LITHUANIA‘S NATIONAL INVENTORY REPORT 2021

GREENHOUSE GAS EMISSIONS 1990-2019

ANNEXES

VILNIUS, 2021

Contents

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***	***-6,892.19***	***0.11***	***0.11***
1.A.1.a Public electricity and heat production - Liquid Fuels	***CO_2***	***6,021.25***	***0.10***	***0.21***
1.A.1.a Public electricity and heat production - Gaseous Fuels	***CO_2***	***5,796.59***	***0.10***	***0.31***
1.A.3.b Road transportation	***CO_2***	***5,247.15***	***0.09***	***0.40***
3.A.1 Enteric Fermentation - Cattle	***CH_4***	***4,146.14***	***0.07***	***0.46***
1.A.2 Manufacturing industries and construction-Liquid fuels	***CO_2***	***3,873.72***	***0.06***	***0.53***
1.A.4 Other sectors-Solid fuels	***CO_2***	***2,760.55***	***0.05***	***0.57***
1.A.4 Other sectors-Liquid fuels	***CO_2***	***2,736.38***	***0.05***	***0.62***
1.A.2 Manufacturing industries and construction-Gaseous fuels	***CO_2***	***2,045.42***	***0.03***	***0.65***
2.A.1 Cement Production	***CO_2***	***1,668.07***	***0.03***	***0.68***
1.A.1.b Petroleum refining - Liquid Fuels	***CO_2***	***1,509.64***	***0.02***	***0.70***
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	***CO_2***	***1,443.18***	***0.02***	***0.73***
1.A.4 Other sectors-Gaseous fuels	***CO_2***	***1,379.27***	***0.02***	***0.75***
2.B.1 Ammonia Production	***CO_2***	***1,253.68***	***0.02***	***0.77***
5.A Solid Waste Disposal	***CH_4***	***1,028.83***	***0.02***	***0.79***
3.D.1.1 Direct N2O Emissions From Managed Soils - Inorganic N Fertilizers	***N_2O***	***992.77***	***0.02***	***0.80***
2.B.2 Nitric Acid Production	***N_2O***	***893.01***	***0.01***	***0.82***
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	***CO_2***	***858.08***	***0.01***	***0.83***
4.A.2 Land converted to forest land - carbon stock change in biomass	***CO_2***	***-600.70***	***0.01***	***0.84***
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	***N_2O***	***529.59***	***0.01***	***0.85***
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	***CO_2***	***517.32***	***0.01***	***0.86***
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	***CO_2***	***-474.03***	***0.01***	***0.87***
5.D Wastewater Treatment and Discharge	***CH_4***	***422.99***	***0.01***	***0.88***
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	***N_2O***	***419.85***	***0.01***	***0.88***
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	***CO_2***	***-412.62***	***0.01***	***0.89***
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	***N_2O***	***401.10***	***0.01***	***0.90***
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	***CO_2***	***353.40***	***0.01***	***0.90***
1.A.3.c Railways	***CO_2***	***349.97***	***0.01***	***0.91***
3.B.1.3 Manure Management - Swine	***CH_4***	***329.25***	***0.01***	***0.91***
3.D.1.2 Direct N_2O Emissions From Managed	***N_2O***	***301.24***	***0.00***	***0.92***

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment*	*Cumulative total*
Soils - Organic N Fertilizers				
4.C.2 Land converted to grassland - carbon stock change in biomass	***CO_2***	***-285.53***	***0.00***	***0.92***
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	***N_2O***	***268.18***	***0.00***	***0.93***
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	***CH_4***	***260.55***	***0.00***	***0.93***
4.G Harvested wood products	***CO_2***	***-252.55***	***0.00***	***0.94***
3.B.1.1 Manure Management - Cattle	***CH_4***	***251.55***	***0.00***	***0.94***
3.B.2 Manure Management - Indirect N_2O Emissions	***N_2O***	***247.61***	***0.00***	***0.94***
2.A.4 Other process use of carbonates	***CO_2***	***239.53***	***0.00***	***0.95***
2.A.2 Lime Production	***CO_2***	***210.27***	***0.00***	***0.95***
3.B.2 Manure Management - Cattle	***N_2O***	***205.85***	***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
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	N_2O	166.49	0.00	0.96
1.A.4 Other sectors-Liquid fuels	N_2O	159.35	0.00	0.97
4.A.2 Land converted to forest land - net carbon stock change in mineral soils	CO_2	-150.23	0.00	0.97
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Total		***42,323.3***		

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***	***6,021.25***	***0.13***	***0.13***
1.A.1.a Public electricity and heat production - Gaseous Fuels	***CO_2***	***5,796.59***	***0.12***	***0.25***
1.A.3.b Road transportation	***CO_2***	***5,247.15***	***0.11***	***0.36***
3.A.1 Enteric Fermentation - Cattle	***CH_4***	***4,146.14***	***0.09***	***0.44***
1.A.2 Manufacturing industries and construction-Liquid fuels	***CO_2***	***3,873.72***	***0.08***	***0.53***
1.A.4 Other sectors-Solid fuels	***CO_2***	***2,760.55***	***0.06***	***0.58***
1.A.4 Other sectors-Liquid fuels	***CO_2***	***2,736.38***	***0.06***	***0.64***
1.A.2 Manufacturing industries and construction-Gaseous fuels	***CO_2***	***2,045.42***	***0.04***	***0.68***
2.A.1 Cement Production	***CO_2***	***1,668.07***	***0.03***	***0.72***
1.A.1.b Petroleum refining - Liquid Fuels	***CO_2***	***1,509.64***	***0.03***	***0.75***
1.A.4 Other sectors-Gaseous fuels	***CO_2***	***1,379.27***	***0.03***	***0.78***
2.B.1 Ammonia Production	***CO_2***	***1,253.68***	***0.03***	***0.80***
5.A Solid Waste Disposal	***CH_4***	***1,028.83***	***0.02***	***0.83***
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	***N_2O***	***992.77***	***0.02***	***0.85***
2.B.2 Nitric Acid Production	***N_2O***	***893.01***	***0.02***	***0.87***
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	***N_2O***	***529.59***	***0.01***	***0.88***
5.D Wastewater Treatment and Discharge	***CH_4***	***422.99***	***0.01***	***0.89***
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	***N_2O***	***419.85***	***0.01***	***0.89***
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	***N_2O***	***401.10***	***0.01***	***0.90***
1.A.3.c Railways	***CO_2***	***349.97***	***0.01***	***0.91***
3.B.1.3 Manure Management - Swine	***CH_4***	***329.25***	***0.01***	***0.92***
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	***N_2O***	***301.24***	***0.01***	***0.92***
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	***N_2O***	***268.18***	***0.01***	***0.93***
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	***CH_4***	***260.55***	***0.01***	***0.93***
3.B.1.1 Manure Management - Cattle	***CH_4***	***251.55***	***0.01***	***0.94***
3.B.2 Manure Management - Indirect N_2O Emissions	***N_2O***	***247.61***	***0.01***	***0.94***
2.A.4 Other process use of carbonates	***CO_2***	***239.53***	***0.01***	***0.95***
2.A.2 Lime Production	***CO_2***	***210.27***	***0.00***	***0.95***
3.B.2 Manure Management - Cattle	N_2O	205.85	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	0.97
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Total		***47,791.9***		

Approach 1 Level Assessment for 2019

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	*5,992.86*	*0.17*	*0.17*
2.B.1 Ammonia Production	CO_2	*-5,605.38*	*0.16*	*0.33*
3.A.1 Enteric Fermentation - Cattle	CO_2	*1,988.84*	*0.06*	*0.39*
1.A.1.b Petroleum refining - Liquid Fuels	CH_4	*1,409.41*	*0.04*	*0.43*
4.B.1 Cropland remaining cropland - net carbon stock change in mineral soils	CO_2	*1,204.92*	*0.03*	*0.47*
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	*-1,138.14*	*0.03*	*0.50*
3.D.1.1 Direct N2O Emissions From Managed Soils - Inorganic N Fertilizers	CO_2	*1,044.87*	*0.03*	*0.53*
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	N_2O	*828.87*	*0.02*	*0.55*
4.A.2 Land converted to forest land - carbon stock change in biomass	CO_2	*816.62*	*0.02*	*0.58*
4.G Harvested wood products	CO_2	*-810.82*	*0.02*	*0.60*
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	CO_2	*-808.30*	*0.02*	*0.62*
4.E.2 Land converted to settlements	CO_2	*-747.44*	*0.02*	*0.65*
1.A.2 Manufacturing industries and construction-Gaseous fuels	CO_2	*719.45*	*0.02*	*0.67*
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	*706.44*	*0.02*	*0.69*
1.A.4 Other sectors-Gaseous fuels	CO_2	*592.42*	*0.02*	*0.70*
2.A.1 Cement Production	CO_2	*591.42*	*0.02*	*0.72*
5.A Solid Waste Disposal	CO_2	*578.06*	*0.02*	*0.74*
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	CH_4	*572.71*	*0.02*	*0.75*
2.F.1 Refrigeration and Air Conditioning Equipment	CO_2	*545.92*	*0.02*	*0.77*
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	*HFCs*	*516.04*	*0.01*	*0.78*
1.A.2 Manufacturing industries and construction-Solid fuels	N_2O	*486.81*	*0.01*	*0.80*
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	*427.21*	*0.01*	*0.81*
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	CO_2	*381.15*	*0.01*	*0.82*
4.F Other land	CO_2	*-358.46*	*0.01*	*0.83*
1.A.4 Other sectors-Liquid fuels	CO_2	*342.42*	*0.01*	*0.84*
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	CO_2	*336.30*	*0.01*	*0.85*
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	*320.60*	*0.01*	*0.86*
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	N_2O	*305.92*	*0.01*	*0.87*
1.A.4 Other sectors-Solid fuels	CH_4	*288.56*	*0.01*	*0.88*
1.B.2 Oil, natural gas and other emissions from energy production	CO_2	*246.60*	*0.01*	*0.89*

IPCC Category	***Greenhouse gas***	***GHG emissions, kt CO_2 eq.***	***Level assessment***	***Cumulative total***
4.A.2 Land converted to forest land - net carbon stock change in mineral soils	***CO_2***	***233.94***	***0.01***	***0.89***
4.B.2 Land converted to cropland- carbon stock change in biomass	***CO_2***	***-232.78***	***0.01***	***0.90***
2.B.2 Nitric Acid Production	***CO_2***	***208.11***	***0.01***	***0.90***
1.A.1 Energy industries-Other fossil fuels	***N_2O***	***179.33***	***0.01***	***0.91***
1.A.3.c Railways	***CO_2***	***178.94***	***0.01***	***0.91***
3.B.1.1 Manure Management - Cattle	***CO_2***	***169.06***	***0.00***	***0.92***
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	***CH_4***	***156.03***	***0.00***	***0.92***
1.A.4 Other sectors-Biomass	***N_2O***	***140.50***	***0.00***	***0.93***
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	***CH_4***	***137.70***	***0.00***	***0.93***
1.A.2 Manufacturing industries and construction-Liquid fuels	***N_2O***	***136.32***	***0.00***	***0.94***
5.D Wastewater Treatment and Discharge	***CO_2***	***125.57***	***0.00***	***0.94***
1.A.1.b Petroleum refining - Gaseous Fuels	***CH_4***	***120.19***	***0.00***	***0.94***
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	***CO_2***	***119.30***	***0.00***	***0.95***
4.B.2 Land converted to cropland- net carbon stock change in dead organic matter	***N_2O***	***99.60***	***0.00***	***0.95***
4.C.2 Land converted to grassland - net carbon stock change in dead organic matter	***CO_2***	***98.72***	***0.00***	***0.95***
4.A.1 Forest land remaining forest land - carbon stock change in biomass	CO_2	-94.86	0.00	0.96
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Total		***14,856.3***		

Approach 1 Level Assessment for 2019 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	*5,992.86*	*0.29*	*0.29*
2.B.1 Ammonia Production	CO_2	*1,988.84*	*0.10*	*0.39*
3.A.1 Enteric Fermentation - Cattle	CH_4	*1,409.41*	*0.07*	*0.46*
1.A.1.b Petroleum refining - Liquid Fuels	CO_2	*1,204.92*	*0.06*	*0.52*
3.D.1.1 Direct N2O Emissions From Managed Soils - Inorganic N Fertilizers	N_2O	*828.87*	*0.04*	*0.56*
1.A.2 Manufacturing industries and construction-Gaseous fuels	CO_2	*706.44*	*0.03*	*0.60*
1.A.1.a Public electricity and heat production - Gaseous Fuels	CO_2	*592.42*	*0.03*	*0.63*
1.A.4 Other sectors-Gaseous fuels	CO_2	*591.42*	*0.03*	*0.65*
2.A.1 Cement Production	CO_2	*578.06*	*0.03*	*0.68*
5.A Solid Waste Disposal	CH_4	*572.71*	*0.03*	*0.71*
2.F.1 Refrigeration and Air Conditioning Equipment	*HFCs*	*516.04*	*0.03*	*0.74*
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	N_2O	*486.81*	*0.02*	*0.76*
1.A.2 Manufacturing industries and construction-Solid fuels	CO_2	*427.21*	*0.02*	*0.78*
1.A.4 Other sectors-Liquid fuels	CO_2	*336.30*	*0.02*	*0.80*
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	N_2O	*320.60*	*0.02*	*0.81*
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	N_2O	*305.92*	*0.02*	*0.83*
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH_4	*288.56*	*0.01*	*0.84*
1.A.4 Other sectors-Solid fuels	CO_2	*246.60*	*0.01*	*0.86*
1.B.2 Oil, natural gas and other emissions from energy production	CO_2	*233.94*	*0.01*	*0.87*
2.B.2 Nitric Acid Production	N_2O	*179.33*	*0.01*	*0.88*
1.A.1 Energy industries-Other fossil fuels	CO_2	*178.94*	*0.01*	*0.88*
1.A.3.c Railways	CO_2	*169.06*	*0.01*	*0.89*
3.B.1.1 Manure Management - Cattle	CH_4	*156.03*	*0.01*	*0.90*
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	N_2O	*140.50*	*0.01*	*0.91*
1.A.4 Other sectors-Biomass	CH_4	*137.70*	*0.01*	*0.91*
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	N_2O	*136.32*	*0.01*	*0.92*
1.A.2 Manufacturing industries and construction-Liquid fuels	CO_2	*125.57*	*0.01*	*0.93*
5.D Wastewater Treatment and Discharge	CH_4	*120.19*	*0.01*	*0.93*
1.A.1.b Petroleum refining - Gaseous Fuels	CO_2	*119.30*	*0.01*	*0.94*
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	N_2O	*99.60*	*0.00*	*0.94*
1.A.4 Other sectors-Peat	CO_2	*91.30*	*0.00*	*0.95*
3.B.2 Manure Management - Indirect N_2O Emissions	N_2O	*85.57*	*0.00*	*0.95*
3.B.2 Manure Management - Cattle	N_2O	80.84	0.00	0.96
3.A. Enteric Fermentation - Others	CH_4	73.71	0.00	0.96

5.B Biological Treatment of Solid Waste	CH_4	61.38	0.00	0.96
2. D Non-energy products from fuels and solvent use	CO_2	59.75	0.00	0.97
1.A.3.b Road transportation	N_2O	52.04	0.00	0.97
3.B.1.3 Manure Management - Swine	CH_4	50.85	0.00	0.97
1.A.1.a Public electricity and heat production - Liquid Fuels	CO_2	44.88	0.00	0.97
5.D Wastewater Treatment and Discharge	N_2O	42.49	0.00	0.98
2.F.2 Foam Blowing Agents	HFCs	41.39	0.00	0.98
1.A.1.c Manufacture of solid fuels and other energy industries - Gaseous fuels	CO_2	37.02	0.00	0.98
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Total		***20,338.4***		

Approach 1 Trend Assessment for 2019

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2019 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*	*-6,892.19*	*-5,605.38*	*0.07*	*0.14*	*0.14*
1.A.1.a Public electricity and heat production - Liquid Fuels	*CO_2*	*6,021.25*	*44.88*	*0.05*	*0.11*	*0.25*
1.A.3.b Road transportation	*CO_2*	*5,247.15*	*5,992.86*	*0.05*	*0.10*	*0.35*
1.A.1.a Public electricity and heat production - Gaseous Fuels	*CO_2*	*5,796.59*	*592.42*	*0.04*	*0.08*	*0.44*
1.A.2 Manufacturing industries and construction-Liquid fuels	*CO_2*	*3,873.72*	*125.57*	*0.03*	*0.07*	*0.50*
2.B.1 Ammonia Production	*CO_2*	*1,253.68*	*1,988.84*	*0.02*	*0.04*	*0.55*
1.A.4 Other sectors-Solid fuels	*CO_2*	*2,760.55*	*246.60*	*0.02*	*0.04*	*0.59*
1.A.4 Other sectors-Liquid fuels	*CO_2*	*2,736.38*	*336.30*	*0.02*	*0.04*	*0.63*
4.B.1 Cropland remaining cropland - net carbon stock change in mineral soils	*CO_2*	*0.00*	*-1,138.14*	*0.02*	*0.04*	*0.66*
3.A.1 Enteric Fermentation - Cattle	*CH_4*	*4,146.14*	*1,409.41*	*0.01*	*0.03*	*0.69*
4.E.2 Land converted to settlements	*CO_2*	*16.09*	*719.45*	*0.01*	*0.02*	*0.71*
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	*CO_2*	*517.32*	*816.62*	*0.01*	*0.02*	*0.73*
2.F.1 Refrigeration and Air Conditioning Equipment	*HFCs*	*0.00*	*516.04*	*0.01*	*0.02*	*0.75*
4.G Harvested wood products	*CO_2*	*-252.55*	*-808.30*	*0.01*	*0.01*	*0.76*
1.A.2 Manufacturing industries and construction-Gaseous fuels	*CO_2*	*2,045.42*	*706.44*	*0.01*	*0.01*	*0.78*
1.A.1.b Petroleum refining - Liquid Fuels	*CO_2*	*1,509.64*	*1,204.92*	*0.01*	*0.01*	*0.79*
4.C.2 Land converted to grassland - carbon stock change in biomass	*CO_2*	*-285.53*	*-68.32*	*0.01*	*0.01*	*0.80*
4.F Other land	*CO_2*	*0.00*	*342.42*	*0.01*	*0.01*	*0.81*
2.A.1 Cement Production	*CO_2*	*1,668.07*	*578.06*	*0.01*	*0.01*	*0.82*
1.A.2 Manufacturing industries and construction-Solid fuels	*CO_2*	*171.63*	*427.21*	*0.01*	*0.01*	*0.83*
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	*CO_2*	*-474.03*	*-358.46*	*0.01*	*0.01*	*0.84*
2.B.2 Nitric Acid Production	*N_2O*	*893.01*	*179.33*	*0.01*	*0.01*	*0.85*
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	*N_2O*	*992.77*	*828.87*	*0.00*	*0.01*	*0.86*
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	*CO_2*	*1,443.18*	*1,044.87*	*0.00*	*0.01*	*0.87*
1.B.2 Oil, natural gas and other emissions from energy production	*CO_2*	*23.88*	*233.94*	*0.00*	*0.01*	*0.88*
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	*N_2O*	*529.59*	*486.81*	*0.00*	*0.01*	*0.89*
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	*CO_2*	*353.40*	*381.15*	*0.00*	*0.01*	*0.89*
1.A.1 Energy industries-Other fossil fuels	*CO_2*	*0.00*	*178.94*	*0.00*	*0.01*	*0.90*
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	*N_2O*	*268.18*	*320.60*	*0.00*	*0.01*	*0.90*

IPCC Category	Greenhouse gas	1990 kt CO_2 eq.	2019 kt CO_2 eq.	Trend assessment	% Contribution to Trend	Cumulative total
1.A.4 Other sectors-Gaseous fuels	***CO_2***	***1,379.27***	***591.42***	***0.00***	***0.01***	***0.91***
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	***CO_2***	***-412.62***	***-747.44***	***0.00***	***0.00***	***0.91***
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	***CH_4***	***260.55***	***288.56***	***0.00***	***0.00***	***0.92***
4.B.2 Land converted to cropland- carbon stock change in biomass	***CO_2***	***138.74***	***208.11***	***0.00***	***0.00***	***0.92***
3.B.1.3 Manure Management - Swine	***CH_4***	***329.25***	***50.85***	***0.00***	***0.00***	***0.93***
1.A.1.b Petroleum refining - Gaseous Fuels	***CO_2***	***0.00***	***119.30***	***0.00***	***0.00***	***0.93***
2.A.4 Other process use of carbonates	***CO_2***	***239.53***	***14.81***	***0.00***	***0.00***	***0.93***
2.A.2 Lime Production	***CO_2***	***210.27***	***1.39***	***0.00***	***0.00***	***0.94***
5.D Wastewater Treatment and Discharge	***CH_4***	***422.99***	***120.19***	***0.00***	***0.00***	***0.94***
1.A.4 Other sectors-Biomass	***CH_4***	***70.28***	***137.70***	***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***	***419.85***	***140.50***	***0.00***	***0.00***	***0.95***
1.A.1. Energy industries-Solid fuels	***CO_2***	***174.05***	***7.42***	***0.00***	***0.00***	***0.95***
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	***N_2O***	***403.33***	***305.92***	***0.00***	***0.00***	***0.95***
1.A.4 Other sectors-Peat	CO_2	27.13	91.30	0.00	0.00	0.96
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	CO_2	858.08	545.92	0.00	0.00	0.96
1.A.4 Other sectors-Liquid fuels	N_2O	159.35	14.13	0.00	0.00	0.96
4.B.2 Land converted to cropland- net carbon stock change in dead organic matter	CO_2	65.28	98.72	0.00	0.00	0.96
4.A.2 Land converted to forest land - carbon stock change in biomass	CO_2	-600.70	-810.82	0.00	0.00	0.97
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Total		***42,323.3***	***14,856.3***	***0.50***	***1.00***	

Approach 1 Trend Assessment for 2019 using a subset (LULUCF was excluded from analysis)

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2019 kt CO_2 eq.*	*Trend assessment*	*% Contribution to Trend*	*Cumulative total*
1.A.3.b Road transportation	*CO_2*	*5,247.15*	*5992.86*	*0.08*	*0.20*	*0.20*
1.A.1.a Public electricity and heat production - Liquid Fuels	*CO_2*	*6,021.25*	*44.88*	*0.05*	*0.14*	*0.34*
1.A.1.a Public electricity and heat production - Gaseous Fuels	*CO_2*	*5,796.59*	*592.42*	*0.04*	*0.10*	*0.44*
1.A.2 Manufacturing industries and construction-Liquid fuels	*CO_2*	*3,873.72*	*125.57*	*0.03*	*0.08*	*0.52*
2.B.1 Ammonia Production	*CO_2*	*1,253.68*	*1988.84*	*0.03*	*0.08*	*0.60*
1.A.4 Other sectors-Solid fuels	*CO_2*	*2,760.55*	*246.60*	*0.02*	*0.05*	*0.65*
1.A.4 Other sectors-Liquid fuels	*CO_2*	*2,736.38*	*336.30*	*0.02*	*0.04*	*0.70*
1.A.1.b Petroleum refining - Liquid Fuels	*CO_2*	*1,509.64*	*1204.92*	*0.01*	*0.03*	*0.73*
2.F.1 Refrigeration and Air Conditioning Equipment	*HFCs*	*0.00*	*516.04*	*0.01*	*0.03*	*0.76*
3.D.1.1 Direct N2O Emissions From Managed Soils - Inorganic N Fertilizers	*N_2O*	*992.77*	*828.87*	*0.01*	*0.02*	*0.78*
3.A.1 Enteric Fermentation - Cattle	*CH_4*	*4,146.14*	*1409.41*	*0.01*	*0.02*	*0.80*
1.A.2 Manufacturing industries and construction-Solid fuels	*CO_2*	*171.63*	*427.21*	*0.01*	*0.02*	*0.82*
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	*N_2O*	*529.59*	*486.81*	*0.01*	*0.01*	*0.83*
1.B.2 Oil, natural gas and other emissions from energy production	*CO_2*	*23.88*	*233.94*	*0.00*	*0.01*	*0.84*
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	*N_2O*	*268.18*	*320.60*	*0.00*	*0.01*	*0.85*
2.B.2 Nitric Acid Production	*N_2O*	*893.01*	*179.33*	*0.00*	*0.01*	*0.87*
1.A.1 Energy industries-Other fossil fuels	*CO_2*	*0.00*	*178.94*	*0.00*	*0.01*	*0.88*
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	*CH_4*	*260.55*	*288.56*	*0.00*	*0.01*	*0.88*
1.A.2 Manufacturing industries and construction-Gaseous fuels	*CO_2*	*2,045.42*	*706.44*	*0.00*	*0.01*	*0.89*
5.A Solid Waste Disposal	*CH_4*	*1,028.83*	*572.71*	*0.00*	*0.01*	*0.90*
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	*N_2O*	*403.33*	*305.92*	*0.00*	*0.01*	*0.91*
2.A.1 Cement Production	*CO_2*	*1,668.07*	*578.06*	*0.00*	*0.01*	*0.92*
1.A.1.b Petroleum refining - Gaseous Fuels	*CO_2*	*0.00*	*119.30*	*0.00*	*0.01*	*0.92*
1.A.4 Other sectors-Biomass	*CH_4*	*70.28*	*137.70*	*0.00*	*0.01*	*0.93*
3.B.1.3 Manure Management - Swine	*CH_4*	*329.25*	*50.85*	*0.00*	*0.00*	*0.93*
2.A.2 Lime Production	*CO_2*	*210.27*	*1.39*	*0.00*	*0.00*	*0.94*
2.A.4 Other process use of carbonates	*CO_2*	*239.53*	*14.81*	*0.00*	*0.00*	*0.94*
1.A.4 Other sectors-Peat	*CO_2*	*27.13*	*91.30*	*0.00*	*0.00*	*0.95*
1.A.1. Energy industries-Solid fuels	*CO_2*	*174.05*	*7.42*	*0.00*	*0.00*	*0.95*
5.B Biological Treatment of Solid Waste	*CH_4*	*0.20*	*61.38*	*0.00*	*0.00*	*0.95*

5.D Wastewater Treatment and Discharge	CH_4	422.99	120.19	0.00	0.00	0.96
1.A.4 Other sectors-Liquid fuels	N_2O	159.35	14.13	0.00	0.00	0.96
3.B.1.1 Manure Management - Cattle	CH_4	251.55	156.03	0.00	0.00	0.96
1.A.4 Other sectors-Solid fuels	CH_4	128.56	10.81	0.00	0.00	0.96
2. D Non-energy products from fuels and solvent use	CO_2	41.28	59.75	0.00	0.00	0.97
2.F.2 Foam Blowing Agents	HFCs	0.00	41.39	0.00	0.00	0.97
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Total		***47,791.9***	***20,338.4***	***0.39***	***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***	***-6,892.19***	***0.05***	***0.21***
5.A Solid Waste Disposal	***CH_4***	***1,028.83***	***0.02***	***0.29***
3.A.1 Enteric Fermentation - Cattle	***CH_4***	***4,146.14***	***0.02***	***0.36***
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	***CO_2***	***517.32***	***0.02***	***0.42***
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	***CO_2***	***1,443.18***	***0.01***	***0.48***
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	***N_2O***	***992.77***	***0.01***	***0.53***
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	***N_2O***	***401.10***	***0.01***	***0.56***
3.B.2 Manure Management - Indirect N_2O Emissions	***N_2O***	***247.61***	***0.01***	***0.60***
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	***N_2O***	***529.59***	***0.01***	***0.62***
5.D Wastewater Treatment and Discharge	***CH_4***	***422.99***	***0.01***	***0.65***
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	***CO_2***	***858.08***	***0.01***	***0.67***
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	***N_2O***	***419.85***	***0.01***	***0.70***
4.A.2 Land converted to forest land - carbon stock change in biomass	***CO_2***	***-600.70***	***0.00***	***0.71***
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	***N_2O***	***301.24***	***0.00***	***0.73***
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	***N_2O***	***166.49***	***0.00***	***0.74***
3.B.2 Manure Management - Cattle	***N_2O***	***205.85***	***0.00***	***0.76***
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	***CO_2***	***-474.03***	***0.00***	***0.77***
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	***N_2O***	***268.18***	***0.00***	***0.79***
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	***CO_2***	***353.40***	***0.00***	***0.80***
1.A.1.a Public electricity and heat production - Liquid Fuels	***CO_2***	***6,021.25***	***0.00***	***0.81***
1.A.1.a Public electricity and heat production - Gaseous Fuels	***CO_2***	***5,796.59***	***0.00***	***0.82***
1.A.4 Other sectors-Solid fuels	***CO_2***	***2,760.55***	***0.00***	***0.83***
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	***CO_2***	***-412.62***	***0.00***	***0.84***
4.G Harvested wood products	***CO_2***	***-252.55***	***0.00***	***0.85***
1.A.3.b Road transportation	***CO_2***	***5,247.15***	***0.00***	***0.86***

IPCC Category	***Greenhouse gas***	***GHG emissions, kt CO_2 eq.***	***Level assessment with uncertainty***	***Cumulative total***
3.B.2 Manure Management - Other	***N_2O***	***127.49***	***0.00***	***0.87***
4.D.2 Land converted to wetlands	***CO_2***	***63.13***	***0.00***	***0.88***
4.C.2 Land converted to grassland - carbon stock change in biomass	***CO_2***	***-285.53***	***0.00***	***0.89***
1.A.4 Other sectors-Biomass	***CH_4***	***70.28***	***0.00***	***0.89***
1.A.2 Manufacturing industries and construction-Liquid fuels	***CO_2***	***3,873.72***	***0.00***	***0.90***
1.A.4 Other sectors-Liquid fuels	CO_2	2,736.38	0.00	0.91
2.B.2 Nitric Acid Production	N_2O	893.01	0.00	0.91
2.A.1 Cement Production	CO_2	1,668.07	0.00	0.92
1.A.4 Other sectors-Liquid fuels	N_2O	159.35	0.00	0.92
4.A.2 Land converted to forest land - net carbon stock change in mineral soils	CO_2	-150.23	0.00	0.93
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Total		***42,323.3***		

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***	***1,028.83***	***0.03***	***0.15***
3.A.1 Enteric Fermentation - Cattle	***CH_4***	***4,146.14***	***0.02***	***0.27***
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	***N_2O***	***992.77***	***0.02***	***0.37***
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	***N_2O***	***401.10***	***0.01***	***0.44***
3.B.2 Manure Management - Indirect N_2O Emissions	***N_2O***	***247.61***	***0.01***	***0.50***
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	***N_2O***	***529.59***	***0.01***	***0.55***
5.D Wastewater Treatment and Discharge	***CH_4***	***422.99***	***0.01***	***0.59***
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	***N_2O***	***419.85***	***0.01***	***0.63***
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	***N_2O***	***301.24***	***0.01***	***0.66***
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	***N_2O***	***166.49***	***0.00***	***0.69***
3.B.2 Manure Management - Cattle	***N_2O***	***205.85***	***0.00***	***0.72***
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	***N_2O***	***268.18***	***0.00***	***0.74***
1.A.1.a Public electricity and heat production - Liquid Fuels	***CO_2***	***6,021.25***	***0.00***	***0.76***
1.A.1.a Public electricity and heat production - Gaseous Fuels	***CO_2***	***5,796.59***	***0.00***	***0.78***
1.A.4 Other sectors-Solid fuels	***CO_2***	***2,760.55***	***0.00***	***0.80***
1.A.3.b Road transportation	***CO_2***	***5,247.15***	***0.00***	***0.81***
3.B.2 Manure Management - Other	***N_2O***	***127.49***	***0.00***	***0.83***
1.A.4 Other sectors-Biomass	***CH_4***	***70.28***	***0.00***	***0.84***
1.A.2 Manufacturing industries and construction-Liquid fuels	***CO_2***	***3,873.72***	***0.00***	***0.86***
1.A.4 Other sectors-Liquid fuels	***CO_2***	***2,736.38***	***0.00***	***0.87***
2.B.2 Nitric Acid Production	***N_2O***	***893.01***	***0.00***	***0.88***
2.A.1 Cement Production	***CO_2***	***1,668.07***	***0.00***	***0.89***
1.A.4 Other sectors-Liquid fuels	***N_2O***	***159.35***	***0.00***	***0.90***
1.A.4 Other sectors-Solid fuels	CH_4	128.56	0.00	0.91
2.A.2 Lime Production	CO_2	210.27	0.00	0.91
3.B.1.3 Manure Management - Swine	CH_4	329.25	0.00	0.92
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Total		***47,791.9***		

Approach 2 Level Assessment for 2019

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*	*-5,605.38*	*0.08*	*0.20*
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	*CO_2*	*816.62*	*0.05*	*0.33*
5.A Solid Waste Disposal	*CH_4*	*572.71*	*0.02*	*0.38*
3.D.1.1 Direct N2O Emissions From Managed Soils - Inorganic N Fertilizers	*N_2O*	*828.87*	*0.02*	*0.44*
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	*CO_2*	*1,044.87*	*0.02*	*0.48*
4.B.1 Cropland remaining cropland - net carbon stock change in mineral soils	*CO_2*	*-1,138.14*	*0.01*	*0.52*
4.G Harvested wood products	*CO_2*	*-808.30*	*0.01*	*0.56*
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	*N_2O*	*305.92*	*0.01*	*0.59*
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	*N_2O*	*486.81*	*0.01*	*0.62*
4.A.2 Land converted to forest land - carbon stock change in biomass	*CO_2*	*-810.82*	*0.01*	*0.65*
3.A.1 Enteric Fermentation - Cattle	*CH_4*	*1,409.41*	*0.01*	*0.68*
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	*CO_2*	*-747.44*	*0.01*	*0.70*
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	*N_2O*	*320.60*	*0.01*	*0.72*
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	*CO_2*	*545.92*	*0.01*	*0.74*
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	*CO_2*	*381.15*	*0.01*	*0.76*
1.A.4 Other sectors-Biomass	*CH_4*	*137.70*	*0.01*	*0.77*
3.B.2 Manure Management - Indirect N_2O Emissions	*N_2O*	*85.57*	*0.01*	*0.79*
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	*CO_2*	*-358.46*	*0.00*	*0.80*
1.A.3.b Road transportation	*CO_2*	*5,992.86*	*0.00*	*0.81*
2.F.1 Refrigeration and Air Conditioning Equipment	*HFCs*	*516.04*	*0.00*	*0.82*
1.B.2 Oil, natural gas and other emissions from energy production	*CO_2*	*233.94*	*0.00*	*0.83*
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	*N_2O*	*99.60*	*0.00*	*0.85*
4.E.2 Land converted to settlements	*CO_2*	*719.45*	*0.00*	*0.86*
4.F Other land	*CO_2*	*342.42*	*0.00*	*0.86*
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	*N_2O*	*140.50*	*0.00*	*0.87*
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	*N_2O*	*136.32*	*0.00*	*0.88*
4.A.2 Land converted to forest land - net carbon stock	*CO_2*	*-232.78*	*0.00*	*0.89*

IPCC Category	*Greenhouse gas*	*GHG emissions, kt CO_2 eq.*	*Level assessment with uncertainty*	*Cumulative total*
change in mineral soils				
5.D Wastewater Treatment and Discharge	***CH_4***	***120.19***	***0.00***	***0.90***
4.B.2 Land converted to cropland- carbon stock change in biomass	***CO_2***	***208.11***	***0.00***	***0.91***
3.B.2 Manure Management - Cattle	***N_2O***	***80.84***	***0.00***	***0.91***
4.E Settlements	N_2O	52.72	0.00	0.92
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Total		***14,856.23***		

Approach 2 Level Assessment for 2019 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***	***572.71***	***0.04***	***0.14***
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	***N_2O***	***828.87***	***0.03***	***0.28***
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	***N_2O***	***305.92***	***0.02***	***0.36***
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	***N_2O***	***486.81***	***0.02***	***0.44***
3.A.1 Enteric Fermentation - Cattle	***CH4***	***1,409.41***	***0.02***	***0.51***
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	***N_2O***	***320.60***	***0.01***	***0.57***
1.A.4 Other sectors-Biomass	***CH4***	***137.70***	***0.01***	***0.61***
3.B.2 Manure Management - Indirect N_2O Emissions	***N_2O***	***85.57***	***0.01***	***0.64***
1.A.3.b Road transportation	***CO_2***	***5,992.86***	***0.01***	***0.68***
2.F.1 Refrigeration and Air Conditioning Equipment	***HFCs***	***516.04***	***0.01***	***0.71***
1.B.2 Oil, natural gas and other emissions from energy production	***CO_2***	***233.94***	***0.01***	***0.73***
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	***N_2O***	***99.60***	***0.01***	***0.76***
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	***N_2O***	***140.50***	***0.01***	***0.79***
3.D.1.2 Direct N_2O Emissions From Managed Soils - Organic N Fertilizers	***N_2O***	***136.32***	***0.01***	***0.81***
5.D Wastewater Treatment and Discharge	***CH4***	***120.19***	***0.01***	***0.83***
3.B.2 Manure Management - Cattle	***N_2O***	***80.84***	***0.00***	***0.85***
5.B Biological Treatment of Solid Waste	***CH4***	***61.38***	***0.00***	***0.86***
2.B.1 Ammonia Production	***CO_2***	***1,988.84***	***0.00***	***0.87***
1.A.1 Energy industries-Biomass	***N_2O***	***33.34***	***0.00***	***0.88***
1.A.4 Other sectors-Biomass	***N_2O***	***25.25***	***0.00***	***0.89***
1.A.1.b Petroleum refining - Liquid Fuels	***CO_2***	***1,204.92***	***0.00***	***0.90***
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	***CH4***	***288.56***	***0.00***	***0.90***
1.A.1 Energy industries-Biomass	***CH4***	***20.98***	***0.00***	***0.91***
2.A.1 Cement Production	***CO_2***	***578.06***	***0.00***	***0.91***
3.B.1.1 Manure Management - Cattle	CH4	156.03	0.00	0.92
5.B Biological Treatment of Solid Waste	N_2O	24.94	0.00	0.92
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Total		***20,338.4***		

Approach 2 Trend Assessment for 2019

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2019 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*	*-6,892.19*	*-5,605.38*	*0.04*	*0.26*	*0.26*
4.D.1 Wetlands remaining wetlands -net carbon stock change in organic soils	*CO_2*	*517.32*	*816.62*	*0.02*	*0.14*	*0.40*
4.B.1 Cropland remaining cropland - net carbon stock change in mineral soils	*CO_2*	*0.00*	*-1,138.14*	*0.01*	*0.06*	*0.46*
4.G Harvested wood products	*CO_2*	*-252.55*	*-808.30*	*0.00*	*0.03*	*0.49*
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	*N_2O*	*992.77*	*828.87*	*0.00*	*0.03*	*0.52*
3.A.1 Enteric Fermentation - Cattle	*CH_4*	*4,146.14*	*1,409.41*	*0.00*	*0.03*	*0.55*
4.A.1 Forest land remaining forest land - net carbon stock change in dead wood	*CO_2*	*-474.03*	*-358.46*	*0.00*	*0.02*	*0.57*
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	*N_2O*	*529.59*	*486.81*	*0.00*	*0.02*	*0.59*
1.A.4 Other sectors-Biomass	*CH_4*	*70.28*	*137.70*	*0.00*	*0.02*	*0.61*
4.B Cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	*CO_2*	*1,443.18*	*1,044.87*	*0.00*	*0.02*	*0.63*
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	*N_2O*	*268.18*	*320.60*	*0.00*	*0.02*	*0.65*
2.F.1 Refrigeration and Air Conditioning Equipment	*HFCs*	*0.00*	*516.04*	*0.00*	*0.02*	*0.67*
1.B.2 Oil, natural gas and other emissions from energy production	*CO_2*	*23.88*	*233.94*	*0.00*	*0.02*	*0.69*
4.C.2 Land converted to grassland - carbon stock change in biomass	*CO_2*	*-285.53*	*-68.32*	*0.00*	*0.02*	*0.70*
4.E.2 Land converted to settlements	*CO_2*	*16.09*	*719.45*	*0.00*	*0.02*	*0.72*
4.F Other land	*CO_2*	*0.00*	*342.42*	*0.00*	*0.02*	*0.73*
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	*N_2O*	*403.33*	*305.92*	*0.00*	*0.02*	*0.75*
4.A Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	*CO_2*	*353.40*	*381.15*	*0.00*	*0.01*	*0.76*
3.B.2 Manure Management - Indirect N_2O Emissions	*N_2O*	*247.61*	*85.57*	*0.00*	*0.01*	*0.78*
5.D Wastewater Treatment and Discharge	*CH_4*	*422.99*	*120.19*	*0.00*	*0.01*	*0.79*
1.A.1.a Public electricity and heat production - Liquid Fuels	*CO_2*	*6,021.25*	*44.88*	*0.00*	*0.01*	*0.80*

IPCC Category	Greenhouse gas	1990 kt CO_2 eq.	2019 kt CO_2 eq.	Trend assessment with uncertainty	% Contribution to Trend	Cumulative total
1.A.3.b Road transportation	***CO_2***	***5,247.15***	***5,992.86***	***0.00***	***0.01***	***0.81***
4.E Settlements	***N_2O***	***0.47***	***52.72***	***0.00***	***0.01***	***0.82***
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	***N_2O***	***419.85***	***140.50***	***0.00***	***0.01***	***0.83***
1.A.4 Other sectors-Solid fuels	***CO_2***	***2,760.55***	***246.60***	***0.00***	***0.01***	***0.84***
1.A.1.a Public electricity and heat production - Gaseous Fuels	***CO_2***	***5,796.59***	***592.42***	***0.00***	***0.01***	***0.85***
5.B Biological Treatment of Solid Waste	***CH_4***	***0.20***	***61.38***	***0.00***	***0.01***	***0.86***
3.B.2 Manure Management - Other	***N_2O***	***127.49***	***16.32***	***0.00***	***0.01***	***0.86***
4.B.2 Land converted to cropland- carbon stock change in biomass	***CO_2***	***138.74***	***208.11***	***0.00***	***0.01***	***0.87***
4.C.2 Land converted to grassland - net carbon stock change in mineral soils	***CO_2***	***-412.62***	***-747.44***	***0.00***	***0.01***	***0.88***
1.A.2 Manufacturing industries and construction-Liquid fuels	***CO_2***	***3,873.72***	***125.57***	***0.00***	***0.01***	***0.88***
4.D.2 Land converted to wetlands	***CO_2***	***63.13***	***7.94***	***0.00***	***0.01***	***0.89***
1.A.1 Energy industries-Biomass	***N_2O***	***0.63***	***33.34***	***0.00***	***0.01***	***0.90***
1.A.4 Other sectors-Liquid fuels	***CO_2***	***2,736.38***	***336.30***	***0.00***	***0.01***	***0.90***
2.B.1 Ammonia Production	***CO_2***	***1,253.68***	***1,988.84***	***0.00***	***0.00***	***0.91***
1.A.4 Other sectors-Liquid fuels	***N_2O***	***159.35***	***14.13***	***0.00***	***0.00***	***0.91***
4.B.2 Land converted to cropland - net carbon stock change in mineral soils	CO_2	858.08	545.92	0.00	0.00	0.92
……………………………………………						
Total		***42,323.3***	***14,856.3***	***0.13***	***1.00***	

Approach 2 Trend Assessment for 2019 using a subset (LULUCF was excluded from analysis)

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2019 kt CO_2 eq.*	*Trend assessment with uncertainty*	*% Contribution to Trend*	*Cumulative total*
3.D.1.1 Direct N_2O Emissions From Managed Soils - Inorganic N Fertilizers	***N_2O***	***992.77***	***828.87***	***0.01***	***0.12***	***0.12***
3.D.1.6 Direct N_2O Emissions From Managed Soils - Cultivation of organic soils	***N_2O***	***529.59***	***486.81***	***0.00***	***0.08***	***0.20***
3.D.2.2 Indirect N_2O Emissions From Managed Soils - Nitrogen leaching and run-off	***N_2O***	***403.33***	***305.92***	***0.00***	***0.07***	***0.27***
5.A Solid Waste Disposal	***CH_4***	***1,028.83***	***572.71***	***0.00***	***0.06***	***0.33***
3.D.1.4 Direct N_2O Emissions From Managed Soils - Crop Residues	***N_2O***	***268.18***	***320.60***	***0.00***	***0.06***	***0.39***
1.A.4 Other sectors-Biomass	***CH_4***	***70.28***	***137.70***	***0.00***	***0.06***	***0.45***
2.F.1 Refrigeration and Air Conditioning Equipment	***HFCs***	***0.00***	***516.04***	***0.00***	***0.05***	***0.50***
1.B.2 Oil, natural gas and other emissions from energy production	***CO2***	***23.88***	***233.94***	***0.00***	***0.05***	***0.55***
1.A.3.b Road transportation	***CO2***	***5,247.15***	***5992.86***	***0.00***	***0.04***	***0.59***
3.A.1 Enteric Fermentation - Cattle	***CH_4***	***4,146.14***	***1409.41***	***0.00***	***0.03***	***0.62***
1.A.1.a Public electricity and heat production - Liquid Fuels	***CO2***	***6,021.25***	***44.88***	***0.00***	***0.03***	***0.65***
5.B Biological Treatment of Solid Waste	***CH_4***	***0.20***	***61.38***	***0.00***	***0.02***	***0.67***
5.D Wastewater Treatment and Discharge	***CH_4***	***422.99***	***120.19***	***0.00***	***0.02***	***0.69***
1.A.4 Other sectors-Solid fuels	***CO2***	***2,760.55***	***246.60***	***0.00***	***0.02***	***0.71***
1.A.1.a Public electricity and heat production - Gaseous Fuels	***CO2***	***5,796.59***	***592.42***	***0.00***	***0.02***	***0.73***
1.A.1 Energy industries-Biomass	***N_2O***	***0.63***	***33.34***	***0.00***	***0.02***	***0.74***
1.A.2 Manufacturing industries and construction-Liquid fuels	***CO2***	***3,873.72***	***125.57***	***0.00***	***0.02***	***0.76***
3.B.2 Manure Management - Other	***N_2O***	***127.49***	***16.32***	***0.00***	***0.02***	***0.77***
3.B.2 Manure Management - Indirect N_2O Emissions	***N_2O***	***247.61***	***85.57***	***0.00***	***0.01***	***0.79***

IPCC Category	*Greenhouse gas*	*1990 kt CO_2 eq.*	*2019 kt CO_2 eq.*	*Trend assessment with uncertainty*	*% Contribution to Trend*	*Cumulative total*
2.B.1 Ammonia Production	***CO2***	***1,253.68***	***1988.84***	***0.00***	***0.01***	***0.80***
3.D.2.1 Indirect N_2O Emissions From Managed Soils - Atmospheric deposition	***N_2O***	***168.48***	***99.60***	***0.00***	***0.01***	***0.82***
3.D.1.3 Direct N_2O Emissions From Managed Soils - Urine and dung deposited by grazing animals	***N_2O***	***419.85***	***140.50***	***0.00***	***0.01***	***0.83***
1.A.1 Energy industries-Biomass	***CH_4***	***0.40***	***20.98***	***0.00***	***0.01***	***0.84***
1.A.4 Other sectors-Biomass	***N_2O***	***12.97***	***25.25***	***0.00***	***0.01***	***0.85***
1.A.4 Other sectors-Liquid fuels	***CO2***	***2,736.38***	***336.30***	***0.00***	***0.01***	***0.86***
1.A.4 Other sectors-Liquid fuels	***N_2O***	***159.35***	***14.13***	***0.00***	***0.01***	***0.87***
2.A.2 Lime Production	***CO2***	***210.27***	***1.39***	***0.00***	***0.01***	***0.88***
5.B Biological Treatment of Solid Waste	***N_2O***	***0.15***	***24.94***	***0.00***	***0.01***	***0.89***
1.A.4 Other sectors-Solid fuels	***CH_4***	***128.56***	***10.81***	***0.00***	***0.01***	***0.90***
2.B.2 Nitric Acid Production	***N_2O***	***893.01***	***179.33***	***0.00***	***0.01***	***0.91***
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	***CH_4***	***260.55***	***288.56***	***0.00***	***0.01***	***0.91***
1.A.2 Manufacturing industries and construction-Solid fuels	CO2	171.63	427.21	0.00	0.01	0.92
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Total		***47,791.9***	***20,338.4***	***0.06***	***1.00***	

ANNEX II. Tier 1 Uncertainty assessment

Table 1a. Uncertainty evaluation including LULUCF

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2019*	*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*	*Uncertainty in trend in national emissions introduced by activity data uncertainty*	*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	7,540.22	1,261.59	2%	2%	3%	0.000	0.033	0.030	0.001	0.001	0.000
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH_4	6.90	0.75	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	16.11	1.38	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	174.05	7.42	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	0.05	0.00	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	0.82	0.03	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	5,796.59	748.74	2%	2%	3%	0.000	0.030	0.018	0.001	0.001	0.000
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH_4	2.63	0.34	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	3.13	0.40	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	0.00	178.94	2%	5%	5%	0.000	0.004	0.004	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CH_4	0.00	1.06	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	0.00	1.69	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

1.A.1 Fuel combustion - Energy Industries - Peat	CO_2	11.06	22.33	2%	5%	5%	0.000	0.000	0.001	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Peat	CH_4	0.00	0.01	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	0.05	0.10	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	0.00	0.00	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	0.40	20.98	5%	150%	150%	0.000	0.000	0.000	0.001	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Biomass	N_2O	0.63	33.34	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	3,873.72	125.57	2%	2%	3%	0.000	0.029	0.003	0.001	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH_4	4.46	0.15	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	47.81	5.88	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	171.63	427.21	2%	5%	5%	0.000	0.009	0.010	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH_4	0.45	1.10	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	0.81	1.98	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	2,045.42	706.44	2%	2%	3%	0.000	0.000	0.017	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH_4	0.93	0.32	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and	N_2O	1.11	0.38	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

Construction - Gaseous Fuels												
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	CO_2	17.53	4.49	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	0.01	0.00	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	0.08	0.02	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	0.00	0.00	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	0.38	3.35	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	0.60	5.32	5%	150%	150%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	CO_2	8.16	1.99	10%	2%	10%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	CH_4	0.00	0.00	10%	79%	79%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	N_2O	0.07	0.02	10%	110%	110%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.b Road Transportation	CO_2	5,247.15	5,992.86	2%	2%	3%	0.000	0.098	0.142	0.002	0.004	0.000
1.A.3.b Road Transportation	CH_4	39.42	5.93	2%	40%	40%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.b Road Transportation	N_2O	49.78	52.04	2%	50%	50%	0.000	0.001	0.001	0.000	0.000	0.000
1.A.3.c Railways	CO_2	349.97	169.06	5%	2%	5%	0.000	0.001	0.004	0.000	0.000	0.000
1.A.3.c Railways	CH_4	0.50	0.25	5%	75%	75%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.c Railways	N_2O	40.92	19.78	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	15.49	16.09	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	0.04	0.04	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	0.13	0.13	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	64.28	12.23	5%	2%	5%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.e.i Other Transportation -	CH_4	0.03	0.01	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

Pipeline Transportation												
1.A.3.e.i Other Transportation - Pipeline Transportation	N_2O	0.03	0.01	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	CO_2	2,736.38	336.30	3%	2%	4%	0.000	0.015	0.008	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	CH_4	7.04	0.77	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	N_2O	159.35	14.13	3%	50%	50%	0.000	0.001	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	CO_2	2,760.55	246.60	3%	5%	6%	0.000	0.017	0.006	0.001	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	CH_4	128.56	10.81	3%	50%	50%	0.000	0.001	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	N_2O	13.00	1.16	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Gaseous Fuels	CO_2	1,379.27	591.42	3%	2%	4%	0.000	0.003	0.014	0.000	0.001	0.000
1.A.4 Other Sectors - Gaseous Fuels	CH_4	3.13	1.33	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Gaseous Fuels	N_2O	0.75	0.32	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	CO_2	27.13	91.30	3%	5%	6%	0.000	0.002	0.002	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	CH_4	1.12	4.72	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	N_2O	0.11	0.37	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors- Biomass	CO_2	0.00	0.00	10%	15%	18%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors- Biomass	CH_4	70.28	137.70	10%	150%	150%	0.000	0.003	0.003	0.004	0.000	0.000
1.A.4 Other Sectors- Biomass	N_2O	12.97	25.25	10%	150%	150%	0.000	0.000	0.001	0.001	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CO_2	23.30	232.02	5%	50%	50%	0.000	0.005	0.005	0.003	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH_4	4.25	2.89	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	0.00	0.00	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	0.01	0.01	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	260.55	288.56	5%	10%	11%	0.000	0.005	0.007	0.000	0.000	0.000
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CO_2	0.58	1.92	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	0.26	0.87	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	0.00	0.01	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.1 Cement Production	CO_2	1,668.07	578.06	2%	5%	5%	0.000	0.000	0.014	0.000	0.000	0.000

2.A.2 Lime Production	CO_2	210.27	1.39	5%	5%	7%	0.000	0.002	0.000	0.000	0.000	0.000
2.A.3 Glass Production	CO_2	11.74	8.00	7%	5%	9%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.4.a Ceramics	CO_2	227.92	2.20	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	5.20	0.99	15%	5%	16%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.4.d Mineral wool production	CO_2	6.41	11.62	7%	5%	9%	0.000	0.000	0.000	0.000	0.000	0.000
2.B.1 Ammonia Production	CO_2	1,253.68	1,988.84	2%	2%	3%	0.000	0.037	0.047	0.001	0.001	0.000
2.B.2 Nitric Acid Production	N_2O	893.01	179.33	2%	10%	10%	0.000	0.003	0.004	0.000	0.000	0.000
2.B.8.a Methanol	CO_2	24.35	0.00	5%	30%	30%	0.000	0.000	0.000	0.000	0.000	0.000
2.B.8.a Methanol	CH_4	5.24	0.00	5%	30%	30%	0.000	0.000	0.000	0.000	0.000	0.000
2.C.1 Iron and Steel Production	CO_2	16.98	1.51	10%	10%	14%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.1 Lubricant use	CO_2	6.06	15.59	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.2 Parafin wax use	CO_2	0.88	1.42	5%	100%	100%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.3 Solvent use	CO_2	34.33	41.68	30%	20%	36%	0.000	0.001	0.001	0.000	0.000	0.000
2.D.3 Asphalt roofing	CO_2	0.02	0.01	5%	25%	25%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.3 Road paving with asphalt	CO_2	0.00	0.00	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.3 Urea-based catalyst	CO_2	0.00	1.05	10%	2%	10%	0.000	0.000	0.000	0.000	0.000	0.000
2.E.1 Semiconductor	SF6	0.00	4.46	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.E.3 Photovoltaics	NF3	0.00	0.00	5%	20%	21%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.a Domestic Refrigeration	HFCs	0.00	1.57	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.a Commercial Refrigeration	HFCs	0.00	190.53	20%	50%	54%	0.000	0.005	0.005	0.002	0.001	0.000
2.F.1.a Transport Refrigeration	HFCs	0.00	110.81	20%	50%	54%	0.000	0.003	0.003	0.001	0.001	0.000
2.F.1.a Industrial Refrigeration	HFCs	0.00	52.82	20%	50%	54%	0.000	0.001	0.001	0.001	0.000	0.000
2.F.1.a Stationary Air-Conditioning	HFCs	0.00	17.42	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.b Mobile Air-Conditioning	HFCs	0.00	142.90	20%	50%	54%	0.000	0.003	0.003	0.002	0.001	0.000
2.F.2 Foam Blowing Agents	HFCs	0.00	41.39	30%	30%	42%	0.000	0.001	0.001	0.000	0.000	0.000
2.F.3 Fire Protection	HFCs	0.00	3.92	20%	20%	28%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.4 Aerosols/metered dose inhalers	HFCs	0.00	7.38	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.1 Manufacture of electrical equipments	SF6	0.00	0.49	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.2.b Accelerators	SF6	0.00	0.16	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.3.a Medical applications	N_2O	93.35	2.56	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	2.70	2.04	20%	100%	102%	0.000	0.000	0.000	0.000	0.000	0.000

3.A Enteric Fermentation	CH_4	4,290.91	1,483.12	4%	26%	26%	0.001	0.000	0.035	0.000	0.002	0.000
3.B Manure Management	CH_4	665.91	232.43	14%	13%	19%	0.000	0.000	0.005	0.000	0.001	0.000
3.B Manure Management	N_2O	580.96	182.72	21%	231%	232%	0.001	0.000	0.004	0.001	0.001	0.000
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	2,521.54	1,913.10	7%	83%	84%	0.012	0.024	0.045	0.020	0.005	0.000
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	571.81	405.52	40%	137%	142%	0.002	0.005	0.010	0.007	0.005	0.000
3.G Liming	CO_2	20.59	12.42	10%	50%	51%	0.000	0.000	0.000	0.000	0.000	0.000
3.H Urea Application	CO_2	35.71	16.19	10%	50%	51%	0.000	0.000	0.000	0.000	0.000	0.000
4.A.1 Forest Land Remaining Forest Land	CO_2	-7,364.87	-5,960.97	3%	46%	46%	0.034	0.080	0.141	0.037	0.006	0.001
4.A.1 Forest Land Remaining Forest Land	CH_4	0.47	0.50	32%	40%	51%	0.000	0.000	0.000	0.000	0.000	0.000
4.A.1 Forest Land Remaining Forest Land	N_2O	0.31	0.33	32%	27%	42%	0.000	0.000	0.000	0.000	0.000	0.000
4.A.2 Land Converted to Forest Land	CO_2	-782.92	-1,100.11	15%	46%	48%	0.001	0.020	0.026	0.009	0.005	0.000
4.A.2 Land Converted to Forest Land	CH_4	0.02	0.03	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	0.02	0.02	32%	27%	42%	0.000	0.000	0.000	0.000	0.000	0.000
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	1,847.99	1,487.78	7%	56%	57%	0.003	0.020	0.035	0.011	0.003	0.000
4(II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	35.32	36.20	9%	86%	87%	0.000	0.001	0.001	0.000	0.000	0.000
4.B Cropland	CO_2	1,139.64	-213.74	5%	31%	31%	0.000	0.014	0.005	0.004	0.000	0.000
4.B Cropland	CH_4	0.05	0.00	6%	85%	85%	0.000	0.000	0.000	0.000	0.000	0.000
4.B Cropland	N_2O	73.08	49.30	15%	151%	151%	0.000	0.001	0.001	0.001	0.000	0.000
4.C Grassland	CO_2	-765.93	-910.62	7%	42%	42%	0.001	0.015	0.022	0.006	0.002	0.000
4.C Grassland	CH_4	2.46	0.57	6%	85%	85%	0.000	0.000	0.000	0.000	0.000	0.000
4.C Grassland	N_2O	2.68	0.62	6%	76%	76%	0.000	0.000	0.000	0.000	0.000	0.000
4.D Wetlands	CO_2	580.45	816.62	6%	205%	205%	0.013	0.014	0.019	0.030	0.002	0.001
4.D Wetlands	N_2O	6.08	4.66	15%	151%	151%	0.000	0.000	0.000	0.000	0.000	0.000

4.E Settlements	CO_2	16.09	719.45	10%	15%	18%	0.000	0.017	0.017	0.002	0.002	0.000
4.E Settlements	N_2O	0.47	52.72	18%	151%	152%	0.000	0.001	0.001	0.002	0.000	0.000
4.F Other Land	CO_2	0.00	342.42	17%	15%	23%	0.000	0.008	0.008	0.001	0.002	0.000
4.F Other Land	N_2O	0.00	21.59	23%	151%	152%	0.000	0.001	0.001	0.001	0.000	0.000
4.G Harvested Wood Products	CO_2	-252.55	-808.30	15%	59%	61%	0.001	0.017	0.019	0.010	0.004	0.000
5.A Solid Waste Disposal	CH_4	1,028.83	572.71	30%	124%	128%	0.002	0.005	0.014	0.006	0.006	0.000
5.B Biological Treatment of Solid Waste	CH_4	0.20	61.38	40%	100%	108%	0.000	0.001	0.001	0.001	0.001	0.000
5.B Biological Treatment of Solid Waste	N_2O	0.15	24.94	40%	100%	108%	0.000	0.001	0.001	0.001	0.000	0.000
5.C Incineration and Open Burning of Waste	CO_2	2.66	1.68	25%	43%	50%	0.000	0.000	0.000	0.000	0.000	0.000
5.C Incineration and Open Burning of Waste	CH_4	0.00	0.00	25%	60%	65%	0.000	0.000	0.000	0.000	0.000	0.000
5.C Incineration and Open Burning of Waste	N_2O	0.08	0.05	25%	60%	65%	0.000	0.000	0.000	0.000	0.000	0.000
5.D Wastewater Treatment and Discharge	CH_4	422.99	120.19	59%	73%	93%	0.000	0.001	0.003	0.000	0.002	0.000
5.D Wastewater Treatment and Discharge	N_2O	67.21	42.49	30%	46%	55%	0.000	0.000	0.001	0.000	0.000	0.000
Total emission		***42,330.8***	***14,838.3***	**Overall uncertainty (%)**			**26.6**	**Trend uncertainty (%)**				**5.8**

Table 1b. Uncertainty evaluation excluding LULUCF

IPCC Source category	*Gas*	*Base year (1990) emissions*	*Emissions in 2019*	*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*	*Uncertainty in trend in national emissions introduced by activity data uncertainty*	*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	7,540.22	1,261.59	2%	2%	3%	0.000	0.041	0.026	0.001	0.001	0.000
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH_4	6.90	0.75	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	16.11	1.38	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	174.05	7.42	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	0.05	0.00	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	0.82	0.03	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	5,796.59	748.74	2%	2%	3%	0.000	0.036	0.016	0.001	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH_4	2.63	0.34	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	3.13	0.40	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	0.00	178.94	2%	5%	5%	0.000	0.004	0.004	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CH_4	0.00	1.06	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	0.00	1.69	2%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.1 Fuel combustion - Energy Industries	CO_2	11.06	22.33	2%	5%	5%	0.000	0.000	0.000	0.000	0.000	0.000

- Peat												
1.A.1 Fuel combustion - Energy Industries - Peat	CH_4	0.00	0.01	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	0.05	0.10	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	0.00	0.00	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	0.40	20.98	5%	150%	150%	0.000	0.000	0.000	0.001	0.000	0.000
1.A.1 Fuel combustion - Energy Industries - Biomass	N_2O	0.63	33.34	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	3,873.72	125.57	2%	2%	3%	0.000	0.032	0.003	0.001	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH_4	4.46	0.15	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	47.81	5.88	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	171.63	427.21	2%	5%	5%	0.000	0.007	0.009	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH_4	0.45	1.10	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	0.81	1.98	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	2,045.42	706.44	2%	2%	3%	0.000	0.003	0.015	0.000	0.000	0.000
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH_4	0.93	0.32	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	1.11	0.38	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	17.53	4.49	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	0.01	0.00	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	0.08	0.02	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	0.00	0.00	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	0.38	3.35	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	0.60	5.32	5%	150%	150%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	CO_2	8.16	1.99	10%	2%	10%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	CH_4	0.00	0.00	10%	79%	79%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.a Domestic Aviation	N_2O	0.07	0.02	10%	110%	110%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.b Road Transportation	CO_2	5,247.15	5,992.86	2%	2%	3%	0.000	0.079	0.125	0.002	0.004	0.000
1.A.3.b Road Transportation	CH_4	39.42	5.93	2%	40%	40%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.b Road Transportation	N_2O	49.78	52.04	2%	50%	50%	0.000	0.001	0.001	0.000	0.000	0.000
1.A.3.c Railways	CO_2	349.97	169.06	5%	2%	5%	0.000	0.000	0.004	0.000	0.000	0.000
1.A.3.c Railways	CH_4	0.50	0.25	5%	75%	75%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.c Railways	N_2O	40.92	19.78	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	15.49	16.09	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	0.04	0.04	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	0.13	0.13	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	64.28	12.23	5%	2%	5%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3.e.i Other Transportation - Pipeline Transportation	CH_4	0.03	0.01	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	0.03	0.01	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	CO_2	2,736.38	336.30	3%	2%	4%	0.000	0.017	0.007	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	CH_4	7.04	0.77	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Liquid Fuels	N_2O	159.35	14.13	3%	50%	50%	0.000	0.001	0.000	0.001	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	CO_2	2,760.55	246.60	3%	5%	6%	0.000	0.019	0.005	0.001	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	CH_4	128.56	10.81	3%	50%	50%	0.000	0.001	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Solid Fuels	N_2O	13.00	1.16	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Gaseous Fuels	CO_2	1,379.27	591.42	3%	2%	4%	0.000	0.000	0.012	0.000	0.001	0.000

1.A.4 Other Sectors - Gaseous Fuels	CH_4	3.13	1.33	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Gaseous Fuels	N_2O	0.75	0.32	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	CO_2	27.13	91.30	3%	5%	6%	0.000	0.002	0.002	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	CH_4	1.12	4.72	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors - Peat	N_2O	0.11	0.37	3%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors- Biomass	CO_2	0.00	0.00	10%	15%	18%	0.000	0.000	0.000	0.000	0.000	0.000
1.A.4 Other Sectors- Biomass	CH_4	70.28	137.70	10%	150%	150%	0.000	0.002	0.003	0.003	0.000	0.000
1.A.4 Other Sectors- Biomass	N_2O	12.97	25.25	10%	150%	150%	0.000	0.000	0.001	0.001	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CO_2	23.30	232.02	5%	50%	50%	0.000	0.005	0.005	0.002	0.000	0.000
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH_4	4.25	2.89	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	0.00	0.00	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	0.01	0.01	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	260.55	288.56	5%	10%	11%	0.000	0.004	0.006	0.000	0.000	0.000
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CO_2	0.58	1.92	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	0.26	0.87	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	0.00	0.01	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.1 Cement Production	CO_2	1,668.07	578.06	2%	5%	5%	0.000	0.003	0.012	0.000	0.000	0.000
2.A.2 Lime Production	CO_2	210.27	1.39	5%	5%	7%	0.000	0.002	0.000	0.000	0.000	0.000
2.A.3 Glass Production	CO_2	11.74	8.00	7%	5%	9%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.4.a Ceramics	CO_2	227.92	2.20	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	5.20	0.99	15%	5%	16%	0.000	0.000	0.000	0.000	0.000	0.000
2.A.4.d Mineral wool production	CO_2	6.41	11.62	7%	5%	9%	0.000	0.000	0.000	0.000	0.000	0.000
2.B.1 Ammonia Production	CO_2	1,253.68	1,988.84	2%	2%	3%	0.000	0.030	0.042	0.001	0.001	0.000
2.B.2 Nitric Acid Production	N_2O	893.01	179.33	2%	10%	10%	0.000	0.004	0.004	0.000	0.000	0.000
2.B.8.a Methanol	CO_2	24.35	0.00	5%	30%	30%	0.000	0.000	0.000	0.000	0.000	0.000
2.B.8.a Methanol	CH_4	5.24	0.00	5%	30%	30%	0.000	0.000	0.000	0.000	0.000	0.000
2.C.1 Iron and Steel Production	CO_2	16.98	1.51	10%	10%	14%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.1 Lubricant use	CO_2	6.06	15.59	5%	50%	50%	0.000	0.000	0.000	0.000	0.000	0.000

2.D.2 Parafin wax use	CO_2	0.88	1.42	5%	100%	100%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.3 Solvent use	CO_2	34.33	41.68	30%	20%	36%	0.000	0.001	0.001	0.000	0.000	0.000
2.D.3 Asphalt roofing	CO_2	0.02	0.01	5%	25%	25%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.3 Road paving with asphalt	CO_2	0.00	0.00	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000
2.D.3 Urea-based catalyst	CO_2	0.00	1.05	10%	2%	10%	0.000	0.000	0.000	0.000	0.000	0.000
2.E.1 Semiconductor	SF_6	0.00	4.46	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.E.3 Photovoltaics	NF_3	0.00	0.00	5%	20%	21%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.a Domestic Refrigeration	HFCs	0.00	1.57	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.a Commercial Refrigeration	HFCs	0.00	190.53	20%	50%	54%	0.000	0.004	0.004	0.002	0.001	0.000
2.F.1.a Transport Refrigeration	HFCs	0.00	110.81	20%	50%	54%	0.000	0.002	0.002	0.001	0.001	0.000
2.F.1.a Industrial Refrigeration	HFCs	0.00	52.82	20%	50%	54%	0.000	0.001	0.001	0.001	0.000	0.000
2.F.1.a Stationary Air-Conditioning	HFCs	0.00	17.42	20%	50%	54%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.1.b Mobile Air-Conditioning	HFCs	0.00	142.90	20%	50%	54%	0.000	0.003	0.003	0.001	0.001	0.000
2.F.2 Foam Blowing Agents	HFCs	0.00	41.39	30%	30%	42%	0.000	0.001	0.001	0.000	0.000	0.000
2.F.3 Fire Protection	HFCs	0.00	3.92	20%	20%	28%	0.000	0.000	0.000	0.000	0.000	0.000
2.F.4 Aerosols/metered dose inhalers	HFCs	0.00	7.38	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.1 Manufacture of electrical equipments	SF_6	0.00	0.49	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.2.b Accelerators	SF_6	0.00	0.16	5%	5%	7%	0.000	0.000	0.000	0.000	0.000	0.000
2.G.3.a Medical applications	N_2O	93.35	2.56	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	2.70	2.04	20%	100%	102%	0.000	0.000	0.000	0.000	0.000	0.000
3.A Enteric Fermentation	CH_4	4,290.91	1,483.12	4%	26%	26%	0.000	0.007	0.031	0.002	0.002	0.000
3.B Manure Management	CH_4	665.91	232.43	14%	13%	19%	0.000	0.001	0.005	0.000	0.001	0.000
3.B Manure Management	N_2O	580.96	182.72	21%	231%	232%	0.000	0.001	0.004	0.003	0.001	0.000
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	2,521.54	1,913.10	7%	83%	84%	0.006	0.018	0.040	0.015	0.004	0.000
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	571.81	405.52	40%	137%	142%	0.001	0.003	0.008	0.005	0.005	0.000
3.G Liming	CO_2	20.59	12.42	10%	50%	51%	0.000	0.000	0.000	0.000	0.000	0.000
3.H Urea Application	CO_2	35.71	16.19	10%	50%	51%	0.000	0.000	0.000	0.000	0.000	0.000
5.A Solid Waste Disposal	CH_4	1,028.83	572.71	30%	124%	128%	0.001	0.003	0.012	0.004	0.005	0.000
5.B Biological Treatment of Solid Waste	CH_4	0.20	61.38	40%	100%	108%	0.000	0.001	0.001	0.001	0.001	0.000
5.B Biological Treatment of Solid Waste	N_2O	0.15	24.94	40%	100%	108%	0.000	0.001	0.001	0.001	0.000	0.000
5.C Incineration and Open Burning of Waste	CO_2	2.66	1.68	25%	43%	50%	0.000	0.000	0.000	0.000	0.000	0.000

5.C Incineration and Open Burning of Waste	CH_4	0.00	0.00	25%	60%	65%	0.000	0.000	0.000	0.000	0.000	0.000
5.C Incineration and Open Burning of Waste	N_2O	0.08	0.05	25%	60%	65%	0.000	0.000	0.000	0.000	0.000	0.000
5.D Wastewater Treatment and Discharge	CH_4	422.99	120.19	59%	73%	93%	0.000	0.001	0.003	0.001	0.002	0.000
5.D Wastewater Treatment and Discharge	N_2O	67.21	42.49	30%	46%	55%	0.000	0.000	0.001	0.000	0.000	0.000
Total emission		**47,791.9**	**20,299.2**	**Overall uncertainty (%)**			**9.7**				**Trend uncertainty (%)**	**2.0**

ANNEX III. Lithuanian energy balance

Table 3-1. Balance of crude oil, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		502	5358	13491	9217	4909	3065	2691	2336	1948	1675
Liquid biofuels for blending											
Import		396707	131189	199709	380035	385276	356108	394439	415437	408513	404744
Export			335	13254	6312	4736	2067	2185	1773	1914	1588
International marine bunkers											
Changes in stocks		2093	-4730	-1169	9169	-1081	-1194	-372	-424	1500	-4893
Gross consumption		**399302**	**131482**	**198777**	**392109**	**384368**	**355912**	**394573**	**415576**	**410047**	**399938**
Statistical difference			-42								
Transformed in power, heat and other plants:		399302	131440	198777	392101	384357	355912	394573	415576	410047	399938
- 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	394573	415576	410047	399938
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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		87988	37709	68838	112699	123626	107664	117465	122611	114204	110125
Liquid biofuels for blending					26	445	600	337	375	557	637
Import		220	14328	736	1115	2616	2881	2906	2811	2016	1996
Export		42104	23601	50765	95698	114237	101063	111419	117451	107056	102035
International marine bunkers											
Changes in stocks		-2725	-1758	-2012	-3193	506	-1256	62	937	406	-109
Gross consumption		**43379**	**26678**	**16797**	**14949**	**12956**	**8826**	**9351**	**9283**	**10127**	**10614**
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	2	3	3	1
- in peat extraction enterprises	1.A.1.c.i				1		1	1	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	1	2	2	
Non energy use											
Distribution and transmission losses*		308	176	68	61	22	5	3	3	5	6
Final consumption:		**43071**	**26502**	**16714**	**14883**	**12934**	**8819**	**9346**	**9277**	**10119**	**10607**
- in industry	1.A.2.g.vii	44	88	48	31	15	8	9	6	17	7
- in construction	1.A.2.g.vii	439	176	101	69	28	16	15	14	17	16
- in transport	1.A.3	41840	25887	16337	14711	12841	8761	9301	9234	10063	10557
- in agriculture	1.A.4.c.ii	440	307	170	53	43	28	17	18	17	19
- in fishing											
- in commercial / public services	1.A.4.a.ii	308	44	58	19	7	6	4	5	5	8
- in households											

Table 3-3. Balance of aviation gasoline, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production											
Liquid biofuels for blending											
Import				14	20	18	19	16	19	22	20
Export											
International marine bunkers											
Changes in stocks											
Gross consumption				**14**	**20**	**18**	**19**	**16**	**19**	**22**	**20**
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**	**16**	**19**	**22**	**20**
- in industry											
- in construction											
- in transport	1.A.3			14	20	18	19	16	19	22	20
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		28125	9088	18566	24705	10352	7780	10012	12264	14565	15166
Liquid biofuels for blending											
Import		387	948	846		837	2244	2943	2233	1622	1938
Export		22956	8442	16673	21406	9062	6113	8645	9229	10964	11436
International marine bunkers											
Changes in stocks		86	129	-1651	-1185	115	10	40	-476	340	-120
Gross consumption		**5642**	**1723**	**1088**	**2114**	**2242**	**3921**	**4350**	**4792**	**5563**	**5578**
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**	**4350**	**4792**	**5563**	**5578**
- in industry											
- in construction											
- in transport	1.A.3	5642	1723	1088	2100	2237	3921	4350	4792	5563	5578
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-6. Balance of transport diesel, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		107712	42490	56232	127985	150168	156249	165004	170006	164846	159469
Liquid biofuels for blending					119	1478	2393	1931	2151	3308	3233
Import		8923	9475	1670	2840	7882	68750	48563	27342	21096	21815
Export		49416	27364	28516	92877	116251	169375	153347	135819	116666	111813
International marine bunkers				942							
Changes in stocks		-1997	1573	-4819	-2586	31	-768	-274	2379	-1918	834
Gross consumption		**65222**	**26174**	**23625**	**35481**	**43308**	**57249**	**61877**	**66059**	**70666**	**73538**
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	168	175	185	161
- in peat extraction enterprises	1.A.1.c.i	128	43	60	125	109	153	160	159	175	155
- in crude oil extraction enterprises	1.A.1.c.ii			22	49	23	13		8	1	
- in refineries	1.A.1.b			5			2	1			
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.ii			49	20	12	6	7	8	9	6
Non energy use	1.AD			6							
Distribution and transmission losses*		297	128	55	122	73	22	14	13	13	19
Final consumption:		**57276**	**24474**	**24245**	**35165**	**43091**	**57053**	**61695**	**65871**	**70468**	**73358**
- in industry	1.A.2.g.vii	2124	1827	510	499	190	248	235	247	299	297
- in construction	1.A.2.g.vii	2507	935	613	589	382	320	309	360	355	377
- in transport	1.A.3	34289	14489	21476	32515	41030	55021	59595	63677	68233	71055
- in agriculture	1.A.4.c.ii	14277	4207	1327	1362	1444	1438	1516	1548	1544	1578
- in fishing	1.A.4.c.iii				14	5	6	7	7	7	8
- in commercial / public services	1.A.4.a.ii	2889	2804	319	186	40	20	33	32	30	43
- in households	1.A.4.b.ii	1190	212								

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production					2125	1130	4777	5068	6107	6884	7064
Liquid biofuels for blending						2	73	68	76	79	76
Import			717		915	854	701	1231	1107	1169	711
Export					985		206	2	114	9	318
International marine bunkers					770	756	1738	2858	3133	3567	3381
Changes in stocks			-717	65	-225	-7	-61	63	-24	-126	138
Gross consumption				**65**	**1060**	**1223**	**3546**	**3570**	**4019**	**4430**	**4290**
Statistical difference											
Transformed in power, heat and other plants:				22	102	55	38	43	42	44	26
- in public CHP plants	1.A.1.a ii					1					
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii			22	64	52	37	43	41	44	26
- in autoproducer heat plants	1.A.1.a iii				38	2	1		1		
- in geothermal plants											
- in other industries											
Consumed in energy sector:						5	4	18	12	2	
- in peat extraction enterprises	1.A.1.c.i					5	4	1	1	1	
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.ii							17	11	1	
Non energy use											
Distribution and transmission losses											
Final consumption:				**43**	**958**	**1163**	**3504**	**3509**	**3965**	**4384**	**4264**
- in industry	1.A.2			7	405	220	228	138	193	232	264
- in construction	1.A.2.g.v			7	25	47	67	39	44	54	57
- in transport	1.A.3				226	235	2413	2358	2571	2839	2615
- in agriculture	1.A.4.c.i			23	137	230	264	287	301	283	377
- in fishing	1.A.4.c.i				59	73	76	37	25	33	36
- in commercial / public services	1.A.4.a			6	55	69	48	24	35	98	22
- in households	1.A.4.b				51	289	408	626	796	845	893

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		12006	7636	11026	21046	12720	12155	13388	14350	13723	16377
Liquid biofuels for blending											
Import		2208	1056	3972	3110	5024	4882	3612	3767	3770	3513
Export		7038	4646	5793	11596	8114	9662	9730	11099	10830	13053
International marine bunkers											
Changes in stocks		46	230	-420	163	-111	31	8	88		-111
Gross consumption		**7222**	**4276**	**8785**	**12723**	**9519**	**7406**	**7278**	**7106**	**6663**	**6726**
Statistical difference											
Transformed in power, heat and other plants:		46		51	90	90	81	90	81	79	78
- 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	41	35	35	35
- in autoproducer heat plants	1.A.1.a iii	46		31	71	69	45	49	46	44	43
- 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	14	20	14	23
Final consumption:		**6302**	**4046**	**8595**	**12580**	**9403**	**7311**	**7174**	**7005**	**6570**	**6625**
- in industry	1.A.2			201	229	273	326	329	355	355	396
- in construction	1.A.2.g.v	92	46	74	77	122	38	55	58	50	49
- in transport	1.A.3	920	1058	5032	9593	7275	5573	5254	4878	4572	4405
- in agriculture	1.A.4.c.i	230	46	19	38	41	54	94	142	100	149
- in fishing											
- in commercial / public services	1.A.4.a	460	92	62	23	6	20	42	57	27	29
- in households	1.A.4.b	4600	2804	3207	2620	1686	1300	1400	1515	1466	1597

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		133867	33356	39422	71994	65373	60871	72114	66347	65761	60218
Liquid biofuels for blending											
Import		293464	47887	4110	5056	7883	1377	3504	3391	3495	3112
Export		277769	8148	16608	56627	60139	57774	68493	65099	64036	60363
International marine bunkers		3894	5780	2857	4712	2801	1255	3409	3270	3416	3132
Changes in stocks		-8951	-11159	-4689	-1824	-3450	926	-693	995	147	927
Gross consumption		**136717**	**56156**	**19378**	**13887**	**6866**	**4145**	**3023**	**2364**	**1951**	**762**
Statistical difference			40	5592							438
Transformed in power, heat and other plants:		70406	39377	14650	5536	4648	1634	1109	651	474	231
- in public CHP plants	1.A.1.a ii	44195	20511	7233	3837	4157	493	77	59		
- in autoproducer CHP plants	1.A.1.a ii	642	201	27			1115	930	522	420	215
- in public heat plants	1.A.1.a iii	20190	16618	6813	1659	491	26	102	70	54	16
- 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	1865	1624	1462	946
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries	1.A.1.b	8068	3693	4899	6716	2005	2444	1865	1624	1462	943
- in electricity, gas, steam and air conditioning enterprises											3
Non energy use											
Distribution and transmission losses*		361			38						
Final consumption:		**57882**	**13126**	**5421**	**1597**	**213**	**67**	**49**	**89**	**15**	**23**
- in industry	1.A.2	43993	11520	5202	1486	148	67	49	89	15	23
- 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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	219
Production						4306	267	256	340	182	416
Liquid biofuels for blending											
Import				1407	1191	2779	516	701	1068	1565	1747
Export					23	40	10	33	160	68	274
International marine bunkers				29	451	2224	203	475	890	1386	1587
Changes in stocks				56	-60	-308	196	62	156	264	80
Gross consumption				**1434**	**657**	**4513**	**766**	**511**	**514**	**557**	**382**
Statistical difference											
Transformed in power, heat and other plants:				755	328	1232	436	178	161	357	120
- in public CHP plants	1.A.1.a ii					18	348	16	41	170	39
- in autoproducer CHP plants	1.A.1.a ii					1017					
- in public heat plants	1.A.1.a iii			713	318	197	87	162	120	187	81
- 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											
Final consumption:				**679**	**329**	**239**	**330**	**333**	**353**	**200**	**262**
- in industry	1.A.2			363	220	147	275	278	298	187	248
- in construction	1.A.2.g.v			47	93	75	35	30	33	6	7
- in transport											
- in agriculture	1.A.4.c.i			15	2	5	17	16	17	5	7
- in fishing	1.A.4.c.i				9						
- in commercial / public services	1.A.4.a			254	5	12	3	9	5	2	
- in households											

Table 3-11. Balance of refinery gas, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		11032	5318	8253	15250	14127	14007	15353	15518	14638	13549
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks											
Gross consumption		**11032**	**5318**	**8253**	**15250**	**14127**	**14007**	**15353**	**15518**	**14638**	**13549**
Statistical difference											
Transformed in power, heat and other plants:						109	175	358	250	326	182
- in public CHP plants											
- in autoproducer CHP plants	1.A.1.a ii						175	358	250	326	182
- 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	14995	15268	14312	13367
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries	1.A.1.b	11032	5318	8253	15250	14018	13832	14995	15268	14312	13367
- 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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		9534	1108	3117	6804	4938	5449	6588	8417	9776	14893
Liquid biofuels for blending											
Import		40	791	474	1150	1814	1812	1371	1793	2174	2722
Export		1662	356	839	2587	2896	3506	3824	5049	4655	12264
International marine bunkers											
Changes in stocks		40	39	71	28	-165	-143	71	16	-274	196
Gross consumption		**7952**	**1582**	**2823**	**5395**	**3691**	**3612**	**4206**	**5177**	**7021**	**5547**
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	4206	5177	7021	5547
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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production				1226	847	1504	1931	2350	2757	3006	3597
Liquid biofuels for blending											
Import		413	620	602	1121	1709	1655	1411	1386	1393	1459
Export				924	843	2350	2781	2970	3203	3355	3889
International marine bunkers											
Changes in stocks				129	-14	-17	3	-46	-44	-3	-104
Gross consumption		**413**	**620**	**1033**	**1111**	**846**	**808**	**745**	**896**	**1041**	**1063**
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	745	896	1041	1063
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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		1962	1393	2740	3940	3856	3745	4146	3890	3964	3972
Liquid biofuels for blending											
Import					1100	9					
Export											
International marine bunkers											
Changes in stocks					-1054	102					
Gross consumption		**1962**	**1393**	**2740**	**3986**	**3967**	**3745**	**4146**	**3890**	**3964**	**3972**
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	4146	3890	3964	3972
- in peat extraction enterprises											
- in crude oil extraction enterprises											
- in refineries	1.A.1.b	1962	1393	2740	3940	3856	3745	4146	3890	3964	3972
- 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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production			8513	418	1827		640	77		505	246
Liquid biofuels for blending											
Import		1304	17209	13934	3568	12171	24815	24167	12907	9043	8725
Export							33	15	31	14	4
International marine bunkers											
Changes in stocks		-1220	-8470	213	-1121	614	-1420	322	230	-507	-90
Gross consumption		**84**	**17252**	**14565**	**4274**	**12785**	**24002**	**24551**	**13106**	**9027**	**8877**
Statistical difference			-43								
Transformed in power, heat and other plants:		84	17209	14565	4274	12785	24002	24551	13106	9027	8877
- 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	24551	13106	9027	8877
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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production					3477						
Liquid biofuels for blending											
Import											
Export					3257						
International marine bunkers											
Changes in stocks					-220						
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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production											
Liquid biofuels for blending											
Import		31752	6506	176	53	4343	5701	5624	6833	6585	7161
Export			50			438					
International marine bunkers											
Changes in stocks		980	2889			-275	640	536	-567	79	-595
Gross consumption		**32732**	**9345**	**176**	**53**	**3630**	**6341**	**6160**	**6266**	**6664**	**6566**
Statistical difference											
Transformed in power, heat and other plants:		1834	452	25	53	55	88	83	69	69	78
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii	904	126	25	53	32	88	83	69	69	78
- 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			0	10	2			
Final consumption:		**30898**	**8843**	**151**		**3575**	**6243**	**6075**	**6197**	**6595**	**6488**
- in industry	1.A.2	1583	703	137		2860	3602	3141	2975	3373	3889
- in construction	1.A.2.g.v	226	25	14		0	6	11	12	12	8
- in transport											
- in agriculture	1.A.4.c.i	1557	50			3	86	94	90	92	74
- in fishing											
- in commercial / public services	1.A.4.a	12359	6632			406	1089	1323	1377	1535	1190
- in households	1.A.4.b	15173	1433			305	1460	1506	1743	1583	1327

Table 3-20. Balance of anthracite, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production											
Liquid biofuels for blending											
Import				100		90		24			
Export						1					
International marine bunkers											
Changes in stocks						-74			5		
Gross consumption				**100**		**15**		**24**	**5**		
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**		**24**	**5**		
- in industry	1.A.2					5		24	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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production											
Liquid biofuels for blending											
Import				2698	6618	3248			60	35	
Export					37	406					
International marine bunkers											
Changes in stocks				11	-168	672	1	13	10	-9	29
Gross consumption				**2709**	**6413**	**3514**	**1**	**13**	**70**	**26**	**29**
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**		**13**	**70**	**26**	**29**
- in industry	1.A.2			5	3059	207			57	22	27
- 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	7	4	2
- in households	1.A.4.b			651	1048	1772		9	6		

Table 3-22. Balance of coke, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production											
Liquid biofuels for blending											
Import				445	440	466	391	456	474	546	505
Export											
International marine bunkers											
Changes in stocks				-52	96	7	8	14	21	2	-10
Gross consumption				**393**	**536**	**473**	**399**	**470**	**495**	**548**	**495**
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**	**470**	**495**	**548**	**495**
- in industry	1.A.2			346	534	473	399	470	495	548	495
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-23. Balance of lignite, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production											
Liquid biofuels for blending											
Import				15	40	14					
Export											
International marine bunkers											
Changes in stocks				1	2	-6	1	1			
Gross consumption				**16**	**42**	**8**	**1**	**1**			
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:				**16**	**42**	**8**	**1**	**1**			
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a			16	25			1			
- in households	1.A.4.b				17	8	1				

Table 3-24. Balance of peat, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		580	600	494	825	364	872	200	284	332	353
Liquid biofuels for blending											
Import											
Export				76	1	104	94	13	15	36	20
International marine bunkers											
Changes in stocks		116	222	51	-235	94	-510	153	341	307	30
Gross consumption		**696**	**822**	**469**	**589**	**354**	**268**	**340**	**610**	**603**	**363**
Statistical difference											
Transformed in power, heat and other plants:		445	357	258	299	202	141	191	418	423	246
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii	67	96	80	128	102	67	101	343	364	203
- in autoproducer heat plants	1.A.1.a iii	39	10	14							
- in geothermal plants											
- in other industries		339	251	163	171	100	74	90	75	59	43
Consumed in energy sector:			126	36	11		3	1	1		
- in peat extraction enterprises	1.A.c.i			20	11		3	1	1		
- 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				36		
Final consumption:		**242**	**329**	**170**	**272**	**152**	**124**	**148**	**155**	**180**	**117**
- in industry	1.A.2	155	174	43	7	9	33	34	36	41	23
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a	87	58		21	44	51	66	68	78	44
- in households	1.A.4.b		97	127	244	99	40	48	51	61	50

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		239	186	138	147	84	63	77	64	50	37
Liquid biofuels for blending											
Import			119	2	143	696	604	797	786	976	769
Export							26	70	52	9	7
International marine bunkers											
Changes in stocks		-53	-13	-1	-35	-44	9	-26	62	-18	13
Gross consumption		**186**	**292**	**139**	**255**	**736**	**650**	**778**	**860**	**999**	**812**
Statistical difference											
Transformed in power, heat and other plants:					9	3				3	8
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii				2	1				3	8
- in autoproducer heat plants	1.A.1.a iii				7	2					
- in geothermal plants											
- in other industries											
Consumed in energy sector:				2							3
- in peat extraction enterprises	1.A.c.i			2							3
- in crude oil extraction enterprises											
- in refineries											
- in electricity, gas, steam and air conditioning enterprises											
Non energy use											
Distribution and transmission losses**								7			
Final consumption:		**186**	**293**	**137**	**246**	**733**	**650**	**771**	**860**	**996**	**801**
- in industry	1.A.2	13	53		8	27	16	18	23	28	20
- in construction											
- in transport											
- in agriculture	1.A.4.c.i				3	16	13	15	20	27	19
- in fishing											
- in commercial / public services	1.A.4.a	27	53	1	28	193	173	190	216	261	210
- in households	1.A.4.b	146	186	136	207	497	448	548	601	680	552

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production											
Liquid biofuels for blending											
Import					176	520	1776	1166	1356	1173	781
Export					106	384	1427	1017	1171	1103	660
International marine bunkers											
Changes in stocks						3	-202	34	68	71	-24
Gross consumption					**70**	**139**	**147**	**183**	**253**	**141**	**97**
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	183	253	141	97
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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production											
Liquid biofuels for blending											
Import		201957	84929	86453	104363	104017	89642	79106	87082	79844	96189
Export		6102					3335	1536	7182	6301	18158
International marine bunkers											
Changes in stocks				-37	-671	304	255	-466	547	803	27
Gross consumption		**195855**	**84929**	**86416**	**103692**	**104321**	**86562**	**77104**	**80447**	**74346**	**78058**
Statistical difference											
Transformed in power, heat and other plants:		105124	41480	47241	57134	58186	24104	17721	14138	12662	10657
- in public CHP plants	1.A.1.a ii	62825	17664	29650	42536	45755	17354	11413	8230	7084	5236
- in autoproducer CHP plants	1.A.1.a ii	1787	473	324	1160	1003	1970	1675	1831	1056	2269
- in public heat plants	1.A.1.a iii	34248	21952	16272	11414	10525	4357	4050	3708	4203	2744
- in autoproducer heat plants	1.A.1.a iii	6265	1391	688	667	558	327	483	336	319	408
- in geothermal plants	1.A.1.a iii				819	345	96	100	33		
- in other industries	1.AD			307	538						
Consumed in energy sector:				140	130	65	1298	1103	773	778	2812
- in peat extraction enterprises											
- in crude oil extraction enterprises	1.A.1.c.ii			3	3	3	2	2	2	1	1
- in refineries	1.A.1.b			28	28	4	15	58	63	46	2146
- in electricity, gas, steam and air conditioning enterprises	1.A.1.c.ii			109	99	58	1281	1043	708	731	665
Non energy use	1.AD	26934	20167	22716	21335	20139	39432	35200	41679	35913	40136
Distribution and transmission losses***		1688	1935	1119	420	5					
Final consumption:		**62109**	**21347**	**15200**	**24673**	**25926**	**21728**	**23080**	**23857**	**24993**	**24453**
- in industry	1.A.2	36065	8916	8285	14573	13670	11417	11528	11601	12412	12104
- in construction	1.A.2.g.v	1030	219	266	513	501	477	519	612	616	604
- in transport	1.A.3				647	1028	1250	1303	1412	1132	1106
- in agriculture	1.A.4.c.i	2946	1197	991	1192	1309	872	899	911	876	866
- in fishing											
- in commercial / public services	1.A.4.a	12831	3319	1302	2118	2793	2575	2741	2883	3060	3039
- in households	1.A.4.b	9237	7696	4356	5630	6625	5137	6090	6438	6897	6734

Table 3-28. Balance of charcoal, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production					18	24	26	15	11	15	15
Liquid biofuels for blending											
Import					14	61	210	215	201	171	199
Export					15	38	163	180	126	110	77
International marine bunkers											
Changes in stocks					3	1	-7	-10	-13	5	-30
Gross consumption					**20**	**48**	**66**	**40**	**73**	**81**	**107**
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**	**40**	**73**	**81**	**107**
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a				20	48	66	40	73	81	107
- in households											

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production		11930	19632	27324	35293	41734	49852	49647	53960	52657	50969
Liquid biofuels for blending											
Import			61	4	727	2008	5628	6203	4554	5637	5711
Export				255	710	5102	5725	5669	6835	5482	5787
International marine bunkers											
Changes in stocks		-14	-381	-54	-498	444	457	85	815	224	1140
Gross consumption		**11916**	**19312**	**27019**	**34812**	**39084**	**50212**	**50266**	**52494**	**53036**	**52033**
Statistical difference					457				574	736	
Transformed in power, heat and other plants:		527	558	1640	6273	10408	24371	24324	27576	26689	26522
- in public CHP plants	1.A.1.a ii				191	2472	6365	5771	7009	7327	7268
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii	274	156	1060	4906	7121	16987	17563	19341	17932	17415
- in autoproducer heat plants	1.A.1.a iii	253	402	580	1128	772	980	990	1205	1404	1839
- in geothermal plants											
- in other industries					48	43	39	41	21	26	33
Consumed in energy sector:				25	13	19	2	3			
- 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	3			
Non energy use											
Distribution and transmission losses				12	4						
Final consumption:		**11389**	**18754**	**25342**	**28979**	**28657**	**25839**	**25898**	**25492**	**26347**	**25478**
- in industry	1.A.2	453	756	1218	4007	2920	3520	3776	3981	4373	4349
- in construction	1.A.2.g.v	51	105	100	185	143	62	73	72	76	70
- in transport											
- in agriculture	1.A.4.c.i	187	211	272	253	399	383	434	568	588	566
- in fishing											
- in commercial / public services	1.A.4.a	1699	1104	1703	1278	1178	1332	1359	1191	1230	1178
- in households	1.A.4.b	8999	16578	22049	23256	24017	20542	20256	19680	20 080	19315

Table 3-30. Balance of agricultural waste, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production					96	228	585	591	535	603	672
Liquid biofuels for blending											
Import							10	2	28	4	1
Export							386	401	371	382	432
International marine bunkers											
Changes in stocks					16	11	-31	14	9	-25	-12
Gross consumption					**112**	**239**	**178**	**206**	**201**	**200**	**229**
Statistical difference											
Transformed in power, heat and other plants:					64	144	68	85	90	107	94
- in public CHP plants											
- in autoproducer CHP plants											
- in public heat plants	1.A.1.a iii				55	131	68	85	90	107	94
- 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**	**121**	**111**	**93**	**135**
- in industry	1.A.2				41	11	16	28	30	24	43
- in construction											
- in transport											
- in agriculture	1.A.4.c.i				2	56	73	57	49	45	65
- in fishing											
- in commercial / public services	1.A.4.a					18	20	32	26	21	25
- in households	1.A.4.b				5	7	1	4	6	3	2

Table 3-31. Balance of bioethanol, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production					195	1060	470	381	362	463	460
Liquid biofuels for blending											
Import						106	269	111	155	216	282
Export					162	649	308	184	189	342	333
International marine bunkers											
Changes in stocks					-7	-3	11	-39	16	-3	
Gross consumption					**26**	**514**	**442**	**269**	**344**	**334**	**409**
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**	**269**	**344**	**334**	**409**
- in industry											
- in construction											
- in transport	1.A.3				26	436	405	269	344	334	409
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-32. Balance of biodiesel, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production					260	3299	4353	3816	4372	5706	6179
Liquid biofuels for blending											
Import						527	2035	1323	2171	2214	1826
Export					168	2538	3865	3027	3953	5151	4998
International marine bunkers											
Changes in stocks					27	166	-101	-15	68	153	-266
Gross consumption					**119**	**1454**	**2422**	**2097**	**2658**	**2922**	**2741**
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**	**2097**	**2658**	**2922**	**2741**
- in industry											
- in construction											
- in transport	1.A.3				119	1454	2422	2097	2658	2922	2741
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

Table 3-33. Balance of sludge biogas, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production					57	125	294	316	303	289	286
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks											
Gross consumption					**57**	**125**	**294**	**316**	**303**	**289**	**286**
Statistical difference											
Transformed in power, heat and other plants:					36	55	106	109	118	112	112
- in public CHP plants	1.A.1.a ii				17	8	21	4			
- in autoproducer CHP plants	1.A.1.a ii				3	47	85	105	118	112	112
- 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**	**207**	**185**	**177**	**174**
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a				21	70	188	207	185	177	174
- in households											

Table 3-34. Balance of landfill biogas, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production						83	343	356	213	418	366
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks											
Gross consumption						**83**	**343**	**356**	**213**	**418**	**366**
Statistical difference											
Transformed in power, heat and other plants:						83	338	342	197	391	344
- in public CHP plants	1.A.1.a ii					35	266	264	115	305	258
- in autoproducer CHP plants	1.A.1.a ii					48	72	78	82	86	86
- 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**	**14**	**16**	**27**	**22**
- in industry	1.A.2						2	1	1	1	
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services	1.A.4.a						3	13	15	26	22
- in households											

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production					20	210	344	669	834	847	980
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks											
Gross consumption					**20**	**210**	**344**	**669**	**834**	**847**	**980**
Statistical difference											
Transformed in power, heat and other plants:					7	91	225	545	689	706	808
- in public CHP plants	1.A.1.a ii							50	211	494	590
- in autoproducer CHP plants	1.A.1.a ii				7	91	225	495	478	212	218
- 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:					**13**	**119**	**119**	**124**	**145**	**141**	**172**
- in industry	1.A.2					104	119	124	145	141	172
- 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	2016	2017	2018	2019
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, TJ

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production							303	626	183	699	775
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks							-13		-1	-13	8
Gross consumption							**290**	**626**	**182**	**686**	**783**
Statistical difference											
Transformed in power, heat and other plants:							290	626	181	584	665
- in public CHP plants	1.A.1.a ii						290	626	181	584	578
- in autoproducer CHP plants											87
- 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****									1	3	3
Final consumption:										**99**	**115**
- in industry	1.A.2.f									99	115
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production								140	186	572	562
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks									-2	-9	8
Gross consumption								**140**	**184**	**563**	**570**
Statistical difference											
Transformed in power, heat and other plants:								140	183	560	567
- in public CHP plants	1.A.1.a ii							140	183	560	567
- 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****									1	3	3
Final consumption:											
- in industry											
- 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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production							661	1583	1246	865	751
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks							-8	-6	-19	1	4
Gross consumption							**653**	**1577**	**1227**	**866**	**755**
Statistical difference											
Transformed in power, heat and other plants:							653	1577	1220	861	751
- in public CHP plants	1.A.1.a ii						653	1577	1220	861	751
- 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****									7	5	4
Final consumption:											
- in industry											
- in construction											
- in transport											
- in agriculture											
- in fishing											
- in commercial / public services											
- in households											

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

	CRF category	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Production							676	912	1230	827	747
Liquid biofuels for blending											
Import											
Export											
International marine bunkers											
Changes in stocks							-17	-9	-2	-5	8
Gross consumption							**659**	**903**	**1228**	**822**	**755**
Statistical difference											
Transformed in power, heat and other plants:							659	903	1223	817	752
- in public CHP plants	1.A.1.a ii						659	903	1223	817	752
- 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****									5	5	3
Final consumption:											
- in industry											
- 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 Tier1, 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 lose humidity, evaporate, rot and decompose during that time. These losses are not accounted in fugitive emissions.

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**	**2016**	**2017**	**2018**	**2019**
Heating and other gasoil	0	0	0	0	0	0	0	0	1	0
Residual fuel oil (RFO)	883	281	20	0	47	0	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	0	7	17	31	23	41	39	54
Other bituminous coal	0	0	0	0	0	0	0	1	0	0
Sub-bituminous coal	0	0	0	0	0	0	0	0	0	0
Natural gas	6001	1563	191	4972	5476	5489	4781	4876	5136	5577
Wood and wood waste	0	0	3	0	0	66	113	607	459	451
Biogas	0	0	0	0	94	84	92	96	99	126
Total	**6884**	**1844**	**214**	**4980**	**5634**	**5670**	**5009**	**5621**	**5734**	**6208**

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

Fuel type	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**
Heating and other gasoil	0	0	4	0	0	0	2	5	6	6
Residual fuel oil (RFO)	883	401	64	0	0	0	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	42	4	3	6	5	4	47	58
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	510	587	707	618
Wood and wood waste	3	5	1	0	128	161	195	258	779	794
Peat	0	0	0	0	0	0	0	0	2	1
Total	**4274**	**1231**	**1291**	**453**	**1303**	**551**	**712**	**854**	**1541**	**1477**

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

Fuel type	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Heating and other gasoil	0	0	3	148	94	99	53	71	84	95
Residual fuel oil (RFO)	2248	1606	1567	334	212	271	273	289	180	239
Liquefied petroleum gases (LPG)	0	0	121	158	192	209	219	217	168	156
Shale oil	0	0	0	13	0	0	0	0	0	0
Coke	0	0	105	64	54	45	60	38	60	52
Other bituminous coal	352	151	68	0	3	36	33	61	24	15
Anthracite	0	0	0	0	0	0	0	5	0	0
Sub-bituminous coal	0	0	0	50	38	0	0	0	0	0
Natural gas	8498	2077	2890	3695	4005	3379	3515	3477	3815	3412
Wood and wood waste	36	57	77	297	93	668	640	624	491	406
Other solid biomass	0	0	0	0	0	16	24	25	16	16
Biogas	0	0	0	0	10	35	32	49	42	46
Peat	0	0	0	6	15	7	8	8	10	6
Total	**11134**	**3890**	**4831**	**4765**	**4716**	**4765**	**4857**	**4864**	**4890**	**4443**

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

Fuel type	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Heating and other gasoil	0	0	0	148	65	75	43	70	83	100
Residual fuel oil (RFO)	35444	7787	3522	1180	1	57	45	86	13	23
Liquefied petroleum gases (LPG)	0	0	5	5	2	3	3	3	3	11
Petroleum coke	0	0	0	46	111	0	0	0	0	0
Coke	0	0	190	402	387	336	394	439	471	429
Other bituminous coal	628	327	8	0	2847	3545	3088	2890	3332	3861
Anthracite	0	0	0	0	0	0	24	0	0	0
Sub-bituminous coal	0	0	0	2924	153	0	0	57	22	23
Natural gas	6934	1833	1775	1615	909	945	1055	986	1001	947
Wood and wood waste	19	63	152	566	345	266	302	166	471	449
Other solid biomass	0	0	0	0	0	0	0	0	0	0
Peat	168	227	43	7	11	33	34	36	38	23
Waste (used tires)					209	0	0	45	99	115
Total	**43193**	**10237**	**5695**	**6894**	**5040**	**5260**	**4988**	**4778**	**5533**	**5981**

Table 4-5. Energy consumption by fuel type in Transport Equipment industries, TJ

Fuel type	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Heating and other gasoil	0	0	0	1	1	1	2	3	5	5
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	3	2
Other bituminous coal	0	0	0	0	1	4	2	1	1	0
Sub-bituminous coal	0	0	0	4	1	0	0	0	0	1
Natural gas	189	102	171	238	105	47	54	61	73	60
Wood and wood waste	0	0	0	1	1	0	0	1	3	5
Other solid biomass	0	0	0	0	0	0	0	0	1	0
Total	**189**	**102**	**180**	**252**	**110**	**54**	**58**	**66**	**86**	**73**

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

Fuel type	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Heating and other gasoil	0	0	0	4	8	2	2	2	4	5
Residual fuel oil (RFO)	1565	482	48	0	0	3	4	8	0	0
Liquefied petroleum gases (LPG)	0	0	5	15	9	7	9	10	13	22
Coke	0	0	23	17	3	0	0	0	0	0
Other bituminous coal	50	0	8	0	0	5	4	8	4	3
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	327	362	417	406
Wood and wood waste	14	68	108	373	36	14	18	4	25	17
Other solid biomass	0	0	0	0	9	0	0	5	7	27
Peat	0	0	0	1	3	1	2	3	3	3
Total	**4553**	**1586**	**1116**	**1522**	**335**	**270**	**366**	**402**	**473**	**483**

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

Fuel type	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Heating and other gasoil	0	0	0	5	0	1	1	1	2	1
Residual fuel oil (RFO)	80	40	56	0	0	0	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	0	0	0	0	0	0	2	2
Other bituminous coal	0	0	3	0	0	1	1	1	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	9	9	11	10
Wood and wood waste	0	0	2	5	4	18	25	16	14	6
Peat	0	0	0	0	1	0	0	0	1	0
Total	**350**	**304**	**80**	**53**	**22**	**31**	**36**	**27**	**30**	**19**

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

Fuel type	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Heating and other gasoil	0	0	0	3	0	0	1	1	1	1
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	7	9	17
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	3
Natural gas	1167	451	288	1046	944	131	445	472	394	279
Wood and wood waste	240	284	466	2081	1905	1670	1995	1775	1673	1704
Other solid biomass	0	0	0	0	0	0	4	0	0	0
Peat	0	0	0	1	1	1	2	3	4	3
Total	**2611**	**1056**	**906**	**3294**	**2900**	**1809**	**2455**	**2258**	**2081**	**2007**

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

Fuel type	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Heating and other gasoil	0	0	7	25	47	67	39	44	54	57
Residual fuel oil (RFO)	1044	201	58	110	75	35	30	33	6	7
Liquefied petroleum gases (LPG)	92	46	74	77	122	38	55	58	50	49
Other bituminous coal	226	25	14	0	0	6	11	12	12	8
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	519	612	616	604
Wood and wood waste	51	105	100	185	143	62	73	72	76	70
Peat	0	0	0	0	0	0	0	0	0	0
Total	**2443**	**596**	**519**	**928**	**892**	**685**	**727**	**831**	**814**	**795**

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

Fuel type	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Heating and other gasoil	0	0	0	76	41	26	17	18	24	26
Residual fuel oil (RFO)	1365	442	140	40	4	11	5	4	9	9
Liquefied petroleum gases (LPG)	0	0	5	2	12	14	13	18	18	19
Other bituminous coal	528	100	35	0	7	10	10	8	9	7
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	647	555	638	564
Wood and wood waste	20	50	109	37	18	35	28	29	29	25
Other solid biomass	0	0	0	41	2	0	0	0	0	0
Peat	0	0	0	1	1	0	0	1	0	0
Total	**4379**	**1238**	**1099**	**1474**	**686**	**664**	**720**	**633**	**727**	**650**

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

Fuel type	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Heating and other gasoil	0	0	0	20	11	24	17	22	22	25
Residual fuel oil (RFO)	321	161	0	3	0	0	0	0	0	0
Liquefied petroleum gases (LPG)	0	0	9	26	18	47	49	55	53	55
Coke	0	0	28	52	29	18	16	18	17	14
Other bituminous coal	25	50	0	0	2	1	3	5	3	3
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	185	216	220	231
Wood and wood waste	121	229	300	646	390	622	460	501	429	492
Other solid biomass	0	0	0	0	0	0	0	0	0	0
Biogas	0	0	0	0	0	2	1	1	1	0
Peat	0	0	0	1	4	7	6	8	11	7
Industrial waste	0	0	0	0	0	9	48	57	67	63
Total	**4695**	**635**	**396**	**943**	**648**	**955**	**785**	**883**	**823**	**890**

ANNEX V. Energy sector country specific CO_2 emission factors

Country specific CO_2 emission factors have been derived in study "Determination of national GHG emission factors for energy sector" (performed in 2012 by Lithuanian Energy Institute) and study "Update of country specific GHG emission factors for energy sector" (performed in 2016 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 study "Update of country specific GHG emission factors for energy sector" is presented in Annex IX.

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 practise 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

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
Liquid fuel						
Heating and other gasoil	72.89	72.73	72.73	72.80	72.80	72.80
Residual fuel oil (RFO)	77.60	78.40	78.40	78.40	78.40	78.40
Liquefied petroleum gases (LPG)	65.42	66.34	66.34	66.81	66.81	66.81
Shale oil	77.40	76.60	76.60	76.60	76.60	76.60
Crude oil	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
Diesel oil	72.89	72.73	72.73	72.80	72.80	72.80
Motor gasoline	72.97	72.77	72.77	70.13	70.13	70.13
Aviation gasoline and gasoline type jet fuel	71.62	70.81	70.81	70.81	70.81	70.81
Jet kerosene	72.24	71.74	71.74	71.67	71.67	71.67
Solid fuel						
Coke	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
Anthracite	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
Lignite	101.2	101.0	101.0	101.0	101.0	101.0
Peat	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
Other solid biomass	103.69	103.69	103.69	103.69	103.69	103.69
Biogas	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
Waste						
Municipal waste (non-biomass fraction)	111.65	111.65	111.65	111.65	111.65	111.65
Municipal and industrial waste (biomass fraction)	109.03	109.03	109.03	109.03	109.03	109.03
Industrial waste – used tires (rubber)	85.00					

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	2016	2017	2018	2019
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	55.73	55.57	55.54	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 not influence on CO_2 emission factors. CO_2 emission factors depend on 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 to 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 to the group of equipment and fuel type. However, the measurements have to 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 to 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 to the significantly lower uncertainties of the updated CO_2 emission factors.

Value of CO_2 emission factor for biogas and industrial waste is updated in accordance to 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.

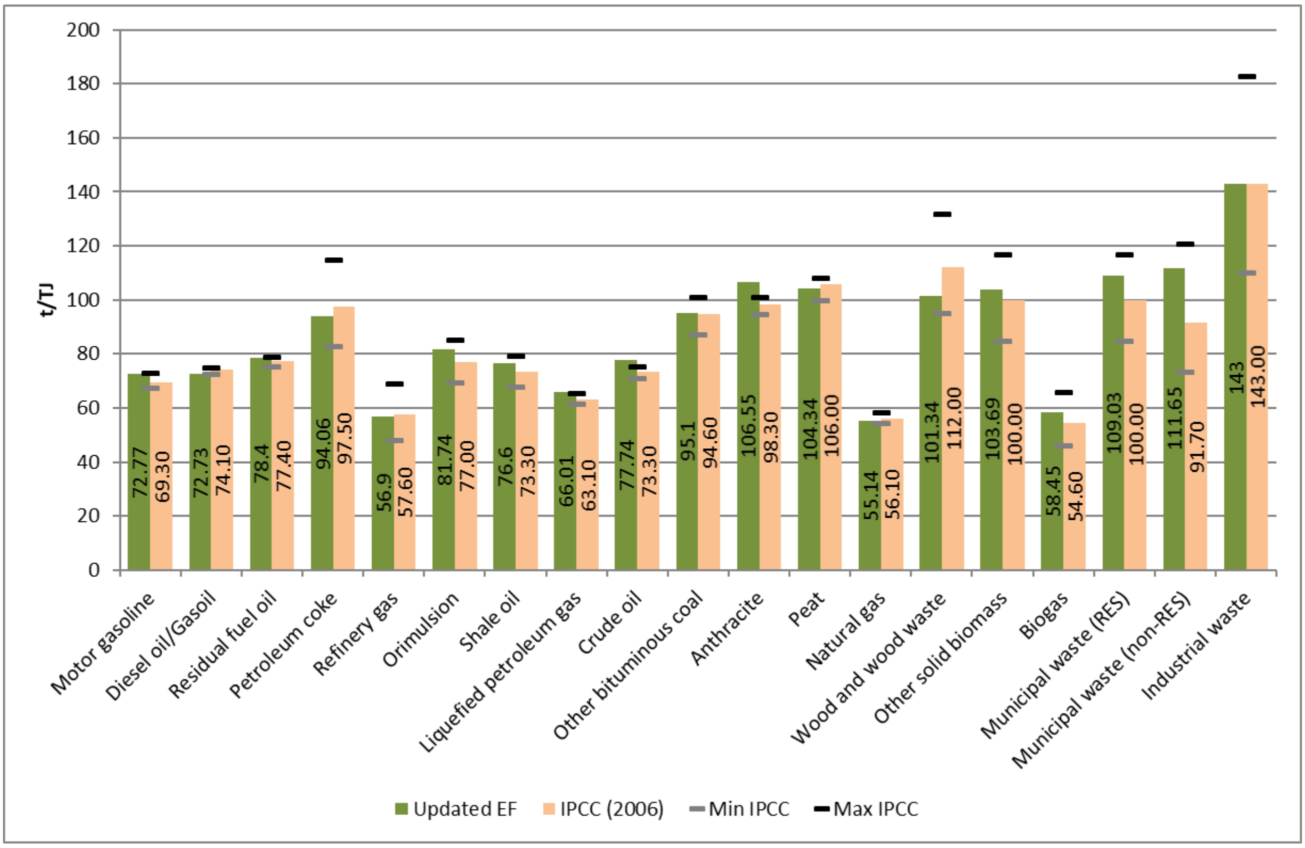


Figure 6-1. Comparison of updated country specific CO_2 emission factors and default *2006 IPCC Guidelines* emission factors: energy industries

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.

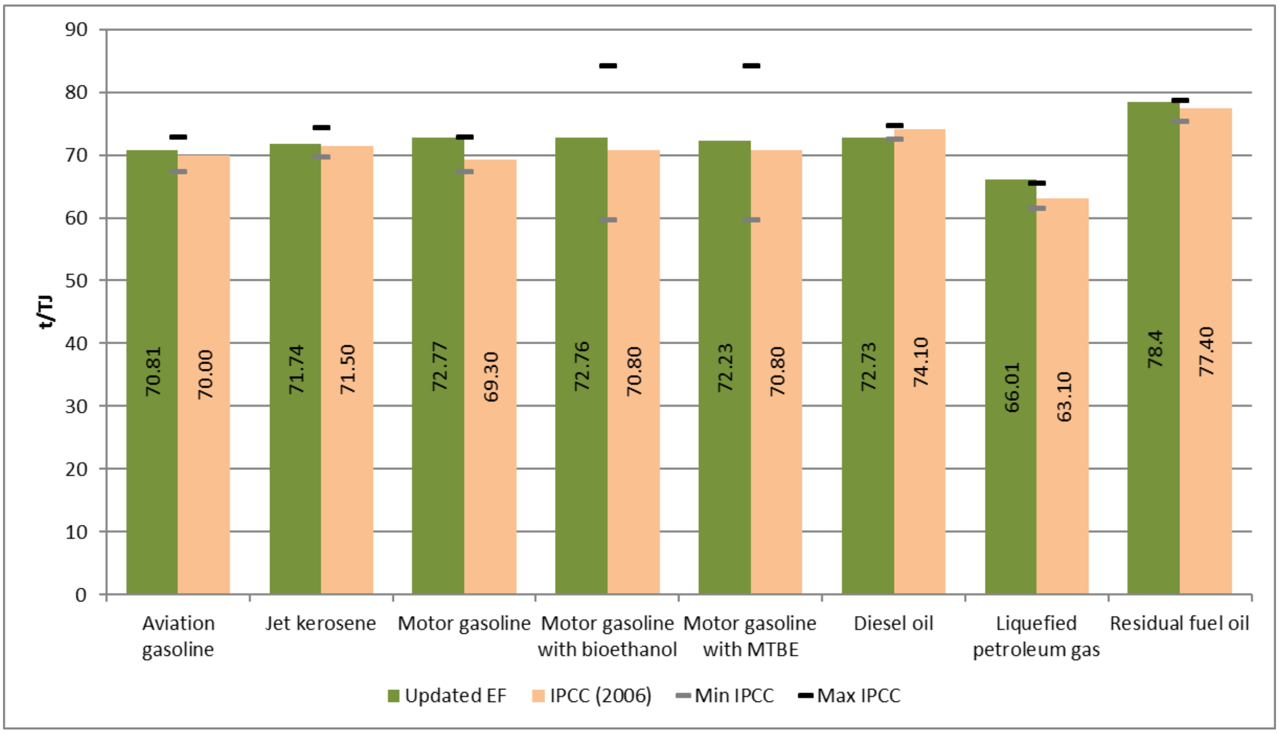


Figure 6-2. Comparison of updated country specific CO_2 emission factors with default *2006 IPCC Guidelines* emission factors: transport sector

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*. Uncertainty of CO_2 emission factor for biomass is the highest and reaches ±15%.

ANNEX VII. CO_2 emissions from the installations of the GHG registry, 2019

Table 7-1. CO_2 emissions from the installations registered in the GHG Emission Allowance Registry, 2019

No	*Company*	*Name of the Installation*	*Allocated EUA*	*Verified Emissions, t CO_2*	*Corresponding CRF Sector (Fuel combustion)*
1	AB "Akmenės cementas"	Boiler house, cement production furnace	567,464	965,272	1.A.2.F Non-Metallic Minerals
2	AB "Naujasis kalcitas"	Whitewash production furnace	410,738	0	1.A.2.F Non-Metallic Minerals
3	UAB "Švenčionėlių keramika"	Furnace for ceramics	4,879	0	1.A.2.F Non-Metallic Minerals
4	UAB "Rokų keramika"	Ceramics combustion furnace	7,414	0	1.A.2.F Non-Metallic Minerals
5	AB "Palemono keramikos gamykla"	Boiler house, ceramics combustion furnace	7,189	3,169	1.A.2.F Non-Metallic Minerals
6	UAB "Kauno stiklas"	Glass melting furnace	5,166	14,709	1.A.2.F Non-Metallic Minerals
7	AB "Panevėžio stiklas"	Glass melting furnace	9,679	17,320	1.A.2.F Non-Metallic Minerals
8	AB "ORLEN Lietuva"	Oil refining factory	1,253,382	1,599,384	1.A.1.B Petroleum Refining / 1.A.1.A Public electricity and heat production
9	AB "Grigeo Klaipėda"	Boiler house	21,956	13,485	1.A.2.D Pulp, Paper and Print
10	AB "Grigeo"	Boiler house	29,327	6,859	1.A.2.D Pulp, Paper and Print
11	AB "Simega"	Boiler house	1,467	0	1.A.1.A Public electricity and heat production
12	AB "Achema"	Boiler houses, CHP	1,817,507	2,486,023	1.A.2.C Chemicals / 1.A.1.A Public electricity and heat production
13	AB "Nordic Sugar Kėdainiai"	Boiler house, oilcake desiccation	26,282	26,905	1.A.2.E Food processing, Beverages and Tobacco
14	AB "Lifosa"	Boiler house	148,474	1,124	1.A.2.C Chemicals
15	AB "Klaipėdos nafta"	Boiler house	7,007	16,406	1.A.1.A Public electricity and heat production
16	UAB "Lietuvos cukrus"	Boiler house	11,654	14,046	1.A.2.E Food processing, Beverages and Tobacco
17	UAB "Idavang"	Boiler house	172	0	1.A.4.C Agriculture/ Forestry/ Fisheries
18	AB "Klaipėdos mediena"	Boiler house	13,400	121	1.A.2.G.iv Wood and Wood Products
19	UAB "Matuizų plytinė"	Boiler house	4,469	0	1.A.2.F Non-Metallic Minerals
20	AB "Jonavos šilumos tinklai"	Jonava boiler house	2,090	1,358	1.A.1.A Public electricity and heat production
21	AB "Jonavos šilumos tinklai"	Girele boiler house	1,965	447	1.A.1.A Public electricity and heat production
22	UAB "Mažeikių šilumos tinklai"	Mazeikiai boiler house	8,890	8	1.A.1.A Public electricity and heat production
23	UAB "Raseinių šilumos tinklai"	Raseiniai boiler house No 4	2,188	1,528	1.A.1.A Public electricity and heat production

No	Company	Name of the Installation	Allocated EUA	Verified Emissions, t CO_2	Corresponding CRF Sector (Fuel combustion)
24	UAB "Molėtų šiluma"	Moletai boiler house	1,551	0	1.A.1.A Public electricity and heat production
25	UAB "Šilutės šilumos tinklai"	Šilute boiler house	4,265	19	1.A.1.A Public electricity and heat production
26	UAB "Vilniaus šilumos tinklai"	Vilnius power plant No 2 (E-2)	105,023	265,149	1.A.1.A Public electricity and heat production
27	AB "Ignitis gamyba"	Vilnius power plant No 3 (E-3)	63,637	0	1.A.1.A Public electricity and heat production
28	UAB "Vilniaus šilumos tinklai"	Vilnius boiler house No 2	4,924	1,839	1.A.1.A Public electricity and heat production
29	UAB "Vilniaus šilumos tinklai"	Vilnius boiler house No 8	374	783	1.A.1.A Public electricity and heat production
30	UAB "Širvintų šiluma"	Širvintu boiler house No 3	1,683	0	1.A.1.A Public electricity and heat production
31	AB "Šiaulių energija"	Šiauliai southern boiler house	28,195	12,499	1.A.1.A Public electricity and heat production
32	AB "Klaipėdos energija"	Power plant	5,434	6,153	1.A.1.A Public electricity and heat production
33	UAB "Radviliškio šiluma"	Radviliškis city boiler house	3,487	346	1.A.1.A Public electricity and heat production
34	UAB "Utenos šilumos tinklai"	Utena boiler house	13,720	676	1.A.1.A Public electricity and heat production
35	UAB "Tauragės šilumos tinklai"	Taurage - Berže boiler house	3,393	95	1.A.1.A Public electricity and heat production
36	UAB "Šalčininkų šilumos tiklai"	Šalcininkai boiler house	1,446	28	1.A.1.A Public electricity and heat production
37	Pravieniškių pataisos namai-atviroji kolonija	Boiler house	1,083	3,774	1.A.1.A Public electricity and heat production
38	UAB "Varėnos šiluma"	Varena boiler house	2,870	0	1.A.1.A Public electricity and heat production
39	AB "Panevėžio energija"	Panevezio boiler house No 2	12,011	16,114	1.A.1.A Public electricity and heat production
40	AB "Panevėžio energija"	Rokiškio boiler house	8,129	0	1.A.1.A Public electricity and heat production
41	AB "Panevėžio energija"	Panevezio boiler house No 1	13,496	163	1.A.1.A Public electricity and heat production
42	AB "Panevėžio energija"	Pasvalio boiler house	2,014	6	1.A.1.A Public electricity and heat production
43	AB "Panevėžio energija"	Zarasai boiler house No 4	1,850	0	1.A.1.A Public electricity and heat production
44	UAB "GEOTERMA"	Klaipeda geothermal PP	7,971	0	1.A.1.A Public electricity and heat production
45	AB "Kauno energija"	Petrašiunai PP	2,008	5,947	1.A.1.A Public electricity and heat production
46	AB "Kauno energija"	Pergale boiler house	434	2,038	1.A.1.A Public electricity and heat production
47	AB "Kauno energija"	Šilkas boiler house	846	3,227	1.A.1.A Public electricity and heat production
48	AB "Kauno energija"	Garliava boiler house	0	112	1.A.1.A Public electricity and heat production
49	AB "Kauno energija"	Jurbarkas boiler house	2,615	1,320	1.A.1.A Public electricity and heat production
50	UAB "Plungės šilumos tinklai"	Plunge boiler house No 1	3,352	355	1.A.1.A Public electricity and heat production

No	Company	Name of the Installation	Allocated EUA	Verified Emissions, t CO_2	Corresponding CRF Sector (Fuel combustion)
51	UAB "Birštono šiluma"	Birštonas region boiler house	1,256	743	1.A.1.A Public electricity and heat production
52	UAB "Litesko"	Druskininkai industry boiler house	7,542	2,351	1.A.1.A Public electricity and heat production
53	UAB "Litesko"	Boiler house of Biržai city hall	753	120	1.A.1.A Public electricity and heat production
54	UAB "Litesko"	Vilkaviškis boiler house	1,979	185	1.A.1.A Public electricity and heat production
55	UAB "Litesko"	Luoke boiler house	1,549	82	1.A.1.A Public electricity and heat production
56	UAB "Litesko"	Mackevicius boiler house	1,420	101	1.A.1.A Public electricity and heat production
57	UAB "Palangos šilumos tinklai"	Palanga boiler house	1,215	1,240	1.A.1.A Public electricity and heat production
58	UAB "Litesko"	Marijampole region boiler house	10,283	4,881	1.A.1.A Public electricity and heat production
59	UAB "Litesko"	Alytus boiler house	17,877	9,978	1.A.1.A Public electricity and heat production
60	AB "Ignitis gamyba"	Lietuvos PP	10,258	19,012	1.A.1.A Public electricity and heat production
61	UAB "Kauno termofikacijos elektrinė"	Kaunas PP	0	3,782	1.A.1.A Public electricity and heat production
62	UAB "Kaišiadorių šiluma"	Kaišiadoriai boiler house	2,329	0	1.A.1.A Public electricity and heat production
63	UAB "Kretingos šilumos tinklai"	Kretinga boiler house No 3	2,156	0	1.A.1.A Public electricity and heat production
64	AB "Klaipėdos energija"	Klaipeda region boiler house	9,471	11,740	1.A.1.A Public electricity and heat production
65	AB "Klaipėdos energija"	Lypkiai regiopn boiler house	2,707	2,689	1.A.1.A Public electricity and heat production
66	UAB "Pramonės energija"	Boiler house	5,401	0	1.A.1.A Public electricity and heat production
67	VĮ "Ignalinos atominė elektrinė"	Boiler house	2,288	,3737	1.A.4.A Commercial/institutional
68	UAB "Trakų energija"	Lentvaris boiler house	843	0	1.A.1.A Public electricity and heat production
69	UAB "Gargždų plytų gamykla"	Boiler house	2,136	0	1.A.2.F Non-Metallic Minerals
70	UAB "Akmenės energija"	Zalgiris boiler house	2,059	815	1.A.1.A Public electricity and heat production
71	AB "Panevėžio energija"	Panevežys thermal PP	10,530	12	1.A.1.A Public electricity and heat production
72	UAB "IKEA Industry Lietuva"	Fuel combustion plants	35,939	10,347	1.A.2.G.iv Wood and wood products
73	UAB "NEO Group"	Boiler house	31,330	28,020	1.A.2.C Chemicals
74	AB "Panevėžio energija"	Kėdainiai region boiler house	39	379	1.A.1.A Public electricity and heat production
75	UAB "Paroc"	Plants producing stone-wool	30,933	62,338	1.A.2.F Non-Metallic Minerals
76	AB "Vilniaus GKG-3"	Boiler house	95	343	1.A.2.G.v Construction
77	AB “Vilniaus šilumos tinklai”	Boiler house No 7	0	0	1.A.1.A Public electricity and heat production

No	Company	Name of the Installation	Allocated EUA	Verified Emissions, t CO_2	Corresponding CRF Sector (Fuel combustion)
78	UAB "Pramonės energija"	Boiler house	13,995	0	1.A.1.A Public electricity and heat production
79	VĮ "Visagino energija"	Thermal boiler house	12,225	7,079	1.A.1.A Public electricity and heat production
80	AB "Roquette Amilina"	Boiler house and driers	0	2,599	1.A.2.E Food processing, Beverages and Tobacco
81	AB " Roquette Amilina"	Boiler house	0	0	1.A.2.E Food processing, Beverages and Tobacco
82	AB "Amber Grid"	Jauniūnų gas compressor station	0	4,441	1.A.3.E.i Pipeline transport
83	UAB "Hoegh LNG Klaipėda"	LNG ship	0	49,720	1.A.1.C.iii Other energy industries
84	UAB "Fortum Klaipėda"	Power plant	0	139,590	1.A.1.A Public electricity and heat production
85	UAB "Idex Biruliškių"	Boiler house	0	754	1.A.1.A Public electricity and heat production
86	UAB "Idex Paneriškių"	Boiler house	0	754	1.A.1.A Public electricity and heat production
87	UAB "Kauno kogeneracine jėgainė"	Power plant	0	179	1.A.1.A Public electricity and heat production
		Total	**4,315,390**	**5,856,426**	

Source: https://www.apva.lt/wp-content/uploads/2020/06/Atsiskaitymas-u%C5%BE-2019-m.-1.pdf

ANNEX VIII. Additional information of Agriculture sector

Other relavant information

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

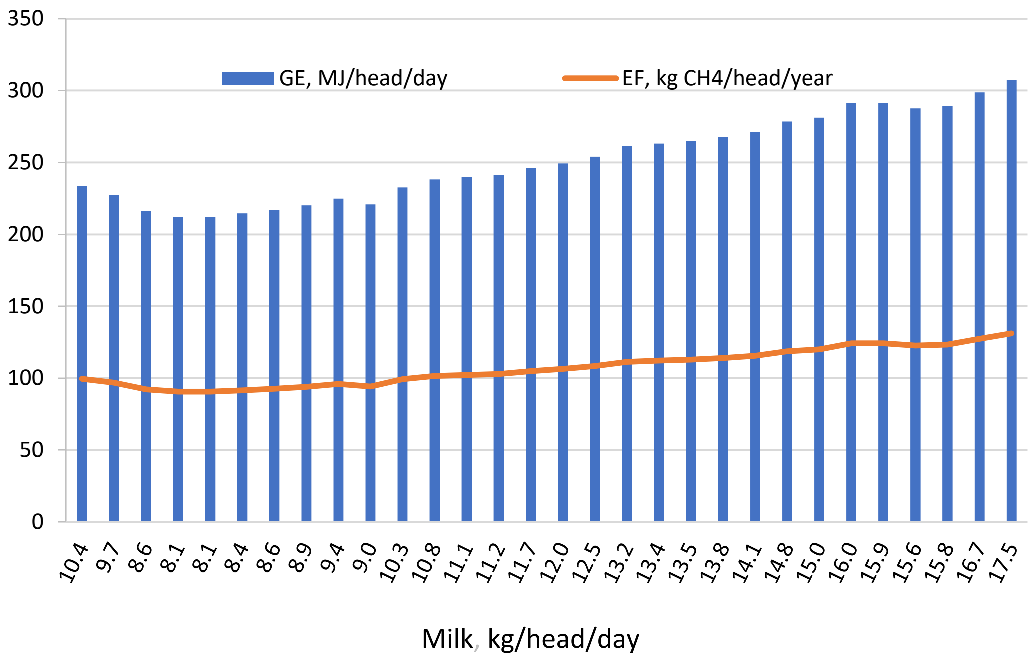


Figure A.5-1. Impact of milk yeld on GE and EF's

Milk yield, gross energy, and emission factors are closely related. Positive relationships between milk production and gross energy as well as between milk yield and emission factors.

Figure below shows distribution of horses by breeds in 2019.

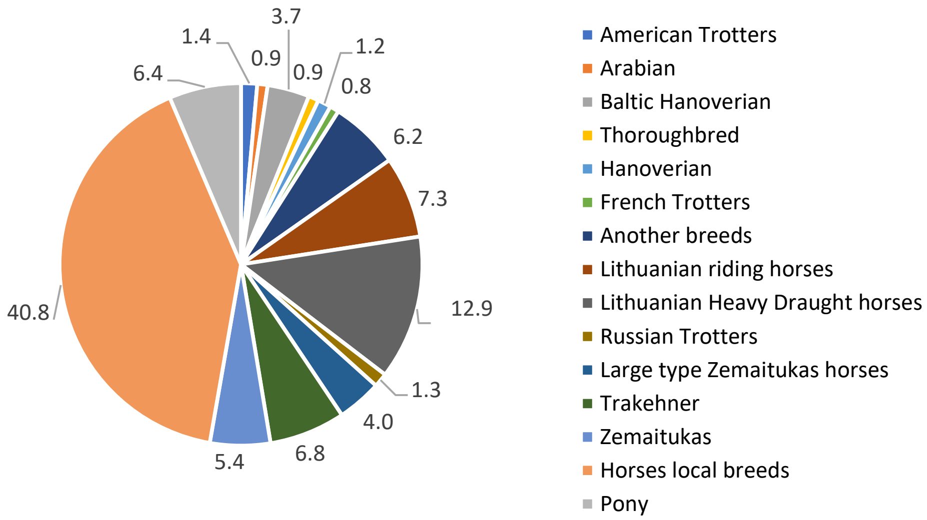


Figure A.5-2. Distribution by breeds of horses, %

Local breeds horses with no known origins constitute about 47% 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	6.45	5.98	0.60
1995	6.50	6.44	5.98	0.60
2000	6.50	6.45	5.98	0.60
2005	6.50	6.45	5.98	0.60
2010	6.50	6.50	5.98	0.60
2015	6.50	6.59	6.00	0.60
2016	6.50	6.61	5.99	0.60
2017	6.50	6.63	5.97	0.60
2018	6.50	6.65	5.96	0.60
2019	6.50	6.67	5.97	0.60

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	GE	CH_4 EF	Emissions
1990	100	100	100	100	100
1995	71	81	92	92	65
2000	55	99	100	100	55
2005	50	116	107	107	54
2010	43	133	115	115	50
2015	36	153	125	125	45
2016	35	150	123	123	43
2017	33	152	124	124	41
2018	31	160	128	128	40
2019	29	167	132	132	39

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

Year	Swine, thous. heads	Manure Management System	
		Liquid manure, %	Liquid manure, % (Anaerobic digesters)
1990	2,577.35	16.0	0
1995	1,266.28	32.07	0
2000	895.89	48.13	0
2005	1,094.00	61.05	3.15
2010	928.79	76.47	3.8
2015	700.99	81.29	6.13
2016	675.87	65.09	22.78
2017	637.92	61.97	26.35
2018	591.97	59.31	29.46
2019	561.43	57.54	31.68

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	2319.9	64.8
1995	171.8	1094.4	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

Diet composition parameters are provided in the tables below for different livestock (non-dairy, swine and sheep subcategories). All data provided in the tables were taken from Livestock manual[1].

Diet composition for cattle subcategories

Table A. 5 - 5. Nutrition standards for dairy cattle

Item	Quantity of milk/4% of milk fat/day		
	10	**15**	**20**
Dry matter, kg	12.7	15.1	17.0
Crude protein, g	1,524	2,038	2,550
Crude fat, g	279	362	459
Crude fiber, g	3,048	3,473	3,740
Nitrogen-free extract (in accordance by used feeds, identified based on the study data)	6,350	7,420	8,990

Intermediate values were interpolated

Table A. 5 - 6. Composition of diet for Non-dairy cattle suckling cows

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Hay	112.84	23.54	321.36	469.1	844.8	18.30	1.0
Straw	49.4	16.3	434.4	451.5	820.9	18.46	2.0
Silage	120	38.4	349	412	232	18.62	14.0
Green fodder - grass	183.75	39.2	243	431.9	215.05	18.39	25.0
Concentrates	134.8	19.5	42.2	781.9	869.3	18.53	1.0

Non-dairy cattle less than 1 year old

Table A. 5 - 7. Composition of diet for Calves for slaughter

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Hay	115	23.7	310.7	476.3	851.3	18.27	0.82
Silage	114.1	32.5	298.4	390	279	16.84	4
Green fodder – grass	182.9	37.6	250.1	432.7	213.1	18.47	8
Milk substitutes	275	301	0	368.8	125	25.01	1.51
Concentrates	173.5	26.4	52.6	719.2	866	18.84	0.92

Table A. 5 - 8. Composition of diet for Bulls for breeding

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Hay	115	23.7	310.7	476.3	851.3	18.27	1
Silage	114.1	32.5	298.4	390	279	16.84	4
Green fodder – grass	182.9	37.6	250.1	432.7	213.1	18.47	11.8
Milk substitutes	275	301	0	368.8	125	25.01	1.1
Concentrates	173.5	26.4	52.6	719.2	866	18.84	1

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

Table A. 5 – 9. Composition of diet for Heifers for breeding

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	115	23.7	310.7	476.3	851.3	18.27	0.7
Silage	114.1	32.5	298.4	390	279	16.84	2.2
Green fodder – grass	182.9	37.6	250.1	432.7	213.1	18.47	10.9
Milk substitutes	275	301	0	368.8	125	25.01	1.1
Concentrates	173.5	26.4	52.6	719.2	866	18.84	0.7

Non-dairy cattle from 1 to 2 years old

Table A. 5 - 10. Composition of diet for Bulls

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	115	23.7	310.7	476.3	851.3	18.27	1.8
Silage	114.1	32.5	298.4	390	279	16.84	13.6
Green fodder - grass	182.9	37.6	250.1	432.7	213.1	18.47	15.1
Concentrates	173.5	26.4	52.6	719.2	866	18.84	1.85

Table A. 5 – 11. Composition of diet for Heifers for slaughter

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	115	23.7	310.7	476.3	860	18.27	0.6
Straw	49.4	16.25	434.4	451.45	820.9	18.46	0.5
Silage	109.3	33.8	297.3	343.8	232	15.95	12.2
Green fodder - grass	175	40	258	422	220	18.35	18.1
Concentrates	173.5	26.4	52.6	719.2	866	18.84	1

Table A. 5 – 12. Composition of diet for Heifers for breeding

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	115	23.7	310.7	476.3	851.3	18.27	1.8
Straw	49.4	16.25	434.4	451.45	820.9	18.46	0.5
Silage	114.1	32.5	298.4	390	279	16.84	8.4
Green fodder - grass	182.9	37.6	250.1	432.7	213.1	18.47	15
Concentrates	173.5	26.4	52.6	719.2	866	18.84	0.2

Non-dairy cattle 2 years old and older

Table A. 5 – 13. Composition of diet for Dairy cattle sires bulls

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	121.75	23.8	304.05	473.4	847.5	18.25	1.7

Silage	123.6	29.9	300.6	482.4	373	18.63	16
Green fodder - grass	183.75	39.2	243	431.9	215.1	18.39	16.9
Concentrates	173.5	26.4	52.6	719.2	866	18.84	1.1

Table A. 5 – 14. Composition of diet for Non-dairy cattle sires bulls

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	112.84	23.54	321.36	469.1	844.8	18.3	1.7
Straw	49.4	16.25	434.4	451.45	820.9	18.46	0.8
Silage	120	38.4	349	412	232	18.62	15
Green fodder - grass	183.75	39.2	243	431.9	215.1	18.39	24
Concentrates	173.5	26.4	52.6	719.2	866	18.84	0.3

Table A. 5 – 15. Composition of diet for Other Bulls

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	115	23.7	310.7	476.3	851.3	18.27	2
Silage	114.1	32.5	298.4	390	279	16.84	12
Green fodder - grass	182.9	37.6	250.1	432.7	213.1	18.47	17
Concentrates	173.5	26.4	52.6	719.2	866	18.84	1.4

Table A. 5 – 16. Composition of diet for Heifers for slaughter

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	115	23.7	310.7	476.3	851.3	18.27	1.8
Silage	121.8	34.2	324.8	447.2	302.5	18.63	9.1
Green fodder - grass	182.9	37.6	250.1	432.7	213.1	18.47	18
Concentrates	170.3	25.7	49.3	726.9	869.9	18.8	1.3

Table A. 5 – 17. Composition of diet Heifers for breeding

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	115	23.7	310.7	476.3	851.3	18.27	2.1
Silage	121.8	34.2	324.8	447.2	302.5	18.63	9.6
Green fodder - grass	182.9	37.6	250.1	432.7	213.1	18.47	17.7
Concentrates	173.5	26.4	52.6	719.2	866	18.84	0.9

Table A. 5 – 18. Composition of diet for Non-dairy catle Other cow

Feedstuff	**Crude protein**	**Crude fat**	**Crude fibre**	**Nitrogen-free extract**	**DM**	**GE**	**Fooder**
	g/kg DM				**g/kg**	**MJ/kg DM**	**kg/day**
Hay	115	23.7	310.7	476.3	851.3	18.27	1.1
Straw	49.4	16.25	434.4	451.45	820.9	18.46	0.81

Silage	114.1	32.5	298.4	390	279	16.84	16.3
Green fodder - grass	182.9	37.6	250.1	432.7	213.1	18.47	24
Concentrates	173.5	26.4	52.6	719.2	866	18.84	0.7

Diet composition for Swine subcategories

Breeding Sows

Table A. 5- 19. Composition of diet for Mated

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.4	23.3	60.4	764.5	853	18.61	0.898
Oats	123	38.8	108.2	704.8	860	18.99	0.705
Wheat bran	145.1	42.2	82.3	693.3	867.5	18.93	0.08
Legumes	245	20.4	76	628.4	840	19.19	0.2
Rape cake	313.2	190.6	101.5	335.5	902	22.98	0.116
Soy Meal	500.3	16.4	78.1	337.3	880.6	20.08	0.017
Fish Meal	695	102	8	18	910	21.15	0.013
Premix	0	0	0	0	950	0	0.067

Table A. 5- 20. Composition of diet for Nursing young

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.4	23.3	60.4	764.5	853	18.61	2.64
Oats	123	38.8	108.2	704.8	860	18.99	0.807
Wheat bran	145.1	42.2	82.3	693.3	867.5	18.93	0.233
Legumes	245	20.4	76	628.4	840	19.19	0.714
Rape cake	313.2	190.6	101.5	335.5	902	22.98	0.295
Soy meal	500.3	16.4	78.1	337.3	880.6	20.08	0.419
Fish meal	695	102	8	18	910	21.15	0.155
Oil	0	998	0	0	0	39.72	0.171
Premix	0	0	0	0	950	0	0.155

Replacement Sows

Table A. 5- 21. Composition of diet for Mated

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.4	23.3	60.4	764.5	853	18.61	0.8
Oats	123	38.8	108.2	704.8	860	18.99	0.7
Wheat bran	145.1	42.2	82.3	693.3	867.5	18.93	0.164
Legumes	245	20.4	76	628.4	840	19.19	0.244
Rape cake	313.2	190.6	101.5	335.5	902	22.98	0.153
Soy meal	500.3	16.4	78.1	337.3	880.6	20.08	0.038
Fish Meal	695	102	8	18	910	21.15	0.019
Premix	0	0	0	0	950	0	0.076

Table A. 5- 22. Composition of diet for Nursing young

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free	DM	GE	Fooder

				extract			
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.4	23.3	60.4	764.5	853	18.61	3.059
Oats	123	38.8	108.2	704.8	860	18.99	0.978
Wheat bran	145.1	42.2	82.3	693.3	867.5	18.93	0.311
Legumes	245	20.4	76	628.4	840	19.19	0.795
Rape cake	313.2	190.6	101.5	335.5	902	22.98	0.311
Soy meal	500.3	16.4	78.1	337.3	880.6	20.08	0.469
Fish meal	695	102	8	18	910	21.15	0.186
Oil	0	998	0	0	0	39.72	0.202
Premix	0	0	0	0	950	0	0.186

Table A. 5- 23. Composition of diet for Swine Piglets < 2 month (< 20 kg)

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.41	23.3	60.4	764.5	853	18.61	0.208
Wheat	137.51	19.4	30.8	793.1	850	18.56	0.282
Legumes	245	20.4	76	628.4	840	19.19	0.032
Soy meal	500.3	16.4	78.1	337.3	880.6	20.08	0.08
Milk substitutes	366	11.2	0	549.3	960	18.81	0.118
Fish meal	695	102	8	18	910	21.15	0.027
Oil	0	998	0	0	0	39.72	0.027
Premix	0	0	0	0	950	0	0.027

Table A. 5- 24. Composition of diet for Swine Growing pigs (20-50 kg)

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.41	23.3	60.4	764.5	853	18.61	0.48
Wheat	137.51	19.4	30.8	793.1	850	18.56	0.23
Triticale	135.31	17	29.9	797	880	18.46	0.49
Legumes	245	20.4	76	628.4	840	19.19	0.19
Rape cake	313.2	190.6	101.5	335.5	902	22.98	0.13
Soybean meal	500.3	16.4	78.1	337.3	880.6	20.08	0.15
Fish meal	695	102	8	18	910	21.15	0.04
Oil	0	998	0	0	0	39.72	0.04
Premix	0	0	0	0	950	0	0.05

Table A. 5- 25. Composition of diet for Swine Growing pigs (50-80 kg)

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.41	23.3	60.4	764.5	853	18.61	0.66
Wheat	137.51	19.4	30.8	793.1	850	18.56	0.28
Triticale	135.31	17	29.9	797	880	18.46	0.95
Legumes	245	20.4	76	628.4	840	19.19	0.42
Rape cake	313.2	190.6	101.5	335.5	902	22.98	0.19
Soybean meal	500.3	16.4	78.1	337.3	880.6	20.08	0.06
Oil	0	998	0	0	0	39.72	0.01
Premix	0	0	0	0	950	0	0.07

Table A. 5- 26. Composition of diet for Swine growing pigs 80-110 kg

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.41	23.3	60.4	764.5	853	18.61	0.73
Wheat	137.51	19.4	30.8	793.1	850	18.56	0.31
Triticale	135.31	17	29.9	797	880	18.46	1.04
Legumes	245	20.4	76	628.4	840	19.19	0.46
Rape cake	313.2	190.6	101.5	335.5	902	22.98	0.2
Soybean meal	500.3	16.4	78.1	337.3	880.6	20.08	0.06
Oil	0	998	0	0	0	39.72	0.01
Premix	0	0	0	0	950	0	0.08

Table A. 5-27. Composition of diet for Swine pigs >110 kg (8 month and more)

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.41	23.3	60.4	764.5	853	18.61	0.7
Wheat	137.51	19.4	30.8	793.1	850	18.56	0.3
Triticale	135.31	17	29.9	797	880	18.46	1.01
Legumes	245	20.4	76	628.4	840	19.19	0.45
Rape cake	313.2	190.6	101.5	335.5	902	22.98	0.2
Soybean meal	500.3	16.4	78.1	337.3	880.6	20.08	0.06
Oil	0	998	0	0	0	39.72	0.01
Premix	0	0	0	0	950	0	0.08

Table A. 5- 28. Composition of diet for Swine Gilts for breed

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.4	23.3	60.4	764.5	853	18.61	0.73
Wheat	137.51	19.4	30.8	793.1	850	18.56	0.11
Triticale	135.31	17	29.9	797	880	18.46	0.16
Oats	123	38.8	108.2	704.8	860	18.99	0.44
Wheat bran	145.1	42.2	82.3	693.3	867.5	18.93	0.14
Soybean meal	500.3	16.4	78.1	628.4	880.6	25.18	0.11
Legumes	245	20.4	76	335.5	840	14.07	0.31
Rapeseed cake	313.2	190.6	101.5	337.3	902	23.01	0.16
Milk substitutes	366	11.2	0	549.3	960	18.81	0.02
Oil	0	998	0	0	0	39.72	0.01
Premix	0	0	0	0	950	0	0.06

Boars

Table A. 5- 29. Composition of diet for Mature

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day

Barley	129.4	23.3	60.4	764.5	853	18.61	0.86
Oats	123	38.8	108.2	704.8	860	18.99	0.79
Wheat bran	145.1	42.2	82.3	693.3	867.5	18.93	0.17
Legumes	245	20.4	76	628.4	840	19.19	0.25
Rape cake	313.2	190.6	101.5	335.5	902	22.98	0.1
Soy meal	500.3	16.4	78.1	337.3	880.6	20.08	0.15
Fish meal	695	102	8	18	910	21.15	0.07
Premix	0	0	0	0	950	0	0.07

Table A. 5- 30. Composition of diet for Young for breed

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Barley	129.4	23.3	60.4	764.5	853	18.61	0.75
Wheat	137.51	19.4	30.8	793.1	850	18.56	0.09
Triticale	135.31	17	29.9	797	880	18.46	0.14
Oats	123	38.8	108.2	704.8	860	18.99	0.55
Wheat bran	145.1	42.2	82.3	693.3	867.5	18.93	0.2
Soybean meal	500.3	16.4	78.1	628.4	880.6	25.18	0.15
Legumes	245	20.4	76	335.5	840	14.07	0.37
Rapeseed cake	313.2	190.6	101.5	337.3	902	23.01	0.19
Fish Meal	695	102	8	18	910	21.15	0.004
Oil	0	998	0	0	0	39.72	0.007
Premix	0	0	0	0	950	0	0.08

Diet composition for Sheep subcategories

Table A. 5- 31. Composition of diet for Mature ewes

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Hay	113.4	23.05	313.6	478.4	847.30	18.30	0.60
Silage	123.6	29.9	300.6	482.4	373	18.63	1.27
Green fodder - grass	187.3	37.5	225.5	454.7	186.5	18.46	3.31
Concentrates	123	38.8	108.2	704.8	880	18.99	0.21

Table A. 5- 32. Composition of diet for Ewe over 1 years

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Hay	113.4	23.05	313.6	478.4	847.3	18.25	0.5
Silage	123.6	29.9	300.6	482.4	373	18.63	0.91
Green fodder - grass	187.3	37.5	225.5	454.7	186.5	18.46	2.8
Concentrates	123	38.8	108.2	704.8	880	18.99	0.26

Table A. 5-33. Composition of diet for Mature Rams

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Hay	113.4	23.05	313.6	478.4	847.3	18.3	0.70

Silage	123.6	29.9	300.6	482.4	373	18.63	1.22
Green fodder - grass	187.3	37.5	225.5	454.7	186.5	18.46	3.2
Concentrates	123	38.8	108.2	704.8	880	18.99	0.36

Table A. 5- 34. Composition of diet for Rams over 1 years

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Hay	113.4	23.05	313.6	478.4	847.3	18.3	0.5
Silage	123.6	29.9	300.6	482.4	373	18.63	1.35
Green fodder - grass	187.3	37.5	225.5	454.7	186.5	18.46	3
Concentrates	123	38.8	108.2	704.8	880	18.99	0.30

Table A. 5- 35. Composition of diet for Ewe to 1 years

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Hay	119.8	23.6	313.9	465	853.8	18.25	0.32
Silage	123.6	29.9	300.6	482.4	373	18.63	0.5
Milk and milk substitutes	275	301	0	368.8	125	25.01	0.198
Green fodder - grass	168.5	36.2	263	440.7	185.5	18.47	1.22
Concentrates	171.7	29.6	64.3	705.3	869.2	18.92	0.22

Table A. 5-36. Composition of diet for Lambs to 1 years

Feedstuff	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract	DM	GE	Fooder
	g/kg DM				g/kg	MJ/kg DM	kg/day
Hay	119.8	23.6	313.9	465	853.8	18.25	0.22
Silage	123.6	29.9	300.6	482.4	373	18.63	0.35
Milk and milk substitutes	275	301	0	368.8	125	25.01	0.198
Green fodder - grass	168.5	36.2	263	440.7	185.5	18.47	1.07
Concentrates	171.7	29.6	64.3	705.3	869.2	18.92	0.26

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. 5-37. Average diet nutrition indicators for dairy cattle, g/kg DM

Year	Crude protein	Crude fat	Crude fibre	Nitrogen-free extract
1990	1,718	312	3,176	6,639
1995	1,491	272	3,000	6,164
2000	1,709	311	3,169	6,619
2005	1,913	346	3,321	7,034
2010	2,119	385	3,433	7,574
2015	2,386	439	3,551	8,305
2016	2,345	431	3,533	8,192
2017	2,366	435	3,542	8,248
2018	2,467	456	3,589	8,540
2019	2,549	485	3,638	8,804

Table A.5-38. Average diet nutrition indicators for non-dairy cattle, g/kg DM

Sub-category			Crude protein	Crude fat	Crude fiber	Nitrogen free extracts	DM kg/day
Suckling cows			1,671	399	3,461	5,477	11.98
Less than 1 year old	Calves for slaughter		709	195	1,018	2,148	4.50
	For breeding	Bulls	873	215	1,272	2,602	5.49
		Heifers	706	179	981	2,015	4.28
From 1 to 2 years old	Bulls		1,476	323	2,497	4,754	10.15
	Heifers	For slaughter	1,236	297	2,253	3,707	8.60
		For breeding	1,079	244	2,162	3,337	7.66
2 years old and older	Bulls	Dairy cattle sires	1,746	380	3,165	5,816	12.00
		Non-dairy cattle sires	1,606	387	3,229	4,820	11.00
		Other bulls	1,451	317	2,498	4,556	9.89
	Heifers	For slaughter	1,406	304	2,385	4,443	9.25
		For breeding	1,384	304	2,483	4,342	9.24
Other cows			1,700	389	3,248	5,169	11.87

Table A.5-39. Average diet nutrition indicators for swine, g/kg DM

Sub-category			Crude protein	Crude fat	Crude fibre	Nitrogen-free extracts	DM kg/day
Breeding	Sows	Mated	273.4	69.1	142.2	1,207	1.805
		Nursing young	918.9	171.5	330.3	2,944	4.671
Replacement	Sows	Mated	305.2	78.1	150.4	1,231.3	1.893
		Nursing young	1,055.9	196.1	383.6	3,430.8	5.427
Piglets < 2 months (< 20 kg)			156.2	14.3	25.8	429.1	0.678
Growing pigs (20-50 kg)			305.4	52.2	78.3	996.6	1.529
Growing pigs (50-80 kg)			385.2	72.7	114.7	1,582.5	2.280
Growing pigs (80-110 kg)			418.3	78.3	124.9	1,735.6	2.497
Pigs > 110 kg (8 months and >)			408.1	76.9	121.7	1,682.9	2.428
Gilts for breeds			341.1	73.2	137.6	1,220.8	1.935
Boars		Mature	389.9	79.8	165.9	1,349.8	2.123
		Young for breed	391.8	85.7	161.5	1,346.8	2.180

Table A.5-40. Average diet nutrition indicators for sheep, g/kg DM

Sub-category	Crude protein	Crude fat	Crude fiber	Nitrogen-free extracts	DM kg/day
Mature ewes	255	56	461	883	1.784
Ewe over 1 years	216	48	377	765	1.514
Ewe to 1 years	134	33	214	461	0.902
Lambs to 1 years	118	30	165	406	0.768
Mature Rams	274	62	492	998	1.962
Rams over 1 years	248	56	439	886	1.751

Agricultural soils

All activity data used to estimated 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.5-41. Harvested annual dry matter yield

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
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
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
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
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
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	2,895
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
Grain maize	2,543	2,543	2,543	2,721	5,754	6,441	5,253	6,360	5,205	4,146	5,978	4,952	5,622	6,584
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
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
Flax	408	423	270	400	430	573	573	573	860	860	860	1,505	1,032	645
Buckwheat	581	523	772	482	627	822	776	798	819	855	984	943	871	957
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
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
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
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
Soya beans	753	753	753	753	753	753	595	921	696	573	1,433	1,066	1,505	1,099
Lupines	631	1,013	768	912	591	932	860	760	808	1,171	1,041	1,097	827	812
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
Mixed dried pulses	1,618	1,618	1,618	1,609	1,437	1,670	1,733	1,635	1,891	1,964	1750	1,810	1,319	1,807
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
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
Fodder beet	6,175	4,249	4,488	4,026	3264	3,565	4,166	3,712	4,003	3,785	3,213	1,980	2,370	2,606
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
Alfalfa (for hay)	IE	IE	IE	3	2	3	3	3	3	2	5	4	5	6
Alfalfa (for green fodder, silage)	IE	IE	IE	6	7	7	6	6	5	4	6	6	4	5
Clover and their mixture (for hay)	IE	IE	IE	4	3	3	2	2	2	3	3	4	3	2
Clover and their mixture (for green fodder, silage)	IE	IE	IE	2	6	5	5	5	5	4	5	4	4	4
Silage crops	5	4	5	5	3	4	4	4	4	4	3	3	4	4
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
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
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
Perennial grasses (for	2,773	3,113	2,651	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE

hey)														
Perennial grasses heylage harvested	3,726	4,183	3,562	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
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
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
Perennial pastures (for silage and green fodder)	828	2,272	1,964	1,109	3,288	2,761	2,597	2,435	2,361	2,232	2,045	1,982	2,000	1,550
Meadows and natural pastures (for hey)	3,320	3,320	3,320	2,098	1,769	1,754	2,009	1,977	1,983	1,977	1,978	2,646	1,107	1,807
Meadows and natural pastures (for silage and green fodder)	3,489	3,489	3,489	1,352	2,766	2,434	2,280	2,019	1,963	2,172	2,322	2,698	1,731	2,216

Table A.5-42. Total annual area harvested

	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
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
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
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
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
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
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
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
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
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
Flax	21,500	13,200	8,600	4,300	400	600	300	300	300	300	200	400	500	400
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
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
Other cereals	100	100	200	200	700	700	600	800	900	200	100	100	100	200
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
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
Soya beans	800	800	800	800	800	800	2,600	1,400	2,100	2700	1,800	2,500	2,000	1,800
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
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
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
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
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
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
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

Alfalfa (for hay)	IE	IE	IE	952	600	700	700	900	1,300	1,700	1,800	1,300	1,900	2,700
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
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
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
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
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
Annual grasses (for hay)	9,328	3,898	2,226	5,755	500	700	900	900	1,500	300	400	600	800	1,000
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
Perennial grasses (for hey)	257,946	168,269	109,982	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
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
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
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
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
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
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

Table A.5-43. Ratio of above-ground residues dry matter to harvested yield

	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
$R_{AG(T)}$	**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
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

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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
Perennial grasses (for hey)	0.30	0.30	0.30	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
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
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
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

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
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
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

Table A.5-44. Ratio of below-ground residues to harvested yield

	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
$R_{BG(T)}$	**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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

Perennial grasses (for hey)	2.00	2.00	2.00	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
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
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
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
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
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
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

Table A.5-45. Other relavant 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.5-46

Table A.5-46. 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	7,106,929	49
1995	9,382,984	4,513,520	48
2000	13,415,910	3,334,998	25
2005	13,127,255	3,043,114	23
2010	13,249,666	2,610,443	20
2011	16,587,058	2,442,192	15
2012	22,526,166	2,285,012	10
2013	21,128,355	2,168,192	10
2014	26,395,789	2,107,523	8
2015	29,640,919	2,072,139	7
2016	23,792,972	2,082,121	9
2017	22,827,399	2,050,372	9
2018	18,779,141	1,995,504	11
2019	22,821,930	1,886,234	8

ANNEX IX. 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:

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

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-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 X. LULUCF area matrices

1990

Land category	**Forest land**	**Cropland**	**Grassland**	**Wetlands**	**Settlements**	**Other land**	**Final**	**Net change**
Forest land	2,043,372	0	6,389	3,594	0	799	2,054154	10,782
Cropland	0	2,392,387	22,362	0	0	0	2,414749	-37,936
Grassland	0	60,299	1,2263,43	0	0	0	1,286,642	27,554
Wetlands	0	0	3,594	378,565	0	0	382,159	0
Settlements	0	0	399	0	346,619	0	347,018	399
Other land	0	0	0	0	0	43,926	43,926	-799
Initial	2,043,372	2,452,686	1,259,088	382,159	346,619	44,725	6,528,648	

1991

Land category	**Forest land**	**Cropland**	**Grassland**	**Wetlands**	**Settlements**	**Other land**	**Final**	**Net change**
Forest land	2,054,154	399	3,993	2,396	399	0	2,061,342	7,188
Cropland	0	2,352,454	22,362	0	799	399	2,376,014	-38,735
Grassland	0	60,299	1,257,491	3,195	799	4,393	1,326,175	39,534
Wetlands	0	399	1,597	376,568	0	0	378,565	-3,594
Settlements	0	1,198	1,198	0	345,021	799	348,216	1,198
Other land	0	0	0	0	0	38,336	38,336	-5,591
Initial	2,054,154	2,414,749	1,286,642	382,159	347,018	43,926	6,528,648	

1992

Land category	**Forest land**	**Cropland**	**Grassland**	**Wetlands**	**Settlements**	**Other land**	**Final**	**Net change**
Forest land	2,061,342	399	3,195	1,997	0	399	2,067,332	5,990
Cropland	0	2,311,722	25,158	0	0	799	2,337,679	-38,336
Grassland	0	60,299	1,297,024	799	1,198	4,792	1,364,112	37,936
Wetlands	0	399	0	375,770	0	2,396	378,565	0
Settlements	0	2,396	799	0	347,018	399	350,612	2,396
Other land	0	799	0	0	0	29,550	30,349	-7,987
Initial	2,061,342	2,376,014	1,326,175	378,565	348,216	38,336	6,528,648	

1993

Land category	**Forest land**	**Cropland**	**Grassland**	**Wetlands**	**Settlements**	**Other land**	**Final**	**Net change**
Forest land	2,067,332	1,198	3,993	0	0	0	2,072,523	5,191
Cropland	0	2,275,383	22,762	1,198	799	1,597	2,301,739	-35,940
Grassland	0	58,702	1,336,957	1,198	1,198	5,191	1,403,246	39,134
Wetlands	0	799	0	376,169	0	399	377,367	-1,198
Settlements	0	799	399	0	348,615	0	349,813	-799
Other land	0	799	0	0	0	23,161	23,960	-6,389
Initial	2,067,332	2,337,679	1,364,112	378,565	350,612	30,349	6,528,648	

1994

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,072,124	0	2,396	399	399	0	2,075,319	2,795
Cropland	0	2,231,457	27,953	0	0	799	2,260,209	-41,530
Grassland	0	66,688	1,371,300	799	799	4,792	1,444,377	41,131
Wetlands	0	399	0	376,169	0	399	376,968	-399
Settlements	0	2,795	1,597	0	348,615	0	353,008	3,195
Other land	399	399	0	0	0	17,970	18,769	-5,191
Initial	2,072,523	2,301,739	1,403,246	377,367	349,813	23,960	6,528,648	

1995

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,075,319	0	1,597	799	0	0	2,077,715	2,396
Cropland	0	2,197,913	24,758	0	0	399	2,223,071	-37,138
Grassland	0	59,500	1,417,622	1,198	3,195	4,393	1,485,907	41,530
Wetlands	0	399	399	374,971	0	1,198	376,968	0
Settlements	0	1,997	0	0	349,813	399	352,209	-799
Other land	0	399	0	0	0	12,379	12,779	-5,990
Initial	2,075,319	2,260,209	1,444,377	376,968	353,008	18,769	6,528,648	

1996

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,077,715	399	2,795	799	0	0	2,081,708	3,993
Cropland	0	2,196,715	8,386	0	0	0	2,205,101	-17,970
Grassland	0	25,956	1,474,726	399	0	399	1,501,481	15,574
Wetlands	0	0	0	375,770	0	0	375,770	-1,198
Settlements	0	0	0	0	352,209	0	352,209	0
Other land	0	0	0	0	0	12,379	12,379	-399
Initial	2,077,715	2,223,071	1,485,907	376,968	352,209	12,779	6,528,648	

1997

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,081,708	799	2,396	399	0	0	2,085,302	3,594
Cropland	0	2,153,188	19,567	0	0	399	2,173,155	-31,946
Grassland	0	50,715	1,478,719	0	0	0	1,529,434	27,953
Wetlands	0	0	399	375,370	0	0	375,770	0
Settlements	0	399	399	0	351,810	0	352,609	399
Other land	0	0	0	0	399	11,980	12,379	0
Initial	2,081,708	2,205,101	1,501,481	375,770	352,209	12,379	6,528,648	

1998

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,085,302	0	2,795	0	0	399	2,088,497	3,195
Cropland	0	2,088,497	37,138	0	0	0	2,125,634	-47,520
Grassland	0	83,859	1,489,102	0	0	0	1,572,961	43,527
Wetlands	0	0	0	375,770	0	0	375,770	0
Settlements	0	399	399	0	352,609	0	353,407	799
Other land	0	399	0	0	0	11,980	12,379	0
Initial	2,085,302	2,173,155	1,529,434	375,770	352,609	12,379	6,528,648	

1999

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,088,097	399	1,597	1,198	0	0	2,091,292	2,795
Cropland	0	2,028,597	51,913	0	0	0	2,080,510	-45,124
Grassland	0	96,239	1,518,652	0	0	0	1,614,891	41,930
Wetlands	399	0	0	374,572	0	0	374,971	-799
Settlements	0	399	799	0	353,407	0	354,605	1,198
Other land	0	0	0	0	0	12,379	12,379	0
Initial	2,088,497	2,125,634	1,572,961	375,770	353,407	12,379	6,528,648	

2000

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,091,292	0	2,396	2,396	0	399	2,096,483	5,191
Cropland	0	1,969,896	50,715	0	0	0	2,020,610	-59,900
Grassland	0	108,618	1,558,186	399	1,198	0	1,668,401	53,510
Wetlands	0	0	1,198	372,176	0	0	373,374	-1,597
Settlements	0	1,997	2,396	0	353,407	0	357,800	3,195
Other land	0	0	0	0	0	11,980	11,980	-399
Initial	2,091,292	2,080,510	1,614,891	374,971	354,605	12,379	6,528,648	

2001

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,096,483	399	1,997	0	0	0	2,098,879	2,396
Cropland	0	1,918,382	43,128	0	0	0	1,961,510	-59,101
Grassland	0	101,430	1,622,478	399	399	399	1,725,106	56,705
Wetlands	0	0	0	372,974	0	0	372,974	-399
Settlements	0	399	399	0	357,400	0	358,199	399
Other land	0	0	399	0	0	11,581	11,980	0
Initial	2,096,483	2,020,610	1,668,401	373,374	357,800	11,980	6,528,648	

2002

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,098,879	0	3,993	399	0	0	2,103,272	4,393
Cropland	0	1,872,459	40,332	0	0	0	1,912,791	-48,718
Grassland	0	88,252	1,680,381	0	0	0	1,768,633	43,527
Wetlands	0	0	399	372,575	0	799	373,773	799
Settlements	0	799	0	0	358,199	0	358,998	799
Other land	0	0	0	0	0	11,181	11,181	-799
Initial	2,098,879	1,961,510	1,725,106	372,974	358,199	11,980	6,528,648	

2003

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,102,872	799	3,195	799	399	0	2,108,064	4,792
Cropland	0	1,847,701	23,560	0	0	0	1,871,261	-41,530
Grassland	0	64,292	1,740,680	0	0	0	1,804,972	36,339
Wetlands	399	0	399	372,974	0	399	374,172	399
Settlements	0	0	399	0	358,598	0	358,998	0
Other land	0	0	399	0	0	10,782	11,181	0
Initial	2,103,272	1,912,791	1,768,633	373,773	358,998	11,181	6,528,648	

2004

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,107,265	399	6,389	1,198	0	0	2,115,252	7,188
Cropland	0	1,821,744	29,151	0	0	0	1,850,895	-20,366
Grassland	0	48,718	1,768,633	399	0	0	1,817,751	12,779
Wetlands	799	0	399	372,575	0	399	374,172	0
Settlements	0	399	399	0	3589,98	0	359,796	799
Other land	0	0	0	0	0	10,782	10,782	-399
Initial	2,108,064	1,871,261	1,804,972	374,172	358,998	11,181	6,528,648	

2005

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,114,852	799	5,191	1,597	0	399	2,122,839	7,587
Cropland	0	1,810,163	22,762	0	0	0	1,832,925	-17,970
Grassland	0	39,134	1,787,402	0	0	0	1,826,536	8,785
Wetlands	0	0	799	372,575	0	399	373,773	-399
Settlements	399	799	1,597	0	359,796	0	362,592	2,795
Other land	0	0	0	0	0	9,983	9,983	-799
Initial	2,115,252	1,850,895	1,817,751	374,172	359,796	10,782	6,528,648	

2006

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,122,440	799	5,591	1,597	0	0	2,130,426	7,587
Cropland	0	1,796,986	83,859	0	0	0	1,880,845	47,920
Grassland	0	34,742	1,735,089	399	0	0	1,770,230	-56,306
Wetlands	0	399	399	371,776	0	0	372,575	-1,198
Settlements	399	0	1,597	0	362,592	0	364,588	1,997
Other land	0	0	0	0	0	9,983	9,983	0
Initial	2,122,839	1,832,925	1,826,536	373,773	362,592	9,983	6,528,648	

2007

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,130,426	2,396	2,795	1,997	0	399	2,138,014	7,587
Cropland	0	1,854,090	80,665	0	0	0	1,934,754	53,910
Grassland	0	24,359	1,684,374	0	399	0	1,709,133	-61,098
Wetlands	0	0	1,198	370,578	0	0	371,776	-799
Settlements	0	0	1,198	0	364,189	0	365,387	799
Other land	0	0	0	0	0	9,584	9,584	-399
Initial	2,130,426	1,880,845	1,770,230	372,575	364,588	9,983	6,528,648	

2008

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,138,014	1,597	4,792	399	0	0	2,144,802	6,789
Cropland	0	1,907,201	76,671	0	399	0	1,984,271	49,517
Grassland	0	25,557	1,624,475	399	0	0	1,650,431	-58,702
Wetlands	0	0	799	370,978	0	0	371,776	0
Settlements	0	399	1,597	0	364,988	0	366,984	1,597
Other land	0	0	799	0	0	9,584	10,383	799
Initial	2,138,014	1,934,754	1,709,133	371,776	365,387	9,584	6,528,648	

2009

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,144,403	0	3,594	0	0	0	2,147,997	3,195
Cropland	0	1,968,698	50,715	0	0	0	2,019,412	35,141
Grassland	0	15,175	1,591,730	0	399	399	1,607,703	-42,728
Wetlands	399	0	0	371,776	0	0	372,176	399
Settlements	0	399	3,594	0	366,585	0	370,578	3,594
Other land	0	0	799	0	0	9,983	10,782	399
Initial	2,144,802	1,984,271	1,650,431	371,776	366,984	10,383	6,528,648	

2010

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,147,997	399	5,990	0	0	0	2,154,386	6,389
Cropland	0	1,945,137	5,191	0	0	0	1,950,328	-69,084
Grassland	0	73,876	1,592,529	399	1,198	0	1,668,002	60,299
Wetlands	0	0	0	371,776	0	0	371,776	-399
Settlements	0	0	3,993	0	369,380	0	373,374	2,795
Other land	0	0	0	0	0	10,782	10,782	0
Initial	2,147,997	2,019,412	1,607,703	372,176	370,578	10,782	6,528,648	

2011

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,154,386	2,396	5,990	0	0	0	2,162,772	8,386
Cropland	0	1,890,030	41,131	0	0	0	1,931,161	-19,168
Grassland	0	57,903	1,620,482	0	399	0	1,678,784	10,782
Wetlands	0	0	0	371,776	0	399	372,176	399
Settlements	0	0	399	0	372,974	0	373,374	0
Other land	0	0	0	0	0	10,383	10,383	-399
Initial	2,154,386	1,950,328	1,668,002	371,776	373,374	10,782	6,528,648	

2012

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,162,772	1,198	8,785	1,597	0	0	2,174,353	11,581
Cropland	0	1,871,660	41,930	0	0	0	1,913,590	-17,571
Grassland	0	58,302	1,627,270	799	1,198	0	1,687,569	8,785
Wetlands	0	0	0	369,780	0	0	369,780	-2,396
Settlements	0	0	799	0	372,176	0	372,974	-399
Other land	0	0	0	0	0	10,383	10,383	0
Initial	2,162,772	1,931,161	1,678,784	372,176	373,374	10,383	6,528,648	

2013

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,174,353	799	4,393	0	799	0	2,180,343	5,990
Cropland	0	1,887,634	39,933	0	399	0	1,927,966	14,376
Grassland	0	24,758	1,638,452	0	799	0	1,664,009	-23,560
Wetlands	0	0	0	369,780	0	0	369,780	0
Settlements	0	399	4,393	0	370,978	0	375,770	2,795
Other land	0	0	399	0	0	10,383	10,782	399
Initial	2,174,353	1,913,590	1,687,569	369,780	372,974	10,383	6,528,648	

2014

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,180,343	1,997	3,594	2,396	0	0	2,188,329	7,987
Cropland	0	1,900,013	47,920	0	0	0	1,947,932	19,967
Grassland	0	25,158	1,609,300	399	399	399	1,635,656	-28,352
Wetlands	0	0	1,198	366,984	0	0	368,182	-1,597
Settlements	0	799	1,597	0	375,370	0	377,766	1,997
Other land	0	0	399	0	0	10,383	10,782	0
Initial	2,180,343	1,927,966	1,664,009	369,780	375,770	10,782	6,528,648	

2015

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,188,329	799	7,587	799	0	0	2,197,514	9,185
Cropland	0	1,922,775	25,158	0	399	0	1,948,332	399
Grassland	0	23,960	1,600,515	0	0	1,198	1,625,673	-9,983
Wetlands	0	0	399	367,384	0	399	368,182	0
Settlements	0	399	1,997	0	377,367	0	379,763	1,997
Other land	0	0	0	0	0	9,185	9,185	-1,597
Initial	2,188,329	1,947,932	1,635,656	368,182	377,766	10,782	6,528,648	

2016

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,197,114	399	3,993	1,198	0	0	2,202,705	5,191
Cropland	0	1,923,973	18,369	0	799	0	1,943,140	-5,191
Grassland	0	23,960	1,602,512	399	0	799	1,627,670	1,997
Wetlands	0	0	799	366,585	0	0	367,384	-799
Settlements	399	0	0	0	378,964	0	379,364	-399
Other land	0	0	0	0	0	8,386	8,386	-799
Initial	2,197,514	1,948,332	1,625,673	368,182	379,763	9,185	6,528,648	

2017

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,201,906	399	5,990	2,396	0	0	2,210,692	7,987
Cropland	0	1,913,989	45,923	0	0	0	1,959,912	16,772
Grassland	0	28,352	1,574,958	399	1,198	399	1,605,307	-22,362
Wetlands	799	0	0	364,588	0	0	365,387	-1,997
Settlements	0	399	799	0	378,166	0	379,364	0
Other land	0	0	0	0	0	7,987	7,987	-399
Initial	2,202,705	1,943,140	1,627,670	367,384	379,364	8,386	6,528,648	

2018

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,208,695	0	3,594	399	0	0	2,212,688	1,997
Cropland	0	1,928,765	38,336	0	0	0	1,967,100	7,188
Grassland	1,198	31,148	1,562,579	799	399	399	1,596,522	-8,785
Wetlands	0	0	0	364,189	0	0	364,189	-1,198
Settlements	799	0	799	0	378,964	0	380,562	1,198
Other land	0	0	0	0	0	7,587	7,587	-399
Initial	2,210,692	1,959,912	1,605,307	365,387	379,364	7,987	6,528,648	

2019

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2,211,490	0	3,594	399	0	0	2,215,484	2,795
Cropland	0	1,947,932	33,544	0	399	0	1,981,875	14,775
Grassland	399	19,168	1,556,988	399	0	0	1,576,955	-19,567
Wetlands	0	0	399	363,390	0	0	363,790	-399
Settlements	0	0	1,997	0	380,162	0	382,159	1,597
Other land	799	0	0	0	0	7,587	8,386	799
Initial	2,212,688	1,967,100	1,596,522	364,189	380,562	7,587	6,528,648	

ANNEX XI. 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.*

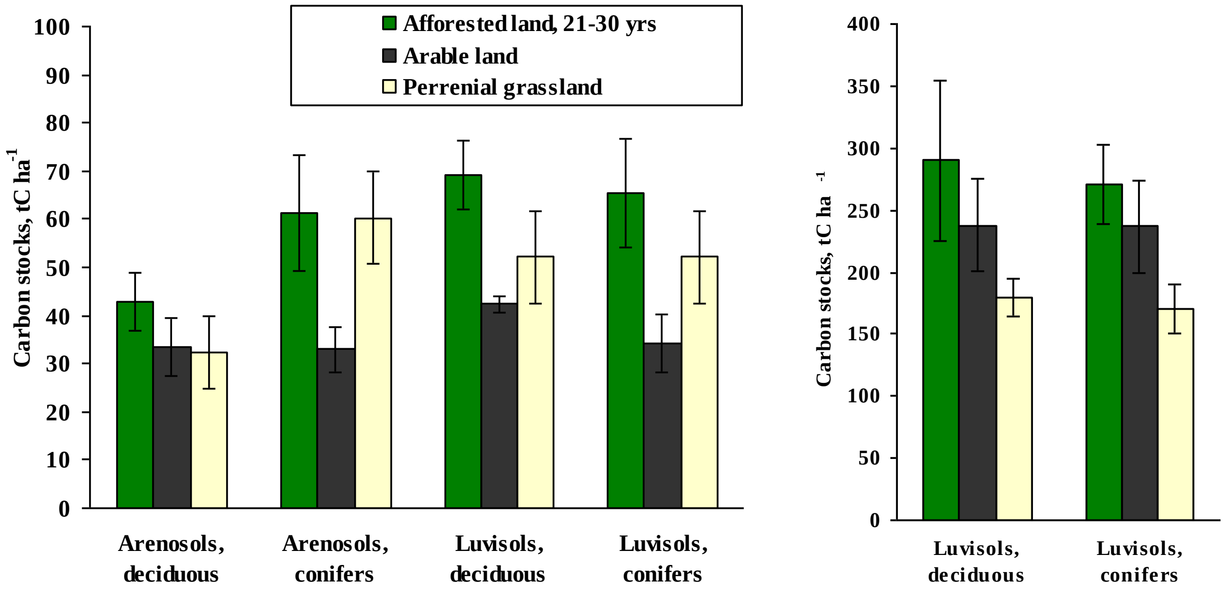


Fig.1. Stocks (t ha^{-1}) of organic carbon in 0–30 cm mineral soil/peat layer in the afforested land in the 21-30-year old coniferous and deciduous forest plantations and the control (arable land and grassland).

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**).

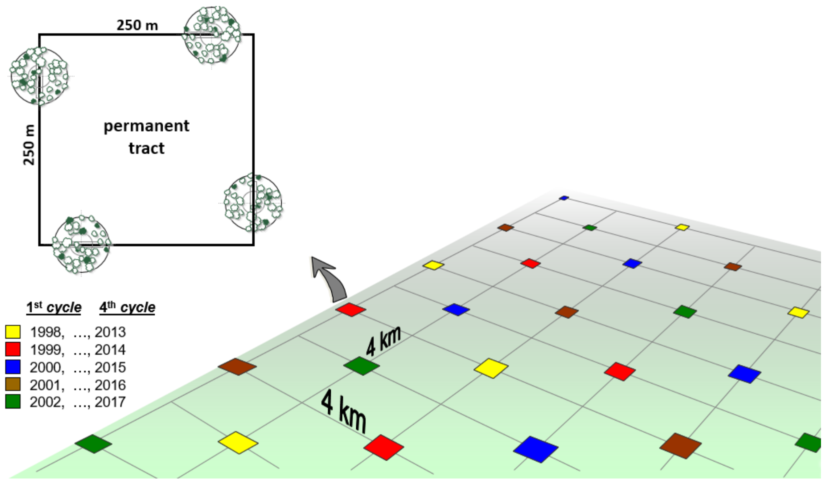


Fig. 1. National Forest Inventory permanent sample plots grid in Lithuania

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

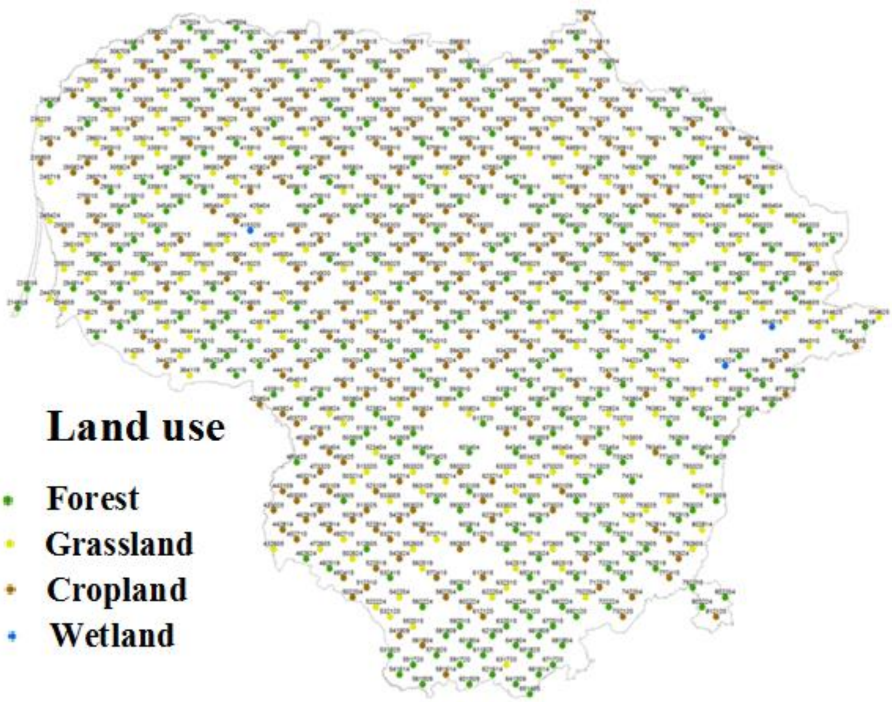


Fig. 2. Sample plots in the grid (9x9 km) of Lithuanian National Forest Inventory (NFI) (Total N=752; forest land – 298; grassland – 206; cropland – 244; wetland – 4)

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):

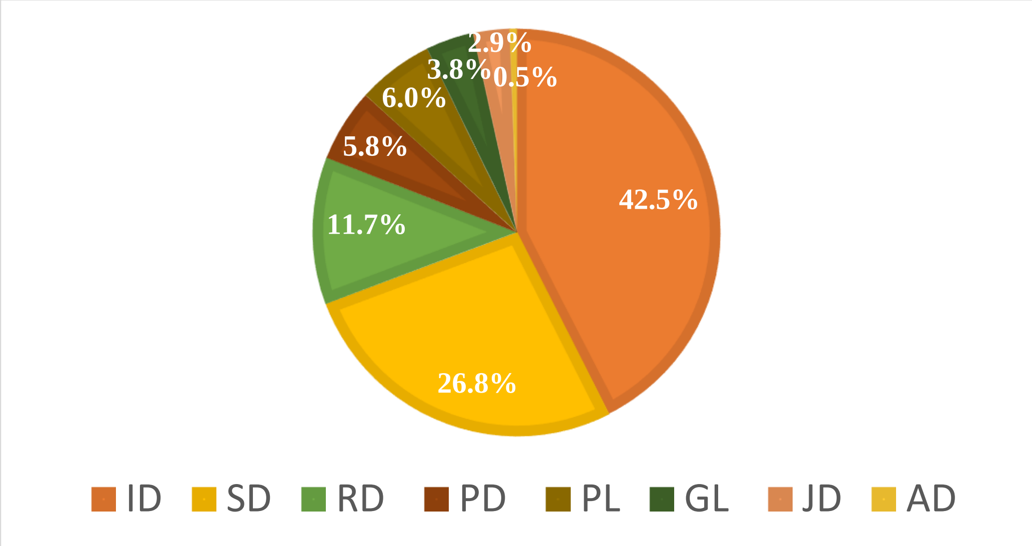
$$\mathrm{SOC_i} = \mathrm{p_i}(1 - (\frac{Qi{,}2mm}{100}))d_\mathrm{i}C_\mathrm{i} * 10^{-1}$$

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 Disscusion

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.

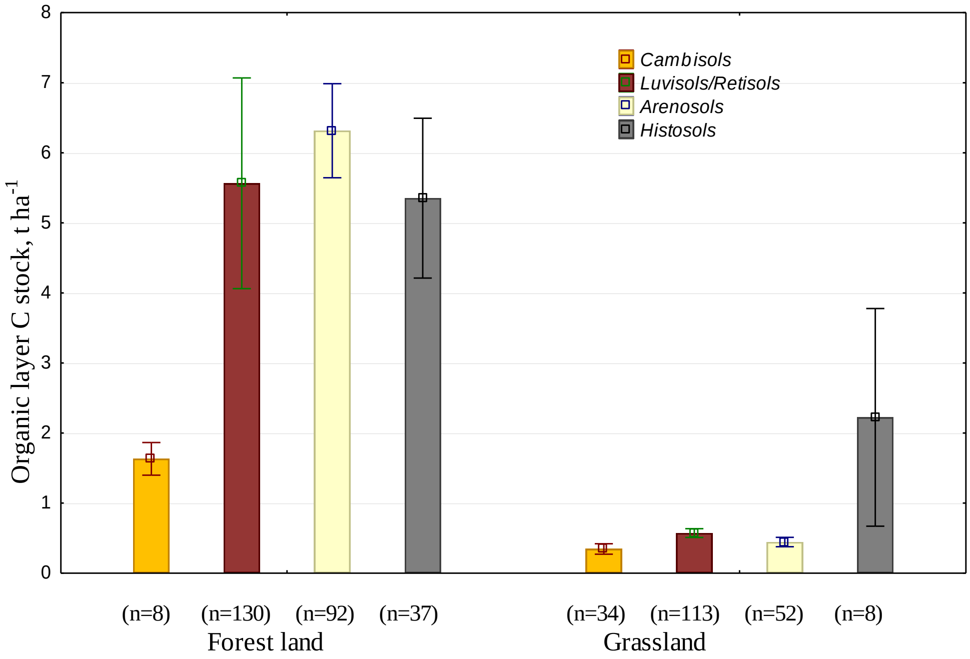


Fig. 4. Mean organic layer stocks of carbon in organic layer of different mineral soils in forest land and grassland (the bars represent SE)

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 sotcks 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, grasslan 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%)	-	-

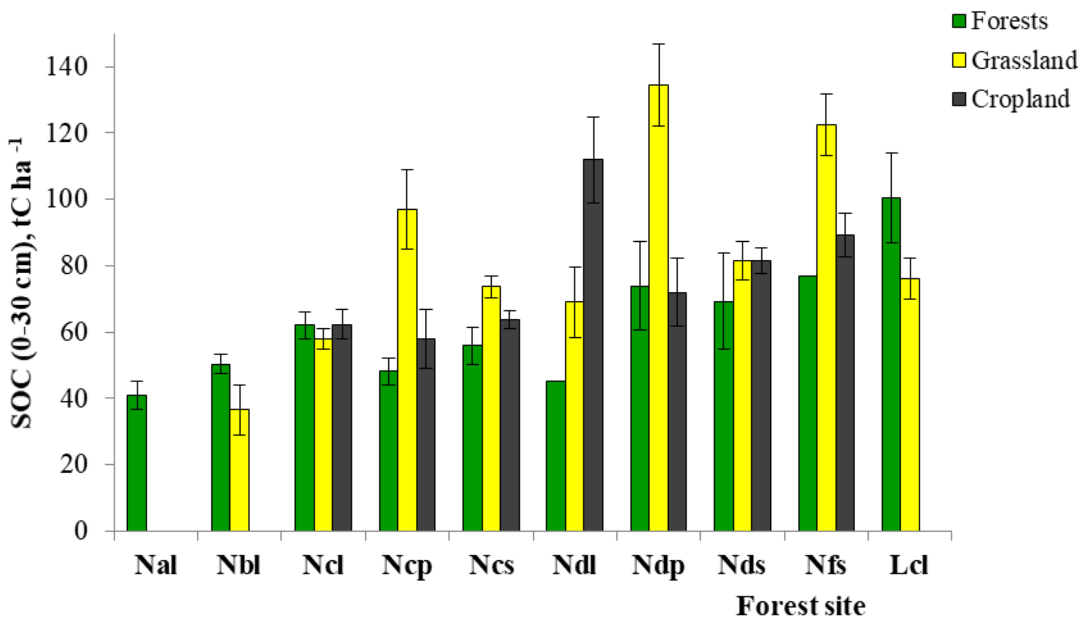


Fig. 5. Mean sotcks of soil organic carbon (SOC) in surface 0-30 cm layer of different forest sites (according Lithuanian classification, Vaičys et al., 2006)

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 XII. Improvements in response to UN reviews recommendations/encouragements

Review recommendation	***Paragraph No***	***Response/ status of implementation***	***Chapter/section in the NIR***
The ERT recommends that Lithuania report on changes undertaken or planned in response to the review process in its next annual submissions. The ERT encourages the Party to include in section 10.4 of the NIR a table containing the follow-up to previous review recommendations.	G.3	The description of the previous recommendations status is provided in the NIR Annexes.	NIR Annex XI
The ERT recommends that Lithuania report in the NIR the rationale for its calculation of the CPR, including the comparison of 90 per cent of the Party’s assigned amount with 100 per cent of eight times the most recently reviewed inventory.	G.4	Calculation of CPR is provided in the NIR.	NIR Chapter 12.5
The ERT recommends that Lithuania improve the transparency of the information in its NIR by including a follow-up to activities initiated in past years, as reported in previous NIRs, and ensure the reporting of any changes in its activities on the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol since the previous annual submission.	G.5	The newest data and follow-up activities initiated in past years, as reported in previous NIRs, any changes in activities on the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol since the previous annual submission are provided in Lithuania's 4th biennial report, chapter 5 (https://unfccc.int/sites/default/files/resource/BR4_2020_LT.pdf)	Reference to Lithuania's 4th bienial report is given in the NIR Chapter 15.

Lithuania provided a list of the typical constituents considered to form the non-biomass fraction of municipal waste in the NIR (section 3.3.1.3.1, p.75, and annex V, p.92), but not a quantitative assessment of biogenic and non-biogenic waste. During the review, the Party explained that the calorific value and carbon content were measured using 17 samples considered to represent the non-biomass fraction and 6 samples considered to represent the biomass fraction. The ERT noted that this information was not included in the NIR (see ID# E.11).	E.3	Information on measurements of the calorific value and the carbon content factors of waste is provided in the NIR.	Chapter 3.3.1.3.1 Combined Heat and Power Generation (CRF 1.A.1.a.ii)
The ERT recommends that Lithuania investigate the much higher difference in CO_2 emissions between the reference approach and the sectoral approach compared with the difference in energy consumption for liquid fuels in 2017 and report the relevant quantitative results in the NIR, as well as any actions undertaken to ensure the consistency of the reporting between the two approaches.	E.9	In the SA method for liquid fuels plant-specific and country-specific EFs are used, while in RA method for crude oil default EF is used and for oil products country-specific EFs are used. Performed calculation showed that emission factors of liquid fuels had impact more than 4% in 2017. The much higher difference in CO_2 emissions compared to the difference in energy consumption for liquid fuels in the year 2017 is explained in the NIR.	Chapter 3.2.2 Comparison of sectoral approach with the reference approach.

The ERT is of the opinion that peat should be treated in analogy to crude oil, as its processing only involves a conversion from a primary fuel into a secondary fuel (peat briquettes), and therefore recommends that Lithuania do not include peat in the feedstock and NEU of fuels in CRF table 1.A(d). For sulfur, the ERT recommends that the Party investigate if and how sulfur is used as a feedstock, how this is related to carbon emissions, if at all, and how an EF could be derived. Depending on the outcome of these investigations, the ERT recommends that Lithuania include appropriate information in the NIR and consider eliminating sulfur from the reporting of feedstocks and NEU of fuels or report any resulting emissions if they do occur.	E.10	Peat is not included in the feedstock and non-energy use of fuels table of the CRF in the NIR 2020 submission. Information about sulphur used as a feedstock is provided in the NIR.	Chapter 3.2.4 Feedstocks and non-energy use of fuels

The ERT recommends that Lithuania report information on the sampling and analytical procedures used for estimating CO_2 EFs for each fuel type in an annex to the NIR, including transparent information on changes in the CO_2 EFs over time, with a reference to the studies on which these changes are based. To improve consistency between different sections of the NIR, the ERT suggests that Lithuania group in one single table the CO_2 EFs applicable to all categories (e.g. CO_2 EFs for category 1.A fuel combustion). The ERT further recommends that Lithuania provide in the sections of the NIR for each subcategory, only additional information specific to this subcategory, such as plant-specific CO_2 EFs and how they were determined, in addition to a reference to the summary table containing the common CO_2 EFs and to the annex to the NIR.	E.11	All information is provided in the NIR.	Annex V. Country specific CO_2 emission factors. For plant-specific CO_2 EFs: chapters 3.3.1.3.2 Combined Heat and Power Generation (CRF 1.A.1.a.ii), 3.3.1.4.2 Heat plants (CRF 1.A.1.a.iii), 3.3.2.2 Petroleum Refining (CRF 1.A.1.b), 3.4.2 Manufacturing Industries and Construction (CRF 1.A.2).
In order to increase transparency and facilitate the assessment of completeness, the ERT recommends that Lithuania provide in the NIR information (e.g. in tabular format) compiling gasoline and diesel oil consumption under the different categories of the energy sector to show where these fuels are used.	E.12	Tables, showing gasoline and diesel oil use in the various categories where the fuels are consumed, are provided in the NIR.	ANNEX III. Lithuanian energy balance, tables 3-2 and 3-6.

In order to increase the transparency of the reporting, the ERT recommends that Lithuania include detailed information on subcategories 1.A.1.c.i manufacture of solid fuels and 1.A.1.c.ii other energy industries in the corresponding section of the NIR, including which activities are considered under these subcategories, and provide a brief explanation for the large increase in emissions during 2014–2017 and any subsequent changes.	E.13	Information on subcategories 1.A.1.c.i manufacture of solid fuels and 1.A.1.c.ii other energy industries, including which activities are considered under these subcategories, is provided in the NIR. An explanation for the large increase in emissions since 2014 is also provided in the NIR.	Chapter 3.3.3.1 Category description and chapter 3.3.3.1.2 Other Energy Industries (CRF 1.A.1.c.ii).
The ERT recommends that Lithuania reallocate the AD on and emissions from waste tyres used in the cement industry to category 1.A.2.f non-metallic minerals in the next annual submission. While the ERT commends the Party for including additional information on fuel use in the cement industry based on EU ETS information, it encourages the Party to explore whether the information on this additional waste stream used as fuel could also be included in the energy statistics to increase the consistency between the energy statistics and the GHG inventory AD.	E.14	Lithuanian Statistics included consumption of used tires in cement industry in the national fuel and energy balance as industrial waste (non-biomass fraction) from 2018. Hereby consistency between the energy statistics and GHG inventory activity data is increased.	Annex III. Lithuanian energy balance (table 3-37)
The ERT recommends that Lithuania continue reporting N_2O emissions from diesel oil use in cars and lightduty trucks using default N_2O EFs and a tier 1 approach until estimates calculated by the COPERT V model can be fully justified. If Lithuania decides to use the COPERT V model, the ERT recommends that the Party investigate and document in the NIR the reasons for the very low N_2O emissions calculated by the COPERT V model for cars and light-duty	E.15	N_2O emissions for diesel PC and LD vehicles are calculated using tier 3 method. The reasons for the low N_2O IEF calculated by the COPERT V model for passenger cars up to year 2004 were investigated and documented in the NIR.	Chapter 3.5.2.2 Methodological issues (table 3-30 and section "IEF value estimation")

trucks. In addition, the ERT recommends that Lithuania aim to improve the input parameters to allow the COPERT V model to provide more accurate and reliable estimates of N_2O emissions from these subcategories.			
In order to increase the transparency of reporting, the ERT recommends that Lithuania provide additional information in annex III to the NIR on the nature of distribution and transmission losses reported in the energy balance, why these losses are not considered to cause GHG emissions and how they relate to fugitive emissions in the GHG inventory.	E.16	Lithuanian Statistics confirmed that natural gas leakages into atmosphere until 2000 were reported in energy balance under “Transmission and distribution losses”. However, the change in the natural gas transmission and distribution accounting methodologies and the consultation with EUROSTAT have led to the conclusion that natural gas consumption, without which pipelines cannot operate, including releases to the atmosphere, should be considered as “pipeline consumption”. Since 2000 natural gas transmission and distribution losses and natural gas consumption in the pipeline are reported under “natural gas consumption in pipeline transport”. EUROSTAT did not require perform a recalculation of previous years data therefore natural gas leakages into atmosphere until 2000 are reported in energy balance under “Transmission and distribution losses” and since 2000 - under “natural gas consumption in pipeline transport”. Information on the nature of distribution and transmission losses of natural gas, liquid fuels, peat and waste reported in the energy balance as well as how they relate to fugitive emissions in the GHG inventory is provided in the NIR.	Chapter 3.9.3.2 Fugitive emissions from natural gas (CRF 1.B.2.b). ANNEX III. Lithuanian energy balance, asterisks below all tables.
The ERT recommends that Lithuania continue to report emissions from hydrogen production under category 1.B.2.a.6 and provide information on methodologies, AD and EFs in the appropriate section in the NIR. In order to prevent any double counting, the ERT encourages Lithuania to investigate together with Statistics Lithuania whether refinery gas consumption for hydrogen production is included in the	E.17	Estimates from hydrogen production are continued to report in the NIR 2020 submission. Lithuanian Statistics informed that refinery gas consumption for hydrogen production as intermediate process cannot be reported separately according to the international energy balance preparation principles. AB ORLEN Lietuva confirmed that refinery gas and hydrogen are not final products and not purchased as raw materials. Refinery gas and hydrogen are involved in chemical reactions at various facilities during the oil refining process therefore they cannot be included separately in national energy balance. This	Chapter 3.9.2.2 Fugitive emissions from oil (CRF 1.B.2.a)

energy balance for refinery gas and aim to make consistent the reporting of refinery gas consumption in the energy balance and in the GHG inventory.		information is provided in the NIR.	
The ERT recommends that Lithuania seek more information from the gas industry regarding the reported CO_2 and CH_4 emissions from the gas transmission and distribution network (methodology, AD, EFs and assumptions, etc.) and document this in the NIR.	E.18	Information regarding the reported emissions from the gas industry is provided in the NIR.	Chapter 3.9.3.2 Fugitive emissions from natural gas (CRF 1.B.2.b).
The ERT recommends to include in the NIR the explanation for the decrease in the amount of HFC-143a for the amount of gas “filled into new manufactured products” between 2013 and 2014 (from 3.53 t to 2.18 t) for subcategory 2.F.1.a (commercial refrigeration).	I.13	The explanation of decrease in the amount of HFC-143a for "filled into new manufactured products" between 2013 and 2014 is included in the NIR.	Chapter 4.7.1.2 Methodological issues (CRF 2.F.1)
Include in the NIR a brief explanation of the reason for the fluctuating trend in CO_2 emissions from flue gas desulphurization and report all emissions from limestone used in flue gas desulphurization under category 2.A.4.d Other (Other process uses of carbonates).	I.15	Information about the reasons for changes in CO_2 emissions from flue gas desulphurization were included in the NIR. All emissions from limestone used in flue gas desulphurization were reported under category 2.A.4.d Other (Other process uses of carbonates).	Chapter 3.3.1.5.1 Methodological issues (CRF 2.A.4.d)
The ERT encourages Lithuania to work together with the secretariat to try to fill in all the necessary cells and resolve the issue of reporting blank cells in the CRF tables.	I.16	All the necessary cells were filled in and the issue of reporting blank cells were resolved.	CRF
The ERT recommends that Lithuania correct the uncertainty estimate of the CO_2 EFs, correct the related calculations and present the estimation method and uncertainty values used in the NIR of the next annual submission.	I.17	CO_2 EFs uncertainty were corrected and estimation method and values reported in the NIR.	Chapter 4.2.2.3 Uncertainties and time-series consistency (CRF 2.A.2)

The ERT recommends that Lithuania estimate the country-specific correction factor for hydrated lime, apply it in the calculations for the entire time series and report the revised CO_2 emissions in the next annual submission.	I.18	The country-specific correction factor for hydrated lime were estimated and applied in the calculations for the entire time series and revised emissions were reported in the NIR.	Chapter 4.2.2.2 Methodological issues (CRF 2.A.2) 4.2.2.5 Category-specific recalculations (CRF 2.A.2)
The ERT recommends that Lithuania provide in the NIR clear information concerning the completeness of the AD used and concerning the derivation of the CaO content in lime from the composition of limestone obtained from a single quarry in the country.	I.19	Information regarding AD used and the CaO content in lime from the composition of limestone obtained from a single quarry in the country were reported in the NIR.	Chapter 4.2.2.2 Methodological issues (CRF 2.A.2)
The ERT recommends that Lithuania correct the estimated CO_2 EF for high-calcium lime production and revise and report the emission estimates in the next annual submission.	I.20	The used CO_2 EF for the high-calcium lime production were corrected and revised emissions were provided in the NIR.	Chapter 4.2.2.2 Methodological issues (CRF 2.A.2) 4.2.2.5 Category-specific recalculations (CRF 2.A.2)
The ERT recommends that Lithuania report CO_2 removals from the consumption of carbonates in the sugar production industry under category 2.H.2 food and beverages industry.	I.21	CO_2 removals from consumption of carbonates in the sugar production industry were reported in category 2.H.2 food and beverages industry.	Chapter 4.9.2 Food and beverages industry (CRF 2.H.2)
The ERT recommends that Lithuania include information on the method and time period used for estimating the average plant-specific EFs used for estimating CO_2 emissions for 1990–1998 for the first plant; 1990–2003 for the second plant; and 1990–2004 for the third plant in the NIR of the next annual submission.	I.22	Information about the method used for estimation of the EF used for extrapolation were included.	4.2.3.2 Methodological issues (CRF 2.A.3)
The ERT recommends that Lithuania report all CO_2 emissions from fuel consumption	I.23	The comparison of CO2 emissions from ammonia production (process emissions) vs total CO2 emissions from ammonia	4.3.1.2 Methodological issues (CRF 2.B.1)

(used as feedstock and fuel) under category 2.B.1 ammonia production in accordance with the 2006 IPCC Guidelines.		production (process and combustion emissions) and difference in associated IEFs were provided in the NIR.	
The ERT recommends that Lithuania include in the NIR historical information on imported urea and its uses and explain whether all other uses of urea are allocated to category 2.B.1 ammonia production.	I.24	Information regarding import of urea were included in the NIR.	4.3.1.2 Methodological issues (CRF 2.B.1)
The ERT recommends that Lithuania include in the section of the NIR for category 2.D.3 a clear reference to the section of the NIR where the methodology, AD and EF used for estimating CO_2 emissions from urea based catalysts are presented.	I.25	In the section of the NIR for category 2.D.3 the information were added that methodology, AD and EF used for CO_2 emissions estimation from the use of the urea-based catalyst in transport were reported in the energy sector chapter of the NIR under the category 1.A.3 transport (NIR, chapter 3.5.3).	4.5.3.1 Category Description (CRF 2.D.3)
The ERT recommends that Lithuania improve the transparency of the NIR by clearly indicating that CF_4 and C_2F_6 emissions do not occur under category 2.E.3 photovoltaics.	I.26	Notation keys for CF_4 and C_2F_6 under category 2.E.3. were added in CRF and relevant information was included in the NIR.	NIR Chapters 4.6.3.1 Category Description and 4.6.3.2 Methodological issues (CRF 2.E.3)
The ERT recommends that Lithuania include in the NIR information on the change in the trend of HFC emissions from category 2.F.1 refrigeration and air conditioning in 2017 and any subsequent changes in the trend of HFC emissions.	I.27	Information on the change in the trend of HFC emissions in 2017 were included in the NIR.	Chapter 4.7. Methodological issues (CRF 2.F.)
The ERT recommends that Lithuania include in the NIR a clear description of the method used for estimating the HFC-23 emissions for category 2.F.3 fire protection.	I.28	The description of the method used for estimation of the HFC-23 emissions were included in the NIR.	Chapter 4.7.3.2 Methodological issues (CRF 2.F.3)
The ERT recommends that Lithuania include the revised values for CO_2 emissions for category 2.H.3 use of	I.29	The revised values for the CO_2 emissions for flue gas desulphurization category using the correct assumptions on pure carbonate were included in the NIR.	Chapter 3.3.1.5.2 Methodological issues (2.A.4.d)

carbonates for flue gas desulfurization using the correct assumptions on pure carbonate for AD in the next annual submission.			
The ERT encourages Lithuania to use the tier 2 method for estimating CO_2 emissions for category 2.H.3 use of carbonates for flue gas desulfurization in order to improve the accuracy of the inventory.	I.30	The tier 2 method for estimating CO_2 emissions for flue gas desulphurization category was used.	Chapter 3.3.1.5.2 Methodological issues (2.A.4.d)
There are still inconsistencies in the use of subcategory names for non-dairy cattle; for example, in table 5-8 of the NIR, two-yearold bulls and older bulls, and dairy and nondairy cattle sires are grouped in the same subcategory, while in tables 5-12, 5-15 and 5-27 of the NIR and A.5-38 of annex VII to the NIR they are separated into two different subcategories.	A.1	The recommendation was implemented.	NIR Tables 5-8; 5-12; 5-15; 5-27 NIR Annexes Table A.5-38
Report consistent CH4 EFs for nondairy cattle in the NIR and in CRF table 3.As1.	A.4	Consistent CH4 EFs for non-dairy cattle was reported in the NIR and CRF.	NIR Table 5-15 CRF Table 3.As1.
Correct the inconsistencies in the average diet nutrition indicators (NIR, p.315, table 5-24), GE and EFs for sheep (NIR, p.315, table 5- 25) so that the calculations can be replicated, and report, in its NIR, correct and consistent values for the average diet nutrition indicators (crude protein, crude fat, crude fibre, N-free extracts and dm), GE and consumption of each feedstuff for all sheep subcategories.	A.6	The recommendation was implemented.	NIR Table 5-17 NIR Annexes Tables A5-31 – A5-36
When using the parameters from table A.5-39 of the annex to the NIR to calculate GE values, the ERT found slightly different values from those reported in table 5-16, except for growing pigs (50–80 kg) and gilts for breed.	A.8	Values of diet nutrition indicators were checked in order to avoid inconsistencies between parameters.	NIR Table 5-16 NIR Annexes Tables A5-19 – A5-36 and Table A5-39

In the NIR, remove all references to the N2O EF reported for dry lot and explain that management of manure in dry lots does not occur in the country.	A.10	Recommendation was implemented and explanation is provided in the NIR.	NIR Chapter 5.1 Overview of sector
The ERT recommends that Lithuania include in the NIR a description of the improvements of the estimates of CH4 emissions from enteric fermentation, firstly on the refining of the number of suckling cows that affects the GE estimate, and secondly in the calculation of the annual average fur-bearing population.	A.17	Statistics Lithuania updated data on the number of suckling cows, therefore this data was updated in the NIR. Regarding annual average fur-bearing population explanation is provided in the NIR.	NIR Chapter 5.2.2 Methodological issues
Since the digestibility of feed is the key parameter for estimating volatile solids and thus CH4 and N2O emissions from manure management, to improve the accuracy of the emission estimates, the ERT recommends that Lithuania conduct a study to develop country-specific data on feed digestibility, and when available, apply these data for estimating CH4 and N2O emissions, and update the information reported on the manure management category in the NIR.	A.18	Study to develop country-specific data on feed digestibility is under implementation.	
The ERT recommends that Lithuania report under category 3.D.a.2.a animal manure applied to soils the estimated N2O emissions from bedding per animal species using the results from the survey on the amount of N in bedding per animal species. To avoid double counting, the ERT also recommends that Lithuania correct the FracREMOVE value under category 3.D.a.4 crop residues and use a country-specific FracREMOVE value.	A.12 A.14 A.19	Lithuania has reported under the category 3.D.a.2.a animal manure applied to soils the estimated N2O emission from bedding per animal species and accordingly updated the FracREMOVE values under the category 3.D.a.4 crop residues.	Chapter 5.6.1.2 Methodological issues (Animal manure applied to soils (F_{AM}) (CRF 3.D.1.2.a) and Crop residues (F_{CR}) (CRF 3.D.1.4))

The ERT recommends that Lithuania correct this explanation in the NIR (in the agriculture sector section), stating explicitly that CH4 emissions from anaerobic digesters are included in the waste sector.	A.20	Explanation regarding CH4 leakage from anaerobic digestion system is provided in the NIR.	Chapter 5.3.2 Methodological issues
The ERT considers that the explanation and information provided by Lithuania are reasonable, and recommends that Lithuania explain in the NIR that the mean FracleachMS values from the 2018 annual submissions of Estonia and Latvia were used in the 2019 annual submission because the 2006 IPCC Guidelines do not provide default values of FracleachMS, and a justification for the selection of those FracleachMS values.	A.21	During the 2019 EU ERT review experts noted that in category 3.B.2. the amount of N applied with animal manure in 3.D.1.2.a is too large as compared to N managed in MMS minus N lost as NH3+NOx or leaching, this issue ocurred due to average FracleachMS values from Estonia and Latvia used. Therefore in the 2020 NIR Lithuania has used 2019 IPCC Refinement to the 2006 IPCC Guidelines as no national FracleachMS values are available.	Chapter 5.4.2.2 Methodological issues
The ERT recommends that Lithuania determine and evaluate the differences between the IFA and Statistics Lithuania databases when data on N fertilizer consumption are made available in both databases, report the findings and the effects on the estimation of N2O emissions in the NIR and use for the calculations the data from the source that provide a more accurate and consistent estimate of emissions.	A.22	Explanation on differences between IFA and Statistics Lithuania databases is provided in the NIR.	Chapter 5.6.1.4 Category-specific QA/QC and verification
The ERT recommends that Lithuania report in the NIR that N2O emissions from subcategory 3.D.a.5 have not occurred since 2015, and provide documented explanations as to why emissions ceased in 2015.	A.23	Explanation is provided in the NIR.	NIR Chapter 5.6.1.2 Methodological issues (Mineralization/Immobilization associated with loss/gain of soil organic matter (FSOM) (CRF 3.D.1.5)

Report CSC in soils for forest land converted to settlements and other land across the whole 20-year period, or provide a justification for the assumption in the 2016 submission of instantaneous oxidation of soil organic matter in the year of conversion.	L.1	The recommendation was implemented.	NIR Ch. 6.5.2.2, 6.6.2.2, 6.7.2.2.
Justify the modification of equation 2.8 from the 2006 IPCC Guidelines and, when modifying any equation from the 2006 IPCC Guidelines, provide transparent information regarding the reasons for doing so.	L.3	The recommendation was implemented.	NIR Ch. 6.2.2.1 Forest land remaining forest land
The ERT recommends Lithuania to apply the correct values of carbon stock for cropland (for cropland containing annual crops, the 2006 IPCC Guidelines indicate a default of 4.7 t C/ha or 10 t dm/ha (p.6.27, section 6.3.1.2) and, for croplands containing perennial crops, the suggested default value is 63 t C/ha (p.5.9, table 5.1)) before conversion to other land uses to avoid underestimating the net emissions.	L.8	The recommendation was implemented.	NIR Chapters: 6.4.2.2 Land converted to grassland, 6.5.2.5 Land converted to flooded land, 6.6.2.2 Land converted to settlements, 6.7.2.2 Land converted to other land
The ERT recommends Lithuania to correct the fraction of organic soils in land converted to cropland (0.7 per cent instead of 10.5 per cent) reported in the NIR.	L.10	The recommendation was implemented. Lithuania has updated national fraction of organic soils in forest land, cropland grassland, using the most recent National Forest Inventory data: NFI 2014 – 2018. Organic soils constitute of 13.6 percent in forest land remaining forest land and forest land converted to other land uses, 6.6 percent of grassland remaining grassland and grassland converted to other land uses, 1.1. percent of cropland remaining cropland and cropland converted to other land uses.	NIR Chapters: 6.3.2.2 Land converted to cropland, 6.4.2.2. Land converted to grassland, 6.6.2.2 Land converted to settlements, 6.7.2.2 Land converted to other land.

The ERT recommends Lithuania to use above-ground biomass and/or living biomass carbon stocks in accordance with the 2006 IPCC Guidelines when estimating CSC in biomass for conversions from cropland, grassland, wetlands and other land to settlements.	L.11	The reommendation was implemented.	NIR Chapter 6.6.2.2.
The ERT recommends Lithuania to review and, if necessary, revise the values of assumed carbon stocks for the land-use categories cropland and grassland prior to conversion for all conversions from cropland and grassland reported to ensure that the estimates of CSC are not underestimated and are in accordance with the 2006 IPCC Guidelines.	L.12	The recommendation is implemented.	NIR Chapters: 6.3.2.2 Land converted to cropland, 6.4.2.2 Land converted to grassland, 6.5.2.5. Land converted to flooded land, 6.6.2.2. Land converted to settlements, 6.7.2.2 Land converted to other land.
The ERT recommends that Lithuania explain why it assumed that DOM in a previous state before conversion (e.g. cropland) was zero in the NIR and seek to obtain information on the DOM pool, particularly for perennial crops, including information on expert judgment from relevant experts in the country.	L.18	The recommendation was implemented. Lithuania has no estimates of the dead wood and litter in the initial land-use systems (except Forest land and Grassland) prior to conversion. Carbon stock gain was estimated in cropland, settlements and other land converted to grassland, while carbon stock loss in litter was estimated in forest land converted to grassland. It is assumed that dead wood and litter stocks are not present in annual crops in Cropland category or are at equilibrium in agroforestry systems and orchards, in addition to this, no dead wood was identified in cropland during the National Forest Inventory measurements.	NIR Chapters: 6.2.2.2 Land converted to forest land, 6.3.2.2 Land converted to Cropland, 6.4.2.2 Land converted to Grassland
The ERT encourages Lithuania to assume that all conversions of settlements to other land-use categories occur in lands with herbaceous vegetation, for which the biomass immediately before conversion (BBEFORE) can be assumed to be equal to	L.19	The recommendation was implemented.	NIR Chapters: 6.3.2.2 Land converted to Cropland and 6.4.2.2 Land converted to Grassland

zero, and continue not to report any increase in carbon stock in biomass after the conversion of other land-use categories to settlements.			
The ERT recommends that Lithuania use the correct notation key “NA” instead of “NO” when applying the assumption under the tier 1 approach that there is no CSC in a pool, and use “NO” instead of “NE” when a conversion is not observed in a given year.	L.20	The recommendation was implemented. Notation Keys changed from NO to NA in cropland remaining cropland dead organic matter carbon pool; grassland remaining grassland living biomass, dead organic matter and mineral soil carbon pool; settlements remaining settlements living biomass, dead organic matter and mineral soil carbon pools.	CRF tables: 4.B.1 Cropland remaining cropland; 4.C.1 Grassland remaining grassland; 4.E.1 Settlements remaining settlements
The ERT recommends that Lithuania, when defining the parameters used for estimating the annual CSC in deadwood in forest land remaining forest land, not refer to managed forest land in the NIR to avoid confusion as to the status of the management of forest land, since all forest land in the country is managed.	L.21	The recommendation was implemented.	NIR Chapter 6.2.2.1 Forest land remaining forest land
The ERT recommends that Lithuania include in the NIR an explanation that the below-ground biomass from stumps left on the ground after harvesting is transferred to the dead organic carbon pool and decayed linearly over a five-year period.	L.22	The recommendation was implemented.	NIR Chapter 6.2.2.1 Forest land remaining forest land
The ERT recommends that Lithuania revise the equation presented in the NIR (p.348) and delete the term “ΔVnew (GSV increment)” since it is no longer used or, in case the term is maintained, explain the measures taken to ensure that the annual change in GSV is not overestimated.	L.23	The recommendation was implemented.	NIR Chapter 6.2.2.1 Forest land remaining forest land

The ERT recommends that Lithuania 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.24	Addressing. Lithuania is planning to improve carbon stock changes estimation in forest land carbon pool, performing primary analysis of scientific studies in order to obtain reliable data of carbon stock changes in litter pool in forest land remaining forest land.	NIR Chapter 6.2.7 Category-specific plannned improvements.
The ERT recommends that Lithuania estimate N2O emissions from drainage of mineral forest soils. In case the Party cannot report these emissions, the ERT recommends that the Party use the notation key "NE" instead of "NO" in CRF table 4(II), since N2O emissions may occur but are not assessed owing to a lack of data, and provide, in the NIR of the next annual submission, information on improvements undertaken to estimate these emissions in case the Party is unable to report these emissions.	L.25	The recommendation was implemented. There is no table for information about drained forest mineral soils available in CRF, only the table for rewetted mineral forest soils is present. There are no rewetted mineral soils in Lithuania, therefore it is reported as NO.	CRF Table 4 (II) Emissions and removals from drainage and rewetting and other management of organic and mineral soils
The ERT recommends that Lithuania specify in the NIR the correct reference to the values used in the comparison with those in table 4.5 of the 2006 IPCC Guidelines (vol. 4, chap. 4, section 4.5, p.4.50) to improve the transparency of the GHG inventory.	L.26	The recommendation was implemented.	NIR Chapters: 6.2.2.1 Forest land remaining forest land, 6.2.2.2 Land converted to forest land
The ERT recommends that Lithuania use separate carbon fraction values of above-ground forest biomass for coniferous and broadleaved stands from the 2006 IPCC Guidelines when calculating CSCs in above-ground biomass in land converted to forest land in its next annual submission.	L.27	The recommendation was implemented.	NIR Chapters: 6.2.2.1 Forest land remaining forest land, 6.2.2.2 Land converted to forest land

The ERT recommends that the Party include information on the country-specific values for MB and Cf used to estimate non-CO2 emissions from biomass burning in the NIR of the next annual submission.	L.28	The recommendation was implemented.	NIR Chapters: 6.2.2.1 Forest land remaining forest land, 6.2.2.2 Land converted to forest land
The ERT recommends that Lithuania discount the litter carbon stock accumulated in agricultural land converted to forest land only in the first year after the conversion and ensure a consistent use of methods for estimating CSCs from conversion. The ERT also recommends that, if litter is not a significant pool, Lithuania apply a tier 1 method from the 2006 IPCC Guidelines (vol. 4, chap. 1, section 5.2.2.1, p.5.13), assuming the value for the dead organic carbon pool as zero. If this method is applied, the ERT further recommends that Lithuania apply it consistently to the issues identified in ID#s L.31 and L.34 below.	L.29	The recommendation was implemented.	NIR Chapter 6.2.2.2 Land converted to forest land
The ERT recommends that Lithuania report in the next annual submission emissions from the biomass burning of perennial crops and provide in the NIR information on the MB and Cf used to estimate non-CO2 emissions from biomass burning in cropland remaining cropland by type of crop (annual/perennial).	L.30	The recommendation was implemented.	NIR Chapter 6.3.2.1 Cropland remaining cropland
The ERT recommends that Lithuania 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	L.31	0.4 t C ha-1 was estimated as national value of litter carbon stock in grassland previous to conversion to forest land. Average litter carbon stock in all grassland is estimated to be 0.8 t C ha-1 (national value). No litter carbon stock was estimated in cropland during the study implemented to obtain national carbon stock values in soils and litter of various land	NIR Chapters: 6.2.2.2 Land converted to forest land, 6.3.2.2 Land converted to cropland and 6.4.2.2 Land converted to grassland

different value.		uses, therefore carbon stock change in litter of grassland converted to cropland was estimated as carbon stock losses, applying litter carbon stock value of grassland. However, Lithuania is considering to develop (applying literature analysis and/or expert judgment) national carbon stock value in litter of perennial cropland.	
The ERT recommends that Lithuania apply the value 0.8 t C/ha when estimating DOM in conversions to and from grassland in the next annual submission to enhance the completeness of reporting.	L.32	The recommendation was implemented.	NIR Chapters: 6.2.2.2 Land converted to forest land, 6.3.2.2 Land converted to cropland, 6.4.2.2 Land converted to grassland, 6.5.2.5 Land converted to flooded land, 6.6.2.2 Land converted to settlements and 6.7.2.2 Land converted to other land
The ERT recommends that Lithuania provide the explanation regarding the value used for the annual increase in carbon stocks in biomass due to growth and that grassland achieves its steady-state biomass during the first year following conversion and hence no annual growth is reported thereafter in the NIR of the next annual submission to increase the transparency of the reporting.	L.33	The recommendation was implemented.	NIR Chapter: 6.4.2.2 Land converted to grassland
The ERT recommends that Lithuania report in CRF table 4.C the CSCs in litter from the conversion of perennial crops to grassland and, if applying a value different from 0.4 t C/ha, explain in the NIR the reason for using a different value.	L.34	0.4 t C ha-1 was estimated as national value of litter carbon stock in grassland previous to conversion to forest land. Average litter carbon stock in all grassland is estimated to be 0.8 t C ha-1 (national value). No litter carbon stock was estimated in cropland during the study implemented to obtain national carbon stock values in soils and litter of various land uses, therefore carbon stock changes in cropland converted to grassland were estimated only as litter carbon stock gains due to annual cropland converted to grassland, applying litter	NIR Chapters: 6.3.2.2 Land converted to cropland and 6.4.2.2 Land converted to grassland

		carbon stock value of grassland. However, Lithuania is considering to develop (applying literature analysis and/or expert judgment) national carbon stock value in litter of perennial cropland.	
The ERT recommends that Lithuania report in the NIR the methodology and values applied to estimate the CSCs from the conversion of forest land to flooded land, if applicable.	L.35	The recommendation was implemented.	NIR Chapter 6.5.2.5 Land converted to flooded land
The ERT recommends that Lithuania provide in the NIR the justification for simplifying equation 11.1 from the 2006 IPCC Guidelines (vol. 4, chap. 11, section 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. The ERT also recommends that Lithuania provide the corresponding information in the NIR and CRF table 4(I).	L.36	The recommendation was implemented.	NIR Chapters 6.3.2.2 Land converted to cropland, 6.4.2.2 Land converted to grassland, 6.5.2.5 Land converted to flooded land, 6.6.2.2 Land converted to settlements and 6.7.2.2 Land converted to other land
The ERT recommends that Lithuania provide in the NIR the justification for the simplification of equation 11.10 from the 2006 IPCC Guidelines (vol. 4, chap. 11, section 11.2.2.1, p.11.21), which excludes synthetic N fertilizers (known as FSN); managed animal manure, compost, sewage sludge and other organic N additions applied to soils (known as FON); urine and dung N deposited by grazing animals (known as FPRP); and N in crop residues (above- and below-ground), including N-fixing crops and N from forage/pasture renewal, returned to	L.37	The recommendation was implemented.	NIR Chapters 6.3.2.2 Land converted to cropland, 6.4.2.2 Land converted to grassland, 6.5.2.5 Land converted to flooded land, 6.6.2.2 Land converted to settlements and 6.7.2.2 Land converted to other land

soils annually (known as FCR) from the calculation of indirect N2O emissions from leaching/runoff from managed soils, and include a related explanation in the documentation box of CRF table 4(IV).			
The ERT recommends that Lithuania correct the inconsistencies between the data in the NIR and CRF table 4.G (sheet 2), and provide updated production, export and import data in the next annual submission, as well as additional information on the factors used to convert product units to carbon units in CRF table 4.G (sheet 2).	L.38	The information was updated and lacking information was filled, inconsistencies between NIR and CRF Table 4.G were corrected.	CRF Table 4.Gs2; NIR Table 6.44
The ERT identified significant inter-annual changes in the CH4 IEF values (an increase of 42.9 per cent from 1992 to 1993) and in the amount of sludge removed (kt DC/year) (an increase of 62.0 per cent from 1991 to 1992 and a decrease of 51.0 per cent from 1992 to 1993) under category 5.D.1 domestic wastewater. Furthermore, the ERT identified that NOX and carbon monoxide emissions from category 5.A solid waste disposal are reported as “NA” for the entire time series, except for 2003, when “NE” is used for NOX emissions from unmanaged solid waste disposal sites under category 5.A.2 unmanaged waste disposal sites. In response to a question raised by the ERT, Lithuania explained that erroneous values for the total organic product and sludge removal were reported in the CRF tables for 1992, but the emissions were reported correctly. The correct value for the total organic product is 113.02 kt DC/year,	W.2	We believe ERT recommendation should be read as "use appropriate notation key ("NA")" The correct data for total organic product and sludge removal in CRF tables for category 5.D.1 domestic wastewater and appropriate notation key (“NA”) for NOx and CO emissions in the CRF tables for category 5.A.2 unmanaged waste disposal sites have been reported.	CRF Tables 5, 5.D

resulting in a CH4 IEF of 0.15kg/kg DC for 1992, while the correct value for sludge removal is 17.11 kt DC/year, resulting in inter-annual changes of –9.0 per cent for 1991–1992 and –12.7 per cent for 1992–1993. Furthermore, Lithuania explained that "NE" was erroneously reported for NOX emissions in 2003, and the notation key "NA" should be applied instead. The ERT recommends that Lithuania report the correct data for the total organic product and sludge removal in CRF table 5.D for category 5.D.1 domestic wastewater in 1992 and use the appropriate notation key ("NE") for NOX and CO emissions for the entire time series in CRF table 5 for category 5.A.2 unmanaged waste disposal sites in the next annual submission.			
The ERT recommends that Lithuania correct the misallocation of small town landfills, report them as unmanaged-deep waste disposal sites in CRF table 5.A, and report consistent information on small town landfills in the NIR and CRF tables in the next annual submission.	W.3	The small town landfills has been reported as unmanaged deep waste disposal site in the CRF, the consistent information on small town landfills in the NIR and CRF tables has been reported	CRF Tables 5.A; Chapter 7.2.1
The ERT recommends that Lithuania provide information on the assumptions and parameters used for estimating CH4 for energy recovery in the NIR.	W.4	The parameters and assumptions are provided in the NIR	Chapter 7.2.1 and 7.3.1

The ERT recommends that Lithuania provide clearly documented information in the NIR on any assumptions made for reporting estimates of the amount of CH4 flared, which should be reported only if the data are based on metering or substantiated and verified assumptions.	W.5	As information on assumptions used by personnel of the flaring systems for the estimation of the flared landfill gas is not available, the amount of flared CH4 was revised during the review week and assumed to be zero, consistent with the default value for flared landfill gas.	Chapter 7.2.1
The ERT recommends that Lithuania use the correct uncertainty values for the methane correction factor (fraction treated anaerobically) in shallow lagoons and untreated systems and latrines when assessing the overall uncertainty of category 5.D wastewater treatment and discharge in the next annual submission.	W.6	The correct uncertainty values have been used	Chapter 7.5.3
The ERT recommends that Lithuania report the correct source of information on protein consumption per capita in the NIR and provide justification of any observed trends as far as possible. In addition, the ERT encourages Lithuania to investigate all possible causes as to why the protein consumption per capita in the country is among the lowest of all reporting Parties, to investigate the significant differences compared with FAOSTAT data and to report the related results in the NIR of its next annual submission.	W.7	The information are reported in the NIR	Chapter 7.5.2
The ERT recommends that Lithuania report consistent information on the factor for industrial and commercial co-discharged protein into the sewage system (known as FIND-COMM) in the NIR and the CRF tables	W.8	The FIND-COMM factor was corrected in the CRF	CRF 5.D

in the next annual submission.			
The ERT recommends Lithuania to ensure the use of correct values of BBEFORE by using values for biomass stocks immediately before conversion, in accordance with the 2006 IPCC Guidelines, since the values used in the 2017 submission could lead to an underestimation of CO2 emissions from AR.	KL.1	The recommendation was implemented.	NIR Ch. 11.3.1. Methods for carbon stock change and GHG emission and removals estimates
The ERT recommends that Lithuania clarify in the NIR that the plantations were not disaggregated into coniferous or deciduous plantations for the data for AR reported in table 11-10 of the NIR. The ERT further recommends that Lithuania include a table for FM with similar data to those in table 11.10.	KL.5	Recommendation was implemented.	11.3.1.1 Description of the methodologies and the underlying assumptions used
The ERT encourages Lithuania to explore the use of high-resolution satellite data for validating the AR, deforestation and FM area change estimates, for example by using the freely available OpenFORIS – CEnsure the use of correct values of BBEFORE by using values for biomass stocks immediately before conversion, in accordance with the 2006 IPCC Guidelines, since the values used in the 2017 submission could lead to an underestimation of CO2 emissions from AR.ollect Earth (see http://www.openforis.org/tools/collect.html), which is a tool that enables data	KL.6	Lithuania will consider application of high resolution satellite imagery data to validate areas and area changes of afforestation/reforestation, deforestation and forest management activities. Satellite images could be important additional data source to verify accuracy of the spatial data (GIS-layers) applied for estimation of areas of afforestation/reforestation and deforestation activities, as provided by national Paying Agency and State Forest Cadaster for annual GHG inventory.	11.2 Land related information

collection through Google Earth that can be used for a wide variety of purposes, including validating existing maps and estimating AR, deforestation and FM areas and area changes.			
The ERT recommends that Lithuania revise the equation presented in the NIR (p.526) and delete the term "ΔVnew (GSV increment)" since it is no longer used or, in case the term is maintained, explain the measures taken to ensure that the annual change in GSV is not overestimated.	KL.7	Recommendation was implemented.	11.3.1.1 Description of the methodologies and the underlying assumptions used