Ministry of Environment Republic of Lithuania
ENVIRONMENTAL PROTECTION AGENCY
State Forest Service

LITHUANIA'S NATIONAL INVENTORY DOCUMENT 2025

GREENHOUSE GAS EMISSIONS 1990-2023

ANNEXES

VILNIUS, 2025

ANNEX I. Approach 1 and Approach 2 key categories analysis

Approach 1 Level Assessment for 1990

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment*	*Cumulative total*
4.A.1 Forest land remaining forest land - carbon stock change in biomass	CO_2	-6892.19	0.11	0.11
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	6021.25	0.10	0.20
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	5796.59	0.09	0.30
1.A.3.b Road transportation	CO_2	5247.15	0.08	0.38
3.A.1 Enteric Fermentation - Cattle	CH_4	4717.44	0.07	0.45
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	3873.72	0.06	0.51
1.A.4 Other sectors-Solid fuels	CO_2	2760.55	0.04	0.56
1.A.4 Other sectors-Liquid fuels	CO_2	2736.38	0.04	0.60
1.A.2 Manufacturing industries and construction-Gaseous fuels	CO_2	2042.93	0.03	0.63
4.C Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1915.63	0.03	0.66
2.A.1 Cement Production	CO_2	1668.07	0.03	0.69
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	CO_2	-1629.67	0.03	0.72
1.A.1.b Petroleum refining - Liquid Fuels	CO_2	1509.64	0.02	0.74
1.A.4 Other sectors-Gaseous fuels	CO_2	1379.27	0.02	0.76
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1292.75	0.02	0.78
2.B.1 Ammonia Production	CO_2	1236.56	0.02	0.80
5.A Solid Waste Disposal	CH_4	1152.29	0.02	0.82
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	CO_2	900.77	0.01	0.83
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	882.83	0.01	0.85
2.B.2 Nitric Acid Production	N_2O	794.12	0.01	0.86
4.A.2 Land converted to forest land - carbon stock change in biomass	CO_2	-600.70	0.01	0.87
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	437.65	0.01	0.88
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	CO_2	422.72	0.01	0.88
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	377.12	0.01	0.89
3.B.1.3 Manure Management - Swine	CH_4	368.76	0.01	0.89
1.A.3.c Railways	CO_2	349.97	0.01	0.90
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	N_2O	324.33	0.01	0.91
4.A Forest land	N_2O	322.10	0.01	0.91
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	CO_2	-306.59	0.00	0.92

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment*	*Cumulative total*
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	306.17	0.00	0.92
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH_4	291.81	0.00	0.92
3.B.1.1 Manure Management - Cattle	CH_4	286.33	0.00	0.93
4.G Harvested wood products	CO_2	-240.10	0.00	0.93
2.A.4 Other process use of carbonates	CO_2	239.53	0.00	0.94
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	224.14	0.00	0.94
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	222.89	0.00	0.94
2.A.2 Lime Production	CO_2	210.27	0.00	0.95
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	188.21	0.00	0.95
3.B.2 Manure Management - Cattle	N_2O	186.05	0.00	0.95
1.A.1. Energy industries-Solid fuels	CO_2	174.05	0.00	0.96
1.A.2 Manufacturing industries and construction-Solid fuels	CO_2	171.63	0.00	0.96
4.A.2 Land converted to forest land - net carbon stock change in mineral soils	CO_2	-168.75	0.00	0.96
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	N_2O	165.18	0.00	0.96
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Total		***43,183.8***		

Approach 1 Level Assessment for 1990 using a subset (LULUCF was excluded from analysis)

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment*	*Cumulative total*
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	6021.25	0.13	0.13
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	5796.59	0.12	0.25
1.A.3.b Road transportation	CO_2	5247.15	0.11	0.36
3.A.1 Enteric Fermentation - Cattle	CH_4	4717.44	0.10	0.46
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	3873.72	0.08	0.54
1.A.4 Other sectors-Solid fuels	CO_2	2760.55	0.06	0.60
1.A.4 Other sectors-Liquid fuels	CO_2	2736.38	0.06	0.66
1.A.2 Manufacturing industries and construction-Gaseous fuels	CO_2	2042.93	0.04	0.70
2.A.1 Cement Production	CO_2	1668.07	0.04	0.73
1.A.1.b Petroleum refining - Liquid Fuels	CO_2	1509.64	0.03	0.77
1.A.4 Other sectors-Gaseous fuels	CO_2	1379.27	0.03	0.79
2.B.1 Ammonia Production	CO_2	1236.56	0.03	0.82
5.A Solid Waste Disposal	CH_4	1152.29	0.02	0.84
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	882.83	0.02	0.86
2.B.2 Nitric Acid Production	N_2O	794.12	0.02	0.88
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	377.12	0.01	0.89
3.B.1.3 Manure Management - Swine	CH_4	368.76	0.01	0.90
1.A.3.c Railways	CO_2	349.97	0.01	0.90
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	N_2O	324.33	0.01	0.91
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	306.17	0.01	0.92
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH_4	291.81	0.01	0.92
3.B.1.1 Manure Management - Cattle	CH_4	286.33	0.01	0.93
2.A.4 Other process use of carbonates	CO_2	239.53	0.01	0.93
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	224.14	0.00	0.94
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	222.89	0.00	0.94
2.A.2 Lime Production	CO_2	210.27	0.00	0.95
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	188.21	0.00	0.95
3.B.2 Manure Management - Cattle	N_2O	186.05	0.00	0.96
1.A.1. Energy industries-Solid fuels	CO_2	174.05	0.00	0.96
1.A.2 Manufacturing industries and construction-Solid fuels	CO_2	171.63	0.00	0.96
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	N_2O	165.18	0.00	0.97
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Total		***47,519.9***		

Approach 1 Level Assessment for 2023

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment*	*Cumulative total*
1.A.3.b Road transportation	CO_2	5933.78	0.16	0.16
4.A.1 Forest land remaining forest land - carbon stock change in biomass	CO_2	-4511.71	0.12	0.28
4.C Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1729.09	0.05	0.33
3.A.1 Enteric Fermentation - Cattle	CH_4	1668.64	0.05	0.38
4.G Harvested wood products	CO_2	-1668.00	0.05	0.42
4.B.1 Cropland remaining cropland - net carbon stock change in mineral soils	CO_2	-1629.67	0.04	0.47
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	CO_2	-1574.76	0.04	0.51
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1466.70	0.04	0.55
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	CO_2	-1391.37	0.04	0.59
1.A.1.b Petroleum refining - Liquid Fuels	CO_2	1360.87	0.04	0.62
4.A.2 Land converted to forest land - carbon stock change in biomass	CO_2	-943.46	0.03	0.65
2.B.1 Ammonia Production	CO_2	921.54	0.03	0.67
4.E.2 Land converted to settlements	CO_2	811.64	0.02	0.69
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	CO_2	687.58	0.02	0.71
1.A.4 Other sectors-Gaseous fuels	CO_2	683.59	0.02	0.73
1.A.2 Manufacturing industries and construction-Gaseous fuels	CO_2	580.67	0.02	0.75
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	CO_2	564.57	0.02	0.76
5.A Solid Waste Disposal	CH_4	563.15	0.02	0.78
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	543.41	0.01	0.79
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	530.45	0.01	0.81
2.A.1 Cement Production	CO_2	497.70	0.01	0.82
2.F.1 Refrigeration and Air Conditioning Equipment	HFCs	448.46	0.01	0.83
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	437.27	0.01	0.85
1.A.4 Other sectors-Liquid fuels	CO_2	413.92	0.01	0.86
4.A Forest land	N_2O	365.18	0.01	0.87
4.B.2 Land converted to cropland- carbon stock change in biomass	CO_2	361.71	0.01	0.88
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	315.39	0.01	0.88
1.A.2 Manufacturing industries and construction-Solid fuels	CO_2	290.54	0.01	0.89
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	242.65	0.01	0.90
4.A.2 Land converted to forest land - net carbon stock change in mineral soils	CO_2	-237.13	0.01	0.91

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment*	*Cumulative total*
1.A.1 Energy industries-Other fossil fuels	CO_2	234.03	0.01	0.91
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	199.01	0.01	0.92
1.B.2 Oil, natural gas and other emissions from energy production	CO_2	197.84	0.01	0.92
3.B.1.1 Manure Management - Cattle	CH_4	190.31	0.01	0.93
4.B.2 Land converted to cropland- net carbon stock change in dead organic matter	CO_2	169.83	0.00	0.93
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	150.60	0.00	0.94
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	134.43	0.00	0.94
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	N_2O	130.45	0.00	0.94
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	113.25	0.00	0.95
2.B.2 Nitric Acid Production	N_2O	107.82	0.00	0.95
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH_4	107.19	0.00	0.95
1.A.4 Other sectors-Solid fuels	CO_2	104.94	0.00	0.96
5.B Biological Treatment of Solid Waste	CH_4	90.51	0.00	0.96
1.A.3.c Railways	CO_2	85.72	0.00	0.96
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Total		***12,587.1***		

Approach 1 Level Assessment for 2023 using a subset (LULUCF was excluded from analysis)

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment*	*Cumulative total*
1.A.3.b Road transportation	CO_2	5933.78	0.33	0.33
3.A.1 Enteric Fermentation - Cattle	CH_4	1668.64	0.09	0.43
1.A.1.b Petroleum refining - Liquid Fuels	CO_2	1360.87	0.08	0.50
2.B.1 Ammonia Production	CO_2	921.54	0.05	0.55
1.A.4 Other sectors-Gaseous fuels	CO_2	683.59	0.04	0.59
1.A.2 Manufacturing industries and construction-Gaseous fuels	CO_2	580.67	0.03	0.62
5.A Solid Waste Disposal	CH_4	563.15	0.03	0.66
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	530.45	0.03	0.69
2.A.1 Cement Production	CO_2	497.70	0.03	0.71
2.F.1 Refrigeration and Air Conditioning Equipment	HFCs	448.46	0.03	0.74
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	437.27	0.02	0.76
1.A.4 Other sectors-Liquid fuels	CO_2	413.92	0.02	0.79
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	315.39	0.02	0.80
1.A.2 Manufacturing industries and construction-Solid fuels	CO_2	290.54	0.02	0.82
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	242.65	0.01	0.83
1.A.1 Energy industries-Other fossil fuels	CO_2	234.03	0.01	0.85
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	199.01	0.01	0.86
1.B.2 Oil, natural gas and other emissions from energy production	CO_2	197.84	0.01	0.87
3.B.1.1 Manure Management - Cattle	CH_4	190.31	0.01	0.88
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	150.60	0.01	0.89
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	134.43	0.01	0.90
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	N_2O	130.45	0.01	0.90
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	113.25	0.01	0.91
2.B.2 Nitric Acid Production	N_2O	107.82	0.01	0.92
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH_4	107.19	0.01	0.92
1.A.4 Other sectors-Solid fuels	CO_2	104.94	0.01	0.93
5.B Biological Treatment of Solid Waste	CH_4	90.51	0.01	0.93
1.A.3.c Railways	CO_2	85.72	0.00	0.94
1.A.4 Other sectors-Biomass	CH_4	82.31	0.00	0.94
3.A. Enteric Fermentation - Others	CH_4	74.07	0.00	0.95
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	72.82	0.00	0.95
3.B.2 Manure Management - Cattle	N_2O	70.98	0.00	0.95
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	N_2O	70.47	0.00	0.96
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Total		***17,842.2***		

Approach 1 Trend Assessment for 2023

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2023 kt CO_2 eq.*	*Trend assessment*	*% Contribution to Trend*	*Cumulative total*
4.A.1 Forest land remaining forest land - carbon stock change in biomass	CO_2	-6892.19	-4511.71	0.09	0.17	0.17
1.A.3.b Road transportation	CO_2	5247.15	5933.78	0.05	0.10	0.27
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	6021.25	242.65	0.05	0.09	0.35
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	5796.59	437.27	0.04	0.08	0.43
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	3873.72	150.60	0.03	0.06	0.48
4.B.1 Cropland remaining cropland - net carbon stock change in mineral soils	CO_2	0.00	-1629.67	0.03	0.05	0.53
1.A.4 Other sectors-Solid fuels	CO_2	2760.55	104.94	0.02	0.04	0.57
4.G Harvested wood products	CO_2	-240.10	-1668.00	0.02	0.04	0.61
1.A.4 Other sectors-Liquid fuels	CO_2	2736.38	413.92	0.02	0.03	0.64
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	CO_2	-306.59	-1391.37	0.01	0.03	0.67
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	CO_2	-1629.67	-1574.76	0.01	0.03	0.69
4.E.2 Land converted to settlements	CO_2	5.93	811.64	0.01	0.02	0.72
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1292.75	1466.70	0.01	0.02	0.74
3.A.1 Enteric Fermentation - Cattle	CH_4	4717.44	1668.64	0.01	0.02	0.76
4.C Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1915.63	1729.09	0.01	0.02	0.78
1.A.1.b Petroleum refining - Liquid Fuels	CO_2	1509.64	1360.87	0.01	0.02	0.80
1.A.2 Manufacturing industries and construction-Gaseous fuels	CO_2	2042.93	580.67	0.01	0.01	0.82
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	CO_2	422.72	687.58	0.01	0.01	0.83
2.F.1 Refrigeration and Air Conditioning Equipment	HFCs	0.00	448.46	0.01	0.01	0.84
2.A.1 Cement Production	CO_2	1668.07	497.70	0.01	0.01	0.85
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	437.65	543.41	0.01	0.01	0.86
2.B.2 Nitric Acid Production	N_2O	794.12	107.82	0.00	0.01	0.87
4.B.2 Land converted to cropland- carbon stock change in biomass	CO_2	138.74	361.71	0.00	0.01	0.88
2.B.1 Ammonia Production	CO_2	1236.56	921.54	0.00	0.01	0.89
1.A.1 Energy industries-Other fossil fuels	CO_2	0.00	234.03	0.00	0.01	0.90
1.A.2 Manufacturing industries and construction-Solid fuels	CO_2	171.63	290.54	0.00	0.01	0.90
4.A Forest land	N_2O	322.10	365.18	0.00	0.01	0.91
1.B.2 Oil, natural gas and other emissions from energy production	CO_2	23.88	197.84	0.00	0.01	0.91
3.B.1.3 Manure Management - Swine	CH_4	368.76	29.98	0.00	0.00	0.92

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2023 kt CO_2 eq.*	*Trend assessment*	*% Contribution to Trend*	*Cumulative total*
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	306.17	315.39	0.00	0.00	0.92
4.C.2 Land converted to grassland - carbon stock change in biomass	CO_2	-138.05	-56.72	0.00	0.00	0.93
4.B.2 Land converted to cropland- net carbon stock change in dead organic matter	CO_2	65.14	169.83	0.00	0.00	0.93
2.A.4 Other process use of carbonates	CO_2	239.53	9.58	0.00	0.00	0.93
2.A.2 Lime Production	CO_2	210.27	1.51	0.00	0.00	0.94
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	188.21	199.01	0.00	0.00	0.94
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	CO_2	900.77	564.57	0.00	0.00	0.94
1.A.3.c Railways	CO_2	349.97	85.72	0.00	0.00	0.95
5.B Biological Treatment of Solid Waste	CH_4	0.23	90.51	0.00	0.00	0.95
1.A.1. Energy industries-Solid fuels	CO_2	174.05	3.42	0.00	0.00	0.95
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	377.12	113.25	0.00	0.00	0.95
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	882.83	530.45	0.00	0.00	0.96
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Total		***43,183.8***	***12,587.1***	***0.53***	***1.00***	

Approach 1 Trend Assessment for 2023 using a subset (LULUCF was excluded from analysis)

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2023 kt CO_2 eq.*	*Trend assessment*	*% Contribution to Trend*	*Cumulative total*
1.A.3.b Road transportation	CO_2	5247.15	5933.78	0.08	0.25	0.25
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	6021.25	242.65	0.04	0.13	0.38
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	5796.59	437.27	0.04	0.11	0.49
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	3873.72	150.60	0.03	0.08	0.57
1.A.4 Other sectors-Solid fuels	CO_2	2760.55	104.94	0.02	0.06	0.63
1.A.1.b Petroleum refining - Liquid Fuels	CO_2	1509.64	1360.87	0.02	0.05	0.68
1.A.4 Other sectors-Liquid fuels	CO_2	2736.38	413.92	0.01	0.04	0.72
2.B.1 Ammonia Production	CO_2	1236.56	921.54	0.01	0.03	0.75
2.F.1 Refrigeration and Air Conditioning Equipment	HFCs	0.00	448.46	0.01	0.03	0.78
1.A.1 Energy industries-Other fossil fuels	CO_2	0.00	234.03	0.00	0.01	0.79
1.A.2 Manufacturing industries and construction-Solid fuels	CO_2	171.63	290.54	0.00	0.01	0.81
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	306.17	315.39	0.00	0.01	0.82
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	882.83	530.45	0.00	0.01	0.83
2.B.2 Nitric Acid Production	N_2O	794.12	107.82	0.00	0.01	0.84
1.B.2 Oil, natural gas and other emissions from energy production	CO_2	23.88	197.84	0.00	0.01	0.86
1.A.2 Manufacturing industries and construction-Gaseous fuels	CO_2	2042.93	580.67	0.00	0.01	0.87
1.A.4 Other sectors-Gaseous fuels	CO_2	1379.27	683.59	0.00	0.01	0.88
5.A Solid Waste Disposal	CH_4	1152.29	563.15	0.00	0.01	0.89
2.A.1 Cement Production	CO_2	1668.07	497.70	0.00	0.01	0.89
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	188.21	199.01	0.00	0.01	0.90
3.B.1.3 Manure Management - Swine	CH_4	368.76	29.98	0.00	0.01	0.91
3.A.1 Enteric Fermentation - Cattle	CH_4	4717.44	1668.64	0.00	0.01	0.92
5.B Biological Treatment of Solid Waste	CH_4	0.23	90.51	0.00	0.01	0.92
3.B.1.1 Manure Management - Cattle	CH_4	286.33	190.31	0.00	0.01	0.93
2.A.4 Other process use of carbonates	CO_2	239.53	9.58	0.00	0.01	0.93
2.A.2 Lime Production	CO_2	210.27	1.51	0.00	0.00	0.94
1.A.1. Energy industries-Solid fuels	CO_2	174.05	3.42	0.00	0.00	0.94
1.A.4 Other sectors-Biomass	CH_4	78.71	82.31	0.00	0.00	0.94
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	224.14	134.43	0.00	0.00	0.95
1.A.4 Other sectors-Solid fuels	CH_4	143.99	5.11	0.00	0.00	0.95
1.A.4 Other sectors-Peat	CO_2	27.13	58.22	0.00	0.00	0.95
1.A.2 Manufacturing industries and construction-Other fossil fuels	CO_2	0.00	46.24	0.00	0.00	0.96

1.A.3.c Railways	CO_2	349.97	85.72	0.00	0.00	0.96
1.A.4 Other sectors-Liquid fuels	N_2O	141.71	11.04	0.00	0.00	0.96
5.D Wastewater Treatment and Discharge	CH_4	161.97	22.44	0.00	0.00	0.96
1.A.1 Energy industries-Biomass	N_2O	0.56	34.71	0.00	0.00	0.97
3.G Liming	CO_2	20.59	41.84	0.00	0.00	0.97
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Total		***47,519.9***	***17,842.2***	***0.33***	***1.00***	

Approach 2 Level Assessment for 1990

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment with uncertainty*	*Cumulative total*
4.A.1 Forest land remaining forest land - carbon stock change in biomass	CO_2	-6892.19	0.05	0.19
5.A Solid Waste Disposal	CH_4	1152.29	0.02	0.28
3.A.1 Enteric Fermentation - Cattle	CH_4	4717.44	0.02	0.36
4.C Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1915.63	0.02	0.42
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	CO_2	422.72	0.01	0.48
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	882.83	0.01	0.52
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1292.75	0.01	0.57
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	CO_2	-1629.67	0.01	0.61
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	222.89	0.01	0.64
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	224.14	0.01	0.66
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	377.12	0.01	0.68
4.A.2 Land converted to forest land - carbon stock change in biomass	CO_2	-600.70	0.00	0.69
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	CO_2	900.77	0.00	0.71
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	N_2O	324.33	0.00	0.73
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	306.17	0.00	0.74
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	437.65	0.00	0.76
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	N_2O	165.18	0.00	0.77
3.B.2 Manure Management - Cattle	N_2O	186.05	0.00	0.78
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	6021.25	0.00	0.80
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	5796.59	0.00	0.81
1.A.4 Other sectors-Solid fuels	CO_2	2760.55	0.00	0.82
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	188.21	0.00	0.83
1.A.3.b Road transportation	CO_2	5247.15	0.00	0.83
5.D Wastewater Treatment and Discharge	CH_4	161.97	0.00	0.84
4.G Harvested wood products	CO_2	-240.10	0.00	0.85

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment with uncertainty*	*Cumulative total*
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	CO_2	-306.59	0.00	0.86
4.A Forest land	N_2O	322.10	0.00	0.87
4.D.2 Land converted to wetlands	CO_2	63.15	0.00	0.88
3.B.2 Manure Management - Other	N_2O	113.37	0.00	0.89
1.A.4 Other sectors-Biomass	CH_4	78.71	0.00	0.89
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	3873.72	0.00	0.90
1.A.4 Other sectors-Liquid fuels	CO_2	2736.38	0.00	0.91
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Total		***43,183.8***		

Approach 2 Level Assessment for 1990 using a subset (LULUCF was excluded from analysis)

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment with uncertainty*	*Cumulative total*
5.A Solid Waste Disposal	CH_4	1152.29	0.03	0.18
3.A.1 Enteric Fermentation - Cattle	CH_4	4717.44	0.03	0.34
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	882.83	0.02	0.43
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	222.89	0.01	0.49
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	224.14	0.01	0.53
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	377.12	0.01	0.56
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	N_2O	324.33	0.01	0.60
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	306.17	0.01	0.63
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	N_2O	165.18	0.00	0.66
3.B.2 Manure Management - Cattle	N_2O	186.05	0.00	0.68
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	6021.25	0.00	0.71
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	5796.59	0.00	0.73
1.A.4 Other sectors-Solid fuels	CO_2	2760.55	0.00	0.75
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	188.21	0.00	0.77
5.D Wastewater Treatment and Discharge	CH_4	161.97	0.00	0.78
1.A.3.b Road transportation	CO_2	5247.15	0.00	0.80
3.B.2 Manure Management - Other	N_2O	113.37	0.00	0.82
1.A.4 Other sectors-Biomass	CH_4	78.71	0.00	0.83
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	3873.72	0.00	0.85
1.A.4 Other sectors-Liquid fuels	CO_2	2736.38	0.00	0.86
2.G Other product manufacture and use	N_2O	85.41	0.00	0.87
2.A.1 Cement Production	CO_2	1668.07	0.00	0.88
2.B.2 Nitric Acid Production	N_2O	794.12	0.00	0.89
1.A.4 Other sectors-Solid fuels	CH_4	143.99	0.00	0.90
1.A.4 Other sectors-Liquid fuels	N_2O	141.71	0.00	0.91
3.B.1.3 Manure Management - Swine	CH_4	368.76	0.00	0.92
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Total		***47,519.9***		

Approach 2 Level Assessment for 2023

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment with uncertainty*	*Cumulative total*
4.A.1 Forest land remaining forest land - carbon stock change in biomass	CO_2	-4511.71	0.06	0.15
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	CO_2	687.58	0.04	0.25
4.G Harvested wood products	CO_2	-1668.00	0.03	0.32
4.C Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1729.09	0.03	0.39
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1466.70	0.02	0.45
5.A Solid Waste Disposal	CH_4	563.15	0.02	0.51
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	CO_2	-1574.76	0.02	0.55
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	CO_2	-1391.37	0.02	0.60
4.B.1 Cropland remaining cropland - net carbon stock change in mineral soils	CO_2	-1629.67	0.01	0.64
4.A.2 Land converted to forest land - carbon stock change in biomass	CO_2	-943.46	0.01	0.67
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	530.45	0.01	0.70
3.A.1 Enteric Fermentation - Cattle	CH_4	1668.64	0.01	0.73
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	543.41	0.01	0.75
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	315.39	0.01	0.77
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	134.43	0.01	0.79
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	CO_2	564.57	0.00	0.80
1.A.3.b Road transportation	CO_2	5933.78	0.00	0.81
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	199.01	0.00	0.82
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	72.82	0.00	0.83
4.A Forest land	N_2O	365.18	0.00	0.85
4.E.2 Land converted to settlements	CO_2	811.64	0.00	0.86
2.F.1 Refrigeration and Air Conditioning Equipment	HFCs	448.46	0.00	0.87
1.A.4 Other sectors-Biomass	CH_4	82.31	0.00	0.87
4.A.2 Land converted to forest land - net carbon stock change in mineral soils	CO_2	-237.13	0.00	0.88
4.B.2 Land converted to cropland- carbon stock change in biomass	CO_2	361.71	0.00	0.89
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	N_2O	130.45	0.00	0.90

IPCC Category	***Greenhouse gas***	***GHG emissions, kt CO_2 eq.***	***Level assessment with uncertainty***	***Cumulative total***
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	N_2O	70.47	0.00	0.91
5.B Biological Treatment of Solid Waste	CH_4	90.51	0.00	0.91
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	113.25	0.00	0.92
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Total		***12,587.1***		

Approach 2 Level Assessment for 2023 using a subset (LULUCF was excluded from analysis)

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment with uncertainty*	*Cumulative total*
5.A Solid Waste Disposal	CH_4	563.15	0.04	0.18
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	530.45	0.02	0.29
3.A.1 Enteric Fermentation - Cattle	CH_4	1668.64	0.02	0.40
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	315.39	0.01	0.47
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	134.43	0.01	0.51
1.A.3.b Road transportation	CO_2	5933.78	0.01	0.56
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	199.01	0.01	0.60
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	72.82	0.01	0.64
2.F.1 Refrigeration and Air Conditioning Equipment	HFCs	448.46	0.01	0.67
1.A.4 Other sectors-Biomass	CH_4	82.31	0.01	0.70
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	N_2O	130.45	0.01	0.73
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	N_2O	70.47	0.01	0.75
5.B Biological Treatment of Solid Waste	CH_4	90.51	0.01	0.78
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	113.25	0.01	0.80
1.B.2 Oil, natural gas and other emissions from energy production	CO_2	197.84	0.00	0.82
3.B.2 Manure Management - Cattle	N_2O	70.98	0.00	0.84
1.A.1 Energy industries-Biomass	N_2O	34.71	0.00	0.85
1.A.1 Energy industries-Biomass	CH_4	27.51	0.00	0.86
1.A.1.b Petroleum refining - Liquid Fuels	CO_2	1360.87	0.00	0.87
3.B.1.1 Manure Management - Cattle	CH_4	190.31	0.00	0.88
1.A.4 Other sectors-Biomass	N_2O	19.86	0.00	0.89
5.B Biological Treatment of Solid Waste	N_2O	26.60	0.00	0.90
2.A.1 Cement Production	CO_2	497.70	0.00	0.90
2.B.1 Ammonia Production	CO_2	921.54	0.00	0.91
1.A.4 Other sectors-Gaseous fuels	CO_2	683.59	0.00	0.92
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Total		***17,842.2***		

Approach 2 Trend Assessment for 2023

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2023 kt CO_2 eq.*	*Trend assessment with uncertainty*	*% Contribution to Trend*	*Cumulative total*
4.A.1 Forest land remaining forest land - carbon stock change in biomass	CO_2	-6892.19	-4511.71	0.04	0.27	0.27
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	CO_2	422.72	687.58	0.02	0.10	0.37
4.G Harvested wood products	CO_2	-240.10	-1668.00	0.01	0.08	0.45
4.B.1 Cropland remaining cropland - net carbon stock change in mineral soils	CO_2	0.00	-1629.67	0.01	0.05	0.51
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1292.75	1466.70	0.01	0.05	0.55
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	CO_2	-306.59	-1391.37	0.01	0.04	0.60
4.C Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1915.63	1729.09	0.01	0.04	0.64
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	CO_2	-1629.67	-1574.76	0.01	0.04	0.68
3.A.1 Enteric Fermentation - Cattle	CH_4	4717.44	1668.64	0.00	0.02	0.70
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	437.65	543.41	0.00	0.02	0.72
4.E.2 Land converted to settlements	CO_2	5.93	811.64	0.00	0.02	0.73
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	306.17	315.39	0.00	0.01	0.75
2.F.1 Refrigeration and Air Conditioning Equipment	HFCs	0.00	448.46	0.00	0.01	0.76
5.B Biological Treatment of Solid Waste	CH_4	0.23	90.51	0.00	0.01	0.77
1.A.3.b Road transportation	CO_2	5247.15	5933.78	0.00	0.01	0.78
4.B.2 Land converted to cropland- carbon stock change in biomass	CO_2	138.74	361.71	0.00	0.01	0.79
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	222.89	72.82	0.00	0.01	0.80
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	188.21	199.01	0.00	0.01	0.80
4.A Forest land	N_2O	322.10	365.18	0.00	0.01	0.81
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	6021.25	242.65	0.00	0.01	0.82
4.E Settlements	N_2O	0.45	52.49	0.00	0.01	0.83

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2023 kt CO_2 eq.*	*Trend assessment with uncertainty*	*% Contribution to Trend*	*Cumulative total*
1.B.2 Oil, natural gas and other emissions from energy production	CO_2	23.88	197.84	0.00	0.01	0.84
1.A.4 Other sectors-Solid fuels	CO_2	2760.55	104.94	0.00	0.01	0.85
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	5796.59	437.27	0.00	0.01	0.85
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	377.12	113.25	0.00	0.01	0.86
4.D.2 Land converted to wetlands	CO_2	63.15	0.00	0.00	0.01	0.87
1.A.4 Other sectors-Biomass	CH_4	78.71	82.31	0.00	0.01	0.87
4.C.2 Land converted to grassland - carbon stock change in biomass	CO_2	-138.05	-56.72	0.00	0.01	0.88
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	882.83	530.45	0.00	0.01	0.89
5.D Wastewater Treatment and Discharge	CH_4	161.97	22.44	0.00	0.01	0.89
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	3873.72	150.60	0.00	0.01	0.90
1.A.1 Energy industries-Biomass	N_2O	0.56	34.71	0.00	0.01	0.90
3.B.2 Manure Management - Other	N_2O	113.37	13.53	0.00	0.01	0.91
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Total		***43,183.8***	***12,587.1***	***0.15***	***1.00***	

Approach 2 Trend Assessment for 2023 using a subset (LULUCF was excluded from analysis)

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2023 kt CO_2 eq.*	*Trend assessment with uncertainty*	*% Contribution to Trend*	*Cumulative total*
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	306.17	315.39	0.00	0.08	0.08
5.A Solid Waste Disposal	CH_4	1152.29	563.15	0.00	0.08	0.16
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	882.83	530.45	0.00	0.08	0.24
2.F.1 Refrigeration and Air Conditioning Equipment	HFCs	0.00	448.46	0.00	0.06	0.31
1.A.3.b Road transportation	CO_2	5247.15	5933.78	0.00	0.05	0.36
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	188.21	199.01	0.00	0.05	0.41
5.B Biological Treatment of Solid Waste	CH_4	0.23	90.51	0.00	0.05	0.46
1.B.2 Oil, natural gas and other emissions from energy production	CO_2	23.88	197.84	0.00	0.04	0.50
1.A.4 Other sectors-Biomass	CH_4	78.71	82.31	0.00	0.04	0.54
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	224.14	134.43	0.00	0.03	0.57
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	6021.25	242.65	0.00	0.03	0.60
1.A.4 Other sectors-Solid fuels	CO_2	2760.55	104.94	0.00	0.03	0.63
1.A.1 Energy industries-Biomass	N_2O	0.56	34.71	0.00	0.03	0.65
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	5796.59	437.27	0.00	0.02	0.68
1.A.1 Energy industries-Biomass	CH_4	0.44	27.51	0.00	0.02	0.70
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	3873.72	150.60	0.00	0.02	0.71
5.D Wastewater Treatment and Discharge	CH_4	161.97	22.44	0.00	0.02	0.73
3.B.2 Manure Management - Other	N_2O	113.37	13.53	0.00	0.02	0.75
2.G Other product manufacture and use	N_2O	85.41	3.48	0.00	0.02	0.76
5.B Biological Treatment of Solid Waste	N_2O	0.13	26.60	0.00	0.01	0.78

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2023 kt CO_2 eq.*	*Trend assessment with uncertainty*	*% Contribution to Trend*	*Cumulative total*
3.A.1 Enteric Fermentation - Cattle	CH_4	4717.44	1668.64	0.00	0.01	0.79
1.A.4 Other sectors-Solid fuels	CH_4	143.99	5.11	0.00	0.01	0.80
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	377.12	113.25	0.00	0.01	0.81
1.A.4 Other sectors-Biomass	N_2O	11.54	19.86	0.00	0.01	0.83
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	222.89	72.82	0.00	0.01	0.84
1.A.1.b Petroleum refining - Liquid Fuels	CO_2	1509.64	1360.87	0.00	0.01	0.85
1.A.4 Other sectors-Liquid fuels	CO_2	2736.38	413.92	0.00	0.01	0.86
1.A.4 Other sectors-Liquid fuels	N_2O	141.71	11.04	0.00	0.01	0.87
3.B.1.3 Manure Management - Swine	CH_4	368.76	29.98	0.00	0.01	0.88
2.B.2 Nitric Acid Production	N_2O	794.12	107.82	0.00	0.01	0.89
3.G Liming	CO_2	20.59	41.84	0.00	0.01	0.90
3.B.1.1 Manure Management - Cattle	CH_4	286.33	190.31	0.00	0.01	0.90
1.A.3.b Road transportation	N_2O	44.27	49.39	0.00	0.01	0.91
…………………………………………						
Total		***47,519.9***	***17,842.2***	***0.04***	***1.00***	

ANNEX II. Tier 1 Uncertainty assessment

Table 1a. Uncertainty evaluation including LULUCF

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2023*	*Activity data uncertainty*	*Emission factor uncertainty*	*Combined uncertainty*	*Combined uncertainty as % of total national*	*Type A sensitivity*	*Type B sensitivity*	*Uncertainty in trend in national emissions introduced by emission factor*	*Uncertainty in trend in national emissions introduced by*	*Uncertainty introduced into the trend in total national emissions*
		kt CO_2 eq.	***kt CO_2 eq.***	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	7,540.2	1,611.3	2%	2%	3%	0.000	0.014	0.037	0.000	0.001	0.000
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH_4	7.7	1.1	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N_2O	14.3	1.7	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	174.0	3.4	2%	5%	5%	0.000	0.001	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH_4	0.1	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N_2O	0.7	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	5,796.6	480.1	2%	2%	3%	0.000	0.028	0.011	0.001	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH_4	2.9	0.2	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N_2O	2.8	0.2	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CO_2	0.0	234.0	2%	5%	5%	0.000	0.005	0.005	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CH_4	0.0	2.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	N_2O	0.0	2.6	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	Gas	Base year (1990) emissions	Emissions in 2023	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor	Uncertainty in trend in national emissions introduced by	Uncertainty introduced into the trend in total national emissions
		kt CO_2 eq.	kt CO_2 eq.	%	%	%	%	%	%	%	%	%
1.A.1 Fuel combustion - Energy Industries - Peat	CO_2	11.1	8.2	2%	5%	5%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Peat	CH_4	0.0	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Peat	N_2O	0.0	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Biomass	CO_2	0.0	0.0	5%	15%	16%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Biomass	CH_4	0.4	27.5	5%	150%	150%	0.000	0.001	0.001	0.001	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Biomass	N_2O	0.6	34.7	5%	150%	150%	0.000	0.001	0.001	0.001	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	3,873.7	150.6	2%	2%	3%	0.000	0.023	0.003	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH_4	5.0	0.2	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N_2O	42.5	4.6	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	171.6	290.5	2%	5%	5%	0.000	0.006	0.007	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH_4	0.5	0.8	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2023*	*Activity data uncertainty*	*Emission factor uncertainty*	*Combined uncertainty*	*Combined uncertainty as % of total national*	*Type A sensitivity*	*Type B sensitivity*	*Uncertainty in trend in national emissions introduced by emission factor*	*Uncertainty in trend in national emissions introduced by*	*Uncertainty introduced into the trend in total national emissions*
		kt CO_2 eq.	***kt CO_2 eq.***	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N_2O	0.7	1.2	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	2,042.9	580.7	2%	2%	3%	0.000	0.000	0.013	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH_4	1.0	0.3	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N_2O	1.0	0.3	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction -Other fossil fuels	CO_2	0.0	46.2	2%	2%	3%	0.000	0.001	0.001	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction -Other fossil fuels	CH_4	0.0	0.4	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction -Other fossil fuels	N_2O	0.0	0.6	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	CO_2	17.5	0.0	2%	5%	5%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	CH_4	0.0	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2023*	*Activity data uncertainty*	*Emission factor uncertainty*	*Combined uncertainty*	*Combined uncertainty as % of total national*	*Type A sensitivity*	*Type B sensitivity*	*Uncertainty in trend in national emissions introduced by emission factor*	*Uncertainty in trend in national emissions introduced by*	*Uncertainty introduced into the trend in total national emissions*
		kt CO_2 eq.	***kt CO_2 eq.***	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	N_2O	0.0	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CO_2	0.0	0.0	5%	15%	16%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH_4	0.4	4.8	5%	150%	150%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N_2O	0.5	6.0	5%	150%	150%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	CO_2	8.2	2.1	10%	2%	10%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	CH_4	0.0	0.0	10%	79%	79%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	N_2O	0.1	0.0	10%	110%	110%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.b Road Transportation	CO_2	5,247.2	5,933.8	2%	2%	3%	0.000	0.102	0.138	0.002	0.004	0.000
1.A.3.b Road Transportation	CH_4	44.2	8.1	2%	40%	40%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.b Road Transportation	N_2O	44.3	49.4	2%	40%	40%	0.000	0.001	0.001	0.000	0.000	0.000
1.A.3.c Railways	CO_2	350.0	85.7	5%	2%	5%	0.000	0.000	0.002	0.000	0.000	0.000
1.A.3.c Railways	CH_4	0.6	0.1	5%	75%	75%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.c Railways	N_2O	36.4	8.9	5%	75%	75%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.d Domestic Navigation - Liquid Fuels	CO_2	15.5	7.8	5%	3%	6%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.d Domestic Navigation - Liquid Fuels	CH_4	0.0	0.0	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.d Domestic Navigation - Liquid Fuels	N_2O	0.1	0.1	5%	90%	90%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.e.i Other Transportation	CO_2	64.3	48.8	5%	2%	5%	0.000	0.001	0.001	0.000	0.000	0.000

IPCC Source category	Gas	Base year (1990) emissions	Emissions in 2023	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor	Uncertainty in trend in national emissions introduced by	Uncertainty introduced into the trend in total national emissions
		kt CO_2 eq.	kt CO_2 eq.	%	%	%	%	%	%	%	%	%
1.A.3.e.i Other Transportation	CH_4	0.0	0.0	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.e.i Other Transportation	N_2O	0.0	1.8	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	CO_2	2,736.4	413.9	3%	2%	4%	0.000	0.009	0.010	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	CH_4	7.9	1.1	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	N_2O	141.7	11.0	3%	50%	50%	0.000	0.001	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	CO_2	2,760.5	104.9	3%	5%	6%	0.000	0.016	0.002	0.001	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	CH_4	144.0	5.1	3%	50%	50%	0.000	0.001	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	N_2O	11.6	0.4	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Gaseous Fuels	CO_2	1,379.3	683.6	3%	2%	4%	0.000	0.007	0.016	0.000	0.001	0.000
1.A.4 Other Sectors - Gaseous Fuels	CH_4	3.5	1.7	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Gaseous Fuels	N_2O	0.7	0.3	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	CO_2	27.1	58.2	3%	5%	6%	0.000	0.001	0.001	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	CH_4	1.3	2.8	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	N_2O	0.1	0.2	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors- Biomass	CO_2	0.0	0.0	10%	15%	18%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors- Biomass	CH_4	78.7	82.3	10%	150%	150%	0.000	0.001	0.002	0.002	0.000	0.000
1.A.4 Other Sectors- Biomass	N_2O	11.5	19.9	10%	150%	150%	0.000	0.000	0.000	0.001	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CO_2	23.3	197.3	5%	50%	50%	0.000	0.004	0.005	0.002	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH_4	4.8	2.4	5%	75%	75%	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	N_2O	0.0	0.0	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CO_2	0.0	0.0	5%	10%	11%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	Gas	Base year (1990) emissions	Emissions in 2023	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor	Uncertainty in trend in national emissions introduced by	Uncertainty introduced into the trend in total national emissions
		kt CO_2 eq.	kt CO_2 eq.	%	%	%	%	%	%	%	%	%
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH_4	291.8	107.2	5%	10%	11%	0.000	0.001	0.002	0.000	0.000	0.000
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CO_2	0.6	0.5	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH_4	0.3	0.5	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	N_2O	0.0	0.0	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.1 Cement Production	CO_2	1,668.1	497.7	2%	5%	5%	0.000	0.000	0.012	0.000	0.000	0.000
2.A.2 Lime Production	CO_2	210.3	1.5	5%	5%	7%	0.000	0.001	0.000	0.000	0.000	0.000
2.A.3 Glass Production	CO_2	11.7	5.9	7%	5%	9%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.4.a Ceramics	CO_2	227.9	0.2	5%	5%	7%	0.000	0.002	0.000	0.000	0.000	0.000
2.A.4.b Other use of soda ash	CO_2	5.2	0.3	15%	5%	16%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.4.d Mineral wool production	CO_2	6.4	9.1	7%	5%	9%	0.000	0.000	0.000	0.000	0.000	0.000
2.B.1 Ammonia Production	CO_2	1,236.6	921.5	2%	2%	3%	0.000	0.013	0.021	0.000	0.001	0.000
2.B.2 Nitric Acid Production	N_2O	794.1	107.8	2%	10%	10%	0.000	0.003	0.002	0.000	0.000	0.000
2.B.8.a Methanol	CO_2	24.4	0.0	5%	30%	30%	0.000	0.000	0.000	0.000	0.000	0.000
2.B.8.a Methanol	CH_4	5.9	0.0	5%	30%	30%	0.000	0.000	0.000	0.000	0.000	0.000
2.C.1 Iron and Steel Production	CO_2	17.0	0.0	10%	10%	14%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.1 Lubricant use	CO_2	6.1	11.7	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.2 Parafin wax use	CO_2	0.9	3.2	5%	100%	100%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.3 Urea-based catalyst	CO_2	0.0	2.4	10%	2%	10%	0.000	0.000	0.000	0.000	0.000	0.000
2.E.1 Semiconductor	SF_6	0.0	7.6	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.E.3 Photovoltaics	NF_3	0.0	0.0	5%	20%	21%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.a Commercial Refrigeration	HFCs	0.0	141.1	20%	50%	54%	0.000	0.003	0.003	0.002	0.001	0.000
2.F.1.b Domestic Refrigeration	HFCs	0.0	2.0	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	Gas	Base year (1990) emissions	Emissions in 2023	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor	Uncertainty in trend in national emissions introduced by	Uncertainty introduced into the trend in total national emissions
		kt CO_2 eq.	kt CO_2 eq.	%	%	%	%	%	%	%	%	%
2.F.1.c. Industrial Refrigeration	HFCs	0.0	35.5	20%	50%	54%	0.000	0.001	0.001	0.000	0.000	0.000
2.F.1.d. Transport Refrigeration	HFCs	0.0	78.9	20%	50%	54%	0.000	0.002	0.002	0.001	0.001	0.000
2.F.1.e. Mobile air-conditioning	HFCs	0.0	160.3	20%	50%	54%	0.000	0.004	0.004	0.002	0.001	0.000
2.F.1.f. Stationary Air Conditioning	HFCs	0.0	30.7	20%	50%	54%	0.000	0.001	0.001	0.000	0.000	0.000
2.F.2 Foam Blowing Agents	HFCs	0.0	14.9	30%	30%	42%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.3 Fire Protection	HFCs	0.0	4.4	20%	20%	28%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.4 Aerosols/metered dose inhalers	HFCs	0.0	8.7	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.1 Manufacture of electrical equipments	SF_6	0.0	0.6	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.2.b Accelerators	SF_6	0.0	0.1	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.3.a Medical applications	N_2O	83.0	1.6	5%	5%	7%	0.000	0.001	0.000	0.000	0.000	0.000
2.G.3.b Propellant for pressure and aerosol products	N_2O	2.4	1.9	20%	100%	102%	0.000	0.000	0.000	0.000	0.000	0.000
3.A Enteric Fermentation	CH_4	4,879.6	1,742.7	4%	26%	26%	0.001	0.007	0.040	0.002	0.002	0.000
3.B Manure Management	CH_4	750.4	250.1	14%	12%	19%	0.000	0.001	0.006	0.000	0.001	0.000
3.B Manure Management	N_2O	522.3	157.3	29%	232%	234%	0.001	0.000	0.004	0.000	0.002	0.000
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	2,078.7	1,288.5	7%	83%	84%	0.007	0.016	0.030	0.013	0.003	0.000
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	389.3	204.9	40%	137%	142%	0.001	0.002	0.005	0.003	0.003	0.000
3.G Liming	CO_2	20.6	41.8	10%	50%	51%	0.000	0.001	0.001	0.000	0.000	0.000
3.H Urea Application	CO_2	59.6	22.1	10%	50%	51%	0.000	0.000	0.001	0.000	0.000	0.000
4.A.1 Forest Land Remaining Forest Land	CO_2	-6,003.5	-4,550.6	3%	46%	46%	0.028	0.065	0.105	0.030	0.005	0.001
4.A.1 Forest Land Remaining Forest Land	CH_4	0.5	0.1	32%	40%	51%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	Gas	Base year (1990) emissions	Emissions in 2023	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor	Uncertainty in trend in national emissions introduced by	Uncertainty introduced into the trend in total national emissions
		kt CO_2 eq.	kt CO_2 eq.	%	%	%	%	%	%	%	%	%
4.A.1 Forest Land Remaining Forest Land	N_2O	297.5	336.6	32%	27%	42%	0.000	0.006	0.008	0.002	0.004	0.000
4.A.2 Land Converted to Forest Land	CO_2	-702.6	-1,127.4	15%	46%	48%	0.002	0.021	0.026	0.010	0.005	0.000
4.A.2 Land Converted to Forest Land	CH_4	0.0	0.0	32%	40%	51%	0.000	0.000	0.000	0.000	0.000	0.000
4.A.2 Land Converted to Forest Land	N_2O	24.6	28.5	32%	27%	42%	0.000	0.000	0.001	0.000	0.000	0.000
4.B Cropland	CO_2	1,635.5	31.7	5%	31%	31%	0.000	0.010	0.001	0.003	0.000	0.000
4.B Cropland	CH_4	0.5	0.6	6%	85%	85%	0.000	0.000	0.000	0.000	0.000	0.000
4.B Cropland	N_2O	68.2	46.1	15%	151%	151%	0.000	0.001	0.001	0.001	0.000	0.000
4.C Grassland	CO_2	79.7	37.8	7%	42%	42%	0.000	0.000	0.001	0.000	0.000	0.000
4.C Grassland	CH_4	4.8	2.0	6%	85%	85%	0.000	0.000	0.000	0.000	0.000	0.000
4.C Grassland	N_2O	2.4	0.3	6%	76%	76%	0.000	0.000	0.000	0.000	0.000	0.000
4.D Wetlands	CO_2	485.9	687.6	6%	205%	205%	0.013	0.013	0.016	0.026	0.001	0.001
4.D Wetlands	N_2O	5.4	4.0	15%	151%	151%	0.000	0.000	0.000	0.000	0.000	0.000
4.E Settlements	CO_2	5.9	811.6	10%	15%	18%	0.000	0.019	0.019	0.003	0.003	0.000
4.E Settlements	N_2O	0.4	52.5	18%	151%	152%	0.000	0.001	0.001	0.002	0.000	0.000
4.F Other Land	CO_2	0.0	47.4	17%	15%	23%	0.000	0.001	0.001	0.000	0.000	0.000
4.F Other Land	N_2O	0.0	4.4	23%	151%	152%	0.000	0.000	0.000	0.000	0.000	0.000
4.G Harvested Wood Products	CO_2	-240.1	-1,668.0	15%	59%	61%	0.007	0.037	0.039	0.022	0.008	0.001
5.A Solid Waste Disposal	CH_4	1,152.3	563.2	10%	125%	125%	0.003	0.005	0.013	0.007	0.002	0.000
5.B Biological Treatment of Solid Waste	CH_4	0.2	90.5	10%	100%	100%	0.000	0.002	0.002	0.002	0.000	0.000
5.B Biological Treatment of Solid Waste	N_2O	0.1	26.6	10%	100%	100%	0.000	0.001	0.001	0.001	0.000	0.000

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2023*	*Activity data uncertainty*	*Emission factor uncertainty*	*Combined uncertainty*	*Combined uncertainty as % of total national*	*Type A sensitivity*	*Type B sensitivity*	*Uncertainty in trend in national emissions introduced by emission factor*	*Uncertainty in trend in national emissions introduced by*	*Uncertainty introduced into the trend in total national emissions*
		kt **CO_2** ***eq.***	***kt*** **CO_2** ***eq.***	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
5.C Incineration and Open Burning of Waste	CO_2	2.7	2.1	10%	33%	34%	0.000	0.000	0.000	0.000	0.000	0.000
5.C Incineration and Open Burning of Waste	CH_4	0.0	0.0	10%	60%	61%	0.000	0.000	0.000	0.000	0.000	0.000
5.C Incineration and Open Burning of Waste	N_2O	0.1	0.1	10%	60%	61%	0.000	0.000	0.000	0.000	0.000	0.000
5.D Wastewater Treatment and Discharge	CH_4	162.0	22.4	54%	73%	91%	0.000	0.001	0.001	0.000	0.000	0.000
5.D Wastewater Treatment and Discharge	N_2O	23.1	6.8	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000
Indirect emissions (2. Industrial processes and product use)	Indirect CO_2	34.3	38.6	30%	20%	36%	0.000	0.001	0.001	0.000	0.000	0.000
Total emission		**43,185.2**	**12,587.5**	**Overall uncertainty (%)**			**25.1**	**Trend uncertainty (%)**				**5.1**

Table 1b. Uncertainty evaluation excluding LULUCF

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2023*	*Activity data uncertainty*	*Emission factor uncertainty*	*Combined uncertainty*	*Combined uncertainty as % of total national emissions in 2019*	*Type A sensitivity*	*Type B sensitivity*	*Uncertainty in trend in national emissions introduced by emission factor*	*Uncertainty in trend in national emissions introduced by*	*Uncertainty introduced into the trend in total national emissions*
		kt CO_2 eq.	***kt CO_2 eq.***	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	7,540.2	1,611.3	2%	2%	3%	0.000	0.026	0.034	0.001	0.001	0.000
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH_4	7.7	1.1	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N_2O	14.3	1.7	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	174.0	3.4	2%	5%	5%	0.000	0.001	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH_4	0.1	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N_2O	0.7	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	5,796.6	480.1	2%	2%	3%	0.000	0.036	0.010	0.001	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH_4	2.9	0.2	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N_2O	2.8	0.2	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CO_2	0.0	234.0	2%	5%	5%	0.000	0.005	0.005	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CH_4	0.0	2.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	N_2O	0.0	2.6	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2023*	*Activity data uncertainty*	*Emission factor uncertainty*	*Combined uncertainty*	*Combined uncertainty as % of total national emissions in 2019*	*Type A sensitivity*	*Type B sensitivity*	*Uncertainty in trend in national emissions introduced by emission factor*	*Uncertainty in trend in national emissions introduced by*	*Uncertainty introduced into the trend in total national emissions*
		kt CO_2 eq.	*kt CO_2 eq.*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
1.A.1 Fuel combustion - Energy Industries - Peat	CO_2	11.1	8.2	2%	5%	5%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Peat	CH_4	0.0	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Peat	N_2O	0.0	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Biomass	CO_2	0.0	0.0	5%	15%	16%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Biomass	CH_4	0.4	27.5	5%	150%	150%	0.000	0.001	0.001	0.001	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Biomass	N_2O	0.6	34.7	5%	150%	150%	0.000	0.001	0.001	0.001	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	3,873.7	150.6	2%	2%	3%	0.000	0.027	0.003	0.001	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH_4	5.0	0.2	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N_2O	42.5	4.6	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	171.6	290.5	2%	5%	5%	0.000	0.005	0.006	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH_4	0.5	0.8	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N_2O	0.7	1.2	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2023*	*Activity data uncertainty*	*Emission factor uncertainty*	*Combined uncertainty*	*Combined uncertainty as % of total national emissions in 2019*	*Type A sensitivity*	*Type B sensitivity*	*Uncertainty in trend in national emissions introduced by emission factor*	*Uncertainty in trend in national emissions introduced by activity data*	*Uncertainty introduced into the trend in total national emissions*
		kt CO_2 eq.	*kt CO_2 eq.*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	2,042.9	580.7	2%	2%	3%	0.000	0.004	0.012	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH_4	1.0	0.3	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N_2O	1.0	0.3	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction -Other fossil fuels	CO_2	0.0	46.2	2%	2%	3%	0.000	0.001	0.001	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction -Other fossil fuels	CH_4	0.0	0.4	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction -Other fossil fuels	N_2O	0.0	0.6	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	CO_2	17.5	0.0	2%	5%	5%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	CH_4	0.0	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	N_2O	0.0	0.0	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CO_2	0.0	0.0	5%	15%	16%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	Gas	Base year (1990) emissions	Emissions in 2023	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor	Uncertainty in trend in national emissions introduced by	Uncertainty introduced into the trend in total
		kt CO_2 eq.	kt CO_2 eq.	%	%	%	%	%	%	%	%	%
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH_4	0.4	4.8	5%	150%	150%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N_2O	0.5	6.0	5%	150%	150%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	CO_2	8.2	2.1	10%	2%	10%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	CH_4	0.0	0.0	10%	79%	79%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	N_2O	0.1	0.0	10%	110%	110%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.b Road Transportation	CO_2	5,247.2	5,933.8	2%	2%	3%	0.000	0.083	0.125	0.002	0.004	0.000
1.A.3.b Road Transportation	CH_4	44.2	8.1	2%	40%	40%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.b Road Transportation	N_2O	44.3	49.4	2%	40%	40%	0.000	0.001	0.001	0.000	0.000	0.000
1.A.3.c Railways	CO_2	350.0	85.7	5%	2%	5%	0.000	0.001	0.002	0.000	0.000	0.000
1.A.3.c Railways	CH_4	0.6	0.1	5%	75%	75%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.c Railways	N_2O	36.4	8.9	5%	75%	75%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.d Domestic Navigation - Liquid Fuels	CO_2	15.5	7.8	5%	3%	6%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.d Domestic Navigation - Liquid Fuels	CH_4	0.0	0.0	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.d Domestic Navigation - Liquid Fuels	N_2O	0.1	0.1	5%	90%	90%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.e.i Other Transportation - Pipeline Transportation	CO_2	64.3	48.8	5%	2%	5%	0.000	0.001	0.001	0.000	0.000	0.000
1.A.3.e.i Other Transportation - Pipeline Transportation	CH_4	0.0	0.0	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.e.i Other Transportation - Pipeline Transportation	N_2O	0.0	1.8	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	CO_2	2,736.4	413.9	3%	2%	4%	0.000	0.013	0.009	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	CH_4	7.9	1.1	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	N_2O	141.7	11.0	3%	50%	50%	0.000	0.001	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	CO_2	2,760.5	104.9	3%	5%	6%	0.000	0.020	0.002	0.001	0.000	0.000

IPCC Source category	Gas	Base year (1990) emissions	Emissions in 2023	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor	Uncertainty in trend in national emissions introduced by	Uncertainty introduced into the trend in total national
		kt CO_2 eq.	kt CO_2 eq.	%	%	%	%	%	%	%	%	%
1.A.4 Other Sectors - Solid Fuels	CH_4	144.0	5.1	3%	50%	50%	0.000	0.001	0.000	0.001	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	N_2O	11.6	0.4	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Gaseous Fuels	CO_2	1,379.3	683.6	3%	2%	4%	0.000	0.003	0.014	0.000	0.001	0.000
1.A.4 Other Sectors - Gaseous Fuels	CH_4	3.5	1.7	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Gaseous Fuels	N_2O	0.7	0.3	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	CO_2	27.1	58.2	3%	5%	6%	0.000	0.001	0.001	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	CH_4	1.3	2.8	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	N_2O	0.1	0.2	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors- Biomass	CO_2	0.0	0.0	10%	15%	18%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors- Biomass	CH_4	78.7	82.3	10%	150%	150%	0.000	0.001	0.002	0.002	0.000	0.000
1.A.4 Other Sectors- Biomass	N_2O	11.5	19.9	10%	150%	150%	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CO_2	23.3	197.3	5%	50%	50%	0.000	0.004	0.004	0.002	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH_4	4.8	2.4	5%	75%	75%	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	N_2O	0.0	0.0	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CO_2	0.0	0.0	5%	10%	11%	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH_4	291.8	107.2	5%	10%	11%	0.000	0.000	0.002	0.000	0.000	0.000
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CO_2	0.6	0.5	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH_4	0.3	0.5	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2023*	*Activity data uncertainty*	*Emission factor uncertainty*	*Combined uncertainty*	*Combined uncertainty as % of total national emissions in 2019*	*Type A sensitivity*	*Type B sensitivity*	*Uncertainty in trend in national emissions introduced by emission factor*	*Uncertainty in trend in national emissions introduced by*	*Uncertainty introduced into the trend in total national emissions*
		kt CO_2 eq.	***kt CO_2 eq.***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	N_2O	0.0	0.0	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.1 Cement Production	CO_2	1,668.1	497.7	2%	5%	5%	0.000	0.003	0.010	0.000	0.000	0.000
2.A.2 Lime Production	CO_2	210.3	1.5	5%	5%	7%	0.000	0.002	0.000	0.000	0.000	0.000
2.A.3 Glass Production	CO_2	11.7	5.9	7%	5%	9%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.4.a Ceramics	CO_2	227.9	0.2	5%	5%	7%	0.000	0.002	0.000	0.000	0.000	0.000
2.A.4.b Other use of soda ash	CO_2	5.2	0.3	15%	5%	16%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.4.d Mineral wool production	CO_2	6.4	9.1	7%	5%	9%	0.000	0.000	0.000	0.000	0.000	0.000
2.B.1 Ammonia Production	CO_2	1,236.6	921.5	2%	2%	3%	0.000	0.010	0.019	0.000	0.001	0.000
2.B.2 Nitric Acid Production	N_2O	794.1	107.8	2%	10%	10%	0.000	0.004	0.002	0.000	0.000	0.000
2.B.8.a Methanol	CO_2	24.4	0.0	5%	30%	30%	0.000	0.000	0.000	0.000	0.000	0.000
2.B.8.a Methanol	CH_4	5.9	0.0	5%	30%	30%	0.000	0.000	0.000	0.000	0.000	0.000
2.C.1 Iron and Steel Production	CO_2	17.0	0.0	10%	10%	14%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.1 Lubricant use	CO_2	6.1	11.7	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.2 Parafin wax use	CO_2	0.9	3.2	5%	100%	100%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.3 Urea-based catalyst	CO_2	0.0	2.4	10%	2%	10%	0.000	0.000	0.000	0.000	0.000	0.000
2.E.1 Semiconductor	SF6	0.0	7.6	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.E.3 Photovoltaics	NF3	0.0	0.0	5%	20%	21%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.a Commercial Refrigeration	HFCs	0.0	141.1	20%	50%	54%	0.000	0.003	0.003	0.001	0.001	0.000
2.F.1.b Domestic Refrigeration	HFCs	0.0	2.0	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.c. Industrial Refrigeration	HFCs	0.0	35.5	20%	50%	54%	0.000	0.001	0.001	0.000	0.000	0.000
2.F.1.d. Transport Refrigeration	HFCs	0.0	78.9	20%	50%	54%	0.000	0.002	0.002	0.001	0.000	0.000
2.F.1.e. Mobile air-conditioning	HFCs	0.0	160.3	20%	50%	54%	0.000	0.003	0.003	0.002	0.001	0.000
2.F.1.f. Stationary Air Conditioning	HFCs	0.0	30.7	20%	50%	54%	0.000	0.001	0.001	0.000	0.000	0.000
2.F.2 Foam Blowing Agents	HFCs	0.0	14.9	30%	30%	42%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.3 Fire Protection	HFCs	0.0	4.4	20%	20%	28%	0.000	0.000	0.000	0.000	0.000	0.000

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2023*	*Activity data uncertainty*	*Emission factor uncertainty*	*Combined uncertainty*	*Combined uncertainty as % of total national emissions in 2019*	*Type A sensitivity*	*Type B sensitivity*	*Uncertainty in trend in national emissions introduced by emission factor*	*Uncertainty in trend in national emissions introduced by*	*Uncertainty introduced into the trend in total national emissions*
		kt CO_2 eq.	***kt CO_2 eq.***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***	***%***
2.F.4 Aerosols/metered dose inhalers	HFCs	0.0	8.7	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.1 Manufacture of electrical equipments	SF6	0.0	0.6	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.2.b Accelerators	SF6	0.0	0.1	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.3.a Medical applications	N_2O	83.0	1.6	5%	5%	7%	0.000	0.001	0.000	0.000	0.000	0.000
2.G.3.b Propellant for pressure and aerosol products	N_2O	2.4	1.9	20%	100%	102%	0.000	0.000	0.000	0.000	0.000	0.000
3.A Enteric Fermentation	CH_4	4,879.6	1,742.7	4%	26%	26%	0.001	0.002	0.037	0.000	0.002	0.000
3.B Manure Management	CH_4	750.4	250.1	14%	12%	19%	0.000	0.001	0.005	0.000	0.001	0.000
3.B Manure Management	N_2O	522.3	157.3	29%	232%	234%	0.000	0.001	0.003	0.002	0.001	0.000
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	2,078.7	1,288.5	7%	83%	84%	0.004	0.011	0.027	0.009	0.003	0.000
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	389.3	204.9	40%	137%	142%	0.000	0.001	0.004	0.002	0.002	0.000
3.G Liming	CO_2	20.6	41.8	10%	50%	51%	0.000	0.001	0.001	0.000	0.000	0.000
3.H Urea Application	CO_2	59.6	22.1	10%	50%	51%	0.000	0.000	0.000	0.000	0.000	0.000
5.A Solid Waste Disposal	CH_4	1,152.3	563.2	10%	125%	125%	0.002	0.003	0.012	0.003	0.002	0.000
5.B Biological Treatment of Solid Waste	CH_4	0.2	90.5	10%	100%	100%	0.000	0.002	0.002	0.002	0.000	0.000
5.B Biological Treatment of Solid Waste	N_2O	0.1	26.6	10%	100%	100%	0.000	0.001	0.001	0.001	0.000	0.000
5.C Incineration and Open Burning of Waste	CO_2	2.7	2.1	10%	33%	34%	0.000	0.000	0.000	0.000	0.000	0.000
5.C Incineration and Open Burning of Waste	CH_4	0.0	0.0	10%	60%	61%	0.000	0.000	0.000	0.000	0.000	0.000
5.C Incineration and Open Burning of Waste	N_2O	0.1	0.1	10%	60%	61%	0.000	0.000	0.000	0.000	0.000	0.000
5.D Wastewater Treatment and Discharge	CH_4	162.0	22.4	54%	73%	91%	0.000	0.001	0.000	0.001	0.000	0.000

IPCC Source category	Gas	Base year (1990) emissions	Emissions in 2023	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor	Uncertainty in trend in national emissions introduced by	Uncertainty introduced into the trend in total national emissions
		kt CO_2 eq.	kt CO_2 eq.	%	%	%	%	%	%	%	%	%
5.D Wastewater Treatment and Discharge	N_2O	23.1	6.8	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000
Indirect emissions (2. Industrial processes and product use)	Indirect CO_2	34.3	38.6	30%	20%	36%	0.000	0.001	0.001	0.000	0.000	0.000
Total emission		**47,519.9**	**17,842.2**	**Overall uncertainty (%)**			**8.3**	**Trend uncertainty (%)**				**1.3**

ANNEX III. Lithuanian energy balance

Table 3-1. Balance of crude oil, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		502	5358	13491	9217	4909	3065	1313	1165	967	484
Liquid biofuels for blending											
Import		396707	131189	199709	380035	385276	356108	331780	338910	347889	383804
Export			335	13254	6312	4736	2067	1556	1131	965	1387
International marine bunkers											
Changes in stocks		2093	-4730	-1169	9169	-1081	-1194	567	-2332	1533	5464
Gross consumption		**399302**	**131482**	**198777**	**392109**	**384368**	**355912**	**332104**	**336612**	**349424**	**388365**
Statistical difference			-42								
Transformed in power, heat and other plants:		399302	131440	198777	392101	384357	355912	332104	336612	349424	388365
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants	1.A.1.a iii	84	167	99							
- in geothermal plants											
- in other industries		399218	131273	198678	392101	384357	355912	332104	336612	349424	388365
Consumed in energy sector:					3						
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries	1.A.1.b				3						
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses*					5	11					
Final consumption:											
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-2. Balance of motor gasoline, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		87988	37709	68838	112699	123626	107664	95230	106842	107706	127730
Liquid biofuels for blending					26	445	600	931	844	797	764
Import		220	14328	736	1115	2616	2881	2125	4375	1811	2106
Export		42104	23601	50765	95698	114237	101063	87753	101157	97886	115504
International marine bunkers											
Changes in stocks		-2725	-1758	-2012	-3193	506	-1256	96	-226	-572	-1975
Gross consumption		**43379**	**26678**	**16797**	**14949**	**12956**	**8826**	**10629**	**10678**	**11856**	**13121**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:				15	5		2	1			
- in peat extraction enterprises	1.A.1.c.i				1		1	1			
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.iii			15	4		1				
Non energy use											
Distribution and transmission losses*		308	176	68	61	22	5	4	2	4	3
Final consumption:		**43071**	**26502**	**16714**	**14883**	**12934**	**8819**	**10624**	**10676**	**11852**	**13118**
- in industry	1.A.2.g.vii	44	88	48	31	15	8	13	8	14	14
- in construction	1.A.2.g.vii	439	176	101	69	28	16	14	17	16	15
- in transport*****	1.A.3	41840	25887	16337	14711	12841	8761	10581	10629	11805	13064
- in agriculture	1.A.4.c.ii	440	307	170	53	43	28	12	18	14	22
- in fishing											
- in commercial / public services	1.A.4.a.ii	308	44	58	19	7	6	4	4	3	3
- in households											

Table 3-3. Balance of aviation gasoline, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import				14	20	18	19	18	18	17	22
Export											
International marine bunkers											
Changes in stocks											
Gross consumption				**14**	**20**	**18**	**19**	**18**	**18**	**17**	**22**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:				**14**	**20**	**18**	**19**	**18**	**18**	**17**	**22**
- in industry											
- in construction											
- in transport	1.A.3			14	20	18	19	18	18	17	22
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-4. Balance of gasoline type jet fuel, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import				65	3						
Export											
International marine bunkers											
Changes in stocks				-65							
Gross consumption					**3**						
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:					**3**						
- in industry											
- in construction											
- in transport	1.A.3				3						
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-5. Balance of kerosene type jet fuel, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		28125	9088	18566	24705	10352	7780	6732	9304	7689	9568
Liquid biofuels for blending											
Import		387	948	846		837	2244		5	141	
Export		22956	8442	16673	21406	9062	6113	4455	5959	3310	4515
International marine bunkers											
Changes in stocks		86	129	-1651	-1185	115	10	386	-371	152	-21
Gross consumption		**5642**	**1723**	**1088**	**2114**	**2242**	**3921**	**2663**	**2979**	**4672**	**5032**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses*					14	5					
Final consumption:		**5642**	**1723**	**1088**	**2100**	**2237**	**3921**	**2663**	**2979**	**4672**	**5032**
- in industry											
- in construction											
- in transport	1.A.3	5642	1723	1088	2100	2237	3921	2663	2979	4672	5032
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-6. Balance of transport diesel, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		107712	42490	56232	127985	150168	156249	135526	126772	137435	153053
Liquid biofuels for blending					119	1478	2393	3777	4122	3626	3430
Import		8923	9475	1670	2840	7882	68750	23206	26570	30109	19262
Export		49416	27364	28516	92877	116251	169375	85924	83679	99680	103851
International marine bunkers				942							
Changes in stocks		-1997	1573	-4819	-2586	31	-768	-3894	-243	141	-24
Gross consumption		**65222**	**26174**	**23625**	**35481**	**43308**	**57249**	**72691**	**73542**	**71631**	**71327**
Statistical difference			213	853							
Transformed in power, heat and other plants:		7521	1742	36							
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii	7521	1615	28							
- in autoproducer heat plants	1.A.1.a iii		127	8							
- in geothermal plants											
- in other industries											
Consumed in energy sector:		128	43	136	194	144	174	177	140	95	107
- in peat extraction enterprises	1.A.1.c.i	128	43	60	125	109	153	172	136	91	103
- in crude oil extraction enterprises	1.A.1.c.ii			22	49	23	13				
- in refineries	1.A.1.b			5			2				
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.ii			49	20	12	6	5	4	4	4
Non energy use	1.AD			6							
Distribution and transmission losses*		297	128	55	122	73	22	13	9	12	10
Final consumption:		**57276**	**24474**	**24245**	**35165**	**43091**	**57053**	**72501**	**73393**	**71524**	**71753**
- in industry	1.A.2.g.vii	2124	1827	510	499	190	248	309	305	323	369
- in construction	1.A.2.g.vii	2507	935	613	589	382	320	266	217	212	224
- in transport*****	1.A.3	34289	14489	21476	32515	41030	55021	70436	71274	69452	69751
- in agriculture	1.A.4.c.ii	14277	4207	1327	1362	1444	1438	1437	1530	1485	1350
- in fishing	1.A.4.c.iii				14	5	6	7	8	6	5
- in commercial / public services	1.A.4.a.ii	2889	2804	319	186	40	20	46	59	46	54
- in households	1.A.4.b.ii	1190	212								

Table 3-7. Balance of heating and other gasoil, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production					2125	1130	4777	6740	8357	8141	6545
Liquid biofuels for blending						2	73	99	179	78	72
Import			717		915	854	701	848	1214	731	261
Export					985		206	35	523	703	790
International marine bunkers					770	756	1738	3206	4480	3200	1935
Changes in stocks			-717	65	-225	-7	-61	92	51	-240	76
Gross consumption				**65**	**1060**	**1223**	**3546**	**4538**	**4798**	**4807**	**4229**
Statistical difference											
Transformed in power, heat and other plants:				22	102	55	38	26	107	344	274
- in public CHP plants	1.A.1.a ii					1				15	
- in autoproducer CHP plants								2		16	
- in public heat plants	1.A.1.a iii			22	64	52	37	24	107	275	264
- in autoproducer heat plants	1.A.1.a iii				38	2	1			38	10
- in geothermal plants											
- in other industries											
Consumed in energy sector:						5	4				
- in peat extraction enterprises	1.A.1.c.i					5	4				
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.ii										
Non energy use											
Distribution and transmission losses											
Final consumption:				**43**	**958**	**1163**	**3504**	**4512**	**4691**	**4463**	**3955**
- in industry	1.A.2			7	405	220	228	328	378	483	433
- in construction	1.A.2.g.v			7	25	47	67	64	75	216	149
- in transport*****	1.A.3				226	235	2413	2475	2438	1352	1350
- in agriculture	1.A.4.c.i			23	137	230	264	672	671	1085	739
- in fishing	1.A.4.c.i				59	73	76	21	26	23	18
- in commercial / public services	1.A.4.a			6	55	69	48	29	33	35	37
- in households	1.A.4.b				51	289	408	923	1070	1269	1229

Table 3-8. Balance of liquefied petroleum gases (LPG), TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		12006	7636	11026	21046	12720	12155	13767	13422	10617	12877
Liquid biofuels for blending											
Import		2208	1056	3972	3110	5024	4882	2387	2553	5979	6557
Export		7038	4646	5793	11596	8114	9662	10111	10268	9915	12587
International marine bunkers											
Changes in stocks		46	230	-420	163	-111	31	-8	31	-585	568
Gross consumption		**7222**	**4276**	**8785**	**12723**	**9519**	**7406**	**6035**	**5738**	**6096**	**7415**
Statistical difference											
Transformed in power, heat and other plants:		46		51	90	90	81	83	100	92	108
- in public CHP plants	1.A.1.a ii					3					
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii			21	19	18	36	43	45	78	91
- in autoproducer heat plants	1.A.1.a iii	46		31	71	69	45	40	55	14	17
- in geothermal plants											
- in other industries											
Consumed in energy sector:		552	138	36	4						
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries	1.A.1.b	552	138	22							
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.ii			14	4						
Non energy use											
Distribution and transmission losses*		322	92	103	47	26	14	24	21	30	19
Final consumption:		**6302**	**4046**	**8595**	**12580**	**9403**	**7311**	**5928**	**5617**	**5974**	**7288**
- in industry	1.A.2			201	229	273	326	281	335	529	841
- in construction	1.A.2.g.v	92	46	74	77	122	38	72	58	62	80
- in transport	1.A.3	920	1058	5032	9593	7275	5573	4058	3867	3872	3944
- in agriculture	1.A.4.c.i	230	46	19	38	41	54	150	202	196	194
- in fishing											
- in commercial / public services	1.A.4.a	460	92	62	23	6	20	30	35	18	36
- in households	1.A.4.b	4600	2804	3207	2620	1686	1300	1337	1120	1297	2193

Table 3-9. Balance of residual fuel oil (RFO) – high sulphur (>1%), TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		133867	33356	39422	71994	65373	60871	44554	45303	43460	36393
Liquid biofuels for blending											
Import		293464	47887	4110	5056	7883	1377	2707	2795	3272	3190
Export		277769	8148	16608	56627	60139	57774	41314	42681	41872	34684
International marine bunkers		3894	5780	2857	4712	2801	1255	2700	2697	2779	2673
Changes in stocks		-8951	-11159	-4689	-1824	-3450	926	-1074	-1446	882	-439
Gross consumption		**136717**	**56156**	**19378**	**13887**	**6866**	**4145**	**2173**	**1274**	**2963**	**1787**
Statistical difference			40	5592							
Transformed in power, heat and other plants:		70406	39377	14650	5536	4648	1634	516	1249	1100	428
- in public CHP plants	1.A.1.a ii	44195	20511	7233	3837	4157	493				
- in autoproducer CHP plants	1.A.1.a ii	642	201	27			1115	495	185	1100	410
- in public heat plants	1.A.1.a iii	20190	16618	6813	1659	491	26	21	18		18
- in autoproducer heat plants	1.A.1.a iii	5379	2047	577	40						
- in geothermal plants											
- in other industries											
Consumed in energy sector:		8068	3693	4899	6716	2005	2444	1630	1046	1847	1352
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries	1.A.1.b	8068	3693	4899	6716	2005	2444	1628	1046	1847	1352
- in electricity, gas, steam and air conditioning enterprises								2			
Non energy use											
Distribution and transmission losses*		361			38						
Final consumption:		**57882**	**13126**	**5421**	**1597**	**213**	**67**	**27**	**25**	**16**	**7**
- in industry	1.A.2	43993	11520	5202	1486	148	67	27	25	16	7
- in construction	1.A.2.g.v	1044	201	11	17						
- in transport	1.A.3			3	4						
- in agriculture	1.A.4.c.i	1084	201	114	80	41					
- in fishing											
- in commercial / public services	1.A.4.a	11641	1204	91	10	24					
- in households	1.A.4.b	120									

Table 3-10. Balance of residual fuel oil (RFO) – low sulphur (<1%), TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production						4306	267	217	255	249	79
Liquid biofuels for blending											
Import				1407	1191	2779	516	1728	715	1709	1783
Export					23	40	10	27	59	89	50
International marine bunkers				29	451	2224	203	1738	709	440	400
Changes in stocks				56	-60	-308	196	250	420	-202	283
Gross consumption				**1434**	**657**	**4513**	**766**	**430**	**622**	**1227**	**1695**
Statistical difference											
Transformed in power, heat and other plants:				755	328	1232	436	159	426	1213	1685
- in public CHP plants	1.A.1.a ii					18	348	136	212	989	1598
- in autoproducer CHP plants	1.A.1.a ii					1017					
- in public heat plants	1.A.1.a iii			713	318	197	87	23	214	224	87
- in autoproducer heat plants	1.A.1.a iii			42	10		1				
- in geothermal plants											
- in other industries											
Consumed in energy sector:						3042					
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries	1.A.1.b					3042					
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses									12		
Final consumption:				**679**	**329**	**239**	**330**	**271**	**184**	**14**	**10**
- in industry	1.A.2			363	220	147	275	253	174	14	10
- in construction	1.A.2.g.v			47	93	75	35	8	6		
- in transport											
- in agriculture	1.A.4.c.i			15	2	5	17	10	4		
- in fishing	1.A.4.c.i				9						
- in commercial / public services	1.A.4.a			254	5	12	3				
- in households											

Table 3-11. Balance of refinery gas, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		11032	5318	8253	15250	14127	14007	11148	12763	13979	17008
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks											
Gross consumption		**11032**	**5318**	**8253**	**15250**	**14127**	**14007**	**11148**	**12763**	**13979**	**17008**
Statistical difference											
Transformed in power, heat and other plants:						109	175	228	364	1041	869
- in public CHP plants											
- in autoproducer CHP plants	1.A.1.a ii						175	228	364	1041	869
- in public heat plants											
- in autoproducer heat plants	1.A.1.a iii					109					
- in geothermal plants											
- in other industries											
Consumed in energy sector:		11032	5318	8253	15250	14018	13832	10920	12399	12938	16139
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries	1.A.1.b	11032	5318	8253	15250	14018	13832	10920	12399	12938	16139
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:											
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-12. Balance of bitumen, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		9534	1108	3117	6804	4938	5449	14289	11618	11843	19034
Liquid biofuels for blending											
Import		40	791	474	1150	1814	1812	3658	2442	1888	1403
Export		1662	356	839	2587	2896	3506	11449	8236	10102	14567
International marine bunkers											
Changes in stocks		40	39	71	28	-165	-143	-112	-153	165	55
Gross consumption		**7952**	**1582**	**2823**	**5395**	**3691**	**3612**	**6386**	**5671**	**3794**	**5925**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use	1.AD	7952	1582	2823	5395	3691	3612	6386	5671	3794	5925
Distribution and transmission losses											
Final consumption:											
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-13. Balance of lubricants, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production				1226	847	1504	1931	3506	4246	4150	4176
Liquid biofuels for blending											
Import		413	620	602	1121	1709	1655	1489	1616	2177	1951
Export				924	843	2350	2781	4053	4884	5548	5162
International marine bunkers											
Changes in stocks				129	-14	-17	3	4	53	-88	-167
Gross consumption		**413**	**620**	**1033**	**1111**	**846**	**808**	**946**	**1031**	**691**	**798**
Statistical difference				-84							
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use	1.AD	413	620	949	1111	846	808	946	1031	691	798
Distribution and transmission losses											
Final consumption:											
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-14. Balance of petroleum coke, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		1962	1393	2740	3940	3856	3745	3340	3626	3423	3750
Liquid biofuels for blending											
Import					1100	9					
Export											
International marine bunkers											
Changes in stocks					-1054	102					
Gross consumption		**1962**	**1393**	**2740**	**3986**	**3967**	**3745**	**3340**	**3626**	**3423**	**3750**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:		1962	1393	2740	3940	3856	3745	3340	3626	3423	3750
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries	1.A.1.b	1962	1393	2740	3940	3856	3745	3340	3626	3423	3750
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:					**46**	**111**					
- in industry	1.A.2				46	111					
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-15. Balance of refinery feedstock, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production			8513	418	1827		640	1374			
Liquid biofuels for blending											
Import		1304	17209	13934	3568	12171	24815	7923	9439	9712	5724
Export							33			57	25
International marine bunkers											
Changes in stocks		-1220	-8470	213	-1121	614	-1420	-1592	762	-947	454
Gross consumption		**84**	**17252**	**14565**	**4274**	**12785**	**24002**	**7705**	**9340**	**9450**	**5806**
Statistical difference			-43								
Transformed in power, heat and other plants:		84	17209	14565	4274	12785	24002	7705	9340	9450	5806
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries		84	17209	14565	4274	12785	24002	7705	9340	9450	5806
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:											
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-16. Balance of naphtha, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production					3477				31	5110	644
Liquid biofuels for blending											
Import											
Export					3257				31	5099	655
International marine bunkers											
Changes in stocks					-220					-11	11
Gross consumption											
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:											
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-17. Balance of orimulsion, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import			729	1383	1681						
Export											
International marine bunkers											
Changes in stocks				-734	700						
Gross consumption			**729**	**649**	**2381**						
Statistical difference											
Transformed in power, heat and other plants:			729	649	2381						
- in public CHP plants	1.A.1.a ii		729	649	2381						
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:											
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-18. Balance of shale oil, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import					73	19					
Export						18					
International marine bunkers											
Changes in stocks					-7	31					
Gross consumption					**66**	**32**					
Statistical difference											
Transformed in power, heat and other plants:					9	10					
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii				9	1					
- in autoproducer heat plants	1.A.1.a iii					9					
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:					**57**	**22**					
- in industry	1.A.2				13						
- in construction											
- in transport											
- in agriculture	1.A.4.c.i				23	4					
- in fishing											
- in commercial / public services	1.A.4.a				21	18					
- in households											

Table 3-19. Balance of other bituminous coal, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import		31752	6506	176	53	4343	5701	4420	5653	7400	2902
Export			50			438					
International marine bunkers											
Changes in stocks		980	2889			-275	640	674	545	-1799	434
Gross consumption		**32732**	**9345**	**176**	**53**	**3630**	**6341**	**5094**	**6198**	**5601**	**3336**
Statistical difference											
Transformed in power, heat and other plants:		1834	452	25	53	55	88	56	61	54	36
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii	904	126	25	53	32	88	56	61	54	36
- in autoproducer heat plants	1.A.1.a iii	930	326			23					
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use	1.AD		25								
Distribution and transmission losses			25				10				
Final consumption:		**30898**	**8843**	**151**		**3575**	**6243**	**5038**	**6137**	**5547**	**3300**
- in industry	1.A.2	1583	703	137		2860	3602	3169	3859	4011	2608
- in construction	1.A.2.g.v	226	25	14			6	3	3	2	
- in transport											
- in agriculture	1.A.4.c.i	1557	50			3	86	48	35	72	15
- in fishing											
- in commercial / public services	1.A.4.a	12359	6632			406	1089	786	973	358	101
- in households	1.A.4.b	15173	1433			305	1460	1032	1267	1104	576

Table 3-20. Balance of anthracite, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import				100		90					
Export						1					
International marine bunkers											
Changes in stocks						-74					
Gross consumption				**100**		**15**					
Statistical difference											
Transformed in power, heat and other plants:				100							
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii			100							
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:						**15**					
- in industry	1.A.2					5					
- in construction	1.A.2.g.v					2					
- in transport											
- in agriculture	1.A.4.c.i					3					
- in fishing											
- in commercial / public services	1.A.4.a					4					
- in households	1.A.4.b					1					

Table 3-21. Balance of sub-bituminous coal, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import				2698	6618	3248				575	394
Export					37	406					
International marine bunkers											
Changes in stocks				11	-168	672	1	4		-47	13
Gross consumption				**2709**	**6413**	**3514**	**1**	**4**		**528**	**407**
Statistical difference											
Transformed in power, heat and other plants:				154	207	100	1				
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii			85	147	66	1				
- in autoproducer heat plants	1.A.1.a iii			69	60	34					
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use				7	3						
Distribution and transmission losses				11	6	8					
Final consumption:				**2537**	**6197**	**3406**		**4**		**528**	**407**
- in industry	1.A.2			5	3059	207					
- in construction	1.A.2.g.v				18	2					
- in transport											
- in agriculture	1.A.4.c.i			14	36	8					
- in fishing											
- in commercial / public services	1.A.4.a			1867	2036	1417		4		528	407
- in households	1.A.4.b			651	1048	1772					

Table 3-22. Balance of coke, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import				445	440	466	391	533	504	446	416
Export											
International marine bunkers											
Changes in stocks				-52	96	7	8	2	-1	12	-27
Gross consumption				**393**	**536**	**473**	**399**	**535**	**503**	**458**	**389**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use	A.AD			47	2						
Distribution and transmission losses											
Final consumption:				**346**	**534**	**473**	**399**	**535**	**503**	**458**	**389**
- in industry	1.A.2			346	534	473	399	535	503	458	389
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-23. Balance of lignite, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import				15	40	14				25	26
Export											
International marine bunkers											
Changes in stocks				1	2	-6	1				
Gross consumption				**16**	**42**	**8**	**1**			**25**	**26**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use										25	26
Distribution and transmission losses											
Final consumption:				**16**	**42**	**8**	**1**				
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a			16	25						
- in households	1.A.4.b				17	8	1				

Table 3-24. Balance of peat, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		580	600	494	825	364	872	207	197	141	204
Liquid biofuels for blending											
Import										5	
Export				76	1	104	94	12	21	14	8
International marine bunkers											
Changes in stocks		116	222	51	-235	94	-510	40	96	170	13
Gross consumption		**696**	**822**	**469**	**589**	**354**	**268**	**235**	**272**	**302**	**209**
Statistical difference											
Transformed in power, heat and other plants:		445	357	258	299	202	141	185	229	275	172
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii	67	96	80	128	102	67	139	179	118	76
- in autoproducer heat plants	1.A.1.a iii	39	10	14							
- in geothermal plants											
- in other industries		339	251	163	171	100	74	46	50	157	96
Consumed in energy sector:			126	36	11		3	1	3	1	2
- in peat extraction enterprises	1.A.c.i			20	11		3	1	3	1	2
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises	1.A.c.ii		126	15							
Non energy use											
Distribution and transmission losses**		9	10	5	7			2			
Final consumption:		**242**	**329**	**170**	**272**	**152**	**124**	**47**	**40**	**26**	**35**
- in industry	1.A.2	155	174	43	7	9	33				
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a	87	58		21	44	51	31	28	17	23
- in households	1.A.4.b		97	127	244	99	40	16	12	9	12

Table 3-25. Balance of peat briquettes and peat pellets, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		239	186	138	147	84	63	39	43	135	80
Liquid biofuels for blending											
Import			119	2	143	696	604	513	681	768	480
Export							26	4	8	93	35
International marine bunkers											
Changes in stocks		-53	-13	-1	-35	-44	9	16	-27	5	-1
Gross consumption		**186**	**292**	**139**	**255**	**736**	**650**	**564**	**689**	**815**	**524**
Statistical difference											
Transformed in power, heat and other plants:					9	3		3	2	3	
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii				2	1		3	2	3	
- in autoproducer heat plants	1.A.1.a iii				7	2					
- in geothermal plants											
- in other industries											
Consumed in energy sector:				2					3	1	1
- in peat extraction enterprises	1.A.c.i			2					3	1	1
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses**											
Final consumption:		**186**	**293**	**137**	**246**	**733**	**650**	**561**	**684**	**811**	**523**
- in industry	1.A.2	13	53		8	27	16	4	3	1	
- in construction											
- in transport											
- in agriculture	1.A.4.c.i				3	16	13	7	12	19	8
- in fishing											
- in commercial / public services	1.A.4.a	27	53	1	28	193	173	136	170	235	206
- in households	1.A.4.b	146	186	136	207	497	448	414	499	556	309

Table 3-26. Balance of paraffin and waxes, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Liquid biofuels for blending											
Import					176	520	1776	608	607	674	485
Export					106	384	1427	538	394	491	208
International marine bunkers											
Changes in stocks						3	-202	75	17	4	-61
Gross consumption					**70**	**139**	**147**	**145**	**230**	**187**	**216**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use	1.AD				70	139	147	145	230	187	216
Distribution and transmission losses											
Final consumption:											
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-27. Balance of natural gas, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production											
Injected to the natural gas network											152
Import		201957	84929	86453	104363	104017	89642	99751	83854	123951	116239
Export		6102					3335	18080	4651	69647	66105
International marine bunkers											
Changes in stocks				-37	-671	304	255	884	-647	-652	2113
Gross consumption		**195855**	**84929**	**86416**	**103692**	**104321**	**86562**	**82555**	**78556**	**53652**	**52399**
Statistical difference											
Transformed in power, heat and other plants:		105124	41480	47241	57134	58186	24104	16417	16209	7945	7866
- in public CHP plants	1.A.1.a ii	62825	17664	29650	42536	45755	17354	11960	10694	4474	4197
- in autoproducer CHP plants	1.A.1.a ii	1787	473	324	1160	1003	1970	2072	1572	986	1114
- in public heat plants	1.A.1.a iii	34248	21952	16272	11414	10525	4357	2052	3631	2232	2286
- in autoproducer heat plants	1.A.1.a iii	6265	1391	688	667	558	327	333	312	253	269
- in geothermal plants	1.A.1.a iii				819	345	96				
- in other industries	1.AD			307	538						
Consumed in energy sector:				140	130	65	1298	3823	2160	1167	770
- in peat extraction enterprises											
- in crude oil extraction enterprises	1.A.1.c.ii			3	3	3	2	1			
- in refineries	1.A.1.b			28	28	4	15	2869	1577	359	212
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.ii			109	99	58	1281	953	583	808	558
Non energy use	1.AD	26934	20167	22716	21335	20139	39432	37913	33059	20012	19792
Distribution and transmission losses***		1688	1935	1119	420	5					3
Final consumption:		**62109**	**21347**	**15200**	**24673**	**25926**	**21728**	**24402**	**27128**	**24528**	**23968**
- in industry	1.A.2	36065	8916	8285	14573	13670	11417	11439	11887	10507	9811
- in construction	1.A.2.g.v	1030	219	266	513	501	477	712	725	665	639
- in transport	1.A.3				647	1028	1250	1198	1286	1226	1221
- in agriculture	1.A.4.c.i	2946	1197	991	1192	1309	872	849	989	850	845
- in fishing											
- in commercial / public services	1.A.4.a	12831	3319	1302	2118	2793	2575	2904	3034	3009	3842
- in households	1.A.4.b	9237	7696	4356	5630	6625	5137	7300	9207	8271	7610

Table 3-28. Balance of charcoal, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production					18	24	26	15	8		
Liquid biofuels for blending											
Import					14	61	210	198	200	156	188
Export					15	38	163	98	86	40	40
International marine bunkers											
Changes in stocks					3	1	-7	-7	39	-5	
Gross consumption					**20**	**48**	**66**	**108**	**161**	**111**	**148**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:					**20**	**48**	**66**	**108**	**161**	**111**	**148**
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a				20	48	66	108	161	111	148
- in households											

Table 3-29. Balance of wood and wood waste, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production		11930	19632	27324	35293	41734	49852	51852	56892	52650	52081
Liquid biofuels for blending											
Import			61	4	727	2008	5628	6214	6502	5227	5589
Export				255	710	5102	5725	5751	5795	5321	5456
International marine bunkers											
Changes in stocks		-14	-381	-54	-498	444	457	420	673	164	287
Gross consumption		**11916**	**19312**	**27019**	**34812**	**39084**	**50212**	**52735**	**58272**	**52720**	**52501**
Statistical difference					457						
Transformed in power, heat and other plants:		527	558	1640	6273	10408	24371	26456	31739	27356	27753
- in public CHP plants	1.A.1.a ii				191	2472	6365	7665	7881	7629	8047
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii	274	156	1060	4906	7121	16987	16041	21496	17340	18053
- in autoproducer heat plants	1.A.1.a iii	253	402	580	1128	772	980	2750	2351	2387	1653
- in geothermal plants											
- in other industries					48	43	39	27	11		
Consumed in energy sector:				25	13	19	2				
- in peat extraction enterprises	1.A.1.c.i				13	4					
- in crude oil extraction enterprises											
- in refineries	1.A.1.b					1					
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.ii			25		14	2				
Non energy use											
Distribution and transmission losses				12	4						
Final consumption:		**11389**	**18754**	**25342**	**28979**	**28657**	**25839**	**26252**	**26533**	**25364**	**24748**
- in industry	1.A.2	453	756	1218	4007	2920	3520	4944	5138	4921	5086
- in construction	1.A.2.g.v	51	105	100	185	143	62	91	88	84	90
- in transport											
- in agriculture	1.A.4.c.i	187	211	272	253	399	383	674	724	714	699
- in fishing											
- in commercial / public services	1.A.4.a	1699	1104	1703	1278	1178	1332	1273	1230	1195	1243
- in households	1.A.4.b	8999	16578	22049	23256	24017	20542	19270	19353	18450	17630

Table 3-30. Balance of agricultural waste, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production					96	228	585	608	577	528	479
Liquid biofuels for blending											
Import							10	10		3	2
Export							386	423	417	323	276
International marine bunkers											
Changes in stocks					16	11	-31	2	23	15	-35
Gross consumption					**112**	**239**	**178**	**197**	**183**	**223**	**170**
Statistical difference											
Transformed in power, heat and other plants:					64	144	68	66	64	88	52
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii				55	131	68	66	64	88	52
- in autoproducer heat plants	1.A.1.a iii				9	13					
- in geothermal plants											
- in other industries											
Consumed in energy sector:						3					
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.ii					3					
Non energy use											
Distribution and transmission losses											
Final consumption:					**48**	**92**	**110**	**131**	**119**	**135**	**118**
- in industry	1.A.2				41	11	16	61	71	75	69
- in construction											
- in transport											
- in agriculture	1.A.4.c.i				2	56	73	47	25	31	29
- in fishing											
- in commercial / public services	1.A.4.a					18	20	23	23	29	20
- in households	1.A.4.b				5	7	1				

Table 3-31. Balance of bioethanol, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production					195	1060	470	854	597	475	379
Liquid biofuels for blending											
Import						106	269	257	438	458	619
Export					162	649	308	445	338	140	140
International marine bunkers											
Changes in stocks					-7	-3	11	-7	-5	32	-1
Gross consumption					**26**	**514**	**442**	**659**	**692**	**825**	**857**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use						78	37				
Distribution and transmission losses											
Final consumption:					**26**	**436**	**405**	**659**	**692**	**825**	**857**
- in industry											
- in construction											
- in transport	1.A.3				26	436	405	659	692	825	857
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-32. Balance of biodiesel, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production					260	3299	4353	6020	5772	5885	5861
Liquid biofuels for blending											
Import						527	2035	3355	5101	5401	4715
Export					168	2538	3865	5588	6379	7159	6626
International marine bunkers											
Changes in stocks					27	166	-101	-137	122	61	139
Gross consumption					**119**	**1454**	**2422**	**3650**	**4616**	**4188**	**4089**
Statistical difference											
Transformed in power, heat and other plants:											
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:					**119**	**1454**	**2422**	**3650**	**4616**	**4188**	**4089**
- in industry											
- in construction											
- in transport	1.A.3				119	1454	2422	3650	4616	4188	4089
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-33. Balance of sludge biogas, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production					57	125	294	300	340	344	338
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks											
Gross consumption					**57**	**125**	**294**	**300**	**340**	**344**	**338**
Statistical difference											
Transformed in power, heat and other plants:					36	55	106	116	106	113	111
- in public CHP plants	1.A.1.a ii				17	8	21				
- in autoproducer CHP plants	1.A.1.a ii				3	47	85	116	106	113	111
- in public heat plants	1.A.1.a iii				16						
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:					**21**	**70**	**188**	**184**	**234**	**231**	**227**
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a				21	70	188	184	234	231	227
- in households											

Table 3-34. Balance of landfill biogas, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production						83	343	274	231	230	137
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks											
Gross consumption						**83**	**343**	**274**	**231**	**230**	**137**
Statistical difference											
Transformed in power, heat and other plants:						83	338	262	224	220	127
- in public CHP plants	1.A.1.a ii					35	266	180	148	140	116
- in autoproducer CHP plants	1.A.1.a ii					48	72	82	76	80	11
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:							**5**	**12**	**7**	**10**	**10**
- in industry	1.A.2						2	1			
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a						3	11	7	10	10
- in households											

Table 3-35. Balance of other biogas from agricultural waste, TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production					20	210	344	1043	1111	1176	1163
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks											
Gross consumption					**20**	**210**	**344**	**1043**	**1111**	**1176**	**1163**
Statistical difference											
Transformed in power, heat and other plants:					7	91	225	858	924	960	972
- in public CHP plants	1.A.1.a ii							604	690	724	484
- in autoproducer CHP plants	1.A.1.a ii				7	91	225	254	234	236	327
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											161
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses											
Final consumption:					**13**	**119**	**119**	**185**	**187**	**216**	**191**
- in industry	1.A.2					104	119	185	187	216	191
- in construction											
- in transport											
- in agriculture	1.A.4.c.i				13	15					
- in fishing											
- in commercial / public services											
- in households											

Table 3-36. Balance of emulsified vacuum residue, TJ

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2020	2021	2022	2023
Production						19		40						
Liquid biofuels for blending														
Import														
Export						19		40						
International marine bunkers														
Changes in stocks														
Gross consumption														
Statistical difference														
Transformed in power, heat and other plants:														
- in public CHP plants														
- in autoproducer CHP plants														
- in public heat plants														
- in autoproducer heat plants														
- in geothermal plants														
- in other industries														
Consumed in energy sector:														
- in peat extraction enterprises														
- in crude oil extraction enterprises														
- in refineries														
- in electricity, gas, steam and air conditioning enterprises														
Non energy use														
Distribution and transmission losses														
Final consumption:														
- in industry														
- in construction														
- in transport														
- in agriculture														
- in fishing														
- in commercial / public services														
- in households														

Table 3-37. Balance of industrial waste (non-biomass fraction), TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production							303	1010	1312	1279	1265
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks							-13	-12	-3	12	-3
Gross consumption							**290**	**998**	**1309**	**1291**	**1262**
Statistical difference											
Transformed in power, heat and other plants:							290	927	1196	1180	1205
- in public CHP plants	1.A.1.a ii						290	831	1059	1055	1082
- in autoproducer CHP plants								96	137	125	123
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses****								4	4	3	
Final consumption:								**67**	**109**	**108**	**57**
- in industry	1.A.2.f							67	109	108	57
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-38. Balance of industrial waste (biomass fraction), TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production								823	965	1129	1182
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks								-12	2	3	2
Gross consumption								**811**	**967**	**1132**	**1184**
Statistical difference											
Transformed in power, heat and other plants:								782	930	1092	1166
- in public CHP plants	1.A.1.a ii							782	930	1092	1166
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses****								4	3	6	
Final consumption:								**25**	**34**	**34**	**18**
- in industry								25	34	34	18
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-39. Balance of municipal waste (non-biomass fraction), TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production							661	1511	2465	2396	1674
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks							-8	-56	24	18	5
Gross consumption							**653**	**1455**	**2489**	**2414**	**1679**
Statistical difference											
Transformed in power, heat and other plants:							653	1451	2484	2410	1214
- in public CHP plants	1.A.1.a ii						653	1451	2484	2410	1214
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses****								4	5	4	
Final consumption:											**465**
- in industry											465
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-40. Balance of municipal waste (biomass fraction), TJ

	CRT category	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Production							676	1182	2268	2214	4172
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks							-17	-17	16	-1	-3
Gross consumption							**659**	**1165**	**2284**	**2213**	**4169**
Statistical difference											
Transformed in power, heat and other plants:							659	1161	2280	2207	3749
- in public CHP plants	1.A.1.a ii						659	1161	2280	2207	3749
- in autoproducer CHP plants											
- in public heat plants											
- in autoproducer heat plants											
- in geothermal plants											
- in other industries											
Consumed in energy sector:											
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses****								4	4	6	
Final consumption:											**420**
- in industry											420
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

*According to Lithuania Statistics, transmission losses of liquid fuels arise during the primary refining of oil, but fugitive emissions from oil refining are calculated using Tier 1, on the basis of crude oil refined.

**Losses of peat are not related to fugitive emissions.

*** Part of natural gas losses is natural gas combustion for technological needs; therefore, not all the losses are treated as fugitive emissions.

****Waste losses occur from delivery to a landfill up to the moment of utilization. Waste loses humidity, evaporates, rots and decomposes during that time. These losses are not accounted in fugitive emissions.

*****Fossil fuels are provided together with mixed biofuels in transport, in line with data provided in Official statistics portal of Lithuania. On the contrary, only fossil parts of transport fuels are provided in CRT as fossil fuel.

ANNEX IV. Lithuanian energy consumption in manufacturing industries

Table 4-1. Energy consumption by fuel type in Chemicals industries, TJ

Fuel type	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2021**	**2022**	**2023**
Heating and other gasoil	0	0	0	0	0	0	2	0	39	9
Residual fuel oil (RFO)	883	281	20	0	47	0	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	0	7	17	31	55	69	73	256
Other bituminous coal	0	0	0	0	0	0	0	0	0	0
Sub-bituminous coal	0	0	0	0	0	0	0	0	0	0
Natural gas	6001	1563	191	4972	5476	5489	4992	5003	4264	3447
Wood and wood waste	0	0	3	0	0	66	445	454	447	462
Biogas	0	0	0	0	94	84	124	142	170	150
Total	**6884**	**1844**	**214**	**4980**	**5634**	**5670**	**5618**	**5668**	**4993**	**4324**

Table 4-2. Energy consumption by fuel type in Pulp, paper and print industries, TJ

Fuel type	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2021**	**2022**	**2023**
Heating and other gasoil	0	0	4	0	0	0	8	9	9	4
Residual fuel oil (RFO)	883	401	64	0	0	0	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	42	4	3	6	3	6	5	5
Coke	0	0	0	0	0	0	0	0	0	0
Other bituminous coal	0	75	18	0	0	0	0	0	0	0
Sub-bituminous coal	0	0	0	0	0	0	0	0	0	0
Natural gas	3388	749	1162	448	1172	384	556	520	492	415
Wood and wood waste	3	5	1	0	128	161	766	762	804	829
Peat	0	0	0	0	0	0	2	3	1	0
Total	**4274**	**1231**	**1291**	**453**	**1303**	**551**	**1335**	**1300**	**1311**	**1253**

Table 4-3. Energy consumption by fuel type in Food Processing, Beverages and Tobacco industries, TJ

Fuel type	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Heating and other gasoil	0	0	3	148	94	99	112	129	228	249
Residual fuel oil (RFO)	2248	1606	1567	334	212	271	249	169	14	17
Liquefied petroleum gases (LPG)	0	0	121	158	192	209	124	140	162	247
Shale oil	0	0	0	13	0	0	0	0	0	0
Coke	0	0	105	64	54	45	82	58	49	64
Other bituminous coal	352	151	68	0	3	36	16	17	5	10
Anthracite	0	0	0	0	0	0	0	0	0	0
Sub-bituminous coal	0	0	0	50	38	0	0	0	0	0
Natural gas	8498	2077	2890	3695	4005	3379	3536	3535	3166	3973
Wood and wood waste	36	57	77	297	93	668	545	610	552	568
Other solid biomass	0	0	0	0	0	16	41	46	50	46
Biogas	0	0	0	0	10	35	61	45	46	41
Peat	0	0	0	6	15	7	0	0	0	0
Total	**11134**	**3890**	**4831**	**4765**	**4716**	**4765**	**4766**	**4749**	**4272**	**5215**

Table 4-4. Energy consumption by fuel type in Machinery industries, TJ

Fuel type	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Heating and other gasoil	0	0	0	4	8	2	7	16	17	22
Residual fuel oil (RFO)	1565	482	48	0	0	3	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	5	15	9	7	9	12	10	9
Coke	0	0	23	17	3	0	0	0	0	0
Other bituminous coal	50	0	8	0	0	5	3	2	5	2
Anthracite	0	0	0	0	3	0	0	0	0	0
Sub-bituminous coal	0	0	0	13	2	0	0	0	0	0
Natural gas	2923	1036	924	1099	262	238	372	373	431	296
Wood and wood waste	14	68	108	373	36	14	12	10	18	19
Other solid biomass	0	0	0	0	9	0	17	25	25	23
Peat	0	0	0	1	3	1	0	0	0	0
Total	**4553**	**1586**	**1116**	**1522**	**335**	**270**	**420**	**438**	**506**	**371**

Table 4-5. Energy consumption by fuel type in Non-Metallic Minerals industries, TJ

Fuel type	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Heating and other gasoil	0	0	0	148	65	75	109	135	129	90
Residual fuel oil (RFO)	35444	7787	3522	1180	1	57	24	25	16	0
Liquefied petroleum gases (LPG)	0	0	5	5	2	3	4	8	128	182
Petroleum coke	0	0	0	46	111	0	0	0	0	0
Coke	0	0	190	402	387	336	453	445	409	325
Other bituminous coal	628	327	8	0	2847	3545	3138	3829	3999	2580
Anthracite	0	0	0	0	0	0	0	0	0	0
Sub-bituminous coal	0	0	0	2924	153	0	0	0	0	0
Natural gas	6934	1833	1775	1615	909	945	901	933	678	487
Wood and wood waste	19	63	152	566	345	266	436	457	336	345
Other solid biomass	0	0	0	0	0	0	3	0	0	0
Peat	168	227	43	7	11	33	1	0	0	0
Industrial waste (used tires)	0	0	0	0	209	0	67	109	108	57
Industrial waste (biomass)	0	0	0	0	0	0	25	34	34	18
Municipal waste (non-RES)	0	0	0	0	0	0	0	0	0	465
Municipal waste (RES)	0	0	0	0	0	0	0	0	0	420
Total	**43193**	**10237**	**5695**	**6894**	**5040**	**5260**	**5161**	**5975**	**5837**	**4969**

Table 4-6. Energy consumption by fuel type in Transport Equipment industries, TJ

Fuel type	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Heating and other gasoil	0	0	0	1	1	1	7	5	4	8
Residual fuel oil (RFO)	0	0	0	0	0	0	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	9	8	1	2	0	0	0	9
Other bituminous coal	0	0	0	0	1	4	1	0	0	0
Sub-bituminous coal	0	0	0	4	1	0	0	0	0	0
Natural gas	189	102	171	238	105	47	71	86	89	71
Wood and wood waste	0	0	0	1	1	0	4	0	1	1
Other solid biomass	0	0	0	0	0	0	0	0	0	0
Total	**189**	**102**	**180**	**252**	**110**	**54**	**83**	**91**	**94**	**89**

Table 4-7. Energy consumption by fuel type in Mining and Quarrying industries, TJ

Fuel type	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2021**	**2022**	**2023**
Heating and other gasoil	0	0	0	5	0	1	2	2	0	0
Residual fuel oil (RFO)	80	40	56	0	0	0	3	0	0	0
Liquefied petroleum gases (LPG)	0	0	0	0	0	0	5	5	19	55
Other bituminous coal	0	0	3	0	0	1	1	0	0	0
Anthracite	0	0	0	0	0	0	0	0	0	0
Sub-bituminous coal	0	0	0	2	0	0	0	0	0	0
Natural gas	270	264	20	41	17	11	44	48	33	5
Wood and wood waste	0	0	2	5	4	18	12	25	43	42
Peat	0	0	0	0	1	0	1	0	0	0
Total	**350**	**304**	**80**	**53**	**22**	**31**	**68**	**80**	**95**	**102**

Table 4-8. Energy consumption by fuel type in Wood and Wood Products industries, TJ

Fuel type	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2021**	**2022**	**2023**
Heating and other gasoil	0	0	0	3	0	0	7	11	9	13
Residual fuel oil (RFO)	1204	321	148	147	31	0	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	5	3	19	7	8	10	55	5
Other bituminous coal	0	0	0	0	0	0	0	0	0	0
Anthracite	0	0	0	0	0	0	0	0	0	0
Sub-bituminous coal	0	0	0	12	0	0	0	0	0	0
Natural gas	1167	451	288	1046	944	131	315	397	397	333
Wood and wood waste	240	284	466	2081	1905	1670	2213	2316	2128	2226
Other solid biomass	0	0	0	0	0	0	0	0	0	0
Peat	0	0	0	1	1	1	0	0	0	0
Total	**2611**	**1056**	**906**	**3294**	**2900**	**1809**	**2543**	**2734**	**2589**	**2577**

Table 4-9. Energy consumption by fuel type in Construction industries, TJ

Fuel type	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Heating and other gasoil	0	0	7	25	47	67	64	75	216	149
Residual fuel oil (RFO)	1044	201	58	110	75	35	8	6	0	0
Liquefied petroleum gases (LPG)	92	46	74	77	122	38	72	58	62	80
Other bituminous coal	226	25	14	0	0	6	3	3	2	0
Anthracite	0	0	0	0	2	0	0	0	0	0
Sub-bituminous coal	0	0	0	18	2	0	0	0	0	0
Natural gas	1030	219	266	513	501	477	712	725	665	639
Wood and wood waste	51	105	100	185	143	62	91	88	84	90
Peat	0	0	0	0	0	0	0	0	0	0
Total	**2443**	**596**	**519**	**928**	**892**	**685**	**950**	**955**	**1029**	**958**

Table 4-10. Energy consumption by fuel type in Textile and Leather industries, TJ

Fuel type	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Heating and other gasoil	0	0	0	76	41	26	37	32	22	16
Residual fuel oil (RFO)	1365	442	140	40	4	11	4	5	0	0
Liquefied petroleum gases (LPG)	0	0	5	2	12	14	12	17	18	14
Other bituminous coal	528	100	35	0	7	10	6	7	2	16
Anthracite	0	0	0	0	2	0	0	0	0	0
Sub-bituminous coal	0	0	0	49	8	0	0	0	0	0
Natural gas	2467	646	810	1228	591	568	397	580	579	444
Wood and wood waste	20	50	109	37	18	35	26	21	26	19
Other solid biomass	0	0	0	41	2	0	0	0	0	0
Peat	0	0	0	1	1	0	0	0	0	0
Total	**4379**	**1238**	**1099**	**1474**	**686**	**664**	**482**	**662**	**647**	**509**

Table 4-11. Energy consumption by fuel type in Non-Specified Industry, TJ

Fuel type	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
Heating and other gasoil	0	0	0	20	11	24	37	39	26	22
Residual fuel oil (RFO)	321	161	0	3	0	0	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	9	26	18	47	61	68	59	59
Coke	0	0	28	52	29	18	0	0	0	0
Other bituminous coal	25	50	0	0	2	1	4	4	0	0
Anthracite	0	0	0	0	0	0	0	0	0	0
Sub-bituminous coal	0	0	5	5	5	0	0	0	0	0
Natural gas	4228	195	54	189	189	225	255	412	378	340
Wood and wood waste	121	229	300	646	390	622	485	483	566	575
Other solid biomass	0	0	0	0	0	0	0	0	0	0
Biogas	0	0	0	0	0	2	1	0	0	0
Peat	0	0	0	1	4	7	0	0	0	0
Total	**4695**	**635**	**396**	**943**	**648**	**946**	**843**	**1006**	**1029**	**996**

ANNEX V. Energy sector country specific CO_2 emission factors

Country specific CO_2 emission factors have been derived in studies to determine and update national GHG emission factors for energy sector performed in 2012, 2016 and 2023 by Lithuanian Energy Institute. Results of 2012 study are presented in scientific publication "Assessment of national carbon dioxide emission factors for the Lithuanian fuel combustion sector" published in journal "Greenhouse Gas Measurement and Management", Volume 4, 2014 – Issue 1 https://www.tandfonline.com/doi/full/10.1080/20430779.2014.905243. Summary of 2016 study "Update of country specific GHG emission factors for energy sector" is presented in Annex VI.

According to the agreement with Ministry of Environment the accredited Laboratory of Quality Research Centre of AB "ORLEN Lietuva" (petroleum refining company) performed measurements for CO_2 emission factors for all oil products produced at this refinery in 2017. Refinery provided measurements' protocols for all samples of their products. AB "ORLEN Lietuva" performed measurements for 6 samples of diesel, jet fuel, gasoline (A-95), LPG (summer and winter types), 4 samples of gasoline (A-98) and 6 samples of liquefied petroleum gas for residential sector (BT and SPBT types). Standard practice for sampling petroleum products has been used as presented in Table 5-1.

Table 5-1. Sampling and test methods used by AB „ORLEN Lietuva“

Product	Sampling method	Test method for CO_2 emission factor evaluation
Diesel	LST EN ISO 3170:2004 ASTM D5291-16 D	Thermo Fisher Scientific method No. 85
Gasoline	LST EN ISO 3170:2004 PIANO method	Thermo Fisher Scientific method No. 85
Jet fuel	ASTM D4057-12 ASTM D5291-16 D	Thermo Fisher Scientific method No. 85
Liquefied petroleum gas	LST EN ISO 4257:2002 LST EN SIO 4257:2002/AC:2007	Thermo Fisher Scientific method No. 85

In 2023, new study "Update of country specific GHG emission factors for energy sector" was performed by Lithuanian Energy Institute. The summary of this 2023 study "Update of country specific GHG emission factors for energy sector" is presented in Annex VII.

Country specific CO_2 emission factors for all fuel types are presented in Table 5-2 and Table 5-3.

Table 5-2. Country specific CO_2 emission factors, t/TJ

Fuel type	1990-2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Liquid fuel										
Heating and other gasoil	72.89	72.73	72.73	72.80	72.80	72.80	72.80	72.80	72.80	72.95
Residual fuel oil (RFO)	77.60	78.40	78.40	78.40	78.40	78.40	78.40	78.40	78.40	79.15
Liquefied petroleum gases (LPG) – 1.A.1, 1.A.2, 1.A.4	65.42	66.34	66.34	66.81	66.81	66.81	66.81	66.81	66.81	66.78
Liquefied petroleum gases (LPG) – 1.A.3	65.42	66.34	66.34	66.81	66.81	66.81	66.81	66.81	66.81	66.44
Shale oil	77.40	76.60	76.60	76.60	76.60	76.60	76.60	76.60	76.60	76.60
Crude oil	77.74	77.74	77.74	77.74	77.74	77.74	77.74	77.74	77.74	77.74
Petroleum coke	94.06	94.06	94.06	94.06	94.06	94.06	94.06	94.06	94.06	94.06
Diesel oil	72.89	72.73	72.73	72.80	72.80	72.80	72.80	72.80	72.80	72.95
Motor gasoline	72.97	72.77	72.77	70.13	70.13	70.13	70.13	70.13	70.13	70.03
Aviation gasoline and gasoline type jet fuel	71.62	70.81	70.81	70.81	70.81	70.81	70.81	70.81	70.81	70.81
Jet kerosene	72.24	71.74	71.74	71.67	71.67	71.67	71.67	71.67	71.67	72.00
Solid fuel										
Coke	109.11	109.11	109.11	109.11	109.11	109.11	109.11	109.11	109.11	109.11
Other bituminous coal	94.90	95.10	95.10	95.10	95.10	95.10	95.10	95.10	95.10	95.10
Anthracite	106.55	106.55	106.55	106.55	106.55	106.55	106.55	106.55	106.55	106.55
Sub-bituminous coal	96.10	96.10	96.10	96.10	96.10	96.10	96.10	96.10	96.10	96.10
Lignite	101.2	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0
Peat	104.34	104.34	104.34	104.34	104.34	104.34	104.34	104.34	104.34	104.34
Biomass										
Wood and wood waste	101.34	101.34	101.34	101.34	101.34	101.34	101.34	101.34	101.34	104.1
Other solid biomass	103.69	103.69	103.69	103.69	103.69	103.69	103.69	103.69	103.69	88.50
Biogas	58.45	58.45	58.45	58.45	58.45	58.45	58.45	58.45	58.45	58.45
Charcoal	109.9	109.9	109.9	109.9	109.9	109.9	109.9	109.9	109.9	109.9
Waste										
Municipal waste (non-biomass fraction)	111.65	111.65	111.65	111.65	111.65	111.65	111.65	111.65	111.65	115.63
Municipal and industrial waste (biomass fraction)	109.03	109.03	109.03	109.03	109.03	109.03	109.03	109.03	109.03	115.63
Industrial waste – used tires (rubber)	85.00	-	-	84.40	88.70	88.70	88.70	66.40	66.40	66.40

Table 5-3. Country specific CO_2 emission factors of natural gas, t/TJ

Fuel type	1990-2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Natural gas	55.14	55.09	55.09	55.12	55.11	55.11	55.16	55.12	55.12	55.16	55.21	55.24	55.53

Fuel type	2016	2017	2018	2019	2020	2021	2022	2023
Natural gas	55.73	55.57	55.54	55.59	55.34	55.34	55.40	55.59

ANNEX VI. Summary of study "Update of country specific GHG emission factors for energy sector" (2016)

During combustion a great share of carbon is removed immediately as CO_2, therefore conditions of combustion process practically have no influence on CO_2 emission factors. CO_2 emission factors depend on the type of fuel, i.e. on the amount of carbon content in this fuel. After the summarization of performed comparative analysis of applied emission factors in other EU countries, summarization of data provided by the operators under the EU ETS system and aggregation of results provided by the accredited research laboratories, the study determined country specific CO_2 emission factors for energy sector (fuel combustion). Updated values of country specific CO_2 emission factors are set considering the results of analysis performed. Besides, determined values of emission factors assure low as possible uncertainty of emission factors.

CH_4 and N_2O emission factors are influenced by type of technology, operating conditions, age of equipment and other combustion conditions, therefore values of these emission factors significantly differ between the individual technologies. Seeking to precisely set country specific CH_4 and N_2O emission factors of energy technologies used in Lithuania, it is essential to perform comprehensive and multiplex measurements of emissions by differencing in accordance with the group of equipment and fuel type. However, the measurements should be long-lasting, therefore in this study recommended values of CH_4 and N_2O emission factors are based on the default IPCC (2006) values.

Updated CO_2 emission factors and previously applied CO_2 emission factors (presented in the study on “Determination of national GHG emission factors for energy sector”, 2012) for energy sector are provided in Tables 6-1.

Table 6-1. GHG emission factors for *energy industries*

1.A.1 Energy industries	*CO_2 emission factors in the study of 2016, t/TJ*	*CO_2 emission factors in the study of 2012, t/TJ*
Liquid fuel		
Motor gasoline	72.77	72.97
Diesel	72.73	72.89
Gasoil	72.73	72.89
Residual fuel oil (RFO)	78.4	77.6
Petroleum coke	94.06	94.06
Refinery gas	56.9	55.82
Orimulsion	81.74	81.74
Shale oil	76.6	77.4
Liquified petroleum gas (LPG)	66.34	65.42
Crude oil	77.74	77.74
Solid fuel		
Other bituminous coal	95.1	94.9
Anthracite	106.55	-
Sub-bituminous coal	96.1	-
Peat	104.34	104.34
Natural gas		
Natural gas	55.14*	55.23
Biomass		
Wood and wood waste	101.34	109.9
Other solid biomass	103.69	-
Biogas	58.45	58.45
Waste		
Municipality waste (RES)	109.03	-
Municipality waste (non-RES)	111.65	-

Industrial waste	143	-

Remark: * Seeking to ensure higher accuracy of GHG emissions accounting, it is valuable to apply time series of CO_2 emission factor for a period 2004-2014, but an average value of 55,14 t/TJ for a period 1990-2003. Since 2015, country will have to calculate CO_2 emission factor for natural gas considering to the chemical composition of natural gas imported through the pipeline and the liquefied natural gas terminal by applying the method of weighted average.

Updated country specific CO_2 emission factor for natural gas is determined considering to the chemical composition of natural gas during 2004-2014 that was provided by Central Calibration and Test Laboratory of AB "Lietuvos dujos". Seeking to ensure higher accuracy of GHG inventory, it is valuable to apply time series of CO_2 emission factor for a period 2004-2014, but an average value of 55.14 t/TJ – for a period 1990-2003. Since 2015, country specific CO_2 emission factor for natural gas should be estimated considering chemical composition of natural gas imported through the pipeline and the liquefied natural gas terminal. The CO_2 emission factor for natural gas since 2015 should be calculated applying the method of weighted average and considering the import structure and chemical composition of natural gas.

Values of country specific CO_2 emission factors for gasoline, diesel, gasoil, jet kerosene, residual fuel oil and liquefied petroleum gas are updated considering the results of measurements of petroleum products that were performed by the accredited Laboratory of Quality Research Centre of AB „ORLEN Lietuva". When accounting GHG emissions, it is valuable to apply the updated CO_2 emission factors for a specified in this paragraph fuels for a period after 2015 and for a period 1990-2014 to use the emission factors determined in the study of 2012.

Values of country specific CO_2 emission factors for other bituminous coal, petroleum coke, orimulsion, refinery gas and coke are updated on the basis of data provided by the operators under EU ETS and considering to the Tier 3 reliability that ensures the lowest uncertainty of emission factor. Sustaining to data base of EU ETS, in some cases it is possible to apply emission factors set at the plant-specific level. For example, this can be applied for orimulsion or residual fuel oil combusted in CHP of the AB "ORLEN Lietuva". The application of plant-specific emission factors enables to use higher Tiers in the national GHG inventory.

Value of CO_2 emission factor for shale oil is based on national Estonian emission factor, considering the fact that shale oil is imported to Lithuania from Estonia. When preparing the inventory of GHG emissions, it is recommended to apply the updated CO_2 emission factor for shale oil after 2015.

Country specific CO_2 emission factors for wood, wood waste, agricultural waste and municipality waste (renewable and non-renewable) are specified by performed measurements in the Laboratory of Heat Equipment Research and Testing (Lithuanian Energy Institute). The Laboratory of Heat Equipment Research and Testing performed measurements for 17 samples of municipal waste (non-biomass fraction); 6 samples of municipal waste (biomass fraction); 21 samples of agricultural waste and 4 samples of wood/wood waste. It is recommended to apply the updated CO_2 emission factors for the specified in this paragraph fuels when recalculating GHG emissions from 1990. This will ensure higher reliability of accounting, considering the significantly lower uncertainties of the updated CO_2 emission factors.

The Value of CO_2 emission factor for biogas and industrial waste is updated in accordance with the results of analysis on applied emission factors in other EU countries and considering the results of long-lasting research analysis performed in other countries. However, seeking to ensure low uncertainty of emission factor for biogas, it is essential to perform long-lasting measurements for different types of biogas in Lithuania.

The reliability of the updated CO_2 emission factors is assessed considering default values given in *2006 IPCC Guidelines* and results of performed comparative analysis, where the updated CO_2 emission factors were compared with the emission factors applied in EU countries. The comparison of updated CO_2 emission factors with default values of *2006 IPCC Guidelines* is presented in Figure 6-1.

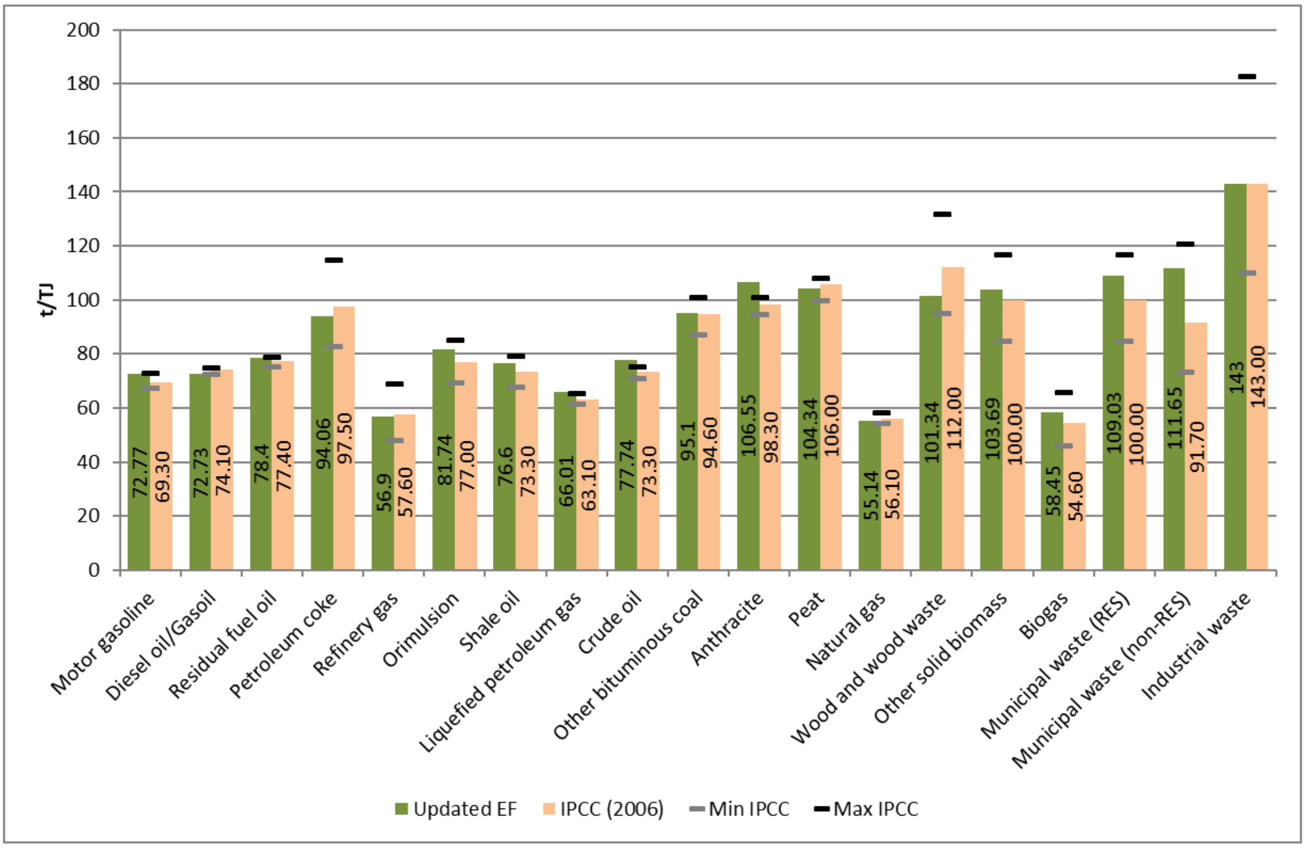


Figure 6-1. Comparison of updated country specific CO_2 emission factors and default *2006 IPCC Guidelines* emission factors: energy industries

As it is seen from Figure 6-1, the updated values of country specific CO_2 emission factors for fuels fall into the uncertainty ranges of default *2006 IPCC Guidelines*, except for crude oil and anthracite. The updated values of country specific CO_2 emission factors for crude oil and anthracite are by 5.71% and 7.74% higher than default *2006 IPCC Guidelines* values, respectively.

CO_2 emission factors for manufacturing industries and construction are recommended the same as for energy industries sector (Table 6-2).

Table 6-2. GHG emission factors for *manufacturing industries and construction*

1.A.2 Manufacturing industries and construction	***CO_2 emission factors in the study of 2016, t/TJ***	***CO_2 emission factors in the study of 2012, t/TJ***
Liquid fuel		
Gasoil	72.73	72.89
Residual fuel oil	78.4	77.60
Petroleum coke	94.06	94.06
Shale oil	76.6	77.40
Liquified petroleum gas	66.34	65.42
Jet kerosene	71.74	72.24
Solid fuel		
Other bituminous coal	95.1	94.90
Anthracite	106.55	-
Sub-bituminous coal	96.1	-
Peat	104.34	104.34
Coke	109.11	109.11
Natural gas		
Natural gas	55.14*	55.23
Biomass		

Wood and wood waste	101.34	109.9
Other solid biomass	103.69	-
Biogas	58.45	58.45
Waste		
Industrial waste (used tires)	85.00	-

Remark: * Seeking to ensure higher accuracy of GHG emissions accounting, it is valuable to apply time series of CO_2 emission factor for a period 2004-2014, but an average value of 55,14 t/TJ for a period 1990-2003. Since 2015, country will have to calculate CO_2 emission factor for natural gas considering to the chemical composition of natural gas imported through the pipeline and the liquefied natural gas terminal by applying the method of weighted average.

Updated values of CO_2 emission factors for transport sector are presented in Table 6-3. CO_2 emission factors of fuels (except aviation gasoline) used in transport sector are updated on the basis of measurement performed by the accredited Laboratory of Quality Research Centre of AB „ORLEN Lietuva“. AB ORLEN Lietuva performed measurements for 1 sample of diesel, jet fuel, RFO, gasoil; 3 samples of gasoline and 2 samples of liquefied petroleum gas. Aviation gasoline is not produced in Lithuania. Minor volume of this fuel is imported from Sweden and other EU countries; therefore, it is recommended for aviation gasoline to apply average value of emission factors applied in EU countries.

Table 6-3. GHG emission factors for *transport sector*

1.A.3 Transport	*CO_2 emission factors in the study of 2016, t/TJ*	*CO_2 emission factors in the study of 2012, t/TJ*
Aviation gasoline	70.81	71.62
Jet kerosene	71.74	72.24
Motor gasoline	72.77	72.97
Gasoline with bioethanol	72.76	-
Gasoline with MTBE	72.23	-
Diesel	72.73	72.89
Liquefied petroleum gas (LPG)	66.01	65.42
Residual fuel oil	78.4	77.60

The comparison of updated country specific CO_2 emission factors with default *2006 IPCC Guidelines* emission factors are presented in Figure 6-2.

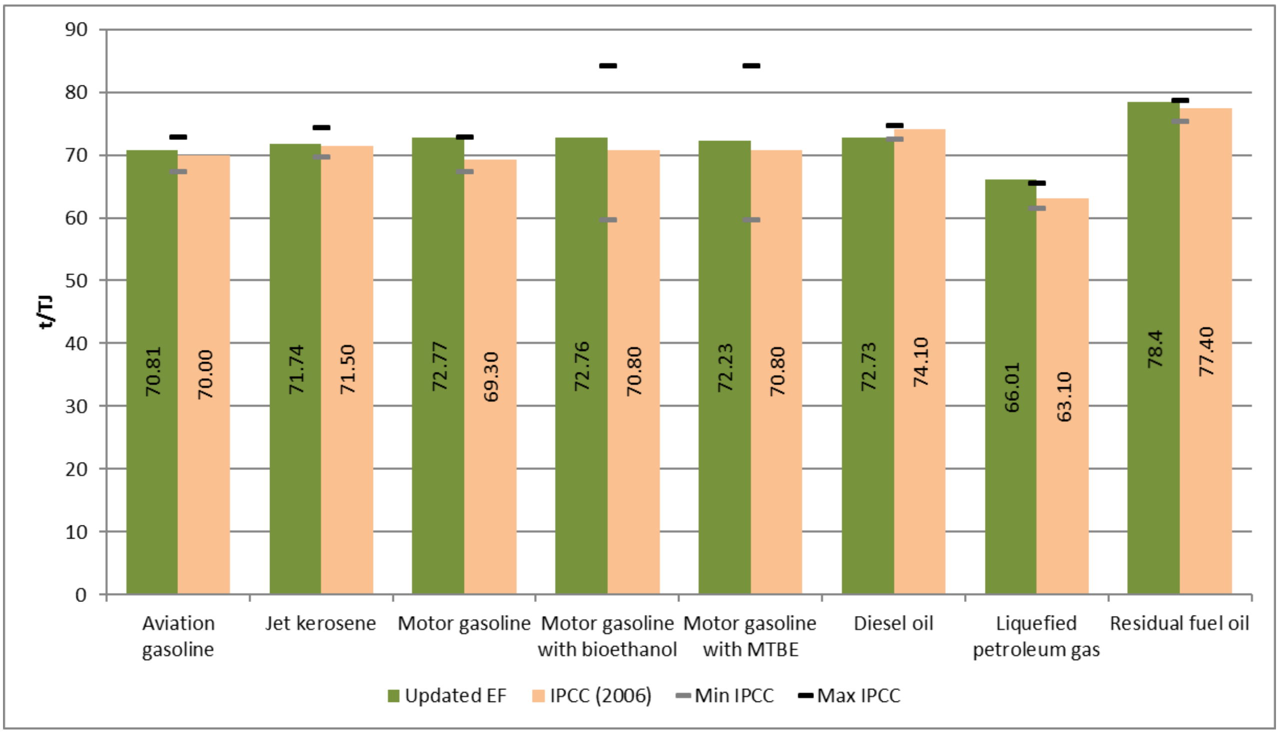


Figure 6-2. Comparison of updated country specific CO_2 emission factors with default *2006 IPCC Guidelines* emission factors: transport sector

As it is seen from Figure 6-2, updated values of country specific CO_2 emission factors for fuels in transport sector fall into the uncertainty ranges of *2006 IPCC Guidelines*, except for liquefied petroleum gas. The updated value of CO_2 emission factor for liquefied petroleum gas is by 4.41% higher than its default value.

Recommended values of CO_2 emission factors for commercial/institutional, household, agriculture/forestry/fishing sector are presented in Table 6-4.

Table 6-4. GHG emission factors for *commercial/institutional, household, agriculture/forestry and fishing sectors*

1.A.4 Other sectors	CO_2 *emission factors in the study of 2016, t/TJ*	CO_2 *emission factors in the study of 2012, t/TJ*
Commercial/ institutional sector		
Other bituminous coal	95.1	94.9
Anthracite	106.55	-
Sub-bituminous coal	96.1	-
Biogas	58.45	58.45
Peat	104.34	104.34
Natural gas	55.14*	55.23
Gasoil	72.73	72.89
Lignite	101	101.2
Wood and wood waste	101.34	109.9
Other solid biomass	103.69	-
Residual fuel oil	78.4	77.6
Charcoal	109.9	109.9
Shale oil	76.6	77.4
Liquified petroleum gas	66.34	65.42
Household sector		
Other bituminous coal	95.1	94.9
Anthracite	106.55	-
Sub-bituminous coal	96.1	-
Peat	104.34	104.34
Natural gas	55.14*	55.23
Gasoil	72.73	72.89
Lignite	101	101.2
Wood and wood waste	101.34	109.9
Other solid biomass	103.69	-
Residual fuel oil	78.4	77.6
Liquified petroleum gas	66.34	65.42
Agriculture/forestry and fishing sector		
Other bituminous coal	95.1	94.9
Anthracite	106.55	-
Sub-bituminous coal	96.1	-
Biogas	58.45	58.45
Peat	104.34	104.34
Natural gas	55.14*	55.23
Gasoil	72.73	72.89
Wood and wood waste	101.34	109.9
Other solid biomass	103.69	-

Residual fuel oil	78.4	77.6
Shale oil	76.6	77.4
Liquified petroleum gas	66.34	65.42

Remark: * Seeking to ensure higher accuracy of GHG emissions accounting, it is valuable to apply time series of CO_2 emission factor for a period 2004-2014, but an average value of 55.14 t/TJ for a period 1990-2003. Since 2015, country will have to calculate CO_2 emission factor for natural gas considering to the chemical composition of natural gas imported through the pipeline and the liquefied natural gas terminal by applying the method of weighted average.

Preparing the national GHG inventory, it is essential to evaluate the overall inventory uncertainty. For this purpose, it is needed to have uncertainty estimates of emission factors, therefore in this study expert valuations of determined national emission factors uncertainties are performed.

Considering international practice, uncertainty assessment of CO_2, CH_4 and N_2O emission factors is performed at aggregated sector-specific and fuel type-specific (liquid, solid, gaseous fuel and biomass) levels. Uncertainty estimations of recommended GHG emission factors are presented in Table 6-5.

Table 6-5. Uncertainties of recommended GHG emission factors

IPCC source category	***Fuel type***	***CO_2, %***
1.A.1 Energy industries	Liquid fuel	± 2.0
	Solid fuel	± 5.0
	Natural gas	± 2.0
	Biomass	± 15.0
1.A.2 Manufacturing industry and construction	Liquid fuel	± 2.0
	Solid fuel	± 5.0
	Natural gas	± 2.0
	Biomass	± 15.0
1.A.3 Transport	Liquid fuel	± 2.0
1.A.4 Other sectors: commercial/institutional, household, agriculture and fishing	Liquid fuel	± 2.0
	Solid fuel	± 5.0
	Natural gas	± 2.0
	Biomass	± 15.0

Assessment of uncertainty of CO_2 emission factors is performed considering the fact that carbon share of some types of fuels is relatively stable. Emission factors for liquid fuels mainly are identified at the accredited laboratory that satisfies the requirements of LST EN ISO/IEC 17025:2005 standard or are based on data provided by EU ETS applying the Tier 3. Chemical composition of natural gas is determined in the laboratory, which is accredited by the National Accreditation Bureau, too. This has an influence on low uncertainties of emission factors for liquid fuels and natural gas (±2,0%). Uncertainties of emission factors for solid fuels are remarkably higher, because, for example, carbon share in peat is variable, therefore uncertainties of emission factors for solid fuels are estimated considering the recommendations provided in *2006 IPCC Guidelines*. The Uncertainty of CO_2 emission factor for biomass is the highest and reaches ±15%.

ANNEX VII. Summary of study “Update of country specific GHG emission factors for energy sector” (2023)

Updated CO_2 EFs for energy sector and CH_4 and N_2O EFs of biomass for residential and commercial/institutional sectors are provided in Table 7-1 and Table 7-2.

Table 7-1. CO_2 emission factors for energy sector

Fuel type	*CO_2 emission factors in the study of 2023, t/TJ*
Liquid fuel	
Motor gasoline	70.03
Diesel / gasoil	72.95
Jet kerosene	72.00
Residual fuel oil (RFO)	79.15
Petroleum coke	94.06
Refinery gas	57.11
Liquified petroleum gas (LPG)	66.44 (1.A.3) / 66.78 (1.A.1, 1.A.2, 1.A.4)
Solid fuel	
Other bituminous coal	95.13
Biomass	
Wood and wood waste	104.10
Other solid biomass	88.50
Waste	
Municipality waste (non-RES)	115.63
Municipality waste (RES)	
Industrial waste (non-RES)	
Industrial waste (RES)	

Table 7-2. CH_4 and N_2O EFs of biomass for residential and commercial/institutional sectors

IPCC category	*Fuel type*	*Emission factors, kg/TJ*		*IPCC (2006), kg/TJ*	
		CH_4	**N_2O**	**CH_4**	**N_2O**
Residential	Wood logs	206.60	4.12	300	4
	Wood waste	19.80	6.10		
	Wood pellets	3.84	0.33		
Commercial/institutional	Wood logs	11.10	0.00		
	Wood waste	16.90	1.67		
	Wood pellets	0.24	0.06		

The national CO_2 EFs for petroleum products (gasoline, diesel, gasoil, jet kerosene fuel, residual fuel oil and liquefied petroleum gas) have been revised considering the results of measurements of petroleum products that were performed by the accredited Laboratory of the Quality Research Centre of AB "ORLEN Lietuva" in 2023. Refinery provided measurements’ protocols for all samples of their products. Standard practice for sampling petroleum products has been used as presented in Table 7-3.

Table 7-3. Sampling and test methods used by AB „ORLEN Lietuva“

Product	**Sampling method**	**Test method for CO_2 EFs evaluation**	**Number of samples**
Gasoline	LST EN ISO 3170	Thermo Fisher Scientific	12
Diesel	LST EN ISO 3170	Thermo Fisher Scientific	8

Jet kerosene	ASTM D 4057	Thermo Fisher Scientific	6
Residual fuel oil	LST EN ISO 3170	Thermo Fisher Scientific	6
Liquefied petroleum gas (transport)	LST EN ISO 4257	Thermo Fisher Scientific	12
Liquefied petroleum gas (other)	GOST 14921	Thermo Fisher Scientific	12

The comparison of updated country specific CO_2 EFs of petroleum products with default *2006 IPCC Guidelines* emission factors are presented in Figure 7-1.

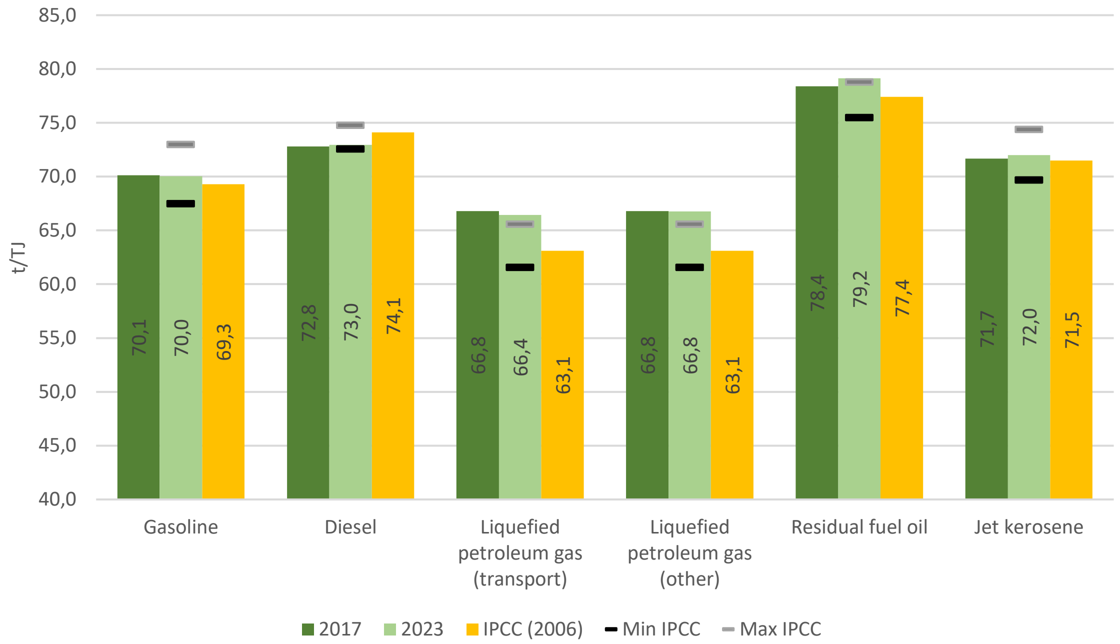


Figure 7-1. Comparison of updated CS CO_2 EFs of petroleum products with default *2006 IPCC Guidelines* emission factors

As it seen from Figure 7-1, updated values of CS CO_2 EFs of petroleum products fall into the uncertainty ranges of *2006 IPCC Guidelines*, except for liquefied petroleum gas and residual fuel oil. When accounting GHG emissions, it is appropriate to apply these revised CO_2 EFs for petroleum products from 2023.

Country specific CO_2 EFs for wood, wood waste, agricultural waste, municipal and industrial waste (renewable and non-renewable) have been updated at the Laboratory of Heat Equipment Research and Testing (Lithuanian Energy Institute). CO_2 EFs for wood and wood waste, wood pellets and agricultural waste have been updated by direct measurement. The following equipment was used for measurements: S type Pito tube for the determination of the combustion products flow; a moisture meter and a pressure sensor with secondary instruments; a portable gas analyser Testo 350XL for the measurement of the concentrations of the combustion products (CO_2, CH_4, N_2O) and a portable FTIR analyser Gasmet DX-4000.

The concentration of combustion products (CO_2 %, CH_4 and N_2O mg/m^3) was directly measured using combustion product analysers. Then, taking into account the flue gas volume flow (Nm^3/h) from the boiler and the fuel consumption (kg/h) and calorific value (TJ/kg), the amount of emissions (mg/h) were calculated.

CO_2 emissions concentration was measured from the combustion of different fuels: biomass (wood logs, wood chips, wood pellets) and agricultural waste. In order to update the national CO_2 EFs for biomass, the concentration of emissions and other parameters were measured at:

- 11 wood logs burning equipment with a capacity ranging from 5 kW to 1200 kW;
- 8 wood waste (chips) burning equipment with a capacity ranging from 5 kW to 24 MW;

- 29 wood pellet burning equipment with a capacity ranging from 4 kW to 500 kW;
- 5 agricultural waste burning equipment with a capacity ranging from 5 kW to 32 kW.

CH_4 and N_2O emissions concentration from the combustion of biomass (wood logs, wood chips and pellets) were also measured at the stationary combustion equipment: residential sector and commercial/institutional sector. In order to determine the national CH_4 and N_2O EFs for biomass, the concentrations of CH_4 and N_2O emissions and other parameters were measured at 15 biomass burning equipment in residential sector with a capacity ranging from 4 to 24 kW and 11 biomass burning equipment in commercial/institutional sector with a capacity ranging from 30 to 1200 kW. Direct measurements of CH_4 and N_2O emissions from wood, wood waste and wood pellets combusted in equipment of residential and commercial/institutional sectors have shown that modern biofuel (especially wood pellets) boilers are characterised by low CH_4 and N_2O emission factors (Table 7-2).

The comparison of country specific CH_4 and N_2O EFs of biomass for residential sector and commercial/institutional sector with default *2006 IPCC Guidelines* emission factors are presented in Figure 7-2 and Figure 7-3.

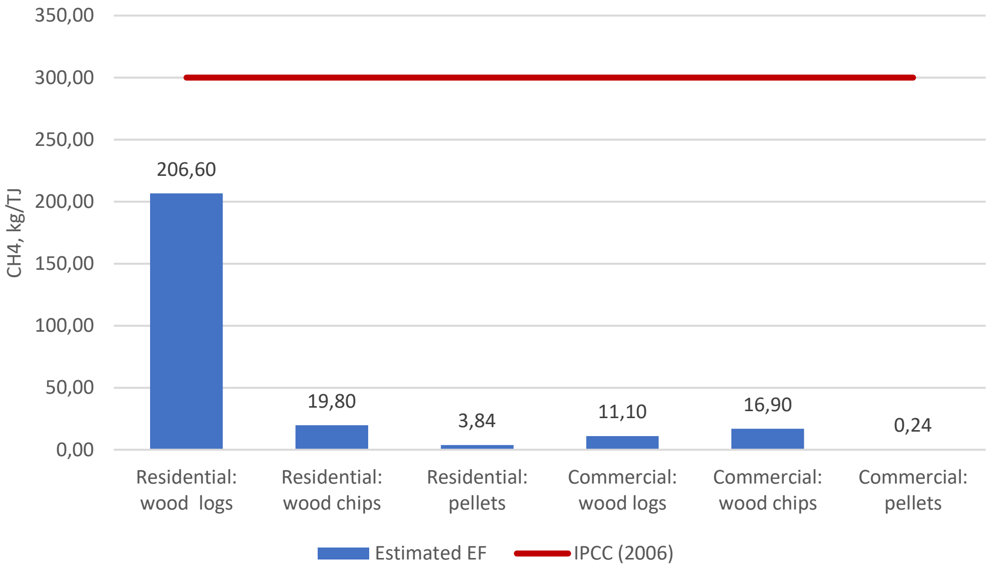


Figure 7-2. Comparison of country specific CH_4 EFs of biomass for residential sector and commercial/institutional sector with default *2006 IPCC Guidelines* emission factors

As it seen from Figure 7-2, estimated CS CH_4 EFs for wood, wood chips and wood pellets burned in residential and commercial/institutional sector have been found to be well below the default (300 kg/TJ) *2006 IPCC Guidelines* emission factors. Only CS CH_4 EF for wood logs burned in residential sector falls into the uncertainty ranges of default *2006 IPCC Guidelines* (100-900 kg/TJ) emission factors.

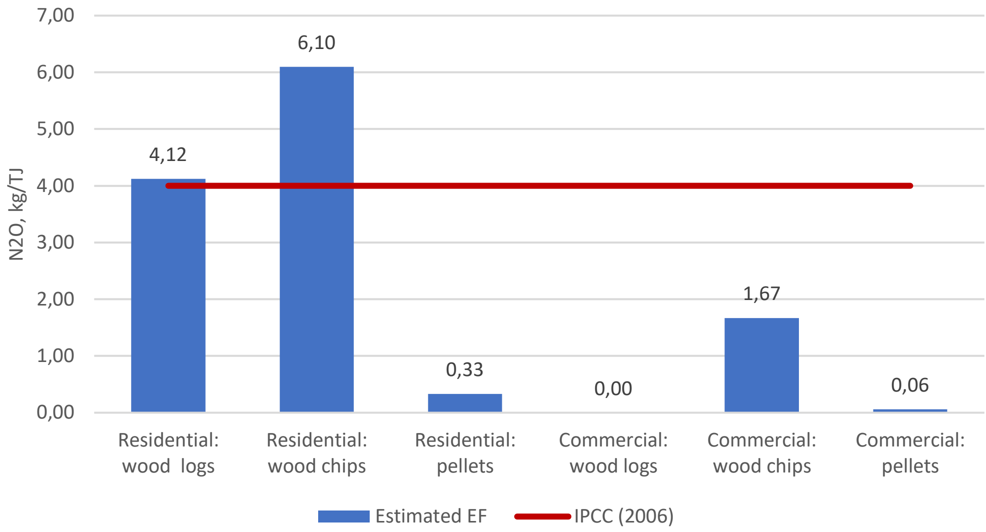


Figure 7-3. Comparison of country specific N_2O EFs of biomass for residential sector and commercial/institutional sector with default *2006 IPCC Guidelines* emission factors

As it seen from Figure 7-3, estimated CS N_2O EFs for wood and wood chips burned in residential and commercial/institutional sector fall within the uncertainty range of *2006 IPCC Guidelines* default values (1,5-15 kg/TJ), except wood pellets. CS N_2O EFs for wood pellets burned in residential and commercial/institutional sector are below the lower limit of *2006 IPCC Guidelines* emission factor uncertainty range.

It is recommended to apply the updated CO_2 EFs and CH_4 and N_2O EFs for wood, wood waste and agricultural waste when accounting GHG emissions from 2023.

CO_2 EFs for municipal and industrial waste (renewable and non-renewable) have been determined on the basis of chemical composition of the fuel obtained from the waste. For the update of CO_2 EFs of municipal and industrial (non-renewable and renewable) waste, a drying oven (for moisture content), a calorimeter (for calorific value), an incinerator (for ash content) and an analyser for the main elements (C, H, N, S) were used.

It should be noted that the waste samples from Lithuanian incinerators were unsorted or only partially sorted during the study, resulting in a mix of municipal and industrial waste, as well as renewable and non-renewable wastes. The study analysed two groups of waste samples: 30 samples in I group and 13 samples in II group. Measurements of municipal and industrial waste (renewable and non-renewable) have shown that the results for the experimental sample of fuels derived from waste are scattered over a wide range due to the wide variation in the samples (Table 7-4).

Table 7-4. CO_2 **EFs of municipal and industrial (RES and non-RES) waste**

Fuel types	CO_2 emission factor, t/TJ			Number of samples
	Min	Average	Max	
Municipal and industrial (RES and non-RES) waste	**65.03**	**115.63**	**182.30**	**43**
I group of samples	74.78	115.17	182.30	30
II group of samples	65.03	116.70	162.78	13

The comparison of updated country specific CO_2 EFs of biomass, municipal and industrial (RES and non-RES) waste with default *2006 IPCC Guidelines* emission factors are presented in Figure 7-4.

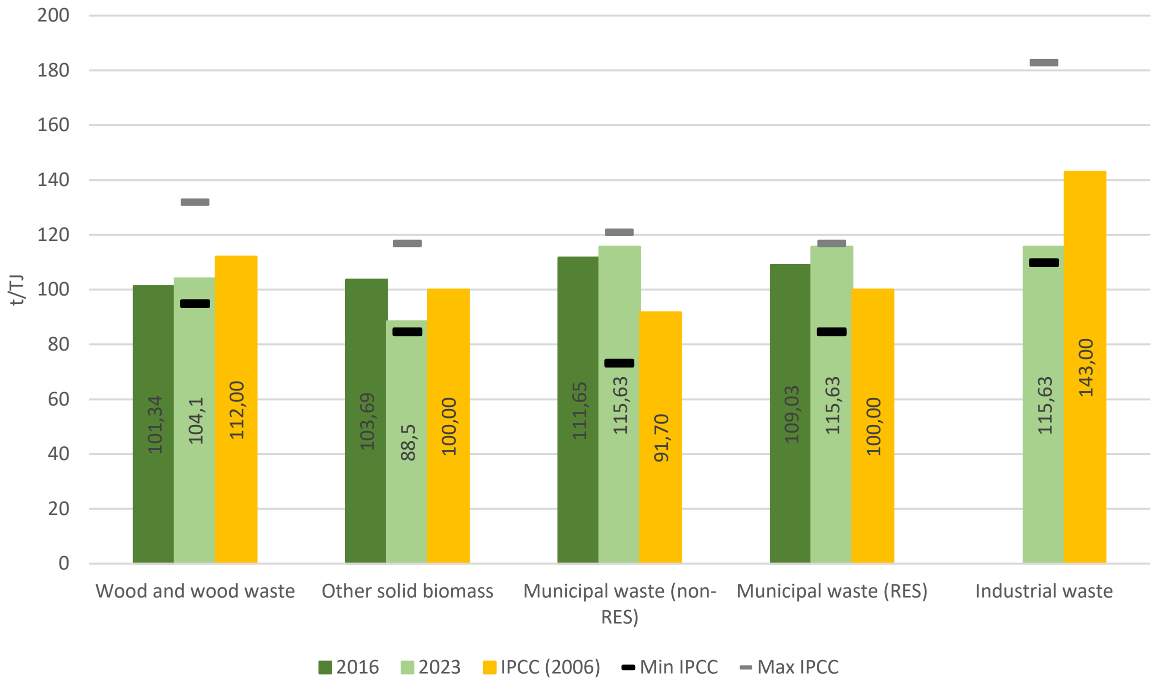


Figure 7-4. Comparison of updated CS CO_2 EFs of biomass, municipal and industrial (RES and non-RES) and default *2006 IPCC Guidelines* emission factors

As it seen from Figure 7-4, updated values of CS CO_2 EFs of biomass, municipal and industrial (RES and non-RES) fall into the uncertainty ranges of *2006 IPCC Guidelines.*

Values of country specific CO_2 EFs for other bituminous coal, petroleum coke and coke are updated on the basis of data provide by the operators under EU ETS and considering to the Tier 3 reliability that ensures the lowest uncertainty of emission factor. Sustaining to the data base of EU ETS, in some cases it is possible to apply EFs set at the plant-specific level. When accounting GHG emissions, it is appropriate to continue apply PS EFs based on the EU ETS Tier 3.

CHPs incinerating municipal and industrial waste use the instrumental measurement method (Tier 4) under EU ETS. Analysis of EU ETS reports of waste-fired CHPs for the period 2016-2022 showed that CO_2 emission factor for municipal and industrial waste varied between 72.46 and 106.76 t/TJ. The average value of CO_2 EF for municipal and industrial waste for the period 2016-2022 was 92.37 t/TJ. The average value of CO_2 EF for municipal and industrial waste is 0.7% higher than the default *2006 IPCC Guidelines* emission factor for municipal waste and 35.4% lower than the default *2006 IPCC Guidelines* emission factor for industrial waste. The instrumental measurement method (Tier 4) used under EU ETS ensures a low uncertainty ±2.5% through continuous monitoring of emissions, therefore it is appropriate to use these measured and verified emissions for the national GHG emissions accounting.

Country specific CO_2 EF for natural gas have not been analysed in this study, as in preparation of the national GHG inventory is applied CS CO_2 EF that varies from year to year, depending on the chemical composition of natural gas.

Preparing the national GHG inventory, it is necessary to evaluate the overall inventory uncertainty, therefore for this purpose, uncertainty estimates of updated EFs have been revised. Considering international practice, uncertainty assessment of CO_2, CH_4 and N_2O emission factors is performed at aggregated sector-specific and fuel type-specific (liquid, solid, gaseous fuel and biomass) levels. Uncertainty estimations of recommended GHG emission factors are presented in Table 7-5.

Table 7-5. Uncertainties of recommended GHG emission factors

IPCC source category	***Fuel type***	**CO_2, %**
1.A.1 Energy industries	Liquid fuel	± 2.0
	Solid fuel	± 5.0
	Natural gas	± 2.0
	Waste	± 2.5
	Biomass	± 8.1
1.A.2 Manufacturing industry and construction	Liquid fuel	± 2.0
	Solid fuel	± 5.0
	Natural gas	± 2.0
	Waste	± 4.0
	Biomass	± 8.1
1.A.3 Transport	Liquid fuel	± 2.0
1.A.4 Other sectors	Liquid fuel	± 2.0
	Solid fuel	± 5.0
	Natural gas	± 2.0
	Biomass	± 8.1

The uncertainties of the aggregated CH_4 and N_2O EFs are very high, as these emission factors are highly dependent on specific combustion technologies. Uncertainties of CH_4 and N_2O EFs for biomass are based on measurements results: CH_4 – ±60%, N_2O – ±40%.

ANNEX VIII. CO_2 emissions from the installations of the GHG registry, 2023

Table 8-1. CO_2 emissions from the installations registered in the GHG Emission Allowance Registry, 2023

No	*Company*	*Name of the Installation*	*Verified emissions, t CO_2*	*Corresponding CRT Sector (Fuel combustion)*
1	AB "Akmenės cementas"	Boiler house, cement production furnace	783,849	1.A.2.F Non-Metallic Minerals
2	AB "Palemono keramikos gamykla"	Boiler house, ceramics combustion furnace	1,671	1.A.2.F Non-Metallic Minerals
3	UAB "Kauno stiklas"	Glass melting furnace	13,695	1.A.2.F Non-Metallic Minerals
4	AB "Panevėžio stiklas"	Glass melting furnace	18,531	1.A.2.F Non-Metallic Minerals
5	AB "ORLEN Lietuva"	Oil refining factory	1,646,257	1.A.1.B Petroleum Refining / 1.A.1.A Public electricity and heat production
6	AB "Grigeo Klaipėda"	Boiler house	8,865	1.A.2.D Pulp, Paper and Print
7	AB "Grigeo"	Boiler house	7,786	1.A.2.D Pulp, Paper and Print
8	AB "Achema"	Boiler houses, CHP	1,363,398	1.A.2.C Chemicals / 1.A.1.A Public electricity and heat production
9	AB "Nordic Sugar Kėdainiai"	Boiler house, oilcake desiccation	28,052	1.A.2.E Food processing, Beverages and Tobacco
10	AB "Lifosa"	Boiler house	4,965	1.A.2.C Chemicals
11	AB "KN Energies"	Boiler house	5,096	1.A.1.A Public electricity and heat production
12	UAB "Lietuvos cukraus fabrikas"	Boiler house	15,763	1.A.2.E Food processing, Beverages and Tobacco
13	AB "Jonavos šilumos tinklai"	Jonava boiler house	0	1.A.1.A Public electricity and heat production
14	UAB "Mažeikių šilumos tinklai"	Mazeikiai boiler house	92	1.A.1.A Public electricity and heat production
15	UAB "Raseinių šilumos tinklai"	Raseiniai boiler house No 4	65	1.A.1.A Public electricity and heat production
16	UAB "Šilutės šilumos tinklai"	Šilute boiler house	0	1.A.1.A Public electricity and heat production
17	UAB "Vilniaus šilumos tinklai"	Vilnius power plant No 2 (E-2)	233,200	1.A.1.A Public electricity and heat production
18	AB "Ignitis gamyba"	Vilnius power plant No 3 (E-3)	0	1.A.1.A Public electricity and heat production
19	UAB "Vilniaus šilumos tinklai"	Vilnius boiler house No 2	4,584	1.A.1.A Public electricity and heat production
20	UAB "Vilniaus šilumos tinklai"	Vilnius boiler house No 8	42	1.A.1.A Public electricity and heat production
21	UAB "Širvintų šiluma"	Širvintu boiler house No 3	0	1.A.1.A Public electricity and heat production

No	Company	Name of the Installation	Verified emissions, t CO_2	Corresponding CRT Sector (Fuel combustion)
22	AB "Šiaulių energija"	Šiauliai southern boiler house	14,056	1.A.1.A Public electricity and heat production
23	AB "Klaipėdos energija"	Power plant	764	1.A.1.A Public electricity and heat production
24	UAB "Radviliškio šiluma"	Radviliškis city boiler house	7	1.A.1.A Public electricity and heat production
25	UAB "Utenos šilumos tinklai"	Utena boiler house	1,086	1.A.1.A Public electricity and heat production
26	UAB "Tauragės šilumos tinklai"	Taurage - Berže boiler house	0	1.A.1.A Public electricity and heat production
27	UAB "Šalčininkų šilumos tiklai"	Šalcininkai boiler house	161	1.A.1.A Public electricity and heat production
28	UAB "Varėnos šiluma"	Varena boiler house	0	1.A.1.A Public electricity and heat production
29	AB "Panevėžio energija"	Panevezio boiler house No 2	6,054	1.A.1.A Public electricity and heat production
30	AB "Panevėžio energija"	Rokiškio boiler house	54	1.A.1.A Public electricity and heat production
31	AB "Panevėžio energija"	Panevezio boiler house No 1	2	1.A.1.A Public electricity and heat production
32	AB "Panevėžio energija"	Pasvalio boiler house	14	1.A.1.A Public electricity and heat production
33	AB "Kauno energija"	Petrašiunai PP	618	1.A.1.A Public electricity and heat production
34	AB "Kauno energija"	Pergale boiler house	588	1.A.1.A Public electricity and heat production
35	AB "Kauno energija"	Šilkas boiler house	1,147	1.A.1.A Public electricity and heat production
36	AB "Kauno energija"	Garliava boiler house	154	1.A.1.A Public electricity and heat production
37	AB "Kauno energija"	Jurbarkas boiler house	1,094	1.A.1.A Public electricity and heat production
38	UAB "Plungės šilumos tinklai"	Plunge boiler house No 1	4,786	1.A.1.A Public electricity and heat production
39	UAB "Litesko"	Druskininkai industry boiler house	1,341	1.A.1.A Public electricity and heat production
40	UAB "Vilkaviškio šilumos tinklai"	Vilkaviškis boiler house	76	1.A.1.A Public electricity and heat production
41	UAB "Litesko"	Luoke boiler house	23	1.A.1.A Public electricity and heat production
42	UAB "Palangos šilumos tinklai"	Palanga boiler house	868	1.A.1.A Public electricity and heat production
43	UAB "Litesko"	Marijampole region boiler house	2,628	1.A.1.A Public electricity and heat production
44	UAB "Alytaus šilumos tinklai"	Alytus boiler house	6,156	1.A.1.A Public electricity and heat production
45	AB "Ignitis gamyba"	Lietuvos PP	128,564	1.A.1.A Public electricity and heat production

No	Company	Name of the Installation	Verified emissions, t CO_2	Corresponding CRT Sector (Fuel combustion)
46	UAB "Kauno termofikacijos elektrinė"	Kaunas PP	1,135	1.A.1.A Public electricity and heat production
47	UAB "Kaišiadorių šiluma"	Kaišiadoriai boiler house	0	1.A.1.A Public electricity and heat production
48	UAB "Kretingos šilumos tinklai"	Kretinga boiler house No 3	0	1.A.1.A Public electricity and heat production
49	AB "Klaipėdos energija"	Klaipeda region boiler house	5,974	1.A.1.A Public electricity and heat production
50	AB "Klaipėdos energija"	Lypkiai regiopn boiler house	1,079	1.A.1.A Public electricity and heat production
51	VĮ "Ignalinos atominė elektrinė"	Boiler house	4,870	1.A.4.A Commercial/institutional
52	UAB "Gren Trakai"	Lentvaris boiler house	0	1.A.1.A Public electricity and heat production
53	UAB "Gren Akmenė"	Zalgiris boiler house	1,124	1.A.1.A Public electricity and heat production
54	AB "Panevėžio energija"	Panevežys thermal PP	3,332	1.A.1.A Public electricity and heat production
55	UAB "IKEA Industry Lietuva"	Fuel combustion plants	14,226	1.A.2.G.iv Wood and wood products
56	UAB "NEO Group"	Boiler house	18,203	1.A.2.C Chemicals
57	AB "Panevėžio energija"	Kėdainiai region boiler house	15,127	1.A.1.A Public electricity and heat production
58	UAB "Paroc"	Plants producing stone-wool	49,235	1.A.2.F Non-Metallic Minerals
59	AB "Vilniaus GKG-3"	Boiler house	25	1.A.2.G.v Construction
60	AB “Vilniaus šilumos tinklai”	Boiler house No 7	0	1.A.1.A Public electricity and heat production
61	VĮ "Visagino energija"	Thermal boiler house	6,856	1.A.1.A Public electricity and heat production
62	AB "Roquette Amilina"	Boiler house and driers	1,676	1.A.2.E Food processing, Beverages and Tobacco
63	AB " Roquette Amilina"	Boiler house	0	1.A.2.E Food processing, Beverages and Tobacco
64	AB "Amber Grid"	Jauniūnų gas compressor station	8,089	1.A.3.E.i Pipeline transport
65	UAB "Hoegh LNG Klaipėda"	LNG ship	94,023	1.A.1.C.iii Other energy industries
66	UAB “Gren Klaipėda”	Power plant	100,151	1.A.1.A Public electricity and heat production
67	UAB “Idex Biruliškių”	Boiler house	158	1.A.1.A Public electricity and heat production
68	UAB “Idex Paneriškių”	Boiler house	155	1.A.1.A Public electricity and heat production
69	UAB “Kauno kogeneracine jėgainė”	Power plant	119,661	1.A.1.A Public electricity and heat production

No	***Company***	***Name of the Installation***	***Verified emissions, t CO_2***	***Corresponding CRT Sector (Fuel combustion)***
70	UAB “VMG Wood Solutions”	Boiler house and dryer	802	1.A.2.G.iv Wood and Wood Products
		Total	**4,752,053**	

Source: https://apva.lrv.lt/public/canonical/1728989138/790/Atsiskaitymas%20uz%202023%20(4).pdf

ANNEX IX. Additional information of Agriculture sector

Other relevant information

Figure below shows impact of milk yield on GE and EFs.

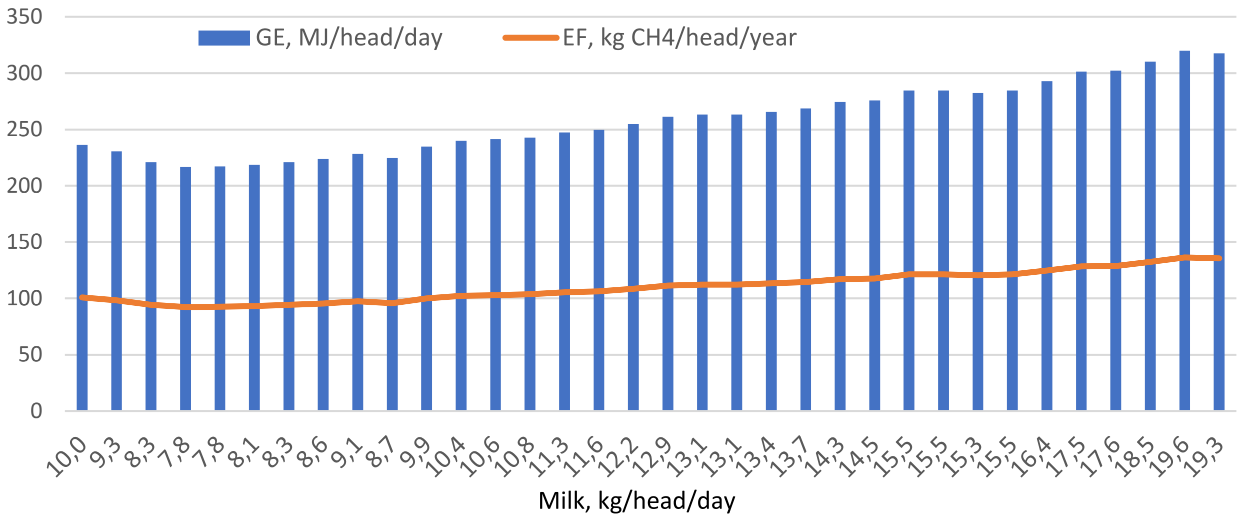


Figure A.5-1. Impact of milk yield on GE and EF's

Milk yield, gross energy, and emission factors are indeed closely related. There are positive relationships between milk production and gross energy, meaning that higher milk yield is often associated with higher levels of gross energy. Similarly, there are positive relationships between milk yield and emission factors, indicating that higher milk production can result in increased emission factors.

Figure below shows distribution of horses by breeds in 2023.

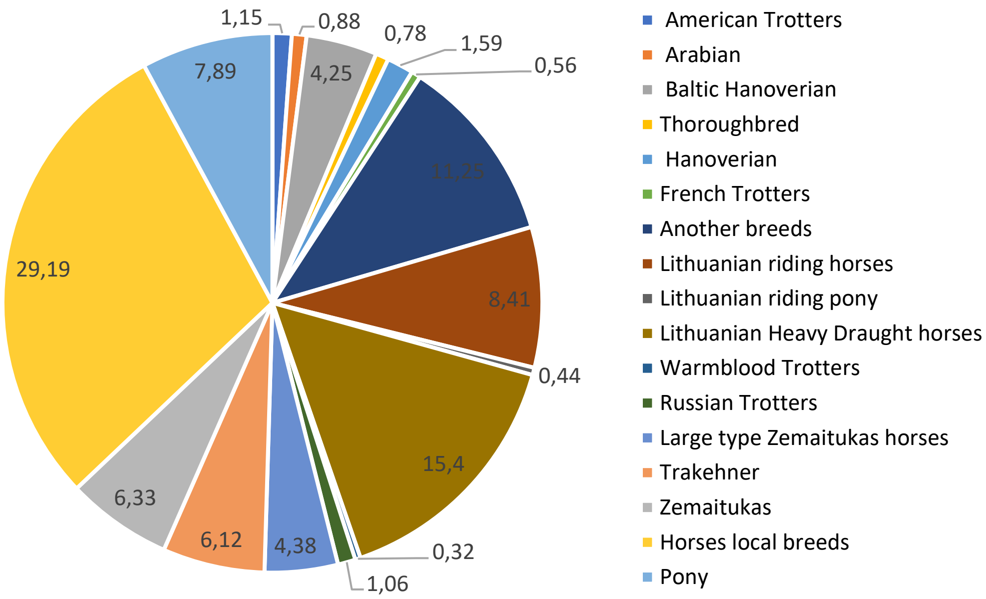


Figure A.5-2. Distribution by breeds of horses, %

Local breeds horses with no known origins constitute about 29.2% of grown horses breeds in Lithuania.

Table A. 5-1. Methane conversion factors values estimated in enteric fermentation category

Year	Methane conversion factor, %			
	Dairy cattle	Non-dairy cattle	Sheep	Swine
1990	6.50	6.44	5.98	0.596
1995	6.50	6.44	5.98	0.596
2000	6.50	6.43	5.98	0.597
2005	6.50	6.42	5.98	0.597
2010	6.50	6.43	5.98	0.596
2015	6.50	6.44	6.00	0.597
2016	6.50	6.44	5.99	0.597
2017	6.50	6.44	5.97	0.597
2018	6.50	6.44	5.96	0.597
2019	6.50	6.44	5.97	0.597
2020	6.50	6.44	5.97	0.597
2021	6.50	6.45	5.97	0.597
2022	6.50	6.45	5.97	0.597
2023	6.50	6.45	5.98	0.597

Table A. 5-2. Changes in dairy cattle population, milk yield, GE, CH_4 EF per cow and methane emission, % (1990=100%)

Year	Population of Dairy cattle	Milk production (4% of milk fat, 3.4% of milk protein)	GE	CH_4 **EF**	Emissions
1990	100	100	100	100	100
1995	71	81	93	93	66
2000	55	99	99	99	55
2005	50	116	106	106	53
2010	43	134	112	112	49
2015	36	155	120	120	44
2016	35	153	120	120	41
2017	33	155	120	120	40
2018	31	164	124	124	39
2019	29	175	128	128	38
2020	28	176	128	128	36
2021	27	185	131	131	36
2022	27	196	135	135	36
2023	26	193	134	134	35

Table A. 5-3. The number of swine and dairy cattle and fraction of swine and dairy cattle manure managed in liquid MMS

Year	Swine, thous. heads	Dairy cattle, thous. heads	Manure Management System			
			Liquid manure, %		Liquid manure, % (Anaerobic digesters)	
			Swine	Dairy cattle	Swine	Dairy cattle
1990	2,577.35	-	16.0	12.0	-	-
1995	1,266.28	-	32.07	15.68	-	-
2000	895.89	-	48.13	19.35	-	-
2005	1,094.00	-	61.05	23.03	3.15	-
2010	928.79	-	76.47	26.71	3.8	-
2015	700.99	-	81.29	30.38	6.13	-
2016	675.87	-	65.09	31.12	22.78	-
2017	637.92	-	59.11	31.85	29.21	-
2018	591.97	-	56.06	32.59	32.71	-

2019	561.43	-	53.97	33.32	35.25	-
2020	565.61	-	55.51	34.21	34.16	-
2021	577.59	-	57.54	35.6	32.58	-
2022	546.83	0,12	56.53	36.74	34.04	0.05
2023	508.44	-	53.47	38.08	37.55	-

Table A. 5-4. The number of breeding and market swine in the population, thous. head

Year	Breeding swine	Marked swine	Weight, kg
1990	257.5	2,319.9	64.8
1995	171.8	1,094.4	70.1
2000	84.2	811.7	63.9
2005	99.3	994.7	63.4
2010	84.1	844.7	63.4
2015	55.5	645.4	61.7
2016	51.7	624.2	61.3
2017	49.6	588.3	61.5
2018	47.7	544.3	61.9
2019	44.3	517.1	61.7
2020	44.3	521.3	61.6
2021	45.7	531.9	61.7
2022	43.4	503.4	61.8
2023	41.1	467.4	61.9

Nutritional value of diet for cattle subcategories

Table A. 5 – 5. Nutritional standards for dairy cattle (Livestock manual[1])

Item	Quantity of milk/day (4% of milk fat, 3.4% of milk protein)		
	10	**15**	**20**
Dry matter, kg	12.7	15.1	17.0
Crude protein, g	1,524.0	2,038.0	2,550.0
Crude fat, g	279.0	362.0	459.0
Crude fiber, g	3,048.0	3,473.0	3,740.0
Nitrogen-free extract, g (in accordance by used feeds, identified based on the study data)	6,350.0	7,420.0	8,990.0

Table A. 5 – 6. Nutritional value of diet for dairy cattle (The study data[2])

Item	Quantity of milk/day (4% of milk fat, 3.4% of milk protein)		
	25	**15**	**25**
Dry matter, kg	18.8	Dry matter, kg	18.8
Crude protein, g	2,914.0	Crude protein, g	2,914.0
Crude fat, g	602.0	Crude fat, g	602.0
Crude fiber, g	3,948.0	Crude fiber, g	3,948.0
Nitrogen-free extract, g	10,186.0	Nitrogen-free extract, g	10,186.0

Table A. 5 - 7. Nutritional value of diet for dairy cattle in 1990-2023

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	13.35	1,717.13	314.33	3,035.51	6,955.10

[1] Gyvulininkystės žinynas. Baisogala (en. Livestock manual. Institute of Animal Science of LVA), 2007.

[2] Studija „Pašarų virškinamumo nacionalinių verčių nustatymas klasikiniu in vivo metodu, tobulinant Lietuvos šiltnamio efektą sukeliančių dujų apskaitos metodologiją“ (en. The study "Determination of national values of feed digestibility by the classic in vivo method, improving the Lithuanian greenhouse gas accounting methodology"), Baisogala, 2022

1995	12.53	1,529.95	271.15	2,915.18	6,442.19
2000	13.28	1,701.53	310.73	3,025.48	6,912.36
2005	13.96	1,857.52	346.72	3,125.75	7,339.79
2010	14.71	2,029.10	386.30	3,236.05	7,809.96
2015	15.59	2,231.87	433.09	3,366.41	8,365.61
2016	15.49	2,208.47	427.69	3,351.37	8,301.50
2017	15.59	2,231.87	433.09	3,366.41	8,365.61
2018	15.96	2,317.66	452.88	3,421.56	8,600.70
2019	16.37	2,411.25	474.47	3,481.73	8,857.16
2020	16.41	2,419.05	476.27	3,486.74	8,878.53
2021	16.78	2,504.84	496.07	3,541.89	9,113.61
2022	17.22	2,606.23	519.46	3,607.07	9,391.44
2023	17.12	2,582.83	514.06	3,592.03	9,327.33

Table A. 5 - 8. Nutritional value of diet for Non-dairy cattle suckler cows

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1997[3]	11.98	1,671.26	399.07	3,461.35	5,477.45
2000	12.28	1,701.23	402.45	3,442.22	5,774.96
2005	12.79	1,751.17	408.08	3,410.33	6,270.80
2010	13.29	1,801.12	413.71	3,378.45	6,766.64
2015	13.80	1,851.06	419.34	3,346.56	7,262.49
2016	13.90	1,861.05	420.47	3,340.19	7,361.66
2017	14.00	1,871.04	421.60	3,333.81	7,460.83
2018	14.10	1,881.03	422.72	3,327.43	7,559.99
2019	14.20	1,891.02	423.85	3,321.05	7,659.16
2020	14.30	1,901.01	424.97	3,314.68	7,758.33
2021-2023	14.40	1,911.00	426.10	3,308.30	7,857.50

Non-dairy cattle less than 1 year old

Table A. 5 - 9. Nutritional value of diet for Calves for slaughter

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	4.98	777.76	194.24	1,143.80	2,374.46
1995	5.05	751.20	190.47	1,181.96	2,462.73
2000	5.26	744.10	185.91	1,261.38	2,621.39
2005	5.49	739.16	181.54	1,344.56	2,787.37
2010	5.69	731.87	177.54	1,420.86	2,941.69
2015	5.93	727.20	172.76	1,508.78	3,115.66
2016	5.99	727.14	171.90	1,528.35	3,154.36
2017	6.04	726.05	170.85	1,546.17	3,189.45
2018	6.08	724.02	169.83	1,561.25	3,219.54
2019	6.11	721.74	168.67	1,576.08	3,248.88
2020	6.16	720.12	167.57	1,592.34	3,281.00
2021	6.19	717.67	166.75	1,605.07	3,307.14
2022	6.21	719.50	166.78	1,610.42	3,317.11
2023	6.20	719.16	166.79	1,609.37	3,315.18

Table A. 5 – 10. Nutritional value of diet for Bulls for breeding

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	5.49	873.22	215.24	1,271.96	2,602.31

[3] Jukna Č., Jukna V. Mėsinių galvijų auginimas (en. Beef cattle rearing), 2004, Kaunas

1995	5.62	849.73	207.12	1,331.40	2,726.03
2000	5.75	826.24	199.00	1,390.84	2,849.76
2005	5.88	802.76	190.88	1,450.29	2,973.48
2010	6.01	779.27	182.76	1,509.73	3,097.21
2015	6.14	755.78	174.64	1,569.17	3,220.93
2016	6.17	751.09	173.02	1,581.06	3,245.68
2017	6.19	746.39	171.40	1,592.95	3,270.42
2018	6.22	741.69	169.77	1,604.83	3,295.17
2019	6.25	736.99	168.15	1,616.72	3,319.91
2020	6.27	732.30	166.52	1,628.61	3,344.66
2021-2023	6.30	727.60	164.90	1,640.50	3,369.40

Table A. 5 – 11. Nutritional value of diet for Heifers for breeding

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	4.28	706.39	178.80	981.12	2,014.97
1995	4.60	709.81	176.56	1,087.47	2,233.43
2000	4.93	713.23	174.32	1,193.83	2,451.89
2005	5.26	716.65	172.07	1,300.18	2,670.34
2010	5.58	720.07	169.83	1,406.53	2,888.80
2015	5.91	723.49	167.59	1,512.88	3,107.25
2016	5.97	724.18	167.14	1,534.15	3,150.94
2017	6.04	724.86	166.69	1,555.42	3,194.64
2018	6.10	725.55	166.25	1,576.69	3,238.33
2019	6.17	726.23	165.80	1,597.96	3,282.02
2020	6.23	726.92	165.35	1,619.23	3,325.71
2021-2023	6.30	727.60	164.90	1,640.50	3,369.40

Non-dairy cattle from 1 to 2 years old

Table A. 5 - 12. Nutritional value of diet for Bulls

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	10.15	1475.66	322.92	2,497.39	4,754.25
1995	10.01	1410.23	309.95	2,483.70	4,786.63
2000	9.86	1344.80	296.98	2,470.01	4,819.01
2005	9.72	1279.37	284.01	2,456.32	4,851.39
2010	9.58	1213.94	271.04	2,442.62	4,883.76
2015	9.44	1148.52	258.07	2,428.93	4,916.14
2016	9.41	1135.43	255.47	2,426.19	4,922.62
2017	9.38	1122.34	252.88	2,423.45	4,929.10
2018	9.35	1109.26	250.28	2,420.72	4,935.57
2019	9.33	1096.17	247.69	2,417.98	4,942.05
2020	9.30	1083.09	245.09	2,415.24	4,948.52
2021-2023	9.27	1070.00	242.50	2,412.50	4,955.00

Table A. 5 – 13. Nutritional value of diet for Heifers for slaughter

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	8.60	1,236.08	296.71	2,253.01	3,707.39
1995	8.71	1,209.29	287.97	2,278.73	3,908.62
2000	8.82	1,182.51	279.22	2,304.46	4,109.85
2005	8.93	1,155.72	270.48	2,330.18	4,311.07
2010	9.03	1,128.93	261.74	2,355.91	4,512.30
2015	9.14	1,102.14	252.99	2,381.63	4,713.53
2016	9.16	1,096.79	251.24	2,386.78	4,753.77

2017	9.18	1,091.43	249.49	2,391.92	4,794.02
2018	9.21	1,086.07	247.75	2,397.07	4,834.26
2019	9.23	1,080.71	246.00	2,402.21	4,874.51
2020	9.25	1,075.36	244.25	2,407.36	4,914.75
2021-2023	9.27	1,070.00	242.50	2,412.50	4,955.00

Table A. 5 – 14. . Nutritional value of diet for Heifers for breeding

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	7.66	1,078.59	243.91	2,162.28	3,336.85
1995	7.92	1,077.20	243.69	2,202.64	3,597.84
2000	8.18	1,075.82	243.46	2,243.00	3,858.83
2005	8.44	1,074.43	243.23	2,283.36	4,119.82
2010	8.70	1,073.05	243.00	2,323.71	4,380.82
2015	8.96	1,071.66	242.77	2,364.07	4,641.81
2016	9.01	1,071.39	242.73	2,372.14	4,694.01
2017	9.06	1,071.11	242.68	2,380.21	4,746.21
2018	9.11	1,070.83	242.64	2,388.29	4,798.40
2019	9.17	1,070.55	242.59	2,396.36	4,850.60
2020	9.22	1,070.28	242.55	2,404.43	4,902.80
2021-2023	9.27	1,070.00	242.50	2,412.50	4,955.00

Non-dairy cattle 2 years old and older

Table A. 5 – 15. Nutritional value of diet for Dairy and non-dairy cattle sires bulls

Item	Dairy cattle sires bulls	Non-dairy cattle sires bulls
	Accounting year	
	1990 - 2023	1990 - 2023
Dry matter, kg	12.00	11.00
Crude protein, g	1,746.30	1,605.76
Crude fat, g	380.38	387.34
Crude fiber, g	3,165.50	3,229.45
Nitrogen-free extract, g	5,816.16	4,820.43

Table A. 5 – 16. Nutritional value of diet for other bulls

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	9.89	1,450.75	317.38	2,497.85	4,556.17
1995	10.08	1,423.85	313.13	2,561.91	4,780.34
2000	10.28	1,396.96	308.87	2,625.96	5,004.50
2005	10.47	1,370.06	304.62	2,690.02	5,228.67
2010	10.67	1,343.17	300.36	2,754.08	5,452.83
2015	10.86	1,316.27	296.11	2,818.13	5,677.00
2016	10.90	1,310.90	295.26	2,830.94	5,721.83
2017	10.94	1,305.52	294.40	2,843.75	5,766.67
2018	10.98	1,300.14	293.55	2,856.57	5,811.50
2019	11.02	1,294.76	292.70	2,869.38	5,856.33
2020	11.06	1,289.38	291.85	2,882.19	5,901.17
2021-2023	11.10	1,284.00	291.00	2,895.00	5,946.00

Table A. 5 – 17. Nutritional value of heifer diet for slaughter

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	9.25	1,405.66	303.75	2,385.28	4,442.66
1995	9.55	1,386.04	301.69	2,467.49	4,685.14
2000	9.85	1,366.41	299.64	2,549.70	4,927.61

2005	10.15	1,346.79	297.58	2,631.92	5,170.08
2010	10.44	1,327.17	295.52	2,714.13	5,412.56
2015	10.74	1,307.55	293.47	2,796.34	5,655.03
2016	10.80	1,303.62	293.06	2,812.79	5,703.53
2017	10.86	1,299.70	292.65	2,829.23	5,752.02
2018	10.92	1,295.77	292.23	2,845.67	5,800.52
2019	10.98	1,291.85	291.82	2,862.11	5,849.01
2020	11.04	1,287.92	291.41	2,878.56	5,897.51
2021-2023	11.10	1,284.00	291.00	2,895.00	5,946.00

Table A. 5 – 18. Nutritional value of diet for breeding heifers

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	9.24	1,384.40	304.08	2,483.01	4,342.80
1995	9.54	1,368.20	301.97	2,549.46	4,601.38
2000	9.84	1,352.01	299.86	2,615.91	4,859.96
2005	10.14	1,335.82	297.75	2,682.36	5,118.54
2010	10.44	1,319.62	295.64	2,748.81	5,377.12
2015	10.74	1,303.43	293.53	2,815.26	5,635.70
2016	10.80	1,300.19	293.11	2,828.55	5,687.42
2017	10.86	1,296.95	292.69	2,841.84	5,739.14
2018	10.92	1,293.72	292.27	2,855.13	5,790.85
2019	10.98	1,290.48	291.84	2,868.42	5,842.57
2020	11.04	1,287.24	291.42	2,881.71	5,894.28
2021-2023	11.10	1,284.00	291.00	2,895.00	5,946.00

Table A. 5 – 19. Nutritional value of diet for non-dairy cattle other cow

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	11.87	1,700.03	389.10	3,247.83	5,168.79
1995	11.94	1,690.02	384.89	3,181.24	5,418.98
2000	12.01	1,680.02	380.68	3,114.66	5,669.18
2005	12.08	1,670.01	376.47	3,048.07	5,919.37
2010	12.15	1,660.01	372.26	2,981.49	6,169.57
2015	12.22	1,650.01	368.05	2,914.90	6,419.77
2016	12.23	1,648.00	367.21	2,901.58	6,469.80
2017	12.24	1,646.00	366.37	2,888.27	6,519.84
2018	12.26	1,644.00	365.53	2,874.95	6,569.88
2019	12.27	1,642.00	364.68	2,861.63	6,619.92
2020	12.29	1,640.00	363.84	2,848.32	6,669.96
2021-2023	12.30	1,638.00	363.00	2,835.00	6,720.00

Nutritional value of diet for swine subcategories

Breeding Sows

Table A. 5- 20. Nutritional value of diet for Mated

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	1.80	273.41	69.12	142.23	1,206.98
1995	1.82	285.30	68.37	131.11	1,229.57
2000	1.84	297.20	67.62	119.98	1,252.16
2005	1.86	309.09	66.87	108.86	1,274.76
2010	1.88	320.99	66.11	97.73	1,297.35
2015	1.90	332.89	65.36	86.61	1,319.95
2016	1.90	335.26	65.21	84.38	1,324.47

2017	1.91	337.64	65.06	82.16	1,328.98
2018	1.91	340.02	64.91	79.93	1,333.50
2019	1.91	342.40	64.76	77.71	1,338.02
2020	1.92	344.78	64.61	75.48	1,342.54
2021-2023	1.92	347.16	64.46	73.26	1,347.06

Table A. 5- 21. Nutritional value of diet for Nursing young

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	4.67	919.00	171.49	330.28	2,944.03
1995	4.70	918.47	182.05	311.02	2,979.34
2000	4.73	917.95	192.62	291.77	3,014.65
2005	4.75	917.43	203.18	272.51	3,049.96
2010	4.78	916.90	213.75	253.26	3,085.27
2015	4.81	916.38	224.31	234.01	3,120.58
2016	4.81	916.27	226.43	230.15	3,127.64
2017	4.82	916.17	228.54	226.30	3,134.70
2018	4.82	916.06	230.65	222.45	3,141.76
2019	4.83	915.96	232.76	218.60	3,148.83
2020	4.83	915.85	234.88	214.75	3,155.89
2021-2023	4.84	915.75	236.99	210.90	3,162.95

Replacement Sows

Table A. 5- 22. Nutritional value of diet for mated

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	1.89	305.19	78.06	150.40	1,231.32
1995	1.92	315.78	76.58	138.76	1,264.80
2000	1.94	326.36	75.09	127.13	1,298.28
2009	1.99	345.42	72.42	106.18	1,358.55
2010	1.99	347.54	72.12	103.86	1,365.25
2015	2.02	358.13	70.64	92.22	1,398.73
2016	2.02	360.24	70.34	89.90	1,405.43
2017	2.03	362.36	70.05	87.57	1,412.12
2018	2.03	364.48	69.75	85.24	1,418.82
2019	2.04	366.60	69.45	82.91	1,425.52
2020	2.04	368.71	69.16	80.59	1,432.21
2021-2023	2.05	370.83	68.86	78.26	1,438.91

Table A. 5- 23. Nutritional value of diet for Nursing young

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	5.43	1,055.98	196.15	383.65	3,430.78
1995	5.39	1,044.01	205.49	358.24	3,424.35
2000	5.35	1,032.03	214.83	332.83	3,417.92
2005	5.31	1,020.06	224.17	307.41	3,411.49
2010	5.27	1,008.09	233.52	282.00	3,405.06
2015	5.24	996.12	242.86	256.59	3,398.63
2016	5.23	993.72	244.73	251.51	3,397.34
2017	5.22	991.33	246.60	246.43	3,396.05
2018	5.21	988.93	248.46	241.35	3,394.77
2019	5.21	986.54	250.33	236.26	3,393.48
2020	5.20	984.14	252.20	231.18	3,392.20
2021-2023	5.19	981.75	254.07	226.10	3,390.91

Growing swine

Table A. 5- 24. Nutritional value of diet for piglets till 20 kg

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	0.68	156.29	14.29	25.84	429.07
1995	0.64	147.84	15.70	23.40	408.47
2000	0.61	139.38	17.12	20.96	387.87
2005	0.58	130.93	18.53	18.52	367.27
2010	0.54	122.48	19.95	16.08	346.68
2015	0.51	114.02	21.36	13.64	326.08
2016	0.50	112.33	21.65	13.15	321.96
2017	0.50	110.64	21.93	12.66	317.84
2018	0.49	108.95	22.21	12.17	313.72
2019	0.48	107.26	22.49	11.69	309.60
2020	0.48	105.57	22.78	11.20	305.48
2021-2023	0.47	103.88	23.06	10.71	301.36

Table A. 5- 25. Nutritional value of diet for growing pigs (20-50 kg)

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	1.53	305.42	52.19	78.28	996.58
1995	1.56	315.3	52.17	75.00	1,021.91
2000	1.59	325.1	52.15	71.71	1,047.24
2005	1.62	334.9	52.14	68.43	1,072.57
2010	1.65	344.8	52.12	65.15	1,097.90
2015	1.67	354.6	52.10	61.86	1,123.23
2016	1.68	356.6	52.10	61.20	1,128.30
2017	1.69	358.5	52.09	60.55	1,133.37
2018	1.69	360.5	52.09	59.89	1,138.43
2019	1.70	362.5	52.09	59.23	1,143.50
2020	1.70	364.5	52.08	58.58	1,148.56
2021-2023	1.71	366.42	52.08	57.92	1,153.63

Table A. 5- 26. Nutritional value of diet for growing pigs (50-80 kg)

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	2.28	385.25	72.69	114.67	1,582.47
1995	2.30	399.93	72.20	111.91	1,599.27
2000	2.33	414.62	71.71	109.15	1,616.07
2005	2.35	429.31	71.22	106.39	1,632.87
2010	2.38	443.99	70.73	103.64	1,649.68
2015	2.40	458.68	70.24	100.88	1,666.48
2016	2.41	461.61	70.14	100.33	1,669.84
2017	2.41	464.55	70.04	99.78	1,673.20
2018	2.42	467.49	69.94	99.22	1,676.56
2019	2.42	470.43	69.85	98.67	1,679.92
2020	2.43	473.36	69.75	98.12	1,683.28
2021-2023	2.43	476.30	69.65	97.57	1,686.64

Table A. 5- 27. Nutritional value of diet for growing pigs 80-110 kg

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	2.50	418.26	78.32	124.89	1,735.60
1995	2.52	434.15	77.88	121.83	1,750.86

2000	2.54	450.05	77.44	118.76	1,766.11
2005	2.57	465.95	77.00	115.69	1,781.37
2010	2.59	481.85	76.55	112.63	1,796.63
2015	2.61	497.75	76.11	109.56	1,811.88
2016	2.62	500.93	76.02	108.95	1,814.93
2017	2.62	504.11	75.93	108.33	1,817.99
2018	2.63	507.29	75.85	107.72	1,821.04
2019	2.63	510.47	75.76	107.11	1,824.09
2020	2.64	513.65	75.67	106.49	1,827.14
2021-2023	2.64	516.83	75.58	105.88	1,830.19

Table A. 5-28. Nutritional value of diet for pigs >110 kg (8 month and more)

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	2.43	408.14	76.94	121.66	1,682.98
1995	2.46	425.67	76.72	119.11	1,706.72
2000	2.50	443.20	76.50	116.57	1,730.47
2005	2.53	460.73	76.28	114.02	1,754.21
2010	2.56	478.26	76.06	111.48	1,777.95
2015	2.60	495.79	75.84	108.93	1,801.70
2016	2.61	499.30	75.80	108.43	1,806.45
2017	2.61	502.81	75.76	107.92	1,811.19
2018	2.62	506.31	75.71	107.41	1,815.94
2019	2.63	509.82	75.67	106.90	1,820.69
2020	2.63	513.32	75.62	106.39	1,825.44
2021-2023	2.64	516.83	75.58	105.88	1,830.19

Table A. 5- 29. Nutritional value of diet for gilts for breed

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	1.93	341.14	73.16	137.64	1,220.78
1995	2.00	353.82	73.93	129.73	1,286.57
2000	2.06	366.50	74.70	121.82	1,352.37
2005	2.12	379.18	75.47	113.90	1,418.17
2010	2.18	391.86	76.24	105.99	1,483.97
2015	2.25	404.53	77.01	98.08	1,549.76
2016	2.26	407.07	77.17	96.49	1,562.92
2017	2.27	409.61	77.32	94.91	1,576.08
2018	2.28	412.14	77.48	93.33	1,589.24
2019	2.30	414.68	77.63	91.75	1,602.40
2020	2.31	417.21	77.79	90.16	1,615.56
2021-2023	2.32	419.75	77.94	88.58	1,628.72

Boars

Table A. 5- 30. Nutritional value of diet for mature

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	2.12	389.95	79.82	165.90	1,349.83
1995	2.20	408.37	81.22	158.84	1,409.54
2000	2.27	426.79	82.62	151.78	1,469.24
2005	2.34	445.21	84.02	144.72	1,528.95
2010	2.42	463.63	85.42	137.66	1,588.65
2015	2.49	482.05	86.82	130.60	1,648.35
2016	2.51	485.74	87.10	129.19	1,660.30
2017	2.52	489.42	87.38	127.78	1,672.24

2018	2.54	493.11	87.66	126.37	1,684.18
2019	2.55	496.79	87.94	124.95	1,696.12
2020	2.57	500.48	88.22	123.54	1,708.06
2021-2023	2.58	504.16	88.50	122.13	1,720.00

Table A. 5- 31. Nutritional value of diet for young for breed

Year	Dry matter, kg	Crude protein, g	Crude fat, g	Crude fibre, g	Nitrogen-free extract, g
1990	2.18	391.76	85.71	161.50	1,346.76
1995	2.21	403.00	84.95	153.48	1,382.86
2000	2.24	414.24	84.19	145.46	1,418.96
2005	2.27	425.47	83.43	137.44	1,455.06
2010	2.30	436.71	82.67	129.42	1,491.17
2015	2.33	447.95	81.91	121.40	1,527.27
2016	2.33	450.19	81.76	119.80	1,534.49
2017	2.34	452.44	81.61	118.20	1,541.71
2018	2.34	454.69	81.46	116.59	1,548.93
2019	2.35	456.94	81.30	114.99	1,556.15
2020	2.35	459.18	81.15	113.38	1,563.37
2021-2023	2.36	461.43	81.00	111.78	1,570.59

Average diet nutrition indicators for different livestock categories

Average diet nutrition indicators that were used to estimate gross energy for different livestock categories (dairy cattle, non-dairy cattle, swine and sheep)

Table A. 5-32. Digestibility coefficients for cattle diet, %

Item	Cattle less 1 year	Cattle from 1 to 2 years	Cattle 2 years and older	Dairy cows	Suckling cows	Other cows
Dry matter	63.97	65.13	65.13	67.68	66.51	66.51
Crude protein	53.97	55.84	55.84	65.21	64.95	64.95
Crude fat	59.85	62.70	62.70	60.57	60.06	60.06
Crude fiber	60.39	63.65	63.65	63.94	61.97	61.97
Nitrogen-free extract	71.51	72.45	72.45	73.20	72.50	72.50
Organic matter	66.20	67.79	67.79	69.59	67.64	67.64

Table A.5-33. Digestibility coefficients for swine diet, %

Sub-category of swine	Dry matter	Crude protein	Crude fat	Crude fiber	Nitrogen-free extract	Organic matter
Piglets till 20 kg	83.62	85.92	68.04	25.14	87.65	86.27
Growing pigs 20-50 kg	83.62	85.92	68.04	25.14	87.65	86.27
Growing pigs 50-80 kg	83.27	85.18	67.99	22.24	89.55	85.08
Growing pigs 80-110 kg	83.50	87.15	68.75	23.66	88.96	85.32
Pigs >8 month	83.50	87.15	68.75	23.66	88.96	85.32
Sows main mated	81.15	82.55	70.59	22.32	87.17	83.12
Sows main nursing young	81.15	82.55	70.59	22.32	87.17	83.12
Sows replacement mated	81.15	82.55	70.59	22.32	87.17	83.12
Sows replacement nursing young	81.15	82.55	70.59	22.32	87.17	83.12
Gilts for breeding	81.15	82.55	70.59	22.32	87.17	83.12
Boars Young for breeding	81.15	82.55	70.59	22.32	87.17	83.12
Boars mature	81.15	82.55	70.59	22.32	87.17	83.12

Table A. 5- 34. Nutritional value of diet for sheep subcategories in 1990-2023

Sub-category	Crude protein g/day	Crude fat g/day	Crude fiber g/day	Nitrogen-free Extracts g/day	DM kg/day
Mature ewes	254.55	56.20	461.03	882.67	1.78
Ewe over 1 years	215.95	48.37	377.40	765.12	1.51
Ewe to 1 years	133.56	33.33	213.64	460.75	0.90
Lambs to 1 years	117.69	29.66	164.94	406.31	0.77
Mature Rams	274.25	61.95	491.65	997.91	1.96
Rams over 1 years	247.55	56.05	438.96	886.06	1.75

Agricultural soils

All activity data used to estimate annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils are provided in the tables below.

Table A.5-35. Harvested annual dry matter yield

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CROP (T)	**kg d.m. ha^{-1}**																	
Winter Wheat	2,943	2,117	3,083	3,338	2,927	2,851	4,450	3,921	4,137	4,910	4,081	4,497	3,701	3,897	4,857	4,132	4213	4,274
Spring Wheat	2,208	2,193	2,265	2,803	2,634	2,983	3,344	3,189	3,710	3,622	2,943	3,021	2,349	2,709	3,475	2,557	2943	2,522
Triticale	2,169	1,806	2,247	2,332	2,046	2,159	3,140	2,693	2,830	3,303	2,825	2,808	2,309	2,831	3,270	2,379	2789	2,653
Rye	2,450	1,554	2,047	1,861	1,512	1,740	2,409	1,680	1,936	2,389	2,044	2,095	1,777	2,262	2,557	2,092	2075	2,029
Barley	2,607	1,427	2,121	2,365	2,041	2,586	2,936	2,821	3,281	3,448	2,718	3,156	2,359	2895	3,684	2,974	3372	3,058
Oats	2,232	1,242	1,652	1,690	1,397	1,749	1,986	1,924	2,083	2,192	1,884	2,217	1,523	1,777	2,259	1,584	1992	1,825
Grain maize	2,543	2,543	2,543	2,721	5,754	6,441	5,253	6360	5,205	4,146	5,978	4,952	5,622	6,584	6,033	5,030	4565	6,978
Winter Rape	2,060	1,267	2,051	2,338	1,820	1,642	3,110	2,281	2,507	3,223	2,578	2,866	2,125	2,715	3,168	2,738	2397	2,473
Spring Rape	931	1,265	1,284	1,487	1,345	1,784	1,842	1,670	1,782	1,780	1,554	1,963	1,484	1,420	1,960	1,433	1392	1,259
Flax	408	423	270	400	430	573	573	573	860	860	860	1,505	1,032	645	645	753	645	773
Buckwheat	581	523	772	482	627	822	776	798	819	855	984	943	871	957	818	570	644	742
Mixed cereals	2,335	1,338	1,573	1,600	1,510	1,698	1,937	1,949	2,207	2,130	1,998	1,781	1,594	2,046	2,041	1,579	1956	2,220
Other cereals	1,720	1,720	3,440	1,290	1,106	1,720	2,150	1,398	1,147	860	860	860	860	860	1,147	1,023	938	1,060
Peas	2,389	1,625	1,752	1,524	1,349	1,542	1,734	1,813	2,126	2,477	2,302	2,504	1,731	1,782	2,103	1,693	1831	1,806
Beans	1,251	1,959	1,679	1,295	1,433	1,591	1,845	2,094	2,477	2,696	2,667	2,945	1,842	1,988	3,224	1,539	3277	2,042
Soya beans	753	753	753	753	753	753	595	921	696	573	1,433	1,066	1,505	1,099	1,065	1,228	970	1,190
Lupines	631	1,013	768	912	591	932	860	760	808	1,171	1,041	1,097	827	812	902	785	880	1,076
Vetches	2,061	1,597	1,445	1,488	1,270	1,376	1,310	1,966	1,849	1,852	1,597	1,032	430	1,147	1,003	860	1107	873
Mixed dried pulses	1,618	1,618	1,618	1,609	1,437	1,670	1,733	1,635	1,891	1,964	1,750	1,810	1,319	1,807	1,850	1,728	1895	1,629
Potatoes	3,114	2,850	3,650	2,692	2,867	3,430	3,757	3,269	3,775	3,737	3,499	2,688	3,394	3,966	3,449	2,867	3269	4,174
Sugar beet	6,564	6,580	7,350	8,781	10,624	11,471	12,015	12,567	13,724	11,679	14,125	12,871	13,186	16,338	15,583	13,401	14436	16,604
Fodder beet	6,175	4,249	4,488	4,026	3,264	3,565	4,166	3,712	4,003	3,785	3,213	1,980	2,370	2,606	2,760	2,563	2688	4,295
Field vegetables (carrot, beetroot)	2,615	2,615	2,615	2,195	2,089	3,482	3,861	3,183	3,942	3,011	2,977	2,614	3,025	3,052	3,111	3,890	3856	3,101
Alfalfa (for hay)	IE	IE	IE	3	2	3	3	3	3	2	5	4	5	6	4	2	3	4
Alfalfa (for green fodder, silage)	IE	IE	IE	6	7	7	6	6	5	4	6	6	4	5	6	5	5	5
Clover and their mixture (for hay)	IE	IE	IE	4	3	3	2	2	2	3	3	4	3	2	2	3	3	2
Clover and their mixture (for green fodder, silage)	IE	IE	IE	2	6	5	5	5	5	4	5	4	4	4	4	4	5	4
Silage crops	5	4	5	5	3	4	4	4	4	4	3	3	4	4	4	3	4	3
Maize for silage and green fodder	8,372	7,693	8,403	7,338	8,758	9,904	9,198	8,877	8,812	7,923	9,786	7,947	8,480	9,231	8,539	8,292	7978	8,660
Annual grasses (for hay)	611	1,068	878	620	2,550	2,550	2,928	2,739	3,627	2,550	1,700	2,267	2,444	4,675	3,168	1,983	4144	1,549

Annual grasses (for haylage)	5,411	7,587	6,648	3,708	4,190	4,033	4,562	3,208	3,568	2,975	3,213	3,432	2,672	2,965	3,313	3,232	3492	2,254
Perennial grasses (for hey)	2,773	3,113	2,651	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Perennial grasses heylage harvested	3,726	4,183	3,562	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Perennial grasses (excl. alfalfa and clovers and their mixtures) (for hay)	IE	IE	IE	2,774	2,330	2,216	2,492	2,312	2,356	2,246	2,392	2,777	3,244	2,953	2,730	2,604	2853	1,646
Perennial grasses (excl. alfaalfa and clovers and their mixtures) (for green fodder and silage)	IE	IE	IE	1,716	4,047	3,671	3,951	3,723	3,453	2,964	3,138	2,843	3,196	2,439	3,695	3,311	4220	2,453
Perennial pastures (for hay)	975	2,675	2,312	2,215	1,951	1,948	2,013	1,818	1,920	2,031	2,083	2,360	1,967	1,839	2,268	2,192	2548	1,582
Perennial pastures (for silage and green fodder)	828	2,272	1,964	1109	3,288	2,761	2,597	2,435	2,361	2,232	2,045	1,982	2,000	1,550	2,847	2,727	2597	1,470
Meadows and natural pastures (for hey)	3,320	3,320	3,320	2098	1,769	1,754	2,009	1,977	1,983	1,977	1,978	2,646	1,107	1,807	2,154	2,167	1897	1,773
Meadows and natural pastures (for silage and green fodder)	3,489	3,489	3,489	1352	2,766	2,434	2,280	2,019	1,963	2,172	2,322	2,698	1,731	2,216	2,508	2,024	2106	1,762

Table A.5-36. Total annual area harvested

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AREA (T)	**ha yr^{-1}**																	
Winter Wheat	34,3728	248,496	283,216	295,914	367,400	275,200	436,200	466,000	355,000	573,000	628,600	620,600	463,100	739,600	751,900	787,400	842,000	833,242
Spring Wheat	2,883	10,039	84,391	70,773	150,200	275,900	190,800	201,400	353,000	263,200	251,900	191,300	309,700	156,200	141,700	156,700	104,700	107,052
Triticale	13,357	22,185	50,089	74,147	108,600	94,400	119,100	144,900	120,100	122,000	100,900	75,800	57,100	105,400	115,000	74,500	63,098	67,215
Rye	165,046	132,410	130,837	50,035	49,500	42,000	55,900	49,400	37,900	38,800	32,600	25,900	21,300	41,100	37,000	26,100	29,471	28,088
Barley	394,701	537,422	348,608	344,858	231,800	252,700	217,300	209,300	267,000	202,400	172,500	141,600	225,900	174,800	164,800	144,700	133,124	159,430
Oats	75,388	46,168	43,148	58,050	57,800	63,200	70,800	73,600	75,900	64,100	70,800	76,000	103,000	86,100	104,900	92,400	80,361	91,749
Grain maize	2,807	2,807	2,807	1,549	7,100	9,600	12,900	17,200	19,000	11,700	12,400	9,900	13,400	12,800	20,200	17,900	18,800	11,255
Winter Rape	10,616	3,539	5,308	28,409	89,300	23,400	77,900	116,600	104,200	123,100	123,800	157,500	143,400	221,600	272,300	293,200	333,239	298,097
Spring Rape	393	10,125	49,248	79,132	162,600	226,800	182,900	142,400	110,900	40,400	29,800	23,400	61,900	20,100	11,300	17,300	15,185	6,844
Flax	21,500	13,200	8,600	4,300	400	600	300	300	300	300	200	400	500	400	800	800	800	789
Buckwheat	296	987	16,384	28,031	19,200	27,200	33,900	30,500	37,400	36,700	43,600	48,500	52,700	27,600	39,100	48,600	57,300	41,589

Mixed cereals	6,888	15,744	10,824	20,959	19,700	23,800	22,200	20,300	22,600	17,000	13,300	9,800	10,900	5,800	7,500	7,844	5,891	4,392
Other cereals	100	100	200	200	700	700	600	800	900	200	100	100	100	200	300	365	953	473
Peas	40,850	11,326	24,394	11,906	27,100	26,500	24,000	24,000	40,900	79,400	148,700	154,200	106,200	75,200	61,800	61,500	71,500	71,148
Beans	3,162	1,186	1,383	3,853	3,000	4,000	4,800	6,900	21,700	61,400	67,500	67,100	69,900	55,100	58,400	76,200	55,300	80,260
Soya beans	800	800	800	800	800	800	2,600	1,400	2,100	2,700	1,800	2,500	2,000	1,800	2,100	1,541	2,040	1,234
Lupines	2,452	849	1,792	4,621	9,900	6,000	5,100	4,300	3,300	3,600	3,800	2,900	2,600	3,600	4,100	4,600	4,300	3,665
Vetches	27,200	9,800	10,000	2,600	2,100	2,000	2,100	2,100	2,000	1,300	700	500	400	300	600	800	1,243	1,090
Mixed dried pulses	8,184	8,184	8,184	12,076	7,600	6,900	6,400	7,100	13,600	11,300	11,300	11,500	9,000	6,900	7,300	8,958	9,714	11,423
Potatoes	111,150	123,006	107,988	73,112	36,600	37,700	32,200	28,700	27,300	23,500	22,100	19,400	19,200	18,700	19,300	15,700	15,600	15,168
Sugar beet	31,972	24,203	27,589	20,916	15,300	17,600	19,200	17,700	17,000	12,200	15,200	17,100	15,500	14,100	14,000	14,700	11,600	14,423
Fodder beet	52,061	61,822	37,419	11,197	1,500	1,700	1,400	1,500	1,400	1,300	900	800	800	700	200	323	192	127
Field vegetables (carrot, beetroot)	12,300	12,300	12,300	8,800	4,200	4,600	4,000	4,100	4,000	3,700	4,100	3,700	4,100	4,400	4,200	3,900	4,063	3,576
Alfalfa (for hay)	IE	IE	IE	952	600	700	700	900	1,300	1,700	1,800	1,300	1,900	2,700	3,700	3,732	3,146	2,717
Alfalfa (for green fodder, silage)	IE	IE	IE	3,384	3,000	2,900	3,300	3,100	3,000	5,500	6,300	4,300	6,800	8,000	8,700	11,352	12,520	12,423
Clover and their mixture (for hay)	IE	IE	IE	60,278	15,700	15,400	17,100	17,400	17,400	14,100	11,100	9,900	13,600	15,200	15,400	15,900	13,500	12,089
Clover and their mixture (for green fodder, silage)	IE	IE	IE	100,502	18,300	26,900	27,800	28,200	29,900	28,000	20,300	20,800	29,900	32,400	25,800	34,325	33,041	31,329
Silage crops	82,700	13,600	5,500	7,300	1,100	1,000	1,200	1,400	2,100	4,000	3,900	4,300	5,100	5,600	4,200	4,200	3,800	3,603
Maize for silage and green fodder	77,800	4,200	10,300	13,900	17,600	21,000	21,800	22,700	28,500	29,200	26,600	24,300	28,300	32,900	29,900	29,400	32,900	39,567
Annual grasses (for hay)	9,328	3,898	2,226	5,755	5,00	700	900	900	1500	300	400	600	800	1000	1100	300	800	1,433
Annual grasses (for haylage)	93,131	38,922	22,228	57,460	6,700	6,500	5,800	7,300	9,200	7,600	7,800	5,700	10,400	10,800	9,000	9,000	8,400	8,248
Perennial grasses (for hey)	257,946	168,269	109,982	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE

Perennial grasses heylage harvested	212,602	138,689	90,648	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Perennial grasses (excl. alfalfa and clovers and their mixtures) (for hay)	IE	IE	IE	122,448	232,900	246,400	220,900	228,200	228,400	158,700	107,300	71,300	64,500	72,700	72,300	36,500	44,900	61,978
Perennial grasses (excl. alfaalfa and clovers and their mixtures) (for green fodder and silage)	IE	IE	IE	90,512	150,100	169,400	173,000	143,800	154,100	120,500	101,800	82,800	70,400	115,000	72,700	74,000	74,400	64,514
Perennial pastures (for hay)	373,977	322,985	394,777	367,822	209,600	201,300	166,200	183,800	181,100	273,100	385,700	348,100	366,100	261,800	227,200	300,500	273,200	22,0662
Perennial pastures (for silage and green fodder)	185,565	160,263	195,886	182,511	68,400	61,200	51,700	66,700	76,300	237,500	307,200	305,700	245,200	298,400	158,500	125,200	133,200	14,1340
Meadows and natural pastures (for hey)	244,747	150,721	86,925	82,510	99,400	88,900	66,400	77,200	79,700	95,500	37,000	34,400	25,500	42,800	23,600	38,800	44,400	20,030
Meadows and natural pastures (for silage and green fodder)	81,850	50,405	29,070	27,594	21,700	25,500	19,400	28,100	34,700	30,200	16,100	14,400	9,300	13,300	13,200	12,400	17,800	12,569

Table A.5-37. Ratio of above-ground residues dry matter to harvested yield

	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
$R_{AG(T)}$	**kg d.m.**																	
Winter Wheat	0.80	0.65	0.81	0.84	0.79	0.78	0.92	0.89	0.90	0.95	0.90	0.93	0.87	0.89	0.94	0.90	0.91	0.91
Spring Wheat	1.16	1.16	1.15	1.12	1.13	1.11	1.09	1.10	1.08	1.08	1.11	1.11	1.15	1.12	1.09	1.13	1.11	1.13
Triticale	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Rye	1.67	1.70	1.68	1.69	1.71	1.69	1.67	1.70	1.68	1.67	1.68	1.68	1.69	1.67	1.66	1.68	1.68	1.68
Barley	0.99	1.10	1.02	1.00	1.03	0.99	0.98	0.98	0.96	0.96	0.99	0.97	1.00	0.98	0.95	0.97	0.96	0.97
Oats	1.50	1.07	1.31	1.33	1.18	1.35	1.44	1.42	1.46	1.49	1.40	1.50	1.25	1.36	1.51	1.28	1.44	1.38

Grain maize	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Winter Rape	1.81	1.21	1.81	1.93	1.69	1.57	2.14	1.91	1.99	2.16	2.01	2.09	1.84	2.05	2.15	2.05	1.95	1.98
Spring Rape	0.64	1.21	1.23	1.44	1.30	1.66	1.70	1.59	1.66	1.66	1.50	1.77	1.44	1.38	1.76	1.39	1.35	1.20
Flax	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Buckwheat	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
Mixed cereals	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Other cereals	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Peas	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Beans	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
Soya beans	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
Lupines	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
Vetches	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
Mixed dried pulses	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
Potatoes	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
Sugar beet	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Fodder beet	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Field vegetables (carrot, beetroot)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Alfalfa (for hay)	IE	IE	IE	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Alfalfa (for green fodder, silage)	IE	IE	IE	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Clover and their mixture (for hay)	IE	IE	IE	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Clover and their mixture (for green fodder, silage)	IE	IE	IE	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Silage crops	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Maize for silage and green fodder	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Annual grasses (for hay)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Annual grasses (for haylage)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Perennial grasses (for hey)	0.30	0.30	0.30	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Perennial grasses heylage harvested	0.30	0.30	0.30	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Perennial (excl. alfalfa and clovers and their mixtures) (for hay)	IE	IE	IE	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.3	0.3	0.3	0.3	0.3
Perennial (excl. alfaalfa and clovers and their mixtures) (for green fodder and silage)	IE	IE	IE	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30

Perennial pastures (for hay)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Perennial pastures (for silage and green fodder)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Meadows and natural pastures (for hey)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Meadows and natural pastures (for silage and green fodder)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30

Table A.5-38. Ratio of below-ground residues to harvested yield

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
$R_{BG(T)}$	**kg d.m.**																	
Winter Wheat	0.41	0.38	0.42	0.42	0.41	0.41	0.44	0.43	0.44	0.45	0.44	0.44	0.43	0.43	0.45	0.44	0.44	0.44
Spring Wheat	0.60	0.60	0.60	0.59	0.60	0.59	0.59	0.59	0.58	0.58	0.59	0.59	0.60	0.59	0.58	0.60	0.59	0.60
Triticale	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Rye	0.59	0.59	0.59	0.59	0.60	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Barley	0.44	0.46	0.44	0.44	0.45	0.44	0.43	0.44	0.43	0.43	0.44	0.43	0.44	0.44	0.43	0.43	0.43	0.43
Oats	0.63	0.52	0.58	0.58	0.54	0.59	0.61	0.60	0.62	0.62	0.60	0.62	0.56	0.59	0.63	0.57	0.61	0.60
Grain maize	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Winter Rape	0.84	0.66	0.84	0.88	0.81	0.77	0.94	0.87	0.90	0.95	0.90	0.93	0.85	0.91	0.95	0.92	0.88	0.89
Spring Rape	0.49	0.66	0.67	0.73	0.69	0.80	0.81	0.78	0.80	0.80	0.75	0.83	0.73	0.71	0.83	0.72	0.71	0.66
Flax	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Buckwheat	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
Mixed cereals	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Other cereals	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Peas	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Beans	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Soya beans	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Lupines	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Vetches	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Mixed dried pulses	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Potatoes	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Sugar beet	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Fodder beet	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Field vegetables (carrot, beetroot)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Alfalfa (for hay)	IE	IE	IE	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
Alfalfa (for green fodder, silage)	IE	IE	IE	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
Clover and their mixture (for hay)	IE	IE	IE	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90

Clover and their mixture (for green fodder, silage)	IE	IE	IE	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Silage crops	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Maize for silage and green fodder	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Annual grasses (for hay)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Annual grasses (for haylage)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Perennial grasses (for hey)	2.00	2.00	2.00	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Perennial grasses heylage harvested	2.00	2.00	2.00	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Perennial grasses (excl. alfalfa and clovers and their mixtures) (for hay)	IE	IE	IE	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Perennial (excl. alfaalfa and clovers and their mixtures) (for green fodder and silage)	IE	IE	IE	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Perennial pastures (for hay)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Perennial pastures (for silage and green fodder)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Meadows and natural pastures (for hey)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Meadows and natural pastures (for silage and green fodder)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Table A.5-39. Other relevant parameters used for annual N in crop residues

	DRY	$N_{AG(T)}$	$N_{BG(T)}$	$R_{BG-BIO(T)}$	$Frac_{REMOVE}$	$Frac_{RENEW}$	Area burnt	Slope	Intercept	$R_{AG(T)}$	$R_{BG(T)}$	Emission factor
	kg d.m.	kg N	kg N	kg d.m.	kg N	-	-	-	-	Kg d.m.	Kg d.m.	kg N_2O-N
Non-N-fixing grain crops												
Winter Wheat	0.86	0.005	0.004	0.23	*	1	0	1.17	-1.1	Calculated	Calculated	0.01
Spring Wheat	0.86	0.008	0.005	0.28	*	1	0	0.96	0.44	Calculated	Calculated	0.01
Triticale	0.86	0.006	0.005	0.22	*	1	0	-	-	1.3	Calculated	0.01
Rye	0.86	0.006	0.005	0.22	*	1	0	1.6	0.16	Calculated	Calculated	0.01
Barley	0.86	0.006	0.005	0.22	*	1	0	0.86	0.34	Calculated	Calculated	0.01
Oats	0.86	0.007	0.005	0.25	0	1	0	2.05	-1.22	Calculated	Calculated	0.01

Grain maize	0.86	0.008	0.005	0.22	0	1	0	-	-	1.14	Calculated	0.01
Winter Rape	0.915	0.007	0.006	0.3	0	1	0	2.78	-1.99	Calculated	Calculated	0.01
Spring Rape	0.915	0.008	0.006	0.3	0	1	0	2.78	-1.99	Calculated	Calculated	0.01
Flax	0.86	0.006	0.005	0.22	0	1	0	-	-	1.3	Calculated	0.01
Buckwheat	0.86	0.007	0.005	0.22	0	1	0	-	-	2.3	Calculated	0.01
Mixed cereals	0.86	0.006	0.005	0.22	0	1	0	-	-	1.3	Calculated	0.01
Other cereals	0.86	0.006	0.005	0.22	0	1	0	-	-	1.3	Calculated	0.01
N fixing grains and pulses												
Peas	0.86	0.0167	0.0243	0.19	0	1	0	-	-	1.4	Calculated	0.01
Beans	0.86	0.012	0.016	0.19	0	1	0	-	-	2.2	Calculated	0.01
Soya beans	0.86	0.014	0.02	0.19	0	1	0	-	-	1.75	Calculated	0.01
Lupines	0.86	0.0136	0.0227	0.19	0	1	0	-	-	1.6	Calculated	0.01
Vetches	0.06	0.0129	0.02	0.19	0	1	0	-	-	1.6	Calculated	0.01
Mixed dried pulses	0.86	0.014	0.02	0.19	0	1	0	-	-	1.7	Calculated	0.01
Root/tumber crops												
Potatoes	0.22	0.014	0.0125	0.2	0	1	0	-	-	0.2	Calculated	0.01
Sugar beet	0.23	0.03	0.014	0.2	0	1	0	-	-	0.5	Calculated	0.01
Fodder beet	0.12	0.03	0.014	0.2	0	1	0	-	-	0.3	Calculated	0.01
Field vegetables	0.13	0.022	0.014	0.2	0	1	0	-	-	0.3	Calculated	0.01
N fixing forage crops												
Alfalafa hay	0.85	0.025	0.017	-	0	0.25	0	0.29	0	Calculated	1.7	0.01
Alfalafa haylage	0.35	0.025	0.017	-	0	0.25	0	0.29	0	Calculated	1.7	0.01
Clover and their mixture hay	0.85	0.025	0.016	-	0	0.3	0	0.3	0	Calculated	0.9	0.01
Clover and their mixture haylage	0.35	0.025	0.016	-	0	0.3	0	0.3	0	Calculated	0.9	0.01
Silage crops	0.3	0.008	0.022	0.4	0	1	0	0.3	0	Calculated	Calculated	0.01
Other industrial and forage crops, including annual and perennial pastures and meadows												
Maize for silage and green fodder	0.3	0.008	0.012	0.54	0	1	0	0.3	0	Calculated	Calculated	0.01
Annual grasses hay	0.85	0.015	0.012	-	0	1	0	0.3	0	Calculated	0.6	0.01
Annual grasses haylage	0.35	0.015	0.012	-	0	1	0	0.3	0	Calculated	0.6	0.01
Perennial grasses (excl. alfalafa, clover and their mixture) hay	0.85	0.02	0.015	-	0	0.2	0	0.3	0	Calculated	2	0.01
Perennial grasses (excl. alfalafa, clover and their mixture) haylage	0.35	0.02	0.015	-	0	0.2	0	0.3	0	Calculated	2	0.01
Perennial pasutes hay	0.85	0.02	0.015	-	0	0.07	0	0.3	0	Calculated	2	0.01
Perennial pastures haylage	0.35	0.02	0.015	-	0	0.07	0	0.3	0	Calculated	2	0.01
Meadows and natural pastures hay	0.85	0.02	0.015	-	0	0.07	0	0.3	0	Calculated	2	0.01
Meadows and natural pastures haylage	0.35	0.02	0.015	-	0	0.07	0	0.3	0	Calculated	2	0.01

*Data provided in the Table A.5-40

Table A.5-40. N content in above-ground residues and in bedding material

Year	N content in above-ground residues of grain crops used for bedding (from wheat, barley, triticale and rye), kg N yr	N input from bedding material, kg N yr	$Frac_{REMOVE}$ (from wheat, barley, triticale and rye), %
1990	14,467,259	7,109,900	49
1995	9,382,984	4,514,666	48
2000	13,415,910	3,336,018	25
2005	13,127,255	3,044,323	23
2010	13,249,666	2,611,793	20
2011	16,587,058	2,443,752	15
2012	22,526,166	2,286,523	10
2013	21,128,355	2,169,917	10
2014	26,395,789	2,109,536	8
2015	29,640,919	2,075,370	7
2016	23,792,972	2,083,696	9
2017	22,827,399	2,052,590	9
2018	18,779,141	1,997,695	11
2019	22,821,930	1,887,458	8
2020	28,853,500	1,829,735	6
2021	22,777,581	1,726,893	8
2022	23,430,154	1,711,439	7
2023	23,509,369	1,695,806	7

ANNEX X. Summary of the study on estimation of nitrous oxide (N_2O) emissions from the crop residues category

Following the requirements of the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto protocol, Regulation (EU) No 525/2013 of the European Parliament and of the Council, Member States have to submit their annual national greenhouse gas inventory reports to UNFCCC secretariat and European Commission (EC). GHG inventory agriculture sector must include N_2O emissions from crop residues estimated following 2006 IPCC Guidelines. The default methodology presented in the 2006 IPCC Guidelines for the assessment of N_2O emissions is based on the application of standard coefficients and values, thus it has a rather limited ability to represent country specific conditions in Lithuania and properly describe nitrogen amounts introduced to soil with crop residues. To follow the country's GHG emissions reduction progress, it is crucially important that GHG emissions are accounted for with the adequate accuracy. For this reason, countries are encouraged to develop their own methodologies, ensuring that calculation parameters represent country specific conditions.

In Lithuania, to quantify N_2O emissions from the crop residues two methodologies have been employed so far: by 2015, methodology provided in 2006 IPCC Guidelines was used for the assessment and later, for compilation of inventories for 2015, 2016, and 2017, alternative methodology was elaborated for better and more precise N_2O emissions accounting. The alternative methodology anticipated a modified way of N_2O emission assessment and was partly based on the nationally derived coefficients and parameters.

Lithuanian Environmental Protection Agency (EPA) experts however observe that these two methodologies come out with significantly different results. The assessment based on the 2006 IPCC Guidelines provides N_2O emission estimate which is by around 100 kt CO_2 eq larger if compared with the alternative methodology calculation results.

In relation to this, the main objective of the study was to identify the reasons and sources for errors and inconsistencies in previously used N_2O accounting methodologies and to elaborate revised national methodology for the assessment of N_2O emissions from the sub-category of crop residues in Lithuania that would cover main crops under the following crop groups 1. Non-N-fixing grain crops; 2. N-fixing grains and pulses; 3. Root and tuber crops; 4. N-fixing forage crops; 5. Other forages including perennial grasses and grass/clover pastures.

The initial stage of the study covered an extensive review and analysis of Lithuanian research studies and field experiments to retrieve national parameters for the assessment of N_2O emissions from crop residues. The analysis focused on available national data about crop above ground and below ground biomass, biomass nitrogen contents, residue management practices. The overview has covered all main crops under 5 groups of crops as suggested by the 2006 IPCC Guidelines.

In the next stage, a detailed analysis of methodologies used in Lithuania for N_2O emission assessment so far (i.e. methodology based on 2006 IPCC Guidelines and the alternative methodology) was conducted where input data and parameters of these methodologies were validated against available national data. This analysis has reveal that both methodologies possess some inconsistencies and shortcomings that may consequently lead to inaccurate and biased calculation results.

Some essential differences were observed when comparing parameter values recommended by 2006 IPCC Guidelines and those defined in the national studies. The largest difference was detected for above ground biomass parameters of the most popular crops (wheat, triticale, rye, barley, oat). The main reason for such inconsistency could be the fact that 2006 IPCC Guidelines rely on rather old and USA research based coefficients that eventually revealed as not suitable to describe nowadays crop production trends in Lithuania.

The alternative methodology which was developed to improve N_2O calculations by integrating more national parameters has demonstrated poor performance because of mistakes in the assessment of below ground biomass.

Taking into account shortcomings and gaps of both tested methodologies the study proposes revised national parameters for the assessment of N_2O emissions from crop residues in Lithuania. Emissions are developed according 2006 IPCC Guidelines; Equation 11.2 of the Guidelines which is simplified accounting for no burning of crop residues in Lithuania:

$$F_{CR} = \sum_{T} \{ Crop_{(T)} * Frac_{Renew(T)} * Area_{(T)} [R_{AG(T)} * N_{AG(T)} * (1 - Frac_{Remove(T)}) + R_{BG(T)} * N_{BG(T)}] \}$$

here:

F_{CR} -	annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/ pasture renewal, returned to soils annually, kg N/ year
T -	crop or forage type
$Crop_{(T)}$ -	harvested annual dry matter yield for crop T, kg d.m. / ha
$Area_{(T)}$ -	total annual area harvested of crop T, ha / year
$Frac_{Renew(T)}$ -	fraction of total area under crop T that is renewed annually. For countries where pastures are renewed on average every X years, $Frac_{Renew}$ = 1/X. For annual crops $Frac_{Renew}$ = 1
$R_{AG(T)}$ -	ratio of above-ground residues dry matter ($AG_{DM(T)}$) to harvested yield for crop T ($Crop_{(T)}$), kg d.m. / kg d.m. = $AG_{DM(T)}$*1000/$Crop_{(T)}$; $AG_{DM(T)}$=($Crop_{(T)}$/1000)*$a_{(T)}$+$b_{(T)}$
$N_{AG(T)}$ -	N content of above-ground residues for crop T, kg N / kg d.m.
$Frac_{Remove(T)}$-	fraction of above-ground residues of crop T removed annually for purposes such as feed, bedding and construction, kg N / kg crop-N
$R_{BG(T)}$ -	ratio of belowground residues to harvest yield for crop T, kg d.m. / kg d. If alternative data is not available, $R_{BG(T)}$ can be calculated as =R_{BG-BIO}*(($AG_{DM(T)}$*1000/$Crop_{(T)}$)/$Crop_{(T)}$)
$N_{BG(T)}$ -	N content of below-ground residues for crop T, kg N / kg d.m.

Methodology integrates all available national data in order to ensure better assessment accuracy under the local conditions. Only in calculation stages for which national data is not available, it is recommended to use parameters from 2006 IPCC Guidelines.

Crops which are included into accounting and proposed calculation parameters are listed in the Table below.

In future, when new data is obtained, proposed parameters will need to be further revised by putting special emphasis on parameters which, according to sensitivity analysis, mostly affect accuracy of the N_2O emission assessment. Results of the latest investigations will need to be considered to revise linear regression coefficients describing ratios between above-ground residue biomass and harvested crop yields.

To improve assessment accuracy it would be useful to conduct representative field measurements of above-ground and below-ground biomass under different farming practices and crop productivity conditions. Today, no reliable information is available on usage of straw. Survey of farmers would help to answer the question which part of the residue is left on the fields after the harvest and which factors have impact on straw usage patterns in the country.

The study reveals that national data on grassland contribution to soil nitrogen pool is still rather poor. For better assessment of N_2O emissions from grasslands and meadows a representative study investigating composition and usage of grasslands, root biomass of grasslands of different age and productivity or ratios between root biomass and hay, silage or green fodder production would be very useful. In future Crop structure changes should be considered and new crops included into account, if needed.

Crops	DRY	$Frac_{Renew(T)}$	$R_{AG(T)}$	$a_{(T)}$	$b_{(T)}$	$Frac_{Remove(T)}$	$R_{BG(T)}$	$R_{BG\text{-}BIO}$	$N_{AG(T)}$	$N_{BG(T)}$
1. Non-N-fixing grain crops										
Winter Wheat	0.86	1	to be calculated	1.17	-1.1	0.3	to be calculated	0.23	0.005	0.004
Spring Wheat	0.86	1	to be calculated	0.96	0.44	0.3	to be calculated	0.28	0.008	0.005
Triticale	0.86	1	1.3	-	-	0.3	to be calculated	0.22	0.006	0.005
Rye	0.86	1	to be calculated	1.6	0.16	0.3	to be calculated	0.22	0.006	0.005
Barley	0.86	1	to be calculated	0.86	0.34	0.3	to be calculated	0.22	0.006	0.005
Oats	0.86	1	to be calculated	2.05	-1.22	0.3	to be calculated	0.25	0.007	0.005
Grain maize	0.86	1	1.14	-	-	0.3	to be calculated	0.22	0.008	0.005
Winter Rape	0.915	1	to be calculated	2.78	-1.99	0.3	to be calculated	0.3	0.007	0.006
Spring Rape	0.915	1	to be calculated	2.78	-1.99	0.3	to be calculated	0.3	0.008	0.006
Flax	0.86	1	1.3	-	-	0.3	to be calculated	0.22	0.006	0.005
Buckwheat	0.86	1	2.3	-	-	0.3	to be calculated	0.22	0.007	0.005
Mixed cereals	0.86	1	1.3	-	-	0.3	to be calculated	0.22	0.006	0.005
Other cereals	0.86	1	1.3	-	-	0.3	to be calculated	0.22	0.006	0.005
2. N fixing grains and pulses										
Peas	0.86	1	1.4	-	-	0	to be calculated	0.19	0.0167	0.0243
Beans	0.86	1	2.2	-	-	0	to be calculated	0.19	0.012	0.016
Soya beans	0.86	1	1.75	-	-	0	to be calculated	0.19	0.014	0.02
Lupines	0.86	1	1.6	-	-	0	to be calculated	0.19	0.0136	0.0227
Vetches	0.86	1	1.6	-	-	0	to be calculated	0.19	0.0129	0.02
Mixed dried pulses	0.86	1	1.7	-	-	0	to be calculated	0.19	0.014	0.02
3. Root/tuber crops										
Potatoes	0.22	1	0.2	-	-	0	to be calculated	0.2	0.014	0.0125
Sugar beet	0.23	1	0.5	-	-	0	to be calculated	0.2	0.03	0.014
Fodder beet	0.12	1	0.3	-	-	0	to be calculated	0.2	0.03	0.014
Field vegetables	0.13	1	0.3	-	-	0	to be calculated	0.2	0.022	0.014
4. N fixing forage crops										
Alfalafa (for hay)	0.85	0.25	to be calculated	0.29	0	0	1.7	-	0.025	0.017
Alfalafa (for green fodder, silage)	0.35	0.25	to be calculated	0.29	0	0	1.7	-	0.025	0.017
Clover and their mixtures (for hay)	0.85	0.3	to be calculated	0.3	0	0	0.9	-	0.025	0.016
Clover and their mixtures (for green fodder and silage)	0.35	0.3	to be calculated	0.3	0	0	0.9	-	0.025	0.016
Silage crops	0.3	1	to be calculated	0.3	0	0	to be calculated	0.4	0.008	0.022
5. Other industrial and forage crops, including annual and perennial pastures and meadows										

Crops	DRY	$Frac_{Renew(T)}$	$R_{AG(T)}$	$a_{(T)}$	$b_{(T)}$	$Frac_{Remove(T)}$	$R_{BG(T)}$	$R_{BG\text{-}BIO}$	$N_{AG(T)}$	$N_{BG(T)}$
Maize for silage and green fodder	0.3	1	to be calculated	0.3	0	0	to be calculated	0.54	0.008	0.012
Annual grasses (for hay)	0.85	1	to be calculated	0.3	0	0	0.6	-	0.015	0.012
Annual grasses (for hay)	0.35	1	to be calculated	0.3	0	0	0.6	-	0.015	0.012
Perennial grasses up to 5 years (apart from alfalafa and clovers and their mixtures) (for hay)	0.85	0.2	to be calculated	0.3	0	0	2	-	0.02	0.015
Perennial grasses up to 5 years (apart from alfalafa and clovers and their mixtures) (for green fodder and silage)	0.35	0.2	to be calculated	0.3	0	0	2	-	0.02	0.015
Perennial pastures (for hay)	0.85	0.07	to be calculated	0.3	0	0	2	-	0.02	0.015
Perennial pastures (for silage and green fodder)	0.35	0.07	to be calculated	0.3	0	0	2	-	0.02	0.015
Meadows and natural pastures (for hay)	0.85	0.07	to be calculated	0.3	0	0	2	-	0.02	0.015
Meadows and natural pastures (for silage and green fodder)	0.35	0.07	to be calculated	0.3	0	0	2	-	0.02	0.015

ANNEX XI. Summary of the study on determination of national values of feed digestibility by the classic in vivo method for the Lithuania GHG inventory methodology improvement

Food digestibility is the main parameter to evaluate the amounts of volatile solids methane (CH_4) and nitrous oxide (N_2O) emitted at manure handling. Lithuania has been recommended by UNFCCC secretariat experts to carry out a study and collect the national data on food digestibility that would help to estimate the amounts of CH_4 and N_2O emitted in manure management and included in the national inventory report. Therefore, the aim of this study was to analyze the structure, chemical composition and nutritive value of the rations used for fattening bulls, dairy cows and fattening pigs in Lithuania and, consequently, to estimate nutrient digestibility in vivo and nutrient digestibility coefficients of the average ration for each technological animal group.

Information about feedstuffs and ration structures applied to the animals of different technological groups has been collected in different regions of the country from randomly chosen farms. In 2021, the regions under investigation contained 81.22 % fattening bulls, 95.28 % dairy cows (2 years and older), 90.39 % suckler cows (2 years and older) and 83,74 % fattening pigs. The samples of standard rations collected from farms were analyzed at the Chemical laboratory of the Animal Science Institute of the Lithuanian University of Health Sciences (LUHS). The samples were analyzed for dry matter, crude protein, crude fat, crude fibre and energy (metabolizable, netto energy lactation) contents.

Nutrient digestibility in vivo studies were carried out at the Animal feed nutrient digestibility laboratory of Animal Science Institute of the LUHS with 6 Lithuanian Black-and-White fattening cattle, 6 dairy cows and 12 fattening pigs of different age and condition score according to methodical recommendations for balance-digestibility trials.

Fattening cattle

The study indicated that two different fattening cattle feeding technologies are used on Lithuanian farms, i. e. animals are fed on separate feeds or separate feeds are mixed to make a total mix ration (TMR). TMR was used to feed animals in 16 farms out of 23 (almost 70 %) investigated. Most farms use perennial grass and maize silages, compound feeds or grain mixtures for the production of TMR. In case of fibre shortage, meadow grass straw is added. A similar ration structure is applied on the farms where fattening cattle is given ration feeds separately. We have estimated the amounts of feeds given to different cattle groups, i.e. those up to one and up to 2 years old and older. Up to one year of age animals were fed on the average 14.5 kg feeds and received daily 4.70 – 8.04 kg dry matter (DM), 526 – 1114 g crude protein (CP), 1114 – 2354 g crude fibre (CF) and from 43.95 to 79.32 MJ of metabolizable energy (ME). Up to 2 years of age and older animals were given on the average 23.4 kg feeds of natural moisture and received daily 7.02 – 13.83 kg DM, 598 -2550 g CP, 1796 – 4185 g CF and 61.0 – 138.30 MJ ME. Estimation of the amounts of feeds as fed and the nutritive and energy value of rations indicated that the average rations should amount to 15.0 – 18.0 kg for the fattening cattle up to 12 month of age and for the bulls up to 2 years and old, the average rations should amount to 23 – 25 kg of TMR of natural moisture consisting of perennial grass and maize silages and compound feed. On this basis, we have formulated the average ration for cattle feeding comprising TMR made from maize and perennial grass silages and compound feed (37.1 % DM, 4.28 % CP, 0.9 7% crude fat, 9.65 % CF, 19.82 % NFE, 2.38 % crude ash (CA), 3.38 MJ/kg ME). It is recommended to give 17 and 25 kg of feed for cattle up to 12 month of age and up to 2 years and older, respectively.

The animals of the first age group digested on the average 63.97 % DM, 53.97 % CP, 59.85 % crude fat, 60.39 % CF, 51.24 % ADF, 68.69 % NDF, 71.51 % nitrogen free extracts (NFE) and 66.20 % organic matter

(OM) of total ration digestibility. The animals of the second age group digested on the average 65.13 % DM, 55.84 % CP, 62.70 % crude fat, 63.65 % CF, 52.85 % ADF, 71.27 % NDF, 72.45 % NFE and 67.79 % OM. The daily weight gain of the treated animals was 1.27 – 1.73 and 1.73 – 1.87 kg in, respectively, Group 1 and Group 2.

Dairy cattle

Two different technologies are used for feeding dairy cows in Lithuania, i. e. animals are given ration feeds separately or separate feeds are mixed to make a complete TMR. TMR technology was applied in 19 farms out of 31 under investigation (almost 61.2 %). Most farms use perennial grass and maize silages, compound feeds or grain mixtures for the production of TMR.

A similar ration structure is applied on the farms where cows are given separate ration feedstuffs. The analysis of feeding amounts showed that the average ration of milking cows was composed of 40 – 50 kg natural moisture feeds comprising perennial grass and maize silages and compound feed. In case of dry matter or fibre deficiency, straw or hay was added. The cows fed this type of ration received 18.1 – 28.2 kg DM, 102 – 178 MJ netto energy lactation (NEL), 2115 – 4131 g CP, 314 – 765 g crude fat, 3433 – 7608 g CF, 112 – 288 calcium and 53 – 152 g phosphorus. Dry and suckler cows are fed on the average 30 – 35 kg natural moisture feeds and receive 11.2 – 19.5 kg DM, 59 – 114 MJ NEL, 1383 – 2421 g CP, 290 – 515 g crude fat, 2376 – 5340 g CF, 53 – 226 g calcium and 21 – 76 g phosphorus. On this basis, we have formulated the average ration for cow feeding comprising TMR manufactured from maize and perennial grass silages and compound feed (41 – 47 % DM, 5.46 – 6.45 % CP, 1.21 – 1.39 % crude fat, 9.45 – 9.71 % CF, 22.45 – 25.97 % NFE, 2.43 – 3.48 % CA, 2.46 – 2.87 MJ/kg NEL). It is recommended to feed 50 kg for milking cows and 35 kg for dry and suckler cows. The cows of the first technological group digested on the average 67.68 % DM, 65.21 % CP, 60.57 % crude fat, 63.94 % CF, 57.68 % ADF, 66.49 % NDF, 73.20 % NFE and 69.59 % OM of total ration. The animals of the second technological group digested on the average 66.51 % DM, 64.95 % CP, 60.06 % crude fat, 61.97 % CF, 56.70 % ADF, 62.62 % NDF, 72.50 % NFE and 67.64 % OM. During the trial, the cows of Group 1 yielded daily 19.6 – 30.1 kg whole milk, whereas the cows of Group 2 8.71 – 12.9 kg milk daily.

Swine

On large scale of pig farms in Lithuania pigs are fed complete compound feeds. Three feeding technologies are being applied: feeding dry feeds, moistened feeds or slop feeds. On some farms that apply slop feeding the rations are additionally supplied with whey. Small individual farms with up to 10 – 20 pigs can also use mash feeding rations containing, besides grain feeds, also potatoes, feedroots and other feeds. However, such farms are not numerous and important.

All the 14 studied farms composed their pig rations using the feeds of their own production or purchased compound feeds. Besides, one farm also used whey together with compound feed. For the production of compound feeds, most farms use barley, wheat, triticale. Maize (for piglets and fattening pigs) and oats (for gilts and sows). As protein feeds, the farms use soybean oilmeal, rapeseed cake or meal, sunflower meal, leguminous seeds (peas or beans), also soya or potato protein concentrate (for piglets), fish meal (for piglets and lactating sows), protein-vitamin-mineral premix (for piglets and sows). Components with higher content of crude fiber for sows and gilts comprise wheat bran, dried sugarbeet pulp and soybean hulls. Fodder lime or limestone, monocalcium phosphate, common salt, premixes, aminoacid, trace element, vitamin, enzyme, etc. supplements, also mycotoxin binders are used as minerals and other additives. As an energy source, the farms use vegetable oil, sugarbeet molasses. It should be noted that there was a farm which used dry mixture made from only on farm grown feeds (barley, wheat, peas) and mineral-vitamin supplement. This farm fattens pigs from 45 kg weight.

Dry feeds are given to weaned pigs, fattening pigs and sows on, respectively, 7, 5 and 4 farms. Moistened feeds are given to fattening pigs and sows on, respectively, one and two farms. Weaned pigs, fattening pigs and sows were given slop feeds on, respectively four, eight and three farms. We have estimated the amounts of feeds given to separate groups of pigs, namely, weaned 20-30 kg pigs, fattening pigs, gilts, farrowing and lactating sows.

Weaned 20 to 30 kg pigs are given on the average 1.37-1.44 kg compound feed and get daily 1.20-1.25 kg DM, 18.34-19.48 MJ ME, 246.60-252.42 g CP, 15.98-18.20 g lysine (Lys), 7.73-10.92 g methionine + cystine (Met+Cys), 9.01-11.30 g threonine (Thr), 30.38-69.86 g crude fat, 38.50-53.71 g CF, 10.08-11.52 g calcium (Ca) and 5.96-9.01 g phosphorus (P).

Pigs in the first growing phase (30-60 kg) are offered on the average 2.22-2.45 kg compound feed and get daily 1.96-2.09 kg DM, 29.05-31.19 MJ ME, 343.74-391.08 g CP, 20.34-25.99 g Lys, 9.8-15.64 g Met+Cys, 12.74-17.02 g Thr, 57.56-115.00 g crude fat, 70.67-117.53 g CF, 15.44-18.86 g Ca and 9.59-12.19 g P.

Pigs in the second fattening phase (over 60 kg) are given on the average 2.85-3.10 kg compound feed and get daily 2.47-2.64 kg DM, 36.18-39.62 MJ ME, 434.93-456.00 g CP, 25.61-29.27 g Lys, 12.40-17.23 g Met+Cys, 16.12-19.49 g Thr, 58.98-97.03 g crude fat, 91.98-162.10 g CF, 18.81-21.08 g Ca and 11.39-15.30 g P.

Gilts of more than 50-60 kg weight are given on the average 2.50-2.70 kg compound feed and get daily 2.18-2.36 kg DM, 29.74-33.23 MJ ME, 359.84-401.50 g CP, 16.88-30.00 g Lys, 10.09-18.25 g Met+Cys, 11.26-14.75 g Thr, 51.74-101.00 g crude fat, 96.12-257.14 g CF, 17.85-20.80 g Ca and 11.48-14.56 g P.

Bred sows up to 85 farrowing days are given on the average 2.12-2.26 kg compound feed and get daily 1.87-1.98 kg DM, 25.17-28.16 MJ ME, 304.19-311.88 g CP, 13.67-17.79 g Lys, 8.54-11.07 g Met+Cys, 9.11-11.50 g Thr, 42.20-98.30 g crude fat, 76.32-217.58 g CF, 15.26-17.60 g Ca and 9.12-12.37 g P.

Bred sows having 30 days prior to farrowing days are offered on the average 2.62-2.90 kg compound feed and get daily 2.29-2.52 kg DM, 32.60-35.80 MJ ME, 393.82-435.66 g CP, 17.89-24.10 g Lys, 11.06-15.11 g Met+Cys, 11.93-16.96 g Thr, 56.00-129.11 g crude fat, 99.56-281.87 g CF, 20.16-22.80 g Ca and 12.04-16.25 g P.

Lactating sows are fed on the average 5.61-5.70 kg compound feeds and get daily 4.91-5.06 kg DM, 71.36-76.47 MJ ME, 929.10-935.37 g CP, 50.29-67.83 g Lys, 25.94-41.51 g Met+Cys, 32.77-41.51 g Thr, 216.03-456.65 g crude fat, 196.75-307.80 g CF, 45.20-56.10 g Ca and 27.22-35.34 g P.

Some farms also use whey for pig feeding (on average 1.5 kg for 20-30 kg weaned pigs, 3-4 kg for fattening pigs, gilts) In that case, the pigs are fed compound feeds: on average 1.25 kg for 20-30 kg weaned pigs, 2.15-2.90 kg for fattening pigs in, respectively, growing and finishing fattening phase, 2,50 kg for gilts.

Estimation of daily feed allowance, also nutritive and energy value of rations indicated that complete compound feeds in the average ration should amount to 1.37-1.44 kg for weaned 20-30 kg pigs, 2.22-2.45 kg for 30-65 kg pigs in the first fattening phase, 2.85-3.10 kg for over 60 kg weight pigs in the second fattening phase, 2.50-2.70 kg for over 50-60 kg weight gilts, 2.12-2.26 kg for bred sows up to 85 farrowing days, 2.62-2.90 kg for bred sows with 30 farrowing days left and 5.61-5.70 kg for lactating sows.

Complete compound feeds for fattening pigs and sows were used for nutrient digestibility in vivo studies. The pigs of first technological group were given compound feeds (86.67 % DM, 18.60 % CP, 2.68 % crude fat, 2.94 % CF, 9.80 g/kg Lys, 6.20 g/kg Met+Cys, 6.50 g/kg Thr, 12.96 MJ/kg ME) formulated for the first fattening phase (30-60 kg weight) and composed of barley, wheat, triticale, soybean meal, rapeseed cake, sunflower meal, vegetable oil, fodder lime, monocalcium phosphate, common salt, vitamins, trace elements, aminoacids and enzyme additives. The pigs of the second and third technological groups (60-85 kg and ower 85 kg weight) were given compound feeds (86.31 % DM, 16.89 % CP, 2.47 % crude fat, 3.46 % CF, 8.65 g/kg Lys, 5.05 g/kg Met+Cys, 5.90 g/kg Thr, 12.84 MJ/kg ME) formulated for the second fattening phase (over 60 kg weight) and composed of barley, wheat, wheat bran, soybean meal, rapeseed cake, sunflower meal, vegetable oil, fodder lime, monocalcium phosphate, common salt, vitamins, trace elements, aminoacids and enzyme additives. The pigs of the fourth technological group (sows) were given compound feeds (87.31 % DM, 15.78 % CP, 2.93 % crude fat, 3.33 % CF, 7.20 g/kg Lys, 4.50 g/kg Met+Cys, 4.70 g/kg Thr, 12.35 MJ/kg ME) formulated for farrowing sows and composed of barley, oats, triticale, wheat, wheat bran, soybean meal, rapeseed cake, sunflower meal, vegetable oil, fodder lime, monocalcium phosphate, common salt, vitamins, trace elements, aminoacids and enzyme additives. The chemical composition and nutritive value of the compound feeds used in the study were in agreement with the average values of compound feeds used in the country farms and the average ration which was formulated on the basis of the collected and systematized information about the feeds used for feeding fattening pigs and sows. The average ration used in the study is a reflection of the ration for fattening pigs and sows used in most of the farms in Lithuania and accounts for feeding 83.74 % of the animals of the above technological groups. The pigs of the first technological group digested on the average 83.62 % DM, 85.92 % CP, 68.04 % crude fat, 25.14 % CF, 32.70 % ADF, 52.54 % NDF, 87.65 % NFE and 86.27 % OM of total ration. The animals of the second technological group digested on the average 83.27 % DM, 85.18 % CP, 67.99 % crude fat, 22.24 % CF, 34.28 % ADF, 52.88 % NDF, 89.55 % NFE and 85.08 % OM. The animals of the third technological group digested on the average 83.50 % DM, 87.15 % CP, 68.75 % crude fat, 23.66 % CF, 38.58 % ADF, 51.82 % NDF, 88.96 % NFE and 85.32 % OM. The pigs of the fourth technological group digested on the average 81.15 % DM, 82.55 % CP, 70.59 % crude fat, 22.32 % CF, 33.29 % ADF, 50.62 % NDF, 87.17 % NFE and 83.12 % OM. The daily weight gain of the treated animals was 893-1057 g, 839-1314 g, 739-907 g and 432-604 g in, respectively, Group 1, Group 2, Group 3 and Group 4.

ANNEX XI. LULUCF area matrices

1990

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,042,973	NO	6,389	3,594	NO	799	2,053,755	10,782
Cropland	NO	2,392,387	22,362	NO	NO	NO	2,414,749	-6,789
Grassland	NO	29,151	1,257,091	NO	NO	NO	1,286,242	399
Wetlands	NO	NO	NO	383,357	NO	NO	383,357	-3,594
Settlements	NO	NO	NO	NO	348,216	NO	348,216	NO
Other land	NO	NO	NO	NO	NO	42,329	42,329	-799
Initial	2,042,973	2,421,538	1,285,843	386,951	348,216	43,128	6,528,648	

1991

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,053,755	399	3,993	2,396	399	NO	2,060,943	7,188
Cropland	NO	2,352,454	22,362	NO	799	399	2,376,014	-38,735
Grassland	NO	60,698	1,257,091	2,795	799	4,393	1,325,776	39,534
Wetlands	NO	399	1,597	378,166	NO	NO	380,162	-3,195
Settlements	NO	799	1,198	NO	346,219	799	349,015	799
Other land	NO	NO	NO	NO	NO	36,738	36,738	-5,591
Initial	2,053,755	2,414,749	1,286,242	383,357	348,216	42,329	6,528,648	

1992

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,060,943	399	2,795	1,997	NO	399	2,066,533	5,591
Cropland	NO	2,311,722	25,158	NO	NO	799	2,337,679	-38,336
Grassland	NO	60,299	1,297,024	799	1,198	4,792	1,364,112	38,336
Wetlands	NO	399	NO	377,367	NO	1,997	379,763	NO
Settlements	NO	2,396	799	NO	347,817	399	351,411	2,396
Other land	NO	799	NO	NO	NO	28,352	29,151	-7,587
Initial	2,060,943	2,376,014	1,325,776	380,162	349,015	36,738	6,528,648	

1993

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,066,533	1,198	3,993	NO	NO	NO	2,071,725	5,191
Cropland	NO	2,275,383	22,762	1,198	799	1,597	2,301,739	-35,940
Grassland	NO	58,702	1,336,957	1,198	1,198	5,191	1,403,246	39,134
Wetlands	NO	799	NO	377,367	NO	NO	378,166	-1,597
Settlements	NO	799	399.33013	NO	349,414	NO	350,612	-799
Other land	NO	799	NO	NO	NO	22,362	23,161	-5,990
Initial	2,066,533	2,337,679	1,364,112	379,763	351,411	29,151	6,528,648	

1994

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,071,325	NO	2,396	399	399	NO	2,074,520	2,795
Cropland	NO	2,231,457	27,953	NO	NO	799	2,260,209	-41,530
Grassland	NO	66,688	1,371,300	799	799	4,792	1,444,377	41,131
Wetlands	NO	399	NO	376,968	NO	NO	377,367	-799
Settlements	NO	2,795	1,597	NO	349,414	NO	353,806	3,195
Other land	399	399	NO	NO	NO	17,571	18,369	-4,792
Initial	2,071,725	2,301,739	1,403,246	378,166	350,612	23,161	6,528,648	

1995

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,074,520	NO	1,597	799	NO	NO	2,076,916	2,396
Cropland	NO	2,197,913	24,758	NO	NO	399	2,223,071	-37,138
Grassland	NO	59,500	1,417,622	1,198	3,195	4,792	1,486,307	41,930
Wetlands	NO	399	399	375,370	NO	799	376,968	-399
Settlements	NO	1,997	NO	NO	350,612	NO	352,609	-1,198
Other land	NO	399	NO	NO	NO	12,379	12,779	-5,591
Initial	2,074,520	2,260,209	1,444,377	377,367	353,806	18,369	6,528,648	

1996

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,076,916	399	2,795	799	NO	NO	2,080,909	3,993
Cropland	NO	2,196,715	8,386	NO	NO	NO	2,205,101	-17,970
Grassland	NO	25,956	1,475,126	399	NO	399	1,501,881	15,574
Wetlands	NO	NO	NO	375,770	NO	NO	375,770	-1,198
Settlements	NO	NO	NO	NO	352,609	NO	352,609	NO
Other land	NO	NO	NO	NO	NO	12,379	12,379	-399
Initial	2,076,916	2,223,071	1,486,307	376,968	352,609	12,779	6,528,648	

1997

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,080,909	799	2,396	399	NO	NO	2,084,503	3,594
Cropland	NO	2,153,188	19,567	NO	NO	399	2,173,155	-31,946
Grassland	NO	50,715	1,479,119	NO	NO	NO	1,529,834	27,953
Wetlands	NO	NO	399	375,370	NO	NO	375,770	NO
Settlements	NO	399	399	NO	352,209	NO	353,008	399
Other land	NO	NO	NO	NO	399	11,980	12,379	NO
Initial	2,080,909	2,205,101	1,501,881	375,770	352,609	12,379	6,528,648	

1998

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,084,503	NO	2,795	NO	NO	399	2,087,698	3,195
Cropland	NO	2,088,497	37,138	NO	NO	NO	2,125,634	-47,520
Grassland	NO	83,859	1,489,501	NO	NO	NO	1,573,361	43,527
Wetlands	NO	NO	NO	375,770	NO	NO	375,770	NO
Settlements	NO	399	399	NO	353,008	NO	353,806	799
Other land	NO	399	NO	NO	NO	11,980	12,379	NO
Initial	2,084,503	2,173,155	1,529,834	375,770	353,008	12,379	6,528,648	

1999

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,087,299	399	1,597	1,198	NO	NO	2,090,493	2,795
Cropland	NO	2,028,597	51,913	NO	NO	NO	2,080,510	-45,124
Grassland	NO	96,239	1,519,052	NO	NO	NO	1,615,290	41,930
Wetlands	399	NO	NO	374,572	NO	NO	374,971	-799
Settlements	NO	399	799	NO	353,806	NO	355,004	1,198
Other land	NO	NO	NO	NO	NO	12,379	12,379	NO
Initial	2,087,698	2,125,634	1,573,361	375,770	353,806	12,379	6,528,648	

2000

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,090,493	NO	2,396	2,396	NO	399	2,095,685	5,191
Cropland	NO	1,969,896	50,715	NO	NO	NO	2,020,610	-59,900
Grassland	NO	108,618	1,558,585	399	1,198	NO	1,668,801	53,510
Wetlands	NO	NO	1,198	372,176	NO	NO	373,374	-1,597
Settlements	NO	1,997	2,396	NO	353,806	NO	358,199	3,195
Other land	NO	NO	NO	NO	NO	11,980	11,980	-399
Initial	2,090,493	2,080,510	1,615,290	374,971	355,004	12,379	6,528,648	

2001

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,095,685	399	1,997	NO	NO	NO	2,098,081	2,396
Cropland	NO	1,917,983	43,128	NO	NO	NO	1,961,110	-59,500
Grassland	NO	101,829	1,622,878	399	399	399	1,725,905	57,104
Wetlands	NO	NO	NO	372,974	NO	NO	372,974	-399
Settlements	NO	399	399	NO	357,800	NO	358,598	399
Other land	NO	NO	399	NO	NO	11,581	11,980	NO
Initial	2,095,685	2,020,610	1,668,801	373,374	358,199	11,980	6,528,648	

2002

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,098,081	NO	3,993	399	NO	NO	2,102,473	4,393
Cropland	NO	1,872,858	40,332	NO	NO	NO	1,913,191	-47,920
Grassland	NO	87,453	1,681,180	NO	NO	NO	1,768,633	42,728
Wetlands	NO	NO	399	372,575	NO	799	373,773	799
Settlements	NO	799	NO	NO	358,598	NO	359,397	799
Other land	NO	NO	NO	NO	NO	11,181	11,181	-799
Initial	2,098,081	1,961,110	1,725,905	372,974	358,598	11,980	6,528,648	

2003

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,102,074	799	3,195	799	399	NO	2,107,265	4,792
Cropland	NO	1,848,899	23,560	NO	NO	NO	1,872,459	-40,732
Grassland	NO	63,493	1,740,680	NO	NO	NO	1,804,174	35,540
Wetlands	399	NO	399	372,974	NO	399	374,172	399
Settlements	NO	NO	399	NO	358,998	NO	359,397	NO
Other land	NO	NO	399	NO	NO	10,782	11,181	NO
Initial	2,102,473	1,913,191	1,768,633	373,773	359,397	11,181	6,528,648	

2004

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,106,466	399	6,389	1,198	NO	NO	2,114,453	7,188
Cropland	NO	1,822,143	29,151	NO	NO	NO	1,851,294	-21,164
Grassland	NO	49,517	1,767,834	399	NO	NO	1,817,751	13,577
Wetlands	799	NO	399	372,575	NO	399	374,172	NO
Settlements	NO	399	399	NO	359,397	NO	360,196	799
Other land	NO	NO	NO	NO	NO	10,782	10,782	-399
Initial	2,107,265	1,872,459	1,804,174	374,172	359,397	11,181	6,528,648	

2005

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,114,054	799	5,191	1,597	NO	399	2,122,040	7,587
Cropland	NO	1,811,361	23,161	NO	NO	NO	1,834,523	-16,772
Grassland	NO	38,336	1,787,002	NO	NO	NO	1,825,338	7,587
Wetlands	NO	NO	799	372,575	NO	399	373,773	-399
Settlements	399	799	1,597	NO	360,196	NO	362,991	2,795
Other land	NO	NO	NO	NO	NO	9,983	9,983	-799
Initial	2,114,453	1,851,294	1,817,751	374,172	360,196	10,782	6,528,648	

2006

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,121,641	799	5,591	1,597	NO	NO	2,129,628	7,587
Cropland	NO	1,798,583	76,272	NO	NO	NO	1,874,855	40,332
Grassland	NO	34,742	1,741,479	399	NO	NO	1,776,620	-48,718
Wetlands	NO	399	399	371,776	NO	NO	372,575	-1,198
Settlements	399	NO	1,597	NO	362,991	NO	364,988	1,997
Other land	NO	NO	NO	NO	NO	9,983	9,983	NO
Initial	2,122,040	1,834,523	1,825,338	373,773	362,991	9,983	6,528,648	

2007

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,129,628	2,396	2,795	1,997	NO	399	2,137,215	7,587
Cropland	NO	1,848,100	71,879	NO	NO	NO	1,919,979	45,124
Grassland	NO	24,359	1,699,549	NO	399	NO	1,724,308	-52,312
Wetlands	NO	NO	1,198	370,578	NO	NO	371,776	-799
Settlements	NO	NO	1,198	NO	364,588	NO	365,786	799
Other land	NO	NO	NO	NO	NO	9,584	9,584	-399
Initial	2,129,628	1,874,855	1,776,620	372,575	364,988	9,983	6,528,648	

2008

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,137,215	1,597	4,792	399	NO	NO	2,144,003	6,789
Cropland	NO	1,893,224	73,077	NO	399	NO	1,966,701	46,722
Grassland	NO	24,758	1,643,243	399	NO	NO	1,668,401	-55,906
Wetlands	NO	NO	799	370,978	NO	NO	371,776	0
Settlements	NO	399	1,597	NO	365,387	NO	367,384	1,597
Other land	NO	NO	799	NO	NO	9,584	10,383	799
Initial	2,137,215	1,919,979	1,724,308	371,776	365,786	9,584	6,528,648	

2009

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,143,604	NO	3,594	NO	NO	NO	2,147,198	3,195
Cropland	NO	1,950,328	50,316	NO	NO	NO	2,000,644	33,943
Grassland	NO	15,973	1,610,099	NO	399	399	1,626,871	-41,530
Wetlands	399	NO	NO	371,776	NO	NO	372,176	399
Settlements	NO	399	3,594	NO	366,984	NO	370,978	3,594
Other land	NO	NO	799	NO	NO	9,983	10,782	399
Initial	2,144,003	1,966,701	1,668,401	371,776	367,384	10,383	6,528,648	

2010

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,147,198	399	5,990	NO	NO	NO	2,153,587	6,389
Cropland	NO	1,897,217	5,191	NO	NO	NO	1,902,409	-98,235
Grassland	NO	103,027	1,611,696	399	1,198	NO	1,716,321	89,450
Wetlands	NO	NO	NO	371,776	NO	NO	371,776	-399
Settlements	NO	NO	3,993	NO	369,780	NO	373,773	2,795
Other land	NO	NO	NO	NO	NO	10,782	10,782	NO
Initial	2,147,198	2,000,644	1,626,871	372,176	370,978	10,782	6,528,648	

2011

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,153,587	2,396	5,591	NO	NO	NO	2,161,574	7,987
Cropland	NO	1,859,281	39,933	NO	NO	NO	1,899,214	-3,195
Grassland	NO	40,732	1,670,398	NO	399	NO	1,711,529	-4,792
Wetlands	NO	NO	NO	371,776	NO	399	372,176	399
Settlements	NO	NO	399	NO	373,374	NO	373,773	NO
Other land	NO	NO	NO	NO	NO	10,383	10,383	-399
Initial	2,153,587	1,902,409	1,716,321	371,776	373,773	10,782	6,528,648	

2012

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,161,574	1,198	8,386	1,997	NO	NO	2,173,155	11,581
Cropland	NO	1,864,073	37,138	NO	NO	NO	1,901,211	1,997
Grassland	NO	33,943	1,665,207	399	1,198	NO	1,700,747	-10,782
Wetlands	NO	NO	NO	369,780	NO	NO	369,780	-2,396
Settlements	NO	NO	799	NO	372,575	NO	373,374	-399
Other land	NO	NO	NO	NO	NO	10,383	10,383	NO
Initial	2,161,574	1,899,214	1,711,529	372,176	373,773	10,383	6,528,648	

2013

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,173,155	799	4,393	NO	799	NO	2,179,145	5,990
Cropland	NO	1,880,046	37,138	NO	NO	NO	1,917,184	15,973
Grassland	NO	19,967	1,654,425	NO	1198	NO	1,675,589	-25,158
Wetlands	NO	NO	NO	369,780	NO	399	370,179	399
Settlements	NO	399	4,393	NO	371,377	NO	376,169	2,795
Other land	NO	NO	399	NO	NO	9,983	10,383	NO
Initial	2,173,155	1,901,211	1,700,747	369,780	373,374	10,383	6,528,648	

2014

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,179,145	1,997	3,594	2,396	NO	NO	2,187,131	7,987
Cropland	NO	1,893,224	42,728	NO	NO	NO	1,935,952	18,769
Grassland	NO	21,164	1,626,072	399	399	399	1,648,435	-27,154
Wetlands	NO	NO	1,198	367,384	NO	NO	368,582	-1,597
Settlements	NO	799	1,597	NO	375,770	NO	378,166	1,997
Other land	NO	NO	399	NO	NO	9,983	10,383	NO
Initial	2,179,145	1,917,184	1,675,589	370,179	376,169	10,383	6,528,648	

2015

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,187,131	799	7,587	799	NO	NO	2,196,316	9,185
Cropland	NO	1,925,171	15,973	NO	399	NO	1,941,543	5,591
Grassland	NO	9,584	1,622,478	NO	NO	1,198	1,633,260	-15,175
Wetlands	NO	NO	399	367,783	NO	NO	368,182	-399
Settlements	NO	399	1,997	NO	377,766	NO	380,162	1,997
Other land	NO	NO	NO	NO	NO	9,185	9,185	-1,198
Initial	2,187,131	1,935,952	1,648,435	368,582	378,166	10,383	6,528,648	

2016

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,195,916	399	3,993	1,198	NO	NO	2,201,507	5,191
Cropland	NO	1,931,161	11,980	NO	798.66026	NO	1,943,939	2,396
Grassland	NO	9,983	1,617,287	399	NO	799	1,628,468	-4,792
Wetlands	NO	NO	NO	366,585	NO	NO	366,585	-1,597
Settlements	399	NO	NO	NO	379,364	NO	379,763	-399
Other land	NO	NO	NO	NO	NO	8,386	8,386	-799
Initial	2,196,316	1,941,543	1,633,260	368,182	380,162	9,185	6,528,648	

2017

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,200,708	399	5,990	2,396	NO	NO	2,209,494	7,987
Cropland	NO	1,932,359	34,342	NO	NO	NO	1,966,701	22,762
Grassland	NO	10,782	1,587,337	399	1,198	399	1,600,116	-28,352
Wetlands	799	NO	NO	363,790	NO	NO	364,588	-1,997
Settlements	NO	399	799	NO	378,565	NO	379,763	NO
Other land	NO	NO	NO	NO	NO	7,987	7,987	-399
Initial	2,201,507	1,943,939	1,628,468	366,585	379,763	8,386	6,528,648	

2018

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,206,299	NO	3,594	399	NO	NO	2,210,292	799
Cropland	NO	1,955,919	33,144	NO	399	NO	1,989,463	22,762
Grassland	1,198	10,782	1,562,579	799	799	399	1,576,555	-23,560
Wetlands	NO	NO	NO	363,390	NO	NO	363,390	-1,198
Settlements	799	NO	799	NO	378,565	399	380,562	799
Other land	1,198	NO	NO	NO	NO	7,188	8,386	399
Initial	2,209,494	1,966,701	1,600,116	364,588	379,763	7,987	6,528,648	

2019

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,209,893	NO	3,594	399	NO	NO	2,213,886	3,594
Cropland	NO	1,970,694	33,544	NO	399	NO	2,004,637	15,175
Grassland	399	18,769	1,537,421	399	NO	NO	1,556,988	-19,567
Wetlands	NO	NO	NO	362,592	NO	NO	362,592	-799
Settlements	NO	NO	1,997	NO	380,162	NO	382,159	1,597
Other land	NO	NO	NO	NO	NO	8,386	8,386	NO
Initial	2,210,292	1,989,463	1,576,555	363,390	380,562	8,386	6,528,648	

2020

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,212,688	399	5,990	1,997	NO	NO	2,221,074	7,188
Cropland	NO	1,987,865	41,930	NO	399	0	2,030,194	25,557
Grassland	799	16,373	1,505,874	NO	399	399	1,523,844	-33,144
Wetlands	399	NO	NO	360,595	NO	NO	360,994	-1,597
Settlements	NO	NO	3,195	NO	381,360	NO	384,555	2,396
Other land	NO	NO	NO	NO	NO	7,987	7,987	-399
Initial	2,213,886	2,004,637	1,556,988	362,592	382,159	8,386	6,528,648	

2021

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,220,276	NO	9,185	399	399	NO	2,230,259	9,185
Cropland	NO	2,008,231	45,923	NO	NO	NO	2,054,154	23,960
Grassland	399	21,564	1,467,139	NO	399	NO	1,489,501	-34,342
Wetlands	NO	NO	NO	360,595	NO	NO	360,595	-399
Settlements	399	399	1,198	NO	383,756	NO	385,753	1,198
Other land	NO	NO	399	NO	NO	7,987	8,386	399
Initial	2,221,074	2,030,194	1,523,844	360,994	384,555	7,987	6,528,648	

2022

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,229,859	399	7,987	2,396	NO	NO	2,240,641	10,383
Cropland	399	2,039,379	60,299	NO	399	NO	2,100,476	46,322
Grassland	NO	13,977	1,419,619	NO	399	NO	1,433,994	-55,507
Wetlands	NO	NO	NO	358,199	399	NO	358,598	-1,997
Settlements	NO	399	1,198	NO	384,555	NO	386,152	399
Other land	NO	NO	399	NO	NO	8,386	8,785	399
Initial	2,230,259	2,054,154	1,489,501	360,595	385,753	8,386	6,528,648	

2023

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,240,242	399	6,789	399	NO	NO	2,247,829	7,188
Cropland	NO	2,084,503	58,302	NO	399	NO	2,143,205	42,728
Grassland	NO	15,175	1,365,709	NO	399	NO	1,381,283	-52,712
Wetlands	NO	NO	NO	358,199	NO	NO	358,199	-399
Settlements	399	399	3,195	NO	385,354	NO	389,347	3,195
Other land	NO	NO	NO	NO	NO	8,785	8,785	NO
Initial	2,240,641	2,100,476	1,433,994	358,598	386,152	8,785	6,528,648	

ANNEX XII. Summary of the studies on carbon stock values in forest and non-forest land

In this annex the summaries of two studies performed by Lithuanian Centre of Agriculture and Forestry, Institute of Forestry under the partnership project between Lithuania and Norway.

Summaries do not provide all the studies' results (estimates of each sampling plot estimated carbon stock value) which were used to calculate average national values of carbon stocks in mineral soils of forest land, cropland and grassland as well as afforested/reforested lands mineral soils and carbon stocks in litter in forest remaining forest and land converted to forest land. Summaries are provided here as information item on the methodology used to estimate national carbon stock values in soil and litter.

LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

OF THE STUDY "ASSESSMENT OF CARBON STOCKS IN MINERAL AND ORGANIC SOILS, AND ESTIMATION OF NATIONAL CARBON VALUES IN THE SOILS AFTER AFFORESTATION OF ABANDONED AGRICULTURAL LAND/REFORESTATION"

SHORT REPORT

(Supervised by dr. I.Varnagirytė-Kabašinskienė. Kaunas-Girionys, 2016)

Introduction

The afforestation (conversion to forest land actively promoted through planting of trees) is recognized as an eligible measure to achieve climate change mitigation, biodiversity protection and enhancement goals promoted by recent environmental policies. Generally, the mitigation policies aim to reduce greenhouse gas emissions from individual countries in order to prevent climate change. In accordance with various commitments, Lithuania aims to develop methodically reasonable estimates of national carbon stocks in mineral and organic soils.

This study aims to give an overview of soil organic carbon estimates in *Arenosols*, *Luvisols* and *Histosols* after afforestation of abandoned agricultural land/reforestation in Lithuania. Carbon concentrations and stocks in the coniferous and deciduous forest plantations of different 1–10, 11–20 and 21–30 years age are analysed. Recently obtained data of soil carbon estimates on conversion to forest land or plantations at Lithuanian level are presented.

Conversion to forest land is generally associated with positive effects on the carbon balance, particularly if former agricultural land with low soil organic matter content is afforested. The carbon benefits are produced by biomass accumulation during the conversion and by a potential increase of organic carbon in the soil. However, the carbon dynamics in the conversion to forest can vary a lot. While forest stands always contain more biomass above-ground compared to grassland or agricultural crops, this is not always true for below-ground biomass and soil organic matter.

Materials and methods

The study describes the method used for estimating carbon stocks for managed forest plantations (different tree species, different age classes) and the control – crops and/or grasslands. The effect of land-use change was investigated by applying the paired-site design, i.e. by comparing soil organic carbon in the forest plantation (afforested plot) with identical soil type but different land-use type (control – grassland or crop) at the same moment in time. The soil organic carbon stocks are derived from field measurements up to a depth of 30 cm (forest litter/organic horizon/Ao; mineral soil of 0–10, 10–30 and 0–30 cm depths). A comprehensive soil survey was undertaken in March-September, 2016. The study objectives were selected in Dubrava, Kaunas, Kretinga, Kazlų Rūda, Jonava, Marijampolė, Alytus, Prienai, Varėna, Veisiejai, Ukmergė, Kėdainiai and Valkininkai Forest Enterprises.

Totally soil samples were collected from 383 plots, of which 188 plots were selected in afforested sites (deciduous or conifers), other plots were selected as controls in permanent grassland or arable land.

In the field, the plot characteristics were given: ground vegetation assessment – species composition and projection area (%); projection area of forest litter, especially in young forest plantations; land-use type was described – natural or agricultural grasslands, arable land, etc. The litter layer was collected from five places within 0.25×0.25 m frame. Mineral soil was sampled with a gauge from 10 places. Subsamples were combined both forest litter and mineral soil.

In the laboratory, collected composite samples were analysed: dry mass of forest or grassland litter, bulk density of mineral soil and dry mass of organic soil were determined according ISO 11272:1998. Samples were prepared for the chemical analyses according to the ISO 11464:1994. According to the requirements of LST EN ISO/IEC 17025:2005, total organic carbon was determined by ISO 10694:1995 (total concentrations of organic carbon were given for dry mass according ISO 11465:1993) in the accredited Agrochemical Research laboratory of Lithuanian Research Centre for Agriculture and Forestry.

Main findings and conclusions

1. The study results showed that mean mass of soil organic layer (forest litter) in the studied *Arenosols*, *Luvisols* and *Histosols* of afforested/reforested land (0–30-year-old coniferous and deciduous plantations) in all cases was higher than soil organic layer (mainly annual litter of grasses) of perennial grassland. The mass of soil organic layer in coniferous stands was 1.6 to 2.6 times higher than in deciduous stands.

2. The bulk density (of fine soil fraction, <2 mm) in the 0-10 cm layer of forest soil was 1.15 ± 0.02 g cm^{-3} in *Arenosols*, 1.24 ± 0.02 g cm^{-3} in *Luvisols*, and 0.33 ± 0.02 g cm^{-3} in *Histosols*. Deeper, in the 10–30 cm layer, the bulk density was 1.30 ± 0.02 (*Arenosols*); 1.43 ± 0.02 (*Luvisols*) and 0.35 ± 0.03 g cm^{-3} (*Histosols*). In all studied soils of afforested land the bulk density slightly differed from the bulk density in the perennial grasslands or arable land. Also, in many cases, the bulk density was lower in older forest plantations compared to the arable land. However, it did not significantly differ between forests and perennial grasslands.

The mean soil organic carbon concentrations in the soil organic layer (forest litter) of *Arenosols* and *Luvisols* varied in a range of 340–360 g kg^{-1}, while in the *Histosols* the carbon concentration was about 420 g kg^{-1}. However, in all cases C concentration in the soil organic layer of afforested land did not much differ from the C concentration in the perennial grasslands.

The stocks of organic carbon in the soils at 0–30 depths of afforested land exceeded the organic carbon values in the similar soils of the perennial grasslands. The carbon stocks in the soil of afforested land were by 1.3 times higher in the nutrient poor *Arenosols* and by 1.4 times higher in the *Histosols* compared to the similar grassland soils. The carbon stocks in more fertile *Luvisols* of afforested land were quite similar to the carbon stocks in the perennial grasslands. In the afforested land, the carbon stocks at 0–30 cm soil depth were significantly higher compared to the arable soils: they were about 1.3 times higher in *Arenosols*, by 1.7 times – in *Luvisols*, and by 1.2 times higher – in *Histosols*.

Our study showed that organic carbon more intensively accumulated in the deciduous forest compared to the coniferous forest in the nutrient poor *Arenosols*. In the deciduous forest organic carbon stocks were about 1.4 times lower than in the coniferous forest (Fig.1). However, no significant difference between conifers and deciduous forest were obtained in more fertile *Luvisols* and organic *Histosols.*

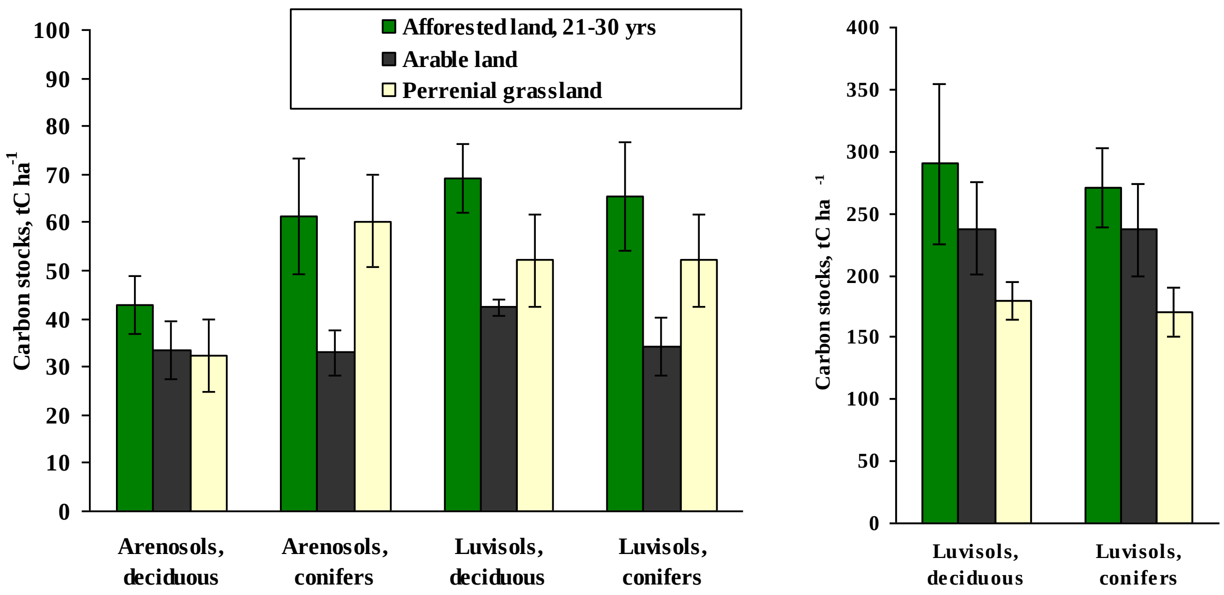


Fig.1. Stocks (t ha^{-1}) of organic carbon in 0–30 cm mineral soil/peat layer in the afforested land in the 21-30-year old coniferous and deciduous forest plantations and the control (arable land and grassland).

Detailed estimates of national carbon stocks in mineral and organic soils in Lithuania are given in a summary Table 1 and Tables 2–4.

This study confirmed the results obtained in the similar surveys of foreign countries stating that the significant increase of organic carbon stocks up to 30–40 years after the afforestation/reforestation is not recorded. For this aim, older afforested sites should be studied.

Table 1. Organic carbon stocks (t ha^{-1}) in the 0–30 cm mineral soil/peat layer of afforested/reforested sites of different age groups and the control (arable land and permanent grasslands). The values are given as the means and standard errors (data of 2016 soil survey in Lithuania)

Land-use	Soil group (WRB, 2015)					
	Arenosols		*Luvisols*		*Histosols*	
	n	tC ha^{-1}	*n*	tC ha^{-1}	*n*	tC ha^{-1}
Afforested land* (0-10 years old)	23	**51.9±5.2**	22	**59.1±4.0**	15	**283.9±15.8**
Arable land	10	44.9±7.1	13	33.6±3.9	7	227.7±47.0
Grassland	9	39.4±4.5	9	63.6±13.9	7	221.0±14.7
Afforested land (11-20 years old)	22	**57.5±4.8**	21	**60.3±4.8**	22	**243.9±26.5**
Arable land	12	40.4±4.1	12	40.1±5.4	6	171.6±18.5
Grassland	11	46.3±5.8	10	61.9±13.0	15	168.4±13.5
Afforested land (21-30 years old)	22	**49.3±6.0**	18	**66.9±7.2**	23	**277.6±29.9**
Arable land	11	33.3±3.9	14	36.9±4.2	7	199.7±32.3
Grassland	9	36.9±7.7	8	52.1±9.7	16	174.3±12.9
Afforested land (0-30 years old)	67	**53.3±3.1**	61	**61.8±3.1**	60	**266.8±15.5**
Arable land	33	40.0±2.8	39	36.9±2.2	22	221.3±23.2
Grassland	29	42.5±3.1	26	58.0±6.1	38	191.2±8.7

* Afforested land – conifers and deciduous plantations

Table 2. Soil organic carbon stocks (t ha^{-1}) in Arenosols (data of 2016 soil survey in Lithuania)

Land-use	Stock of soil organic carbon, tC ha^{-1}			
	Soil organic layer / litter of grasses	Mineral soil 0–10 cm	Mineral soil 10–30 cm	Mineral soil 0–30 cm
Afforested land (0-10 yrs old)	1.2±0.2	19.2±2.0	32.7±3.5	51.9±5.2
Control	0.9±0.1	21.8±2.1	20.1±2.6	41.9±4.0
Conifers (0-10 yrs old)	0.8±0.3	17.4±2.7	29.0±4.9	46.4±7.5
Arable land	-	15.3±3.6	22.5±7.3	37.8±10.9
Grassland	0.9	18.0±3.3	15.1±3.6	33.1±6.9
Deciduous (0-10 yrs old)	1.5±0.3	20.7±2.8	35.7±5.0	56.4±7.3
Arable land	-	25.0±3.4	27.1±6.9	52.1±9.3
Grassland	0.8±0.2	28.5±4.1	17.1±2.4	45.7±5.3
Afforested land (11-20 yrs old)	2.9±0.3	20.3±1.4	37.2±3.8	57.5±4.8
Control	0.7±0.1	22.3±1.8	20.8±1.9	43.1±3.4
Conifers (11-20 yrs old)	3.3±0.4	22.6±1.5	36.8±3.8	59.4±5.2
Arable land	-	23.1±2.5	23.0±3.8	46.1±5.7
Grassland	0.7±0.2	29.9±3.6	24.6±3.5	54.5±6.8
Deciduous (11-20 yrs old)	2.3±0.3	17.3±2.5	37.7±7.6	55.0±9.2
Arable land	-	16.3±1.9	16.1±2.0	32.4±3.7
Grassland	-	19.4±3.9	18.7±4.9	38.1±8.6

Afforested land (21-30 yrs old)	4.1±0.4	19.2±2.4	30.2±4.0	49.3±6.0
Control	0.5	18.7±2.1	15.7±1.8	34.4±3.5
Conifers (21-30 yrs old)	4.8±0.5	17.8±3.0	25.0±3.9	42.8±6.1
Arable land	-	15.5±2.8	18.1±3.4	33.5±6.1
Grassland	-	20.3±4.3	12.0±3.6	32.2±7.5
Deciduous (21-30 yrs old)	2.9±0.4	21.7±4.1	39.6±8.1	61.3±12.1
Arable land	-	19.2±4.4	13.7±0.7	32.9±4.7
Grassland	0.5	32.7	27.7	60.3

Afforested land (0-30 yrs old)	2.6±0.2	19.6±1.1	33.7±2.2	53.3±3.1
Control	0.7±0.1	21.5±1.1	19.7±1.2	41.2±2.1
Conifers (0-30 yrs old)	3.1±0.4	19.6±1.4	30.8±2.5	50.3±3.7
Arable land	-	18.1±1.8	20.9±2.5	39.0±4.1
Grassland	0.7±0.1	22.4±2.4	17.1±2.4	39.5±4.6
Deciduous (0-30 yrs old)	2.1±0.2	19.7±1.7	37.3±3.8	56.9±5.1
Arable land	-	20.1±2.1	18.6±2.6	38.7±4.1
Grassland	0.7±0.1	25.1±2.9	18.7±2.4	43.7±4.6

Table 3. Soil organic carbon stocks (t ha^{-1}) in Luvisols (data of 2016 soil survey in Lithuania)

Land-use	**Stock of soil organic carbon, tC ha^{-1}**			
	Soil organic layer / litter of grasses	**Mineral soil 0–10 cm**	**Mineral soil 10–30 cm**	**Mineral soil 0–30 cm**
Afforested land (0-10 yrs old)	1.0±0.2	22.8±1.8	36.3±2.6	59.1±4.0
Control	-	26.4±4.4	21.5±3.5	47.8±7.5
Conifers (0-10 yrs old)	1.4±0.3	22.6±2.9	34.6±4.1	57.2±6.4
Arable land	-	16.3±3.4	17.0±2.3	33.4±5.2
Grassland	-	41.3±14.3	32.5±16.5	73.8±30.7
Deciduous (0-10 yrs old)	0.7±0.2	23.0±2.3	37.6±3.5	60.6±5.3
Arable land	-	15.7±3.5	18.0±2.4	33.7±5.9
Grassland	-	35.3±7.6	20.2±2.7	55.5±9.4
Afforested land (11-20 yrs old)	2.1±0.3	23.7±1.9	36.7±3.0	60.3±4.8
Control	1.1±0.1	29.8±4.3	21.8±3.7	51.6±7.6
Conifers (11-20 yrs old)	2.2±0.5	25.0±3.0	38.1±5.0	63.0±7.8
Arable land	-	18.7±2.1	14.3±2.0	33.0±3.4
Grassland	1.2	39.7±11.8	17.8±3.5	57.5±14.8
Deciduous (11-20 yrs old)	1.9±0.3	22.4±2.6	35.3±3.6	57.7±5.9
Arable land	-	26.2±6.8	22.8±4.0	49.0±10.4
Grassland	1.0±0.1	34.8±9.7	30.0±10.8	64.8±20.4
Afforested land (21-30 yrs old)	2.5±0.3	26.7±2.5	40.2±5.1	66.9±7.2
Control	-	23.7±3.4	17.9±2.3	41.6±4.4
Conifers (21-30 yrs old)	3.4±0.5	28.0±4.1	41.1±4.2	69.1±7.1
Arable land	-	16.2±1.7	26.2±2.9	42.4±1.7
Grassland	-	30.7±7.7	21.4±2.7	52.1±9.7
Deciduous (21-30 yrs old)	1.9±0.4	25.8±3.3	39.7±8.1	65.4±11.2
Arable land	-	22.8±4.9	11.4±2.2	34.2±6.0
Grassland	-	-	-	-

Afforested land (0-30 yrs old)	1.8±0.2	24.2±1.2	37.6±2.0	61.8±3.1
Control	0.9±0.1	25.6±1.7	26.9±2.1	46.1±3.1
Conifers (0-30 yrs old)	2.2±0.3	25.1±1.8	37.6±2.5	62.7±4.0
Arable land	-	17.3±1.4	18.2±1.9	35.5±2.4
Grassland	1.2	37.2±6.2	23.9±5.5	61.1±11.0
Deciduous (0-30 yrs old)	1.5±0.2	23.7±1.6	37.6±3.1	61.3±4.5
Arable land	-	21.0±2.8	16.7±1.9	37.7±4.1
Grassland	1.0±0.1	35.0±6.0	25.6±6.0	60.6±11.5

Table 4. Soil organic carbon stocks (t ha^{-1}) in *Histosols* (data of 2016 soil survey in Lithuania)

Land-use	Stock of soil organic carbon, tC ha^{-1}			
	Organic layer / litter of grasses	Peat layer 0–10 cm	Peat layer 10–30 cm	Peat layer 0–30 cm
Afforested land (0-10 yrs old)	1.4±0.2	88.3±4.5	195.6±12.4	283.9±15.8
Control	-	113.4±12.3	110.9±12.7	224.3±22.8
Conifers (0-10 yrs old)	1.0±0.2	90.9±8.0	192.2±20.3	283.1±26.9
Arable land	-	110.7±31.0	131.4±35.7	242.1±66.6
Grassland	-	125.2±3.5	96.5±9.5	221.7±6.0
Deciduous (0-10 yrs old)	1.9±0.2	85.4±3.7	199.4±14.7	284.8±16.9
Arable land	-	90.9±2.4	100.7±14.9	191.6±12.5
Grassland	-	120.5±20.9	100.2±10.5	220.7±21.2
Afforested land (11-20 yrs old)	2.7±0.2	75.0±7.2	168.9±22.3	243.9±26.5
Control	2.1	81.2±4.9	87.7±7.3	168.9±11.5
Conifers (11-20 yrs old)	3.0±0.4	90.4±9.6	199.7±38.3	290.1±41.3
Arable land	-	71.3±12.3	84.6±4.8	155.9±17.1
Grassland	-	78.7±5.6	77.2±12.0	155.9±16.9
Deciduous (11-20 yrs old)	2.4±0.2	59.6±8.9	138.1±20.5	197.7±28.5
Arable land	-	71.3±12.3	84.6±4.8	155.9±17.1
Grassland	2.1	84.5±11.3	102.7±10.9	187.2±21.7
Afforested land (21-30 yrs old)	4.8±0.5	87.5±9.7	190.2±24.2	277.6±29.9
Control	-	112.8±11.5	90.3±10.2	206.0±19.0
Conifers (21-30 yrs old)	7.3±0.5	95.9±15.1	194.0±50.0	289.9±64.8
Arable land	-	121.2±21.4	116.3±16.0	237.5±37.2
Grassland	-	104.8±15.2	74.5±5.9	179.3±15.5
Deciduous (21-30 yrs old)	3.4±0.4	83.0±12.8	188.1±27.4	271.1±32.0
Arable land	-	121.2±21.4	116.3±16.0	237.0±37.0
Grassland	-	100.3±18.5	70.0±8.6	170.3±20.2
Afforested land (0-30 yrs old)	3.2±0.3	83.1±4.7	183.7±12.7	266.8±15.5
Control	2.1	98.3±5.6	104.0±6.4	202.2±10.2
Conifers (0-30 yrs old)	3.7±0.5	92.2±6.1	195.8±21.5	288.0±25.7
Arable land	-	128.1±28.2	144.2±31.1	272.4±59.1
Grassland	-	94.0±7.4	78.3±6.5	172.3±11.2
Deciduous (0-30 yrs old)	2.7±0.2	75.7±6.7	173.8±14.9	249.5±18.5
Arable land	-	103.4±13.7	105.8±9.9	209.2±23.3
Grassland	2.1	104.1±10.3	90.4±6.1	194.5±11.4

LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

EVALUATION OF NATIONAL ORGANIC CARBON STOCKS AND THE DETERMINATION OF STOCK VALUES IN ORGANIC AND MINERAL SOILS IN FOREST AND NON-FOREST LAND

Short report

(LRCAF, Institute of Forestry in 2016. Superviser - prof. dr. Kęstutis Armolaitis)

Introduction

It is essential in order to meet the requirements of the Land Use Land Use Change and Forestry (*LULUCF*) reporting under UNFCCC. At the moment Lithuania is using Tier 1 methodology and default values for carbon stock estimations in soil and forest litter in forest and non-forest land. Annual UNFCCC Expert Review Teams revisions encourage countries to follow guidelines of Intergovernmental Panel on Climate Change (IPCC) ant to move to higher Tiers for estimation of carbons stock changes in soils and forest litter.

The aim of study was to estimate soil organic carbon (SOC) stocks in Lithuanian forests, croplands and grasslands. These specific national SOC values in forest floor and mineral or peat topsoil in the land of different use for Land Use, Land Use Change and Forestry (*LULUCF*) reporting under UNFCCC.

The study was funded by Ministry of Environment of the Republic of Lithuania in the frame of 2009-2014 European Economic Area or Norwegian Financial Mechanisms and Co-financing.

Materials and Methods

The study was performed in 2015 at National Forest Inventory (NFI) permanent sample plots grid that covers the whole territory of Lithuania (**Fig. 1**).

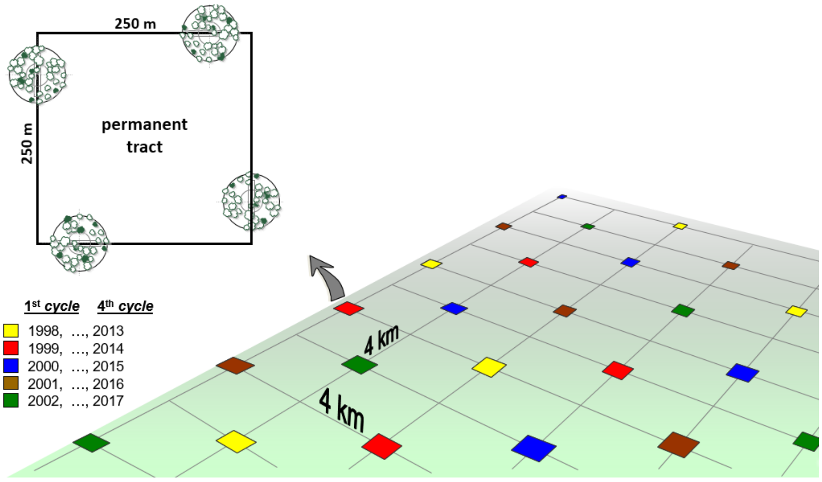


Fig. 1. National Forest Inventory permanent sample plots grid in Lithuania

The data were collected in 752 sample plots (**Fig. 2**).

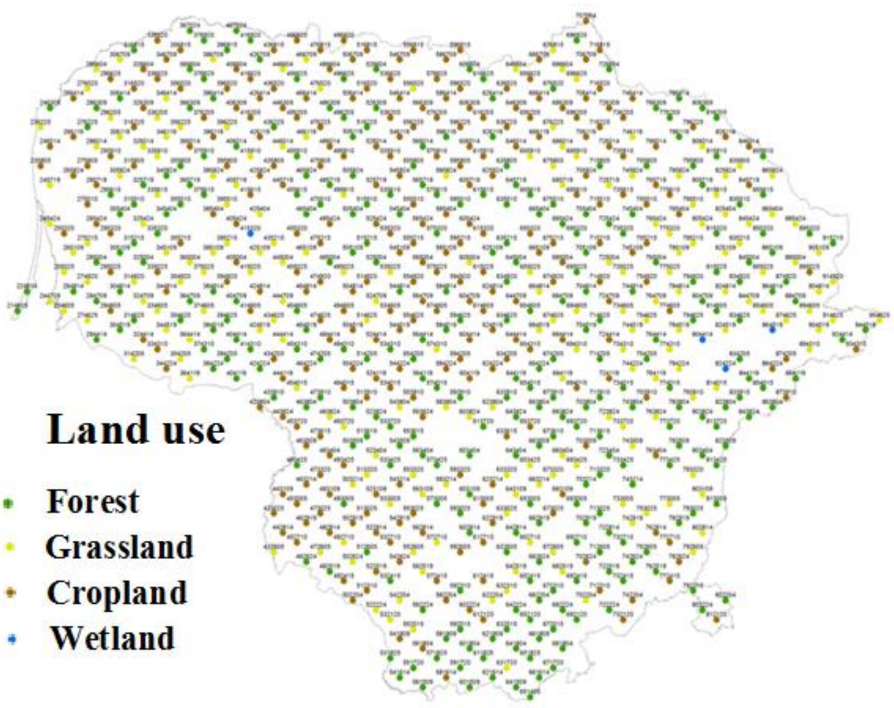


Fig. 2. Sample plots in the grid (9x9 km) of Lithuanian National Forest Inventory (NFI) (Total N=752; forest land – 298; grassland – 206; cropland – 244; wetland – 4)

Forest floor combined (from n=5) samples were collected for the determination of mass and carbon content, whereas mineral topsoil combined samples (from 0-10 cm and 10-30 cm surface layers, from n=10) – for bulk density (ISO 11272:1998) and soil organic carbon (SOC) concentrations (ISO 10694:1995) determination. The SOC stocks in 0-30 cm layer were calculated according following equation (Vesterdal et al., 2008):

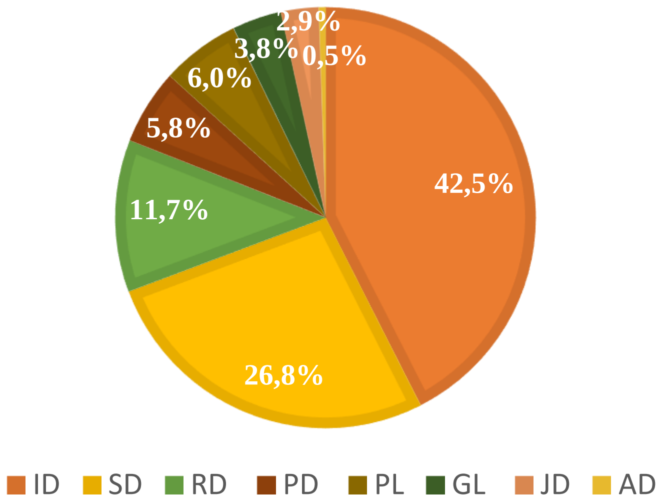
$$\mathrm{SOC_i} = \mathrm{p_i}(1 - (\frac{Qi,2mm}{100}))d_\mathrm{i}C_\mathrm{i} * 10^{-1}$$

where p_i is the bulk density of the <2 mm fraction in g cm^{-3}, $Q_{i,\ 2\ mm}$ is the relative volume of the fraction ≥ 2 mm (%), d_i denotes the thickness of layer *i* in cm, C_i denotes the C concentration of layer *i* (mg g^{-1}), and 10^{-1} is a unit factor (10^{-9} mg Mg^{-1} × 10^8 cm^2 ha^{-1})

Microsoft Excel2016 and Statistica12 were used to analyse the collected data. Mean values ±SE are presented in the report.

Results and discussion

In total 9 major soil groups were found in sample plots (**Fig. 3**).



ID – *Luvisols/Retisols*; SD – *Arenosols*; RD – *Cambisols*; PD – *Histosols*; PL – *Planosols;* GL – *Gleysols*; JD – *Podzols*; AD – *Fluvisols*

Fig.3. Distribution of major soil groups (WRB, 2014) in sample plots

Mean mass of forest floor (total mass of forest litter (OL) + fragmented (OF) + humified (OH) litters) of major soil groups is presented in **Table 1**).

Table.1. Mean mass of forest floor (OL+OF+OH) and mean organic carbon (OC) stocks in major soil groups

Major soil groups: LTDK-99 (*WRB, 2014*)	**Number of sample plots (n)**	**Mean mass, t ha^{-1}**	**Mean OC stocks (tC ha^{-1})**
Rudžemiai (*Cambisols*)	8	4,1±0,6	1,6±0,2
Išplautžemiai ir balkšvažemiai (*Luvisols + Retisols*)	130	13,6±2,8	5,6±1,2
Palvažemiai (*Planosols*)	26	22,9±8,7	9,5±3,7
Smėlžemiai (*Arenosols*)	92	15,7±1,6	6,3±0,7
Jauražemiai (*Podzols*)	21	58,1±15,5	25,0±6,7
Šlynžemiai (*Gleysols*)	20	14,4±6,7	6,3±3,2
Durpžemiai (*Histosols*)	37	12,7±2,5	5,3±1,1
Salpžemiai (*Fluvisols*)	3	2,3±1,0	0,9±0,4

As could be seen from **Fig 4,** from 2.5 time (*Histosols*) to 9 folds (*Arenosols*) mean OC stocks were found for organic layer of grassland as well.

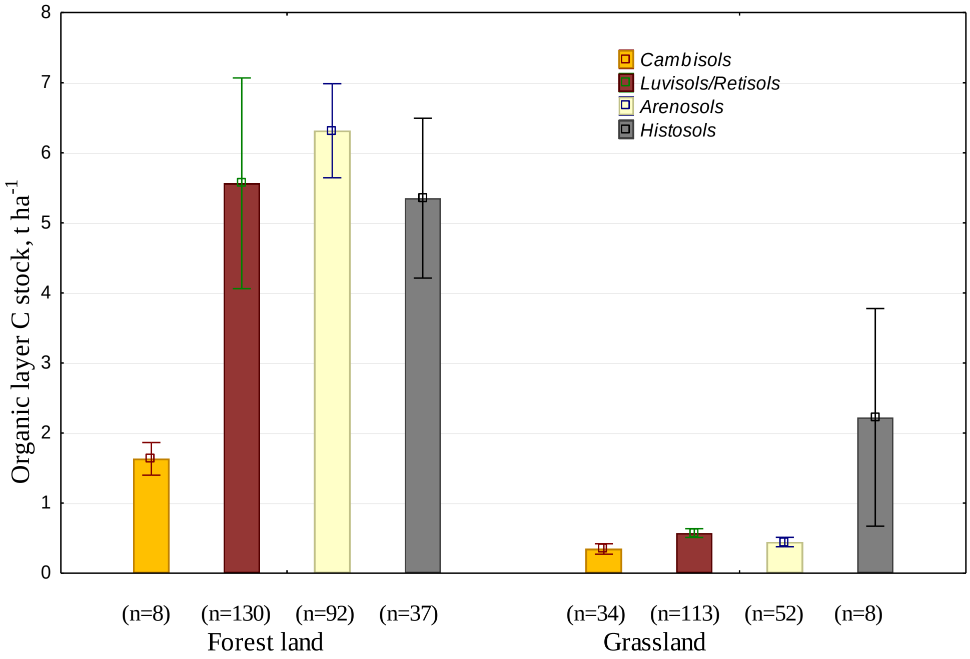


Fig. 4. Mean organic layer stocks of carbon in organic layer of different mineral soils in forest land and grassland (the bars represent SE)

It was found that mean stocks of soil organic carbon (SOC) in surface 0-30 cm layer of some major soil groups (*Cambisols, Arenosols, Podzols, Gleysols, Planosols*) are specific.in Lithuanian forests (**Table 2**).

Table 2. Mean stocks of soil organic carbon (SOC) in surface 0-30 cm layer of major soil groups in forests

Major soil groups: LTDK-99 (*WRB, 2014*)	Average in Europe, (de Vos et al., 2015)	LULUCF default values* (IPCC, 2006)	Average in Lithuania (2016 m., number of plots, n)
Rudžemiai (*Cambisols*)	75	95	118 (n=8)
Išplautžemiai/balkšvažemiai (*Luvisols+Retisols*)	73	95	96 (n=130)
Palvažemiai (*Planosols*)	45	95 (?)	81 (n=26)
Smėlžemiai (*Arenosols*)	50	71	58 (n=92)
Jauražemiai (*Podzols*)	63	115	100 (n=21)
Šlynžemiai (*Gleysols*)	94	87	106 (n=20)
Durpžemiai (*Histosols*)	181	-	154 (n=37)
Salpžemiai (*Fluvisols*)	64	-	80 (n=3)

Cold temperate, moist region

National values of soil organic carbon (SOC) stocks in surface 0-30 cm layer of major soil groups in forests, grassland and cropland are presented in **Table 3.** The most valuable values were determined for *Luvisols/Retisols* (number of sample plots in different land use – 81-130), *Arenosols* (n= 26-92) and *Cambisols* (n=18-81).

Table 3. National values of soil organic carbon (SOC) stocks in surface 0-30 cm layer of major soil groups in forests, grassland and cropland

Major soil groups: LTDK-99 (*WRB, 2014*)	Forests		Grassland		Cropland	
	n	DOC, tC ha^{-1}	n	DOC, tC ha^{-1}	n	DOC, tC ha^{-1}
Rudžemiai (*Cambisols*)	18	118±8 (100%)	34	92±7 (78%)	81	91±4 (69%)
Išplautžemiai/balkšvažemiai (*Luvisols+Retisols*)	130	96±3 (100%)	113	79±3 (82%)	81	71±4 (74%)
Palvažemiai (*Planosols*)	26	81±8 (100%)	7	95±13 (117%)	9	61±7 (75%)
Smėlžemiai (*Arenosols*)	92	58±3 (100%)	52	56±3 (97%)	26	62±4 (107%)
Jauražemiai (*Podzols*)	21	100±12 (100%)	1	83 (83%)	-	-
Šlynžemiai (*Gleysols*)	20	105±8 (100%)	2	106±1 (101%)	1	109 (104%)
Durpžemiai (*Histosols*)	37	154±11 (100%)	8	200±23 (130%)	2	243±131 (158%)
Salpžemiai (*Fluvisols*)	3	80±5 (100%)	1	65 (83%)	-	-

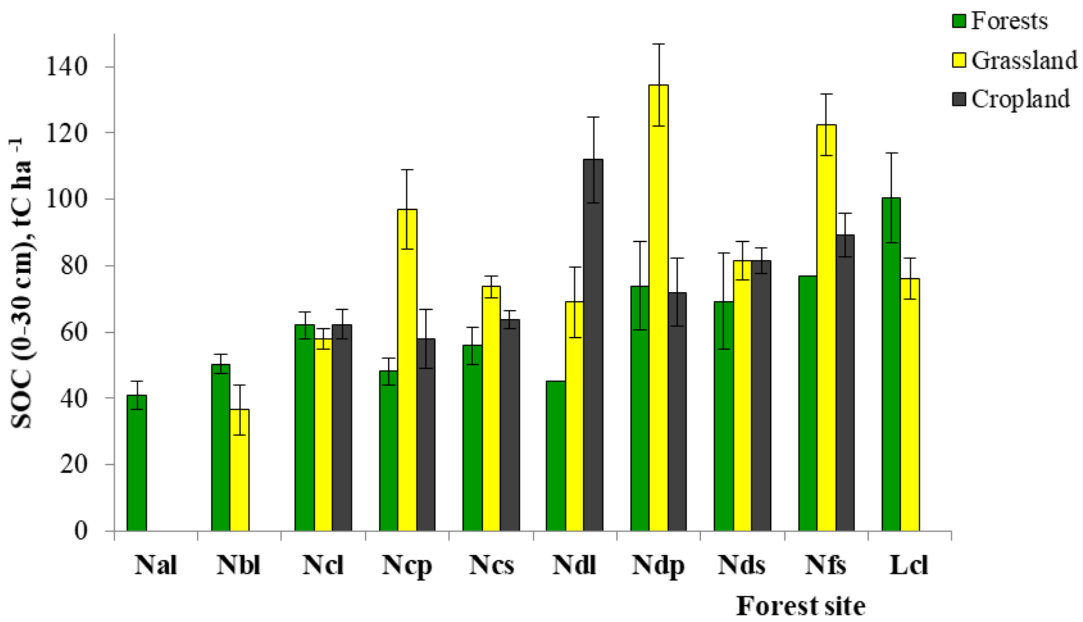


Fig. 5. Mean stocks of soil organic carbon (SOC) in surface 0-30 cm layer of different forest sites (according Lithuanian classification, Vaičys et al., 2006)

Mean stocks of soil organic carbon (SOC) in surface 0-30 cm layer of different forest sites according Lithuanian classification (Vaičys et al., 2006) were presented in **Fig. 5.**

Table 4. Mean stocks of soil organic carbon (SOC) in soil organic layer and surface 0-30 cm mineral layer in forest stands of different age at Luvisol/Retisols

Age, years	N	Mass of organic layer, t ha^{-1}	SOC in organic layer,tC ha^{-1}	SOC (0-30 cm), tC ha^{-1}
1-20	11	2,6±0,5	1,1±0,2	120,7±10,0
21-40	16	4,6±0,8	1,8±0,3	107,6±9,7
41-60	14	3,3±0,6	1,2±0,2	93,2±8,4
61-80	12	4,8±0,6	1,9±0,2	94,9±7,8

In average	53	3,9±0,3	1,5±0,1	103,6±4,7

It was found that the mean stocks of soil organic carbon (SOC) in soil organic layer and surface 0-30 cm mineral layer did not depend directly on forest stands of different age at *Luvisol/Retisols.*

ANNEX XIV. Road transport CH_4 and N_2O IEF analysis

Analysis is provided according to experts review team (ERT) recommendation during centralized review in 2021 with the aim to explain that fluctuations of IEFs did not lead to an underestimation of CH_4 and N_2O emissions for the transport category.

Emission calculations for road transport were done using COPERT V version 5.5.1. All input parameters are country-specific and partially provided as default parameters by COPERT developers. The main parameters influencing CH_4 and N_2O emissions are mileage, fleet and fuel consumed. The reasons of lower IEF are registration by REGITRA peculiarities before 2014 and dieselization (gradually started in 2004) with ratio of fuel consumed for number of vehicles as well as mileage driven especially up to ~2015. N_2O EF for diesel fuel is 4.8 times higher than for petrol, that directly revealed approaching to EU average last years. But it should be noted that Lithuania is fall within range and is not outlier.

The decrease of transport sector CH_4 and N_2O emissions between 2019 and 2021 submissions observed due to major revisions of historical activity data 1990-2019 and data homogenization were made in the latest submission. Vehicles stock was allocated between 'ECE' and 'Euro' standards due to new available data from State Enterprise Regitra. The newly allocated stock configuration was used in model (COPERT 5.4.36) with newly corrected mileage according to fuel consumption by different standard of vehicles. Thus, by using the model estimated pollutant emissions, the amounts of sold diesel oil and gasoline in category were redistributed by type of vehicle and yearly IEF values were recalculated for N_2O for diesel oil (PC and LD) and LPG (N_2O and CH_4) for 1990-2018. Redistributing consumption of diesel oil by type of vehicle changed the distribution of CO_2 emissions by type of road vehicle, but total CO_2 emissions in 1.A.3.b Road transportation remained unchanged (CO_2 emission factors are equal for all types of road vehicles). In contrary with CO_2, N_2O and CH_4 emissions depend on large ensemble of parameters as distance driven, sulfur content (gasoline), Euro standards.

The shift to higher Euro standards is one of the factors having effect on N_2O emissions decrease. Standards requiring the use of catalytic converters on petrol cars first came into force in 1993 with EURO I. Even stricter standards have been agreed, with EURO III and EURO IV, coming into force in 2001 and 2006 for passenger cars. Catalytic converters result in marked reductions of CO, NOx and hydrocarbon emissions from petrol-driven cars, but can increase emissions of N_2O.

As reviewers mentioned, increase of N_2O can be observed, but it should be noted that N_2O EF for EURO I and EURO II standard is highest in comparison with later EURO standards. In Lithuania the share of EURO I and EURO II standards were dominating during 2004-2013 (Figure 13-1). This is an explanation why N_2O emissions start to decrease with bigger share of Euro III – Euro VI which has lower EF N_2O (Table 13-1).

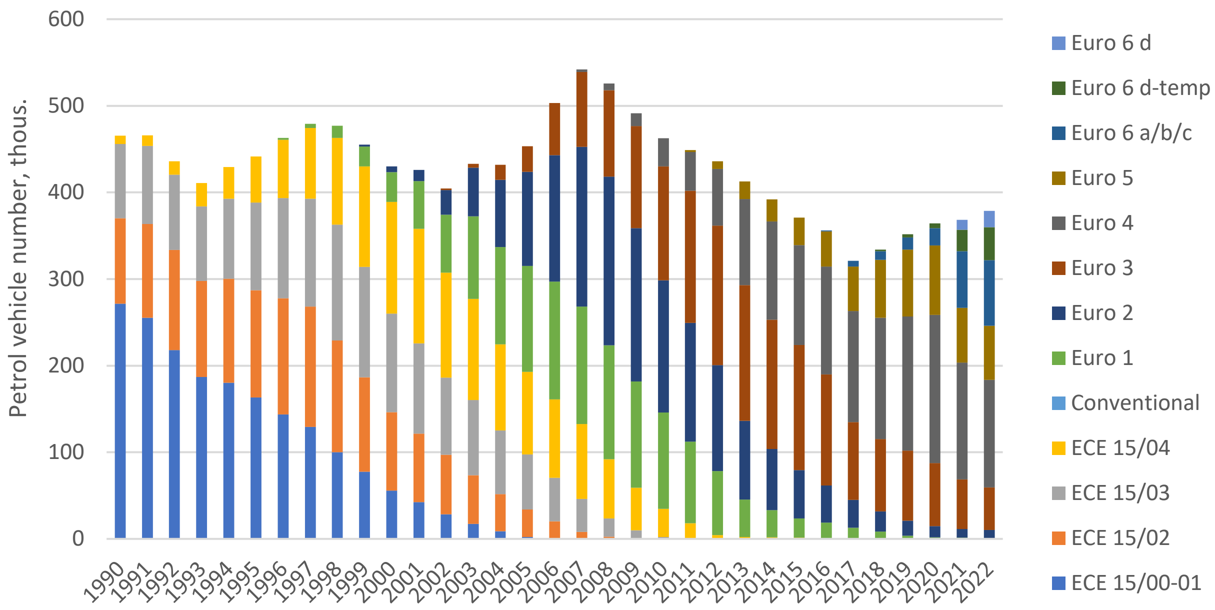


Figure 13-1. Disaggregation of PC petrol driven vehicles by standards.

Table 13-1. N_2O EF for Petrol PC

				Urban Off Peak [g/km]	Urban Peak [g/km]	Rural [g/km]	Highway [g/km]
Passenger Cars	Petrol	Small	PRE ECE	0.01	0.01	0.0065	0.0065
			ECE 15/00-01	0.01	0.01	0.0065	0.0065
			ECE 15/02	0.01	0.01	0.0065	0.0065
			ECE 15/03	0.01	0.01	0.0065	0.0065
			ECE 15/04	0.01	0.01	0.0065	0.0065
			Improved Conventional	0	0	0	0
			Open Loop	0	0	0	0
			Euro 1	**0.024468**	**0.024468**	0.009671	0.00491
			Euro 2	**0.012241**	**0.012241**	0.004666	0.002564
			Euro 3	0.001416	0.001416	0.000319	0.000224
			Euro 4	0.001892	0.001892	0.000294	0.000211
			Euro 5	0.002204	0.002204	0.000183	0.00116
			Euro 6 a/b/c	0.002158	0.002158	0.000171	0.001079

			Euro 6 d-temp	0.002135	0.002135	0.000164	0.001039
			Euro 6 d	0.002066	0.002066	0.000145	0.000918

				Urban Off Peak [g/km]	Urban Peak [g/km]	Rural [g/km]	Highway [g/km]
Passenger Cars	Petrol	Medium	PRE ECE	0.01000	0.01000	0.00650	0.00650
			ECE 15/00-01	0.01000	0.01000	0.00650	0.00650
			ECE 15/02	0.01000	0.01000	0.00650	0.00650
			ECE 15/03	0.01000	0.01000	0.00650	0.00650
			ECE 15/04	0.01000	0.01000	0.00650	0.00650
			Improved Conventional	0.00000	0.00000	0.00000	0.00000
			Open Loop	0.00000	0.00000	0.00000	0.00000
			Euro 1	**0.02447**	**0.02447**	0.00967	0.00491
			Euro 2	**0.01224**	**0.01224**	0.00467	0.00256
			Euro 3	0.00142	0.00142	0.00032	0.00022
			Euro 4	0.00189	0.00189	0.00029	0.00021
			Euro 5	0.00220	0.00220	0.00018	0.00116
			Euro 6 a/b/c	0.00216	0.00216	0.00017	0.00108
			Euro 6 d-temp	0.00214	0.00214	0.00016	0.00104
			Euro 6 d	0.00207	0.00207	0.00015	0.00092

				Urban Off Peak [g/km]	Urban Peak [g/km]	Rural [g/km]	Highway [g/km]
Passenger Cars	Petrol	Large-SUV-Executive	PRE ECE	0.01000	0.01000	0.00650	0.00650
			ECE 15/00-01	0.01000	0.01000	0.00650	0.00650
			ECE 15/02	0.01000	0.01000	0.00650	0.00650
			ECE 15/03	0.01000	0.01000	0.00650	0.00650
			ECE 15/04	0.01000	0.01000	0.00650	0.00650

			Euro 1	**0.02447**	**0.02447**	0.00967	0.00491
			Euro 2	**0.01224**	**0.01224**	0.00467	0.00256
			Euro 3	0.00142	0.00142	0.00032	0.00022
			Euro 4	0.00189	0.00189	0.00029	0.00021
			Euro 5	0.00220	0.00220	0.00018	0.00116
			Euro 6 a/b/c	0.00216	0.00216	0.00017	0.00108
			Euro 6 d-temp	0.00214	0.00214	0.00016	0.00104
			Euro 6 d	0.00207	0.00207	0.00015	0.00092

One more parameter influenced N_2O decrease – sulphur content in gasoline fuel (**Figure 13-2**). In case when fuel consumption and number of vehicles is similar, the shift to lower percentage of sulfur lead to decrease of N_2O IEF. This is primarily due to a decrease in consumption of motor gasoline, but also because emission factors for petrol-driven vehicles have decreased substantially, reflecting the improved control of N_2O emissions (TNO, 2002; Riemersma et al., 2003) in more modern vehicles.

Since January 2008, oil producing company ORLEN started producing and supplying gasoline which already meets the EU requirements to be effective on January 1st, 2009 with sulphur content less than 10 ppm. The implementation of regulations reducing fuel sulphur levels across the EU in 2008 also reduced N_2O emissions for vehicles of all technology categories.

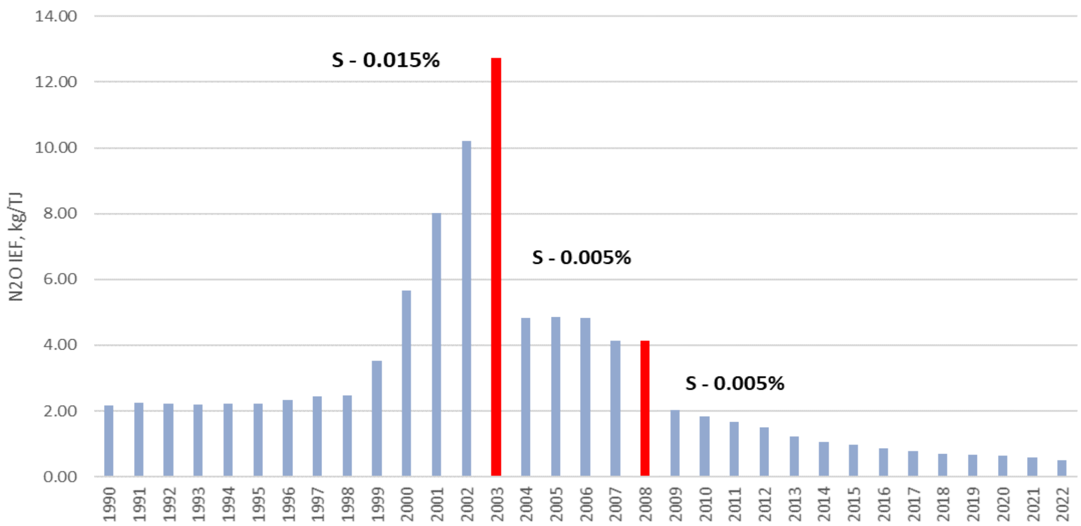


Figure 13-2. Sulphur content impact on implied emission factor of N_2O for gasoline in road transport

One more parameter need to be considered - dieselization of fleet from 2004 until now. During the last decades the stock of Lithuanian diesel passenger cars and heavy-duty vehicles has intensively grown, on the contrary petrol fuel consumption was decreasing from 2007 (Figure 13-3). At the same time share of EURO I and EURO II standard domination in national fleet is also decreasing. All these parameters (sulfur content, dieselization, EURO standards) together lead to lower N_2O IEF.

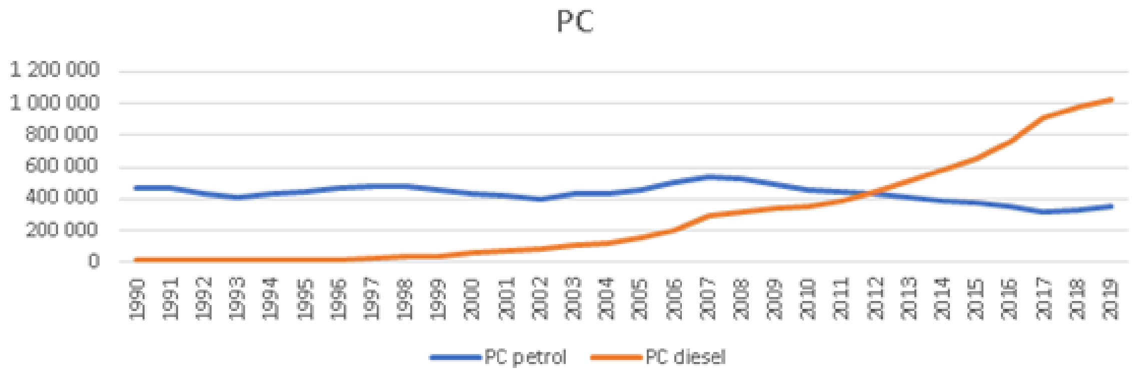


Figure 13-3. Dieselization process

Numbers (in thousands) of different types of road vehicles were adjusted in NIR 2021 submission (see pictures below). New data from State enterprise “Regitra”, responsible for registration of vehicles, has been gathered and adjusted up to 2015 to avoid sharp changes and to reflect the most plausible situation.

After major revision an intercomparison with regional IEF was performed for validation. It is important to note that CH_4 and N_2O IEFs (kg/TJ) of those fuel types, which were included into the COPERT model (gasoline, diesel oil and LPG), were compared to neighbouring countries (Latvia, Estonia and Poland; see pictures below). As values doesn’t seem lower, this approved that modelling was performed correctly in Lithuania for NIR 2021 submission.

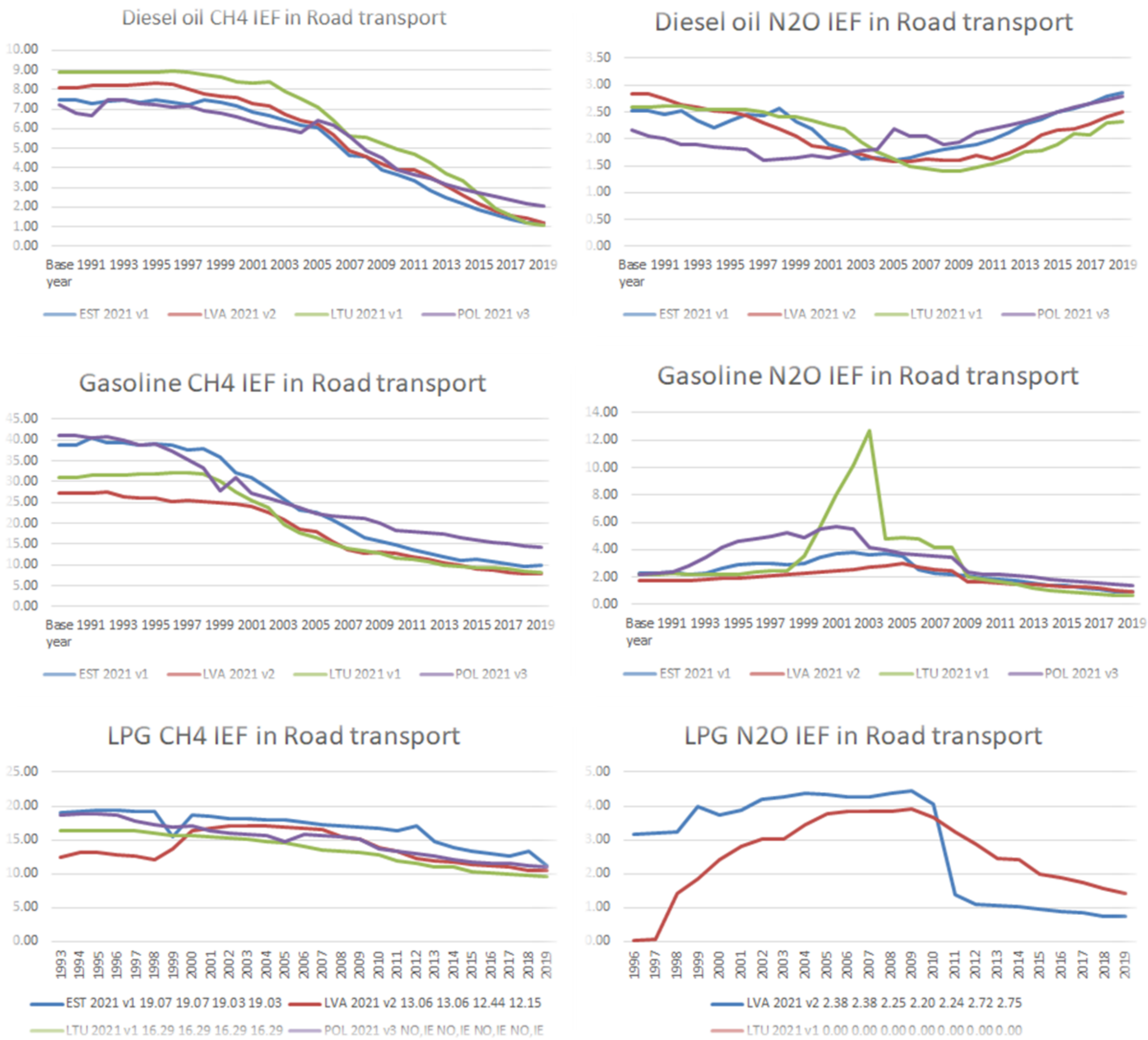


Figure 13-4. IEF in Road transport

N_2O emissions for diesel PC and LD vehicles were recalculated in 2021 submission using tier 3 method and improved COPERT V input parameters. The reasons for low N_2O IEF calculated by the COPERT V model for passenger cars up to year 2004 were investigated and documented in the NID Chapter 3.5.2.2 (section "IEF value estimation") and 3.5.2.3.

LT reported IEF are in the range of provided values by all UNFCCC countries for PC but are slightly lower (Figures 13-5 and 13-6). During 1990-1995 no diesel driven Cars were introduced in LT, only from 1996 a small number occurred, so diesel oil needed to be distributed based on average fuel consumption by vehicle engine type and age. As no information is available for this period, data was provided by COPERT 5 software developers team.

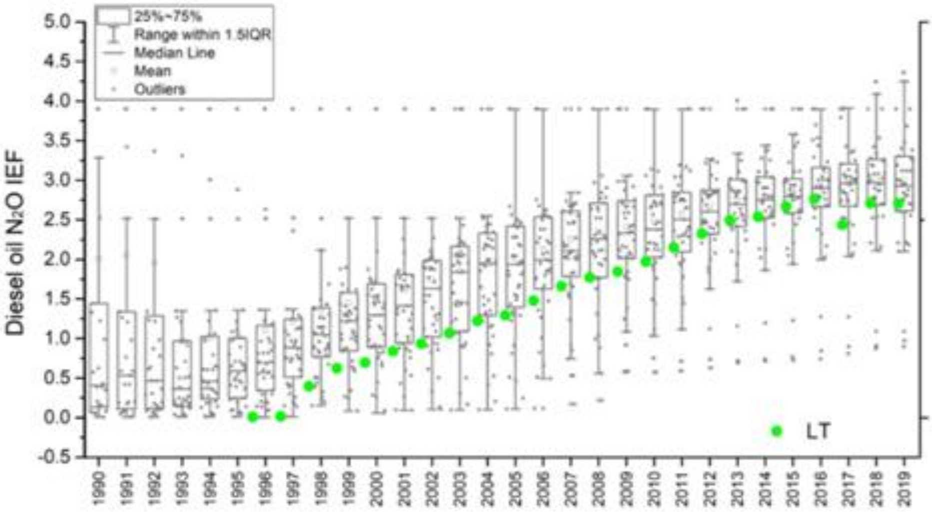


Figure 13-5. N_2O IEF from Cars using Diesel Oil (green dots) reported by LT (1996-2019) and box plots of N_2O IEF from UNFCCC countries, 1990-2019.

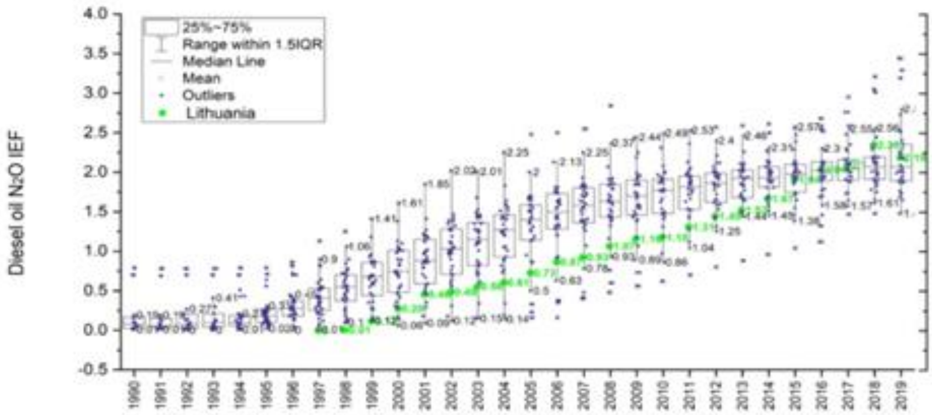


Figure 13-6. N_2O IEF from Light Duty vehicles using Diesel Oil (green dots with values) reported by LT (1996-2019) and box plots of N_2O IEF from UNFCCC countries, numbers mean 25 and 75 percentile values, 1990-2019.

As shown in Figure 13-6, LT reported N_2O IEFs are in the range of IEF values provided by all UNFCCC countries but were at lowest part of their statistical distribution until 2014. It should be noted that IEF reported by neighbouring countries are also in lower quartile (Figure 13-7). For later period (from 2012) IEF reached comparable values and have been in line with neighbouring countries with same practices (mean fleet and mileage).

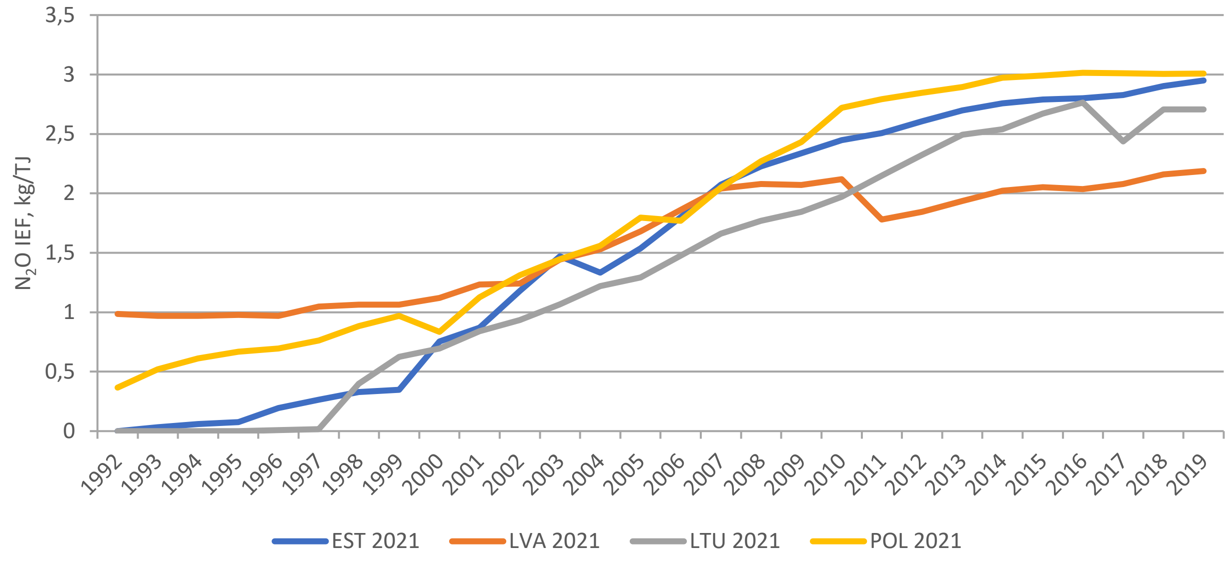


Figure 13-7. Comparison of N_2O IEF from diesel Cars between Lithuania and neighbouring countries with similar vehicle fleet - Latvia, Estonia and Poland, 1990-2019.

Figure 13-7 shows that neighbouring countries have reported similar IEFs with increasing trend, this confirms that LT reported IEFs are in the same range and assumptions are correct.

The impacts of the recalculations on the emissions were less than 1 per cent (Table 13-2).

Table 13-2. Comparison of kt CO_2 eq. between submissions 2020 and 2021 considering shift from IPCC based values for diesel oil N_2O (for PC and LD) to COPERT based values.

	With IPCC N_2O IPCC values for PC, LD	With COPERT-based values	Absolute difference, Gg CO_2 eq.	Relative difference, %
1990	5342.40	5336.36	-6.05	-0.11
1991	5926.48	5919.90	-6.58	-0.11
1992	3784.78	3777.59	-7.19	-0.19
1993	2817.17	2810.69	-6.48	-0.23
1994	2113.50	2107.83	-5.67	-0.27
1995	2823.82	2818.83	-4.99	-0.18
1996	3111.59	3105.48	-6.11	-0.20
1997	3511.76	3506.00	-5.77	-0.16
1998	3716.90	3708.28	-8.62	-0.23
1999	3312.77	3304.14	-8.63	-0.26
2000	2919.29	2920.95	1.66	0.06
2001	3202.74	3212.54	9.80	0.31
2002	3307.25	3323.58	16.33	0.49
2003	3354.18	3376.60	22.43	0.67
2004	3689.77	3669.84	-19.93	-0.54
2005	3918.09	3893.54	-24.55	-0.63
2006	4173.38	4146.91	-26.47	-0.63
2007	4930.14	4892.45	-37.69	-0.76
2008	4904.27	4865.04	-39.23	-0.80
2009	4058.78	4018.78	-40.00	-0.99
2010	4165.11	4123.83	-41.28	-0.99
2011	4131.15	4091.03	-40.12	-0.97

2012	4144.87	4104.28	-40.59	-0.98
2013	4157.15	4114.75	-42.40	-1.02
2014	4627.89	4586.13	-41.76	-0.90
2015	4899.41	4860.59	-38.82	-0.79
2016	5286.16	5248.45	-37.71	-0.71
2017	5494.04	5456.90	-37.15	-0.68
2018	5845.83	5811.50	-34.33	-0.59

ANNEX XV. Improvements in response to UN reviews recommendations (ARR 2022)

Review recommendation	*Paragraph No*	*Response/status of implementation*	*Chapter/section in the NID*
Increase the transparency of its reporting by including in future NIRs the detailed explanations, tables and charts provided to the ERT during the review on the trends in IEFs and the differences in emission levels compared with previous annual submissions, in order to support its use of EFs derived using COPERT V.	E.2	The detailed explanations, tables and charts of IEFs variation and the differences in emission levels compared with previous annual submissions are included in the NID Annex XIII.	ANNEX XIII. Road transport CH_4 and N_2O IEF analysis (CRT 1.A.3.b)
Report all CO_2 emissions from fuel consumption (used as feedstock and fuel) under category 2.B.1 ammonia production in accordance with the 2006 IPCC Guidelines.	I.2	All CO_2 emissions from fuel consumption (used as feedstock and fuel) are reported under category 2.B.1 ammonia production in this submission, in accordance with the 2006 IPCC Guidelines.	NID Chapter 4.3.1.2 Methodological issues
Report national totals with and without indirect CO_2 emissions, in line with paragraph 29 of the UNFCCC Annex I inventory reporting guidelines. To enable the reporting of national totals with and without indirect emissions, report indirect CO_2 emissions separately from direct CO_2 emissions (i.e. in CRT table 6 and the relevant sectoral CRT tables).	I.3	National totals with and without indirect CO_2 emissions were reported separately.	CRT Table 6 and Table2(I)s2
Include detailed information in the NIR regarding HFC emissions for subcategory 2.F.1.b on the calculations performed to obtain the volume of gases in operation, describing the differences by time span and including equations for the calculations performed.	I.4	More detailed description of the calculations performed to obtain volume of gases in operation is provided.	NID Chapter 4.7.1.2 Methodological issues
Obtain data on the volume of gases incorporated into the bank of gases in operation (new products being installed (production plus imports minus exports)) and, in calculating the bank of gases in operation, consider all inputs and outputs of gases, such as annual leakages and gases contained in products at end of life. Recalculate the emissions across the time series considering this new information, where available, and report them accordingly in the relevant CRT tables and the NIR.	I.5	According to national legislation, companies must annually report the amount of F-gases charged into equipment, as well as the quantity refilled into operational systems, specifying whether the gases are unused, recycled, or reclaimed. This data is submitted to the EPA's F-gas system, with mandatory reporting for refills, including those in air-conditioning units. The majority of F-gas consumption reports come from certified service companies, whose data reflects the use of F-gases in refrigeration and air-conditioning equipment of all sizes. However, the actual stock of HFCs in operational equipment remains unknown, as estimating the	-

Review recommendation	*Paragraph No*	*Response/status of implementation*	*Chapter/section in the NID*
		precise F-gas content in systems—especially in small-scale domestic units—based on reported data is unfeasible. To ensure transparency, the adopted methodology applies a reverse calculation approach, where the quantity consumed is assumed to equal the quantity emitted, following the default emission factor (EF) of 22.5% or 16% (2006 IPCC Guidelines) depending on equipment. Emissions from disposal are estimated based on the average lifetime of equipment and data on recovered F-gases, as reported by servicing companies. The alternative approach proposed—directly quantifying the volume of gases entering the operational stock (i.e., new product installations from production plus imports minus exports) and incorporating all gas inputs and outputs (e.g., annual leakages and gases remaining in end-of-life products)—is not feasible due to several limitations. First, the necessary data on the exact volume of gases incorporated into equipment stock is not systematically available, particularly for small-scale applications like household refrigerators and air conditioners. Second, requiring companies to provide such detailed stock-level information would impose a disproportionate administrative burden. Lastly, the current reporting system ensures consistency and completeness by relying on actual refill data, rather than uncertain estimations of gas flows within operational stocks. Consequently, recalculating emissions across the time series using this proposed method is impractical and would not improve accuracy or transparency in the CRT tables and NID.	
Provide in the NIR the mathematical equation used to calculate the bank of gases in operation and the methodology used to calculate	I.6	Mathematical formulas, where appropriate, and descriptions are provided in the NID.	NID Chapter 4.7.1.2 Methodological issues

Review recommendation	Paragraph No	Response/status of implementation	Chapter/section in the NID
the emissions across the time series to further enhance the transparency of the reporting.			
Update the uncertainty values used for SF6 emissions for category 2.G.1, considering specifically the uncertainty values associated with the estimates made, and report the results in the NIR. Include a qualitative discussion in the NIR on the reasons for the uncertainty values used for the category.	I.9	The uncertainty value used for SF_6 emissions has been updated, the description on choice of emission uncertainty is provided.	NID Chapter 4.8.1.3 Uncertainties and time-series consistency
The ERT recommends that the Party accurately define the use of the urea produced in the country, clarify all pathways of the use of urea generating CO_2 emissions in the country, including N solution use, and estimate the CO_2 emissions that could be deducted from the emissions for category 2.B.1 ammonia production. The ERT also recommends that the Party ensure that the emissions deducted from the emissions for category 2.B.1 ammonia production are included elsewhere in the inventory, if these emissions occur within the country's borders.	I.10	All pathways of the use of urea generating CO_2 emissions in the country were clarified. The data of urea (including N solution) export has been updated, as well as the amount of urea used in agriculture sector.	NID Chapter 4.3.1.2 Methodological issues and Chapter 4.3.1.5 Category-specific recalculations
The ERT recommends that the Party correct the HFC emission estimates for subcategory 2.F.1.f stationary air-conditioning in CRT table 2(II).B-H (sheet 2), in particular for 2002–2010 and 2017–2018 and ensure that HFC emissions are reported accurately and consistently in future annual submissions.	I.11	The technical errors have been corrected for subcategory 2.F.1.f stationary air-conditioning in CRT.	CRT Table 2(II).B-Hs2
Conduct a study to develop country-specific data on feed digestibility, and when available, apply these data for estimating CH_4 and N_2O emissions, and update the information reported on the manure management category in the NIR.	A.2	The study on feed digestibility was completed and the results of the study were applied in this submission.	NID Annex X Summary of the study on determination of national values of feed digestibility by the classic in vivo method for the Lithuania GHG inventory methodology improvement
The ERT recommends that for the calculation of emissions for subcategory 3.D.a.2.a animal manure applied to soils, the Party use fractions of N excreted per manure management system that are consistent with the values used for emission calculations under category 3.B manure management, ensure that no double counting occurs with the subcategory 3.D.a.3 urine and dung deposited by grazing animals, and ensure that values used for FracLossMS are in line with the 2006 IPCC Guidelines. The ERT also recommends that Lithuania add to NIR table 5-33 (pp.286–287) fractions of manure	A.6	Fractions of manure produced per manure management system for all poultry subcategories were provided in the NID. The ERT recommendation for the calculation of emissions for subcategory 3.D.a.2.a animal manure applied to soils was implemented in the previous NID submission.	NID Chapter 5.1 Overview of sector – *Manure management systems* (Table 5-12) NID Chapter 5.6.1.5 Category-specific recalculation (2022 NIR submission)

Review recommendation	***Paragraph No***	***Response/status of implementation***	***Chapter/section in the NID***
produced per manure management system for all poultry subcategories.			
The ERT recommends that the Party estimate and report CO_2 emissions from N solution spread in agriculture, including any amount of N solution imported, using data that are consistent with the calculation of N_2O emissions from inorganic fertilizers and consistent with the CO_2 emission estimates from urea produced in Lithuania used for N solution that could be deducted from the emissions under category 2.B.1 ammonia production.	A.7	CO_2 emissions from N solution spread in agriculture was estimated and reported.	NID Chapter 5.10.2 Methodological issues
Conduct an analysis of significance at the pool level to determine whether the DOM pool is significant under category 4.A.1 forest land remaining forest land and, if so, adopt a higher tier to estimate the litter (and DOM) CSCs.	L.1	Lithuania is planning to improve carbon stock changes estimation in forest land carbon pool, performing primary analysis of scientific studies and national forest inventory data in order to obtain reliable data of carbon stock changes in deadwood pool in forest land remaining forest land.	NID Chapter 6.2.7 Category-specific planned improvements
Report the CSC in litter from the conversion of grassland to cropland (perennial crops) and, if applying a value different from 0.4 t C/ha, explain in the NIR the reason for using a different value.	L.3	Carbon stock in litter in grasslands is calculated to be 0.8 t C/ha, thus, this value is used in case grassland is converted to cropland, but we do not calculate grassland conversions to perennial cropland. It is planned to conduct literature analysis on litter pool in perennial cropland.	NID Chapter 6.3.2.2 Land converted to Cropland
Provide a justification for simplifying equation 11.1 from the 2006 IPCC Guidelines (vol. 4, chap. 11.2.1.1, p.11.7) and excluding certain N sources included in equation 11.1 and specify those reported under the agriculture sector or those that do not occur. Provide the corresponding information in the NIR and CRT table 4(I)	L.4	Justification is provided in NID and CRT.	CRT table 4(I) NID Chapter 6.3.2.2 Land converted to Grassland
The ERT recommends that Lithuania, in its NIR, report the assumption that nappy disposal is included under the textile waste component, and provide the rationale for reporting rubber and leather under non-biodegradable waste components, with the	W.1	The Order of the Minister of Environment does not elaborate to which category nappies should be allocated and it is assumed that they are included in textile waste. According to the 2006 IPCC Guidelines, (vol. 5, chap. 2, p.2.11) rubber and leather contain also certain amounts of non-fossil	NID, Chapter 7, Section 7.2.2.3

Review recommendation	*Paragraph No*	*Response/status of implementation*	*Chapter/section in the NID*
justification that this approach does not lead to underestimation of CH_4 emissions from solid waste disposal sites.		carbon, but this is hardly degradable. Therefore, leather and rubber are included in the list as non-biodegradable waste.	
The ERT encourages Lithuania to provide in its NIR a description of raw landfill biogas preliminary treatment and purification practices used at landfills; and the rationale for using the default value of 0.5 for the fraction of CH_4 in landfill gas used for energy purposes and the default density conversion factor of $0.67x10^{-6}$ kt/m^3 to estimate CH_4 recovery at landfills based on statistical data from Statistics Lithuania, taking into account that raw landfill biogas preliminary treatment for removal of impurities is common practice in the country.	W.2	The explanation on this issue is provided in the NID.	NID, Chapter 7, Section 7.2.2.8
The ERT recommends that Lithuania revise the CH_4 emission estimates from sewage sludge disposal by using a corrected amount of sewage sludge disposal for prior to 2020 in the FOD model taking into account that the total amount of already disposed sewage sludge in 2020 decreased compared with 2019.	W.3	Reduction of sewage sludge at the disposal sites in 2020 and 2021 means that methane emission values calculated using FOD model should be accordingly corrected. It was assumed that extraction was performed in equal volumes from sludge stored during the last 5 years when storage exceeded extraction. Reduction of emissions resulting from sludge extraction was calculated multiplying the amount of extracted sludge by relative CH_4 emissions corresponding to the time of sludge storage (see NID, Table 7-27) and the sum of obtained values was subtracted from the value calculated using FOD model.	NID, Chapter 7, Section 7.2.2.7
The ERT recommends that Lithuania either provide a clear explanation in the NIR of why a higher-tier method could not be applied to estimate CH_4 emissions from composting and anaerobic digestion at biogas facilities under category 5.B biological treatment of solid waste without significantly jeopardizing the resources available for addressing other key categories, which is in line with the requirements of paragraph 11 of the UNFCCC Annex I	W.4	Methane emissions from biological treatment of waste were established using country-specific data on amounts and types of composted waste, volumes of biogas extracted from anaerobic digestion facilities and concentration of CH_4 in recovered biogas. However, calculations of emissions from composted waste and unintentional leakages from gas pipelines were performed using default emission factors.	NID, Chapter 7, Section 7.3.2

Review recommendation	*Paragraph No*	*Response/status of implementation*	*Chapter/section in the NID*
inventory reporting guidelines, or estimate and report the CH_4 emissions applying a higher-tier method.		Therefore, estimation of overall CH_4 emissions from biological treatment of waste is denoted as T1, T2. Determination of country-specific emission factors in any pathway requires significant effort and resources, and it is hardly affordable to conduct detailed investigations covering all required pathways in the nearest future. Nevertheless, we are continuously examining priorities and availability of resources for improvement of data and application of higher tier methods.	
The ERT recommends that Lithuania either provide a clear explanation in the NIR of why a higher-tier method could not be applied to estimate N_2O emissions from composting under category 5.B biological treatment of solid waste without significantly jeopardizing the resources available for addressing other key categories, which is in line with the requirements of paragraph 11 of the UNFCCC Annex I inventory reporting guidelines, or estimate and report the N_2O emissions applying a higher-tier method.	W.5	N_2O emissions from biological treatment of waste were established using country-specific data on amounts and types of composted waste and default emission factor, so estimation of overall N_2O emissions from biological treatment of waste is denoted as T1. Determination of country-specific emission factors in any pathway requires significant effort and resources, and it is hardly affordable to conduct detailed investigations covering all required pathways in the nearest future. Nevertheless, we are continuously examining priorities and availability of resources for improvement of data and application of higher tier methods.	NID, Chapter 7, Section 7.3.2
The ERT encourages Lithuania to provide in its NIR a description of biogas preliminary treatment and purification practices used at anaerobic digestion biogas facilities; and the rationale for using the default value of 0.5 for the fraction of CH_4 in anaerobic digestion biogas used for energy purposes and the default density conversion factor of 0.67x10-6 kt/m3 to estimate CH_4 recovery at anaerobic digestion biogas facilities based on biogas recovery statistics reported by Statistics Lithuania, taking into account that raw biogas preliminary treatment for removal of impurities may	W.6	The explanation on this issue is provided in the NID.	NID, Chapter 7, Section 7.3.1

Review recommendation	***Paragraph No***	***Response/status of implementation***	***Chapter/section in the NID***
tangibly influence the physical and chemical properties (including density of the biogas and its and CH_4 concentration) of the treated biogas.			
The ERT recommends that Lithuania either provide a clear explanation in the NIR of why a higher-tier method could not be applied to estimate CH_4 emissions from septic tanks and latrines under category 5.D wastewater treatment and discharge without significantly jeopardizing the resources available for addressing other key categories, which is in line with the requirements of paragraph 11 of the UNFCCC Annex I inventory reporting guidelines, or estimate and report the CH_4 emissions applying a higher-tier method.	W.7	In 2025 submission, calculation of CH_4 emission from septic tanks and latrines under category 5.D was revised taking into account national climatic conditions. Considering low prevailing soil temperatures, the default 2006 IPCC guidelines CH_4 correction factors (MCF) for septic tanks and latrines were revised considering that methanogenesis occurs only two months a year. Following this improvement, we consider that the estimation method used now is Tier1/Tier2. The explanation on this issue is provided in the NID.	NID, Chapter 7, Section 7.5.2.