REPUBLIC OF ESTONIA
MINISTRY OF CLIMATE

GREENHOUSE GAS EMISSIONS IN ESTONIA 1990–2023
ANNEX TO THE NATIONAL INVENTORY DOCUMENT

SUBMISSION TO THE UNFCCC SECRETARIAT

Estonia 2025

CONTENTS

ANNEX I: KEY CATEGORIES

Summary of key category analysis is included in the NID chapter 1.4.

Annex II: Uncertainty assessment

A.II.1 Energy

Energy industries (1.A.1)

Uncertainty evaluation of CO_2 emissions has been conducted for liquid, solid, gaseous, and other fuels used in Estonia in 2023. The data availability allows the estimation of uncertainty by a fuel type rather than by a sector in fuel combustion[1].

Incomplete details of source-specific measurement data of activities and emission factors lead to estimating quantitative uncertainty of CO_2 emission by using available estimates and the combination of available measured data.

Data has been taken from Statistics Estonia database.

In the estimation of uncertainty two main components have been considered:

- Uncertainty component for measurement procedure which provides the comparability of results.
- Uncertainty component for dispersion of the input quantity, which in some cases indicate the level of data disaggregation.

The calculation formula of combined uncertainty in emission u_E is given as Equation A.II.1_1

Equation A.II.1_1[2]

$$u_e = \sqrt{u_{AD}^2 + u_{EF}^2}$$

Where:

u_e = uncertainty of emissions;
u_{AD} = uncertainty of activity data;
u_{EF} = uncertainty of emission factor.

In gaining expanded uncertainty the coverage factor *k*=2 has been used to provide approximately 95% confidence level of the results (see Equation A.II.1_2):

[1] Metrosert AS report: Uncertainty Estimation of CO_2 emission in the Estonian National Greenhouse Gas Inventory, April 2007, Tallinn, Estonia.
[2] IPCC 2006 Guidelines, Volume 1, Chapter 3; Uncertainties, page 3.28, equation 3.1

Equation A.II.1_2[3]

$$U_E = 2 \times u_E$$

Where:

U_E= expanded uncertainty.

The uncertainty of CO_2 emission for fuel combustion in Energy category was evaluated separately for each fuel type. The key points of the evaluation are listed below:

- Liquid Fuels

All liquid fuels, except shale oil and residual fuel oil, are imported to Estonia. Quality requirements for liquid fuels and instrumentation were used in the evaluation of uncertainty of activity data and emission factors.

- Solid Fuels

There are two fuel types produced locally: oil shale and peat. The largest contribution to the uncertainty is caused by fluctuation in emission factors of those fuels.

- Gaseous Fuels

The gaseous fuels are imported to Estonia. Quality requirements for gaseous fuels and instrumentation were used in the evaluation of uncertainty of activity data and emission factors.

- Other Fuels

For calculation of uncertainty of CO_2 emission due to other fuels (waste fuels) combustion in the Energy category, Finnish uncertainty factors were used. The contribution to the total uncertainty of fuel combustion is rather small.

The uncertainty factors of carbon emission factors and activity data are presented in Table A.II.1_1. The largest uncertainty contribution 60% is caused by incomplete data of the emission factor of other fuels (waste fuels).

Table A.II.1_1. Estimated relative uncertainties of CO_2 emission due to Fuel combustion in Estonia in 2023[4]

GHG Source and Sink Categories	Gas	Uncertainty of activity data, %	Uncertainty of emission factor, %	Combined relative uncertainty, %
Liquid fuels	CO_2	1.7	1.8	2.5
Solid fuels and peat	CO_2	3.3	38.9*	39.0
Gaseous fuels	CO_2	1.4	3.6	3.9
Other fuels	CO_2	5	60	60.2

*The uncertainty of the emission factors of the solid fuels category 1.A.1.a is significantly lower – 2.39%.

[3] IPCC 2006 Guidelines, Volume 1, Chapter 3; Uncertainties, page 3.8, Basis for uncertainty analysis
[4] IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories.

As the Good Practice Guidance does not give CH_4 emission factors uncertainty estimations (U_E) for biomass, and N_2O emission factors (U_E) for biomass and fossil fuels, those factors have been taken from the Finnish 2024 national inventory.

Detailed uncertainties information of CH_4 and N_2O emissions for each subsector is presented in the subchapters below.

1.A.1.a Public electricity and heat production

Uncertainty evaluation of CO_2 emissions of Public electricity and heat production is presented in sub-chapter Energy industries (1.A.1). Uncertainty estimates of CH_4 and N_2O emission factors for Public electricity and heat production and Manufacture of solid fuels and other energy industries is presented in Table A.II.1_2.

Table A.II.1_2. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Public electricity and heat production and Manufacture of solid fuels and other energy industries

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A, U_E
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	35%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –**Finnish[5]
Solid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	49%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –**Finnish[5]
Peat	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	60%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –**Finnish[5]
Gaseous fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	48%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –**Finnish[5]
Biomass	CH_4	5%	56%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]
	N_2O	5%	55%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]
Other fuels (waste)	CH_4	5%	60%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]
	N_2O	5%	59%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]

1.A.1.b Petroleum refining

There are no petroleum refining activities taking place in Estonia.

[5] Finnish National Inventory Document 2024.

1.A.1.c Manufacture of solid fuels and other energy industries

Uncertainty evaluation of CO_2 emissions of Manufacture of solid fuels and other energy industries is presented in subchapter Energy industries (1.A.1) and uncertainty estimates of CH_4 and N_2O emission factors in Table A.II.1_2 in subchapter 1.A.1.a Public electricity and heat production.

Manufacturing industries and construction (1.A.2)

Uncertainty evaluation of CO_2 emissions has been conducted for liquid, solid, gaseous, and other fuels used in Estonia in 2023. The data availability allows the estimation of uncertainty by a fuel type rather than by a sector in fuel combustion[1].

Incomplete details of source-specific measurement data of activities and emission factors lead to estimating quantitative uncertainty of CO_2 emission by using available estimates and the combination of available measured data;

Data has been taken from Statistics Estonia database.

In the estimation of uncertainty two main components have been considered:

- Uncertainty component for measurement procedure which provides the comparability of results.
- Uncertainty component for dispersion of the input quantity, which in some cases indicate the level of data disaggregation.

The calculation formula of combined uncertainty in emission u_E is given as Equation A.II.1_3:

Equation A.II.1_3

$$u_e = \sqrt{u_{AD}^2 + u_{EF}^2}$$

Where:

u_e = uncertainty of emissions;
u_{AD} = uncertainty of activity data;
u_{EF} = uncertainty of emission factor.

In gaining expanded uncertainty the coverage factor k=2 has been used to provide approximately 95% confidence level of the results (see Equation A.II.1_4):

Equation A.II.1_4[3]

$$U_E = 2 \times u_E$$

Where:

U_E= expanded uncertainty.

The uncertainty of CO_2 emission for fuel combustion in Energy category was evaluated separately for each fuel type. The key points of the evaluation are listed below:

- Liquid Fuels

All liquid fuels, except shale oil and residual fuel oil, are imported to Estonia. Quality requirements for liquid fuels and instrumentation were used in the evaluation of uncertainty of activity data and emission factors.

- Solid Fuels

There are two fuel types produced locally: oil shale and peat. The largest contribution to the uncertainty is caused by fluctuation in emission factors of those fuels.

- Gaseous Fuels

The gaseous fuels are imported to Estonia. Quality requirements for gaseous fuels and instrumentation were used in the evaluation of uncertainty of activity data and emission factors.

- Other Fuels

For calculation of uncertainty of CO_2 emission due to other fuels (waste fuels) combustion in the Energy category, Finnish uncertainty factors were used. The contribution to the total uncertainty of fuel combustion is rather small.

The uncertainty factors of carbon emission factors and activity data are presented in Table A.II.1_3. The largest uncertainty contribution 60% is caused by incomplete data of the emission factor of other fuels (waste fuels).

Table A.II.1_3. Estimated relative uncertainties of CO_2 emission due to Fuel combustion in Estonia in 2023[4]

GHG Source and Sink Categories	Gas	Uncertainty of activity data, %	Uncertainty of emission factor, %	Combined relative uncertainty, %
Liquid fuels	CO_2	1.7	1.8	2.5
Solid fuels and peat	CO_2	3.3	38.9	39.0
Gaseous fuels	CO_2	1.4	3.6	3.9
Other fuels	CO_2	5	60	60.2

As the Good Practice Guidance does not give CH_4 emission factors uncertainty estimations (U_E) for biomass, and N_2O emission factors (U_E) for biomass and fossil fuels, those factors have been taken from the Finnish 2024 national inventory.

Detailed uncertainties information of CH_4 and N_2O emissions for each subsector is presented in the subchapters below.

1.A.2.a Iron and steel

Uncertainty evaluation of CO_2 emissions of Iron and steel is presented in subchapter Manufacturing industries and construction (1.A.2). Uncertainty estimates of CH_4 and N_2O emission factors for Iron and steel, Non-ferrous metals, Chemicals Pulp, paper and print, Food processing, beverages and tobacco, Non-metallic minerals and Other is presented in Table A.II.1_4.

Table A.II.1_4. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Iron and steel, Non-ferrous metals, Chemicals Pulp, paper and print, Food processing, beverages and tobacco, Non-metallic minerals and Other

Source and Sink	**GHG**	**Activity data uncertainty U_A**	**Emission factor uncertainty U_E**	**Reference U_A. U_E**
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	43%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –**Finnish[5]
Solid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	53%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –**Finnish[5]
Peat	CH_4	5%	55%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	56%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –**Finnish[5]
Gaseous fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	35%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –**Finnish[5]
Biomass	CH_4	5%	29%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]
	N_2O	5%	39%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]

1.A.2.b Non-ferrous metals

Uncertainty evaluation of CO_2 emissions of Non-ferrous metals is presented in subchapter Manufacturing industries and construction (1.A.2) and uncertainty estimates of CH_4 and N_2O emission factors in Table A.II.1_4. in subchapter 1.A.2.a Iron and steel.

1.A.2.c Chemicals

Uncertainty evaluation of CO_2 emissions of Chemicals is presented in subchapter Manufacturing industries and construction (1.A.2) and uncertainty estimates of CH_4 and N_2O emission in Table A.II.1_4 in subchapter 1.A.2.a Iron and steel.

1.A.2.d Pulp, paper and print

Uncertainty evaluation of CO_2 emissions of Pulp, paper and print is presented in subchapter Manufacturing industries and construction (1.A.2) and uncertainty estimates of CH_4 and N_2O emission in Table A.II.1_4 in subchapter 1.A.2.a Iron and steel.

1.A.2.e Food processing, beverages and tobacco

Uncertainty evaluation of CO_2 emissions of Food processing, beverages and tobacco is presented in subchapter Manufacturing industries and construction (1.A.2) and uncertainty estimates of CH_4 and N_2O emission in Table A.II.1_4 in subchapter 1.A.2.a Iron and steel.

1.A.2.f Non-metallic minerals

Uncertainty evaluation of CO_2 emissions of Non-metallic minerals is presented in subchapter Manufacturing industries and construction (1.A.2) and uncertainty estimates of CH_4 and N_2O emission in Table A.II.1_4 in subchapter 1.A.2.a Iron and steel.

1.A.2.g Other

Uncertainty evaluation of CO_2 emissions of Other is presented in subchapter Manufacturing industries and construction (1.A.2) and uncertainty estimates of CH_4 and N_2O emission in Table A.II.1_4 in subchapter 1.A.2.a Iron and steel.

Transport (1.A.3)

Uncertainty evaluation of CO_2 emissions has been conducted for liquid, solid, gaseous, and other fuels used in Estonia in 2023. The data availability allows the estimation of uncertainty by a fuel type rather than by a sector in fuel combustion[1].

Incomplete details of source-specific measurement data of activities and emission factors lead to estimating quantitative uncertainty of CO_2 emission by using available estimates and the combination of available measured data;

Data has been taken from Statistics Estonia database.

In the estimation of uncertainty two main components have been considered:

- Uncertainty component for measurement procedure which provides the comparability of results.
- Uncertainty component for dispersion of the input quantity, which in some cases indicate the level of data disaggregation.

  The calculation formula of combined uncertainty in emission u_E is given as

  Equation A.II.1_5:

Equation A.II.1_5[6]

$$u_e = \sqrt{u_{AD}^2 + u_{EF}^2}$$

Where:

u_e = uncertainty of emissions;
u_{AD} = uncertainty of activity data;
u_{EF} = uncertainty of emission factor.

In gaining expanded uncertainty the coverage factor k=2 has been used to provide approximately 95% confidence level of the results (see Equation A.II.1_6):

[6] IPCC 2006 Guidelines, Volume 1, Chapter 3; Uncertainties, page 3.28, equation 3.1

Equation A.II.1_6[7]

$$U_E = 2 \times u_E$$

Where:

U_E= expanded uncertainty.

The uncertainty of CO_2 emission for fuel combustion in Energy category was evaluated separately for each fuel type. The key points of the evaluation are listed below:

- Liquid Fuels

All liquid fuels, except shale oil and residual fuel oil, are imported to Estonia. Quality requirements for liquid fuels and instrumentation were used in the evaluation of uncertainty of activity data and emission factors.

- Gaseous Fuels

The gaseous fuels are imported to Estonia. Quality requirements for gaseous fuels and instrumentation were used in the evaluation of uncertainty of activity data and emission factors.

The uncertainty factors of carbon emission factors and activity data are presented in Table A.II.1_5.

Table A.II.1_5. Estimated relative uncertainties of CO_2 emission due to Fuel combustion in Estonia in 2023[8]

GHG Source and Sink Categories	Gas	Uncertainty of activity data, %	Uncertainty of emission factor, %	Combined relative uncertainty, %
Liquid fuels	CO_2	1.7	1.8	2.5
Gaseous fuels	CO_2	1.4	3.6	3.9

Detailed uncertainties information of CH_4 and N_2O emissions for each subsector is presented in the subchapters below.

1.A.3.a Domestic aviation

Uncertainty evaluation of CO_2 emissions of Domestic aviation is presented in subchapter Transport (1.A.3) and uncertainty estimates of CH_4 and N_2O emission factors in Table A.II.1_6.

Table A.II.1_6. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Domestic aviation

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A. U_E
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41

[7] IPCC 2006 Guidelines, Volume 1, Chapter 3; Uncertainties, page 3.8, Basis for uncertainty analysis

[8] IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories.

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A. U_E
	N_2O	5%	146%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]

1.A.3.b Road transportation

Uncertainty evaluation of CO_2 emissions of Road transport is presented in subchapter Transport (1.A.3) and uncertainty estimates of CH_4 and N_2O emission factors in Table A.II.1_7.

Table A.II.1_7. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Road transport

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A. U_E
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	149%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Gaseous fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	147%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]

1.A.3.c Railways

Uncertainty evaluation of CO_2 emissions of Railways is presented in subchapter Transport (1.A.3) and uncertainty estimates of CH_4 and N_2O emission factors in Table A.II.1_8.

Table A.II.1_8. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Railways

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A. U_E
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	150%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]

1.A.3.d Domestic navigation

Uncertainty evaluation of CO_2 emissions of Domestic naviation is presented in subchapter Transport (1.A.3) and uncertainty estimates of CH_4 and N_2O emission factors in Table A.II.1_9.

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Table A.II.1_9. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Domestic navigation

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A. U_E
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	103%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]

1.A.3.e Other transportation

Uncertainty evaluation of CO_2 emissions of Other transportation is presented in subchapter Transport (1.A.3) and uncertainty estimates of CH_4 and N_2O emission factors in Table A.II.1_10.

Table A.II.1_10. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Other transportation

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A. U_E
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	149%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]

Other sectors (1.A.4)

Uncertainty evaluation of CO_2 emissions has been conducted for liquid, solid, gaseous, and other fuels used in Estonia in 2023. The data availability allows the estimation of uncertainty by a fuel type rather than by a sector in fuel combustion[1].

As the Good Practice Guidance does not give CH_4 emission factors uncertainty estimations (U_E) for biomass, and N_2O emission factors (U_E) for biomass and fossil fuels, those factors have been taken from the Finnish 2024 national inventory.

The estimated relative uncertainites of CO_2 emissions due to fuel combustion are presented in Table A.II.1_11 in Energy industries (1.A.1) Chapter.

Detailed uncertainties information of CH_4 and N_2O emissions for each subsector is presented in the subchapters below.

1.A.4.a Commercial/institutional

Table A.II.1_11. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Commercial/institutional

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A. U_E
1.A.4.a Commercial/institutional				
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A, U_E
	N_2O	5%	35%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Solid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	60%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Gaseous fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	40%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Biomass	CH_4	5%	150%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	127%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Peat	CH_4	5%	122%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]
	N_2O	5%	132%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]

1.A.4.b Residential

Table A.II.1_12. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Residential

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A, U_E
1.A.4.b Residential				
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	35%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Solid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	60%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Gaseous fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	40%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Biomass	CH_4	5%	150%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	127%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Peat	CH_4	5%	122%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]
	N_2O	5%	132%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]

1.A.4.c Agriculture/forestry/fishing

Table A.II.1_13. Summary of uncertainty estimates of CH_4 and N_2O emission factors and activity data (95% confidence interval) for Agriculture/forestry/fishing

Source and Sink	**GHG**	**Activity data uncertainty U_A**	**Emission factor uncertainty U_E**	**Reference U_A. U_E**
1.A.4.c Agriculture/forestry/fishing				
Liquid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	35%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Solid fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	60%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Gaseous fuels	CH_4	5%	50%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	40%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Biomass	CH_4	5%	150%	**U_A** – IPCC GPG, Table 2.6, p. 2.41 **U_E** – IPCC GPG, Table 2.5, p. 2.41
	N_2O	5%	127%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E** –Finnish[5]
Peat	CH_4	5%	122%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]
	N_2O	5%	132%	**U_A –** IPCC GPG, Table 2.6, p. 2.41 **U_E –** Finnish[5]

Oil and Natural Gas and other emissions from energy production (1.B.2)

1.B.2.b Natural gas

2006 IPCC *Tier 1* method is used to estimate the uncertainties in this category.

Uncertainties of activity data (± 3%) and emission factors (± 25%) are taken from the IPCC Good Practice Guidance.

Table A.II.1_14. Summary of uncertainty estimates of CH_4 and CO_2 emission factors and activity data (95% confidence interval) for Natural gas

Source and Sink	**GHG**	**Activity data uncertainty U_A**	**Emission factor uncertainty U_E**	**Reference U_A. U_E**
1.B.2.b Natural gas				
Natural gas	CH_4	3%	25%	**U_A** – IPCC GPG, p. 2.92 **U_E** – IPCC GPG, p. 2.92
	CO_2	3%	25%	**U_A –** IPCC GPG, p. 2.92 **U_E –** IPCC GPG, p. 2.92

1.B.2.c Venting and flaring

Table A.II.1_15. Summary of uncertainty estimates of CH_4 and CO_2 emission factors and activity data (95% confidence interval) for Venting and flaring

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A, U_E
1.B.2.c Venting and flaring				
Natural gas	CH_4	15%	25%	U_A – IPCC GPG, p. 2.92 U_E – IPCC GPG, p. 2.92
	CO_2	15%	25%	U_A – IPCC GPG, p. 2.92 U_E – IPCC GPG, p. 2.92

A.II.2 IPPU

2.A Mineral industry

2.A.1 Cement production

The uncertainties of activity data and emission factors of clinker as well kiln dust production were provided by the plant operators. During the period of 1990-2020 Estonia had only one plant producing clinker and cement and this plant was also part of the European Union Emissions Trading System (EU ETS). Under the EU ETS, businesses must monitor and report their emissions for each calendar year and have their emission reports checked by an accredited verifier. The uncertainty of activity data in 2020 was 0.024%, the uncertainty of the emission factor was 1.245%. The overall uncertainty was 1.25%.

For overall uncertainty of EF uncertainties of EF-s of clinker and kiln dust were combined by addition[9]. EF-s of both materials were based on chemical analysis of CaO, MgO and free lime. During the 2020 submissions´ centralized review, the review team noted (question I.1) that the influence from possible errors in the chemical analysis on the final uncertainty value was not explained in the NIR. In response to the ERT question during the review, Estonia clarified that the uncertainty of EF is combined (by addition) from the uncertainty of EF of clinker and that of kiln dust and that uncertainties of EFs of both materials consist of uncertainties of chemical analyses of CaO, MgO. For the overall emission uncertainty, the uncertainties of EF and AD are combined by multiplication. The uncertainty of AD is the uncertainty of weighing clinker and kiln dust and does not include chemical analysis. During the review of the annual submission of Estonia submitted in 2020, TERT asked for additional information how uncertainty is calculated[10]. As a response, the plant provided information that they are using World Business Council for Sustainable Development methodology for calculations and provided methodology approval documentation signed by the Minister of the Environment.

The uncertainties of the quantities presented by the company's GHG emissions report are calculated based on the formula, which was provided in the guidelines for the implementation of the Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting

[9] IPCC 2006 Guidelines, Volume 1, Chapter 3, page 3.28, equation 3.2
[10] FCCC/ARR/2020/EST/I.1

of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council – Guidance on Uncertainty Assessment (MRR Guidance document No. 4).

The uncertainty of the activity data of clinker and kiln dust is calculated by using activity data reported by the company and the uncertainty of the scale used to weigh raw materials in the factory. The activity data used in the calculations is the same that is reported in the EU ETS report. The uncertainty of the calibrated scale used to weigh the amounts of the raw mixtures is 0.025.

The uncertainty of the emission factor:

The value of the emission factor of clinker has been calculated according to the measurements of CaO, MgO and free lime content in the clinker made in the laboratory and the calculations of the value of the specific emission factor Calc B2 using the WBCSD CSI version 3.1 methodology with a plant specific clinker uncertainty of 0.007 tCO2/t provided by the company.

The value of the emission factor of kiln dust has been calculated according to the annual weighted average measurements of the CaO, MgO and free lime content carried out in the laboratory, and based on the mentioned results, the emission coefficient calculations made with the WBCSD CSI version 3.1 methodology with a plant specific clinker uncertainty of 0.007 tCO2/t provided by the company. The emission factors of clinker and kiln dust vary from year to year as they are calculated each year taking into account the content of CaO, MgO and free lime.

The overall emission uncertainty:

The overall emission uncertainty is calculated using the uncertainty of the scale used to weigh raw materials (0.0025) and the uncertainty of the emission factor. Possible errors in the chemical analysis affect the final uncertainty values, as the uncertainty of the emission factor (where EFs of clinker and kiln dust already contain possible errors of chemical analyses of CaO, MgO and free lime) is included in the calculation of the overall uncertainty.
The calculation explanations above were given by the company. The Ministry of the Environment (now Ministry of Climate) has also approved the use of the calculation method with an approval document.

2.A.2 Lime production

The uncertainty of tonnes of produced lime is 0.18%. This is combined uncertainty of two largest lime producer´s output.

The default value of EF uncertainty 2%, is used for lime production[11].

The percentage of CaO and MgO in the lime differs from year to year because of differences in the quality of raw material. The EFs of CaO and MgO are calculated based of the ratio of molecular weight of CO2 to CaO/MgO.

2.A.3 Glass production

The plant estimated the activity data uncertainty to be at ±0.32%. Uncertainty of the emission factor is estimated at ±1% as suggested in IPCC 2006 Guidelines[12].

[11] IPCC 2006 Guidelines,Volume 3, Chapter 2, Table 2.5.
[12] IPCC 2006 Guidelines, Volume 3, Chapter 2, page 2.31.

2.A.4 Other process uses of carbonates

2.A.4.a Ceramics

Bricks and roof tiles production

The largest producer estimated the total uncertainty to be about 2%. The uncertainty of activity data is estimated at ±0.1% (by the supplier of limestone filler) and consists of uncertainty of limestone weighing.

Uncertainty of the emission factor was estimated at ±2%, which consists mainly of the uncertainty of chemical analysis for carbonate content.

The total uncertainty is ±2%. The effect of uncertainties of small producers' emissions on the total uncertainty is minimal because its emissions are 0.1% of the total emissions.

Lightweight gravel production

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The emission factor uncertainty was estimated at ±5%. The emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon calcinations of the carbonate.

The uncertainty of activity data is estimated at ±10%. The uncertainty of activity data took into account the uncertainty associated with weighing and proportioning the carbonates in clay and the uncertainty associated with the assumption of a default breakdown of limestone and dolomite of 85%/15%.

2.A.4.d Limestone use for flue gas desulphurisation

The uncertainty of activity data was estimated by the plants at ±0.1%.

The uncertainty of the emission factor depends on the accuracy of chemical analysis. The emission factor uncertainty in 2015- 2017 was estimated to be ±2% by the production facility which is in the middle of the range of default values (1–3%) suggested by the IPCC 2006 Guidelines[13].

2.B Chemical industry

2.B.1 Ammonia production

The uncertainty of activity data was provided by the plant, and it was ±1% in 2013. The uncertainty of emission factor was determined mainly by the carbon content of natural gas and uncertainty of weighing carbamide of which carbon is subtracted from emissions. For carbon content uncertainty the same uncertainty value for natural gas carbon content as in the Energy sector – ±3.6% – was used. Uncertainty of weighing carbamide was 2% according to the plant operator. The carbon oxidation coefficient has negligible uncertainty. The uncertainty of EF is $\sqrt{(3.6^2+2^2)}$= 4.1%. Total uncertainty was $\sqrt{(1^2+4.1^2)}$ = 4.2% in 2013.

[13] IPCC 2006 Guidelines, Volume 3, Chapter 2, page 2.39.

2.C Metal industry

2.C.5 Lead production

The uncertainty of activity data is default value for *Tier 3* method ±5%[14]. Uncertainty of emission factor is also 5% – the default value for *Tier 3*.

Emissions from rare and rare earth metals and compounds industry (reported under CRT category 2.C.5 Lead production aggregated with emissions from lead production)

The uncertainty of the emission factor for this category estimated at ±5%. The emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon decomposition of the carbonate.

The uncertainty of activity data is estimated at ±3% as suggested in the 2006 IPCC Guidelines[15]. The overall uncertainty of category 2.C.5 is 5.83%.

2.D Non-Energy products from fuels and solvent use

2.D.1 Lubricant use

Statistics Estonia estimated the uncertainty of activity data (international trade) to be 5%, which is the same value as suggested in the IPCC 2006 Guidelines (section 5.2.3.2). For ODU, the default uncertainty of 50% was used. For carbon content, the coefficient the default uncertainty of ±3% was used.

2.D.2 Paraffin wax use

Uncertainty of activity data on paraffin wax consumption is estimated to be ca 20% for the years 2007–2023[16]. For earlier years, the uncertainty of activity data is estimated to be 50% because the emissions were calculated on estimates.

For carbon content coefficient the default uncertainty of ± 5% was used.

The applied default ODU factor 0.2 has an uncertainty of about 100%.

2.D.3 Other

Urea based catalysts for motor vehicles

1. Uncertainty of activity data consists of:

   - uncertainty of diesel fuel consumption, which is 1.7% according to a country-specific study[17] done by the Estonian Central Office of Metrology;
   - uncertainty of consumption of DEF per diesel fuel unit. The default average consumption of DEF per fuel consumption is 1–3%[18]. Assuming that the average value is somewhere in

[14] IPCC 2006 Guidelines, Volume 3, Chapter 4, page 4.76, table 4.23
[15] IPCC 2006 Guidelines, Volume 3, Chapter 2, page 2.39, section 2.5.2.2.
[16] IPCC 2006 Guidelines, Volume 3, Chapter 5, page 5.13 section 5.3.3.2.
[17] AS Metrosert (Estonian Central Office of Metrology) (2007). Uncertainty estimation of CO_2 emission in Estonian national greenhouse gas inventory in 2004. Report.
[18] IPCC 2006 Guidelines, Volume 2, Chapter 3, page 3.12.

the higher end of this range as told by Estonian fuel wholesalers, the uncertainty is estimated to be about 30%.

The combined uncertainty of activity data is $\sqrt{(1.7^2+30^2)}=30\%$

2. Uncertainty of emission factor depends mainly on uncertainty of urea concentration in DEF. It is assumed that the concentration range matches the quality standard for aqueous ISO 22241-1:2006 Diesel engines –NO_x reduction agent AUS32 –Part 1: Quality requirements which suggests that concentration is 32.5 ± 0.7%. Therefore, the emission factor uncertainty is 0.7%.

The total uncertainty of emissions from catalysts for motor vehicles is therefore: $\sqrt{(0.7^2+30^2)}=30\%$.

Solvent use

As Estonia has developed a detailed inventory for these sources, the uncertainty of activity data is estimated to be the default value of 25% (as suggested in the IPCC 2006 Guidelines[19]).

Uncertainties of indirect CO_2 from Solvent use were estimated based on the uncertainties of respective NMVOC emissions. For CO_2 emission factor uncertainty, the default value of 10% was used. The uncertainty of emission factor considered the fact that the default fossil carbon content fraction of NMVOC is 60% by mass and can vary between 50–70%.

Road paving with asphalt

The uncertainty of activity data (production of hot asphalt mix) is estimated at ±10%. The uncertainty of NMVOC emission factor for total hot asphalt mix (batch and drum hot mix) production is estimated at ±100% as suggested in the IPCC 2006 Guidelines[20].

The uncertainty of the average carbon content of NMVOCs is 10%. The combined emission factor of indirect CO_2 is $\sqrt{(100^2+10^2)}=100\%$.

2.F Product uses as substitutes for ODS

2.F.1 Refrigeration and air conditioning

2.F.1.a Commercial refrigeration

The uncertainty of the three-activity data 'Filled in new manufactured products', 'HFC stock in operating systems' and 'Remained in products at decommissioning' is estimated at ± 8.9% (0.10). The reviews of the 2020 and 2022 submissions gave recommendation to improve accuracy and completeness of data collected for 2.F.1 subsector (I.7, 2020) in commercial refrigeration subsector. The uncertainty of activity data results mainly from estimations in the determination of the total HFC stock. The collected activity data was more complete than in 2020 and therefore the estimated stock was smaller. The estimated stock comprises mainly from difference of the number of supermarkets present and the number of those which HFC amount is known. The amount HFC-

[19] IPCC 2006 Guidelines, Volume 3, Chapter 5, page 5.17, section 5.5.4.
[20] IPCC 2006 Guidelines, Volume 3, Chapter 5, page 5.16, section 5.4.4.

s in unknown small shops also contributes to activity data uncertainty. Low-GWP refrigerants were reported by 9 of 16 service companies.

The activity data has been collected partly from the FOKA registry (registry for equipment containing F-gases and ozone depleting substances) and partly by questionnaires sent to service companies per e-mails. Data on refilling has been collected by questionnaires sent to service companies per e-mails because data from the FOKA database was incomplete.

The uncertainty of the EF is not changed improved in comparison with previous submission. Activity data of clients of 14 service companies was used, only 9 of them gave refilling data and the refilling data of the rest contributed to the uncertainty. The uncertainty of EF is 41.1%.

The combination of the uncertainty of activity data 8.9% with the respective emission factor (± 41.1%) results in the UN of manufacturing, operating and disposal HFC emissions of ± ~42.0%.

2.F.1.b Domestic refrigeration (CRT 2.F.1.b)

The data are based on direct information from industry, so that the UN of the activity data on the number of units (stock, annual importation, annual decommissioning) is estimated to be (± 20%). The UN of the emission factor is assessed at ± ~10%, so that the combined UN of the emissions (operating and disposal) is estimated to be ± 22%.

2.F.1.c Industrial refrigeration

The uncertainty of the three-activity data ‘Filled in newly manufactured products’, ‘HFC stock in operating systems’ and ‘Remained in products at decommissioning’ is estimated ± 9.1% The uncertainty results from estimations in the determination of the total HFC stock. The UNFCCC reviews of the 2020 (I.7,2020) and 2022 observation gave recommendation to improve accuracy and completeness of data collected for 2.F.1 subsector in industrial refrigeration subsector.

The activity data has been collected partly from the FOKA registry and partly by questionnaires sent to service companies per e-mails. Data on refilling has been collected by questionnaires sent to service companies per e-mails.

Activity data from 14 service companies was used and 6 of them provided refilling data. The refilling data of the rest contributed to the uncertainty. The uncertainty of EF is 17.7%. The combination of this value with the UN of the respective emission factor (± 9.1%) results in the UN of emissions of ± 19.9%.

2.F.1.d Transport refrigeration

Refrigerated vehicles

The uncertainty of the two activity data ‘First fill of new equipment’ and ‘HFC stock in operating vehicles’ is estimated ± 8.5%, which is the combination of the individual uncertainty of a) total registrations (new or operating) by weight categories in 2018 (± 1%), b) refrigerant charges (± 6%) and c) refrigerant split into R-134a, R-404A and R-452A (± 6%).

The combination of the uncertainty of new fill or of stock (± 8.5%) with the uncertainty of the respective emission factors (± 5%) results in the uncertainty of both manufacturing and operating HFC emissions of ± 10%.

Reefer containers

The combination of the individual uncertainties follows approach 1 of the 2006 IPCC Guidelines.

The uncertainty of the basic activity data 'worldwide HFC stock' is the same as in the German inventory: ± 8.4%, which is the combination of the individual uncertainty of a) number of units (± 3%), b) HFC-charges (± 5%), c) HFC-split (± 6%).

The uncertainty of the Estonia share in world trade is estimated at ± 3%, and the uncertainty of the operating emission factor ± 5%. The combined uncertainty of the HFC emissions (both 134a and 404A) can be calculated ± 10%.

2.F.1.e Mobile air-conditioning

Passenger cars

For the combination of individual uncertainties approach 1 of the IPCC 2006 Guidelines was applied.

The UN of the basic activity data 'HFC stock' is estimated ± 8.5%, which is the combination of the individual UN of a) total registrations in 2017 (± 1%), b) MAC quotas (± 6%), c) refrigerant charges (± 6%) – with most quotas and charges being taken from Germany.

The combination of the UN of the stock (± 8.5%) with the UN of the operating emission factors (± 5%) results in the UN of the HFC emissions of ± 10%.

Trucks

For the combination of individual uncertainties approach 1 of the IPCC 2006 Guidelines was applied.

The UN of the basic activity data 'HFC stock' is estimated at ± 8.5%, which is the combination of the individual UN of a) total registrations by weight categories in 2020 (± 1%), b) MAC quotas (± 6%), c) refrigerant charges (± 6%) – with quotas and charges being taken from Germany.

The combination of the UN of the stock (± 8.5%) with the UN of the operating emission factors (± 5%) results in the UN of the HFC emissions of ± 10%.

Buses

For the combination of individual uncertainties approach 1 of the IPCC 2006 Guidelines was applied.

The UN of the basic activity data 'HFC stock' is estimated at ± 8.7%, which is the combination of the individual UN of a) total registrations in 2017 (± 1%), b) bus split (± 5%), c) MAC quota (± 5%), d) refrigerant charge (± 5%).

The combination of the UN of the stock (± 8.7%) with the UN of the operating emission factor (± 5%) results in the UN of the HFC emissions of ± 10%.

Ships

The data on refills are reliable and complete. Consequently, the uncertainty of the HFC emissions is estimated at ± 5%.

Railcars

The emissions uncertainty was assessed by the Öko-Recherche experts in 2007 and the combination of individual uncertainties approach 1 of the IPCC 2006 Guidelines was applied.

The uncertainty of the basic activity data 'HFC stock' is estimated at ± 3%, which is the combination of the individual uncertainty of a) number of operating vehicles with air conditioning in 2023 (± 0%), and b) refrigerant charges (± 3%).

The combination of the uncertainty of the stock (± 3%) with the uncertainty of the operating emission factors (± 5%) results in the uncertainty of the HFC emissions of ± 5.8%.

Wheel tractors and mobile machinery

For the combination of individual uncertainties, approach 1 of the IPCC 2006 Guidelines was applied.

The uncertainty of the basic activity data 'HFC stock' is estimated ± 14.5% for every vehicle type, which is the combination of the individual uncertainty of a) total registrations by vehicle types in 2017 (± 3%), b) MAC quotas (± 10%), c) refrigerant charges (± 10%).

The combination of the uncertainty of the stock (± 14.5%) with the uncertainty of the operating emission factors (± 10%) results in the uncertainty of the HFC emissions of ± 17.6%.

2.F.1.f Stationary air-conditioning

Heat pumps

The data on heat pumps are deemed precise because the relevant associations, companies and experts for heat pumps and refrigeration systems in Estonia provided them.

The uncertainty of the three-activity data 'Filled in newly manufactured products', 'HFC stock in operating systems' and 'Remained in products at decommissioning' is estimated at ± 9%. The emission factors are estimated ± 5%. The combination of the uncertainty of the three-activity data with the uncertainty of the emission factors results in the uncertainty of the HFC emissions of ± 10.3%.

Stationary and room air-conditioning

The relevant associations, companies and experts in Estonia very roughly estimated the data on stationary A/C systems, especially data on emission factors of split systems and chillers.

The uncertainty of the activity data HFC consumption and stock is estimated at ± 15%. The uncertainty of the ventilation emission factors is ± 10%. The EF for chillers and split systems are more uncertain (± 26%); they are supposed to be too low. The combination of the uncertainty of stock/consumption with the uncertainty of the (given) emission factors result in the uncertainty of the HFC emissions of ± 30% (chillers, splits), and ± 18% (ventilation systems).

2.F.2 Foam blowing agents

2.F.2.a Closed cells

PU insulation panels

For the combination of individual uncertainties approach 1 of the IPCC 2006 Guidelines was applied.

The UN of the basic activity data 'HFC stock' is estimated at ± >10% because it is based on both official statistical data and expert judgment.

The combination of the UN of the stock (± >10%) with the UN of the operating emission factor (± 10%) results in the UN of the HFC emissions of ± 14%.

Spray and injection foam

The UN of the basic activity data 'HFC consumption' is estimated at ± >10% because it is based on sales data and expert judgment. The combination of the UN of the consumption (± >10%) with the UN of the manufacturing emission factor (FYL) of ± 10% results in the UN of the HFC emissions of ± 14%.

XPS insulation foam

No official statistical data on the XPS board consumption in Estonia is available. Thus, the annual sales and the current stock of XPS foam with HFC-134a had to be calculated with sector experts. The UN of the activity data 'HFC stock' is estimated at ± 20%. The uncertainty of the emission factor is estimated at 10% so that the UN of the annual use-phase emissions is ± 22.36%.

2.F.2.b Open cells

One component PU foam

The emissions as the domestic and foreign manufacturers uncertainty (UN) was assessed in 2007 by the Öko-Recherche experts. Provided all the relevant data, the data uncertainty is estimated low. The uncertainty of the annual HFC consumption and – consequently – use-phase emissions by the quantity and HFC type is ± 15%. The same value applies to manufacturing emissions.

PU integral skin foam

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts in 2007. The UN of the activity and emissions data 'HFC consumption' is estimated at only ± 3% because it is based on information of the only user.

2.F.3 Fire protection

The estimation for emissions uncertainty (UN) was provided by the Öko-Recherche experts in 2007 according to approach 1 of the IPCC 2006 Guidelines. The data are based on direct information from industry, so that the UN of the data on the different HFC stocks can be estimated comparably low (± 10%). The UN of the emission factor is assessed ± ~10%, so that the combined UN of the emissions is estimated ± 14%.

2.F.4 Aerosols

2.F.4.a Metered dose inhalers

The data are based on direct information from manufacturers and from trade departments in industry, so that the activity data on domestic production and domestic market are deemed highly reliable. Consequently, the uncertainty of the emissions (manufacturing and use-phase) is estimated at ± 10%.

2.F.4.b Technical aerosols

The data are based on direct information from industry, so that the uncertainty of the activity data on the number of units and on charges can be estimated low (± 10%). The same uncertainty value applies to the emissions because the emission factor is 100%.

2.G Other product manufacture and use

2.G.1 Electrical equipment

Öko-Recherche experts assessed the emissions uncertainty (UN) in 2007 pursuant to approach 1 of the IPCC 2006 Guidelines. As the activity data are based on direct information from industry, their UN is estimated low: ± 3%. The UN of the default emission factors is ± 10% (IPCC 2006 GL, Tier 3). The combined UN of the emissions is ± ~10.4%.

2.G.2 SF_6 and PFCs from Other product use

2.G.2.b Accelerators

The data are based on the estimation of the operators. The emissions uncertainty is estimated at ± 30%.

2.G.2.d Adiabatic properties: Shoes and Tires

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts in 2007 according to approach 1 of the IPCC 2006 Guidelines.

Sport shoes

The data are based on direct information from industry, so that the UN of the activity data 'sales in year 2005' and 'emissions in 2008' can be estimated comparably low (± 10%).

Car tires

The activity data are rated reliable, and uncertainty estimated comparably low (± 10%).

2.G.3 N_2O from product use

2.G.3.a Medical applications

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The data are based on direct information from companies importing N_2O to Estonia and selling it to the Estonian market so that the uncertainty of activity data is estimated low: ± 5%. The uncertainty of the emission factor is assumed to be extremely small and is estimated at ± 2%.

2.G.3.b Propellant for pressure and aerosol products

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The data is mainly based on international trade statistics which uncertainty is estimated ± 5%. When combining this with the uncertainty N_2O content of the whipped cream cans – maximally 4% then the overall uncertainty of activity data is 6.4%. The uncertainty of the emission factor is assumed to be extremely small and is estimated at ± 2%.

A.II.3 Agriculture

3.A Enteric fermentation

The estimation of CH_4 emissions from Enteric fermentation of cattle and swine was carried out based on the *Tier 2* approach with Estonian activity data and default factors obtained from the IPCC Guidelines. The *Tier 1* method was used to estimate CH_4 emissions from other livestock: goats, horses, sheep, and fur animals.

Since the 2019 submission, country-specific uncertainty rates of activity data have been implemented for cattle, swine, and sheep calculations. The data for calculating their uncertainties were obtained from Statistics Estonia. Data of uncertainties of other livestock were obtained from the study of Rypdal and Winiwarter (2001), where uncertainties of activity data (livestock population) are presented for a few countries: Austria (±10%), Norway (±5–10%), the Netherlands (<±5%), USA (±2%). The experiences of Austria were used to calculate uncertainties in emissions from Enteric fermentation of livestock (Table A.II.3_1). The uncertainty in CH_4 emission factors for livestock categories (cattle, swine, sheep, goats, horses, fur animals) is reported to be ±40%[21].

Table A.II.3_1. Estimated values of uncertainties used in the Agriculture sector

Input	Uncertainty	References
Activity data		
Estonia's dairy cattle population	± 0.72%	Statistics Estonia
Estonia's non-dairy cattle population	± 1.11%	Statistics Estonia
Estonia's swine population	± 0.49%	Statistics Estonia
Estonia's sheep and goats population	± 6.53%	Statistics Estonia
Estonia's other livestock population (horses and fur animals)	± 10%	Rypdal and Winiwarter, 2001
Emission factors		
Enteric fermentation (CH_4) (cattle, swine, sheep, goats, horses, fur animals)	± 40%	IPCC, 2006. Agriculture. pp. 10.33

3.B Manure management

The estimation of CH_4 emissions from Manure management of cattle and swine was carried out based on the *Tier 2* approach with Estonian activity data and default factors obtained from the IPCC Guidelines. The *Tier 1* method was used to estimate CH_4 emissions from other livestock: goats, horses, sheep, poultry and fur animals.

[21] IPCC 2006 Guidelines, Volume 4, Chapter 10: Emissions from Livestock and Manure Management, page 10.33.

Uncertainties in the estimates of CH_4 emissions from sheep, goats, horses, and poultry manure management are reported in Table A.II.3_2.

Emission factors for cattle and swine were calculated using IPCC default parameters (volatile solids (VS), CH_4 producing capacity (B_0), methane conversion factors (MCF)), and Manure Management Systems (MMS) distributions.

N_2O emissions from livestock manure management were calculated based on activity data (livestock population), nitrogen excretion factors (Nex, kg/head/year) were calculated based on the nitrogen balance of animals and N emission factor related to MMSs. Despite the use of nitrogen balance, default uncertainty rates for Nex (by categories of livestock) were used from the IPCC Guidelines.

IPCC nitrogen emission factors default uncertainty estimates for all systems of manure management used in Estonia's estimates of N_2O emissions from animal manure are reported in Table A.II.3_2.

Uncertainties associated with indirect N_2O emission factors are presented under 3.D.2 Indirect emissions from managed soils discussing indirect N_2O EF uncertainty of Agricultural soils. Default IPCC 2006 uncertainty ranges for total N losses ($Frac_{LossMS}$)[22] are implemented in the estimates.

Table A.II.3_2. Estimated values of uncertainties used in the Agriculture sector

Category	Uncertainties	References
Activity data		
Estonia's dairy cattle population	± 0.72%	Statistics Estonia
Estonia's non-dairy cattle population	± 1.11%	Statistics Estonia
Estonia's swine population	± 0.49%	Statistics Estonia
Estonia's sheep and goats population	± 6.53%	Statistics Estonia
Estonia's other livestock population (horses, poultry, rabbits and fur animals)	± 10%	Rypdal and Winiwarter, 2001
Emission factors		
Manure management (CH_4) (cattle, swine)	± 20%	IPCC, 2006. Agriculture. p. 10.48
Manure management (CH_4) (sheep, goats, horses, fur animals)	± 30%	IPCC, 2006. Agriculture. p. 10.48
Manure management (N_2O)	-50... +100	IPCC, 2006. Agriculture. p. 10.66
Nitrogen excretion factor (Nex)	± 50%	IPCC, 2006. Agriculture. p. 10.66
Anaerobic lagoon	±25... ±50	IPCC, 2006. Agriculture. p. 10.67
Liquid system	±25... ±50	IPCC, 2006. Agriculture. p. 10.67
Solid storage	±25... ±50	IPCC, 2006. Agriculture. p. 10.67
Pasture/range and paddock	±25... ±50	IPCC, 2006. Agriculture. p. 10.67
Other systems (deep litter, poultry manure with bedding, anaerobic digestion)	±25... ±50	IPCC, 2006. Agriculture. p. 10.67

[22] IPCC 2006 Guidelines, Volume 4, Chapter 10: Emissions from Livestock and Manure Management, page 10.67, table 10.23 (Range of $Frac_{LossMS}$).

3.D Agricultural Soils

3.D.1 Direct N_2O emissions from managed soils

The estimation of N_2O emissions from synthetic fertilizers used was carried out based on activity data and emission factors.

Investigations made into the estimates of uncertainties related to the activity data (synthetic fertilizers applied on agricultural soils) are presented by Rypdal and Winiwarter[23]. The authors report uncertainties at ±5% in Austria, at ±5% in Norway, at ±10–50% in the Netherlands, at ±2% in the USA and at ±10% in Finland[24]. No similar research has been carried out in Estonia; therefore, the uncertainty of Finland was used in the estimates (Table A.II.3_III.).

Nitrogen emission factors have been used as the IPCC default in the estimates of N_2O emissions. The IPCC gives an uncertainty of the factor of ±80%, the factor is 0.0125 with a range of 0.0025–0.0225[25].

The estimation of N_2O emissions from animal manure applied and urine and dung deposited by grazing animals to soils was carried out based on activity data (amounts of nitrogen produced by livestock) and emission factors. Uncertainties of N generated were described in the 'Manure management' chapter above. The nitrogen emission factor was taken as the IPCC default.

The estimation of N_2O emissions from crop residues was carried out based on activity data (crop production) and emission factors (N emission factor, crop residue ratios, nitrogen content in crops and fraction of residues left on fields).

Since 2024 submission, uncertainty rates for crop residues were calculated by Statistics Estonia. Data on the uncertainty sewage sludge and compost application in Estonia is not available. In the second order draft of the LULUCF Good Practice Guidance, an uncertainty of <±20% in the amount of organic waste used as fertilizer is given. In the case of crop residues, the uncertainty of Finland was used in the estimates (Table A.II.3_3).

Table A.II.3_3. Estimated values of uncertainties used in the Agriculture sector

Input	Uncertainties	References
Activity data		
Synthetic fertilizers (applied to agricultural soils)	± 10%	Rypdal and Winiwarter, 2001
Cropland remaining cropland – mineral soils	33.24%	IPCC 2006; Kõlli et al., 2009[26]
Cropland remaining cropland – organic soils	21.41%	IPCC 2006
Sewage sludge, compost applied to soils	±20%	LULUCF GPG 2003
Crop residues	±7.59%	Statistics Estonia
Emission factors		

[23] Rypdal, K., Winiwarter, W. (2001). Uncertainties in greenhouses gas emission inventories – evaluation, comparability and implications. Environmental Science and Policy, no.4, p. 107–116.
[24] Monni, S., Syri, S. (2003). Uncertainties in the Finnish 2001 Greenhouse Gas Emission Inventory. VTT Research Notes, no. 2209. Espoo: Otamedia Oy, p. 55–56. .
[25] Revised 1996 IPCC Guidelines, Volume 3, Chapter 4: Agriculture, page 4.89.
[26] Kõlli, R., Ellermäe, O., Köster, T., Lemetti, I. Asi, E., Kauer, K. (2009). Stocks of organic carbon in Estonian soils. Estonian Journal of Earth Sciences, 58 (2), p. 95–108.

Input	Uncertainties	References
EF_1 (mineral fertilizers, organic amendments, crop residues, N mineralized from soil as a result of the loss of soil carbon), kg N_2O–N/kg N	0.003–0.03	Table 11.1 of the 2006 IPCC Guidelines, pp. 11.11
EF_2 for temperate organic crop and grassland soils, kg N_2O–N/ha	2–24	Table 11.1 of the 2006 IPCC Guidelines, pp. 11.11
EF_{3PRP} for cattle (dairy, non-dairy and buffalo), poultry and pigs, kg N_2O–N/ (kg N)	0.007–0.06	Table 11.1 of the 2006 IPCC Guidelines, pp. 11.11
$EF3_{PRP}$, SO for sheep and 'other animals', kg N_2O–N / kg N	0.003–0.03	Table 11.1 of the 2006 IPCC Guidelines, pp. 11.11

3.D.2 Indirect N_2O emissions from managed soils

Atmospheric deposition

The estimation of N_2O emissions from Atmospheric deposition was carried out based on activity data (synthetic fertilizers, organic amendments applied to soils, urine and dung deposited by grazing animals) and emission factors.

Nitrogen (N_2O) emission factor was used from IPCC, 2006. IPCC Guidelines provide the factor at 0.01 with a range of 0.002–0.05.

Nitrogen leaching and run-off

The estimation of N_2O emissions from Nitrogen leaching was carried out based on activity data (synthetic fertilizers, organic amendments applied to soils, urine and dung deposited by grazing animals and crop residues) and emission factors (fraction of the synthetic fertilizers, organic amendments applied to soils, urine and dung deposited by grazing animals, crop residues and nitrogen lost to leaching and surface run-off and N_2O emission factor).

N_2O emission factor is reported from IPCC 2006 GL. The value of the factor is 0.0075 with a range of 0.0005–0.025 (Table A.II.3_4)

Table A.II.3_4. Estimated values of uncertainties used in the Agriculture sector

Input	Uncertainties	References
Fraction of synthetic N fertilizers that volatilize as NH_3 and NO_x	0.03–0.3	IPCC 2006, Table 11.3, p-11.24
Fraction of organic N fertilizers applied, and dung and urine deposited by grazing animals that volatilize as NH_3 and NO_x	0.05–0.5	IPCC 2006, Table 11.3, p-11.24
Emission factor (Atmospheric deposition)	0.002–0.05	IPCC 2006, Table 11.3, p-11.24
Emission factor (N leaching and run-off)	0.0005–0.025	IPCC 2006, Table 11.3, p-11.24
Fraction of the fertilizer and manure nitrogen lost to leaching and surface run-off	0.1–0.8	IPCC 2006, Table 11.3, p-11.24

3.G Liming

CO_2 emissions from liming are estimated in line with the IPCC 2006 GL. Activity data were obtained from the Estonian NFI, national statistics and the Ministry of Regional Affairs and Agriculture, emission factors were employed from IPCC 2006 and uncertainties from GPG-

LULUCF 2003. The uncertainty rates of activity data and the emission factors used are reported in Table A.II.3_5.

Table A.II.3_5. Uncertainties in the Liming category

IPCC category		Uncertainties %		EF references
		Activity data[27]	Emission factors	
5.B\5(IV)	CO_2 emissions from agricultural lime application	29.15	50	LULUCF GPG 2003

3.H Urea application

For the uncertainty of the emission factor, default values (-50%) associated with the EF specified in the 2006 IPCC Guidelines were applied. For activity data, 2% of the weighing uncertainty for the urea fertilizer sales records of LLC Nitrofert were applied in the calculations.

A.II.4 LULUCF

Forest land (4.A)

Uncertainties of activity data and emission factors are presented in Table A.II.4_1. All activity data uncertainty estimates are obtained from the National Forest Inventory (NFI). Emission factor uncertainties are from the NFI, 2006 IPCC Guidelines, Wetlands Supplement, Swedish NIR and national publications, or based on expert judgement.

Table A.II.4_1. Uncertainties in the Forest land category

IPCC category		Activity data, %	Emission factor, %	EF References
4.A.1	Forest land remaining forest land – living biomass	2.9	50.0	IPCC 2006, NFI
4.A.1	Forest land remaining forest land – dead wood	5.5	50.0	Köster et al. 2015, IPCC 2006
4.A.1	Forest land remaining forest land – mineral soils	2.8	60.0	Expert judgement
4.A.1	Forest land remaining forest land – organic soils	6.0	90.0	IPCC 2006
4.A.2	Land converted to forest land – living biomass	32.3	50.0	IPCC 2006, NFI
4.A.2	Land converted to forest land – dead wood	63.4	50.0	Köster *et al*. 2015, IPCC 2006
4.A.2	Land converted to forest land – litter	21.1	50.0	NIR Sweden
4.A.2	Land converted to forest land – mineral soils	22.9	60.0	Expert judgement
4.A.2	Land converted to forest land – organic soils	46.8	90.0	IPCC 2006
4(II) A	Emissions and removals from drainage and rewetting – CH_4	5.9	55.0	IPCC 2014b
4(II) A	Emissions and removals from drainage and rewetting – N_2O	5.9	39.0	IPCC 2014b

[27] All activity data uncertainty estimates are obtained from the NFI.

Cropland (4.B)

The uncertainty estimates of activity data and the emission factors are reported in Table A.II.4_2. The uncertainties for activity data are obtained mainly from NFI and for emission factors from NFI, 2006 IPCC Guidelines, Swedish NIR, and national publications. The uncertainties for mineral soil emission factors are based on expert judgements.

Table A.II.4_2. Uncertainties in the Cropland category

IPCC category		Uncertainties %		EF References
		Activity data	Emission factors	
4.B.1	Cropland remaining cropland – living biomass	39.5	4.3	Metsaruum OÜ 2012, IPCC 2006
4.B.1	Cropland remaining cropland – mineral soils	4.9	60.0	Expert judgement
4.B.1	Cropland remaining cropland – organic soils	31.5	90.0	IPCC 2006
4.B.2	Land converted to cropland – living biomass	75.7	50.0	IPCC, 2006, NFI
4.B.2	Land converted to cropland – dead wood	75.7	50.0	Köster *et al*. 2015, IPCC 2006, NIR Sweden
4.B.2	Land converted to cropland – mineral soils	32.2	60.0	Expert judgement
4.B.2	Land converted to cropland – organic soils	146.1	90.0	IPCC 2006

Grassland (4.C)

The uncertainty estimates related to the activity data and the emission factors are presented in Table A.II.4_3. The uncertainties for activity data are obtained from NFI and for emission factors from NFI, 2006 IPCC Guidelines, Swedish NIR and national publications, or based on expert judgement.

Table A.II.4_3. Uncertainties in the Grassland category

IPCC category		Uncertainties %		EF References
		Activity data	Emission factors	
4.C.1	Grassland remaining grassland – living biomass	38.5	50.0	IPCC 2006, NFI
4.C.1	Grassland remaining grassland – dead wood	57.5	50.0	Köster *et al*. 2015, IPCC 2006
4.C.1	Grassland remaining grassland – organic soils	15.6	90.0	IPCC 2006
4.C.2	Land converted to grassland – living biomass	94.8	50.0	IPCC 2006, NFI
4.C.2	Land converted to grassland – dead wood	196.0	50.0	Köster *et al*. 2015, IPCC 2006
4.C.2	Land converted to grassland – litter	69.7	50.0	NIR Sweden
4.C.2	Land converted to grassland – mineral soils	34.6	60.0	Expert judgement
4.C.2	Land converted to grassland – organic soils	87.7	90.0	IPCC 2006

Wetlands (4.D)

The uncertainty estimates related to the activity data and the emission factors are presented in Table A.II.4_4.

Table A.II.4_4. Uncertainties in the Wetlands category

IPCC category		Uncertainties %		EF References
		Activity data[28]	**Emission factors**	
4.D.1.a	Peat extraction remaining peat extraction – organic soils	43.3	50.0	Salm *et al*. 2012
4.D.2.b	Land converted for peat extraction – living biomass	196.0	50.0	IPCC 2006, NFI
4.D.2.b	Land converted for peat extraction – organic soils	125.1	50.0	Salm *et al*. 2012
4.D.2.c	Land converted to other wetlands	66.2	50.0	IPCC 2006, NFI, Köster *et al*. 2015, NIR Sweden
4(II) D.1	Emissions and removals from drainage and rewetting – CH_4	42.9	100.0	Salm *et al*. 2012
4(II) D.1	Emissions and removals from drainage and rewetting – N_2O	42.9	100.0	Salm *et al*. 2012

Settlements (4.E)

The uncertainty estimates related to the activity data and emission factors in the Settlements category are presented in Table A.II.4_5.

Table A.II.4_5. Uncertainties in the Land converted to settlements category

IPCC category		Uncertainties %		EF References
		Activity data[29]	**Emission factors**	
4.E.2	Land converted to settlements – living biomass	32.7	50.0	IPCC 2006, NFI
4.E.2	Land converted to settlements – dead wood	32.7	50.0	Köster *et al*. 2015, IPCC 2006, NIR Sweden
4.E.2	Land converted to settlements – mineral soils	23.7	70.0	Expert judgement
4.E.2	Land converted to settlements – organic soils	81.4	90.0	IPCC 2006

[28] Activity data uncertainty estimates are obtained from NFI or based on expert judgement (Peat extraction remaining peat extraction – organic soils)
[29] Activity data uncertainty estimates are obtained from NFI

Other land (4.F)

Uncertainty of the Land converted to other land area (activity data) is obtained from NFI and is estimated at 111.0%. Uncertainties of the emission factors are presented in A.II.4_6.

Table A.II.4_6. Uncertainties used in the Land converted to other land category

IPCC category		Emission factors uncertainty %	EF References
4.F.2	Land converted to other land – living biomass	50.0	IPCC 2006, NFI
4.F.2	Land converted to other land – dead organic matter	50.0	Köster *et al.* 2015, IPCC 2006, NIR Sweden
4.F.2	Land converted to other land – soils	70.0	Expert judgement

N_2O emissions from N mineralization and leaching (CRT 4(III))

The uncertainty estimates of the activity data and the emission factors are reported in Table A.II.4_7. Uncertainties for activity data are the same as for mineral soil C stock change values (direct N_2O emissions) or for total F_{SOM} (indirect N_2O emissions). Uncertainties for emission factors are obtained from the 2006 IPCC Guidelines. Since the uncertainties for N_2O emissions are very large and the estimates must be non-negative, the uncertainty ranges are asymmetric with respect to the mean (lognormal distribution was assumed).

Table A.II.4_7. Uncertainties related to N_2O emissions from N mineralization and leaching

IPCC category		Uncertainties %			EF References
		Activity data	Emission factor		
			low	high	
4(III) A.2	Land converted to forest land – Direct N_2O emissions from N mineralization	64.6	-80	230	IPCC 2006
4(III) B.2	Land converted to cropland – Direct N_2O emissions from N mineralization	68.1	-80	230	IPCC 2006
4(III) E.2	Land converted to settlements – Direct N_2O emissions from N mineralization	73.9	-80	220	IPCC 2006
4(III) F	Land converted to other land – Direct N_2O emissions from N mineralization	131.3	-80	220	IPCC 2006
4(III)	Indirect N_2O emissions from managed soils – Nitrogen leaching and runoff	60.5	-90	350	IPCC 2006

Non-CO_2 emissions from biomass burning (CRT 4 (IV))

Uncertainty estimates of CH_4 and N_2O emissions from wildfires are based on 2006 IPCC Guidelines. Activity data concerning the area burnt was obtained from the Estonian Rescue Service and the Estonian Environment Agency. The uncertainty rates are shown in A.II.4_8.

Table A.II.4_8. Uncertainties of non-CO_2 emission estimates from biomass burning

IPCC category	Uncertainties %		EF References
	Activity data[30]	Emission factors	
Biomass burning (CH_4)	34.5	70.0	IPCC 2006, Vol 4, Table 2.5 p. 2.47
Biomass burning (N_2O)	34.5	70.0	IPCC 2006, Vol 4, Table 2.5 p. 2.47

Harvested wood products (CRT 4.G)

The uncertainty rates related to the activity data and emission factors are presented in Table A.II.4_9.

Table A.II.4_9. Uncertainties in the HWP category

IPCC category	Uncertainties %		EF References
	Activity data[31]	Emission factors	
Wood panels and sawnwood	62.8	57	IPCC 2006, Vol 4, p. 12.22 Table 12.6 Lamlom and Savidge, 2003
Paper and paperboard	45.0	57	IPCC 2006, Vol 4, p. 12.22 Table 12.6 Lamlom and Savidge 2003[32]
Semi-chemical wood pulp	44.0	57	IPCC 2006, Vol 4, p. 12.22 Table 12.6 Lamlom and Savidge, 2003

A.II.5 Waste

All calculated uncertainties of emission factors and activity data used are in accordance with methodology used in emission estimations, derived from IPCC 2006 Guidelines, and use

Equation A.II.5_1.Table A.II.5_1, all categories comprising uncertainty estimates are presented; detailed uncertainty values used in uncertainty assessment are presented under the sub-categories' descriptions below.

[30] All activity data uncertainty estimates are obtained from the Estonian Environmental Agency.
[31] Activity data uncertainty estimates are obtained from the NFI and expert judgement.
[32] Lamlom, H. S., Savidge, A.R. (2003). A reassessment of carbon content in wood: variation within and between 41 North American species. Biomass and Bioenergy, 25, 381-388.

Equation A.II.5_1[33]

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \cdots + U_n^2}$$

Where:

U_{total} = the percentage uncertainty in the product of the quantities (half the 95 percent confidence interval divided by the total and expressed as a percentage)

U_i = the percentage uncertainties associated with each of the quantities

Table A.II.5_1. Combined uncertainties in the Waste sector, %

Source category	**Gas**	**Combined uncertainty %**
5.A Solid waste disposal	CH_4	89%
5.B.1 Composting	CH_4	76%
5.B.1 Composting	N_2O	67%
5.C.1 Waste incineration	CH_4	50%
5.C.1 Waste incineration	N_2O	100%
5.C.1 Waste incineration	CO_2	40%
5.C.2 Open burning of waste	CH_4	59%
5.C.2 Open burning of waste	N_2O	105%
5.C.2 Open burning of waste	CO_2	51%
5.D.1 Domestic wastewater	CH_4	90%
5.D.1 Domestic wastewater	N_2O	109%
5.D.2 Industrial wastewater	CH_4	62%

Solid waste disposal (5.A)

The estimation of CH_4 emissions from MSW disposal is carried out based on activity data and emission factors.

Uncertainties of default emission factors and activity data used in the estimations are derived based on methodology from IPCC 2006 Guidelines. Values are presented in Table A.II.5_2.

The combined uncertainty rates related to the sub-category of SWD are reported in Table A.II.5_1.

Table A.II.5_2. Default uncertainty ranges for SWD

Input	**Uncertainties**
Activity data[34]	
Total MSW	±10%
Total uncertainty of waste composition	±10%
MSW sent to SWD sites	±10%

[33] IPCC 2006 vol 1, Chapter 3. Equation 3.1, p 3.28.

[34] IPCC 2006 Guidelines, Volume 5, Chapter 3. Solid Waste Disposal, page 3.27, table 3.5.

Input	Uncertainties
Emission factors	
Uncertainty for default half-life($t_{1/2}$)[35]	
Food waste	(0.185) 0.1–0.2
Garden	(0.1) 0.06–0.1
Paper	(0.06) 0.05–0.07
Wood and straw	(0.03) 0.02–0.04
Textiles	(0.06) 0.05–0.07
Disposable nappies	(0.1) 0.06–0.1
Sewage sludge	(0.185) 0.1–0.2
DOC[34]	±20%
Fraction of DOC decomposed (DOC_f)[34]	±20%
Methane correction factor 1.0[34]	–10%
Methane recovery[34]	±30%
Fraction of CH_4 in generated landfill gas[34]	±5%

Biological treatment of solid waste (5.B)

The estimation of GHG emissions from Biological treatment of solid waste (Table A.II.5_3) is carried out by considering emission factors and the quantities of waste composted per waste type.

The combined uncertainty rates related to the sub-category of Biological treatment of solid waste have been reported in Chapter A.II.5. For activity data uncertainty, the uncertainty percentage from SWD is used.

Table A.II.5_3. Default uncertainty ranges for Biological treatment of solid waste

Input	Value
Activity data[36]	
Waste composition	±10%
Total MSW	±10%
Emission factor[37]	
CH_4 (Composting)	(4) 0.03…8
N_2O (Composting)	(0.3) 0.06…0.6

Waste incineration and open burning (5.C)

The estimation of GHG emissions from waste incineration is carried out by considering the activity data (amount of burned waste) and emission factors. Uncertainties of default emission factors and activity data used in the estimations are derived based on methodology from IPCC 2006 Guidelines. Values used in the estimates are presented in A.II.5_4.

[35] IPCC 2006 Guidelines, Volume 5, Chapter 3: Solid Waste Disposal, page 3.18, table 3.4.
[36] IPCC 2006 Guidelines, Volume 5, Chapter 3: Solid Waste Disposal, page 3.27, table 3.5.
[37] IPCC 2006 Guidelines, Volume 5, Chapter 4: Biological Treatment of Solid Waste, page 4.6, table 4.1.

The combined uncertainty rates related to the sub-category of Waste incineration are given in Table A.II.5_1.

Table A.II.5_4. Default uncertainty ranges for Waste incineration and open burning

Input	Uncertainties
Activity data[38]	
Quantities of waste incinerated without energy recovery	±5%
Quantity of waste open burned	
Dry matter content	±30%
Waste composition[34]	±10%
Quantity of waste open burned	±5%
Emission factors[39]	
CO_2	±40%
CH_4	±50%
N_2O	±100%

Wastewater treatment and discharge (5.D)

The estimation of CH_4 emissions from Wastewater treatment and discharge is carried out by considering activity data and emission factors. Default uncertainty ranges for domestic and industrial wastewater are presented in Table A.II.5_5. The data on protein consumption per capita was received from FAO databases; the uncertainty of this parameter is not recorded.

Table A.II.5_5. Default uncertainty ranges for Wastewater treatment and discharge

Input	**Uncertainties**
CH_4 from domestic Wastewater[40]	
Activity data	
Human population	±5%
BOD/person	±30%
Fraction of people income group	±15%
Degree of utilisation of treatment/discharge pathway or system for each income group	±50%
Emission factor	
Latrines centralised well-managed treatment systems lagoons	±50%; ±10%; ±30%;
Maximum methane producing capacity (B_o)	±30%
CH_4 from industrial Wastewater[41]	
Activity data	

[38] IPCC 2006 Guidelines, Volume 5, Chapter 5: Incineration and Open Burning of Waste, page 5.24.
[39] IPCC 2006 Guidelines, Volume 5, Chapter 5: Incineration and Open Burning of Waste, page 5.23.
[40] IPCC 2006 Guidelines, Volume 5, Chapter 6: Wastewater Treatment and Discharge, page 6.17, table 6.7.
[41] IPCC 2006 Guidelines, Volume 5, Chapter 6: Wastewater Treatment and Discharge, page 6.23, table 6.10.

Input	Uncertainties
Industrial production	±5%[42]
Wastewater/unit production	±50%
COD/unit wastewater	
Emission factor	
Maximum methane producing capacity (B_o)	±30%
Methane correction factor[43]	±20%
N_2O from wastewater[44]	
Activity data	
Human population	±10%
Protein	±10%
FNRP (kg N/year)	(0.16) 0.15–0.17
$F_{NON\text{-}CON}$	(1.4) 1.0–1.5
$F_{IND\text{-}COM}$	(1.25) 1.0–1.5
Emission factor	
$EF_{EFFLUENT}$ (kg N_2O-N/kg-N)	(0.005) 0.0005–0.25
EF_{PLANTS}	(3.2) 2–8

[42] Activity data for calculating emissions from industrial wastewater is plant-based and therefore an expert judgement has been used.
[43] IPCC 2006 Guidelines, Volume 5, Chapter 6: Wastewater Treatment and Discharge, page 6.21.
[44] IPCC 2006 Guidelines, Volume 5, Chapter 6: Wastewater Treatment and Discharge, page 6.27, table 6.11.

Table Annex II. 1. Tier 1 uncertainty analysis without LULUCF

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Liquid Fuels	CO_2	3518.599	106.112	1.70%	1.80%	2.48%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Solid Fuels	CO_2	22017.062	3172.198	3.30%	2.39%	4.07%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Gaseous Fuels	CO_2	1811.983	231.338	1.40%	3.60%	3.86%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Peat	CO_2	842.885	15.796	3.30%	2.39%	4.07%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Other Fuels (Waste)	CO_2	0	137.240	5.00%	60.00%	60.21%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Liquid Fuels	CH_4	1.993	0.091	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Solid Fuels	CH_4	0.231	0.347	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Gaseous Fuels	CH_4	0.277	0.071	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Peat	CH_4	0.375	0.006	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Other Fuels (Waste)	CH_4	0	0.000	5.00%	60.00%	60.21%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Biomass	CH_4	0	17.953	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Liquid Fuels	N_2O	4.757	0.186	5.00%	35.00%	35.36%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Solid Fuels	N_2O	1.837	3.678	5.00%	49.00%	49.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Gaseous Fuels	N_2O	0.987	0.123	5.00%	48.00%	48.26%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Peat	N_2O	5.069	0.076	5.00%	60.00%	60.21%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Other Fuels (Waste)	N_2O	0	0.069	5.00%	59.00%	59.21%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Biomass	N_2O	0	23.233	5.00%	55.00%	55.23%
1.A.1.c Energy Industries/Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CO_2	78.381	1759.975	3.30%	38.90%	39.04%
1.A.1.c Energy Industries/Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CH_4	0.091	1.747	5.00%	50.00%	50.25%
1.A.1.c Energy Industries/Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	N_2O	0.086	1.653	5.00%	49.00%	49.25%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Liquid Fuels	CO_2	0	0.006	1.70%	1.80%	2.48%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Solid Fuels	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Gaseous Fuels	CO_2	0	0.465	1.40%	3.60%	3.86%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Liquid Fuels	CH_4	0	0.000	5.00%	50.00%	50.25%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Solid Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Gaseous Fuels	CH_4	0	0.000	5.00%	50.00%	50.25%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Biomass	CH_4	0	0	5.00%	29.00%	29.43%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Liquid Fuels	N_2O	0	0.000	5.00%	43.00%	43.29%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Solid Fuels	N_2O	0	0	5.00%	53.00%	53.24%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Gaseous Fuels	N_2O	0	0.000	5.00%	35.00%	35.36%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Peat	N_2O	0	0	5.00%	58.00%	58.22%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Biomass	N_2O	0	0	5.00%	39.00%	39.32%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Liquid Fuels	CO_2	0	0.761	1.70%	1.80%	2.48%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Solid Fuels	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Gaseous Fuels	CO_2	0	0	1.40%	3.60%	3.86%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Liquid Fuels	CH_4	0	0.000	5.00%	50.00%	50.25%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Solid Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Gaseous Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Biomass	CH_4	0	0	5.00%	29.00%	29.43%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Liquid Fuels	N_2O	0	0.000	5.00%	43.00%	43.29%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Solid Fuels	N_2O	0	0	5.00%	53.00%	53.24%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Gaseous Fuels	N_2O	0	0	5.00%	35.00%	35.36%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Biomass	N_2O	0	0	5.00%	39.00%	39.32%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Liquid Fuels	CO_2	228.626	0.187	1.70%	1.80%	2.48%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Solid Fuels	CO_2	4.881	0	3.30%	38.90%	39.04%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Gaseous Fuels	CO_2	156.104	6.628	1.40%	3.60%	3.86%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Liquid Fuels	CH_4	0.013	0.000	5.00%	50.00%	50.25%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Solid Fuels	CH_4	0.014	0	5.00%	50.00%	50.25%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Gaseous Fuels	CH_4	0.004	0.001	5.00%	50.00%	50.25%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Biomass	CH_4	0	0.000	5.00%	29.00%	29.43%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Liquid Fuels	N_2O	0.152	0.000	5.00%	43.00%	43.29%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Solid Fuels	N_2O	0.020	0	5.00%	53.00%	53.24%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Gaseous Fuels	N_2O	0.089	0.004	5.00%	35.00%	35.36%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Biomass	N_2O	0	0.001	5.00%	39.00%	39.32%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Liquid Fuels	CO_2	145.236	3.064	1.70%	1.80%	2.48%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Solid Fuels	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Gaseous Fuels	CO_2	0	22.252	1.40%	3.60%	3.86%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Liquid Fuels	CH_4	0.012	0.002	5.00%	50.00%	50.25%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Solid Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Gaseous Fuels	CH_4	0	0.002	5.00%	50.00%	50.25%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Biomass	CH_4	0	0.020	5.00%	29.00%	29.43%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Liquid Fuels	N_2O	0.101	0.002	5.00%	43.00%	43.29%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Solid Fuels	N_2O	0	0	5.00%	53.00%	53.24%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Gaseous Fuels	N_2O	0	0.013	5.00%	35.00%	35.36%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Biomass	N_2O	0	0.047	5.00%	39.00%	39.32%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	695.493	18.837	1.70%	1.80%	2.48%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	0	0.236	3.30%	38.90%	39.04%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	0	27.322	1.40%	3.60%	3.86%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.464	0.015	5.00%	50.00%	50.25%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0	0.001	5.00%	50.00%	50.25%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0	0.003	5.00%	50.00%	50.25%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Biomass	CH_4	0	0.006	5.00%	29.00%	29.43%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.049	0.030	5.00%	43.00%	43.29%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0	0.001	5.00%	53.00%	53.24%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0	0.015	5.00%	35.00%	35.36%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Biomass	N_2O	0	0.014	5.00%	39.00%	39.32%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Liquid Fuels	CO_2	448.146	11.143	1.70%	1.80%	2.48%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Solid Fuels	CO_2	595.120	9.675	3.30%	38.90%	39.04%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Gaseous Fuels	CO_2	0	22.971	1.40%	3.60%	3.86%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Peat	CO_2	9.351	10.158	3.30%	38.90%	39.04%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Other Fuels	CO_2	0	6.980	5.00%	60.00%	60.21%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Liquid Fuels	CH_4	0.252	0.004	5.00%	50.00%	50.25%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Solid Fuels	CH_4	1.557	0.029	5.00%	50.00%	50.25%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Gaseous Fuels	CH_4	0	0.001	5.00%	50.00%	50.25%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Peat	CH_4	0.004	0.005	5.00%	55.00%	55.23%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Other Fuels	CH_4	0	0.076	5.00%	60.00%	60.21%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Biomass	CH_4	0	0.311	5.00%	29.00%	29.43%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Liquid Fuels	N_2O	0.611	0.007	5.00%	43.00%	43.29%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Solid Fuels	N_2O	2.063	0.041	5.00%	53.00%	53.24%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Gaseous Fuels	N_2O	0	0.013	5.00%	35.00%	35.36%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Peat	N_2O	0.054	0.062	5.00%	56.00%	56.22%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Other Fuels	N_2O	0	0.096	5.00%	31.00%	31.40%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Biomass	N_2O	0	0.393	5.00%	39.00%	39.32%
1.A.2.g Manufacturing Industries and Construction/Other - Liquid Fuels	CO_2	682.526	59.259	1.70%	1.80%	2.48%
1.A.2.g Manufacturing Industries and Construction/Other - Solid Fuels	CO_2	194.012	0	3.30%	38.90%	39.04%
1.A.2.g Manufacturing Industries and Construction/Other - Gaseous Fuels	CO_2	286.150	26.637	1.40%	3.60%	3.86%
1.A.2.g Manufacturing Industries and Construction/Other - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.g Manufacturing Industries and Construction/Other - Liquid Fuels	CH_4	0.059	0.029	5.00%	50.00%	50.25%
1.A.2.g Manufacturing Industries and Construction/Other - Solid Fuels	CH_4	0.552	0	5.00%	50.00%	50.25%
1.A.2.g Manufacturing Industries and Construction/Other - Gaseous Fuels	CH_4	0.008	0.003	5.00%	50.00%	50.25%
1.A.2.g Manufacturing Industries and Construction/Other - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.g Manufacturing Industries and Construction/Other - Biomass	CH_4	0.037	0.051	5.00%	29.00%	29.43%
1.A.2.g Manufacturing Industries and Construction/Other - Liquid Fuels	N_2O	0.481	0.059	5.00%	43.00%	43.29%
1.A.2.g Manufacturing Industries and Construction/Other - Solid Fuels	N_2O	0.784	0	5.00%	53.00%	53.24%
1.A.2.g Manufacturing Industries and Construction/Other - Gaseous Fuels	N_2O	0.163	0.015	5.00%	35.00%	35.36%
1.A.2.g Manufacturing Industries and Construction/Other - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.g Manufacturing Industries and Construction/Other - Biomass	N_2O	0.057	0.119	5.00%	39.00%	39.32%
1.A.3.a Transport/Domestic Aviation - Liquid Fuels	CO_2	5.519	5.509	1.70%	1.80%	2.48%
1.A.3.a Transport/Domestic Aviation - Liquid Fuels	CH_4	0.002	0.003	5.00%	50.00%	50.25%
1.A.3.a Transport/Domestic Aviation - Liquid Fuels	N_2O	0.042	0.041	5.00%	146.00%	146.09%
1.A.3.b Transport/Road Transportation - Liquid Fuels	CO_2	2234.910	2341.954	1.70%	1.80%	2.48%
1.A.3.b Transport/Road Transportation - Liquid Fuels	CH_4	24.248	2.043	5.00%	50.00%	50.25%
1.A.3.b Transport/Road Transportation - Biomass	CH_4	0	0.335	5.00%	100.00%	100.12%
1.A.3.b Transport/Road Transportation - Liquid Fuels	N_2O	19.272	20.107	5.00%	149.00%	149.08%
1.A.3.b Transport/Road Transportation - Biomass	N_2O	0	0.740	5.00%	145.00%	145.09%
1.A.3.c Transport/Railways - Liquid Fuels	CO_2	142.272	42.429	1.70%	1.80%	2.48%
1.A.3.c Transport/Railways - Solid Fuels	CO_2	17.082	0	3.30%	38.90%	39.04%
1.A.3.c Transport/Railways - Liquid Fuels	CH_4	0.226	0.068	5.00%	50.00%	50.25%
1.A.3.c Transport/Railways - Solid Fuels	CH_4	0.010	0	5.00%	40.00%	40.31%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
1.A.3.c Transport/Railways - Liquid Fuels	N_2O	14.747	4.406	5.00%	150.00%	150.08%
1.A.3.c Transport/Railways - Solid Fuels	N_2O	0.071	0	5.00%	40.00%	40.31%
1.A.3.d Transport/Domestic Navigation - Liquid Fuels	CO_2	21.650	19.939	1.70%	1.80%	2.48%
1.A.3.d Transport/Domestic Navigation - Liquid Fuels	CH_4	0.058	0.054	5.00%	50.00%	50.25%
1.A.3.d Transport/Domestic Navigation - Liquid Fuels	N_2O	0.157	0.145	5.00%	103.00%	103.12%
1.A.3.e Transport/Other Transportation - Liquid Fuels	CO_2	89.716	207.674	1.70%	1.80%	2.48%
1.A.3.e Transport/Other Transportation - Liquid Fuels	CH_4	0.154	0.080	5.00%	50.00%	50.25%
1.A.3.e Transport/Other Transportation - Liquid Fuels	N_2O	0.966	2.422	5.00%	149.00%	149.08%
1.A.4.a Other Sectors/Commercial/Institutional - Liquid Fuels	CO_2	139.667	73.431	1.70%	1.80%	2.48%
1.A.4.a Other Sectors/Commercial/Institutional - Solid Fuels	CO_2	0	1.888	3.30%	38.90%	39.04%
1.A.4.a Other Sectors/Commercial/Institutional - Gaseous Fuels	CO_2	18.649	87.928	1.40%	3.60%	3.86%
1.A.4.a Other Sectors/Commercial/Institutional - Peat	CO_2	6.207	0	3.30%	38.90%	39.04%
1.A.4.a Other Sectors/Commercial/Institutional - Liquid Fuels	CH_4	0.111	0.243	5.00%	50.00%	50.25%
1.A.4.a Other Sectors/Commercial/Institutional - Solid Fuels	CH_4	0	0.006	5.00%	50.00%	50.25%
1.A.4.a Other Sectors/Commercial/Institutional - Gaseous Fuels	CH_4	0.007	0.057	5.00%	50.00%	50.25%
1.A.4.a Other Sectors/Commercial/Institutional - Peat	CH_4	0.008	0	5.00%	122.00%	122.10%
1.A.4.a Other Sectors/Commercial/Institutional - Biomass	CH_4	6.491	0.502	5.00%	150.00%	150.08%
1.A.4.a Other Sectors/Commercial/Institutional - Liquid Fuels	N_2O	0.136	0.132	5.00%	35.00%	35.36%
1.A.4.a Other Sectors/Commercial/Institutional - Solid Fuels	N_2O	0	0.008	5.00%	60.00%	60.21%
1.A.4.a Other Sectors/Commercial/Institutional - Gaseous Fuels	N_2O	0.010	0.049	5.00%	40.00%	40.31%
1.A.4.a Other Sectors/Commercial/Institutional - Peat	N_2O	0.036	0	5.00%	132.00%	132.09%
1.A.4.a Other Sectors/Commercial/Institutional - Biomass	N_2O	0.898	0.077	5.00%	127.00%	127.10%
1.A.4.b Other Sectors/Residential - Liquid Fuels	CO_2	244.243	26.522	1.70%	1.80%	2.48%
1.A.4.b Other Sectors/Residential - Solid Fuels	CO_2	336.768	0.944	3.30%	38.90%	39.04%
1.A.4.b Other Sectors/Residential - Gaseous Fuels	CO_2	131.637	124.792	1.40%	3.60%	3.86%
1.A.4.b Other Sectors/Residential - Peat	CO_2	308.795	0	3.30%	38.90%	39.04%
1.A.4.b Other Sectors/Residential - Liquid Fuels	CH_4	0.791	0.089	5.00%	50.00%	50.25%
1.A.4.b Other Sectors/Residential - Solid Fuels	CH_4	29.560	0.084	5.00%	50.00%	50.25%
1.A.4.b Other Sectors/Residential - Gaseous Fuels	CH_4	0.334	0.323	5.00%	50.00%	50.25%
1.A.4.b Other Sectors/Residential - Peat	CH_4	26.746	0	5.00%	122.00%	122.10%
1.A.4.b Other Sectors/Residential - Biomass	CH_4	6.438	12.827	5.00%	150.00%	150.08%
1.A.4.b Other Sectors/Residential - Liquid Fuels	N_2O	0.383	0.093	5.00%	35.00%	35.36%
1.A.4.b Other Sectors/Residential - Solid Fuels	N_2O	1.399	0.004	5.00%	60.00%	60.21%
1.A.4.b Other Sectors/Residential - Gaseous Fuels	N_2O	0.063	0.061	5.00%	40.00%	40.31%
1.A.4.b Other Sectors/Residential - Peat	N_2O	1.266	0	5.00%	132.00%	132.09%
1.A.4.b Other Sectors/Residential - Biomass	N_2O	1.714	4.594	5.00%	127.00%	127.10%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Liquid Fuels	CO_2	504.350	60.653	1.70%	1.80%	2.48%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Solid Fuels	CO_2	21.963	0	3.30%	38.90%	39.04%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Gaseous Fuels	CO_2	3.680	3.227	1.40%	3.60%	3.86%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Peat	CO_2	1.552	0	3.30%	38.90%	39.04%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Liquid Fuels	CH_4	0.980	0.183	5.00%	50.00%	50.25%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Solid Fuels	CH_4	1.928	0	5.00%	50.00%	50.25%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Gaseous Fuels	CH_4	0.001	0.002	5.00%	50.00%	50.25%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Peat	CH_4	0.134	0	5.00%	122.00%	122.10%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Biomass	CH_4	2.298	0.292	5.00%	150.00%	150.08%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Liquid Fuels	N_2O	0.706	0.107	5.00%	35.00%	35.36%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Solid Fuels	N_2O	0.091	0	5.00%	60.00%	60.21%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Gaseous Fuels	N_2O	0.002	0.002	5.00%	40.00%	40.31%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Peat	N_2O	0.006	0	5.00%	132.00%	132.09%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Biomass	N_2O	0.292	0.038	5.00%	127.00%	127.10%
1.A.4.c.ii Other Sectors/Agriculture/Forestry/Fishing/Off-road vehicles and other machinery - Liquid Fuels	CO_2	0	0	1.70%	1.80%	2.48%
1.A.4.c.ii Other Sectors/Agriculture/Forestry/Fishing/Off-road vehicles and other machinery - Liquid Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.4.c.ii Other Sectors/Agriculture/Forestry/Fishing/Off-road vehicles and other machinery - Liquid Fuels	N_2O	0	0	5.00%	35.00%	35.36%
1.B.2.b.iv	CO_2	0.002	0.000	3.00%	25.00%	25.18%
1.B.2.b.iv	CH_4	8.212	1.760	3.00%	25.00%	25.18%
1.B.2.b.v	CO_2	0.090	0.019	3.00%	25.00%	25.18%
1.B.2.b.v	CH_4	54.417	11.661	3.00%	25.00%	25.18%
1.B.2.c.ii	CO_2	0.005	0.001	15.00%	25.00%	29.15%
1.B.2.c.ii	CH_4	9.003	1.929	15.00%	25.00%	29.15%
2.A.1 Cement production	CO_2	483.038	0.000	0.00%	0.00%	0.00%
2.A.2 Lime production	CO_2	118.837	18.791	0.18%	2.00%	2.01%
2.A.3 Glass production	CO_2	1.229	9.850	0.32%	1.00%	1.05%
2.A.4.a Ceramics	CO_2	0	3.549	0.10%	2.00%	2.00%
2.A.4.d Other - Limestone use for flue gas desulpurisation	CO_2	0	0	0.00%	0.00%	0.00%
2.B.1 Ammonia production	CO_2	307.735	0	0.00%	0.00%	0.00%
2.C.5 Lead production	CO_2	0.759	2.956	5.00%	5.00%	7.07%
2.D.1 Lubricant use	CO_2	16.108	5.505	5.00%	50.00%	50.25%
2.D.2 Paraffin wax use	CO_2	1.290	1.944	20.00%	5.00%	20.62%
2.D.3 Other - Urea based catalysts for motor vehicles	CO_2	0.000	1.840	30.00%	0.70%	30.01%
2.D.3 Other - Solvent use	indirect CO_2	18.475	23.860	25.00%	10.00%	26.93%
2.D.3 Other - Road paving with asphalt	indirect CO_2	0.045	0.030	10.00%	100.00%	100.50%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
2.F.1.a Commercial Refrigeration	HFC	0	50.844	8.90%	41.10%	42.05%
2.F.1.b Domestic Refrigeration	HFC	0	1.407	20.00%	10.00%	22.36%
2.F.1.c Industrial Refrigeration	HFC	0	32.928	9.10%	17.70%	19.90%
2.F.1.d Refrigerated Vehicles	HFC	0	24.099	8.50%	5.00%	9.86%
2.F.1.d Reefer Containers	HFC	0	1.597	8.40%	10.00%	13.06%
2.F.1.f Heat Pumps	HFC	0	10.200	9.00%	5.00%	10.30%
2.F.1.f Stationary and Room Air-Conditioning	HFC	0	31.243	15.00%	22.00%	26.63%
2.F.1.e Mobile Air-Conditioning - Passenger cars	HFC	0	10.086	8.50%	5.00%	9.86%
2.F.1.e Mobile Air-Conditioning - Trucks	HFC	0	4.565	8.50%	5.00%	9.86%
2.F.1.e Mobile Air-Conditioning - Buses	HFC	0	4.657	8.70%	5.00%	10.03%
2.F.1.e Mobile Air-Conditioning - Ships	HFC	0	7.627	3.00%	5.00%	5.83%
2.F.1.e Mobile Air-Conditioning - Railcars	HFC	0	0.004	3.00%	5.00%	5.83%
2.F.1.e Mobile Air-Conditioning - Wheel tractors and mobile machinery	HFC	0	5.888	14.50%	10.00%	17.61%
2.F.2.a Foam blowing agents; PU Insulation Panels	HFC	0	0.092	10.00%	10.00%	14.14%
2.F.2.a Spray and Injection PU Foam	HFC	0	0.111	10.00%	10.00%	14.14%
2.F.2.a XPS Insulation Foam	HFC	0	0.066	20.00%	10.00%	22.36%
2.F.2.b One Component PU Foam	HFC	0	0.743	15.00%	15.00%	21.21%
2.F.3 Fire protection	HFC	0	2.395	10.00%	10.00%	14.14%
2.F.4 Aerosols; Metered dose inhalers	HFC	0	2.299	10.00%	10.00%	14.14%
2.G.1 Electrical equipment	SF_6	0	3.120	3.00%	10.00%	10.44%
2.G.2 Particle accelerators	SF_6	0	0.089	21.00%	30.00%	36.62%
2.G.3 N2O from product use	N_2O	4.845	2.772	5.00%	2.00%	5.39%
3.A.1 Enteric Fermentation - Dairy Cattle	CH_4	821.087	379.873	0.72%	40.00%	40.01%
3.A.1 Enteric Fermentation - Non-Dairy Cattle	CH_4	533.893	203.054	1.11%	40.00%	40.02%
3.A.2 Enteric Fermentation - Sheep	CH_4	35.501	14.876	6.53%	40.00%	40.53%
3.A.3 Enteric Fermentation - Swine	CH_4	24.872	8.583	0.49%	40.00%	40.00%
3.A.4 Enteric Fermentation - Goats	CH_4	0.293	0.624	6.53%	40.00%	40.53%
3.A.4 Enteric Fermentation - Horses	CH_4	4.334	2.647	10.00%	40.00%	41.23%
3.A.4 Enteric Fermentation - Fur animals	CH_4	0.646	0	10.00%	40.00%	41.23%
3.B.1.1 Manure Management - Dairy Cattle	CH_4	39.963	80.026	0.72%	20.00%	20.01%
3.B.1.1 Manure Management -Non-Dairy Cattle	CH_4	20.065	36.792	1.11%	20.00%	20.03%
3.B.1.2 Manure Management - Sheep	CH_4	0.843	0.353	6.53%	30.00%	30.70%
3.B.1.3 Manure Management - Swine	CH_4	115.836	45.309	0.49%	20.00%	20.01%
3.B.1.4 Manure Management - Goats	CH_4	0.008	0.016	6.53%	30.00%	30.70%
3.B.1.4 Manure Management - Horses	CH_4	0.376	0.229	10.00%	30.00%	31.62%
3.B.1.4Manure Management - Poultry	CH_4	4.268	1.934	10.00%	30.00%	31.62%
3.B.1.4 Manure Management - Fur animals	CH_4	4.394	0.000	10.00%	30.00%	31.62%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
3.B.1.4 Manure Management - Rabbits	CH_4	0.193	0.012	10.00%	30.00%	31.62%
3.B.2.1 Manure Management - Dairy Cattle	N_2O	35.916	22.320	0.72%	111.80%	111.81%
3.B.2.1 Manure Management -Non-Dairy Cattle	N_2O	18.000	13.314	1.11%	111.80%	111.81%
3.B.2.2 Manure Management - Sheep	N_2O	2.558	1.072	6.53%	111.80%	111.99%
3.B.2.3 Manure Management - Swine	N_2O	2.103	0.711	0.49%	111.80%	111.80%
3.B.2.4 Manure Management - Goats	N_2O	0.041	0.088	6.53%	111.80%	111.99%
3.B.2.4 Manure Management - Horses	N_2O	0.635	0.388	10.00%	111.80%	112.25%
3.B.2.4 Manure Management - Poultry	N_2O	5.682	2.157	10.00%	111.80%	112.25%
3.B.2.4 Manure Management - Fur animals	N_2O	3.536	0	10.00%	111.80%	112.25%
3.B.2.4 Manure Management - Rabbits	N_2O	1.450	0.087	10.00%	111.80%	112.25%
3.B.2.5 Indirect N2O Emissions from Manure Management	N_2O	30.177	16.280	50.99%	400.12%	403.36%
3.D.1.1 Direct Soil Emissions - Inorganic N Fertilizers	N_2O	299.991	159.925	10.00%	200.00%	200.25%
3.D.1.2a Direct Soil Emissions - Animal Manure Applied to Soils (including manure digestates)	N_2O	125.280	67.232	50.99%	206.16%	212.37%
3.D.1.2b Direct Soil Emissions - Sewage Sludge Applied to Soils	N_2O	0.496	1.419	20.00%	200.00%	201.00%
3.D.1.2c Direct Soil Emissions - Compost, and Waste Digestates Applied to Soils	N_2O	0.861	17.405	20.00%	200.00%	201.00%
3.D.1.3 Direct Soil Emissions Urine and Dung Deposited by Grazing Animals	N_2O	66.763	17.236	50.99%	206.16%	212.37%
3.D.1.5 Direct Soil Emissions - Mineralization/Immobilization Associated with Loss/Gain of Soil Organic Matter	N_2O	0	14.641	33.24%	30.00%	44.77%
3.D.1.4 Direct Soil Emissions - Crop Residue	N_2O	168.302	129.562	7.59%	200.00%	200.14%
3.D.1.6 Direct Soil Emissions - Cultivation of Organic Soils	N_2O	148.508	141.529	21.41%	200.00%	201.14%
3.D.2.1 Indirect Emissions - Atmospheric Deposition	N_2O	62.597	35.207	14.84%	434.95%	435.20%
3.D.2.2 Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	142.039	90.046	17.60%	286.74%	287.28%
3.G Liming	CO_2	12.113	27.494	29.15%	50.00%	57.88%
3.H Urea Application	CO_2	0.998	2.284	2.00%	50.00%	50.04%
5.A Solid waste disposal	CH_4	239.362	183.277	17.32%	87.16%	88.86%
5.B.1 Composting	CH_4	3.167	17.611	14.14%	74.63%	75.95%
5.B.1 Composting	N_2O	1.798	10.000	14.14%	65.00%	66.52%
5.C.1 Waste incineration	CH_4	0.064	0	5.00%	50.00%	50.25%
5.C.1 Waste incineration	N_2O	0.009	0	5.00%	100.00%	100.12%
5.C.1 Waste incineration	CO_2	0.764	0	5.00%	40.00%	40.31%
5.C.2 Open Burning of Waste	CH_4	1.301	0	32.02%	50.00%	59.37%
5.C.2 Open Burning of Waste	N_2O	0.194	0	32.02%	100.00%	105.00%
5.C.2 Open Burning of Waste	CO_2	1.488	0	32.02%	40.00%	51.23%
5.D.1 Domestic wastewater	CH_4	126.220	55.737	60.42%	66.33%	89.72%
5.D.1 Domestic wastewater	N_2O	34.203	31.440	24.97%	105.91%	108.82%
5.D.2 Industrial wastewater	CH_4	0	2.070	12.97%	36.06%	38.32%

Table Annex II. 2. Tier 1 uncertainty analysis with LULUCF

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Liquid Fuels	CO_2	3518.599	106.112	1.70%	1.80%	2.48%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Solid Fuels	CO_2	22017.062	3172.198	3.30%	2.39%	4.07%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Gaseous Fuels	CO_2	1811.983	231.338	1.40%	3.60%	3.86%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Peat	CO_2	842.885	15.796	3.30%	2.39%	4.07%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Other Fuels (Waste)	CO_2	0	137.240	5.00%	60.00%	60.21%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Liquid Fuels	CH_4	1.993	0.091	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Solid Fuels	CH_4	0.231	0.347	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Gaseous Fuels	CH_4	0.277	0.071	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Peat	CH_4	0.375	0.006	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Other Fuels (Waste)	CH_4	0	0.000	5.00%	60.00%	60.21%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Biomass	CH_4	0	17.953	5.00%	50.00%	50.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Liquid Fuels	N_2O	4.757	0.186	5.00%	35.00%	35.36%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Solid Fuels	N_2O	1.837	3.678	5.00%	49.00%	49.25%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Gaseous Fuels	N_2O	0.987	0.123	5.00%	48.00%	48.26%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Peat	N_2O	5.069	0.076	5.00%	60.00%	60.21%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Other Fuels (Waste)	N_2O	0	0.069	5.00%	59.00%	59.21%
1.A.1.a Energy Industries/Public Electricity and Heat Production - Biomass	N_2O	0	23.233	5.00%	55.00%	55.23%
1.A.1.c Energy Industries/Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CO_2	78.381	1759.975	3.30%	38.90%	39.04%
1.A.1.c Energy Industries/Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CH_4	0.091	1.747	5.00%	50.00%	50.25%
1.A.1.c Energy Industries/Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	N_2O	0.086	1.653	5.00%	49.00%	49.25%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Liquid Fuels	CO_2	0	0.006	1.70%	1.80%	2.48%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Solid Fuels	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Gaseous Fuels	CO_2	0	0.465	1.40%	3.60%	3.86%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Liquid Fuels	CH_4	0	0.000	5.00%	50.00%	50.25%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Solid Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Gaseous Fuels	CH_4	0	0.000	5.00%	50.00%	50.25%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Biomass	CH_4	0	0	5.00%	29.00%	29.43%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Liquid Fuels	N_2O	0	0.000	5.00%	43.00%	43.29%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Solid Fuels	N_2O	0	0	5.00%	53.00%	53.24%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Gaseous Fuels	N_2O	0	0.000	5.00%	35.00%	35.36%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Peat	N_2O	0	0	5.00%	58.00%	58.22%
1.A.2.a Manufacturing Industries and Construction/Iron and Steel - Biomass	N_2O	0	0	5.00%	39.00%	39.32%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Liquid Fuels	CO_2	0	0.761	1.70%	1.80%	2.48%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Solid Fuels	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Gaseous Fuels	CO_2	0	0	1.40%	3.60%	3.86%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Liquid Fuels	CH_4	0	0.000	5.00%	50.00%	50.25%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Solid Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Gaseous Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Biomass	CH_4	0	0	5.00%	29.00%	29.43%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Liquid Fuels	N_2O	0	0.000	5.00%	43.00%	43.29%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Solid Fuels	N_2O	0	0	5.00%	53.00%	53.24%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Gaseous Fuels	N_2O	0	0	5.00%	35.00%	35.36%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.b Manufacturing Industries and Construction/Non-Ferrous Metals - Biomass	N_2O	0	0	5.00%	39.00%	39.32%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Liquid Fuels	CO_2	228.626	0.187	1.70%	1.80%	2.48%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Solid Fuels	CO_2	4.881	0	3.30%	38.90%	39.04%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Gaseous Fuels	CO_2	156.104	6.628	1.40%	3.60%	3.86%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Liquid Fuels	CH_4	0.013	0.000	5.00%	50.00%	50.25%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Solid Fuels	CH_4	0.014	0	5.00%	50.00%	50.25%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Gaseous Fuels	CH_4	0.004	0.001	5.00%	50.00%	50.25%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Biomass	CH_4	0	0.000	5.00%	29.00%	29.43%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Liquid Fuels	N_2O	0.152	0.000	5.00%	43.00%	43.29%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Solid Fuels	N_2O	0.020	0	5.00%	53.00%	53.24%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Gaseous Fuels	N_2O	0.089	0.004	5.00%	35.00%	35.36%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.c Manufacturing Industries and Construction/Chemicals - Biomass	N_2O	0	0.001	5.00%	39.00%	39.32%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Liquid Fuels	CO_2	145.236	3.064	1.70%	1.80%	2.48%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Solid Fuels	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Gaseous Fuels	CO_2	0	22.252	1.40%	3.60%	3.86%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Liquid Fuels	CH_4	0.012	0.002	5.00%	50.00%	50.25%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Solid Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Gaseous Fuels	CH_4	0	0.002	5.00%	50.00%	50.25%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Biomass	CH_4	0	0.020	5.00%	29.00%	29.43%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Liquid Fuels	N_2O	0.101	0.002	5.00%	43.00%	43.29%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Solid Fuels	N_2O	0	0	5.00%	53.00%	53.24%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Gaseous Fuels	N_2O	0	0.013	5.00%	35.00%	35.36%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.d Manufacturing Industries and Construction/Pulp, Paper and Print - Biomass	N_2O	0	0.047	5.00%	39.00%	39.32%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	695.493	18.837	1.70%	1.80%	2.48%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	0	0.236	3.30%	38.90%	39.04%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	0	27.322	1.40%	3.60%	3.86%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.464	0.015	5.00%	50.00%	50.25%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0	0.001	5.00%	50.00%	50.25%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0	0.003	5.00%	50.00%	50.25%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Biomass	CH_4	0	0.006	5.00%	29.00%	29.43%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.049	0.030	5.00%	43.00%	43.29%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0	0.001	5.00%	53.00%	53.24%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0	0.015	5.00%	35.00%	35.36%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.e Manufacturing Industries and Construction/Food Processing, Beverages and Tobacco - Biomass	N_2O	0	0.014	5.00%	39.00%	39.32%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Liquid Fuels	CO_2	448.146	11.143	1.70%	1.80%	2.48%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Solid Fuels	CO_2	595.120	9.675	3.30%	38.90%	39.04%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Gaseous Fuels	CO_2	0	22.971	1.40%	3.60%	3.86%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Peat	CO_2	9.351	10.158	3.30%	38.90%	39.04%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Other Fuels	CO_2	0	6.980	5.00%	60.00%	60.21%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Liquid Fuels	CH_4	0.252	0.004	5.00%	50.00%	50.25%

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1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Solid Fuels	CH_4	1.557	0.029	5.00%	50.00%	50.25%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Gaseous Fuels	CH_4	0	0.001	5.00%	50.00%	50.25%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Peat	CH_4	0.004	0.005	5.00%	55.00%	55.23%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Other Fuels	CH_4	0	0.076	5.00%	60.00%	60.21%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Biomass	CH_4	0	0.311	5.00%	29.00%	29.43%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Liquid Fuels	N_2O	0.611	0.007	5.00%	43.00%	43.29%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Solid Fuels	N_2O	2.063	0.041	5.00%	53.00%	53.24%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Gaseous Fuels	N_2O	0	0.013	5.00%	35.00%	35.36%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Peat	N_2O	0.054	0.062	5.00%	56.00%	56.22%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Other Fuels	N_2O	0	0.096	5.00%	31.00%	31.40%
1.A.2.f Manufacturing Industries and Construction/Non-metallic Minerals - Biomass	N_2O	0	0.393	5.00%	39.00%	39.32%
1.A.2.g Manufacturing Industries and Construction/Other - Liquid Fuels	CO_2	682.526	59.259	1.70%	1.80%	2.48%
1.A.2.g Manufacturing Industries and Construction/Other - Solid Fuels	CO_2	194.012	0	3.30%	38.90%	39.04%
1.A.2.g Manufacturing Industries and Construction/Other - Gaseous Fuels	CO_2	286.150	26.637	1.40%	3.60%	3.86%
1.A.2.g Manufacturing Industries and Construction/Other - Peat	CO_2	0	0	3.30%	38.90%	39.04%
1.A.2.g Manufacturing Industries and Construction/Other - Liquid Fuels	CH_4	0.059	0.029	5.00%	50.00%	50.25%
1.A.2.g Manufacturing Industries and Construction/Other - Solid Fuels	CH_4	0.552	0	5.00%	50.00%	50.25%
1.A.2.g Manufacturing Industries and Construction/Other - Gaseous Fuels	CH_4	0.008	0.003	5.00%	50.00%	50.25%
1.A.2.g Manufacturing Industries and Construction/Other - Peat	CH_4	0	0	5.00%	55.00%	55.23%
1.A.2.g Manufacturing Industries and Construction/Other - Biomass	CH_4	0.037	0.051	5.00%	29.00%	29.43%
1.A.2.g Manufacturing Industries and Construction/Other - Liquid Fuels	N_2O	0.481	0.059	5.00%	43.00%	43.29%
1.A.2.g Manufacturing Industries and Construction/Other - Solid Fuels	N_2O	0.784	0	5.00%	53.00%	53.24%
1.A.2.g Manufacturing Industries and Construction/Other - Gaseous Fuels	N_2O	0.163	0.015	5.00%	35.00%	35.36%
1.A.2.g Manufacturing Industries and Construction/Other - Peat	N_2O	0	0	5.00%	56.00%	56.22%
1.A.2.g Manufacturing Industries and Construction/Other - Biomass	N_2O	0.057	0.119	5.00%	39.00%	39.32%
1.A.3.a Transport/Domestic Aviation - Liquid Fuels	CO_2	5.519	5.509	1.70%	1.80%	2.48%
1.A.3.a Transport/Domestic Aviation - Liquid Fuels	CH_4	0.002	0.003	5.00%	50.00%	50.25%
1.A.3.a Transport/Domestic Aviation - Liquid Fuels	N_2O	0.042	0.041	5.00%	146.00%	146.09%
1.A.3.b Transport/Road Transportation - Liquid Fuels	CO_2	2234.910	2341.954	1.70%	1.80%	2.48%
1.A.3.b Transport/Road Transportation - Liquid Fuels	CH_4	24.248	2.043	5.00%	50.00%	50.25%
1.A.3.b Transport/Road Transportation - Biomass	CH_4	0	0.335	5.00%	100.00%	100.12%
1.A.3.b Transport/Road Transportation - Liquid Fuels	N_2O	19.272	20.107	5.00%	149.00%	149.08%
1.A.3.b Transport/Road Transportation - Biomass	N_2O	0	0.740	5.00%	145.00%	145.09%
1.A.3.c Transport/Railways - Liquid Fuels	CO_2	142.272	42.429	1.70%	1.80%	2.48%
1.A.3.c Transport/Railways - Solid Fuels	CO_2	17.082	0	3.30%	38.90%	39.04%
1.A.3.c Transport/Railways - Liquid Fuels	CH_4	0.226	0.068	5.00%	50.00%	50.25%
1.A.3.c Transport/Railways - Solid Fuels	CH_4	0.010	0	5.00%	40.00%	40.31%

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1.A.3.c Transport/Railways - Liquid Fuels	N_2O	14.747	4.406	5.00%	150.00%	150.08%
1.A.3.c Transport/Railways - Solid Fuels	N_2O	0.071	0	5.00%	40.00%	40.31%
1.A.3.d Transport/Domestic Navigation - Liquid Fuels	CO_2	21.650	19.939	1.70%	1.80%	2.48%
1.A.3.d Transport/Domestic Navigation - Liquid Fuels	CH_4	0.058	0.054	5.00%	50.00%	50.25%
1.A.3.d Transport/Domestic Navigation - Liquid Fuels	N_2O	0.157	0.145	5.00%	103.00%	103.12%
1.A.3.e Transport/Other Transportation - Liquid Fuels	CO_2	89.716	207.674	1.70%	1.80%	2.48%
1.A.3.e Transport/Other Transportation - Liquid Fuels	CH_4	0.154	0.080	5.00%	50.00%	50.25%
1.A.3.e Transport/Other Transportation - Liquid Fuels	N_2O	0.966	2.422	5.00%	149.00%	149.08%
1.A.4.a Other Sectors/Commercial/Institutional - Liquid Fuels	CO_2	139.667	73.431	1.70%	1.80%	2.48%
1.A.4.a Other Sectors/Commercial/Institutional - Solid Fuels	CO_2	0	1.888	3.30%	38.90%	39.04%
1.A.4.a Other Sectors/Commercial/Institutional - Gaseous Fuels	CO_2	18.649	87.928	1.40%	3.60%	3.86%
1.A.4.a Other Sectors/Commercial/Institutional - Peat	CO_2	6.207	0	3.30%	38.90%	39.04%
1.A.4.a Other Sectors/Commercial/Institutional - Liquid Fuels	CH_4	0.111	0.243	5.00%	50.00%	50.25%
1.A.4.a Other Sectors/Commercial/Institutional - Solid Fuels	CH_4	0	0.006	5.00%	50.00%	50.25%
1.A.4.a Other Sectors/Commercial/Institutional - Gaseous Fuels	CH_4	0.007	0.057	5.00%	50.00%	50.25%
1.A.4.a Other Sectors/Commercial/Institutional - Peat	CH_4	0.008	0	5.00%	122.00%	122.10%
1.A.4.a Other Sectors/Commercial/Institutional - Biomass	CH_4	6.491	0.502	5.00%	150.00%	150.08%
1.A.4.a Other Sectors/Commercial/Institutional - Liquid Fuels	N_2O	0.136	0.132	5.00%	35.00%	35.36%
1.A.4.a Other Sectors/Commercial/Institutional - Solid Fuels	N_2O	0	0.008	5.00%	60.00%	60.21%
1.A.4.a Other Sectors/Commercial/Institutional - Gaseous Fuels	N_2O	0.010	0.049	5.00%	40.00%	40.31%
1.A.4.a Other Sectors/Commercial/Institutional - Peat	N_2O	0.036	0	5.00%	132.00%	132.09%
1.A.4.a Other Sectors/Commercial/Institutional - Biomass	N_2O	0.898	0.077	5.00%	127.00%	127.10%
1.A.4.b Other Sectors/Residential - Liquid Fuels	CO_2	244.243	26.522	1.70%	1.80%	2.48%
1.A.4.b Other Sectors/Residential - Solid Fuels	CO_2	336.768	0.944	3.30%	38.90%	39.04%
1.A.4.b Other Sectors/Residential - Gaseous Fuels	CO_2	131.637	124.792	1.40%	3.60%	3.86%
1.A.4.b Other Sectors/Residential - Peat	CO_2	308.795	0	3.30%	38.90%	39.04%
1.A.4.b Other Sectors/Residential - Liquid Fuels	CH_4	0.791	0.089	5.00%	50.00%	50.25%
1.A.4.b Other Sectors/Residential - Solid Fuels	CH_4	29.560	0.084	5.00%	50.00%	50.25%
1.A.4.b Other Sectors/Residential - Gaseous Fuels	CH_4	0.334	0.323	5.00%	50.00%	50.25%
1.A.4.b Other Sectors/Residential - Peat	CH_4	26.746	0	5.00%	122.00%	122.10%
1.A.4.b Other Sectors/Residential - Biomass	CH_4	6.438	12.827	5.00%	150.00%	150.08%
1.A.4.b Other Sectors/Residential - Liquid Fuels	N_2O	0.383	0.093	5.00%	35.00%	35.36%
1.A.4.b Other Sectors/Residential - Solid Fuels	N_2O	1.399	0.004	5.00%	60.00%	60.21%
1.A.4.b Other Sectors/Residential - Gaseous Fuels	N_2O	0.063	0.061	5.00%	40.00%	40.31%
1.A.4.b Other Sectors/Residential - Peat	N_2O	1.266	0	5.00%	132.00%	132.09%
1.A.4.b Other Sectors/Residential - Biomass	N_2O	1.714	4.594	5.00%	127.00%	127.10%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Liquid Fuels	CO_2	504.350	60.653	1.70%	1.80%	2.48%

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1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Solid Fuels	CO_2	21.963	0	3.30%	38.90%	39.04%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Gaseous Fuels	CO_2	3.680	3.227	1.40%	3.60%	3.86%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Peat	CO_2	1.552	0	3.30%	38.90%	39.04%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Liquid Fuels	CH_4	0.980	0.183	5.00%	50.00%	50.25%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Solid Fuels	CH_4	1.928	0	5.00%	50.00%	50.25%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Gaseous Fuels	CH_4	0.001	0.002	5.00%	50.00%	50.25%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Peat	CH_4	0.134	0	5.00%	122.00%	122.10%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Biomass	CH_4	2.298	0.292	5.00%	150.00%	150.08%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Liquid Fuels	N_2O	0.706	0.107	5.00%	35.00%	35.36%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Solid Fuels	N_2O	0.091	0	5.00%	60.00%	60.21%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Gaseous Fuels	N_2O	0.002	0.002	5.00%	40.00%	40.31%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Peat	N_2O	0.006	0	5.00%	132.00%	132.09%
1.A.4.c.i Other Sectors/Agriculture/Forestry/Fishing/Stationary - Biomass	N_2O	0.292	0.038	5.00%	127.00%	127.10%
1.A.4.c.ii Other Sectors/Agriculture/Forestry/Fishing/Off-road vehicles and other machinery - Liquid Fuels	CO_2	0	0	1.70%	1.80%	2.48%
1.A.4.c.ii Other Sectors/Agriculture/Forestry/Fishing/Off-road vehicles and other machinery - Liquid Fuels	CH_4	0	0	5.00%	50.00%	50.25%
1.A.4.c.ii Other Sectors/Agriculture/Forestry/Fishing/Off-road vehicles and other machinery - Liquid Fuels	N_2O	0	0	5.00%	35.00%	35.36%
1.B.2.b.iv	CO_2	0.002	0.000	3.00%	25.00%	25.18%
1.B.2.b.iv	CH_4	8.212	1.760	3.00%	25.00%	25.18%
1.B.2.b.v	CO_2	0.090	0.019	3.00%	25.00%	25.18%
1.B.2.b.v	CH_4	54.417	11.661	3.00%	25.00%	25.18%
1.B.2.c.ii	CO_2	0.005	0.001	15.00%	25.00%	29.15%
1.B.2.c.ii	CH_4	9.003	1.929	15.00%	25.00%	29.15%
2.A.1 Cement production	CO_2	483.038	0.000	0.00%	0.00%	0.00%
2.A.2 Lime production	CO_2	118.837	18.791	0.18%	2.00%	2.01%
2.A.3 Glass production	CO_2	1.229	9.850	0.32%	1.00%	1.05%
2.A.4.a Ceramics	CO_2	0.000	3.549	0.10%	2.00%	2.00%
2.A.4.d Other - Limestone use for flue gas desulpurisation	CO_2	0.000	0.000	0.00%	0.00%	0.00%
2.B.1 Ammonia production	CO_2	307.735	0.000	0.00%	0.00%	0.00%
2.C.5 Lead production	CO_2	0.759	2.956	5.00%	5.00%	7.07%
2.D.1 Lubricant use	CO_2	16.108	5.505	5.00%	50.00%	50.25%
2.D.2 Paraffin wax use	CO_2	1.290	1.944	20.00%	5.00%	20.62%
2.D.3 Other - Urea based catalysts for motor vehicles	CO_2	0.000	1.840	30.00%	0.70%	30.01%
2.D.3 Other - Solvent use	indirect CO_2	18.475	23.860	25.00%	10.00%	26.93%
2.D.3 Other - Road paving with asphalt	indirect CO_2	0.045	0.030	10.00%	100.00%	100.50%
2.F.1.a Commercial Refrigeration	HFC	0	50.844	8.90%	41.10%	42.05%

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2.F.1.b Domestic Refrigeration	HFC	0	1.407	20.00%	10.00%	22.36%
2.F.1.c Industrial Refrigeration	HFC	0	32.928	9.10%	17.70%	19.90%
2.F.1.d Refrigerated Vehicles	HFC	0	24.099	8.50%	5.00%	9.86%
2.F.1.d Reefer Containers	HFC	0	1.597	8.40%	10.00%	13.06%
2.F.1.f Heat Pumps	HFC	0	10.200	9.00%	5.00%	10.30%
2.F.1.f Stationary and Room Air-Conditioning	HFC	0	31.243	15.00%	22.00%	26.63%
2.F.1.e Mobile Air-Conditioning - Passenger cars	HFC	0	10.086	8.50%	5.00%	9.86%
2.F.1.e Mobile Air-Conditioning - Trucks	HFC	0	4.565	8.50%	5.00%	9.86%
2.F.1.e Mobile Air-Conditioning - Buses	HFC	0	4.657	8.70%	5.00%	10.03%
2.F.1.e Mobile Air-Conditioning - Ships	HFC	0	7.627	3.00%	5.00%	5.83%
2.F.1.e Mobile Air-Conditioning - Railcars	HFC	0	0.004	3.00%	5.00%	5.83%
2.F.1.e Mobile Air-Conditioning - Wheel tractors and mobile machinery	HFC	0	5.888	14.50%	10.00%	17.61%
2.F.2.a Foam blowing agents; PU Insulation Panels	HFC	0	0.092	10.00%	10.00%	14.14%
2.F.2.a Spray and Injection PU Foam	HFC	0	0.111	10.00%	10.00%	14.14%
2.F.2.a XPS Insulation Foam	HFC	0	0.066	20.00%	10.00%	22.36%
2.F.2.b One Component PU Foam	HFC	0	0.743	15.00%	15.00%	21.21%
2.F.3 Fire protection	HFC	0	2.395	10.00%	10.00%	14.14%
2.F.4 Aerosols; Metered dose inhalers	HFC	0	2.299	10.00%	10.00%	14.14%
2.G.1 Electrical equipment	SF_6	0	3.120	3.00%	10.00%	10.44%
2.G.2 Particle accelerators	SF_6	0	0.089	21.00%	30.00%	36.62%
2.G.3 N2O from product use	N_2O	4.845	2.772	5.00%	2.00%	5.39%
3.A.1 Enteric Fermentation - Dairy Cattle	CH_4	821.087	379.873	0.72%	40.00%	40.01%
3.A.1 Enteric Fermentation - Non-Dairy Cattle	CH_4	533.893	203.054	1.11%	40.00%	40.02%
3.A.2 Enteric Fermentation - Sheep	CH_4	35.501	14.876	6.53%	40.00%	40.53%
3.A.3 Enteric Fermentation - Swine	CH_4	24.872	8.583	0.49%	40.00%	40.00%
3.A.4 Enteric Fermentation - Goats	CH_4	0.293	0.624	6.53%	40.00%	40.53%
3.A.4 Enteric Fermentation - Horses	CH_4	4.334	2.647	10.00%	40.00%	41.23%
3.A.4 Enteric Fermentation - Fur animals	CH_4	0.646	0.000	10.00%	40.00%	41.23%
3.B.1.1 Manure Management - Dairy Cattle	CH_4	39.963	80.026	0.72%	20.00%	20.01%
3.B.1.1 Manure Management -Non-Dairy Cattle	CH_4	20.065	36.792	1.11%	20.00%	20.03%
3.B.1.2 Manure Management - Sheep	CH_4	0.843	0.353	6.53%	30.00%	30.70%
3.B.1.3 Manure Management - Swine	CH_4	115.836	45.309	0.49%	20.00%	20.01%
3.B.1.4 Manure Management - Goats	CH_4	0.008	0.016	6.53%	30.00%	30.70%
3.B.1.4 Manure Management - Horses	CH_4	0.376	0.229	10.00%	30.00%	31.62%
3.B.1.4Manure Management - Poultry	CH_4	4.268	1.934	10.00%	30.00%	31.62%
3.B.1.4 Manure Management - Fur animals	CH_4	4.394	0.000	10.00%	30.00%	31.62%
3.B.1.4 Manure Management - Rabbits	CH_4	0.193	0.012	10.00%	30.00%	31.62%

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3.B.2.1 Manure Management - Dairy Cattle	N_2O	35.916	22.320	0.72%	111.80%	111.81%
3.B.2.1 Manure Management -Non-Dairy Cattle	N_2O	18.000	13.314	1.11%	111.80%	111.81%
3.B.2.2 Manure Management - Sheep	N_2O	2.558	1.072	6.53%	111.80%	111.99%
3.B.2.3 Manure Management - Swine	N_2O	2.103	0.711	0.49%	111.80%	111.80%
3.B.2.4 Manure Management - Goats	N_2O	0.041	0.088	6.53%	111.80%	111.99%
3.B.2.4 Manure Management - Horses	N_2O	0.635	0.388	10.00%	111.80%	112.25%
3.B.2.4 Manure Management - Poultry	N_2O	5.682	2.157	10.00%	111.80%	112.25%
3.B.2.4 Manure Management - Fur animals	N_2O	3.536	0.000	10.00%	111.80%	112.25%
3.B.2.4 Manure Management - Rabbits	N_2O	1.450	0.087	10.00%	111.80%	112.25%
3.B.2.5 Indirect N2O Emissions from Manure Management	N_2O	30.177	16.280	50.99%	400.12%	403.36%
3.D.1.1 Direct Soil Emissions - Inorganic N Fertilizers	N_2O	299.991	159.925	10.00%	200.00%	200.25%
3.D.1.2a Direct Soil Emissions - Animal Manure Applied to Soils (including manure digestates)	N_2O	125.280	67.232	50.99%	206.16%	212.37%
3.D.1.2b Direct Soil Emissions - Sewage Sludge Applied to Soils	N_2O	0.496	1.419	20.00%	200.00%	201.00%
3.D.1.2c Direct Soil Emissions - Compost, and Waste Digestates Applied to Soils	N_2O	0.861	17.405	20.00%	200.00%	201.00%
3.D.1.3 Direct Soil Emissions Urine and Dung Deposited by Grazing Animals	N_2O	66.763	17.236	50.99%	206.16%	212.37%
3.D.1.5 Direct Soil Emissions - Mineralization/Immobilization Associated with Loss/Gain of Soil Organic Matter	N_2O	0.000	14.641	33.24%	30.00%	44.77%
3.D.1.4 Direct Soil Emissions - Crop Residue	N_2O	168.302	129.562	7.59%	200.00%	200.14%
3.D.1.6 Direct Soil Emissions - Cultivation of Organic Soils	N_2O	148.508	141.529	21.41%	200.00%	201.14%
3.D.2.1 Indirect Emissions - Atmospheric Deposition	N_2O	62.597	35.207	14.84%	434.95%	435.20%
3.D.2.2 Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	142.039	90.046	17.60%	286.74%	287.28%
3.G Liming	CO_2	12.113	27.494	29.15%	50.00%	57.88%
3.H Urea Application	CO_2	0.998	2.284	2.00%	50.00%	50.04%
4.A.1 Forest Land remaining Forest Land - living biomass	CO_2	-4875.450	1337.278	2.92%	50.00%	50.09%
4.A.1 Forest Land remaining Forest Land - dead wood	CO_2	-339.147	-199.404	5.53%	50.00%	50.30%
4.A.1 Forest Land remaining Forest Land - mineral soils	CO_2	-1425.853	-1449.656	2.84%	60.00%	60.07%
4.A.1 Forest Land remaining Forest Land - organic soils	CO_2	713.432	721.092	5.96%	90.00%	90.20%
4.A.2 Land converted to Forest Land - living biomass	CO_2	-6.398	-207.373	32.32%	50.00%	59.53%
4.A.2 Land converted to Forest Land - dead wood	CO_2	-0.074	-2.399	63.40%	50.00%	80.75%
4.A.2 Land converted to Forest Land - litter	CO_2	-1.623	-52.590	21.08%	50.00%	54.26%
4.A.2 Land converted to Forest Land - mineral soils	CO_2	-0.372	2.470	22.91%	60.00%	64.22%
4.A.2 Land converted to Forest Land - organic soils	CO_2	0.357	26.509	46.84%	90.00%	101.46%
4.D Forest Land 4(II) Emissions and removals from drainage and rewetting	N_2O	237.279	242.218	5.91%	39.00%	39.45%
4.D Forest Land 4(II) Emissions and removals from drainage and rewetting	CH_4	74.965	77.506	5.91%	55.00%	55.32%
4.B.1 Cropland remaining Cropland - living biomass	CO_2	-1.140	-1.069	39.50%	4.30%	39.73%
4.B.1 Cropland remaining Cropland - mineral soils	CO_2	0.000	128.915	4.90%	60.00%	60.20%
4.B.1 Cropland remaining Cropland - organic soils	CO_2	647.497	570.405	31.46%	90.00%	95.34%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
4.B.2 Land converted to Cropland - living biomass	CO_2	0	9.805	75.69%	50.00%	90.72%
4.B.2 Land converted to Cropland - DOM	CO_2	0	11.786	75.67%	50.00%	90.70%
4.B.2 Land converted to Cropland - mineral soils	CO_2	0	90.322	32.15%	60.00%	68.07%
4.B.2 Land converted to Cropland - organic soils	CO_2	0	29.242	146.11%	90.00%	171.61%
4.C.1 Grassland remaining Grassland – living biomass	CO_2	-121.044	-98.699	38.53%	50.00%	63.12%
4.C.1 Grassland remaining Grassland – dead wood	CO_2	-6.602	-5.384	57.49%	50.00%	76.19%
4.C.1 Grassland remaining Grassland – organic soils	CO_2	8.413	8.131	15.62%	90.00%	91.34%
4.C.2 Land converted to Grassland – living biomass	CO_2	-0.085	-10.700	94.76%	50.00%	107.15%
4.C.2 Land converted to Grassland– dead wood	CO_2	-0.003	-0.393	196.00%	50.00%	202.28%
4.C.2 Land converted to Grassland– litter	CO_2	0	2.137	69.75%	50.00%	85.82%
4.C.2 Land converted to Grassland – mineral soils	CO_2	-0.325	-72.408	34.64%	60.00%	69.28%
4.C.2 Land converted to Grassland – organic soils	CO_2	0.075	1.903	87.70%	90.00%	125.66%
4.D.1.1 Peat extraction remaining Peat extraction	CO_2	274.046	1068.265	43.29%	50.00%	66.14%
4.D.2.1 Land converted for Peat extraction – living biomass	CO_2	0	0.389	196.01%	50.00%	202.28%
4.D.2.1 Land converted for Peat extraction – organic soils	CO_2	0	3.983	125.10%	50.00%	134.73%
4.D.2.3 Land converted to Other Wetlands	CO_2	5.586	9.378	66.25%	50.00%	83.00%
4.D Wetlands 4(II) Emissions and removals from drainage and rewetting	N_2O	2.197	2.149	42.94%	100.00%	108.83%
4.D Wetlands 4(II) Emissions and removals from drainage and rewetting	CH_4	0.124	0.122	42.94%	100.00%	108.83%
4.E.2 Land converted to Settlements - living biomass	CO_2	0	113.500	32.74%	50.00%	59.76%
4.E.2 Land converted to Settlements - DOM	CO_2	0	43.106	32.69%	50.00%	59.74%
4.B.2 Land converted to Settlements - mineral soils	CO_2	0	136.478	23.65%	70.00%	73.89%
4.B.2 Land converted to Settlements - organic soils	CO_2	0	32.945	81.36%	90.00%	121.32%
4.F.2 Land converted to Other Land	CO_2	0	37.523	111.04%	36.46%	116.87%
4(III) Direct and indirect N_2O emissions from N mineralization	N_2O	0.029	25.224	40.48%	90.13%	98.80%
4(IV) Biomass burning (CH_4)	CH_4	0.310	0.146	34.50%	70.00%	78.04%
4(IV) Biomass burning (N_2O)	N_2O	0.032	0.014	34.50%	70.00%	78.04%
4.G.1 Solid wood	CO_2	-156.265	-586.365	62.80%	57.00%	84.81%
4.G.2 Paper and paperboard	CO_2	-0.009	45.074	45.00%	57.00%	72.62%
4.G.3 Semi-Chemical wood pulp	CO_2	0.000	39.218	44.00%	57.00%	72.01%
5.A Solid waste disposal	CH_4	239.362	183.277	17.32%	87.16%	88.86%
5.B.1 Composting	CH_4	3.167	17.611	14.14%	74.63%	75.95%
5.B.1 Composting	N_2O	1.798	10.000	14.14%	65.00%	66.52%
5.C.1 Waste incineration	CH_4	0.064	0	5.00%	50.00%	50.25%
5.C.1 Waste incineration	N_2O	0.009	0	5.00%	100.00%	100.12%
5.C.1 Waste incineration	CO_2	0.764	0	5.00%	40.00%	40.31%
5.C.2 Open Burning of Waste	CH_4	1.301	0	32.02%	50.00%	59.37%
5.C.2 Open Burning of Waste	N_2O	0.194	0	32.02%	100.00%	105.00%

IPCC category	Gas	Base year emissions or removals	Year 2023 emissions or removals	Activity data uncertainty	Emission factor/estimation parameter uncertainty	Combined uncertainty
5.C.2 Open Burning of Waste	CO_2	1.488	0	32.02%	40.00%	51.23%
5.D.1 Domestic wastewater	CH_4	126.220	55.737	60.42%	66.33%	89.72%
5.D.1 Domestic wastewater	N_2O	34.203	31.440	24.97%	105.91%	108.82%
5.D.2 Industrial wastewater	CH_4	0.000	2.070	50.25%	36.06%	61.85%

ANNEX III: DETAILED DESCRIPTION OF THE REFERENCE APPROACH (INCLUDING INPUTS TO THE REFERENCE APPROACH SUCH AS THE NATIONAL ENERGY BALANCE) AND THE RESULTS OF THE COMPARISON OF NATIONAL ESTIMATES OF EMISSIONS WITH THOSE OBTAINED USING THE REFERENCE APPROACH

Reference approach (RA) is carried out using import–export, production, and stock change data from the Joint Questionnaire dataset reported to Eurostat by Statistics Estonia (www.stat.ee) – see chapter A.V.1.4.

In the 2025 inventory submission, the difference in CO_2 emissions in 2023 between RA and Sectoral approach (SA) was 43.53%. A lot of secondary fuels that are used in final consumption are made from oil shale: shale oil, semi-coke, and oil shale gas. This brings about differences in solid fuel consumption between RA and SA. These two datasets are comparable because in SA and RA the same amount of oil shale must be theoretically consumed. But, the amount of emitted CO_2 is different, as SA considers that some of the oil shale is turned into shale oil, and this process has a smaller CEF (carbon emission factor) than the combustion of oil shale (some of the carbon is transferred into shale oil). In RA calculations entire carbon in oil shale is combusted. To conclude, the emissions in RA from solid fuels are greater than in SA.

Shale oil is reported under Liquid fuels Shale Oil in RA in CRT and under Other hydrocarbons in the energy balance. The production of secondary fuels (which shale oil is) is not accounted for in the energy balance and in RA and Estonia exports most of its produced shale oil. This causes a negative apparent consumption of shale oil in the energy balance. This is the reason there is a negative value reported in the stock change in RA as there is no consumption reported and the calculated consumption in CRT has to be zero.

Waste consumption and emissions allocation reported in CRT Sectoral approach and Reference approach:

- Sectoral approach
  - 1.A.1.a municipal waste fossil part in Other fossil fuels
  - 1.A.1.a municipal waste biogenic part in Biomass
  - 1.A.2.f fossil waste in Other fossil fuels
- Reference approach
  - 1.A.1.a municipal waste fossil part in Waste (non-biomass fraction)
  - 1.A.1.a municipal waste biogenic part in Other non-fossil fuels
  - 1.A.2.f fossil waste in Other fossil fuels

Table Annex III_1 shows the energy consumption and Table Annex III_2 the emissions of the two approaches.

Table Annex III_1. Energy consumption of sectoral and reference approach in [PJ].

	Reference approach						Sectoral Approach						
	Liquid	**Solid**	**Gaseous**	**Other**	**Peat**	**Total**	**Liquid**	**Solid**	**Gaseous**	**Other**	**Peat**	**Total**	**Total difference**
1990	124.0	242.9	51.2	0.0	11.3	**429.4**	120.7	256.3	43.6	0.0	11.3	**431.9**	-0.58%
1991	111.4	221.8	51.4	0.0	12.0	**396.7**	108.5	233.1	44.4	0.0	12.0	**398.0**	-0.33%
1992	62.7	179.9	30.0	0.0	7.8	**280.5**	61.0	190.8	26.4	0.0	7.8	**286.0**	-1.91%
1993	65.0	143.2	14.9	0.0	5.9	**229.0**	63.2	154.9	13.5	0.0	5.9	**237.5**	-3.56%
1994	61.0	148.2	21.4	0.0	5.9	**236.5**	58.9	157.6	16.7	0.0	5.9	**239.2**	-1.10%
1995	48.2	136.2	24.4	0.0	6.3	**215.2**	46.2	147.5	19.5	0.0	6.3	**219.5**	-1.97%
1996	51.7	140.7	26.9	0.0	7.8	**227.2**	50.2	152.8	22.0	0.0	7.8	**232.8**	-2.41%
1997	50.3	139.4	26.1	0.0	6.9	**222.8**	48.8	151.4	21.3	0.0	6.9	**228.5**	-2.51%
1998	50.1	120.6	24.8	0.0	4.4	**199.9**	48.4	128.4	20.0	0.0	4.4	**201.2**	-0.62%
1999	45.8	111.2	24.1	0.0	4.0	**185.1**	44.2	115.9	19.4	0.0	4.0	**183.5**	0.88%
2000	38.4	116.6	27.7	0.0	3.4	**186.1**	36.7	125.0	23.5	0.0	3.4	**188.6**	-1.33%
2001	44.4	114.8	29.8	0.1	4.2	**193.2**	42.8	124.7	25.3	0.1	4.2	**197.1**	-1.95%
2002	46.0	112.0	24.9	0.3	4.7	**188.1**	43.0	122.3	23.8	0.3	4.7	**194.2**	-3.16%
2003	44.6	130.7	28.5	0.4	4.5	**208.7**	42.2	141.5	26.0	0.4	4.5	**214.5**	-2.71%
2004	44.8	131.5	32.4	0.8	3.1	**212.6**	41.8	142.1	27.9	0.8	3.1	**215.8**	-1.45%
2005	46.5	134.9	33.5	0.6	2.9	**218.5**	42.8	140.7	28.6	0.6	2.9	**215.6**	1.34%
2006	47.5	128.1	33.8	0.6	3.6	**213.6**	43.2	135.0	28.9	0.6	3.6	**211.2**	1.12%
2007	49.1	165.3	33.6	0.7	4.6	**253.2**	44.6	166.6	28.9	0.7	4.6	**245.4**	3.21%
2008	46.5	145.4	32.3	1.0	3.4	**228.6**	42.6	149.3	27.4	1.0	3.4	**223.6**	2.21%
2009	42.7	123.7	22.0	0.5	2.7	**191.6**	39.0	129.9	21.4	0.5	2.7	**193.6**	-1.04%
2010	44.1	168.0	23.6	0.5	3.8	**240.0**	40.9	173.3	23.6	0.5	3.8	**242.1**	-0.86%
2011	44.3	171.0	21.1	1.1	3.3	**240.8**	41.4	175.8	21.1	1.1	3.3	**242.7**	-0.79%
2012	44.5	160.6	22.8	1.3	2.8	**232.0**	42.4	162.6	22.4	1.3	2.8	**231.5**	0.20%
2013	43.4	183.7	23.2	2.4	2.6	**255.3**	40.7	180.4	20.4	2.4	2.6	**246.5**	3.59%
2014	44.1	187.8	18.2	2.6	2.4	**255.1**	40.6	178.2	18.2	2.6	2.4	**242.1**	5.38%
2015	45.3	163.2	16.3	2.2	1.5	**228.5**	42.5	163.6	16.3	2.2	1.5	**226.2**	1.03%
2016	45.8	175.0	17.9	2.1	1.5	**242.4**	43.9	168.7	17.9	2.1	1.5	**234.2**	3.50%
2017	46.9	176.8	16.5	2.1	1.6	**244.0**	43.9	193.8	16.5	2.1	1.6	**258.0**	-5.44%
2018	42.9	197.3	17.4	2.5	1.4	**261.5**	43.6	189.8	17.3	2.5	1.4	**254.7**	2.68%
2019	44.8	121.6	16.1	2.5	1.0	**185.9**	42.2	143.3	15.9	2.5	1.0	**204.8**	-9.26%
2020	44.0	98.2	14.8	2.3	0.6	**159.9**	39.3	118.2	14.6	2.3	0.6	**175.1**	-8.67%
2021	42.0	108.9	16.8	2.2	0.2	**170.1**	38.0	127.9	16.6	2.2	0.2	**184.8**	-7.97%
2022	44.5	121.6	12.5	1.5	0.3	**180.5**	41.0	140.3	12.3	1.5	0.3	**195.5**	-7.64%
2023	43.7	100.5	11.0	1.6	0.2	**157.1**	40.8	116.1	10.7	1.6	0.2	**169.4**	-7.26%

Table Annex III_2. CO_2 emissions [kt] of sectoral and reference approach

	Reference approach						Sectoral Approach						
	Liquid	**Solid**	**Gaseous**	**Other**	**Peat**	**Total**	**Liquid**	**Solid**	**Gaseous**	**Other**	**Peat**	**Total**	**Total difference**
1990	9146	24156	2408	0	1169	**36879**	9101	23265	2408	0	1169	**35943**	2.60%
1991	8221	22068	2452	0	1244	**33985**	8171	21302	2452	0	1244	**33169**	2.46%
1992	4641	17850	1459	0	804	**24754**	4606	16992	1459	0	804	**23860**	3.75%
1993	4800	14006	744	0	613	**20163**	4771	12976	744	0	613	**19104**	5.55%
1994	4465	14719	923	0	615	**20722**	4426	13502	923	0	615	**19467**	6.45%
1995	3508	13316	1075	0	652	**18551**	3460	12263	1075	0	652	**17450**	6.31%
1996	3783	13809	1217	0	810	**19619**	3753	12640	1217	0	810	**18420**	6.51%
1997	3657	13649	1179	0	723	**19208**	3643	12468	1179	0	723	**18013**	6.63%
1998	3634	11854	1103	0	459	**17051**	3610	11039	1103	0	459	**16212**	5.18%
1999	3312	11082	1074	0	417	**15885**	3290	10502	1074	0	417	**15284**	3.93%
2000	2718	11483	1301	1	355	**15857**	2691	10494	1301	1	355	**14842**	6.84%
2001	3157	11143	1398	10	440	**16148**	3135	10237	1398	10	440	**15221**	6.09%
2002	3189	10970	1315	26	499	**15999**	3168	9881	1315	26	499	**14890**	7.45%
2003	3121	12867	1436	30	470	**17922**	3106	11701	1436	30	470	**16742**	7.05%
2004	3091	12903	1541	63	329	**17927**	3079	11681	1541	63	329	**16694**	7.39%
2005	3137	13233	1579	45	305	**18299**	3124	11438	1579	45	305	**16491**	10.96%
2006	3148	12539	1599	44	377	**17707**	3133	10668	1599	44	377	**15821**	11.92%
2007	3255	16236	1599	51	483	**21624**	3232	13773	1599	51	483	**19138**	12.99%
2008	3105	14204	1514	72	356	**19251**	3090	11963	1514	72	356	**16995**	13.27%
2009	2857	12031	1185	39	286	**16397**	2844	9733	1185	39	286	**14087**	16.40%
2010	3012	16463	1301	34	402	**21212**	3001	13857	1301	34	402	**18596**	14.07%
2011	3048	16702	1164	89	343	**21347**	3037	13835	1164	89	343	**18469**	15.58%
2012	3071	15655	1237	105	291	**20360**	3102	12307	1237	105	291	**17044**	19.46%
2013	2938	18245	1125	201	272	**22781**	2979	14257	1125	201	272	**18834**	20.96%
2014	2960	19086	1008	228	255	**23537**	2978	13814	1008	228	255	**18283**	28.74%
2015	3099	16197	903	196	156	**20552**	3112	11112	903	196	156	**15480**	32.77%
2016	3206	17796	991	195	162	**22350**	3207	12598	991	195	162	**17153**	30.30%
2017	3220	17660	912	198	174	**22164**	3210	13700	912	198	174	**18193**	21.82%
2018	2946	20070	961	204	151	**24331**	3168	12909	958	204	151	**17388**	39.93%
2019	3053	11910	887	183	102	**16135**	3045	7670	881	183	102	**11881**	35.80%
2020	2863	8890	816	149	68	**12786**	2851	5206	805	149	68	**9079**	40.83%
2021	2773	10030	930	132	21	**13886**	2760	6434	916	132	21	**10263**	35.30%
2022	3002	11147	693	118	35	**14994**	2979	8049	679	118	35	**11858**	26.45%
2023	2966	8677	597	144	26	**12410**	2954	4945	577	144	26	**8646**	43.53%

ANNEX IV: QA/QC PLAN

The Estonia's QA/QC plan consist of seven parts: (1) production plan (see Table Annex IV. 1); (2) annual meetings; (3) QA/QC checks; (4) QA results documentation form; (5) archiving structure; (6) response tables to the review process and (7) a list of planned activities and improvements.

The EERC and the MoC have developed an inventory production plan that sets out the schedule for inventory preparation. The schedule, which is annually reviewed, forms part of Estonia's QA/QC plan and must be followed by all core institutions (MoC, EERC and EstEA). The inventory production plan for 2025 submission cycle is presented in Table Annex IV. 1.

Table Annex IV. 1. Inventory production plan for the

Activity	Responsible	Deadline
Annual meeting: Will be discussed how the previous inventory cycle has been, what should be improved/changed; new contracts, etc	*All*	*April 30*
Independent experts (based on contract agreements) carry out QA of the inventory and submit the results to EERC. Inventory experts analyze the results and implement changes as appropriate.	Independent experts	June-Dec
Coordinators check general information included in NID and update if necessary	EERC	June-Sep
Sectoral experts implement possible changes based on the result of QA / UNFCCC review	Independent experts	Febr. 15
Collection of activity data	EERC, EstEA	*Starting from Sept*
Sectoral experts notify the EERC and MoC of the planned methodological changes, reasons for changes and how they plan to incorporate the UNFCCC review results to the next report	EERC, EstEA	Oct. 21
Annual meeting: Sectoral experts notify the EERC and MoC of the planned methodological changes, reasons for changes, overview of the planning of the new inventory cycle and how they plan to incorporate the UNFCCC review results to the next report. MoC and EERC give an overview of the new requirements, plans, etc	*All*	*Oct. 29*
Sectoral experts´ complete data entry to the Common Reporting Tables (CRT) and notify the EERC	EERC, EstEA	Dec. 15
QC checks are carried out (CRT) and documented by inventory coordinator (EERC) and sent to the sectoral experts	EERC	Dec. 19
Sectoral experts send the necessary data for uncertainty analysis to EERC	EERC, EstEA	Dec. 27
Sectoral experts provide the draft NID to the EERC. Prior to this the QC checks should be carried out and documented	EERC, EstEA	Dec. 27

Activity	Responsible	Deadline
EERC performs the key category analysis and uncertainty analysis and sends the results to the sectoral experts and independent experts	EERC, EstEA	Jan. 7
EERC perform QC of the NID and send the comments to the sectoral experts and independent experts for review	EERC	Jan. 10
Sectoral experts send their comments and possible changes on the CRT according to the QA/QC (performed by independent experts and EERC) to EERC. EERC sends comments to independent experts	EERC	Jan. 12
EERC compiles the NID according to the submitted sectoral parts and sends it to the sectoral experts for approval	EERC	Jan. 12
Reporting to the EU (CRT and draft NID)	EERC	Jan. 15
NID is sent to different departments of MoC and other relevant institutions for approval	EERC	Jan. 17
The NID along with the CRT is uploaded to the MoC webpage	MoC	Jan. 17
MoC different departments and other relevant institutions carry out QA of the CRT and NID and submits the results to the EERC	EERC	Febr. 10
EERC submits the results of the MoC and other relevant institutions QA to the sectoral experts and independent expert	EERC	Febr. 10
Sectoral experts send their comments and possible changes according to the QA/QC (performed by the MoC and independent experts) to EERC, MoC. EERC sends comments to independent experts	EERC, EstEA	Febr. 14
Annual meeting: The comments given during the inventory preparation and the last UNFCCC review report will be looked through. Also, questions/problems that have been raised will be discussed before the submission to the EU	*All*	*Before March 15*
Answers to the EU initial check and if possible then corrections are made to the inventory	All	Jan.15 - March 15
Reporting to the EC (CRT and NID)	EERC	March 15
NID and CRT are uploaded to the MoC webpage	MoC	March 24
Reporting to the UNFCCC	EERC	April 15
Sectoral experts present complete archives to EERC	EERC, EstEA	May 3

Quality control procedures

The QC procedures used in Estonia's GHG inventory comply with 2006 IPCC Guidelines. General inventory QC procedures include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies, documentation and archiving of inventory data and quality control actions. Once the experts have implemented the QC procedures, they complete the QA/QC checklist for each source/sink category, which provides a record of the procedures performed. The QA/QC checklists are part of Estonia's QA/QC plan. Also, assessment of completeness is evaluated.

EERC checks the QC checklists completed by EERC experts and EstEA. When EERC disagrees with the information provided in the checklists then the errors are discussed, and changes are made if necessary.

In addition to the general inventory QC procedures, Estonia applied category-specific QC procedures on some source/sink categories in the 2025 submission, focusing on key categories and on those categories in which significant methodological changes and/or data revisions occurred. More detailed information can be found under sectoral chapters.

After the sectoral experts have completed entering data to the CRT, EERC carries out some general (including visual) checks on the data entered. When the CRT are complete, the experts start preparing the sectoral chapters of the NID. These parts are sent to the compiler (EERC) who adds the introduction part and puts the draft NID together. The compiler arranges the different chapters into one uniform document and makes sure that the structure of the report follows the UNFCCC guidelines. All figures on emissions and removals in tables and text are checked to make sure that they are consistent with those reported in the CRT. The sectoral experts and the inventory compiler also check that all methodological changes, recalculations, trends in emission, and removals are well explained.

In addition, the QA/QC of Member States' submissions conducted under the European Union GHG reporting mechanism (e.g., completeness checks, consistency checks and comparison across Member States) produces valuable information on errors and deficiencies, and the information is considered before Estonia submits its final annual inventory to the UNFCCC.

Quality assurance procedures

The objective of QA implementation is to involve reviewers that can conduct an unbiased review of the inventory and who may have a different technical perspective. It is important to use QA reviewers who have not been involved in preparing the inventory. These reviewers should preferably be independent experts from other agencies or national experts, or groups not closely connected to national inventory compilation.

Estonia's GHG inventory is checked annually by one or more independent experts. From the 2009 to 2012 submission all data collected by institutions involved in the inventory process was checked by an independent expert from Tallinn University of Technology (TalTech). The 2013–2020 inventory submissions were reviewed in parts by the EERC, TalTech, University of Tartu, Estonian University of Life Sciences (EULS) and other national experts. The 2021 submission was checked by experts from TalTech, and other national experts. The methodological changes in LULUCF sector's Forest Land living biomass in the 2022 submission were evaluated by an external expert from Natural Resources Institute Finland (Luke). In general the findings of the independent experts are looked through by experts (in collaboration with the EERC) and adjustments carried out as a result, if necessary.

When the draft NID is completed, it is sent to the MoC Climate, Energy, Transport, Forestry, Environmental Management, and Water Department to ensure that the submitted data is officially valid. The NID draft is uploaded to the MoC website www.envir.ee where all the interested parties can comment on it. The inventory is also checked by other Ministries and institutions. The inventory will be sent to the to the Agricultural Environment Bureau in the Ministry of Regional

Affairs and Agriculture, and Statistics Estonia. Statistics Estonia is routinely involved in the quality checking of the data used in inventory. Also, the draft inventory is annually sent to Statistics Estonia.

UNFCCC reviews are part of QA. The reviews are performed by a team of experts (sectoral experts and generalist) from other countries. They examine the data and methods that Estonia is using and check the documentation, archiving system and national system. In conclusion they report whether Estonia's overall performance is in accordance with current guidelines. The review report indicates the specific areas in which the inventory needs improvements. Estonia's 2018 GHG inventory was a subject of an in-country review performed by the UNFCCC experts. The review of Estonia's 2022 submission was carried out as a centralized review from 12 to 17 September 2022. There was no review in 2023.

The GHG inventories submitted by Member States in 2016–2022 were subject to annual review of national greenhouse gas inventory data pursuant to Article 19(2) of Regulation (EU) No 525/2013. The review was performed in two steps. Step 1 was combined with the 'EU QA/QC procedures' (i.e., initial checks) and was carried out by the EU inventory team (ETC/ACM, JRC, Eurostat). All findings from the initial checks that were relevant for the Effort Sharing Decision (ESD) and that were not resolved within the initial check phase were followed up in the second step of the review. Step 2 of the ESD review of 2017–2022 was performed by TERT. In 2020, the European Commission carried out according to the review process established under the MMR IR and to Article 4(3) of the Effort Sharing Regulation (2018/842) a comprehensive review of Member States' GHG inventories for the years 2005 and 2016 to 2018.

According to article 37(4) of regulation (EU) 2018/1999 of the European Parliament and of the Commission[45], the Commission (the EU inventory team) shall check annually the accuracy of the preliminary greenhouse gas inventory data submitted by Member States. Additionally, where the Commission finds during these initial checks a difference between the annual average of net removals in the years 2016-2018 reported by any Member State in the 2020 and 2023 or subsequent submission of the greenhouse gas inventory that is greater than 500 kt CO_2 eq., the Commission shall make additional checks of the Parties reported information to ensure that TACCC principles have been applied.

Also, according to article 38 of regulation (EU) 2018/1999 the Commission shall, in 2027 and 2032, carry out a comprehensive review of the national inventory data submitted by the EU Member States. Also, in 2025, the Commission shall carry out a comprehensive review of the national inventory data in order to determine the annual targets of net greenhouse gas emissions reduction of the Member States pursuant to Regulation (EU) 2018/841 and in order to determine the annual emission allocations of the Member States of Regulation (EU) 2018/842.

[45] Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action. [www] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02018R1999-20231120 (02.01.2025)

ANNEX V: ANY ADDITIONAL INFORMATION, AS APPLICABLE, INCLUDING DETAILED METHODOLOGICAL DESCRIPTIONS OF SOURCE OR SINK CATEGORIES AND THE NATIONAL EMISSION BALANCE

A.V.1. Assessment of completeness

Completeness of the Estonia's inventory submissions is evaluated here by sectors in tables below. The completeness has been estimated by gases (CO_2, N_2O CH_4, F-gases and also NOx, CO, NMVOC and SO_2) and emission sources according to the detailed CRT classification.

Abbreviations used in tables and additional information:

X – Included in the inventory

NO – Not occurring in Estonia

NA – Not available

NE – Not estimated

IE – Included elsewhere.

Cells marked as gray – emission estimation is not applicable for the specific gas/category

*** Notes,** if category reporting includes some national specific emission source, which is not required in IPCC guidelines and other relevant issue

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
Energy sector (CRT 1)													
1.A Fuel combustion activities (CRT 1.A)													
1.A.1 Energy industries													
1.A.1.a Public Electricity and Heat Production	X	X	X	X	X	X	X						
1.A.1.b Petroleum Refining	NO	NO	NO	NO	NO	NO	NO						
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries	X	X	X	X	X	X	X						
1.A.2 Manufacturing Industries and Construction													
1.A.2.a Iron and Steel*	X	X	X	X	X	X	X						There was no production of iron and steel products in 1990-1994, 1997-1999 and 2008.
1.A.2.b Non-Ferrous Metals*	NO	NO	NO	NO	NO	NO	NO						There was no production of non-ferrous metals products in 1990-2000 and in 2022-2023.
1.A.2.c Chemicals	X	X	X	X	X	X	X						
1.A.2.d Pulp, Paper and Print*	X	X	X	X	X	X	X						
1.A.2.e Food Processing, Beverages and Tobacco	X	X	X	X	X	X	X						
1.A.2.f Non-metallic Minerals	X	X	X	X	X	X	X						
1.A.2.g Other manufacturing industries and construction	X	X	X	X	X	X	X						
1.A.3 Transport													
1.A.3.a. Civil Aviation	X	X	X	X	X	X	X						
1.A.3.b Road Transportation	X	X	X	X	X	X	X						
1.A.3.c Railways	X	X	X	X	X	X	X						
1.A.3.d Navigation	X	X	X	X	X	X	X						
1.A.3.e Other Transportation	X	X	X	X	X	X	X						
1.A.4 Other Sectors													
1.A.4.a Commercial/ Institutional	X	X	X	X	X	X	X						
1.A.4.b Residential	X	X	X	X	X	X	X						

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
1.A.4.c Agriculture/Forestry/ Fisheries	X	X	X	X	X	X	X						
1.B Fugitive emissions from fuels (CRT 1.B)													
1.B.1 Solid fuels													
1.B.1.a Coal Mining and Handling	NO	NO	NO	NO	NO	NO	NO						
1.B.1.b Solid Fuel Transformation	NO	NO	NO	NO	NO	NO	NO						
1.B.1.c Other (please specify)	NO	NO	NO	NO	NO	NO	NO						
1.B.2 Oil and Natural Gas													
1.B.2.a.1 Exploration	NO	NO	NO	NO	NO	NO	NO						
1.B.2.a.2 Production	NO	NO	NO	NO	NO	NO	NO						
1.B.2.a.3 Transport	NO	NO	NO	NO	NO	NO	NO						
1.B.2.a.4 Refining/Storage	NO	NO	NO	NO	NO	NO	NO						
1.B.2.a.5 Distribution of Oil Products	NE	NE	NE	NE	NE	NE	NE						
1.B.2.a.6 Other	NO	NO	NO	NO	NO	NO	NO						
1.B.2.b.1 Exploration	NO	NO	NO	NO	NO	NO	NO						
1.B.2.b.2 Production	NO	NO	NO	NO	NO	NO	NO						
1.B.2.b.3 Processing	NO	NO	NO	NO	NO	NO	NO						
1.B.2.b.4 Natural Gas/Transmission and storage	X	X	NO	NO	NO	NO	NO						
1.B.2.b.5 Natural Gas/Distribution	X	X	NO	NO	NO	NO	NO						
1.B.2.b.6 Other	NO	NO	NO	NO	NO	NO	NO						
1.B.2.c Venting and Flaring	X	X	NO	NO	NO	NO	NO						
1.B.2.d Other (please specify)	NO	NO	NO	NO	NO	NO	NO						
Industrial processes and product use (CRT 2)													
2.A. Mineral Industry													
2.A.1. Cement Production	NO	NO	NO	NO	NO	NO	NO						Historical activity and emissions are reported from 1990 to 2020.
2.A.2. Lime Production	X	NO	NO	NO	NO	NO	NO						
2.A.3. Glass Production	X	NO	NO	NO	NO	NO	NO						
2.A.4.a Ceramics	X	NO	NO	NO	NO	NO	NO						

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
2.A.4.b. Other uses of Soda Ash	IE	NO	NO	NO	NO	NO	IE						Emissions from soda ash use were relocated to 2.C.5 Lead production from 2019 submission onwards.
2.A.4.c Non-metallurgical Magnesium Production	NO	NO	NO	NO	NO	NO	NO						
2.A.4.d Other – Limestone use for flue gas desulphurisation	NO	NO	NO	NO	NO	NO	NO						Starting from 2018 no activity occurred
2.B. Chemical Industry													
2.B.1. Ammonia Production	NO	NO	NO	NO	NO	NO	NO						Historical activity and emissions are reported from 1990 to 2013.
2.B.2.Nitric Acid Production	NO	NO	NO	NO	NO	NO	NO						
2.B.3. Adipic Acid Production	NO	NO	NO	NO	NO	NO	NO						
2.B.4. Caprolactam, Glyoxal and Glyoxylic Acid Production	NO	NO	NO	NO	NO	NO	NO						
2.B.5. Carbide Production	NO	NO	NO	NO	NO	NO	NO						
2.B.6. Titanium Dioxide Production	NO	NO	NO	NO	NO	NO	NO						
2.B.7. Soda Ash Production	NO	NO	NO	NO	NO	NO	NO						
2.B.8. Petrochemical and Carbon Black Production	NO	NO	NO	NO	NO	NO	NO						
2.B.9. Fluorochemical Production								NO	NO	NO	NO	NO	
2.B.10 Other	NO	NO	NO	NO	NO	NO	NO						
2.D. Non-energy Products from fuels and Solvent use													
2.D.1. Lubricant Use	X	NO	NO	NO	NO	NO	NO						
2.D.2. Paraffin Wax use	X	NO	NO	NO	NO	NO	NO						
2.D.3. Other – Solvent Use	X	NO	NO	NO	X	X	NO						
2.D.3. Other – Road paving with asphalt	X	NO	NO	NO	NO	X	NO						Indirect CO_2 emissions from NMVOC emissions are reported.
2.D.3 Other; Other – Urea based catalysts for motor vehicles	X	NO	NO	NO	NO	NO	NO						Indirect CO_2 emissions from NMVOC emissions are reported.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
2.C. Metal Production													
2.C.1. Iron and Steel Production	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	
2.C.2.Ferroalloys Production	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	
2.C.3. Aluminium Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
2.C.4. Magnesium Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
2.C.5. Lead Production	X	NO	NO	NO	NO	NO	X	NA	NA	NA	NA	NA	
2.C.6 Zinc Production	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	
2.C.7 Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
2.E. Electronics Industry													
2.E.1. Integrated Circuit or Semiconductor								NO	NO	NO	NO	NO	
2.E.2. TFT Flat Panel Display								NO	NO	NO	NO	NO	
2.E.3. Photovoltaics								NO	NO	NO	NO	NO	
2.E.4. Heat Transfer Fluid								NO	NO	NO	NO	NO	
2.E.5. Other								NO	NO	NO	NO	NO	
2.F. Product Uses and Substitutes for ODS													
2.F.1. Refrigeration and Air Conditioning								X	NO	NO	NO	NO	
2.F.2. Foam Blowing Agents								X	NO	NO	NO	NO	
2.F.3. Fire Protection								X	NO	NO	NO	NO	
2.F.4. Aerosols								X	NO	NO	NO	NO	
2.F.5. Solvents								NO	NO	NO	NO	NO	
2.F.6. Other applications using ODS Substitutes								NO	NO	NO	NO	NO	
2.G. Other Product Manufacture and Use													
2.G.1 Electrical Equipment				NO				NO	NO	X			
2.G.2. Other - Particle accelerators				NO				NO	NO	X			
2.G.2. Other – Sport Shoes				NO				NO	NO	NO			PFC emissions from sport shoes with gas cushion occurred in Estonia from 2006 to 2008 and SF6 emissions from 1995 to 2006.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
2.G.2. Other – Car tyres				NO				NO	NO	NO			SF_6 emissions from car tyres occurred in 1993–2003.
2.G.3.a N_2O from Medical Applications				X				NO	NO	NO			
2.G.3.b Other – Propellant for pressure and aerosol products				X				NO	NO	NO			
2.H.Other Production													
2.H.1.Pulp and Paper	NO	NO	NO	X	X	X	X						
2.H.2.Food and beverages	NO	NO	NO	NO	NO	X	NO						
Agriculture (CRT 3)													
3.A. Enteric Fermentation	NO	X	NO	NO	NO	NO	NO						CO_2 emissions from livestock are not estimated because annual net CO_2 emissions are assumed to be zero – the CO_2 photosynthesized by plants is returned to the atmosphere as respired CO_2.
3.B. Manure Management	NO	X	X	NO	NO	X	NO						
3.C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO						
3.D. Agricultural soils	NO	NO	X	X	NO	NE, NO	NO						
3.D.1. Direct Soil Emissions	NO	NO	X	NO	NO	NE, NO	NO						
3.D.1.1. Synthetic Fertilizers	NO	NO	X	NO	NO	NE, NO	NO						
3.D.1.2. Organic N Fertilizers	NO	NO	X	NO	NO	NE, NO	NO						
3.D.1.3. Urine and Dung Deposited by Grazing Animals	NO	NO	X	NO	NO	NE, NO	NO						
3.D.1.4. Crop Residues	NO	NO	X	NO	NO	NE, NO	NO						
3.D.1.5. Mineralization/Immobilization Associated with Loss/Gain of Soil Organic Matter	NO	NO	X	NO	NO	NE, NO	NO						According to 2024 submission calculations, annual net emissions from mineralization/immobilization associated with loss/gain of soil organic matter have occurred only in years 1991 and 1992.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
3.D.1.6. Cultivation of Organic Soils	NO	NO	X	NO	NO	NE, NO	NO						
3.D.2. Indirect Emissions	NO	NO	X	NO	NO	NE, NO	NO						
3.D.2.1. Atmospheric Deposition	NO	NO	X	NO	NO	NE, NO	NO						
3.D.2.2. Nitrogen Leaching and Run-off	NO	NO	X	NO	NO	NE, NO	NO						
3.E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO						There are no savannas in Estonia.
3.F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO						Burning of agricultural residues is not a common practice in Estonia.
3.G. Liming	X	NO	NO	NO	NO	NO	NO						
3.H. Urea Application	X	NO	NO	NO	NO	NO	NO						
LULUCF (CRT 4)													
4.A. Forest Land													
4.A.1. Forest Land remaining Forest Land	X	X	X	NE	NE	NE							NE: IPCC 2006 does not provide default method for estimating these emissions.
Carbon stock change	X												Estonia does not have sufficient data regarding litter stock
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	IE, NE	X	X										Only emissions from drained organic soils are estimated. IE: CO_2 emissions are included in Table 4.A.1. NE: According to IPCC 2006 it is not mandatory to report this category (mineral soils).
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			NO										
4(V) Biomass burning	IE, NO	X	X										IE: CO_2 emissions are included in FL remaining FL C stock change in living biomass.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
4.A.2. Land converted to Forest Land	X	IE, NE, NO	X	NE	NE	NE							
Carbon stock change													
4.A.2.a. Cropland to Forest Land	X												
4.A.2.b. Grassland to Forest Land	X												
4.A.2.c. Wetlands to Forest Land	X												
4.A.2.d. Settlements to Forest Land	X												
4.A.2.e. Other Land to Forest Land	X												
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	IE, NE	IE, NE	IE, NE										IE: CO_2 emissions are included in Table 4.A.2. CH_4 and N_2O emissions are included in the Table 4(II).A.1. NE: According to IPCC 2006 it is not mandatory to report this category (mineral soils).
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			X										
4(IV) Biomass burning	IE, NO	IE, NO	IE, NO										IE: Emissions are reported under category 4.A.1 FL remaining FL.
4.B. Cropland													
4.B.1. Cropland remaining Cropland	X	NO, NE	NO, NE	NE	NE	NE							
Carbon stock change	X												

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	IE, NE	NE											IE: CO_2 emissions from drained organic soils are included in Table 4.B.1. NE: According to IPCC 2006 it is not mandatory to report this category.
4(IV) Biomass Burning	NO, NE	NO, NE	NO, NE										NE: Emissions are considered insignificant in terms of the overall level and trend in national emissions.
4.B.2. Land converted to Cropland	X	NO, NE	X	NE	NE	NE							
Carbon stock change													
4.B.2.a. Forest Land to Cropland	X												
4.B.2.b. Grassland to Cropland	X												
4.B.2.c. Wetlands to Cropland	X												
4.B.2.d. Settlements to Cropland	X												
4.B.2.e. Other land to Cropland	NO												
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	IE, NE	NE		IE, NE									IE: CO_2 emissions from drained organic soils are included in Table 4.B.2. N_2O emissions from drained organic soils are included in the Table 3.D.1.f. NE: According to IPCC 2006 it is not mandatory to report this category.
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			X										
4(IV) Biomass Burning	NO, NE	NO, NE	NO, NE										NE: Emissions are considered insignificant in terms of the overall level and trend in national emissions.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
4.C. Grassland													
4.C.1. Grassland remaining Grassland	X	X	X	NE	NE	NE							
Carbon stock change	X												
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	IE, NE	NE											IE: CO_2 emissions from drained organic soils are included in Table 4.C.1. NE: According to IPCC 2006 it is not mandatory to report this category.
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			NO										
4 (IV) Biomass Burning	IE, NO	X	X										IE: CO_2 emissions are included in GL remaining GL C stock change in living biomass.
4.C.2. Land converted to Grassland	X	IE, NE, NO	IE, NE, NO	NE	NE	NE							
Carbon stock change													
4.C.2.a. Forest Land to Grassland	X												
4.C.2.b. Cropland to Grassland	X												
4.C.2.c. Wetlands to Grassland	X												
4.C.2.d. Settlements to Grassland	X												
4.C.2.e. Other land to Grassland	X												

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	IE, NE	NE	IE, NE										IE: CO_2 emissions from drained organic soils are included in Table 4.C.2. N_2O emissions from drained organic soils are included in the Table 3.D.1.f. NE: According to IPCC 2006 it is not mandatory to report this category.
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			NO										
4(IV) Biomass Burning	IE, NO	IE, NO	IE, NO										IE: Emissions are reported under category 4.C.1 GL remaining GL
4.D. Wetlands													
4.D.1. Wetlands remaining Wetlands	X	X	X	NE	NE	NE							
Carbon stock change													
4.D.1.a Peat Extraction remaining Peat Extraction	X												
4.D.1.b Flooded Land Remaining Flooded Land	NA												2006 IPCC Guidelines do not provide default methods for this category.
4.D.1.c Other Wetlands remaining Other Wetlands	NO, NA												NA: 2006 IPCC Guidelines do not provide default methods for this category
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	IE, NE	X	X										Only emissions from Peat Extraction Lands, Drained organic soils are estimated. IE: CO_2 emissions are included in Table 4.D.1.a. NE: According to IPCC 2006 it is not mandatory to report this category.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			NO										
4(IV) Biomass Burning	IE, NO	IE, NO	IE, NO										IE: Emissions are reported under category 4.C.1 Grassland remaining Grassland 4(IV) Biomass Burning due to statistical data available.
4.D.2. Land converted to Wetlands	X	X	X	NE	NE	NE							
Carbon stock change													
4.D.2.a. Land converted for Peat Extraction	X												
4.D.2.b. Land converted to Flooded Land	NO												
4.D.2.c. Land converted to Other Wetlands	X												
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	IE, NE	X	X										Only emissions from Peat Extraction Lands, Drained organic soils are estimated. IE: CO_2 emissions are included in Table 4.D.2.a. NE: According to IPCC 2006 it is not mandatory to report this category.
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			NO										
4(IV) Biomass Burning	IE, NO	IE, NO	IE, NO										IE: Emissions are reported under category 4.C.1 Grassland remaining Grassland 4(IV) Biomass Burning due to statistical data available.
4.E. Settlements													

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
4.E.1. Settlements remaining Settlements	NA, NE, NO	NE, NO	NE, NO	NE	NE	NE							
Carbon stock change	NO, NA												Lack of activity data, it is assumed that C stocks are at equilibrium
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	NE, NO	NE, NO	NE, NO										NE: According to IPCC 2006 it is not mandatory to report this category.
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			NO										
4(IV) Biomass Burning	NE, NO	NE, NO	NE, NO										NE: Emissions are considered insignificant in terms of the overall level and trend in national emissions.
4.E.2. Land converted to Settlements	X	NE, NO	X	NE	NE	NE							
Carbon stock change													
4.E.2.a. Forest Land to Settlements	X												
4.E.2.b. Cropland to Settlements	X												
4.E.2.c. Grassland to Settlements	X												
4.E.2.d. Wetlands to Settlements	X												
4.E.2.e. Other land to Settlements	NO												
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	IE, NE	NE	NE										IE: CO_2 emissions from drained organic soils are included in Table 4.E.2. NE: According to IPCC 2006 it is not mandatory to report this category.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			X										
4(IV) Biomass Burning	NE, NO	NE, NO	NE, NO										NE: Emissions are considered insignificant in terms of the overall level and trend in national emissions.
4.F. Other Land													
4.F.2. Land converted to Other Land	X	NE, NO	X	NE	NE	NE							
Carbon stock change													
4.F.2.a. Forest Land to Other Land	X												
4.F.2.b. Cropland to Other Land	X												
4.F.2.c. Grassland to Other Land	X												
4.F.2.d. Wetlands to Other Land	NO												
4.F.2.e. Settlements to Other Land	NO												
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	NE, NO	NE, NO	NE, NO										NE: According to IPCC 2006 it is not mandatory to report this category.
4(III) Direct and indirect N_2O Emissions from N Mineralization/Immobilization			X										
4(IV) Biomass Burning	NO	NO	NO										
4.G. Harvested Wood Products													
HWP from domestic harvest	X												
4.H. Other	NO	NO	NO	NO	NO	NO							
4(I) Direct and indirect N_2O emissions from N inputs to managed soils			NO										

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
Waste (CRT 5)													
5.A. Solid waste disposal on land													
5.A.1. Managed waste disposal on land													Based on the 2006 IPCC Guidelines, CO_2 emissions from Solid Waste Disposal is not included in national total emission estimates, because the carbon is of biogenic origin and net emissions are accounted for under AFOLU Sector. N_2O emissions from Solid Waste Disposal on Land are not significant and there is no methodology provided to calculate the emissions.
5.A.1.a. Anaerobic	NA	X	NE	NA	NE	X	NA						
5.A.1.b. Semi- aerobic	NO	NO	NO	NO	NO	NO	NO						
5.A.2. Unmanaged waste disposal sites	NO	NO	NO	NO	NO	NO	NO						
5.A.3. Uncategorized waste disposal on land	NO	NO	NO	NO	NO	NO	NO						
5.B. Biological treatment of solid waste													
5.B.1. Composting	NO	X	X	NE	NE	X	NO						
5.B.2. Anaerobic digestion at biogas facility	NO	NO, NE	NO, NE	NO	NO	NO	NO						On the basis of decision 18/CMA.1 Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement paragraph 32 Party may use the notation key "NE" when the estimates would be insignificant. Emissions from anaerobic digestion at biogas facilities, including leakages resulted with insignificant emission since 1994.
5.C. Incineration and open burning of waste													
5.C.1. Waste incineration													

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
5.C.1.1. Biogenic	NE	NO	NO	NE	NE	NE	NE						Based on the 2006 IPCC Guidelines, CO_2 emissions from Incineration of biogenic material is not included in national total emission estimates.
5.C.1.2. Non-biogenic	X	X	NO, NE	NE	NE	NE	NE						On the basis of decision 18/CMA.1 Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement paragraph 32 Party may use the notation key "NE" when the estimates would be insignificant.
5.C.2. Open Burning of Waste				X	X	X	X						NOx, CO and NMVOC from Open Burning of waste from both biogenic and non-bio-genic sources is reported as a sum under 5.C.2 Open burning of Waste
5.C.2.1. Biogenic	NE	NE	NE	IE	IE	IE	IE						Based on the 2006 IPCC Guidelines, CO_2 emissions from Open Burning of biogenic material is not included in national total emission estimates.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFC	PFC	SF_6	NF_3	Unspecified mix of HFC and PFC	Notes*
5.C.2.2. Non-biogenic	NE	NE	NE	NE	NE	NE	NE						On the basis of decision 18/CMA.1 Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement paragraph 32 Party may use the notation key "NE" when the estimates would be insignificant.
5.D. Wastewater Treatment and Discharge													
5.D.1. Domestic wastewater	NO	X	X	NA	NA	X	NA						
5.D.2. Industrial wastewater	NO	X	NO	X	NA	X	NE						
5.F. Memo items	NO	NO	NO	NO	NO	NO	NO						
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	Estonia does not report any emissions under the Other sector.

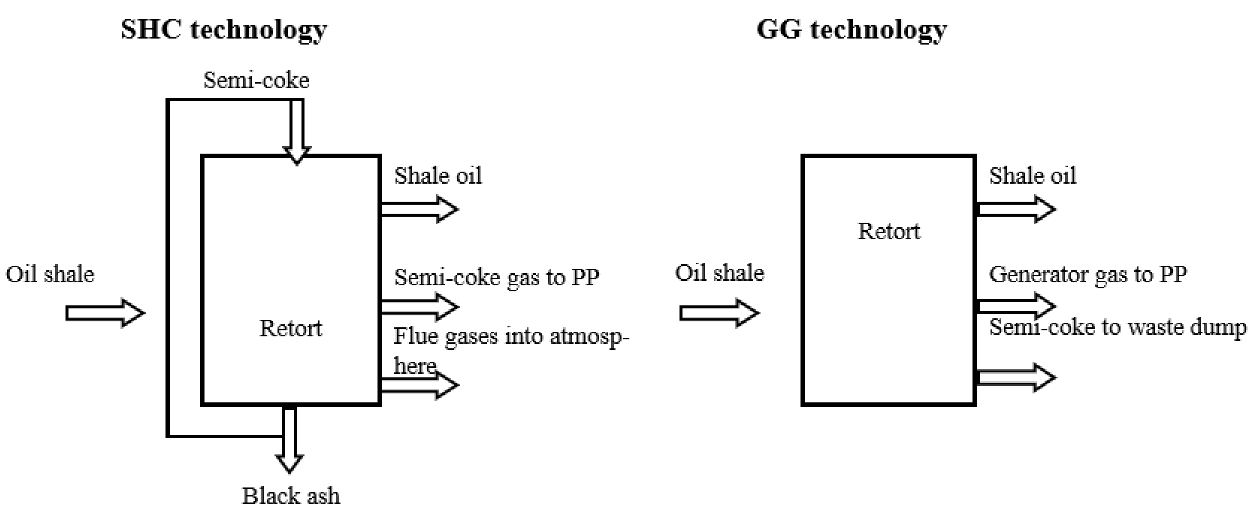
A.V.2 Energy

A.V.1.1 Description of shale oil production technologies and detailed methodology for estimation of carbon emission factors of oil shale gases

There are two different technologies for shale oil production in Estonia: oil shale thermal processing with solid heat carrier (SHC technology) and oil shale thermal processing with gaseous heat carrier in gas generators (GG technology). In 2023 three oil production companies and 9 oil plants were in operation:

1. AS Eesti Energia Narva oil plant – three SHC technology plants;
2. Viru Chemistry Group AS (VKG) oil plant – three SHC technology plants (since 2010, 2014, and 2015) and a GG technology plant;
3. Kiviõli oil plant – SHC technology plant (since 2010) and GG technology plant.

The following simplified schemes describe the output products and waste by different oil shale thermal processing technologies.



During oil shale thermal processing in retort shale oil (a liquid fuel) semi-coke or generator gas will be formed (depending on the technology). Oil shale gases are usually delivered to power plants nearby for combustion and no GHG or other emissions will be emitted at the oil plant. The waste product of the oil shale processing is semi-coke. Using GG technology semi-coke will be delivered to the waste dump and the small amount of carbon in the semi-coke will be stored. Using SHC technology semi-coke will be delivered for combustion in the aerofountain chamber. Flue gases, which is the product of combustion are used for oil shale draining and after that delivered into the atmosphere. To find the amount of CO_2 emitted with flue gases into the atmosphere a carbon balance method has been developed.

The carbon balance method is very simple: from the amount of carbon delivered with oil shale into the retorting process the amount of carbon of shale oil, semi-coke gas, and black ash is subtracted. The rest of the carbon is emitted into the atmosphere.

For generator gas technology the carbon balance method is used to estimate the amount of carbon delivered with semi-coke to waste dump.

Carbon Balances

Activity data used in calculations in carbon balances are collected from private companies and are therefore considered confidential. Activity data on oil shale, shale oil, and oil shale gases production by oil companies and calculations of carbon balances are not part of the national inventory report and are allocated into the archive. The data can be made available during the review process for the review team.

In Table A.V.2_1 the carbon stored with oil shale ash is presented.

Table A.V.2_1. Carbon stored with oil shale ash, kt

Year	kt of ash	Year	kt of ash	Year	kt of ash
1990	160.6	**2002**	124.9	**2014**	171.7
1991	143.3	**2003**	129.9	**2015**	196.3
1992	132.7	**2004**	117.1	**2016**	136.5
1993	161.5	**2005**	136.6	**2017**	231.2
1994	108.8	**2006**	126.5	**2018**	245.6
1995	157.5	**2007**	120.6	**2019**	230.9
1996	147.9	**2008**	122.4	**2020**	307.4
1997	156.2	**2009**	121.1	**2021**	234.4
1998	122.3	**2010**	139.9	**2022**	236.2
1999	71.5	**2011**	154.3	**2023**	235.5
2000	111.5	**2012**	160.4		
2001	151.8	**2013**	164.9		

A.V.1.3 Feedstocks and non-energy use of fuels

In this annex, additional information regarding CRT category 1.AD Feedstocks and non-energy use is presented. Under this category carbon stored in products is reported.

The following fuels are reported under CRT category 1.AD Feedstocks and non–energy use of fuels: lubricants, bitumen, natural gas, and oil shale.

Activity data on lubricants, bitumen, and natural gas consumption as non-energy use is received from *Joint Questionnaire* dataset by Statistics Estonia and sent to IEA and Eurostat. Activity data on oil shale reported in the CRT 1.AD.10 is calculated. This is oil shale semi-coke which is the by-product of shale oil production and contains a small amount of organic matter (carbon). Oil shale semi-coke is stored in the oil shale waste dumps (carbon stored).

In Table A.V.2_2 carbon stored in products is presented.

Table A.V.2_2. Carbon stored in products

Natural Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Fuel consumption, TJ	7 592	7 014	3 635	1 430	4 677	4 932	4 875	4 794	4 837	4 661	4 161	4 460	1 141	2 488	4 532	4 908	4 896	4 694	4 859	539	NO	NO	443	2 873	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fraction of C stored	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
CEF, tC/TJ	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07
C stored, kt	114.4	105.7	54.8	21.6	70.5	74.3	73.5	72.3	72.9	70.2	62.7	67.2	17.2	37.5	68.3	74.0	73.8	70.7	73.2	8.1	NO	NO	6.7	43.3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 not emitted, kt	419.5	387.6	200.9	79.0	258.5	272.5	269.4	264.9	267.3	257.6	229.9	246.5	63.1	137.5	250.4	271.2	270.5	259.4	268.5	29.8	NO	NO	24.5	158.7	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Lubricants	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Fuel consumption, TJ	1134	1092	714	546	714	462	462	378	420	294	336	294	252	252	252	168	168	294	210	168	168	168	126	126	126	126	126	126	84	97	185	210	294	294
Fraction of C stored	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
CEF, tC/TJ	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
C stored, kt	4.5	4.4	2.9	2.2	2.9	1.8	1.8	1.5	1.7	1.2	1.3	1.2	1.0	1.0	1.0	0.7	0.7	1.2	0.8	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.4	0.74	0.84	1.176	1.176
CO_2 not emitted, kt	16.6	16.0	10.5	8.0	10.5	6.8	6.8	5.5	6.2	4.3	4.9	4.3	3.7	3.7	3.7	2.5	2.5	4.3	3.1	2.5	2.5	2.5	1.8	1.8	1.8	1.8	1.8	1.8	1.2	1.4	2.7	3.1	4.3	4.3
Carbon content	22.680	21.840	14.280	10.920	14.280	9.240	9.240	7.560	8.400	5.880	6.720	5.880	5.040	5.040	5.040	3.360	3.360	5.880	4.200	3.360	3.360	3.360	2.520	2.520	2.520	2.520	2.520	2.520	1.680	1.932	3.696	4.200	5.880	5.880
Carbon content CO_2	83.2	80.1	52.4	40.0	52.4	33.9	33.9	27.7	30.8	21.6	24.6	21.6	18.5	18.5	18.5	12.3	12.3	21.6	15.4	12.3	12.3	12.3	9.2	9.2	9.2	9.2	9.2	9.2	6.2	7.1	13.6	15.4	21.6	21.6

Bitumen	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Fuel consumption, TJ	2106	1755	936	1209	1326	1131	1365	1287	1443	1521	1599	1404	2418	2067	2574	3549	4095	3978	3588	3315	2964	2613	2340	3198	3549	2769	1794	2691	2262	2340	4329	3666	3003	2613
Fraction of C stored	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CEF, tC/TJ	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
C stored, kt	46.3	38.6	20.6	26.6	29.2	24.9	30.0	28.3	31.7	33.5	35.2	30.9	53.2	45.5	56.6	78.1	90.1	87.5	78.9	72.9	65.2	57.5	51.5	70.4	78.1	60.9	39.5	59.2	49.8	51.5	95.2	80.65	66.1	57.5
CO_2 not emitted, kt	169.9	141.6	75.5	97.5	107.0	91.2	110.1	103.8	116.4	122.7	129.0	113.3	195.1	166.7	207.6	286.3	330.3	320.9	289.4	267.4	239.1	210.8	188.8	258.0	286.3	223.4	144.7	217.1	182.5	188.8	349.2	295.7	242.2	210.8

Oil Shale	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Fuel consumption, TJ	5269	4700	4354	5298	3570	5167	4851	5124	4012	2345	3657	4978	4095	4259	3841	4479	4149	3954	4015	3972	4588	5062	5263	5408	5632	6438	4478	7585	8054	7574	10071	7687	7748	7984
Fraction of C stored	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CEF, tC/TJ	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
C stored, kt	160.7	143.4	132.8	161.6	108.9	157.6	148.0	156.3	122.4	71.5	111.5	151.8	124.9	129.9	117.2	136.6	126.5	120.6	122.5	121.1	139.9	154.4	160.5	164.9	171.8	196.4	136.6	231.3	245.6	231.0	307.2	234.5	236.3	243.4
CO_2 not emitted, kt	589.2	525.7	486.9	592.5	399.2	577.9	542.5	573.1	448.6	262.2	409.0	556.7	458.0	476.3	429.6	500.9	464.0	442.2	449.1	444.2	513.1	566.1	588.5	604.8	629.8	720.0	500.8	848.2	900.7	847.0	1126.3	859.7	866.5	892.9

A.V.1.4 Joint Questionnaire dataset

The Joint Questionnaire (JQ) dataset made by Statistics Estonia, that is also sent to IEA and Eusrostat, contains activity data for gaseous, solid, liquid fuels and biomass used to calculate GHG emissions in the Energy (1.A) sector. This data can be accessed via Statistics Estonia website (https://www.stat.ee/) or can be shared as Excel files upon request.

A.V.3 Agriculture

A.V.3_I. LIVESTOCK POPULATION IN ESTONIA IN 1990–2023

Table A.V.3_I. 1. Cattle population size in 1990–1998 in Estonia, 1000 heads

Year	Cattle, total	Dairy Cattle	Non-dairy cattle			
			Mature males	Mature females	Bovine animals (aged between 1 and 2 years)	Calves (less than 1 year old)
1990	757.8	280.7	4.2	47	172.1	251.9
1991	706.2	264.3	4.2	46.8	171.1	220
1992	613	253.4	3.4	38.1	139.4	178.8
1993	462.6	226.7	2.3	25.1	91.8	116.9
1994	419.5	211.4	1.9	21.3	78	105.8
1995	369.7	185.4	1.7	18.4	67.3	97
1996	343	171.6	1.6	17.2	63	89.1
1997	325.6	167.7	1.5	16.2	59.3	80.4
1998	307.5	158.6	1.4	15	54.8	77.1

Table A.V.3_I. 2. Swine population size in 1990–1998 in Estonia, 1000 heads

Year	**Swine, total**	**Swine total of which**					
		Piglets, live weight less than 20 kg	**Young pigs, live weight 20–50 kg**	**Pigs, live weight 50–80 kg**	**Pigs, live weight 80–110 kg**	**Pigs, live weight more than 110 kg**	**Breeding pigs, live weight more than 50 kg**
1990	859.9	279.6	237.5	185	103.2	7.6	47.1
1991	798.6	260.4	221.3	172.3	96.1	7	41.5
1992	541.1	176.6	150	116.8	65.2	4.8	27.7
1993	424.3	137.2	116.6	90.8	50.6	3.7	25.3
1994	459.8	149	126.6	98.6	55	4	26.6
1995	448.8	146.3	124.3	96.8	54	4	23.4
1996	298.4	96.6	82.1	63.9	35.6	2.6	17.6
1997	306.3	98	83.3	64.9	36.2	2.6	21.3
1998	326.4	104.5	88.8	69.1	38.6	2.8	22.6

Table A.V.3_I. 3. Cattle population size in 1999–2023 in Estonia, 1000 heads (SE, 2024)

Year	Total	Total of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			Total*	for slaughter	for breeding	
		dairy cows	other		Total*	for slaughter	for breeding		Total*	for slaughter	for breeding			heifers	bulls
1999	267.3	138.4	0.5	1.6	14.0	0.5	13.5	8.3	40.2	1.8	38.4	64.3	10.8	42.9	10.6
2000	252.8	131.0	0.7	1.2	14.0	0.2	13.8	9.2	35.6	1.1	34.5	61.1	10.5	39.5	11.1
2001	260.5	128.6	0.8	1.2	11.2	0.4	10.8	11.1	37.7	3.6	34.1	69.9	16.8	38.9	14.2
2002	253.9	115.6	1.6	1.1	10.5	0.2	10.3	11.5	43.6	2.2	41.4	70.0	6.0	40.7	23.3
2003	257.2	116.8	2.0	0.8	12.5	0.4	12.1	12.6	40.2	1.7	38.5	72.3	7.3	42.7	22.3
2004	249.8	116.5	2.7	1.3	12.0	0.1	11.9	10.2	40.8	1.1	39.7	66.3	3.5	40.1	22.7
2005	249.5	112.8	4.8	0.8	12.0	0.4	11.6	11.2	40.7	1.1	39.6	67.2	3.8	40.6	22.8
2006	244.8	108.4	6.0	1.7	11.1	0.4	10.7	8.7	42.9	1.5	41.4	66.0	3.1	42.4	20.5
2007	240.5	103.0	8.5	1.8	11.6	0.7	10.9	8.4	42.7	1.4	41.3	64.5	3.0	42.3	19.2
2008	237.9	100.4	8.2	2.2	14.5	1.0	13.5	7.5	39.5	1.4	38.1	65.6	3.2	41.8	20.6
2009	234.7	96.7	10.3	2.0	14.3	1.0	13.3	8.3	39.6	1.4	38.2	63.5	3.2	40.4	19.9
2010	236.3	96.5	12.1	2.3	15.0	1.0	14.0	8.1	39.6	1.4	38.2	62.7	3.1	41.7	17.9
2011	238.3	96.2	14.5	2.4	15.3	1.2	14.1	6.5	40.8	1.4	39.4	62.6	3.2	42.1	17.3
2012	246.0	96.8	15.4	2.6	16.2	1.2	15.0	6.7	42.8	1.4	41.4	65.5	3.1	44.3	18.1
2013	261.4	97.9	19.8	3.0	16.4	1.3	15.1	9.8	43.8	1.5	42.3	70.7	3.4	46.3	21.0
2014	264.7	95.6	22.8	3.5	15.7	1.3	14.4	9.3	44.8	1.9	42.9	73.0	4.2	48.3	20.5
2015	256.2	90.6	25.1	3.3	14.3	1.2	13.1	7.7	44.9	1.5	43.2	70.3	3.3	47.9	19.1
2016	248.2	86.1	27.8	3.4	12.9	1.2	11.7	6.8	43.3	1.5	41.8	67.9	3.3	45.9	18.7
2017	250.9	86.4	28.7	3.0	13.4	1.0	12.4	6.8	42.6	1.3	41.3	70.0	3.3	47.1	19.6
2018	251.9	85.2	30.4	3.5	13.0	1.0	12.0	7.1	42.1	1.4	40.7	70.6	3.3	47.6	19.7
2019	254.0	85.0	31.4	3.6	13.2	1.0	12.4	6.9	42.9	1.4	41.5	70.9	3.5	48.2	19.4
2020	253.3	84.3	31.6	3.7	12.2	0.7	11.4	7.3	42.0	1.3	40.8	72.1	3.6	49.6	18.9
2021	250.8	83.7	31.3	3.9	12.2	0.7	11.5	7.1	43.7	1.3	42.4	68.8	3.4	48.6	16.7
2022	249.6	83.7	30.8	4.3	12.8	0.8	12	6.3	42.7	1.3	41.4	69.1	3.5	49	16.6
2023	241.4	83.3	28.7	3.8	11.8	0.7	11.1	5.8	41.1	1.2	39.8	66.8	3.3	48.1	15.3

* Due to rounding, the total sums in tables are not always equal with the total. The difference can be up to some last decimal places. The data may be revised after compiling final data of the year.

Table A.V.3_I. 4. Swine population size in 1999–2023 in Estonia, 1000 heads (SE, 2024)

	Total	Total of which											
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				breeding pigs					
				total	of which, live weight			boars	sows				
					50–80 kg	80–110 kg	more than 110 kg		total	covered sows	of which covered for the first time	other sows	of which gilts not yet covered
1999	285.7	75.2	77.9	98.8	66.0	29.0	3.8	1.6	32.2	18.5	6.1	13.7	6.2
2000	300.2	81.2	79.5	99.0	63.8	32.0	3.2	1.9	38.6	26.1	6.7	12.5	8.0
2001	345.0	100.3	103.6	99.5	57.0	40.8	1.7	1.5	40.1	26.1	7.4	14.0	7.4
2002	340.8	104.1	82.8	114.1	64.7	45.8	3.6	2.1	37.7	27.4	5.5	10.3	4.8
2003	344.6	104.1	91.9	110.7	64.3	44.6	1.8	1.3	36.6	26.3	5.4	10.2	3.1
2004	340.1	113.7	83.9	106.6	65.5	37.8	3.3	1.2	35.9	22.6	5.0	12.1	4.2
2005	346.5	113.3	87.2	110.4	77.2	31.7	1.5	1.3	35.6	26.3	5.3	8.0	4.3
2006	345.8	118.8	76.9	111.7	72.8	36.5	2.4	1.0	38.4	26.3	5.3	11.1	4.5
2007	379.0	123.3	81.8	137.4	78.5	56.3	2.6	0.8	36.5	25.1	5.1	10.6	3.5
2008	364.9	117.1	96.2	116.9	70.1	44.2	2.6	0.6	34.7	22.5	5.0	11.6	4.0
2009	365.1	120.7	94.6	115.2	68.4	36.7	10.1	0.5	34.6	24.1	4.7	10.0	3.5
2010	371.7	116.1	100.2	119.7	73.7	44.5	1.5	0.6	35.7	27.0	4.9	8.1	4.0
2011	365.7	113.9	98.4	117.2	72.6	42.2	2.4	0.6	36.2	27.5	5.8	8.0	4.3
2012	375.1	125.6	94.4	120.2	68.5	48.4	3.3	0.6	34.9	26.3	4.8	8.0	4.3
2013	358.7	118.6	86.7	119.6	67.5	44.2	7.9	0.5	33.8	26.1	4.8	7.2	4.0
2014	357.9	111.6	89.9	121.8	71.1	42.4	8.3	1.0	34.6	26.0	4.1	7.6	3.8
2015	304.5	96.7	76.2	106.5	62.2	38.0	6.3	0.5	25.1	19.1	3.4	5.5	3.1
2016	265.9	85.0	60.4	94.6	49.9	37.8	6.9	0.5	25.9	19.6	3.0	5.8	4.2
2017	289.1	98.4	52.3	111.9	63.0	33.0	15.9	0.5	26.5	19.8	2.9	6.2	4.4
2018	290.4	104.7	42.0	118.8	51.2	49.7	17.9	0.5	24.9	18.9	2.6	5.5	3.7
2019	301.6	111.4	59.2	105.0	53.3	43.1	8.6	0.3	26.1	19.8	3.0	6.0	2.8
2020	316.8	103.4	55.6	130.1	58.0	55.3	16.9	0.3	27.5	18.2	3.1	9.1	4.5
2021	308	104.1	58.8	119.3	55.4	45.1	18.7	0.2	26.0	21.2	3.1	4.5	3.6
2022	269.4	92.9	50.9	102.9	52	37.3	13.6	0.2	22.7	18.3	2.8	4.2	3.3
2023	275	98.4	45.5	106.8	48.2	42	16.6	0.3	24.3	17.9	2.5	6.2	4.7

Table A.V.3_I. 5. Sheep and goats population size in 2004–2023 in Estonia, 1000 heads (SE, 2024)

Sheep and goats quarterly data				
Year	**March 31st**	**June 30th**	**September 30th**	**December 31st**
2004	55.5	57.4	54.6	41.7
2005	60.1	63.0	58.8	52.4

Sheep and goats quarterly data				
Year	**March 31st**	**June 30th**	**September 30th**	**December 31st**
2006	75.4	77.3	70.1	66.0
2007	88.2	90.8	87.0	76.4
2008	100.5	100.0	95.0	81.8
2009	101.0	100.4	101.5	80.4
2010	108.8	108.5	103.0	82.7
2011	101.7	105.3	99.9	88.2
2012	99.3	105.3	99.5	81.4
2013	82.6	88.6	92.9	86.8
2014	83.0	91.5	97.6	89.8
2015	85.8	97.1	99.3	90.9
2016	97.5	102.9	95.9	90.6
2017	97.3	104.9	93.5	85.9
2018	97.1	104.5	87.7	78.3
2019	85.0	95.7	89.3	75.6
2020	80.4	83.6	84.6	72.6
2021	79.7	88.5	80.2	69.9
2022	77.4	78.6	76.2	67.1
2023	73.7	81.6	69	58.7

Table A.V.3_I. 6. Number of poultry in 1990–2023 in Estonia, 1000 heads (SE, 2024)

Year	Eggs, mln pcs	Eggs production per layer per year	Layers	Broilers + dead and perished (average yearly population)	Other poultry	Other hens and roosters	Yearly average population calculated
1990	547.1	246.0	2 224.0	1 951.8	161.9	1 259.5	4 337.7
1991	559.1	254.0	1 788.9	1 653.7	161.9	1 067.2	3 604.5
1992	456.0	228.0	1 816.1	1 020.6	97.7	658.6	2 934.4
1993	345.8	222.0	1 207.8	963.3	45.3	621.6	2 216.4
1994	359.4	246.0	912.5	904.7	41.0	603.1	1 858.2
1995	326.7	260.0	828.3	862.2	22.1	561.0	1 712.6
1996	300.8	285.0	843.4	528.2	19.4	448.0	1 390.9
1997	295.7	280.0	719.2	517.5	16.6	501.4	1 253.3
1998	305.2	298.0	780.9	779.1	13.9	507.9	1 573.8
1999	275.4	302.0	791.7	645.4	11.1	349.3	1 448.2

Year	Eggs, mln pcs	Eggs production per layer per year	Layers	Broilers + dead and perished (average yearly population)	Other poultry	Other hens and roosters	Yearly average population calculated
2000	254.7	306.0	723.5	616.7	18.9	313.5	1 359.1
2001	277.9	295.0	995.6	724.9	42.2	359.0	1 762.7
2002	252.8	303.0	834.3	924.6	31.8	404.6	1 790.7
2003	234.3	290.0	807.9	1 103.6	20.1	450.1	1 931.7
2004	230.9	275.0	839.6	1 142.2	21.4	495.7	2 003.2
2005	209.0	288.0	725.7	1 033.8	24.5	279.8	1 784.0
2006	183.0	287.0	637.6	980.9	29.6	369.0	1 648.1
2007	157.6	245.0	643.3	956.0	34.1	125.9	1 663.4
2008	146.5	290.0	550.1	1 031.0	33.5	395.6	1 614.6
2009	173.3	281.0	644.8	1 083.2	43.9	314.4	1 771.9
2010	181.9	283.0	578.2	1 212.2	48.8	377.2	1 839.2
2011	183.8	288.0	568.9	1 298.3	59.6	513.7	1 926.8
2012	179.5	292.0	693.9	1 267.9	74.0	456.5	2 035.8
2013	189.9	288.0	716.6	1 361.5	91.4	191.5	2 169.5
2014	199.4	291.0	752.8	1 359.6	54.3	450.8	2 166.7
2015	204.4	281.0	825.0	1 376.9	59.0	416.6	2 260.9
2016	199.0	286.0	727.6	1 417.0	57.8	407.0	2 202.4
2017	207.0	289.0	819.4	1 452.8	56.9	434.1	2 329.1
2018	205.6	262.0	608.2	1 451.7	65.9	409.6	2 125.7
2019	NA	287.0	562.8	1 453.5	70.7	414.5	2 087.2
2020	NA	NA	436.1	1 593.2	93.5	414.1	2 122.8
2021	NA	NA	536.0	1 660.4	72.8	405.6	2 269.2
2022	NA	NA	555.5	1679.1	59.3	414.5	2 293.9
2023	NA	NA	662.5	1604.5	78.8	426.2	2 345.8

Table A.V.3_I. 7. Average number of rabbits in 1990–2023 in Estonia, 1000 heads (SE; ARIB, 2024)

Year	Breeding females	Breeding males	Young (yearly average population)	Yearly average population (calculated)
1990	8 298.5	922.1	76 732.4	85 952.9
1991	8 780.8	975.6	81 192.7	90 949.2
1992	9 276.5	1 030.7	85 775.7	96 082.9
1993	9 307.4	1 034.2	86 061.2	96 402.7

Year	Breeding females	Breeding males	Young (yearly average population)	Yearly average population (calculated)
1994	7 847.2	871.9	72 560.2	81 279.3
1995	7 241.4	804.6	66 958.1	75 004.1
1996	5 452.7	605.9	50 418.6	56 477.2
1997	4 587.2	509.7	42 415.7	47 512.6
1998	4 818.0	535.3	44 549.8	49 903.1
1999	3 981.3	442.4	36 813.6	41 237.3
2000	5 798.9	644.3	53 619.8	60 063.0
2001	10 069.0	1 118.8	93 103.8	104 291.5
2002	8 580.5	953.4	79 340.2	88 874.1
2003	7 092.0	788.0	65 576.7	73 456.7
2004	5 067.0	563.0	46 852.4	52 482.4
2005	8 061.0	895.7	74 536.6	83 493.3
2006	7 038.5	782.1	65 082.0	72 902.6
2007	6 016.0	668.4	55 627.4	62 311.8
2008	5 137.0	570.8	47 499.7	53 207.4
2009	4 258.0	473.1	39 371.9	44 103.0
2010	3 379.0	375.4	31 244.2	34 998.6
2011	3 243.5	360.4	29 991.3	33 595.2
2012	3 108.0	345.3	28 738.4	32 191.7
2013	4 778.0	530.9	44 180.1	49 489.0
2014	3 864.7	429.4	35 734.9	40 029.0
2015	2 951.3	327.9	27 289.7	30 569.0
2016	2 038.0	226.4	18 844.5	21 109.0
2017	2 010.0	223.3	18 585.6	20 819.0
2018	1 982.0	220.2	18 326.7	20 529.0
2019	1 954.0	217.1	18 067.8	20 239.0
2020	1 926.0	214.0	17 808.9	19 949.0
2021	1 449.3	161.0	13 401.4	15 012.0
2022	972.7	108.1	8 993.8	10 075.0
2023	496.0	55.1	4 586.3	5 137.0

Table A.V.3_I. 8. Average number of fur animals in 1990–2023 in Estonia, 1000 heads (SE, 2024)

Year	Foxes and racoon dogs			Minks, chinchillas and other fur animals		
	For breeding (calculated)	Killed for fur	Average population	For breeding (calculated)	Killed for fur	Yearly average population calculated
1990	–	–	85.2	–	–	145.6
1991	–	–	85.2	–	–	145.6
1992	–	–	85.4	–	–	117.4
1993	–	–	85.7	–	–	89.1
1994	26.0	59.9	86.0	18.4	42.5	60.9
1995	28.0	65.3	93.3	8.8	29.7	38.5
1996	25.5	15.3	40.8	3.7	10.5	14.3
1997	23.2	52.5	75.7	4.7	9.3	14.0
1998	22.5	49.9	72.4	6.5	13.4	19.9
1999	12.8	50.3	63.1	2.7	7.9	10.6
2000	10.8	32.9	43.6	2.1	4.7	6.8
2001	14.9	29.6	44.5	5.7	11.8	17.5
2002	14.2	32.4	46.6	11.1	21.2	32.3
2003	14.2	28.7	42.8	17.4	37.7	55.2
2004	14.5	28.5	42.9	18.7	39.7	58.4
2005	12.0	26.8	38.8	26.0	61.2	87.2
2006	10.2	22.5	32.7	21.4	49.6	71.0
2007	11.9	26.8	38.7	23.8	56.3	80.1
2008	3.6	9.1	12.7	21.3	57.2	78.6
2009	4.0	9.0	13.0	26.7	63.8	90.6
2010	3.9	8.7	12.6	26.3	61.3	87.7
2011	4.3	9.7	14.0	28.9	68.7	97.6
2012	4.2	9.7	13.9	28.0	68.5	96.6
2013	4.3	9.8	14.1	29.0	69.4	98.4
2014	4.4	9.6	14.0	29.5	67.7	97.2
2015	4.2	10.4	14.6	28.3	73.6	101.9
2016	1.7	4.6	6.3	11.4	32.5	43.9
2017	1.9	4.7	6.7	13.0	33.6	46.6
2018	1.3	3.9	5.2	8.5	27.8	36.3
2019	0.1	0.4	0.5	0.6	2.8	3.4
2020	-0.002	0.4	0.4	-0.01	2.7	2.7

Year	Foxes and racoon dogs			Minks, chinchillas and other fur animals		
	For breeding (calculated)	Killed for fur	Average population	For breeding (calculated)	Killed for fur	Yearly average population calculated
2021	-0.006	0.05	0.05	-0.04	0.4	0.3
2022	0.001	0.02	0.02	0.009	0.2	0.2
2023	0	0	0	0	0	0

A.V.3_II. MILK YIELD PER COW, FAT CONTENT OF MILK AND PERCENTAGE OF COW THAT GAVE BIRTH IN ESTONIA IN 1990–2023

Table A.V.3_II. 1. Average milk yield per cow in 1991–1993, kg/cow (SE, 1994)

Year	Average yield per cow, kg
1991	3 968
1992	3 530
1993	3 322

Table A.V.3_II. 2. Average milk yield per cow in 1994–2023, kg/cow/year (EARC, 2024)

County	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Average yield per cow, kg	3 455	3 588	3 809	4 210	4 456	4 171	4 660	5 152	5 138	5 176	5 528	5 886	6 285	6 484	6 781	6 838	7 021	7 168
Harju county	3 016	3 027	3 301	3 775	4 137	3 831	3 951	4 843	4 588	4 816	5 141	5 756	5 937	6 019	6 396	6 359	6 402	6 600
Hiiu county	2 566	2 498	2 669	3 079	3 132	3 964	4 540	5 603	4 589	4 663	4 510	4 987	4 720	4 687	4 646	5 052	4 520	4 667
Ida-Viru county	2 374	2 143	2 449	2 960	3 320	3 397	4 057	4 425	4 767	4 593	4 706	5 492	5 612	5 438	6 053	6 039	6 334	6 298
Jõgeva county	3 399	3 596	3 769	3 870	4 731	4 218	4 960	5 392	5 461	5 362	5 744	6 188	6 715	6 812	7 119	7 058	7 230	7 465
Järva county	4 066	4 224	4 458	5 020	5 399	4 751	5 375	6 216	6 057	6 058	6 243	6 330	6 900	7 045	7 164	7 048	7 254	7 473
Lääne county	2 520	2 513	2 742	3 017	3 297	3 494	3 513	4 039	4 111	4 223	4 558	4 731	5 343	5 512	6 295	6 281	6 368	6 388
Lääne-Viru county	3 548	3 418	3 950	4 394	4 721	4 061	4 685	5 420	5 291	5 391	5 954	6 205	6 542	6 823	7 096	7 139	7 390	7 524
Põlva county	3 134	3 616	4 111	4 684	4 874	4 517	5 040	6 310	5 868	6 213	6 180	6 506	7 123	7 339	7 562	7 581	7 671	7 737
Pärnu county	3 220	3 256	3 380	3 666	4 210	3 736	4 451	5 005	4 920	4 986	5 373	5 806	6 326	6 407	6 651	6 733	6 948	7 294

County	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Rapla county	3 088	3 301	3 763	4 077	4 673	4 301	4 767	5 232	5 047	5 066	5 809	6 105	6 101	6 325	6 796	7 078	7 355	7 267
Saare county	2 732	2 573	2 894	3 330	3 657	3 817	4 071	5 162	4 341	4 496	5 034	5 113	5 464	5 619	5 844	6 008	6 243	6 179
Tartu county	3 337	3 417	3 785	4 089	4 457	3 767	4 898	5 099	5 028	5 556	6 070	6 423	6 812	7 103	7 880	8 019	7 997	8 237
Valga county	2 553	2 776	2 961	3 135	3 384	3 076	3 496	4 089	4 503	3 866	4 878	5 259	5 598	5 870	5 851	5 926	6 127	6 470
Viljandi county	3 143	2 865	3 140	3 544	3 829	3 406	4 167	4 921	4 918	4 663	4 894	5 098	5 436	5 932	6 205	6 530	6 784	6 711
Võru county	3 126	3 188	3 431	3 747	3 972	3 581	3 880	4 982	4 893	4 996	5 070	5 481	5 810	6 281	6 319	6 493	6 461	6 345

Table A.V.3_II. 2. Average milk yield per cow in 1994–2023, kg/cow/year (EARC, 2024) (continued)

County	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Average yield per cow, kg	7 526	7 990	8 233	8 442	8 878	9 159	9 287	9 633	9 943	9 966	10 144	10 608
Harju county	6 769	7 377	7 351	7 725	8 386	8 677	9 205	8 667	9 105	9 128	9 213	9 472
Hiiu county	5 266	4 650	5 468	4 998	5 875	6 559	7 558	7 372	7 274	7 529	8 000	8 171
Ida-Viru county	6 554	7 250	7 237	7 204	6 668	7 562	7 670	8 175	7 770	8 461	7 024	8 063
Jõgeva county	7 657	7 807	8 176	8 496	9 651	9 506	9 479	9 887	10 162	9 978	10 313	10 794
Järva county	7 816	8 338	8 728	8 895	9 532	9 892	10 193	10 178	10 417	10 630	10 769	11 200
Lääne county	6 802	7 552	7 674	7 944	7 706	8 969	8 568	8 765	9 512	9 183	9 787	10 503
Lääne-Viru county	7 783	8 186	8 317	8 306	9 031	9 266	9 058	10 141	10 175	10 332	10 458	10 982
Põlva county	7 980	8 306	9 543	8 983	9 315	9 228	10 054	10 102	10 410	10 743	10 802	11 087
Pärnu county	7 690	8 054	8 128	8 694	8 941	9 233	9 200	9 708	10 068	9 781	10 416	10 706
Rapla county	7 784	8 108	7 974	9 005	8 712	9 304	9 020	9 646	9 915	9 765	9 897	10 392
Saare county	6 633	7 371	7 588	7 476	7 726	8 139	8 336	8 620	8 907	9 166	9 385	9 923
Tartu county	8 544	9 520	9 463	9 230	9 896	10 127	10 243	10 264	10 696	10 342	10 421	11 071
Valga county	7 125	7 581	7 894	8 149	8 191	8 527	8 941	9 414	10 109	10 157	10 425	11 086
Viljandi county	7 220	7 485	7 818	8 344	8 718	9 048	9 210	9 247	9 504	9 532	9 479	10 076
Võru county	6 948	7 290	7 667	7 586	7 877	8 162	6 803	8 130	8 254	8 280	8 035	8 191

Table A.V.3_II. 3. Average fat content of milk in Estonia in 1990–1997, % (EARC, 2012)[46]

Year	Fat content, %
1990	4.09
1991	4.06
1992	3.98
1993	4.00
1994	4.01
1995	4.08
1996	4.21
1997	4.21

Table A.V.3_II. 4. Fat content of milk in 1998–2023 by county of Estonia, % (EARC, 2024)[47]

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Average	4.26	4.23	4.29	4.31	4.29	4.31	4.27	4.21	4.17	4.15	4.12	4.14	4.11	4.1	4.04	4.0	4.0	3.98	4.0	3.94	3.91	3.89
Harju	4.25	4.23	4.31	4.38	4.32	4.34	4.29	4.27	4.21	4.18	4.14	4.17	4.11	4.07	4.03	3.96	4.0	3.93	4.0	3.95	3.94	3.92
Hiiu	4.46	4.4	4.25	4.29	4.38	4.38	4.26	4.19	4.24	4.28	4.34	4.44	4.41	4.37	4.22	4.27	4.17	4.2	4.17	4.16	4.16	4.20
Ida-Viru	4.32	4.33	4.31	4.29	4.21	4.25	4.23	4.09	4.06	4.08	4.08	4.09	4.07	4.11	4.09	4.09	4.01	3.94	4.03	3.93	3.85	3.77
Jõgeva	4.37	4.32	4.36	4.39	4.46	4.46	4.3	4.28	4.24	4.2	4.18	4.17	4.14	4.14	4.06	4.05	4.07	3.99	4.1	3.95	3.97	3.89
Järva	4.18	4.19	4.25	4.25	4.23	4.29	4.27	4.17	4.14	4.11	4.08	4.09	4.07	4.03	4.03	3.99	3.98	3.93	4.03	3.94	3.84	3.81
Lääne	4.36	4.24	4.34	4.36	4.28	4.27	4.28	4.25	4.28	4.28	4.24	4.29	4.2	4.13	4.03	4.03	4.02	4.01	4.01	4.06	4.03	3.96
Lääne-Viru	4.18	4.14	4.19	4.21	4.19	4.2	4.16	4.11	4.07	4.03	4.02	4.01	4.01	4.05	4.02	3.95	3.9	3.83	3.82	3.81	3.81	3.77
Põlva	4.29	4.24	4.28	4.38	4.33	4.3	4.3	4.23	4.14	4.11	4.09	4.08	4.14	4.12	4.13	4.01	4.0	3.96	4.03	4.01	3.98	3.98
Pärnu	4.23	4.2	4.36	4.41	4.32	4.35	4.33	4.27	4.2	4.19	4.16	4.17	4.12	4.08	3.99	4.01	3.98	3.9	3.94	3.91	3.9	3.91
Rapla	4.23	4.16	4.21	4.27	4.19	4.2	4.21	4.11	4.05	4.06	4.0	4.12	4.18	4.21	4.09	4.01	4.03	3.96	3.97	3.99	3.97	3.88
Saare	4.46	4.4	4.38	4.36	4.4	4.4	4.38	4.27	4.26	4.23	4.17	4.22	4.15	4.13	3.98	3.96	4.06	4.08	4.11	4.02	3.92	3.92
Tartu	4.3	4.26	4.25	4.28	4.32	4.28	4.28	4.22	4.19	4.13	4.08	4.09	4.02	4.03	3.91	3.91	3.89	3.81	3.81	3.79	3.78	3.78
Valga	4.25	4.18	4.27	4.3	4.25	4.26	4.29	4.21	4.19	4.22	4.25	4.29	4.17	4.14	4.16	4.08	4.11	4.08	4.13	4.11	4.08	4.03
Viljandi	4.28	4.19	4.32	4.31	4.31	4.39	4.31	4.26	4.27	4.26	4.21	4.22	4.12	4.1	4.08	4.05	4.07	3.98	4.12	3.99	4.02	4.06
Võru	4.22	4.25	4.35	4.33	4.34	4.32	4.25	4.26	4.28	4.29	4.21	4.29	4.24	4.22	4.16	4.05	4.03	3.95	4.0	3.97	3.99	4.08

[46] EARC. Eesti Jõudluskontrolli aastaraamatud. [www] https://www.jkkeskus.ee/jkk/piimaveised/statistika/j%C3%B5udluskontrolli-aastaraamatud/ (12.12.2024).
[47] EARC. Eesti Jõudluskontrolli aastaaruanded. [www] https://www.epj.ee/assets/tekstid/piimaveised/aastaaruanded/2022/ka2022.pdf (06.01.2025)

Table A.V.3_II. 4. Fat content of milk in 1998–2023 by county of Estonia, % (EARC, 2024) (continued)

Country	2020	2021	2022	2023
Average	3.89	3.9	3.92	3.91
Harju	3.91	3.89	3.92	3.9
Hiiu	4.17	4.13	4.05	4.22
Ida-Viru	3.86	3.88	4.15	3.95
Jõgeva	3.86	3.92	3.99	3.96
Järva	3.88	3.86	3.9	3.88
Lääne	3.78	3.89	3.94	3.91
Lääne-Viru	3.85	3.91	3.95	3.93
Põlva	3.91	3.88	3.91	3.85
Pärnu	3.86	3.83	3.88	3.86
Rapla	3.86	3.95	4.02	3.99
Saare	3.96	3.98	4.01	3.83
Tartu	3.73	3.81	3.85	3.82
Valga	3.95	3.92	3.94	3.8
Viljandi	4.04	3.97	4.06	4.03
Võru	4.04	4.03	4.13	4.08

Table A.V.3_II. 5. Percentage of cows that gave birth in 1990–2023, %

Year	Dairy cows, %	Mature Female Cattle, %
1990	74	80
1991	80	80
1992	86	80
1993	100	80
1994	98	80
1995	100	80
1996	100	80
1997	100	80
1998	100	80
1999	100	80
2000	99	80
2001	100	80
2002	100	80
2003	99	80
2004	100	80
2005	98	80
2006	100	80
2007	100	80
2008	100	80
2009	100	80
2010	100	80
2011	100	80
2012	100	80
2013	100	80
2014	100	80
2015	100	80
2016	100	80
2017	100	80
2018	100	80
2019	100	80
2020	100	80
2021	100	80
2022	100	80
2023	100	80

A.V.3_III. WEIGHT OF DAIRY CATTLE BY CATTLE BREED IN ESTONIA IN 1990–2023

Table A.V.3_III. 1. Average weight of dairy cattle by breed in Estonia in 1990–2023[48]

Year	Population by dairy-cattle breed				Average weight of cows, kg
	Estonian Red	Estonian Holstein	Estonian Native	Total number in Registry	
Typical weight, kg	540[49]	550[50]	460[51]		
1990	121 125	125 235	566	246 926	544.9
1991	107 873	121 077	549	229 499	547.7
1992	94 610	116 722	577	211 909	550.6
1993	74 543	106 033	563	181 139	553.6
1994	59 691	91 676	564	151 931	556.4
1995	49 285	79 767	555	129 607	559.2
1996	43 537	74 968	570	119 075	562.1
1997	40 118	74 186	535	114 839	565.0
1998	38 705	77 717	504	116 926	568.1
1999	33 820	75 589	472	109 881	571.1
2000	29 875	71 799	443	102 117	574.1
2001	27 981	73 173	481	101 636	577.1
2002	26 726	74 733	507	100 841	580.1
2003	26 314	74 981	490	101 785	583.1
2004	26 571	73 781	538	100 890	585.8
2005	26 607	73 261	537	100 405	588.7
2006	25 348	72 894	544	98 947	591.7
2007	23 842	70 816	514	95 398	594.7
2008	22 357	69 599	517	92 698	597.7
2009	20 578	68 058	475	89 389	600.9
2010	19 724	67 904	461	88 438	604.0
2011	18 917	69 216	493	88 967	607.1
2012	18 294	70 511	479	89 616	610.3
2013	18 175	71 716	441	90 702	613.4
2014	18 356	72 810	459	92 000	616.5
2015	17 247	69 772	484	87 844	619.5
2016	15 899	65 896	466	82 543	622.5
2017	14 742	66 713	520	82 244	625.5
2018	13 682	68 044	518	82 513	629.3
2019	12 321	67 990	567	81 155	632.6
2020	11 297	68 754	601	80 910	635.9
2021	10 325	69 351	637	80 589	636.3
2022	9 541	69 962	671	80 456	636.5
2023	8 924	70 456	684	80 341	636.6

[49] pm-mag Tõnu Põlluäär. Eesti Punane veisetõug. [www] https://www.etll.ee/?ARETUS/Piimaveised/Eesti-punane&search=eesti+holstein (06.01.2025).
[50] Tanel Bulitko, pm-knd Enno Siiber, *PhD* Peeter Padrik. Eesti Holstein. https://www.etll.ee/?ARETUS/Piimaveised/Eesti-holstein&search=eesti+holstein (06.01.2025).
[51] EK Seltsi tegevjuhid pm-mag Käde Kalamees (1995–2021) ja Ege Raid (alates 2021). Eesti Maakari. [www] https://www.etll.ee/?ARETUS/Piimaveised/Eesti-maakari&search=eesti+maakari (06.01.2025).

Table A.V.3_III. 2. Data on weight and weight gain of non-dairy cattle used in the estimates

Cattle category	Weight, kg	Weight gain, kg/day
Manure non-dairy cattle[52]:		
Mature females	500	
Mature males	600	
Bovine animals (aged between 1 and 2 years)	300	0.70
Calves (6–12 months)[53]	205	0.55
Calves (0–6 months) [54]	41	0.90

Table A.V.3_III. 3. Data on weight of main swine categories used in the estimates, kg

Swine category	Weight, kg
Piglets, live weight less than 20 kg	10
Young pigs, live weight 20–<50 kg	35
Fattening pigs	
live weight 50–<80 kg	65
live weight 80–<110 kg	95
live weight 110 kg or more	110
Breeding pigs, live weight 50 kg or more	110

A.V.3_IV. MANURE MANAGEMENT SYSTEMS

Manure management systems: cattle and swine livestock categories

The distributions of cattle and swine Manure Management Systems (MMS) are based on the results of the study by Estonian University of Life Sciences and the EERC (2018)[55]. As the study covered the years 1990, 1995, 2000, 2005, 2010 and 2015, the values for the distribution of MMS in-between of those years were interpolated. The MMS distribution values for the year 2020 are based on the new study by A. Kaasik[56] and the years between 2015-2020 were interpolated. Since 2023 submission, therefore values starting from 2021, for MMS splits are available at KOTKAS[57] database yearly. However, the share of manure from grazing from manure female cattle is calculated based on the movement data of this cattle group based on the data from Agricultural Registers and Information Board (ARIB) database. The data on manure sent to digesters is also

[52] Revised 1996 IPCC Guidelines, Volume 3, Chapter 4: Agriculture, pages 4.42–4.43, table A-2 (for Eastern European countries). The data correspond to Estonian data on weight of mature cattle.

[53]The start weight was calculated based on the final weight of calves (0-6 months) and their weight gain. The weight gain of calves was estimated taking into account the start weighs of mature cattle. Production cycle at 183 days per year was applied.

[54]Lehtsalu, S., Kaart, T., Kiiman, H., (2010). Lehmvasikate kasvatamine sündimisest seemendamiseni. Agraarteadus, 21 (1), lk 14–23 – ki the start weight and weight gain. Production cycle at 182 days per year was applied.

[55] Kaasik, A., Möls, M. Loomakasvatusest eralduvate saasteainete heitkoguste inventuurimetoodikate täiendamine ja heite vähendamistehnoloogiate kaardistamine. [www] https://keskkonnaportaal.ee/sites/default/files/2024-04/Loomakasvatusest%20eralduvate%20saasteainete%20heitkoguste%20inventuurimetoodikate%20t%C3%A4iendamine%20ja%20heite%20v%C3%A4hendamistehnoloogiate%20kaardistamine.pdf (30.10.2024).

[56] Kaasik, A. Eesti lauda- ja sõnnikukäitlustehnoloogiate ning sõnniku laotamise tehnoloogiate uuring. [www] https://envir.ee/media/1414/download (12.12.2024)

[57] Keskkonnaamet. KOTKAS. Keskkonnaotsuste infosüsteem. [www] https://kotkas.envir.ee/ (18.10.2024)

calculated based on the data from ARIB database. The corresponding MMS distributions are shown in tables A.V.3_IV.1. and A.V.3_IV.2.

In general, a major number of holdings, which kept cattle and swine, were large in the beginning of ninetieth: about 90% of the total number of farms were with more than 1000 heads of cattle and swine[58]. High number of animals per swine farm, in greater degree, stipulated housing technology occurred in holdings – mostly partially or completely slatted floors, with liquid/slurry MMS, was applied. A smaller number of swine were kept in private farms, where mainly solid storage MMS was applied in Estonia.

In 1990, mainly tie stall housing system occurred in dairy-cattle and non-dairy cattle (including young animals) holdings. The housing technology assumes generation and storage of solid manure. It means that in the beginning of the nineties, mainly solid storage MMS was applied in cattle breeding holdings. The housing technology applied in dairy cattle as well non-dairy cattle breeding holdings has started to be changed in the beginning of 2000s – in 2003, the first farm with loose-housing technology was built up. The technology of young cattle housing started to change also in that time, the changes from tie stall technology to loose-technology with slatted floor and deep litter, namely from solid storage MMS to liquid/slurry MMS or Deep Litter MMS (in accordance, with the definitions established in the IPCC) have started to be launched. In the nineties, calves (0–6 months) were kept in groups or individual boxes with solid storage MMS.

[58] SE. (1991). Eesti statistika 1990. Lk. 445.

Table A.V.3_IV. 1. Country-specific MMS of dairy cows in 1990–2023, %

	Dairy cows, %				
Year	**Liquid/ Slurry**	**Solid Storage**	**Deep litter**	**Pasture/ Range**	**Anaerobic digester**
1990	0	82.7	0	17.3	0
1991	0	82.3	0	17.7	0
1992	0	81.8	0	18.2	0
1993	0	81.4	0	18.6	0
1994	0	80.9	0	19.1	0
1995	0	80.5	0	19.5	0
1996	0	80.9	0	19.1	0
1997	0	81.4	0	18.6	0
1998	0	81.9	0	18.2	0
1999	0	82.3	0	17.7	0
2000	0	82.7	0	17.3	0
2001	0	82.8	0	17.2	0
2002	0	82.9	0	17.1	0
2003	6.7	76.3	0	17.0	0
2004	13.4	69.6	0	17.0	0
2005	20.1	63.0	0	16.9	0
2006	26.3	59.4	0	14.3	0
2007	32.5	55.8	0	11.7	0
2008	38.7	52.2	0	9.1	0
2009	44.8	48.6	0	6.5	0
2010	51	45	0	3.9	0
2011	57.2	38.7	0	4.1	0
2012	59.9	32.4	0	4.3	3.4
2013	62.6	26.1	0	4.4	6.9
2014	67.3	19.8	0	4.6	8.3
2015	72.8	13.5	0	4.8	9.9
2016	74.1	12.1	0.4	4.2	9.3
2017	75.6	10.7	0.8	3.6	9.4
2018	75.3	9.3	1.2	3.0	11.2
2019	78.5	6.4	2.1	1.8	11.3
2020	77.9	4.5	2.9	1.3	13.4
2021	79.7	4.1	3.1	1.2	11.9
2022	81.0	2.4	3.2	1.3	12.1
2023	80.2	2.0	3.0	0.8	14.0

Table A.V.3_IV. 2. Country-specific MMS of non-dairy cows in 1990–2023, %

	Bovine animals (aged 1-2 years), %						Mature non-dairy females, %					Mature non-dairy males, %				
Year	**Liquid/ Slurry**	**Solid Storage**	**Deep litter**	**Pasture / Range**	**Anaerobic digester (liquid)**	**Anaerobic digester (solid)**	**Liquid/ Slurry**	**Solid Storage**	**Deep litter**	**Pasture / Range**	**Anaerobic digester**	**Liquid/ Slurry**	**Solid Storage**	**Deep litter**	**Pasture / Range**	**Anaerobic digester**
1990	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
1991	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
1992	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
1993	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
1994	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
1995	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
1996	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
1997	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
1998	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
1999	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
2000	0	67.1	0	32.9	0	0	0	67.8	0	32.2	0	0	67.1	0	32.9	0
2001	0.4	64.6	2.4	32.6	0	0	0.5	63	0	36.5	0	0.4	64.6	2.4	32.6	0
2002	0.9	62	4.8	32.3	0	0	1	58.1	0	40.9	0	0.9	62	4.8	32.3	0
2003	1.3	59.4	7.3	32	0	0	1.5	53.3	0	45.3	0	1.3	59.4	7.3	32	0
2004	1.8	56.8	9.7	31.8	0	0	2	48.4	0	49.7	0	1.8	56.8	9.7	31.8	0
2005	2.2	54.2	12.1	31.5	0	0	2.5	43.5	0	54	0	2.2	54.2	12.1	31.5	0
2006	2.9	52.8	14.9	29.4	0	0	3.8	53.9	0	42.3	0	2.9	52.8	14.9	29.4	0
2007	3.5	51.5	17.7	27.3	0	0	5	49	0	45.9	0	3.5	51.5	17.7	27.3	0
2008	4.2	50.2	20.4	25.2	0	0	6.3	43.8	0	49.9	0	4.2	50.2	20.4	25.2	0
2009	4.9	48.8	23.2	23.1	0	0	7.6	48.2	0	44.1	0	4.9	48.8	23.2	23.1	0
2010	5.5	47.5	26	21	0	0	8.9	46.3	0	44.8	0	5.5	47.5	26	21	0
2011	10.1	44.8	22.3	22.8	0	0	15.2	44	1.4	39.3	0	10.2	44.9	22.3	22.6	0
2012	11.9	42.2	18.7	24.5	2.8	0	9.7	41.7	2.9	44.1	1.6	14.5	42.3	18.7	24.2	0.3
2013	16.2	39.5	13.4	26.2	3	1.7	12.9	39.4	4.3	41.6	1.8	18.5	39.7	15.1	25.8	1
2014	19.6	36.9	9.8	28	4.2	1.5	13.3	37.2	5.7	42.7	1.1	17.9	37.2	11.4	27.3	6.1
2015	23.7	34.2	6.1	29.7	4.6	1.7	22.7	34.9	7.1	34.5	0.8	23.6	34.6	7.8	28.9	5.1
2016	20.8	27.4	17.8	27.7	4.7	1.6	16.6	28.8	13.3	40.8	0.4	21.5	27.7	19.4	27.1	4.3
2017	18.1	20.6	29.2	25.7	4.6	1.8	17.5	22.8	19.5	39.6	0.5	18.9	20.8	31	25.2	4
2018	14.0	13.8	40.9	23.7	5.9	1.7	17.6	16.8	25.7	39.1	0.9	14.2	13.9	42.6	23.4	5.9
2019	37.4	4.7	36.3	13.8	6.0	1.8	16.5	4.7	38.1	40.1	0.6	9.5	0.1	65.9	19.7	4.8
2020	39.3	4.7	34.8	11.2	6.5	3.5	27.6	3.5	28.9	39.5	0.5	13.1	0.02	66.7	20.2	0.03

Year	Bovine animals (aged 1-2 years), %						Mature non-dairy females, %					Mature non-dairy males, %				
	Liquid/ Slurry	Solid Storage	Deep litter	Pasture / Range	Anaerobic digester (liquid)	Anaerobic digester (solid)	Liquid/ Slurry	Solid Storage	Deep litter	Pasture / Range	Anaerobic digester	Liquid/ Slurry	Solid Storage	Deep litter	Pasture / Range	Anaerobic digester
2021	39.2	5.2	35.9	11.7	5.9	2.1	23.9	3.9	28.4	43.4	0.3	10.1	0	65.8	20.7	3.4
2022	36.6	7.1	37	10.4	6.7	2.2	25.9	5.2	28.8	39.7	0.5	10.3	0.8	65.7	23.1	0.1
2023	45.1	6.8	28.3	10.4	6.1	3.3	25.8	4.9	26.6	42.2	0.4	57.3	4.5	27.3	10.7	0.2

Table A.V.3_IV. 3. Country-specific MMS of calves in 1990–2023, %

Year	Calves (aged 6-12 months), %					Calves (aged 0-6 months), %				
	Liquid/ Slurry	Solid Storage	Deep litter	Pasture/ Range	Anaerobic digester	Liquid/ Slurry	Solid Storage	Deep litter	Pasture/ Range	Anaerobic digester
1990	0	85.7	0	14.3	0	0	85.7	0	14.3	0
1991	0	85.7	0	14.3	0	0	85.7	0	14.3	0
1992	0	85.7	0	14.3	0	0	85.7	0	14.3	0
1993	0	85.7	0	14.3	0	0	85.7	0	14.3	0
1994	0	85.7	0	14.3	0	0	85.7	0	14.3	0
1995	0	85.7	0	14.3	0	0	85.7	0	14.3	0
1996	0	85.7	0	14.3	0	0	85.7	0	14.3	0
1997	0	85.7	0	14.3	0	0	85.7	0	14.3	0
1998	0	85.7	0	14.3	0	0	85.7	0	14.3	0
1999	0	85.7	0	14.3	0	0	85.7	0	14.3	0
2000	0	85.7	0	14.3	0	0	85.7	0	14.3	0
2001	0.6	83.1	2.0	14.3	0	0.6	83.1	2.0	14.3	0
2002	1.1	80.5	4.1	14.3	0	1.1	80.5	4.1	14.3	0
2003	1.7	77.9	6.1	14.3	0	1.7	77.9	6.1	14.3	0
2004	2.2	75.3	8.1	14.4	0	2.2	75.3	8.1	14.4	0
2005	2.8	72.7	10.2	14.4	0	2.8	72.7	10.2	14.4	0
2006	3.6	70.6	12.4	13.4	0	3.6	70.6	12.4	13.4	0
2007	4.4	68.6	14.6	12.4	0	4.4	68.6	14.6	12.4	0
2008	5.2	66.5	16.9	11.4	0	5.2	66.5	16.9	11.4	0
2009	6.0	64.5	19.1	10.4	0	6.0	64.5	19.1	10.4	0
2010	6.8	62.4	21.4	9.4	0	6.8	62.4	21.4	9.4	0
2011	9.6	57	23.1	10.3	0	9.6	57	23.1	10.3	0
2012	12.4	51.5	23.0	11.2	2.0	12.4	51.5	22.7	11.2	2.2

Year	Calves (aged 6-12 months), %					Calves (aged 0-6 months), %				
	Liquid/ Slurry	Solid Storage	Deep litter	Pasture/ Range	Anaerobic digester	Liquid/ Slurry	Solid Storage	Deep litter	Pasture/ Range	Anaerobic digester
2013	15.2	46	22.5	12.1	4.2	15.2	46	22.1	12.1	4.6
2014	18.0	40.5	22.1	13.1	6.3	18	40.5	21.6	13.1	6.9
2015	20.8	35.1	23.4	14	6.8	20.8	35.1	22.7	14	7.5
2016	19.6	28.1	31.3	14.2	6.8	19.7	28.1	30.6	14.2	7.5
2017	18.5	21.0	39.3	14.5	6.6	18.5	21.0	38.6	14.5	7.3
2018	17.4	14.0	45.0	14.8	8.8	17.4	14.0	44	14.8	9.8
2019	17.5	0	58.4	16.9	7.2	17.5	0	57.6	16.9	8.0
2020	15.3	0	63.0	12.3	9.4	15.3	0	63.7	12.3	8.7
2021	16.9	0	62.1	13.0	8.1	16.9	0	61.3	13.0	8.9
2022	16.7	0	62.9	12.8	7.6	16.7	0	62.1	12.8	8.4
2023	11.0	0	68.2	12.8	8.0	11.0	0	68.2	12.8	8.0

Table A.V.3_IV. 4. Country-specific MMS of young pigs in 1990–2023, %

Year	Young pigs, %				
	Liquid/ Slurry	Solid Storage	Deep litter	Pasture/ Range	Anaerobic digester
	%	%	%	%	%
1990	87.0	13.0	0	0	0
1991	85.6	14.4	0	0	0
1992	84.2	15.8	0	0	0
1993	82.8	17.2	0	0	0
1994	81.4	18.6	0	0	0
1995	80.0	20.0	0	0	0
1996	79.6	20.4	0	0	0
1997	79.2	20.8	0	0	0
1998	78.8	21.2	0	0	0
1999	78.4	21.6	0	0	0
2000	78.0	22.0	0	0	0
2001	78.2	21.8	0	0	0
2002	78.4	21.6	0	0	0
2003	78.6	21.4	0	0	0
2004	78.8	21.2	0	0	0
2005	79.0	21.0	0	0	0
2006	75.4	20.8	0	0	3.8

	Young pigs, %				
Year	Liquid/ Slurry	Solid Storage	Deep litter	Pasture/ Range	Anaerobic digester
	%	%	%	%	%
2007	75.5	20.6	0	0	4
2008	75.9	20.4	0	0	3.8
2009	79.8	20.2	0	0	0
2010	75.2	20.0	0	0	4.8
2011	80.4	16.0	0	0	3.6
2012	83.7	12.0	0	0	4.3
2013	87.3	8.0	0	0	4.7
2014	89.6	4.0	0	0	6.4
2015	94	0	0	0	6.0
2016	95.1	0	0	0	4.9
2017	98.8	0	0	0	1.2
2018	98.8	0	0	0	1.2
2019	98.7	0	0	0	1.4
2020	98.3	0	0	0	1.7
2021	99	0	0	0	1.0
2022	98.7	0	0	0	1.3
2023	100.0	0	0	0	0

Table A.V.3_IV. 5. Country-specific MMS of fattening and breeding pigs in 1990–2023, %

	Fattening pigs, %					Sows and boars, %				
Year	Liquid/ Slurry	Solid Storage	Deep litter	Pasture/ Range	Anaerobic digester	Liquid/ Slurry	Solid Storage	Deep litter	Pasture/ Range	Anaerobic digester
	%	%	%	%	%	%	%	%	%	%
1990	87.0	13.0	0	0	0	85.5	14.5	0	0	0
1991	85.6	14.4	0	0	0	84.0	16.0	0	0	0
1992	84.2	15.8	0	0	0	82.5	17.5	0	0	0
1993	82.8	17.2	0	0	0	80.9	19.1	0	0	0
1994	81.4	18.6	0	0	0	79.4	20.6	0	0	0
1995	80.0	20.0	0	0	0	77.9	22.1	0	0	0
1996	79.6	20.4	0	0	0	77.5	22.5	0	0	0
1997	79.2	20.8	0	0	0	77.0	23.0	0	0	0
1998	78.8	21.2	0	0	0	76.6	23.4	0	0	0
1999	78.4	21.6	0	0	0	76.2	23.8	0	0	0

	Fattening pigs, %					Sows and boars, %				
Year	**Liquid/ Slurry**	**Solid Storage**	**Deep litter**	**Pasture/ Range**	**Anaerobic digester**	**Liquid/ Slurry**	**Solid Storage**	**Deep litter**	**Pasture/ Range**	**Anaerobic digester**
	%	%	%	%	%	%	%	%	%	%
2000	78.0	22.0	0	0	0	75.8	24.3	0	0	0
2001	78.2	21.8	0	0	0	76.0	24.0	0	0	0
2002	78.4	21.6	0	0	0	76.2	23.8	0	0	0
2003	78.6	21.4	0	0	0	76.4	23.6	0	0	0
2004	78.8	21.2	0	0	0	76.6	23.4	0	0	0
2005	79.0	21.0	0	0	0	76.8	23.2	0	0	0
2006	69.1	20.8	0	0	10.1	71	23.0	0	0	6.1
2007	70.8	20.6	0	0	8.6	70.9	22.8	0	0	6.3
2008	73.7	20.4	0	0	5.9	71.2	22.5	0	0	5.3
2009	79.8	20.2	0	0	0	77.7	22.3	0	0	0
2010	71.2	20.0	0	0	8.9	71.6	22.1	0	0	6.3
2011	71	17.3	1.4	0	10.3	76	17.7	0	0	6.4
2012	73.1	14.5	2.9	0	9.5	80.2	13.3	0	0	6.6
2013	70.7	11.8	4.3	0	13.2	82	8.9	0	0	9.2
2014	70.1	14.8	5.7	0	15	84.7	4.4	0	0	10.2
2015	69.1	6.4	7.2	0	17.4	87.9	0	0.02	0	12.1
2016	70.9	5.1	7.3	0	16.7	88.9	1.3	0.02	0	9.8
2017	84.7	3.8	7.5	0	3.9	94.6	2.5	0.02	0	2.9
2018	86.7	2.6	7.7	0	3.1	93.4	3.8	0.02	0	2.8
2019	87.2	0	8.1	0	4.7	91.1	6.3	0	0	2.7
2020	87.7	0	7.4	0	5	88.3	7.3	0	0	4.4
2021	88	0	8.5	0	3.6	76.3	2.9	0	0	2.8
2022	86.7	0	9	0	4.4	77.4	19.2	0	0	3.4
2023	88.1	0	11.9	0	0	90.7	9.3	0	0	0

Manure management systems: poultry

The module on MMS for poultry manure storage was developed based on data on poultry population kept by legal and in private agricultural holdings (Table A.V.3_IV.5.).

According to the information presented in the environmental permits, which were submitted by large poultry holdings to the Environmental Board, the holdings use 'solid storage MMS' for all amount of waste generated by poultry. Manure, generated by poultry kept by private holdings (farms), is stored in 'solid storage MMS'. However, in addition, in private holdings, in the summertime during solar time, poultry are kept outside of hen-house, which could be classified as 'dry lot' MMS. Some manure from poultry is also sent to biogas reactors (Table A.V.3_IV.6).

Table A.V.3_IV. 6. Poultry population in agricultural holdings by form in Estonia in 1990–2016, 1000 heads (SE, 2019)

Year	Total population	incl. in private holdings
1990	6 537	1 170
2001	2 214	479
2003	2 276	328
2005	2 132	296
2007	1 719	147
2010	1 941	139
2013	2 166	84
2016	1 903	53

Table A.V.3_IV. 7. Country-specific MMS of poultry in 1990–2023, %

	Layers			Broilers		Other hens and roosters		
Year	**Solid storage**	**Dry lot**	**Anaerobic digester**	**Solid storage**	**Dry lot**	**Solid storage**	**Dry lot**	**Anaerobic digester**
1990	96.7	3.3	0	96.7	3.3	96.7	3.3	0
1991	96.6	3.4	0	96.6	3.4	96.6	3.4	0
1992	96.6	3.4	0	96.6	3.4	96.6	3.4	0
1993	96.5	3.5	0	96.5	3.5	96.5	3.5	0
1994	96.5	3.5	0	96.5	3.5	96.5	3.5	0
1995	96.4	3.6	0	96.4	3.6	96.4	3.6	0
1996	96.4	3.6	0	96.4	3.6	96.4	3.6	0
1997	96.3	3.7	0	96.3	3.7	96.3	3.7	0
1998	96.3	3.7	0	96.3	3.7	96.3	3.7	0
1999	96.2	3.8	0	96.2	3.8	96.2	3.8	0
2000	96.2	3.8	0	96.2	3.8	96.2	3.8	0
2001	96.1	3.9	0	96.1	3.9	96.1	3.9	0
2002	96.7	3.3	0	96.7	3.3	96.7	3.3	0
2003	97.2	2.8	0	97.2	2.8	97.2	2.8	0
2004	97.3	2.7	0	97.3	2.7	97.3	2.7	0
2005	97.3	2.7	0	97.3	2.7	97.3	2.7	0
2006	97.8	2.2	0	97.8	2.2	97.8	2.2	0

	Layers			Broilers		Other hens and roosters		
Year	**Solid storage**	**Dry lot**	**Anaerobic digester**	**Solid storage**	**Dry lot**	**Solid storage**	**Dry lot**	**Anaerobic digester**
2007	98.3	1.7	0	98.3	1.7	98.3	1.7	0
2008	98.4	1.6	0	98.4	1.6	98.4	1.6	0
2009	98.4	1.6	0	98.4	1.6	98.4	1.6	0
2010	98.5	1.5	0	98.5	1.5	98.5	1.5	0
2011	98.8	1.2	0	98.8	1.2	98.8	1.2	0
2012	99.0	1.0	0	99	1	99	1	0
2013	99.2	0.8	0	99.2	0.8	99.2	0.8	0
2014	99.3	0.7	0	99.3	0.7	99.3	0.7	0
2015	99.3	0.7	0	99.3	0.7	99.3	0.7	0
2016	99.4	0.6	0	99.4	0.6	99.4	0.6	0
2017	99.4	0.6	0	99.4	0.6	99.4	0.6	0
2018	99.4	0.6	0	99.4	0.6	99.4	0.6	0
2019	91	0.6	8.4	99.4	0.6	95	0.6	4.4
2020	82.3	0.6	17.1	99.4	0.6	90.4	0.6	9
2021	82.4	0.6	17.1	99.4	0.6	95	0.6	4.4
2022	83.0	0.6	16.4	99.4	0.6	92.2	0.6	7.2
2023	85.6	0.6	13.8	99.4	0.6	99.4	0.6	0

A.V.3_V. NITROGEN EXCRETION RATES

Table A.V.3_V. 1. Nitrogen content of feed, % (Kaasik jt, 2002)[59]

Cattle category	Nitrogen content of feed, %
Dairy cattle	2.4
Mature females	1.6
Mature males	2.3
Bovine animals (aged between 1 and 2 years)	2.3
Calves (0–6 months)	2.3

[59] Kaasik, A., Leming, R., Remmel, T. (2002). Toitainete (N, P, K) kadu veise- ja seakasvatuses. Agraarteadus, nr 13 (4), lk 201–211.

Table A.V.3_V. 2. Content of N in body weight and embryo, g/kg (DIAS, 1997)[60]

	Nitrogen, g/kg
	Dairy cattle
Weight gain	25.6
Embryo	29.6
	Growing cattle
Weight gain	29.6

Table A.V.3_V. 3. Average protein content of milk in Estonia in 1990–1997, % of mass (EARC, 2012)[61]

Year	**Fat content, %**
1990	3.22
1991	3.25
1992	3.14
1993	3.11
1994	3.15
1995	3.17
1996	3.20
1997	3.15

[60] DIAS. Standard Values for Farm Manure. [www] https://dcapub.au.dk/djfpublikation/djfpdf/djfhd7.pdf (02.11.2020).
[61]Results of animal recording in Estonia in 1997–2012. Annual Reports. [www] https://www.jkkeskus.ee/jkk/piimaveised/statistika/aastaaruanded/ (02.11.2020).

Table A.V.3_V. 4. Protein content of milk in 1998–2023 in Estonia, % in mass (EARC, 2024)

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
The average of Estonia	3.18	3.15	3.28	3.31	3.27	3.3	3.31	3.34	3.32	3.36	3.36	3.37	3.36
Harju	3.13	3.11	3.25	3.3	3.2	3.22	3.25	3.28	3.28	3.29	3.3	3.32	3.32
Hiiu	3.21	3.21	3.31	3.3	3.27	3.3	3.29	3.26	3.26	3.26	3.33	3.32	3.3
Ida-Viru	3.16	3.14	3.29	3.31	3.25	3.25	3.3	3.35	3.39	3.38	3.37	3.38	3.38
Jõgeva	3.26	3.22	3.36	3.4	3.36	3.39	3.39	3.41	3.41	3.4	3.4	3.41	3.42
Järva	3.17	3.15	3.26	3.3	3.27	3.31	3.31	3.35	3.34	3.36	3.38	3.37	3.37
Lääne	3.15	3.1	3.22	3.26	3.2	3.2	3.24	3.24	3.28	3.28	3.3	3.31	3.31
Lääne-Viru	3.13	3.11	3.22	3.27	3.24	3.25	3.28	3.32	3.36	3.36	3.36	3.34	3.36
Põlva	3.2	3.19	3.32	3.28	3.32	3.33	3.34	3.34	3.35	3.34	3.34	3.36	3.32
Pärnu	3.14	3.12	3.26	3.28	3.22	3.26	3.29	3.33	3.33	3.33	3.34	3.34	3.33
Rapla	3.16	3.12	3.26	3.27	3.25	3.26	3.3	3.3	3.29	3.31	3.32	3.33	3.34
Saare	3.27	3.24	3.34	3.39	3.36	3.36	3.38	3.38	3.39	3.38	3.4	3.41	3.39
Tartu	3.18	3.16	3.31	3.34	3.32	3.36	3.37	3.38	3.39	3.39	3.37	3.38	3.39
Valga	3.14	3.11	3.25	3.29	3.24	3.29	3.32	3.37	3.4	3.41	3.42	3.43	3.44
Viljandi	3.22	3.17	3.31	3.33	3.29	3.31	3.31	3.34	3.38	3.38	3.38	3.38	3.36
Võru	3.14	3.12	3.24	3.26	3.23	3.26	3.23	3.29	3.32	3.32	3.34	3.36	3.35

Table A.V.3_V. 4. Protein content of milk in 1998–2023 in Estonia, % in mass (EARC, 2024) (continued)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
The average of Estonia	3.39	3.39	3.38	3.37	3.38	3.36	3.38	3.39	3.41	3.39	3.40	3.51	3.39
Harju	3.34	3.37	3.35	3.33	3.36	3.34	3.37	3.36	3.39	3.35	3.37	3.37	3.39
Hiiu	3.34	3.34	3.31	3.32	3.31	3.31	3.38	3.46	3.46	3.43	3.40	3.39	3.47
Ida-Viru	3.4	3.38	3.4	3.38	3.4	3.41	3.4	3.42	3.49	3.47	3.52	3.49	3.57
Jõgeva	3.43	3.44	3.41	3.41	3.41	3.41	3.43	3.41	3.41	3.41	3.43	3.46	3.39
Järva	3.4	3.39	3.36	3.36	3.37	3.33	3.35	3.36	3.40	3.38	3.38	3.40	3.37
Lääne	3.31	3.34	3.31	3.33	3.36	3.32	3.39	3.41	3.40	3.39	3.43	3.37	3.38
Lääne-Viru	3.39	3.38	3.38	3.35	3.35	3.35	3.36	3.37	3.40	3.39	3.40	3.43	3.4
Põlva	3.39	3.4	3.36	3.33	3.35	3.34	3.37	3.36	3.38	3.34	3.35	3.33	3.35
Pärnu	3.38	3.36	3.35	3.34	3.37	3.35	3.37	3.38	3.39	3.36	3.37	3.36	3.36
Rapla	3.36	3.36	3.35	3.37	3.38	3.33	3.38	3.39	3.43	3.39	3.39	3.41	3.39
Saare	3.39	3.39	3.4	3.41	3.44	3.4	3.42	3.45	3.49	3.47	3.49	3.49	3.48
Tartu	3.42	3.41	3.39	3.37	3.39	3.37	3.37	3.37	3.38	3.40	3.40	3.41	3.37
Valga	3.43	3.44	3.43	3.4	3.39	3.38	3.41	3.44	3.42	3.41	3.40	3.37	3.35
Viljandi	3.39	3.41	3.4	3.39	3.42	3.4	3.42	3.42	3.43	3.42	3.42	3.44	3.41
Võru	3.42	3.42	3.38	3.36	3.38	3.37	3.34	3.36	3.41	3.41	3.40	3.4	3.40

A.V.3_VI. SYNTHETIC FERTILIZERS APPLIED ON AGRICULTURAL SOILS IN ESTONIA IN 1990–2023

Table A.V.3_VI. 1. Amounts of synthetic fertilizers applied on agricultural soils in 1990-2023, tonnes (SE, 2024)

Year	Use of mineral fertilizers (nitrogen)
1990	72 039
1991	69 824
1992	58 360
1993	29 949
1994	26 068
1995	18 905
1996	16 560
1997	20 471
1998	24 932
1999	19 895
2000	22 396
2001	19 603
2002	16 700
2003	23 255
2004	24 833
2005	20 083
2006	22 610
2007	24 982
2008	35 455
2009	27 328
2010	28 626
2011	29 803
2012	32 978
2013	33 659
2014	35 806
2015	36 276
2016	36 390
2017	37 333
2018	38 867
2019	41 438
2020	41 486
2021	46 767
2022	42 053
2023	38 404

A.V.3_VII. PRODUCTION OF CROPS IN ESTONIA IN 1990–2023

Table A.V.3_VII. 1. Production of field crops in 1990–2023, 1000 tons (SE, 2024)

Year	Cereals	Dry pulses	Rape seed	Open-field vegetables	Potatoes	Fodder roots
1990	957.3	0.2	1.1	86	618.1	534.8
1991	939.2	0.2	1.1	103.8	592.1	493.8
1992	598.1	0.4	2.3	63.0	669.1	176.8

Year	Cereals	Dry pulses	Rape seed	Open-field vegetables	Potatoes	Fodder roots
1993	810.7	0.7	1.7	58.9	538.6	198.5
1994	510.4	1.1	2.2	69.9	563	216.3
1995	513.5	6.3	7	48.8	537.4	240.8
1996	629.2	13.8	10	48.1	500.2	180.8
1997	650.5	17	9.6	44.2	437.5	146.8
1998	576.2	8.3	17.9	43.1	316.7	96.7
1999	401.6	3.1	29.8	37.5	403.7	58.4
2000	696.6	6.6	38.6	45.5	471.7	49.5
2001	558.4	6.5	41.3	40.0	343.1	36.1
2002	524.7	5	63.9	27.3	210.9	7.3
2003	505.7	5	69.2	50.4	244.4	7.2
2004	608.1	3.3	68.6	44.1	166.5	6.7
2005	760.1	5.7	83.1	50.7	209.8	3.1
2006	619.3	5.5	84.6	48.9	152.6	2
2007	879.5	9.5	133.3	57.4	191.8	3.4
2008	864.2	3.3	111.1	50.7	125.2	0.4
2009	873.5	7.6	136	59.1	139.1	0.7
2010	678.4	12.6	131	59.2	163.4	0.3
2011	771.6	15.5	144.2	74.1	164.7	0.5
2012	991.2	12.9	157.8	53.8	138.9	0.2
2013	975.5	31.4	174.0	67.4	127.7	0.2
2014	1 221.6	39.5	166.2	55.5	117.3	0.3
2015	1 535.3	86.2	196.3	72.4	117.2	0.5
2016	934.1	109.5	102.5	54.4	89.8	1.8
2017	1 311.9	75.3	165.3	49.3	91.2	0.6
2018	919.8	71.0	113.6	52.8	88.4	1.1
2019	1 624.6	111.2	191.4	77.0	120.5	6.1
2020	1 632.8	120.5	203.0	52.4	94.4	3.7
2021	1 285.8	79.2	216.1	43.9	71.2	1.2
2022	1 528.6	123.3	218.7	39.6	78.0	15.1
2023	1 200.7	118.6	137.9	38.1	84.9	1.1

Table A.V.3_VII. 2. Area under cultivation of field crops in 1990–2023, 1000 ha (SE, 2024)

Year	Cereals	Dry pulses	Industrial crops	Open-field vegetables	Potatoes	Fodder roots
1990	397	0.1	3.2	5.2	45.5	11.1
1991	418.1	0.1	3	5.7	52.2	12.3
1992	423.1	0.4	4.7	5.1	46.3	11.8
1993	375.1	0.4	2.1	4.6	42.6	11.4
1994	319.5	0.7	3.6	4.4	39.9	12
1995	304.3	3.7	7.3	4.6	36.9	10.8
1996	288.8	5.8	9.5	4.2	35.3	8.8
1997	326.6	8.7	9	3.9	35.2	6.9
1998	354.1	6.4	17.8	4.2	32.6	4.7
1999	321	2.9	24.6	3.9	31.1	3.5
2000	329.3	3.9	29.1	3.8	30.9	2.5
2001	274.1	3.7	28.3	3.3	22.1	1.4
2002	259.2	2.4	33.2	3	16	0.4
2003	263.2	4.4	46.7	3.4	17	0.3
2004	261	4.3	50.6	3.5	16.1	0.2
2005	282.1	4.4	47.1	3	14	0.2

Year	Cereals	Dry pulses	Industrial crops	Open-field vegetables	Potatoes	Fodder roots
2006	280.3	4.6	62.9	2.8	11.5	0.1
2007	292.3	5.7	74.7	2.8	11.2	0.2
2008	309.3	4.8	78.5	2.4	8.7	0.03
2009	316.4	4.9	83.4	2.8	9.1	0.04
2010	275.3	7.3	99.3	2.8	9.4	0.1
2011	296.9	8.6	90.0	3.0	9.2	0.03
2012	290.5	11.0	87.9	2.9	7.6	0.01
2013	311.0	13.6	87.2	2.8	6.6	0.02
2014	332.9	19.1	81.0	2.9	6.4	0.01
2015	350.4	31.3	72.6	3.1	5.8	0.03
2016	351.4	55.4	75.3	3.1	5.6	0.3
2017	330.7	65.6	85.5	3.4	5.4	0.1
2018	350.4	46.8	79.2	3.1	5.2	0.2
2019	364.4	43.0	79.1	3.1	5.3	0.4
2020	370.1	49.5	79.1	2.3	3.6	0.3
2021	367.1	49.0	85.3	1.8	3.4	0.3
2022	361.8	48.8	95.7	1.7	3.4	0.8
2023	352.1	53.3	82.8	1.5	3.5	0.08

Table A.V.3_VII. 3. Average yields of field crops by field crop in 1990–2023, kg/ha (SE, 2024)

Year	Cereals	Dry pulses	Rape seed	Potatoes	Fodder roots
1990	2 411	1 370	1 780	13 600	48 020
1991	2 247	1 310	991	11 340	40 050
1992	1 414	920	799	14 450	14 950
1993	2 161	1 550	1 324	12 640	17 350
1994	1 597	1 619	819	14 096	18 069
1995	1 687	1 711	1 165	14 559	22 429
1996	2 179	2 398	1 170	14 176	20 651
1997	1 992	1 945	1 216	12 415	21 333
1998	1 627	1 303	1 024	9 729	20 297
1999	1 251	1 044	1 232	12 970	16 489
2000	2 115	1 706	1 339	15 281	19 596
2001	2 037	1 780	1 499	15 503	25 838
2002	2 024	2 115	1 944	13 160	18 087
2003	1 922	1 131	1 494	14 393	21 809
2004	2 330	757	1 362	10 342	30 825
2005	2 694	1 282	1 781	15 028	19 686
2006	2 210	1 198	1 354	13 261	24 650
2007	3 009	1 668	1 812	17 196	18 934
2008	2 794	691	1 431	14 315	12 882
2009	2 761	1 547	1 657	15 275	19 917
2010	2 464	1 713	1 334	17 456	5 460
2011	2 598	1 811	1 620	17 836	13 939
2012	3 412	1 179	1 811	18 217	17 000
2013	3 136	2 315	2 021	19 245	13 294
2014	3 669	2 070	2 078	18 472	23 000
2015	4 382	2 756	2 771	20 138	15 903
2016	2 658	1 975	1 462	15 920	6 865
2017	3 967	1 149	2 240	16 925	8 796
2018	2 625	1 516	1 563	16 990	5 236
2019	4 459	2 590	2 643	22 585	13 572

Year	Cereals	Dry pulses	Rape seed	Potatoes	Fodder roots
2020	4 412	2 432	2 861	25 945	13 574
2021	3 502	1 617	2 740	21 118	4 124
2022	4 225	2 525	2 530	23 060	19 192
2023	3 410	2 223	1 803	24 547	13 578

A.V.3_VIII. AMOUNTS OF LIME FERTILIZERS USED IN ESTONIA IN 1990-2023

Table A.V.3_VIII. 1. Amounts of lime fertilizers applied to soils in 1990–2023, tons (SE, 2024)

Year	Annual amount of calcic limestone ($CaCO_3$) (t/yr)	Annual amount of clinker dust (t/yr)	Annual amount of limestone and other ameliorants (t/yr)	Annual amount of dolomite ($CaMg(CO_3)_2$) (t/yr)
1990	27 529.4	68 000	0	0
1991	25 388.7	62 700	0	0
1992	5 910.7	14 600	0	0
1993	5 404.7	13 350	0	0
1994	4 898.6	12 100	0	0
1995	8 167.2	13 388.2	2 747.1	0
1996	8 291.8	10 286.8	4 127.3	0
1997	13 087.6	13 277.9	7 712.1	0
1998	56 709.2	47 241.1	37 583.9	0
1999	58 719.4	50 172.7	38 407.3	0
2000	44 123.5	39 051.0	28 314.0	0
2001	47 334.7	44 131.8	29 468.2	0
2002	42 797.6	43 446.4	25 208.6	0
2003	38 300.4	45 869.7	19 730.3	0
2004	22 030.0	42 704.1	4 741.4	84.5
2005	16 290.3	22 860.5	7 035.3	111.2
2006	13 095.5	19 426.6	5 230.7	81.6
2007	8 914.0	12 989.9	3 655.1	677.0
2008	11 635.8	20 953.5	3 152.9	40.7
2009	2 690.0	5 623.0	413.5	32.4
2010	2 1087.9	31 487.3	8 340.4	183.3
2011	8 830.3	11 696.5	4 095.1	92.8
2012	15 673.1	0	15 673.1	182.0
2013	13 780.7	0	13 780.7	88.5
2014	18 394.1	0	18 394.1	1 156.5
2015	18 014.0	0	18 014.0	2 342.0
2016	29 137.0	0	29 137.0	2 481.0
2017	34 887.0	0	34 887.0	1 996.0
2018	38 194.0	0	38 194.0	5 178.0
2019	32 534.0	0	32 534.0	2 410.0
2020	31 898.0	0	31 898.0	3 558.0
2021	50 848.0	0	50 848.0	12 822.0
2022	75 849.0	0	75 849.0	5 592.0
2023	56 022.0	0	56 022.0	5 967.0

A.V.3_IX. AMOUNTS OF UREA FERTILIZERS USED IN ESTONIA IN 1990-2023

Table A.V.3_IX. 1. Amounts of urea fertilizers applied to soils in 1990–2023, tons

Year	Annual amount of used urea fertilizers (t/yr)
1990	1 360.2
1991	1 265.4
1992	663.9
1993	269.0
1994	895.0
1995	873.0
1996	807.4
1997	653.9
1998	489.7
1999	631.7
2000	592.9
2001	612.1
2002	378.5
2003	527.5
2004	884.1
2005	1 919.7
2006	1 041.1
2007	2 117.5
2008	251.7
2009	304.0
2010	10.3
2011	14.6
2012	35.4
2013	498.9
2014	31.7
2015	37.9
2016	65.5
2017	102.7
2018	179.3
2019	758.9
2020	722.0
2021	309.1
2022	23.4
2023	3114.3

A.V.3_X. AVERAGE MONTHLY TEMPERATURE AND PERCIPITATION IN ESTONIA IN 1992-2023

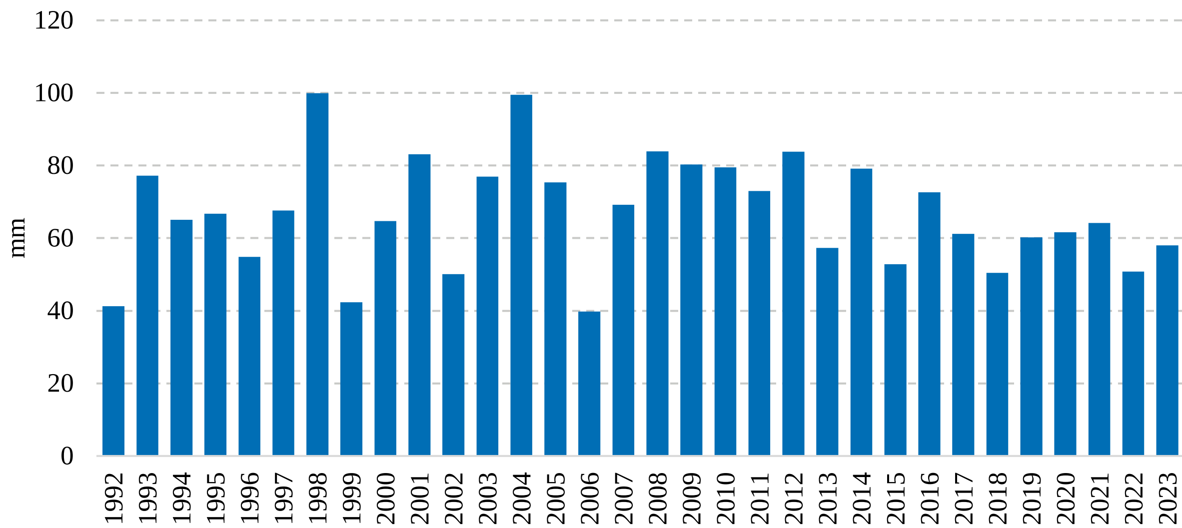


Figure A.V.3_X. 1. Total precipitation from May to September in Estonia in 1992–2023, mm (SE, 2015; EstEA, 2024)

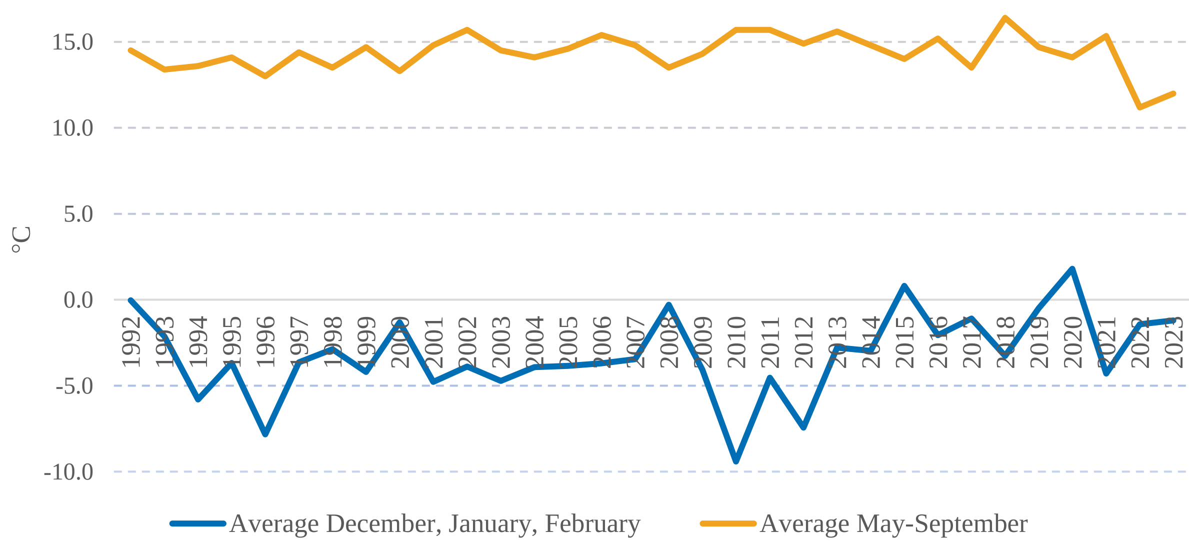


Figure A.V.3_X. 2. Average yearly temperatures in Estonia in 1992–2023, ˚C (SE, 2015; EstEA, 2024)

A.V.4 LULUCF

A.V.4.1 Methodology for Forest land living biomass (CRT 4.A)

Activity data

Activity data is obtained from the National Forest Inventory (NFI). The first NFI covering the whole country commenced in 1999. Estonian NFI has been described in NID, Chapter 6.3.1.

Areas of total FL and land converted to FL are estimated based on current land use of all NFI plots (five years' average) as well as on land-use changes on those plots during the last five years before the measurement. To estimate the losses, area of FL clear-felled in year t is estimated based on the proportion of plots that have been clear-felled during the last three harvest season before the assessment among FL plots assessed by NFI during years $t-2, t-1, t$.

Site quality index and age of stands

Both gains and losses of the growing stock are essentially estimated using the site quality index and the average age of the dominant species in tree stands assessed in NFI (pre-harvest age in case of clear-felled stands). The average age of dominant tree species, A_p, is assessed in the field for all NFI plots, as well as the average height of dominant tree species, H_p. In most cases, site quality indices for stand/plot p are then computed using formula from appendix of forest management planning regulation[62] (Equation A.V.4_1 and Equation A.V.4_2).

Equation A.V.4_1

$$H_{50,p} = \frac{H_p\{1+\alpha[(50/A_p)^c - 1]\}}{\{1-\beta H_p[(50/A_p)^c - 1]\}}$$

And

Equation A.V.4_2

$$H_{100,p} = \frac{H_{50,p}}{[1+(\alpha+\beta H_{50,p})(0.5^c - 1)]}$$

Species-specific parameter values for both equations have been presented in Table A.V.4_1.

Table A.V.4_1. Species-specific parameters α, β, and c for Equation A.V.4_1 and Equation A.V.4_2

Group of tree species	Parameters		
	α	β	c
Pine and non-coniferous hardwoods*	0.7283	-0.0109	1.13925
Spruce and other coniferous sp	0.7977	-0.0137	1.1116
Birch and non-coniferous softwood**	0.7298	-0.0161	1.3460

*oak, ash, maple, elm

** aspen, black alder, gray alder, willow sp.

[62] https://www.riigiteataja.ee/aktilisa/1130/7202/3033/KKM_16012009_m2_Lisa10.pdf

For young stands (stand age less than 15 years), site quality index $H_{100,p}$ is determined using Equation A.V.4_3:

Equation A.V.4_3

$$H_{100,p} = 33.5 - 4B_p$$

where B_p is determined by the field-assessed bonity class (Table A.V.4_2).

Table A.V.4_2. Value of parameter *B* according to the bonity class

Bonity class	Ia	I	II	III	IV	V
B	0	1	2	3	4	5

Model for plot-level volume prediction

Gains and losses per hectare are essentially estimated using the general model (Equation A.V.4_4) to predict the volume of growing stock on each NFI plots p, when the averege age of dominant tree species is A_p:

Equation A.V.4_4

$$V_p = V_p(A_p) = (a_1 + a_2 H_{100,p} + a_3 I_p)\left(\frac{A_p}{A_p + 5}\right)^{c_1 + c_2 H_{100,p}}$$

where species-specific parameter values have been presented in Table A.V.4_3.

Table A.V.4_3. Species-specific parameters a_1, a_2, a_3, c_1, and c_2 for Equation A.V.4_4

Tree species	Parameters				
	a_1	a_2	a_3	c_1	c_2
Pine	-68.8362	26.5981	37.4629	20.1523	-0.3501
Spruce	-93.0840	24.7104	104.4000	19.1073	-0.3051
Birch	-272.4000	29.6551	20.5290	14.9942	-0.2275
Aspen	-384.0000	34.6887	-23.9733	16.4334	-0.3142
Gray alder	-76.8916	23.4961	-58.2197	12.0424	-0.1845
Black alder	-332.5000	33.7791	25.6576	12.8815	-0.2009
Others	-34.6320	23.8111	-43.1965	19.4465	-0.3402

Parameters a_1, a_2, a_3, c_1, and c_2 have been estimated separately for seven groups of dominant tree species using NFI data from volume plots. Age limits are set to the species groups so that the volume predictions remain constant after set age limit. Indicator variable I_p gets value 1 when plot p is located on seaside counties Saaremaa, Hiiumaa or Läänemaa, otherwise $I_p = 0$.

To estimate the parameters for Equation A.V.4_4, plot-level volumes for NFI volume plots are estimated by aggregating modelled tree-level volumes using formulas from appendix of forest management planning regulation[63]. Tree-level volumes v_i are calculated from the breast-height

[63] https://www.riigiteataja.ee/aktilisa/1130/7202/3033/KKM_16012009_m2_Lisa11.pdf#

diameters d_i using Equation A.V.4_5 and Equation A.V.4_6. These formulas include specific parameter values a, b, c, and d for five groups of species.

For trees i with height $h_i \geq$ 6m, tree-level volumes are obtained from the model:

Equation A.V.4_5

$$v_i = 0.0000785\, d_i^2 h_i \left(a + \frac{b}{d_i} + \frac{c}{h_i} + \frac{d}{d_i h_i}\right)$$

where species-specific parameter values have been presented in Table A.V.4_4.

Table A.V.4_4. Species-specific parameters α, b, c and d for Equation A.V.4_5

Group of tree species	Parameters			
	a	b	c	d
Pine, larch, cedar pine	0.3571	0.660	2.156	-8.312
Spruce, fir, other coniferous sp	0.4216	0.181	1.190	-1.309
Birch, lime	0.4080	0.757	0.801	-10.707
Aspen, poplar, gray alder, black alder, willow sp	0.4723	-0.608	0	12.724
Oak, ash, maple, other non-coniferous sp	0.4033	0	1.586	1.440

For trees i with height h_i < 6m, volume estimations are derived from the model:

Equation A.V.4_6

$$v_i = 0.0000785\, D_p^2 H_p \left(a + \frac{b}{H_p^c}\right)$$

where species-specific parameter values are shown in Table A.V.4_5.

Table A.V.4_5. Species-specific parameters α, b and c for Equation A.V.4_6

Group of tree species	Parameters		
	a	b	c
Pine, larch, cedar pine	0.6321	13.4558	3.3642
Spruce, fir, other coniferous sp	0.6819	55.1416	4.7457
Birch, lime	0.5922	46.7815	4.1932
Aspen, poplar, gray alder, black alder, willow sp	0.5964	28.1186	3.7832
Oak, ash, maple, other non-coniferous sp	0.5922	46.7815	4.1932

Since heights are measured only for 3-5 trees per NFI volume plot, height of tree i on plot p was estimated using Equation A.V.4_7:

Equation A.V.4_7

$$h_i = 1.3 + (a_1 + a_2 H_{100,p} + a_3 I_p)\left(\frac{d_i}{d_i + b_1}\right)^{c_1 + c_2 H_{100,p}}$$

where species-specific parameter values are shown in Table A.V.4_6.

Table A.V.4_6. Species-specific parameters a_1, a_2, a_3, c_1, and c_2 for Equation A.V.4_7

Group of tree species	Parameters				
	a_1	a_2	a_3	c_1	c_2
Pine, larch, cedar pine	7.9747	1.1471	-4.6135	4.3775	0.09220
Spruce, fir, Douglas fir, other coniferous sp	17.7460	0.9687	-3.2399	1.4358	0.02590
Birch, lime, other non-coniferous sp	4.5064	1.2125	-1.9142	1.0190	0.02660
Aspen, poplar	9.0748	0.9609	-1.1178	2.0899	-0.00856
Gray alder	5.7631	0.9933	-1.3231	1.5622	0.04030
Black alder	-5.8474	1.5188	-0.3411	0.5695	0.02740
Oak, ash, maple, elm, white elm	9.3977	0.7883	-0.5899	1.0294	0.02040
Willow sp, bird cherry, hazel, apple tree, thorn tree, rowan	8.7686	0.6683	1.2259	0.9580	0.00303

Stem volume gains per unit area of Forest land

Gains of stem volume per hectare for years t=2003, 2004, ..., reporting year, are estimated with Equation A.V.4_4 as an average over all NFI plots measured in years $t' = t-4, t-3, \ldots, t$. Gains are based on the field-assessed age of the dominant species $A_{p,t'}$ and the site quality index $H_{100,p}$. The gains per year contributed by plot *p* are estimated as:

Equation A.V.4_8

$$G_{t,p} = \frac{V_p(A_{p,t}) - V_p(A_{p,t'})}{t - t' + 1}$$

It should be noted that this approach essentially estimates the average difference between the increment (tree growth) and stem volume reductions due to intermediate loggings (thinnings, cleanings, selection fellings) and natural mortality – i.e. reductions, where the age of the dominant species is not altered – since the volume used to fit Equation A.V.4_4 include the impacts of these.

Since the real change of stand age slightly differs from projected change of stand age ($A_{pt} - A_{p,t'}$), the change of age was adjusted by the correction coefficient of real change in average age (i.e usually, the forest becomes five years older in five years, but due to natural disturbances or intermediate fellings, the age change may be different).

Stem volume losses per hectare of Forest land

In accordance with the previous subsection, losses are defined as reductions in stem volume of living trees caused by clear-fellings: average age of the dominant species drops to 0. The losses per hectare of clear-felled FL are estimated for year t as an average over those NFI plots measured in years $t' = t-4, t-3, \dots, t$ that have been clear-felled during the harvest season (May 1, year t'-1 – April 30, year t') preceding. The losses contributed by clear-felled plot p are estimated as:

Equation A.V.4_9

$$L_{t,p} = (1-f)V_p(A_{p,t'-})$$

Where:

$V_p(A_{p,t'-})$	is obtained using Equation A.V.4_4 with $A_{p,t'-}$ set to the average age of dominant tree species before the harvest; and
f	is the average share of trees that remain standing after clear-fellings (seed trees, retention trees, etc.) estimated from NFI felling plots.

The age before harvest is not always available in the earliest NFI measurements. In such exceptional cases, pre-harvest volume is estimated from stump measurements using Equations A.V.4_5, A.V.4_6 and A.V.4_7, with breast-height diameters d_i estimated from stump-height diameters $d_{0,i}$ using Equation A.V.4_10.

Equation A.V.4_10

$$d_i = a_1 + a_2\left(\frac{d_{0,i}}{10}\right) + a_3 I_p$$

where species-specific parameter values have been presented in Table A.V.4_7. Indicator variable I_p gets value 1, when plot p is located on seaside counties Saaremaa, Hiiumaa or Läänemaa, otherwise $I_p = 0$.

Table A.V.4_7. Species-specific parameters a_1, a_2, a_3 for Equation A.V.4_10

Group of tree species	Parameters		
	a_1	a_2	a_3
Pine, larch, cedar pine	-1.069	0.811	-0.315
Spruce, fir, Douglas fir, other coniferous sp	-0.052	0.756	-0.680
Birch, lime, other non-coniferous sp	-0.625	0.749	-0.204
Aspen, poplar	-0.528	0.831	-0.531
Gray alder	0.309	0.737	-0.059
Black alder	-0.128	0.768	-0.077
Oak, ash, maple, elm, white elm	-0.908	0.791	0.126
Willow sp, bird cherry, hazel, apple tree, thorn tree, rowan	-0.848	0.797	1.346

C stock change in living biomass for total Forest land

The plot level stem volume (from stump to top) and difference between stem volume gains and losses is converted to whole tree biomass with country specific biomass conversion and expansion factors (BCEF coefficients, Table A.V.4_8) and below-ground biomass to above-ground biomass ratios (R, Table A.V.4_9).

Table A.V.4_8. Above ground biomass BCEF values [t biomass/m^3 stemwood volume]

Dominant tree species	Growing stock level [m^3/ha]			
	≤ 20	>20…≤50	>50…≤100	>100
Pine	0.6057	0.5587	0.5429	0.5056
Spruce	0.5714	0.5455	0.5321	0.5055
Birch	0.7085	0.6321	0.6148	0.5992
Aspen	0.4246	0.4383	0.4179	0.4365
Gray alder	0.4045	0.4181	0.4313	0.4395
Black alder	0.4281	0.4669	0.4768	0.4844
Other	0.4914	0.4889	0.4852	0.4899

Table A.V.4_9. Ratio of below-ground biomass to above-ground biomass (R) values [t root d.m (t shoot d.m.)$^{-1}$]

Species	R
Pine	0.26
Spruce	0.30
Birch	0.24
Other	0.235

Field works for country-specific BCEFs and root-shoot ratio coefficients were carried out in framework of study by V. Uri (2020) (Estonian University of Life Sciences)[64;65]. Those coefficients were updated by another study by the Estonian University of Life Sciences (Sims, 2024)[66]. BCEFs for other species are based on Latvian studies (Liepins *et al*, 2018, 2021)[67;68]. The

[64]Uri, V. (2020). Riigihanke 191205 „Eesti puistute biomassi mudelite väljatöötamine“ lõpparuanne. [Elaboration of country specific biomass models for Estonian forests.] Estonian University of Life Sciences. Report. [www] https://keskkonnaportaal.ee/sites/default/files/2021-12/Biomassi%20mudelid%2C%20l%C3%B5pparuanne%2C%20Veiko%20Uri%202020.pdf (13.03.2024)

[65] https://keskkonnaportaal.ee/sites/default/files/2021-12/mudelpuud.xlsx (13.03.2024)

[66] Sims, A. (2024). Biomassi mudelid. Käsunduslepingu 4-1/22/38 aruanne. [Biomass models.] Estonian University of Life Sciences. Report, pp. 26-29. [www] https://keskkonnaportaal.ee/sites/default/files/2024-08/K%C3%A4sundusleping_aruanne.pdf, (10.04.2025)

[67] Liepiņš, J., Lazdiņš, A. & Liepiņš, K. (2018). Equations for estimating above- and belowground biomass of Norway spruce, Scots pine, birch spp. and European aspen in Latvia. Scandinavian Journal of Forest Research, 33:1, 58-70, DOI: 10.1080/02827581.2017.1337923

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IPCC default carbon fraction coefficients[69] are applied to the estimates of biomass change to convert them into C stocks.

C stock change in living biomass on Forest land remaining forest land

Based on Estonian NFI data, the average annual increase of stem volume in young stands is estimated to be 3.04 m^3 ha^{-1}. Growing stock was converted to C by applying average woody biomass C stock/growing stock ratio from FL-FL (0.324 t C m^{-3}). C gains on Land converted to FL, based on this estimate and the area converted to FL, are subtracted from C change on total FL to obtain C change on FL remaining FL.

C stock change in forest living biomass in 1990–2002

The first NFI cycle ended in 2003, and NFI growing stock data is available from that year onwards. For the period 1990–1997, C stock change in FL living biomass was estimated using standwise inventory based growing stock data from Statistics Estonia and felling volumes from felling documentation. Growing stocks change were smoothed using linear trend; exponential trend was applied for felling data. For the period 1998–2002, C stock change in FL living biomass was interpolated.

Standwise forest inventory and felling documentation in 1990–2002 systematically underestimates the total volume (e.g., Arumäe & Lang, 2016[70]; Kuliešis *et al*, 2016[71]), but the estimate of the change can be considered adequate.

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