D**	**NA**			
Source	**2006 IPCC GL. Volume 3. Chapter 4**							

Note:
D Default CS Country specific PS Plant specific IEF Implied emission factor

4.4.1.2.4 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C1_Iron_and_Steel
File	2C1_Iron-Steel_DZA.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.C.1 Iron and steel are presented in the following table.

	Uncertainties	CO_2	CH_4	Source
2.C.1.a. Steel -	Activity data (AD)	±10%	NA	Table 4.4 (updated)
	Emission factor (EF)	±25%	NA	
	Combined Uncertainty (U)	**27%**	NA	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$
2.C.1.b. Pig iron	Activity data (AD)	±10%	NA	Table 4.4 (updated)
	Emission factor (EF)	±25%	NA	
	Combined Uncertainty (U)	**27%**	NA	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$
2.C.1.c. Direct Reduced Iron	Activity data (AD)	±10%	10%	Table 4.4 (updated)

	Uncertainties	CO_2	CH_4	Source
	Emission factor (EF)	±25%	400%	
	Combined Uncertainty (U)	**27%**	**400%**	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$
2.C.1.d. Sinter	Activity data (AD)	±10%	10%	Table 4.4 (updated)
	Emission factor (EF)	±25%	400%	
	Combined Uncertainty (U)	**27%**	**400%**	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$
2.C.1.e. Pellet	Activity data (AD)	±10%	NA	Table 4.4 (updated)
	Emission factor (EF)	±25%	NA	
	Combined Uncertainty (U)	**27%**	NA	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$
Source: 2006 IPCC GL. Volume 3. Chapter 4				
Overall Uncertainty				
2.C.1. Iron and steel production	**Combined Uncertainty (U)**	**60%**	**567%**	
	$U_{2C1} = \sqrt{U_{2C1a}^2 + U_{2C1.b}^2 + U_{2C1d}^2 + U_2^2}$			
Calculated based on 2019 Refinements to 2006 IPCC GL. Volume 3. Chapter 4				

4.4.1.2.5 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C1_Iron_and_Steel
File	2C1_Iron-Steel_DZA.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed:

- Checked of calculations by spreadsheets
  - consistent use of production statistics
  - documented sources,
  - use of units,
  - record keeping; use of write protection,
  - unique use of formulas; special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- time series consistency - plausibility checks of dips and jumps.
- cross checks with other relevant sectors (1.B.1, 1.A.2.a) are performed to avoid double counting or omissions;
- cross-checked from different sources:
  - plant data
  - national statistic published by Office National des Statistiques (ONS)[27] and
  - Worldsteel[28]
  - US geological survey[29]
  - UN statistics[30]

[27] https://www.ons.dz/spip.php?rubrique6 and https://www.ons.dz/IMG/pdf/CH8-ENERGIE.pdf; https://www.ons.dz/spip.php?rubrique127

[28] Worldsteel Steel (several years): Statistical Yearbook;
Available (04.06.2022) on https://worldsteel.org/steel-topics/statistics/steel-statistical-yearbook/

[29] U.S. Geological Survey (several years): Algeria Minerals Yearbook.
Available (04.06.2022) on https://www.usgs.gov/search?keywords=Algeria%20Minerals%20Yearbook

[30] United Nations Statistics Division (UNSD) - Industrial Commodity Statistics Database UNdata | explorer

- UNIDO - Statistical Databases INDSTAT[31].

In the following figure are the data presented, which were collected for the Crude steel production in Algeria from different sources. The data used for the GHG inventory are based on Worldsteel as these data were detailed and complete.

4.4.1.2.6 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C1_Iron_and_Steel
File	2C1_Iron-Steel_DZA.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.C.1	Preparation of overview of processes and techniques including changes of the time and application of abatement technology applied in Algeria ● Coke production ● Sinter production ● Pelletizing ● Blast furnace – pig iron production ● Steelmaking in Basic oxygen Furnace (BOF) ● Electric Arc Furnace (EAF) ● Secondary iron production	AD	Transparency completeness	high
2.C.1	Application of TIER 2 or higher methodology			
2.C.1	Collection of plant specific data ● National coke production using coal ○ preparation of consistent and complete time series of import coal ○ determination of coal characteristics ● Coke used ○ national production ○ imports ● Coke oven gas production, consumption and exhaust gases ● Pig iron production in Blast oxygen furnace (BOF) ● Blast oxygen furnace (BOF) gas production. consumption and exhaust gases ● Steel production in ○ Basic Oxygen Furnace (BOF) ○ Electric Arc Furnace (EAF) ● Fuel combustion data related to each processes			

[31] United Nations Industrial Development Organization UNIDO - Statistical Databases INDSTAT https://www.unido.org/researchers/statistical-databases

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.C.1	Collection of plant specific data to prepare country specific Emission factor ● material-specific carbon contents for iron and steel production (tons C/ton) ● exhaust gases from blast furnace gas and metallurgical coke production ● Electrode consumption amounts			

4.4.2 Lead Production (CRT category 2.C.5)

4.4.2.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.C.5	Lead Production	√	-	NA	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.4.2.1.1 Methodological issues

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C5_Lead_Production
File	2C5_Lead-Tool.xlsx
Sheet	ChoiceMethology

This chapter includes the process-related to CO_2 emissions estimations from Lead production. Combustion re-related GHG emissions are allocated in 1.A.2.b Non-ferrous metals.

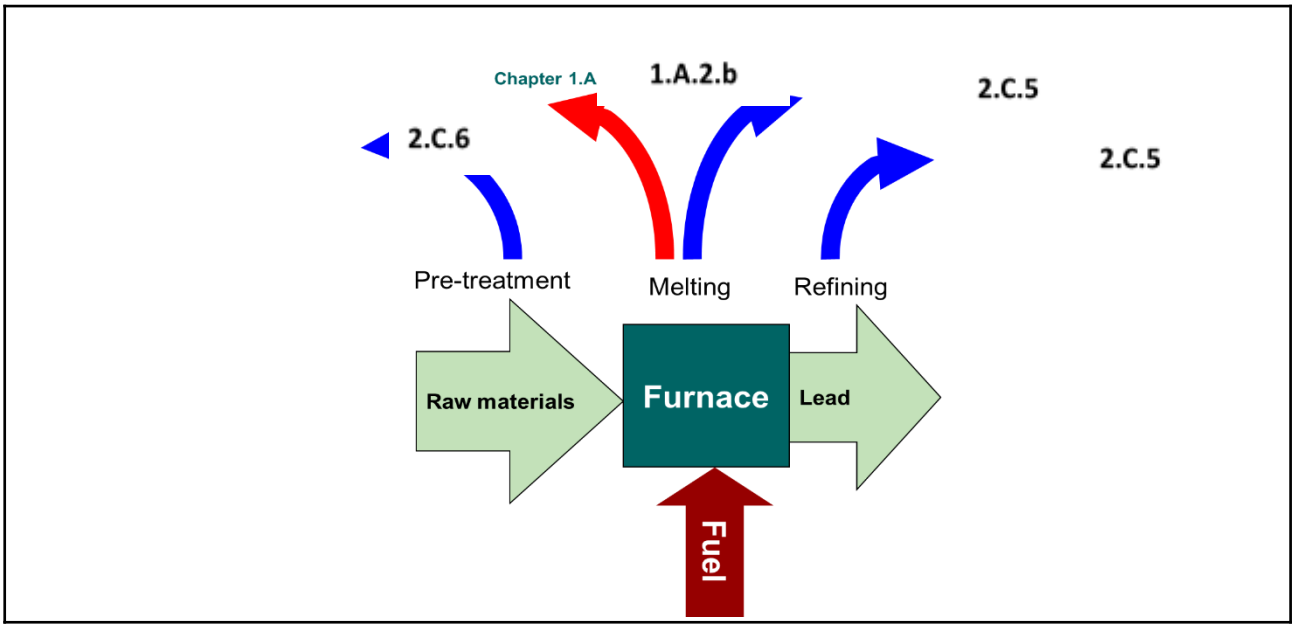


Figure 4-13 Process scheme for CRT category 2.C.5 Lead production: thermal smelting zinc production process[32]

4.4.2.1.2 Choice of methods

4.4.2.1.3

For estimating the CO_2 emissions, the 2006 IPCC Guidelines Tier 1 approach[33] has been applied:

Equation 4.32: CO_2 emissions from Lead production – TIER 1

$$Emissions_{CO_2} = DS \times EF_{CO_2}$$

Where:

Emissions $_{CO2}$ = CO_2 emission for lead production

DS = quantity of lead produced by Direct Smelting (tons)

EF_{CO2} = default CO_2 emission factor emission factor for Direct Smelting (ton CO_2/ton lead product)

In Algeria, lead was produced only by Direct Smelting. No lead production was done in Imperial Smelt Furnace (ISF) or by treatment of Secondary Raw Materials Production.

4.4.2.1.4 Choice of activity data

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C5_Lead_Production
File	2C5_Lead-Tool.xlsx
	ONS.xlsx

4.4.2.1.4.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C5_Lead_Production
File	2C5_Lead-Tool.xlsx
Sheet	TIER 1

If no plant-level information is available, it is *good practice* to use default factors.

Process	Unit	EF_{CO2}	Reference
From Imperial Smelt Furnace (ISF) Production	ton of CO_2/ ton lead	0.59	TABLE 4.21 TIER 1 CO_2 emission factors for Lead production. 2006 IPCC GL. Vol. 3 IPPU. Chapter 4
From Direct Smelting (DS) Production		0.25	
From Treatment of Secondary Raw Materials		0.2	
Default Emission Factor (80% ISF. 20% DS)		0.52	

4.4.2.1.5 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C5_Lead_Production
File	2C5_Lead-Tool.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file

[32]Source: EMEP/EEA air pollutant emission inventory guidebook 2019, 2.C.5 Lead production, Figure 2.1

[33] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 4: Metal Industry Emissions – 4.6.2.1 Choice of method

	19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.C.5 *Lead production* are presented in the following table.

Uncertainty	CO_2	Reference
Activity data (AD)	±10%	Table 4.23 2006 IPCC GL. Vol. 3 IPPU. Chapter 4
Emission factor (EF)	±20%	
Combined Uncertainty (U)	22%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

The time-series are considered to be consistent as the capacity is used as activity data.

4.4.2.1.6 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C5_Lead_Production
File	2C5_Lead-Tool.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- cross-checked from different sources:
  - national statistic published by Office National des Statistiques (ONS)[34] and
  - US geological survey[35]
  - UN statistics[36]
- cross checks with other relevant sectors (1.A.2.b) are performed to avoid double counting or omissions.

4.4.2.1.7 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C5_Lead_Production

[34] https://www.ons.dz/spip.php?rubrique6 and https://www.ons.dz/IMG/pdf/CH8-ENERGIE.pdf; https://www.ons.dz/spip.php?rubrique127

[35] U.S. Geological Survey (several years): Algeria Minerals Yearbook.
Available (04.06.2022) on https://www.usgs.gov/search?keywords=Algeria%20Minerals%20Yearbook

[36] United Nations Industrial Development Organization UNIDO - Statistical Databases INDSTAT
https://www.unido.org/researchers/statistical-databases

File	2C5_Lead-Tool.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.C.5	Application of TIER 2 or higher methodology of 2006 IPCC GL	AD	Accuracy	medium
2.C.5	Preparation of country specific emission factor (CS EF) for TIER 2 methodology ● Collection of total amount of reducing agents and other carbon containing process materials used for Lead production in the country or ● facility-specific measured emissions data	AD	Accuracy Completeness Consistency Transparency Comparability	medium
2.C.1. 2.C.5.	Investigation on the metallurgical coke/coal reductant used in different processes to avoid double counting or omission.	AD	Accuracy Completeness Consistency Transparency	high
2.C.5	Investigation on type of furnace was used in the lead production	AD	Transparency	medium
2.C.5	Investigation a simultaneous treatment of lead and zinc concentrates in the pyrometallurgical process involving the use of an Imperial Smelting Furnace toke place: the process results in the simultaneous production of lead and zinc and the release of non-energy CO_2 emissions. -> double counting	AD	Accuracy Transparency	medium

4.4.3 Zinc Production (CRT category 2.C.6)

4.4.3.1 Category description

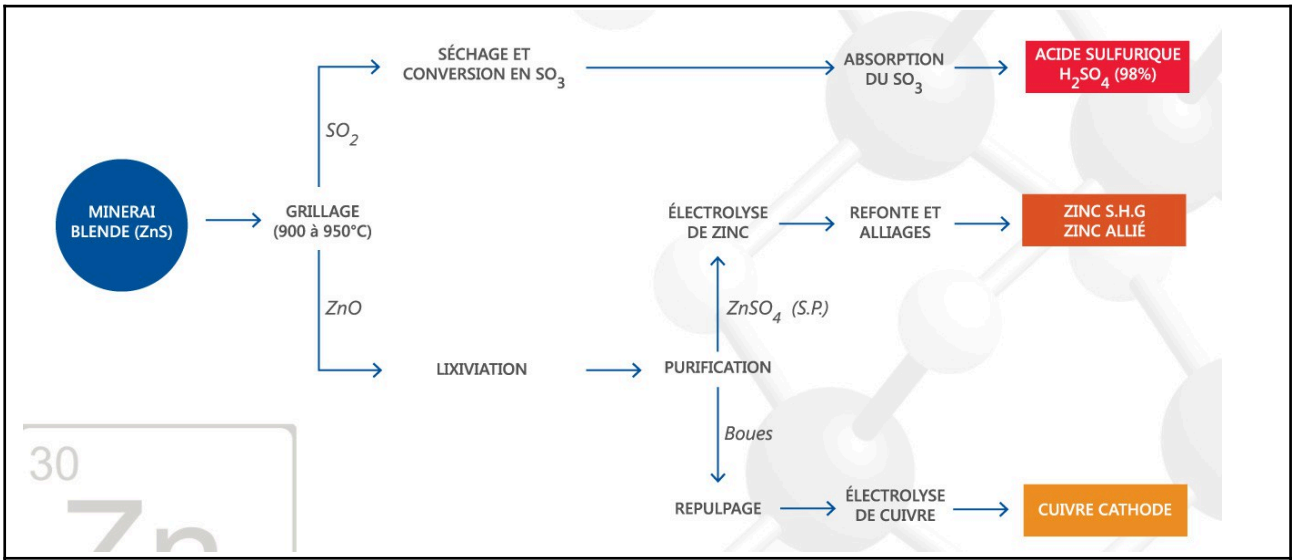
CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.C.6	Zinc Production	NA	-	NA	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.4.3.1.1 Methodological issues

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C6_Zinc_Production
File	2C6_Zinc-Tool.xlsx
Sheet	ChoiceMethology

According to 2006 IPCC, the third zinc production method is the electrolytic process, which is a hydrometallurgical technique. In this process, zinc sulphide is calcined, resulting in the production of zinc

oxide. The zinc oxide is then leached in sulphuric acid and purified to remove iron impurities, copper, and cadmium. The zinc is then drawn out of the solution using electrolysis. The electrolytic process does not result in non-energy CO_2 emissions.



Source: https://spa-alzinc.dz/processus.php

4.4.3.1.2 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C6_Zinc_Production
File	2C6_Zinc-Tool.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- cross-checked from different sources:
  - plant data
  - national statistic published by Office National des Statistiques (ONS)[37] and
  - US geological survey[38]
  - UN statistics[39]
- cross checks with other relevant sectors (1.A.2.b) are performed to avoid double counting or omissions.

[37] https://www.ons.dz/spip.php?rubrique6 and https://www.ons.dz/IMG/pdf/CH8-ENERGIE.pdf; https://www.ons.dz/spip.php?rubrique127

[38] U.S. Geological Survey (several years): Algeria Minerals Yearbook.
Available (04.06.2022) on https://www.usgs.gov/search?keywords=Algeria%20Minerals%20Yearbook

[39] United Nations Industrial Development Organization UNIDO - Statistical Databases INDSTAT
https://www.unido.org/researchers/statistical-databases

4.4.3.1.3 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\ 02_IPPU\2C_Metal_Industry\2C6_Zinc_Production
File	2C6_Zinc-Tool.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

Table 4-13 Planned improvements for CRT category 2.C.6 *Zinc production.*

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.C.6	No planned improvements.			

4.5 Non-Energy Products from Fuels and Solvent Use (CRT category 2.D)

The CRT category 2.D comprises the non-energy products use such as lubricants, paraffin waxes, and bitumen/asphalt, as well as solvents uses where GHG emissions are arising.

4.5.1 Lubricant Use (IPCC subcategory 2.D.1)

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.D.1	Lubricant Use	✔	-	NA	-	NA	-
2.D.2	Paraffin Wax Use	NE	-	NA	-	NA	-
2.D.3	Solvent Use	NE		NE	-	NA	-
2.D.4	Other	NE	-	NA	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.5.1.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.D.1	Lubricant Use	✔	-	NA	-	NA	-
A '✔' indicates emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

Lubricants are mostly used in industrial and transportation applications. Lubricants are produced either at refineries through separation from crude oil or at petrochemical facilities. They can be subdivided into

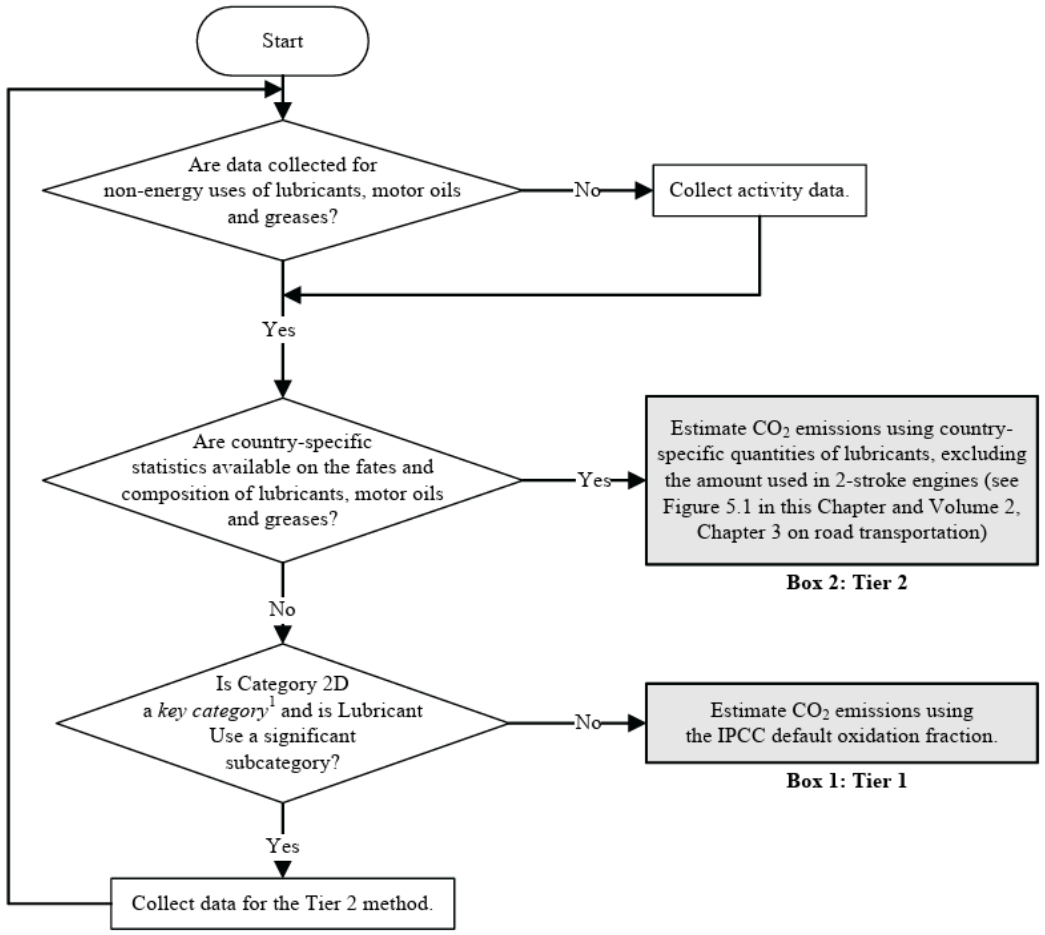
(a) motor oils and industrial oils, and

(b) greases, which differ in terms of physical characteristics (e.g., viscosity), commercial applications. and environmental fate.

4.5.1.1.1 Methodological issues

Folder	\06_Inventory\2024_submission\ 02_IPPU\2D_Non_Energy_Products_from_Fuels_and_Solvent_Use\2D1_Lubricant_Use
File	2D1_Lubricant_Tool.xlsx
Sheet	ChoiceMethology

Figure 4-14 Decision tree for estimating GHG emission from CRT category 2.D.1 Cement production



4.5.1.1.2 Choice of methods

For estimating the CO_2 emissions, the 2006 IPCC Guidelines Tier 1 approach[40] has been applied:

Equation 5.2: CO_2 emissions from lubricant use – *TIER 1*

$$Emissions_{CO_2} = (LC \times CC \times ODU) * \frac{44}{12}$$

Where:

Emissions $_{CO2}$	= CO_2 emissions from lubricants, ton CO_2
LC	= consumption of lubricant, TJ
CC	= carbon content of lubricant, ton C/TJ (= kg C/GJ)
ODU	= ODU factor for lubricant, fraction
44/12	= mass ratio of CO_2/C

4.5.1.1.3 Choice of activity data

Folder	\06_Inventory\2024_submission\ 02_IPPU\2D_Non_Energy_Products_from_Fuels_and_Solvent_Use\2D1_Lubricant_Use
File	2D1_Lubricant_Tool.xlsx
	ONS.xlsx

4.5.1.1.3.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\ 02_IPPU\2D_Non_Energy_Products_from_Fuels_and_Solvent_Use\2D1_Lubricant_Use
File	2D1_Lubricant_Tool.xlsx
Sheet	EF IPCC_1A

If no plant-level information is available, it is *good practice* to use default factors. Therefore, the CO_2 emissions factor of 0.2 ton of CO_2/ ton lubricant used was chosen.

Table 4-14 Carbon content of lubricants and default oxidation fractions for lubricants.

	Lubricating oil (motor oil /industrial oils)	Unit	Reference
Default fraction in total lubricant	90	(%)	TABLE 5.2 Default oxidation fractions for lubricating oils, grease and lubricants in general. 2006 IPCC GL. Vol. 3 IPPU. Chapter 4
ODU factor	0.2		
Carbon content	40.20	TJ/Mg	

4.5.1.2 Uncertainty assessment and time-series consistency

The uncertainties for activity data and emission factors used for CRT category 2.D.1 *Lubricant Use* are presented in the following table.

Folder	\06_Inventory\2024_submission\ 02_IPPU\2D_Non_Energy_Products_from_Fuels_and_Solvent_Use\2D1_Lubricant_Use
File	2D1_Lubricant_Tool.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file

[40] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 4: Metal Industry Emissions – 4.7.2.1 Choice of method

	Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.D.1 *Lubricant Use* are presented in the following table.

Uncertainty	CO_2	Reference
Activity data (AD)	10%	Table 4.25 2006 IPCC GL. Vol. 3 IPPU. Chapter 4
Emission factor (EF)	50%	
Combined Uncertainty (U)	51%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

The time-series are considered to be consistent as the capacity is used as activity data.

4.5.1.2.1 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\ 02_IPPU\2D_Non_Energy_Products_from_Fuels_and_Solvent_Use\2D1_Lubricant_Use
File	2D1_Lubricant_Tool.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- cross checks with other relevant sectors (1.A) are performed to avoid double counting or omissions.

4.5.1.2.2 Category-specific planned improvements including tracking of those identified in the review process

Folder	\06_Inventory\2024_submission\ 02_IPPU\2D_Non_Energy_Products_from_Fuels_and_Solvent_Use\2D1_Lubricant_Use
File	2D1_Lubricant_Tool.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the

total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.D.1	Collection of activity data for the whole time series 1990 – 2022 and incorporation in the ONS	AD	Accuracy Transparency Completeness	Medium

4.6 Product Uses as Substitutes for Ozone Depleting Substances (CRT category 2.F)

The CRT category 2.F *Product Uses as Substitutes for Ozone Depleting Substances* (ODS) comprises HFC, PFC and SF_6 emissions from

- Refrigeration and Air Conditioning units (2.F.1),
- Foam Blowing Agents (2.F.2),
- Fire Protection applications and products (2.F.3),
- Aerosols (2.F.4),
- Solvents (2.F.5),
- Other applications (2.F.6).

All sub-categories are existing in Algeria but are currently not estimated due to lack of resources and (sufficient) data. Only emissions from 2.F.1.b Domestic refrigeration 2.F.1.e Mobile air-conditioning were estimated and 2.F.1.f Stationary air-conditioning.

4.6.1 Refrigeration and Air Conditioning units (CRT category 2.F.1)

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.F.1	Refrigeration and Air Conditioning	NA	-	NA	-	NA	-

CRT code	Description	HFC		PFC		SF_6		NF_3	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.F.1	Refrigeration and Air Conditioning								
2.F.1.a	Commercial refrigeration	NE	-	NO	-	NO	-	NO	-
2.F.1.b	Domestic refrigeration	✔	-	NO	-	NO	-	NO	-
2.F.1.c	Industrial refrigeration	NE	-	NO	-	NO	-	NO	-
2.F.1.d	Transport refrigeration	NE	-	NO	-	NO	-	NO	-
2.F.1.e	Mobile air-conditioning	✔	-	NO	-	NO	-	NO	-

2.F.1.f	Stationary air-conditioning	✔	-	NO	-	NO	-	NO	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential									
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF									

The CRT category 2.F.1 *Refrigeration and Air Conditioning* is estimated but the estimation of HFC, PFC and SF_6 emissions from use, maintaining and disposal of refrigerators, freezers and air-condition machines containing HFC, PFC and SF_6 is not complete.

4.6.1.1.1 Methodological issues and Choice of methods

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	ChoiceMethology

For estimating the HFC emissions from IPCC subcategory 2.F.1.b. Domestic refrigeration, IPCC subcategory 2.F.1.e. Mobile air-conditioning and IPCC subcategory 2.F.1.f Stationary air-conditioning, the 2019 refinements of the 2006 IPCC Guidelines Tier 1 approach[41] has been applied. However, the activity data are based on general assumptions.

Equation 7.10 Summary of sources of emissions
(2019 Refinement to 2006 IPCC GL, Vol. 3, Chap. 7)

$$Emissions_{total.t} = Emissions_{containers.t} + Emissions_{charge.t} + Emissions_{lifetime.t} + Emissions_{end\_of\_life.t}$$

Where

Emissions $_{total}$ = total emissions of gas t

Emissions $_{containers,t}$ = emissions of gas t related to the management of refrigerant containers

Emissions $_{charge,t}$ = emissions of gas t related to the refrigerant charge: connection and disconnection of the refrigerant container and the new equipment to be charged

Emissions $_{lifetime,t}$ = annual emissions of gas t from the banks of refrigerants associated with the six sub-applications during operation (fugitive emissions and ruptures) and servicing

Emissions $_{end\_of\_life,t}$ = emissions of gas t at system disposal

Equation 7.11 Sources of emissions from management of containers
(2019 Refinement to 2006 IPCC GL. Vol. 3. Chap. 7)

$$Emissions_{containers.t} = RM_t + \frac{c}{100}$$

Where

Emissions $_{containers.t}$ = emissions from all HFC containers in year t. kg

RMt = HFC market for new equipment and servicing of all refrigeration application. kg

c = emission factor of HFC container management of the current refrigerant market. percent

[41] Source: 2019 Refinement to the 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances- 7.5.2.1 Methodological issues - Choice of method

Equation 7.12 Sources of emissions from management of containers
(2019 Refinement to 2006 IPCC GL, Vol. 3, Chap. 7)

$$Emissions_{charge.t} = RM_t + \frac{k}{100}$$

Where

Emissions $_{charge.t}$ = emissions during system manufacture/assembly in year t, kg

Mt = amount of HFC charged into new equipment in year t (per sub-application) , kg

k = emission factor of assembly losses of the HFC charged into new equipment (per sub-application), percent

Equation 7.13 Sources during equipment lifetime
(2019 Refinement to 2006 IPCC GL, Vol. 3,. Chap. 7)

$$Emissions_{lifetime,t} = B_t + \frac{x}{100}$$

Where

Emissions $_{lifetime.t}$ = amount of HFC emitted during system operation in year t, kg

B_t = amount of HFC charged into new equipment in year t (per sub-application) , kg

x = annual emission rate (i.e., emission factor) of HFC of each sub-application bank during operation, accounting for average annual leakage and average annual emissions during servicing, percentDomestic refrigeration (IPCC subcategory 2.F.1.b

4.6.1.1.2 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.F.1	Refrigeration and Air Conditioning	NA	-	NA	-	NA	-

CRT code	Description	HFC		PFC		SF_6		NF_3	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.F.1	Refrigeration and Air Conditioning								
2.F.1.b	Domestic refrigeration	✔	-	NO	-	NO	-	NO	-

A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable.
C – confidential

LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF

4.6.1.1.3 Choice of activity data

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
	ONS.xlsx

- In operating systems (average annual stocks)

- Remaining in products at decommissioning

In the following figure and table are the steps presented which are done to prepare the activity data 'Annual bank of HFC-134a' for the Domestic refrigeration.

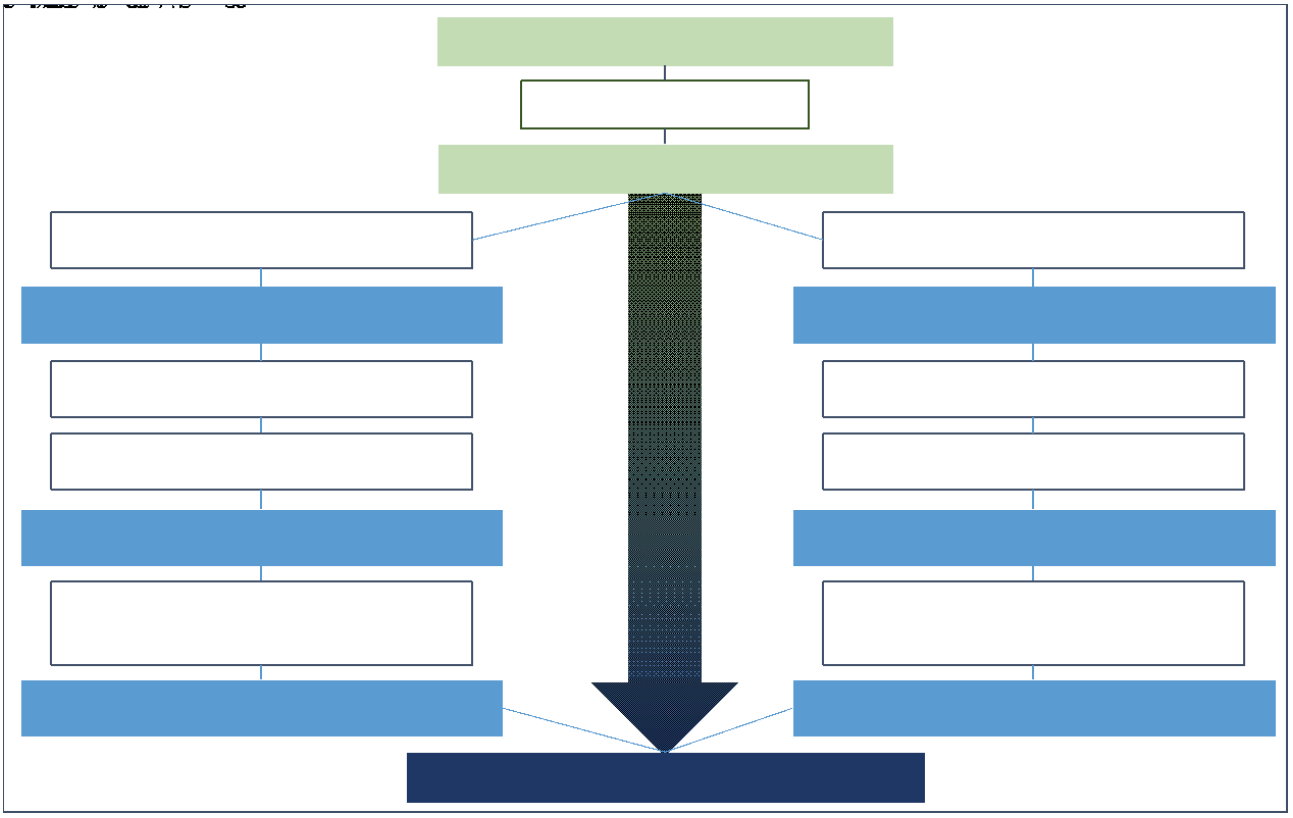


Figure 4-15 Overview on preparing the activity data from CRT category 2.F.1.b *Domestic refrigeration*

4.6.1.1.3.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	Default EF

For default factors and applied factors, calculated from the range provided, for amount of charge, lifetime, emission factor and end-of-Life emissions were taken from 2019 Refinement to the 2006 IPCC Guidelines. TABLE 7.9 (UPDATED) and are presented in the following table.

Sub-application	**Charge**	**Lifetimes (years)**	**Emission Factors**		**End-of-Life Emission**		
Factor in Equation	**(M)**	**(d)**	**(k)**	**(x)**	**(hrec,d)**	**(p)**	
			At Time of Charge	**Annual loss. Operating Lifetime**	**Recovery Efficiency**	**Initial Charge Remaining**	**EF release**
Unit	**kg**		**% of initial charge/year**	**%**	**%**	**%**	**%**
Domestic Refrigeration	0.05 ≤ M ≤ 0.5	12 ≤ d ≤ 20	0.2 ≤ k ≤ 1	0.1 ≤ x ≤ 0.5	0 < rec,d < 70	0 < p < 80	
Applied factor	*0.120*	*16*	*0.6%*	*0.5%*	*NA*	*NA*	*100%*

Note					*It is assumed that no recovery took place and no charge raimed in the unit.*

4.6.1.2 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.F.1.b *Domestic refrigeration* are presented in the following table.

Uncertainty	**Charge**	**Lifetimes**	**Annual loss. Operating Lifetime**	**EF release**	
Activity data (AD)	82%	25%			based on 2019 Refinements to the 2006 IPCC GL, Vol. 3, Chap.7.5.3 and Table 7.8
Emission factor (EF)			67%	100%	based Table 2.13
Combined Uncertainty (U)	148%				$U_{total} = \sqrt{U_{AD1}^2 + U_{AD2}^2 + U_{EF1}^2 + U_{EF}^2}$

4.6.1.2.1 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - consistent use of energy balance data (preparation of a time series) ,
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,

- unique use of formulas, special cases are documented/highlighted,
- quick-control checks for data consistency through all steps of calculation.

- time series consistency - plausibility checks of dips and jumps.

4.6.1.2.2 Category-specific planned improvements including tracking of those identified in the review process

Folder	06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.F.1	In-depth analysis of (a) data on historic and current equipment by elaborating studies on the number of refrigerators since 1990. (b) production, import & export of commodities of ● HS code 8415 'Air-condition' ● HS code 8418 'Refrigerator and freezer'	AD	Accuracy Transparency Completeness Comparability	High
2.F.1.b	In-depth analysis of (a) data on historic and current equipment (b) production, import & export of commodities of ● Containing fluids / gases ● Container size ● Life time ● usage pattern ● maintenance ● disposal	AD	Accuracy Transparency Completeness Comparability	High
2.F.1.b	Analysis of mobile air-conditioning units/equipment	AD	Accuracy Transparency Completeness Comparability	High
2.F.1.b	Application of methodology (TIER 2 or higher) of 2006 IPCC Guidelines and 2019 Refinements to the 2006 IPCC Guidelines Volume 3: Industrial Processes and Product Use, Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances. (7.5 Refrigeration and air conditioning) Page 7.43.	AD	Accuracy Transparency Completeness Comparability Consistency	High

4.6.1.3 Mobile air-conditioning (IPCC subcategory 2.F.1.e)

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.F.1	Refrigeration and Air Conditioning	NA	-	NA	-	NA	-

CRT code	Description	HFC		PFC		SF_6		NF_3	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.F.1	Refrigeration and Air Conditioning								
2.F.1.e	Mobile air-conditioning	✔	-	NO	-	NO	-	NO	-

A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential

LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF

4.6.1.3.1 Methodological issues - Choice of activity data

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
	ONS.xlsx

(A) Activity data - Filled into new manufactured products

It was assumed that no HFC-134a gas was filled into new manufactured products.

(B) Activity data

- In operating systems (average annual stocks)
- Remaining in products at decommissioning

In the following figure and table are the steps presented which are done to prepare the activity data 'Annual bank of HFC-134a' for the equipment of mobile air-conditioning.

Step 1: number of vehicles

The activity data of the vehicle fleet was taken from ONS (several years): Parc national automobile.[42]

Step 2: Estimation of share of vehicles with air-conditioning

Type Of Vehicle	1990	2010	2022
Passenger Vehicle	5%	25%	41%
Truck	1%	6%	15%
Van	1%	6%	15%
Bus-Coach	1%	10%	17%
Road Tractor	1%	4%	8%
Special Vehicle	1%	3%	6%

[42] https://www.ons.dz/spip.php?rubrique228-+

Step 3: Information on the use of cooling agents

It is assumed that only the HFC-134a gas was filled in vehicle, which were completely imported.

Step 4: Average charge of an air-conditioning and lifetime of unit

An 'average' charge of a Mobile air-conditioning: between 0.6 kg/unit and 0.9 kg/unit. Information is taken from TABLE 7.9 (UPDATED). 2019 Refinement to the 2006 IPCC Guidelines[43]

Step 5: Cumulative sum: See following table

Step 6: Mobile air-conditioning - BANK of HFC-134a

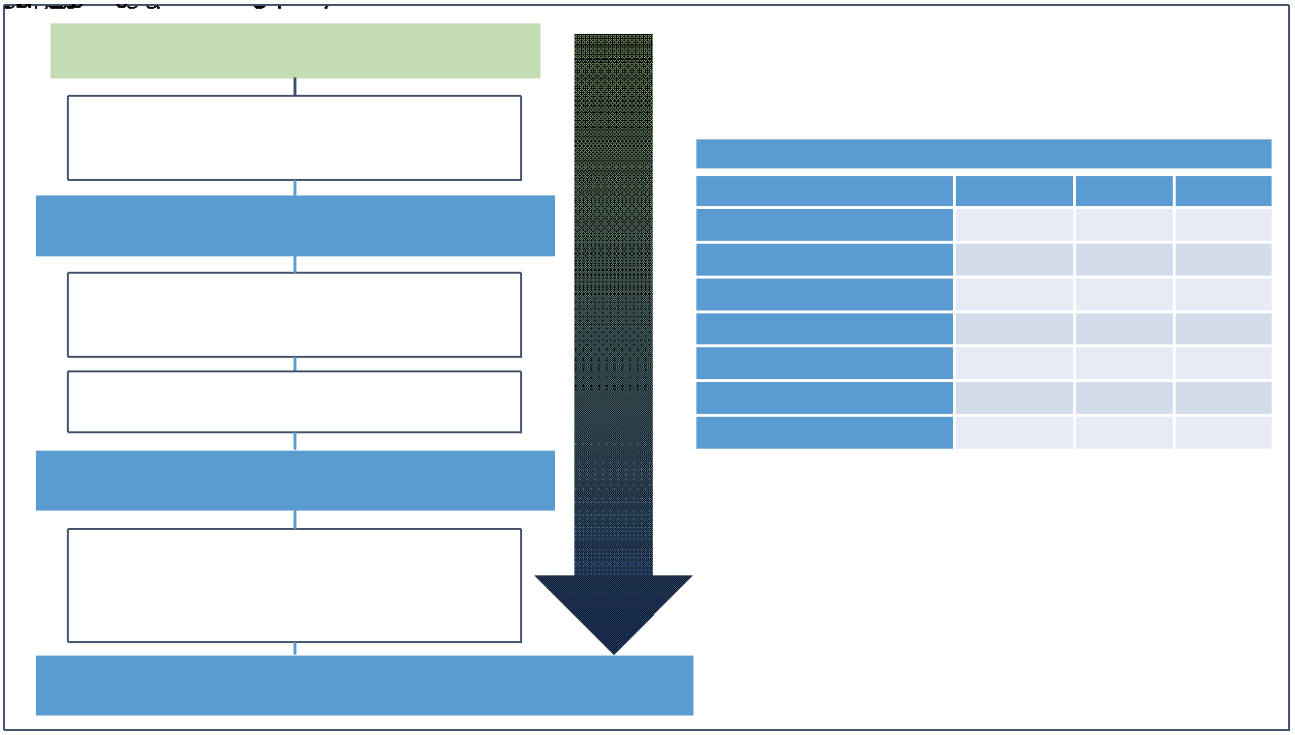


Figure 4-16 Overview on preparation the activity data for CRT category 2.F.1.e *Mobile air-conditioning*

4.6.1.3.1.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	Default EF

For default factors and applied factors, calculated from the range provided, for amount of charge, lifetime, emission factor and end-of-Life emissions were taken from 2019 Refinement to the 2006 IPCC Guidelines, TABLE 7.9 (UPDATED) and are presented in the following table.

Table 4-15 GHG Emission factor TIER 1 for CRT category 2.F.1.e *Mobile air-conditioning*

Sub-application	Charge	Lifetimes (years)	Emission Factors		End-of-Life Emission		
Factor in Equation	(M)	(d)	(k)	(x)	(hrec,d)	(p)	

[43] Source: 2019 Refinement to the 2006 IPCC GL, Vol. 3: IPPU, Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances- 7.5.2.1 Methodological issues - Table 7.9 (updated) Default estimates1 for charge, lifetime and emission factors for refrigeration and air-conditioning systems

			At Time of Charge	Annual loss, Operating Lifetime	Recovery Efficiency	Initial Charge Remaining	EF release
Unit	**kg**		**% of initial charge/year**	**%**	**%**	**%**	**%**
Mobile A/C general road transport	0.5 ≤ M ≤ 1.5	9 ≤ d ≤ 16	0.2 ≤ k ≤ 1	0.2 ≤ x ≤ 0.5	0 < rec,d < 50	0 < p < 50	
Applied factor	0.60 and 0.80	16	NO	15%	NA	NO	100%
Note					*It is assumed that no recovery took place and no charge raimed in the unit.*		

4.6.1.4 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.F.1.e *Mobile air-conditioning* are presented in the following table.

Table 4-16 Uncertainty for CRT category 2.F.1.e *Mobile air-conditioning.*

Uncertainty	Charge	Lifetimes	Annual loss, Operating Lifetime	EF release	
Activity data (AD)	82%	25%			based on 2019 Refinements to the 2006 IPCC GL, Vol. 3, Chap.7.5.3 and Table 7.8
Emission factor (EF)			67%	100%	based Table 2.13
Combined Uncertainty (U)	148%				$U_{total} = \sqrt{U_{AD1}^2 + U_{AD2}^2 + U_{EF1}^2 + U_{EF}^2}$

4.6.1.4.1 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx

Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - consistent use of energy balance data (preparation of a time series) ,
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping. use of write protection,
  - unique use of formulas. special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- time series consistency - plausibility checks of dips and jumps.

4.6.1.4.2 Category-specific planned improvements including tracking of those identified in the review process

Folder	06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

Table 4-17 Planned improvements for CRT category 2.F.1.e Mobile air-conditioning.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.F.1.e	In-depth analysis of data on historic and current equipment used in vehicles of the road transport, trains, ships, planes and off-road vehicles ⇨ containing fluids / gases ⇨ container size and charge (weight) ⇨ container prefilled and/or filled upon use ⇨ life time ⇨ usage pattern ⇨ maintenance and service routine ⇨ disposal ⇨ recovery efficiency	AD	Accuracy Transparency Completeness Comparability	High
2.F.1.e	In-depth analysis of production, import & export of relevant applicants and vehicles ⇨ containing fluids / gases	AD	Accuracy Transparency Completeness Comparability	High

GHG source & sink category	Planned improvement	Type of improvement		Priority
	⇨ container size and charge (weight) ⇨ container prefilled and/or filled upon use			
2.F.1.e	In-depth analysis of second-hand market	AD	Accuracy Transparency	High
2.F.1.e	Application of Tier 2 methodology or higher of 2006 IPCC Guidelines and Application of guidance on methodology and Emission factors provided by the 2019 Refinements to the 2006 IPCC guidelines	AD	Accuracy Transparency Completeness Comparability	High

4.6.1.5 Stationary air-conditioning (IPCC subcategory 2.F.1.f)

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.F.1	Refrigeration and Air Conditioning	NA	-	NA	-	NA	-

CRT code	Description	HFC		PFC		SF_6		NF_3	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.F.1	Refrigeration and Air Conditioning								
2.F.1.f	Stationary air-conditioning	✔	-	NO	-	NO	-	NO	-

A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable. C – confidential

LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF

4.6.1.5.1 Methodological issues and Choice of methods

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx Ons.xlsx
Sheet	ChoiceMethology

Activity data

- In operating systems (average annual stocks)
- Remaining in products at decommissioning

In the following figure and table are the steps presented which are done to prepare the activity data 'Annual bank of R-32 and R-410A' for the air conditioner.

Step 1: number of households

The activity data for population were taken from ONS.

The Information on number of households are also taken from ONS except for 2018 – 2020 which were taken from UNstat.

ONS (2014)[44]: Enquête sur les dépenses de consommation et le niveau de vie des ménages 2011 - Dépenses de consommation des ménages algériens en 2011.
TAB.8 : Répartition et structure des ménages par dispersion en 2000 et 2011.

UNstat (2022)[45]: Household size and composition 2022: Average household size (number of members) (number of members): 4.94

Step 2: Number of air conditioner.

For 2008 and 2011, the Information on number of air conditioner are also taken from ONS except for 2018 – 2022 which were taken from Global Data Lab (and modified)[46].

ONS (2014): Enquête sur les dépenses de consommation et le niveau de vie des ménages 2011 - Dépenses de consommation des ménages algériens en 2011.
Tab. 6 : Taux d'équipement des ménages algériens en 2008 et 2011.
Tab. 10 : Structure des biens d'équipement selon l'année d'acquisition.

Step 3: Information on the use of cooling agents

R-32	2010 onwards		Share is based on expert judgment
R-410A	2017 onwards		
R-22		Not covered under UNFCCC reporting	
R-407C		Not covered under UNFCCC reporting	

Step 4: Average charge of an air conditioner and lifetime of unit

An 'average' charge of an air conditioner is estimated to 0.8 kg/unit. Information is taken from TABLE 7.9 (UPDATED), 2019 Refinement to the 2006 IPCC Guidelines[47]

Step 5: Cumulative sum: See the following table

Step 6: Air conditioner - BANK of R-32 and R-410A.

4.6.1.5.1.1 Choice of emission factors

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	Default EF

For default factors and applied factors, calculated from the range provided, for amount of charge, lifetime, emission factor and end-of-Life emissions were taken from 2019 Refinement to the 2006 IPCC Guidelines TABLE 7.9 (UPDATED) and are presented in the following table.

Sub-application	**Charge**	**Lifetimes (years)**	**Emission Factors**		**End-of-Life Emission**		
Factor in Equation	**(M)**	**(d)**	**(k)**	**(x)**	**(hrec,d)**	**(p)**	
			At Time of Charge	**Annual loss. Operating Lifetime**	**Recovery Efficiency**	**Initial Charge Remaining**	**EF release**
Unit	**kg**		**% of initial charge/year**	**%**	**%**	**%**	**%**

[44] https://www.ons.dz/IMG/pdf/consfinal_1_.pdf

[45] https://population.un.org/household/#/countries/

[46] https://globaldatalab.org/areadata/table/fridge/DZA+MAR+TUN/?levels=1

[47] Source: 2019 Refinement to the 2006 IPCC GL, Vol. 3: IPPU, Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances- 7.5.2.1 Methodological issues - Table 7.9 (updated) Default estimates1 for charge, lifetime and emission factors for refrigeration and air-conditioning systems

Residential and Commercial A/C, including Heat Pumps	0.5 ≤ M ≤ 100	10 ≤ d ≤ 20	0.2 ≤ k ≤ 1	1 ≤ x ≤ 10	0 < rec,d < 80	0 < p < 80	
Applied factor	*0.80*	*16*	*0.6%*	*0.5%*	*NA*	*NA*	*100%*
Note					*It is assumed that no recovery took place and no charge raimed in the unit.*		

4.6.1.6 Uncertainty assessment and time-series consistency

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.F.1.f Stationary air-conditioning are presented in the following table.

Uncertainty	**Charge**	**Lifetimes**	**Annual loss. Operating Lifetime**	**EF release**	
Activity data (AD)	82%	25%			based on 2019 Refinements to the 2006 IPCC GL, Vol. 3, Chap.7.5.3 and Table 7.8
Emission factor (EF)			67%	100%	based Table 2.13
Combined Uncertainty (U)	148%				$U_{total} = \sqrt{U_{AD1}^2 + U_{AD2}^2 + U_{EF1}^2 + U_{EF}^2}$

4.6.1.6.1 Category-specific QA/QC and verification

Folder	\06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - consistent use of energy balance data (preparation of a time series) ,
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- time series consistency - plausibility checks of dips and jumps.

4.6.1.6.2 Category-specific planned improvements including tracking of those identified in the review process

Folder	06_Inventory\2024_submission\02_IPPU\2F_Product_Uses_as_Substitutes_for_Ozone_Depleting_Substances\2F1_Refrigeration_and_Air_Conditioning
File	2F1_ODS_Substitutes.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.F.1.f	In-depth analysis of data on historic and current equipment and application ⇨ containing fluids / gases ⇨ container size and charge (weight) ⇨ container prefilled and/or filled upon use ⇨ life time ⇨ usage pattern ⇨ maintenance and service routine ⇨ disposal ● recovery efficiency	AD	Accuracy Transparency Completeness Comparability	High
2.F.1.f	In-depth analysis of production, import & export of commodities of HS code 8415 'Air-condition' ⇨ containing fluids / gases ⇨ container size and charge (weight) ● container prefilled and/or filled upon use	AD	Accuracy Transparency Completeness Comparability	High

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.F.1.f	In-depth analysis of second hand market	AD	Accuracy Transparency	High
2.F.1.f	Application of Tier 2 methodology or higher of 2006 IPCC Guidelines and Application of guidance on methodology and Emission factors provided by the 2019 Refinements to the 2006 IPCC guidelines	AD	Accuracy Transparency Completeness Comparability	High

4.7 Other Product Manufacture and Use (CRT category 2.G)

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.G	Other product manufacture and use						
2.G.1	Electrical equipment	NA	-	NA	-	NA	-
2.G.2	SF_6 and PFCs from other product use	NA	-	NA	-	NA	-
2.G.3	N_2O from product uses	NA	-	NA	-	✔	-
2.G.4	Other	NO	-	NO	-	NO	-

CRT code	Description	HFC		PFC		SF_6		NF_3	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.G	Other product manufacture and use								
2.G.1	Electrical equipment	NA	-	NE	-	✔	LA, TA	NO	-
2.G.2	SF_6 and PFCs from other product use	NA	-	NE	-	NE	-	NO	-
2.G.3	N_2O from product uses	NA	-	NA	-	NA	-	NA	-
2.G.4	Other	NO	-	NO	-	NO	-	NO	-

A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable.
C – confidential

LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF

4.7.1 Electrical Equipment (CRT category 2.G.1)

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.G.1	Electrical Equipment						
2.G.1.a	Manufacture of Electrical Equipment	NA	-	NA	-	NA	-
2.G.1.b	Use of Electrical Equipment	NA	-	NA	-	NA	-

2.G.1.c	Disposal of Electrical Equipment	NA	-	NA	-	NA	-

CRT code	Description	HFC		PFC		SF_6		NF_3	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.G.1	Electrical Equipment	LA, TA							
2.G.1.a	Manufacture of Electrical Equipment	NA	-	NO	-	NO	-	NO	-
2.G.1.b	Use of Electrical Equipment	NA	-	NE	-	✔	-	NO	-
2.G.1.c	Disposal of Electrical Equipment	NA	-	NE	-	✔	-	NO	-

A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere. NE - not estimated. NA - not applicable.
C – confidential

LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF

4.7.1.1.1 Methodological issues

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G1_Electrical_Equipment
File	2G1_ElectrialEquipment_Tool.xlsx
Sheet	ChoiceMethology

Furthermore, and as described in the 2006 IPCC Guidelines, the electrical applications can be divided into two categories of containments: sealed pressure systems, mainly used in distribution systems and closed pressure systems, mainly used in transmission equipments.

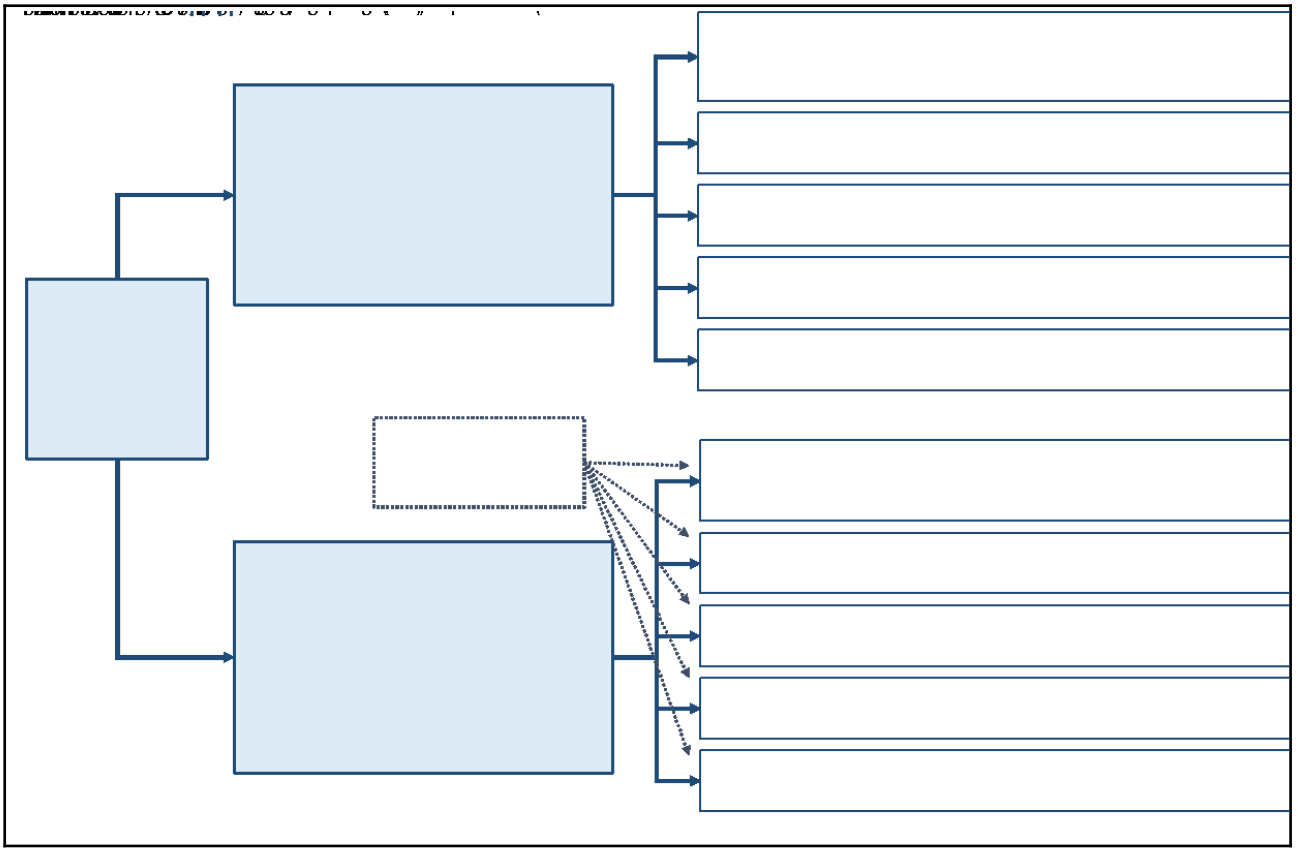


Figure 4-17 Electrical applications divided according to the containment

4.7.1.1.2 Choice of methods

EQUATION 8.3 TIER 1 TOTAL EMISSIONS

Total Emissions = *Equipment Manufacturing Emissions*

+ *Equipment Installation Emissions*
+ *Equipment Use Emissions*
+ *Equipment Disposal and Final Use Emissions*
+ *Emissions from SF_6 Recycling and Destruction*

Where:

Equipment Manufacturing Emissions at the facility level can be estimated by Equations 8.4A and 8.4B. *Equipment Installation Emissions* at the facility level can be estimated by Equations 8.5A and 8.5B. *Equipment Use Emissions* at the facility level can be estimated by Equations 8.6A and 8.6B.

Equipment Disposal and Final Use Emissions at the facility level can be estimated by Equations 8.7A and 8.7B.

Emissions from SF_6 Recycling and Destruction at the facility level can be estimated by Equations 8.8 and 8.9.

In the following figure the way how the bank is estimated is presented.

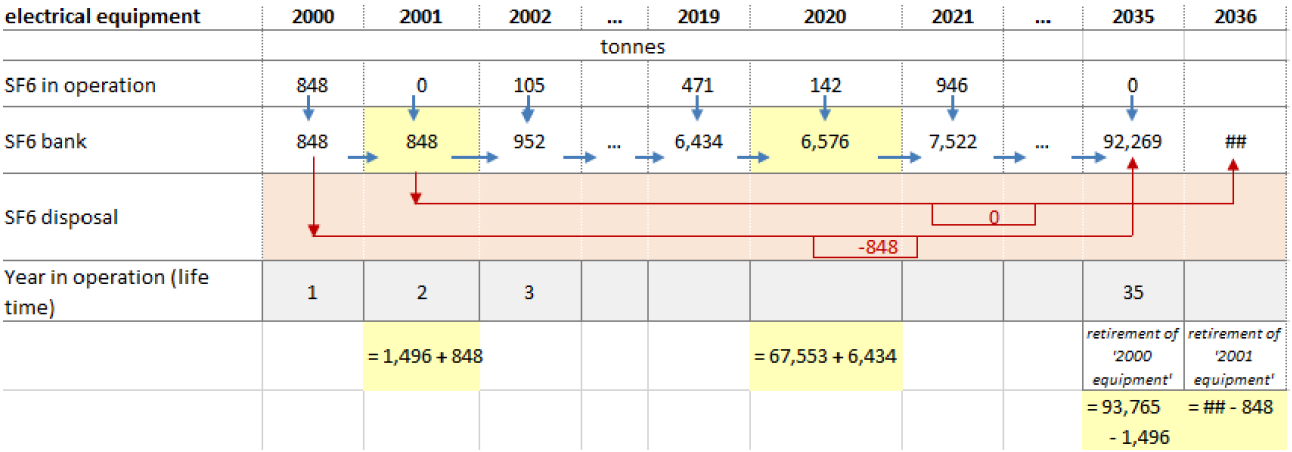


Figure 4-18 General overview on preparation of the bank for operation/use and disposal/retirement

4.7.1.1.3 Choice of activity data

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G1_Electrical_Equipment
File	2G1_ElectrialEquipment_Tool.xlsx
based on	AD_2G1_ElectrialEquipment_Tool.xlsx
	ONS.xlsx

4.7.1.1.3.1 Choice of emission factors

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G1_Electrical_Equipment
File	2G1_ElectrialEquipment_Tool.xlsx
Sheet	EF_CS_DZA

The default emission factors for SF_6 for sealed pressure electrical equipment (MV switchgear) containing SF_6 were taken from IPCC 2006 Guidelines and are presented in the following table.

SF_6 emission factor	**Manufacturing**		**Use** Includes leakage. major failures / arc faults and maintenance losses		**Disposal**					
	Fraction SF_6 consumption by manufacturers		**Fraction per year of all equipment installed / in operation**		**Lifetime (years)**		**Fraction of charge remaining at retirement**		**Fraction of Disposed Equipment**	
	EF	**type**	**EF**	**type**	**EF**	**type**	**EF**	**type**	**EF**	**type**
Europe	0.07	D	0.002	D	35	D	0.93	D	1	D
Note:										
D Default		CS Country specific		PS Plant specific		IEF Implied emission factor				

4.7.1.2 Uncertainty assessment and time-series consistency

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G1_Electrical_Equipment
File	2G1_ElectrialEquipment_Tool.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.G.1 *Electrical Equipment* are presented in the following table.

Uncertainty	**SF_6**			
	Use phase	Disposal	**2.G.1 Electrical Equipment**	**Reference:** 2006 IPCC GL. Vol. 3. Chap. 8

Activity data (AD)	100%	-		Based on Chap. 8.2.3
Lifetime (years)	-	40%		Table 8.5
Emission factor (EF)	±20%	5%		Table 8.5
Combined Uncertainty (U)	102%	40%	110%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

4.7.1.2.1 Category-specific QA/QC and verification

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G1_Electrical_Equipment
File	2G1_ElectrialEquipment_Tool.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - analysis of activity data (completeness, time series)
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection.
  - unique use of formulas, special cases are documented/highlighted.
  - quick-control checks for data consistency through all steps of calculation.
- time series consistency - plausibility checks of dips and jumps.

4.7.1.2.2 Category-specific planned improvements including tracking of those identified in the review process

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G1_Electrical_Equipment
File	2G1_ElectrialEquipment_Tool.xlsx
Sheet	PlannedImprovements

The following table presents the main category-specific planned improvements including tracking of those identified in the review process. Considering the potential contribution of identified improvements in the total GHG emissions and removals and the corresponding resources needed to make these improvements effective, will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.G.1.a	Identification of 'Electrical Equipment Manufacture sector' and relevant manufactures, equipment remakers and servicing companies, importers, exporters and distributers related to ● Manufacture of ▪ gas insulated switchgear (GIS) , ▪ gas circuit breakers (GCB) ,	AD	Completeness Transparency	High

GHG source & sink category	Planned improvement	Type of improvement		Priority
	▪ high voltage gas-insulated lines (GIL), ▪ outdoor gas-insulated instrument transformers, ▪ reclosers, ▪ switches, and ▪ ring main units of both types /differentiated to **sealed and closed pressure systems,** resp. up to and above 52kV ▪ other equipment including but not limited to cast resin instrument transformers and certain types of bushings using SF_6 either as gas for the casting process or as a blowing agent; ● Manufacturer of gas-insulated power transformers (GIT) *The SF_6 distribution chain from producers and distributors to manufacturing facilities.*			
2.G.1.a	● Collection of activity data 'SF_6 consumption' and compilation of time series 1970 – 2020 from identified stakeholders of the 'Electrical Equipment Manufacture sector' using information on ● purchases of SF_6. ● their returns of SF_6 to chemical producers, and ● changes in their inventory of SF_6 in containers. ● Performing completeness checks by including information from chemical producers and/or distributors on their sales to equipment manufacturers (less any returns). ● Ensure confidentiality for single stakeholder but also for entire 'Electrical Equipment Manufacture sector' ● Ensure data collection (practicability) for future years	AD	Completeness Transparency Comparability Accuracy	High
2.G.1.a	Preparation of plant or country specific emission factor for pillar years ● Emission factors for the Tier 2 method are generally developed on the basis of data collected from representative manufacturers and utilities that track emissions by life cycle stage, essentially using the Tier 3, pure mass-balance method at their facilities for at least one year.	EF	Completeness Transparency Comparability Accuracy	High
2.G.1.a	Estimation emission of SF_6 from 'Electrical Equipment Manufacture sector'	Meth	Completeness Transparency Comparability	High
2.G.1.a	Investigation of PFC used in 'Electrical Equipment Manufacture in the country. If yes, ● Collect annual, country-wide consumption of PFC by equipment manufacturers ● *Manufacture sector comprises (see above)* ● Estimation of emissions from 2.G.1.a *(see above)*	AD	Completeness Transparency	High
2.G.1.a	Investigation of electrical equipment manufacturers using PFC were in the country. If yes, ● Annual, country-wide consumption of PFC by equipment manufacturers Estimation of emissions from 2.G.1.a	AD	Completeness Transparency	High

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.G.1.a	Investigation of electrical equipment manufacturers using PFC were in the country Collection of activity data for PFC The CRT category 2.G.1.a Manufacture of Electrical Equipment does not exist in Algeria: it is assumed that no manufacture of electrical equipment, which was filled with PFC and/or SF_6 in country, took place. Annual, country-wide consumption of PFC by equipment manufacturers	AD	Accuracy Transparency Completeness	High

4.7.2 N_2O from Product Uses (CRT category 2.G.3)

2.G.3 N_2O from Product Uses		Occurring		Not Occurring (NO)
		Estimated	Not estimated (NE)	
2.G.3.a	Medical applications (anaesthetic use, analgesic use and veterinary use)	✔		
2.G.3.b	Propellant for pressure and aerosol products, primarily in food industry (pressure-packaged whipped cream, etc.)		✔	
2.G.3.c	Other ● Oxidising agent and etchant used in semiconductor manufacturing ● Oxidising agent used, with acetylene, in atomic absorption spectrometry ● Production of sodium azide, which is used to inflate airbags ● Fuel oxidant in auto racing ● Oxidising agent in blowtorches used by jewellers and others		✔ ✔ ✔	✔ ✔ ✔

4.7.2.1 Medical Applications (CRT category 2.G.3.a)

4.7.2.1.1 Category description

CRT code	Description	CO_2		CH_4		N_2O	
		Estimated	Key Category	Estimated	Key Category	Estimated	Key Category
2.G.3	N_2O from Product Uses						
2.G.3.a	Medical Applications	NA	-	NA	-	✔	-
A '✔' indicates emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere NE - not estimated. NA - not applicable. C – confidential							
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF							

4.7.2.1.2 Methodological issues

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G3_Medical_Applications
File	2G3a_N2O-ProductUse_Tool.xlsx
Sheet	ChoiceMethology

Anaesthetic use of N_2O: This N_2O is used during anaesthesia for two reasons: a) as an anaesthetic and analgesic and as b) a carrier gas for volatile fluorinated hydrocarbon anesthetics such as

isoflurane, sevoflurane and desflurane. The anaesthetic effect of N_2O is additive to that of the fluorinated hydrocarbon agents.

Analgesic use of N_2O: Inhaled N_2O is used to provide pain relief in certain situations. Premixed nitrous oxide and oxygen mixtures are used to provide pain relief in childbirth, and for painful procedures of short duration.

Veterinary use of N_2O: N_2O is also used during animal anaesthesia. Administration methods are similar to those used in human anaesthesia.

As N_2O is used as an anaesthetic, it is presumed that 100% are emitted during the operation.

The trend of N_2O emission is generally driven by the increasing number of population and operations, respectively. Methodological issues

4.7.2.1.3 Choice of methods

It is *good practice* to estimate N_2O emissions from data of quantity of N_2O supplied that are obtained from manufacturers and distributors of N_2O products according to Equation 8.24 below. Additionally for medical applications, the quantity of N_2O usage obtained from the pharmacy department from hospitals based on number and capacity of nitrous oxide cylinders purchased per annum can be used; both information were not available.

Therefore, a simplified Tier 1 approach[48] of the 2006 IPCC Guidelines for estimating the N_2O emissions has been applied:

Equation 8.24: N_2O emissions from Medical Applications – TIER 1

$$Emissions_{N_2O} = AD \times EF$$

Where:

Emissions $_{N2O}$ = NO_2 emissions from medical applications (ton N_2O)

AD = consumption of N_2O (ton)
It is presumed that 100% are emitted during reporting years.

EF = emission factor (100%)
It is presumed that 100% are emitted during reporting years.

4.7.2.1.4 Choice of activity data

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G3_Medical_Applications
File	2G3a_N2O-ProductUse_Tool.xlsx
based on	MEDICAL APPLICATIONS.xlsx
	ONS.xlsx

The amount of N_2O used in medical applications for estimating the GHG emissions for the period 1990-2022 from manufacturers and importers but also not from all hospitals was not available. An analysis of N_2O consumption rate per capita of Annex I submissions 2023[49] was carried. Due to the similarities of medical

[48] Source: 2006 IPCC Guidelines, Volume 3: IPPU, Chapter 4: Metal Industry Emissions – 4.7.2.1 Choice of method

[49] https://unfccc.int/ghg-inventories-annex-i-parties/2023

education systems at French and Algerian universities, the consumption rate per capita was taken from France GHG inventory 2023 submission[50]. Population data were taken from ONS.

4.7.2.1.4.1 Choice of emission factors

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G3_Medical_Applications
File	2G3a_N2O-ProductUse_Tool.xlsx
Sheet	TIER 1_2G3a

It is assumed that none of the administered N_2O is chemically changed by the body, and all is returned to the atmosphere. It is reasonable to assume an emission factor of 1.0.

4.7.2.2 Uncertainty assessment and time-series consistency

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G3_Medical_Applications
File	2G3a_N2O-ProductUse_Tool.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for CRT category 2.G.3.a *Medical applications* are presented in the following table.

Uncertainty	**NO_2**	**Reference**
Activity data (AD)	30%	Expert judgement based on CCNUCC France 2022
Emission factor (EF)	1%	
Combined Uncertainty (U)	30%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

The time-series are considered to be consistent as the number of population taken from ONS and IEF are used as activity data.

4.7.2.2.1 Category-specific QA/QC and verification

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G3_Medical_Applications
File	2G3a_N2O-ProductUse_Tool.xlsx

[50] France. 2023 Common Reporting Format (CRF) Table. https://unfccc.int/documents/627950

Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units and conversion factors,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.

4.7.2.2.2 Category-specific planned improvements including tracking of those identified in the review process

Folder	06_Inventory\2024_submission\02_IPPU\2G_Other_Product_Manufacture_and_Use\2G3_Medical_Applications
File	2G3a_N2O-ProductUse_Tool.xlsx
Sheet	PlannedImprovements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
2.G.3.a	Collection of amounts of N_2O used for/ supplied by ● manufacturers and distributors of N_2O products; ● medical applications: quantity of N_2O usage from the pharmacy department in individual hospitals (nitrous oxide cylinders purchased per annum).	AD	Accuracy Transparency Completeness	High