REPUBLIC OF ESTONIA
MINISTRY OF CLIMATE

Explenatory note to Article 18 of Regulation (EU) 2018/1999 reporting

Estonia

Estonia 2024

PREFACE

According to article 18 of Regulation (EU) 2018/1999 Member States shall communicate to the Commission any substantial changes to the information reported pursuant to paragraph 18(1) during the first year of the reporting period, by 15 March of the year following the previous report.

In 2024 Estonia has updated GHG projections up to 2050 in energy, transport, agriculture and LULUCF sectors and is therefore submitting updated projections and policies and measures in Reportnet 3 datasets as well as explenatroy report herewithin.

The explanatory note was compiled by Estonian Environmental Research Centre.

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1. GENERAL INFORMATION

1.1. Information on changes to national system for reporting on policies and measures and projections

Information on changes to the national system is included in Reportnet 3 dataset on National systems for policies and measures and projections.

2. INFORMATION ON POLICIES AND MEASURES

When updating the GHG projections in 2024, the definitions of the WEM and WAM scenarios were reviewed specifically for Estonia, so it would be clear for everyone which measures were considered part of the WEM and which for WAM scenarios. As an agreement between the ministries, the existing measures (adopted and implemented) in the context of the WEM scenario of GHG projections are considered to be:

1) measures that have been approved/decided by the government or other national institution (including in the margins of the State Budget Strategy and/or in the State Budget, and in the implementation plans of strategic development plans).
2) in the case of the measure type "economic incentives", the measure has an approved regulation on the conditions of the measure or one that will be approved in the near future.
3) measures other than "economic incentives" (e.g. updating standards and/or rules, advice or information etc.) that have a dedicated or clearly planned workstream are also accounted as an existing measures.

As an agreement between the ministries, additional measures (planned) in the context of the WAM scenario of GHG projections are considered to be:

1) Planned measures from sectoral development plans (including those that do not yet have a decision on the specific amount of funding or time scale).
2) goals reflected in the draft directives (if these goals are very likely to be adopted as they are).

The updated list of policies and measures is presented in Reportnet 3 dataset GovReg: Integrated National Policies and Measures [2024].

3. PROJECTED GREENHOUSE GAS EMISSIONS UNTIL 2050

In 2024, the GHG projections were updated in the energy, transport, agriculture and land use, land use change and forestry (so-called LULUCF) sectors. Projections for the industrial processes and product use and waste sectors were not updated in 2024, i.e. the most recent GHG projections are those from the 15.03.2023 submission to the European Commission.

In the 2024 GHG projections update, different inventory submissions have been used for the base year 2020/2021 - the base year of 2021 for the energy, transport and agriculture sectors is

in line with the 2023 national GHG inventory report (2023) submitted by Estonia to the UNFCCC on April 15, 2023. The GHG projections of the LULUCF sector are prepared based on the GHG inventory of 2024. The base year 2020 for the industrial processes and product use (IPPU) and waste sectors are in accordance with the 2022 national GHG inventory report (2022) submitted by Estonia to the UNFCCC on April 15, 2022, using IPCC AR5 global warming potential values.

GHG projections until 2050 in the energy, transport, industrial processes and product use, agriculture and land use, land use change and forestry sectors have been prepared in two scenarios - "with existing measures" (WEM) and "with additional measures" (WAM). For the waste sector, only WEM scenario was prepared.

The 'With Existing Measures' (WEM) scenario evaluates future GHG trends under current policies and measures. In the second scenario a number of additional measures and their impact were taken into consideration, forming the basis of the 'With Additional Measures' (WAM) scenario.

3.1. Key assumptions and parameters used

The key underlying assumptions used in the projections are presented in Reportnet 3 dataset Table 2 and Table 3.

3.2. Sectoral WEM and WAM projections

Detailed information on sectoral projections with WEM and WAM scenarios are included in Reportnet 3 dataset Table 1a. GHG projections have been calculated using AR5 GWPs.

3.2.1. Energy

3.2.1.1. Methodology

Two projections scenarios of GHG emissions have been calculated for the period 2022–2050. The reference year 2021 used in projections is consistent with Estonia's 2023 submission to the UNFCCC on 15th of March 2023 (National Greenhouse Gas Inventory Report 1990–2021, 2023). The 'With Existing Measures' (WEM) scenario evaluates future GHG trends under current policies and measures. In the second scenario a number of additional measures and their impact are taken into consideration, forming the basis of the 'With Additional Measures' (WAM) scenario.

The scenarios projecting GHG emissions in the Energy sector are mainly based on the measures of the Ministry of Climate, which are funded through the Recovery and Resilience Facility, Environmental Investment Centre and the State Shared Service Center.

The Balmorel model was used for the electricity generation projections in the Electricity generation sector. It is a model for analysing the Electricity and Combined heat and power sectors from an international perspective while minimising the total costs of the system. The Balmorel model combines the approach of bottom-up modelling in a classic technical modelling tradition with top-down economic analysis, projections and forecasts. Some of the key strengths of the Balmorel model include the flexible handling of the time and space dimensions and the combination of operation and investment optimisation. The existing functionality and structural suitability for extensions make it a useful tool for assessing

challenges in the ongoing energy transitions. However, the downsides of the Balmorel model are complex user interface, the speed of the model and adding additional sectors to make the energy model more complete. The Balmorel model can differentiate, for example, the fuel consumption between the electricity and heat production, which is useful on order to avoid double counting. Furthermore, the Balmorel model makes estimated projections for both heat and power, to what extent it is reasonable to use a type of fuel (like biomass) to meet energy demand.

The main assumption for the projection was that step-by-step, the use of oil shale shall decrease for the production of electricity and increase for the production of shale oil. The retort gas that occurs as a side product during the production of shale oil is used for electricity production. The projected future usage of fuel based on the model was applied while using the emission calculations of the 2006 IPCC Guidelines.

The projections for heat generation in the Public heat and electricity generation sector are primarily based on measures funded through the Environmental Investment Centre.

The projections of the GHG emissions of shale oil production in the Manufacturing of solid fuels and other energy industries were calculated based on input from the industry. The amounts of oil shale used and the construction of a new shale oil production plant were used for the GHG projections.

The GHG projections in the Manufacturing industries and construction sector and in Other sectors are also based on historical trends, long term real GDP growth rate (the Ministry of Finance) and Shared Service Center measures. The emissions are calculated based on the methodology of the 2006 IPCC and EMEP/EEA 2019 Guidebook.

3.2.1.2. GHG emissions projections

The Energy sector (excluding transport) includes GHG projections from the consumption and production of fuels and energy (electricity and heat). The main sub-sectors in this sector are: Energy industries; Manufacturing industries and construction; Other sectors (incl. Commercial/institutional, Residential, Agriculture/Forestry/ Fishing/Fish farms and Military) and Fugitive emissions from natural gas distribution. The GHG emission increase in 2022 compared to the previous year was primarily in the Energy industries, because of the energy crisis.

The emissions are projected to decrease by 83.4% from 2021 to 2050 according to the Energy sector's WEM scenario. The largest absolute decrease occurs in the Energy industries.

The main electricity producer in Estonia is Enefit Power AS (incl. the Eesti, Balti and Auvere Power Plan), plants mainly use oil shale for electricity production. Enefit power plants are also the largest producers of GHG emissions in Estonia. The decrease of GHG emissions is due to the phasing out of oil shale pulverised combustion in these plants, continuing to use more efficient technology (fluidised bed combustion) and phasing out direct burning of oil shale. It is planned by the oil shale companies to implement CSS/CCSU technology in their facilities largely between 2041-2050, which will lead to a large reduction in greenhouse gas emissions. The GHG emissions are projected to decrease by 95.8% by 2050 compared to 2021 in the Energy industries sector.

GHG emissions in the Manufacturing and construction sector (divided into iron and steel; non-ferrous metals; chemicals; pulp, paper and print; food processing, beverages and tobacco; non-metallic minerals; and other industries) are projected to increase by 24.5% by 2050 compared

to 2021. In this sector, only the WEM scenario is projected, as there are no additional planned policies or measures.

The emissions in Other sectors (Commercial/institutional, Residential and Agriculture/Forestry/Fishing/Fish farms) are expected to decrease by 25.1% in 2050 compared to 2021.

In the WAM scenario, the emissions are projected to decrease by 83.7% in the period of 2021 – 2050. The decreased reduction of GHGs in the WAM scenario results from higher usage of biomass in electricity production.

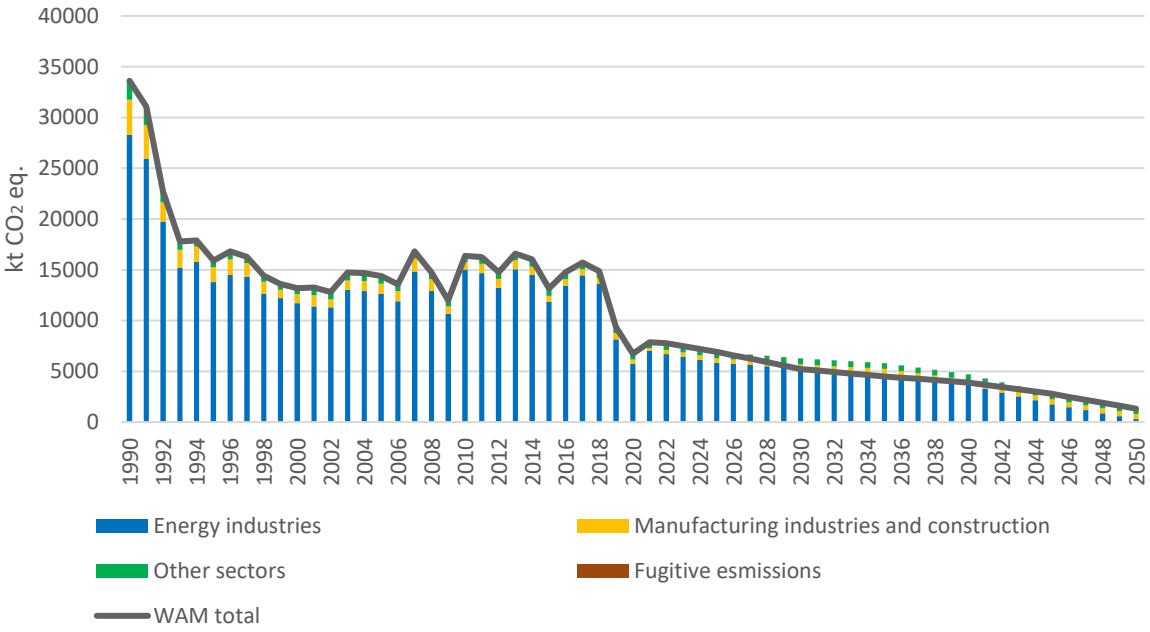

Figure 3.1. Historical GHG emissions (1990–2021) (NIR, 2023) and projected emissions (2022–2050) from the Energy sector according to the WEM and WAM scenarios (using AR5 GWP), kt CO_2 eq.

3.2.2. Transport

3.2.2.1. Methodology

Two projections scenarios of GHG emissions have been calculated for the period 2022–2050. The reference year 2020 used in projections is consistent with Estonia's 2023 submission to the UNFCCC on 15th of April 2023 (National Greenhouse Gas Inventory Report 1990–2021, 2023). The 'With Existing Measures' (WEM) scenario evaluates future GHG trends under current policies and measures. In the second scenario a number of additional measures and their impact are taken into consideration forming the basis of the 'With Additional Measures' (WAM) scenario.

Sybil baseline model was used for the GHG projections in the road transport sector. The model uses a bottom-up approach requiring data about the vehicle fleet, technology (EURO class) and road activity. The biggest strength of the model is compatibility with COPERT, which is used for the compilation of road transport in the national inventory report and kept up to date by EMISIA, the same team as for COPERT. On the other hand, its weakness is the high time consumption of calculating the effect of each individual measure. For that reason, it is easier to calculate separately the effects of the measure and insert the sum effect into the model.

The projections in the Transport sector are based on the information from the ITF report "The Future of Passenger Mobility and Goods", the TalTech report "Traffic survey manual and the business as usual forecast", the Ministry of Climate and the Ministry of Finance. To estimate GHG emissions emission factor data from the 2006 IPCC and EMEP/EEA 2019 Guidebook along with country-specific emission factors were used.

The projections for the WEM scenario are also in line with Regulation (EC) No 2019/631 of the European Parliament and of the Council. In addition, it is also taken to account that by 2035, the average emissions target for a new passenger car is 0 gCO_2/km and 130 gCO_2/km for light duty vehicles.

3.2.2.2. GHG emissions projections

The main share of GHG emissions in the Transport sector originate from road transport. In 2021, the share of GHG emissions from road transport was around 97.0% of total GHG emissions of the Transport sector.

The emissions in the Transport sector in the WEM scenario are expected to decrease by around 57.7% in 2050 compared to 2021. The emissions in Road transport are projected to decrease in both the WEM and WAM scenario.

The emissions in the Transport sector in the WAM scenario are expected to decrease by 68.2% in 2050 compared to 2021. Domestic aviation, navigation and railway emissions are expected to stay at approximately the same level (as in the WEM scenario) during the period of 2022–2050. The largest emission reductions occur in the Road transport sector – emissions are projected to decrease by 68.2% in 2050 compared to 2021 in the WAM scenario, which is the result of implementing additional measures that will help lower demand for private transport even more. However, the biggest driver for the steep decrement of GHG emissions in the WEM and WAM scenarios is the uptake of electric vehicles. This is reinforced by measures which support the promotion of electric vehicles and the notion that from 2035 all new passenger cars have to meet the criteria of 0 g CO_2/km (in accordance with the Regulation (EC) No 2019/631 of the European Parliament and of the Council).

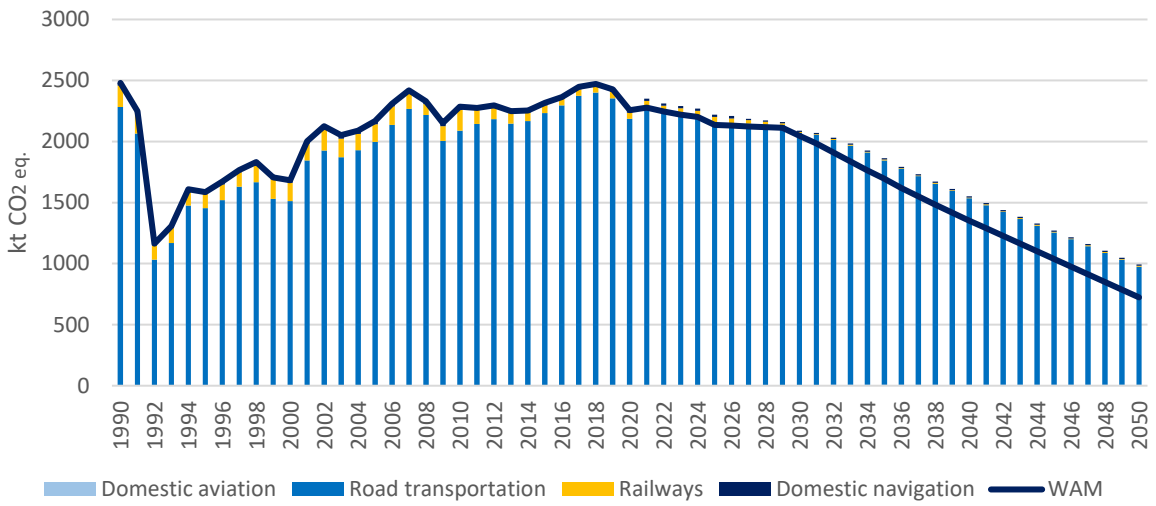

Figure 3.2. Historical GHG emissions (1990–2021) (NIR, 2023) and projected emissions (2022–2050) from the Transport sector in the WEM and WAM scenarios (using AR5 GWP), kt CO_2 eq.

3.2.3. IPPU

IPPU sector projections were not updated in 2024 and therefore the projections information presented below is the same as was for the 15.03.2023 submission.

3.2.3.1. Methodology

Two projection scenarios for GHG emissions have been calculated for the period 2021–2050. The reference year 2020 used in projections is consistent with Estonia's 2022 submission to the UNFCCC on 15th of April 2022 (National Greenhouse Gas Inventory Report 1990–2020, 2022). Emissions from the IPPU sector are projected according to the 'With Existing Measures' (WEM) scenario, which evaluates future GHG trends under current policies and measures and the 'With Additional Measures' (WAM) scenario, whereby WAM only affects the emission from urea-based catalysts for motor vehicles The Estonian industry sector is relatively small. The majority of emissions from subcategories, such as the Mineral industry, Non-energy products from fuels and solvents, and Other product manufacture, as well as their respective subcategories, comprise emissions from the activity of only a few companies who also influence the emissions' trend. In most subsectors bottom-up data gathering, companies' production forecasts, population projection (Statistics Estonia), the long-term real GDP growth rate (the Ministry of Finance) and expert judgements are combined and used. This approach ensures the most proximate projections that reflect the actual situation in subcategories with a limited number of emitting agents.

The Mineral industry's projected emissions are based on industries' operator projections taking into account planned production capacities and and/or maximal production capacities according to companies' environmental permits. The Chemical (ammonia) industry is no longer active in Estonia and emissions from that sector are not occurring. The Metal industry´s projected emissions are based on industries' operator production forecasts. Consumption of lubricants is based on 2014–2021 (as the data for the year 2021 were known while compiling the projections' consumption trend and projection of GDP growth rate and is slightly increasing. Consumption of paraffin waxes (candles and other paraffin waxes) is based on the average consumption of the years 2017–2021 (as the data for the year 2021 were known while

compiling the projections) and will decrease compared to 2020 in the years 2021–2022 and then stabilise.

Indirect CO_2 emissions from the Solvent use sector, affected by both GDP growth and population decline, are projected to decrease a little because of decreasing emission factors in the Domestic solvent use and Coating (paint use) categories.

Emissions from urea-based catalyst AdBlue are projected taking into account:

1. broadening of NO_X emission standards to light vehicles (Euro 6 standards);
2. the forecast of the number of vehicles and their average fuel consumption is consistent with the projections of the Transport sector

Emissions of fluorinated gases are projected according to the GHG inventory's calculation methods. Emissions from each group of HFC-containing equipment are projected separately. Bans and restrictions stipulated in the Regulation (EU) No. 517/2014 and Directive 2006/40/EC were taken into account. Trends in the domestic market of refrigeration and air-conditioning could be seen from the national database for F-gases (according Article 6 paragraph 2 of Regulation (EU) No. 517/2014). Some companies who service large commercial refrigeration systems were interviewed about their intentions towards restrictions of Regulation (EU) No. 517/2014. Trends in the import of pre-charged air conditioning equipment could be seen from import reports of companies.

Emissions were calculated from large and small commercial refrigeration equipment, industrial refrigeration and cooling, stationary air conditioning/cooling, mobile refrigeration, mobile air conditioning, fire protection equipment and foam producing by taking the following bans into account:

1. Bans on placing on the market, e.g.:
   - stationary refrigeration equipment that contains HFCs with GWP of 2500 or more (from 2020);
   - commercial refrigeration equipment (hermetic equipment with HFCs, multipack systems (40 kW or more) with HFCs except multilevel cascade systems partly with HFC-134a (from 2020);
   - single split stationary air conditioners and heat pumps that contain HFCs with GWP of 750 or more (from 2025);
   - fire protection equipment with HFC-23 (additionally, HFC-227ea containing fire protection systems have a sharply decreasing trend);
   - one-component foams that contain HFCs with GWP 150 or higher;
   - ban of the sale of new vehicles with EU-type approval having refrigerant with GWP over 150 in the air conditioner since 01.01.2017 is taken into account (according to the Directive 2006/40/EC);
2. Ban of refilling equipment that contains HFCs with GWP of 2500 or more (from 2020).

It is assumed that an effect of a completed project of the promotion of alternative and low-GWP refrigerants is that the majority of commercial and industrial refrigeration is switching to alternative refrigerants (CO_2 and NH_3 based systems respectively). In categories where the use of banned, high-GWP HFCs was subtracted but there is no information about alternatives, substitutions with lower GWP HFC-s were taken into account.

It was assumed that HFC refrigerants are properly collected from discharged equipment.

Projection of emissions from subsector 2.F.2 Foam blowing agents is based on forecasts of foam producers, real GDP growth rate and population size. Projection of emissions from 2.F.3 Fire protection is based on expert opinion from service companies concerning new equipment and a method of calculating the stock based on the GHG inventory. Projection of emissions from 2.F.4 Aerosols is based on the trend of medical aerosol use in 2014–2020, population size and real GDP growth rate.

SF_6 emissions (from 2.G Other product manufacture and use) are not regulated by the Regulation (EU) No. 517/2014. SF_6 emissions were calculated according to the methods of GHG inventory while taking into account plans on equipment replacement by the electrical network operators in Estonia.

Regarding N_2O — consumption of medical N_2O was provided by wholesalers who explained that sales will decline and consumption of N_2O in aerosols was calculated with the projection of population size and average emissions of N_2O per population in 2020–2021 (as the data for the year 2021 were known while compiling the projections).

3.2.3.2. GHG emissions projections

Emissions from the IPPU sector are projected according to the WEM and WAM scenarios whereby WAM only affects the emissions from urea-based catalysts for motor vehicles.

The WAM scenario for IPPU is projected because additional measures in the transport sector– additional promotion of economical driving, road usage fees for heavy-duty vehicles, vehicle tyres and aerodynamics – have an effect on subsector 2.D.3 Other — Urea-based catalysts for motor vehicles. In the WAM scenario diesel fuel consumption decreases, as does the consumption of urea-based diesel exhaust fluid.

The overall emissions from the IPPU sector are projected to decrease by 45.81% from 2020 until 2050 in the WEM scenario and 45.82% in the WAM scenario.The main decrease comes from the mineral industry (because a large plant has ceased its clinker production) and product uses as substitutes for ODS (F-gases).

Emissions from the mineral industry already decreased in 2020 when the cement industry ceased burning clinker in wet process kilns because it was not economically feasible anymore (production only took place in the first 3 months of 2020). The plant does not foresee starting production again. Other mineral industries estimated future production volumes in 2025 either as the same as in 2020 or up to 50% higher. After 2025 the production volumes will stabilise. Nevertheless, total emissions from the mineral industry sector remain ca 5 times lower than before the shutdown of clinker production.

Estonia's chemical industry sector emissions originate from the ammonia industry. The plant operator has announced that it has sold all of its production equipment and no longer plans to continue ammonia production activities, as ammonia production in Estonia has not been profitable since 2014 due to low global market prices for ammonia and rising natural gas prices.

In the metal industry production volumes will rise by around 10% from 2020 to 2022, as will the emissions from this category, and then stay the same until 2050. The metal industry made up 0.47% of the emissions in the year 2020 (2.9 kt CO_2 eq.), therefore the rise will not strongly influence the overall emissions.

Emissions (both direct and indirect CO_2) from non-energy products from the Fuels and solvent subsector use (2.D.3) in most subcategories (Use of diesel exhaust fluid AdBlue and Use of paraffin wax and solvents) are projected to decrease and emissions from the subcategory lubricant use is projected to increase both in WEM and WAM scenarios. This difference in

WAM scenario is mainly caused by curbing diesel fuel consumption and urea containing diesel exhaust fluid consumption as a result of additional measures in the transport sector. Consumption of these products depends on the economic situation of many small industries (linked to real GDP growth rate). Given the economic growth (the Ministry of the Finance) these emissions are projected to increase. Emission of NMVOCs from the solvents sector and indirect CO_2 from NMVOCs is projected to decrease. Although the consumption of solvent containing products has an upward trend because of its correlation with GDP growth, the emission factors have a declining trend. Concerning paints (2.D.3.d Coating applications) probably the Directive 2004/42/CE on the limitation of emissions of VOCs from paints and varnishes and vehicle refinishing products has contributed to declining emission factors. The same declining trend of emission factors can be seen in the Domestic use of solvents (2.D.3.a) and it results from the restrictions of the regulations (EC) No 648/2004 on detergents, (EC) No 1223/2009 on cosmetic products and (EU) No 528/2012 on biocidal products. In some subcategories NMVOCs decrease because of the declining population. In comparison to 2020 the emissions are projected to decrease by 24% by 2030 and stay around the same level until 2050.

Emissions of HFC-s (substitutes for ozone-depleting substances (ODS) are projected to be the same in the WEM=WAM scenarios. HFC emissions projections will decrease by 70% from 2020 to 2050. The majority of R-404A containing equipment (to which installation and servicing bans are applying from 2020) should be decommissioned until 2035 and also most old split-type air conditioners and heat pumps. Directive 2006/40/EC has a gradual effect on HFC emissions until 2030 when most old vehicles equipped with HFC-134a based air conditioners should have been replaced.

Emissions of SF_6 reported under the subcategory Other product manufacture and use are projected to rise steadily until 2050 when they are projected to be 62.3% larger than today (according to the WEM=WAM scenarios). SF_6 insulated electrical equipment is not directly affected by Regulation (EU) No. 517/2014. Until 2030 new equipment is installed instead of old air insulated switchgear. After 2030 emissions continue to rise because many items of SF_6 insulated equipment exceeding their service life will be decommissioned. After 2040 it is assumed that no more medium-voltage switchgear with SF_6 will be installed.

N_2O emissions from the subcategory Other product manufacture and use are projected to decline from 2020 to 2050 by 87.8% as the use of N_2O is connected to declining population numbers.

The historical and projected emissions in 1990–2050 according to WEM and WAM scenarios are depicted in Figure 3.3.

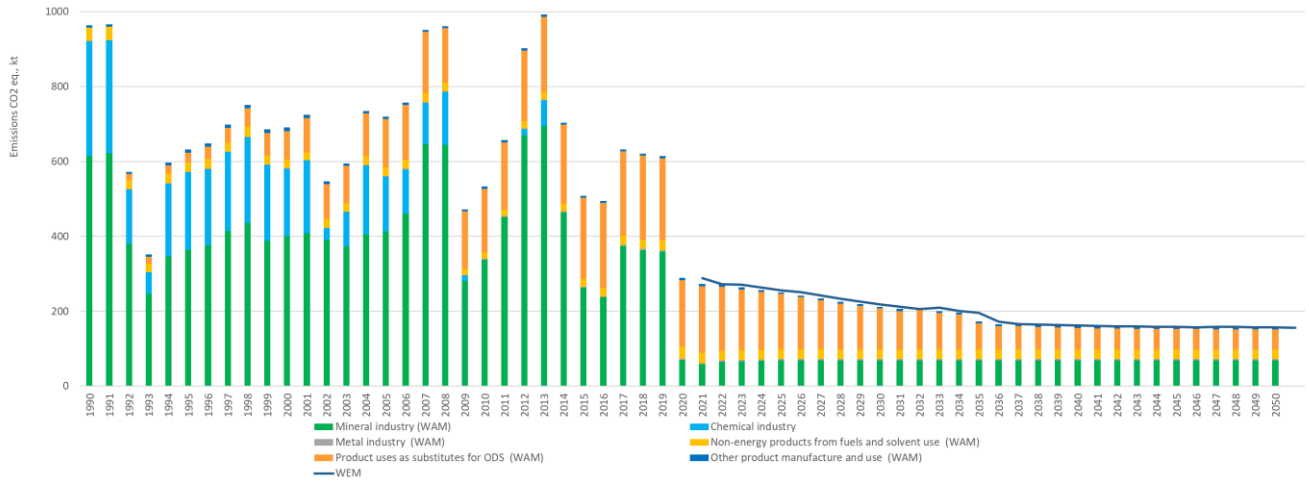

Figure 3.3. Historical GHG emissions (1990–2020) (NIR, 2022) and projected emissions (2021–2050) from the IPPU sector (with Solvent use) according to the WEM and WAM scenarios (using AR5 GWP), kt CO_2 eq.

3.2.4. Agriculture

3.2.4.1. Methodology

GHG emissions from the Agriculture sector are projected according to the With Existing Measures (WEM) and With Additional Measures (WAM) scenarios for the period 2022–2050. The reference year 2021 used in projections is consistent with Estonia's 2023 submission to the UNFCCC on the 15th of April (2023 NIR).

Estonia's agricultural GHG emissions are projected to increase by approximately 5.2% by the year 2050, compared to the year 2021. Methane emissions from enteric fermentation are most affected by the predicted decrease in the number of animals and a slight increase in the milk yield of dairy cows. Aricultural soils is the second largest GHG emission source in Estonia, of which emissions are mostly driven by synthetic N-containing fertilisers applied to soils, however also organic soils cultivation, crop production, organic fertilisers applied to soils such as compost, sewage sludge and digestate, and data about mineralization are affecting the total projections. CH_4 emissions from manure management are primarily influenced by the distribution of manure management systems by animal groups and thus the construction of new biogas plants. In 2030, three new biogas plants are expected to open, and thus the amount of animal manure sent to biogas plants will also increase, and thus methane emissions will decrease. Other categories, e.g. CO_2 emissions from Liming and Urea fertilization do not have a significant impact on the GHG emission trend.

Projections of emissions are calculated based on the 2006 IPCC methodology applied in the Estonian Greenhouse Gas Inventory. The projected numbers of animals, crop productions and the amounts of mineral and lime fertilisers used are based on the results of the Agriculture Projection Model (APM), developed in 2021 by Centre of Estonian Rural Research and Knowledge. This model considers the characteristics common to Estonia and provides opportunities to analyse different policy scenarios and changing market and macroeconomic conditions. All animal numbers from the APM results were rounded to an integer. Also, average sheep, goat and poultry annual numbers were calculated for keeping consistency with the GHG inventory methodology. The quarterly sheep and goat numbers were divided with the last five-year average ratio of sheep and goats used in the inventory. The total number of broilers was

projected based on the last five years in the 2023 NIR. The number of other hens and roosters was calculated based on the average ratio of the animal group used in the 2023 NIR. Poultry, layers and other poultry projections are based on the APM result.

Main activity data for calculating CH_4 emissions from Enteric fermentation and CH_4 and N_2O emissions from Manure management are livestock population, distribution of animal waste management systems (AWMS) and milk yield and pregnancy rate for dairy cows. Estonian-specific volatile solids (VS) and N excretion rates (kg/head/year) of dairy cattle have been calculated on the basis of projected milk yields. The population for all licestock categories is projected to decline until 2032, and then stay at that level until 2050. this is caused by a current difficult situation in the agriculture sector. The population of fur animals will decrease steadily to zero in 2026, when fur farms will be banned in Estonia. The number of pigs is anticipated to decrease moderately until 2022, then start rising again until 2031 and then remain at that level until 2050. The level of poultry production is expected to fluctuate until 2031 and then remain at that level until 2050. Feed intake parameters and the methane conversion rate are harmonised with the national GHG inventory. Gross energy intake of dairy cows was calculated on the basis of projected milk yields. Average milk yield per cow is projected to increase until 2031. Projected values are in accordance with the projections in GPCP 2050. Fat content in milk (%) for the projected period is assumed to remain at the same level as in 2021 (3.9%) until 2050.

Projected N_2O emissions from the Agricultural soils subsector are based on the amounts of organic and synthetic N-containing fertilisers applied to soil, quantities of harvested crops, carbon stock change in mineral soils, and area of cultivated organic soils. Direct N_2O emissions include emissions from synthetic and organic fertilisers applied to agricultural soils, emissions from animal manure, emissions from crop residues, emissions from the cultivation of organic soils and emissions from mineralization associated with loss/gain of soil organic matter. Indirect N_2O emissions include emissions from atmospheric deposition and from leaching and run-off. The quantities of sewage sludge, composted organic waste and waste-based digestates applied to soils are harmonised with the Waste sector projections (see Waste sector GHG projections chapter), data for calculating carbon stock change in mineral soils and organic soils cultivation are provided by the LULUCF sector expert. The use of synthetic fertilizers are projected to start growing from 2022 until 2032, then stay at that level until 2050. Estonia's crop production is projected to increase over the timeseries until 2032 and then stay at that level until 2050.

The amount of lime fertilizers applied to soils are projected with the APM model. The amounts of lime fertilizers are projected to grow until 2032 and then stay at that level until the year of 2050. Therefore, emissions from liming are projected to increase until 2032 and then stay at that level until 2050.

3.2.4.2. GHG emissions projections

The differences in the results of the scenarios with existing and additional measures were due to alternative parameters in the Agricultural land category: the input regarding the restoration of meadows came from the Department of Nature Protection of the Ministry of Climate and is in line with the 2023 LULUCF projections. The larger area of grasslands in WAM scenario increases the emissions of the agricultural sector. Therefore, according to the sWAM scenario, the total greenhouse gas emissions of the agricultural sector were slightly higher than in the WEM scenario. According to the WEM scenario, emissions from the agricultural sector will increase from 1,583.94 kt CO_2 equivalent in 2021 to 1,665.83 kt CO_2 equivalent in 2050, or 5.17%. According to the WAM scenarios, emissions will increase from 1,583.94 kt CO_2 equivalent to 1,665.91 kt CO_2 equivalent by 2050, or 5.175%.

Emissions from enteric fermentation are predicted to increase slightly until 2032 and then remain at that level until 2050. Although the number of farm animals is predicted to decrease, milk production is projected to increase slightly – hence the small increase in emissions (approx. 5% by 2050 compared to 2021). Emissions from manure management are predicted to decrease by around 8% in 2050 compared to 2021. This is due to the opening of new biogas plants and the fact that the emission factor of manure that has passed through a biogas digester is lower than, for example, liquid manure. Emissions from agricultural lands are predicted to increase during the time series by approx. 9.61% (in WEM scenario) until 2032 and then remain at this level until 2050 – it is in correlatation with the projected production volumes of agricultural crops and application amounts of fertilizers.

According to the projections, CO_2 emission due to liming will increase by approx. 20% by 2050 compared to 2021, this is in correlation with the amounts of lime fertilizers used on fields.

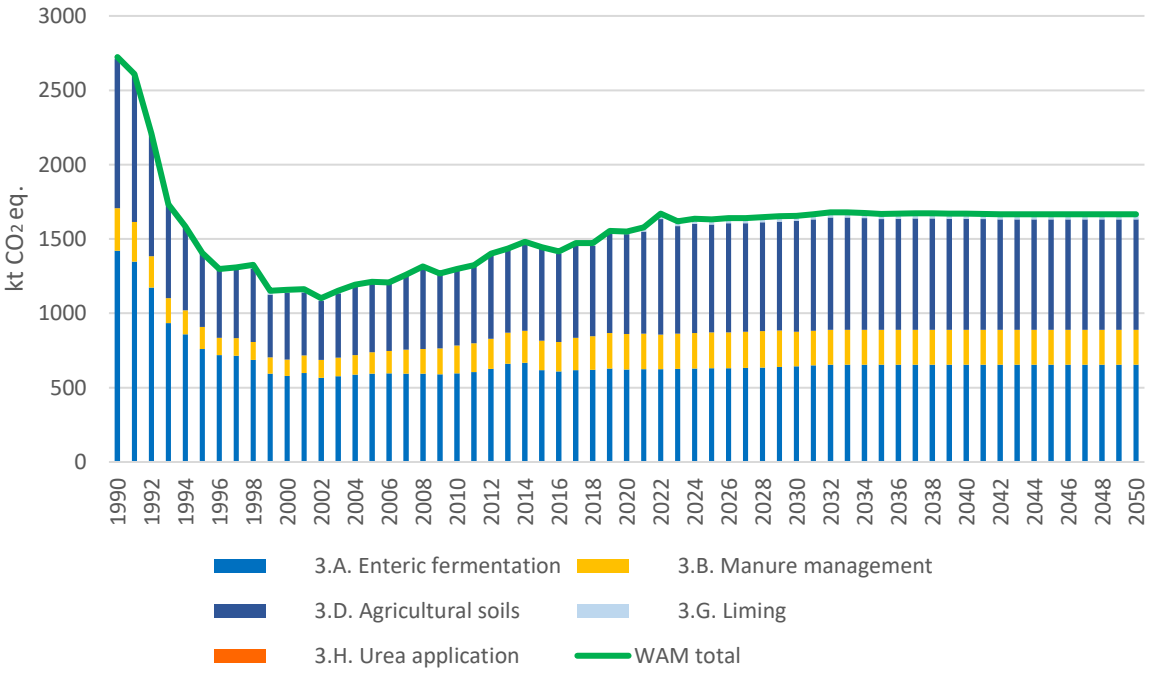

Figure 3.4. Historical GHG emissions (1990–2021 (NIR, 2023) and projected emissions (2022–2050) from the Agriculture sector in the WEM and WAM scenarios (using AR5 GWP), kt CO_2 eq.

3.2.5. LULUCF

3.2.5.1. Methodology

LULUCF sector 'With Existing Measures' (WEM) scenario and 'With Additional Measures' (WAM) scenario GHG projections have been calculated for the period 2023–2050. LULUCF sector includes emissions and removals of GHGs from Forest land, Cropland, Grassland, Wetlands, Settlements, Other land and Harvested wood products. The projections of land use categories are based on the following assumptions and planned activities:

- Annual land conversions will generally continue to occur at the same level as the average of 2018–2022, except for the conversions described below;
- Deforestation of 1200 ha of Forest land due to the restoration of heritage meadows (Grassland category) was divided equally between 2023–2027 in the WEM scenario (MoC). Additional deforestation area 1200 ha in 2028–2050 was taken into account in the WAM scenario;
- The following changes in land use were expected due to the construction of Rail Baltic (Steiger, 2021) in the period of 2023–2028: Forest land converted to settlements 722.3 ha, Cropland converted to settlements 157.5 ha, Grassland converted to settlements 29.8 ha, Wetlands converted to settlements 38.8 ha, Other land converted to settlements 106.5 ha;
- Deforestation due to the establishment and development of training grounds of the Defence Forces was considered under Forest land converted to settlements category. Total projected deforested areas in 2024–2026 were about 5220 ha (Estonian Centre for Defence Investment);
- Shares of drained organic soils from the total area of organic soils for Forest land remaining forest land and Grassland were projected as an average of 2018–2022.

Projected areas of land use categories and methods described in the NIR 2023 and NID 2024 Chapter 6 were used for estimating GHG emissions and removals. Additional assumptions for specific categories are stated below.

Future harvesting rates in Estonia depend on adopted and planned policies. WEM projections for Forest land are based on the business-as-usual scenario and WAM projections on the uniform final felling scenario, both composed by the Estonian Environment Agency. The following assumptions and methods were applied in WEM scenario projections for Forest land category:

- Total final felling volume was expected to be 11 mln m3 $year^{-1}$, which is the average of five felling seasons (NFI, 2022);
- In modelling the final fellings, actual harvesting distribution between dominant tree species in recent years was used. The calculation of the final felling area is only applied in the case of forest available for wood supply. Strictly protected forests are modelled without fellings;
- Final fellings are projected by dominant tree species and site quality classes depending on the age, diameter and stocking of the stand;
- The growing stock volume in Forest land was projected by decade and was obtained by multiplying the area in age class with the average growing stock per hectare in the relevant age class;
- Distribution of forest area by dominant tree species remains the same during the entire period;
- The area of the forest not available for wood supply (strictly protected area) is 421.7

kha (NFI, 2022). It is projected to remain at the same level;

- In the case of forest available for wood supply with additional protective measures (excluding water protection forests on banks), in total 200.5 kha, half of the uniform final felling coupe intensity was applied;
- Growing stock in Forest land remaining forest land was calculated as the difference between projected value for total forest land and estimated Land converted to forest land growing stocks;
- To assess changes in dead wood C stock in Forest land remaining forest land, the same trend was expected to continue, and the value of 2022 was used throughout the 2023–2050 period;
- Non-CO_2 emissions from drained organic forest soils were estimated by multiplying the 5-year average emissions per hectare by the projected area.

According to the WAM scenario, the uniform annual final felling area is assumed during the whole rotation period. The final felling volume is expected to be 9.9–10.2 mln m^3 $year^{-1}$, felling rates were projected as ten-year averages. The distribution of felling areas by dominant tree species is optimal and does not consider the actual harvesting distribution (as in WEM). In addition, the WAM scenario takes into account additional afforestation (in 2024 1 000 ha $year^{-1}$, from 2025 onwards 2 500 ha $year^{-1}$) and additional deforestation during the 2027-2050 period due to the restoration of heritage meadows (52.2 ha $year^{-1}$), (MoC).
Estimations for the HWP pool are based on the projected harvest levels; therefore, both WEM and WAM scenarios have been projected. The fraction of harvest for the HWP commodity production and the share of HWP commodities were assumed to remain at the current level.

For calculating C stock changes in the mineral soils of the Cropland remaining cropland category, areas under different crops were projected based on the Agriculture Projections Model developed by the Centre of Estonian Rural Research and Knowledge. The same model was also applied in the Agriculture sector. It was assumed that the present management practices (shares of areas under full tillage, reduced tillage and no-till) will continue.

The majority of emissions from the Wetlands category derive from the horticultural use of peat. The amount of peat removed for horticultural use is calculated as the difference between total peat production and the primary production of energy peat. The long-term average total peat extraction was calculated as the average of the 2018–2022 period. The use of energy peat has had a declining trend which was expected to continue, and, after 2035, all extracted peat was projected to be used in horticulture. Default carbon fraction of peat from the IPCC 2006 Guidelines was used in calculations and peat was assumed to be oxidised in the year of extraction. The area of active and unrestored peat extraction sites in 2022 was also applied in projections (MoC).

CH_4 and N_2O emissions from wildfires were estimated as the average of the 2018–2022 period. Reported and projected non-CO_2 emissions from biomass burning in Land converted to forest land areas are included under the Forest land remaining forest land category. Similarly, CH_4 and N_2O emissions from biomass burning in the Grassland remaining grassland category also include emissions from Land converted to grassland and Wetlands categories. GHG emissions from wildfires were not estimated for Croplands and Settlements as they were considered insignificant in terms of the overall level and trend in national emission.;

3.2.5.2. GHG emissions projections

GHG emissions from the LULUCF sector are projected according to the With Existing Measures (WEM) and With Additional Measures (WAM) scenarios for the period 2023–2050. The WAM scenario mainly concerns Forest land and HWP categories: the WEM scenario assumes the continuation of current forest management practices and intensity, whereas the WAM scenario is based on the assumption of uniform final felling which is proposed in the draft Forestry Development Plan until 2030 (Ministry of the Environment, 2023). In addition, the WAM scenario takes into account additional afforestation (in 2024 1000 ha year^{-1}, from 2025 2500 ha year^{-1}) and additional deforestation during the 2027-2050 period due to the restoration of heritage meadows (52.2 ha year^{-1}).

Estimation of land category areas was based on the assumption that land use changes would continue at the average level of the years 2018-2022. The effect of larger planned activities on the land use was also taken into account. As a result, the projected areas of Forest land and Cropland are growing slightly. At the same time, the area of Grassland is decreasing, despite the restoration of semi-natural communities (heritage meadows). The area under Settlements will increase, both due to the continuation of current trends and several planned infrastructure objects.

According to the projections, the LULUCF sector is expected to remain a source of GHGs in both scenarios, meaning that total emissions arising from the sector will exceed total removals. The projected overall emissions from the LULUCF sector were 1,768.74 and 293.93 kt CO_2 eq. in 2050 according to the WEM and WAM scenarios, respectively.

Projected changes in forest growing stock primarily depend on the age distribution of forests, management practices and changes in the area of forest land. Growing stock changes were projected as ten-year averages. Due to the high proportion of mature and premature forest stands and increasing proportion of forest area belonging to the first development classes (treeless area, area under regeneration and young stands), the capacity of carbon sequestration in tree biomass has decreased in recent years and the decline is expected to continue during the next decades. According to the WEM scenario (total felling volume is 11 mln m^3 year^{-1}), total forest growing stock will be approximately 5% lower in 2050 than it is now. Net emissions from the Forest land category are projected to decrease from 288.27 kt CO_2 eq. in 2023 to 211.21 kt CO_2 eq. in 2031. After that, Forest land fluctuates between sequestration and emission sides, and from 2043 onward is a net sequester, as the decline of the forest growing stock is expected to slow down. Projected Forest land net emissions are -315.37 kt CO_2 eq. in 2050.

In the WAM scenario (total felling volume is 9.9–10.2 mln m^3 year^{-1}), Forest land will sequester carbon. It is expected that the forest growing stock will remain quite stable, CO_2 sequestration in forest land will increase from the level of -795.40 kt CO_2 eq in 2023. In the following years (2024-2050), the additional effect of afforestation will be added, and in 2050, Forest land net emissions will be -1,873.66 kt CO_2 eq.

C sequestration in HWP will decrease both in the WEM and WAM scenarios. According to the WEM scenario, removals from HWP will decrease from -641.58 kt CO_2 in 2022 to -487.62 kt CO_2 by 2050. In the WAM scenario, the removals are projected to decrease to -407.72 kt CO_2 in 2050. It is likely that the production of wood products will become more efficient and thus it can be assumed that production volumes and consequently carbon sequestration has been considered rather conservatively. Estonia is also planning to build a pulp mill, which will have a bigger impact in the first ten years, during which the HWP category would sequester an additional 200 kt CO_2 per year.

Emissions from the Cropland category are expected to decrease compared to the current level (850.84 kt CO_2 eq. in 2022). In particular, emissions from mineral soils will be reduced, as agricultural land use and management practices are not expected to change significantly in the future, leading to stabilization of soil organic carbon stocks. In 2050, the projected emissions from the Cropland category are 633.58 kt CO_2 eq.

Net emissions from the Grassland category were -171.97 kt CO_2 eq. in 2022. As the area of grassland decreases, as well as conversion of croplands to grasslands, carbon sequestration on grasslands will also decrease by 2050. In addition, emissions from deforestation are expected to increase. According to the WEM scenario, the projected net emissions of the Grassland category are -99.36 kt CO_2 eq. and according to the WAM scenario -95.79 kt CO_2 eq.

Assuming that the current peat production volumes will continue, the projected emissions from the Wetlands category will be 1 496.77 t CO_2 eq. in 2050. Of this, 1 316.16 kt CO_2 results from the production and use of horticultural peat and 166,89 kt CO_2 eq. are emitted by peat extraction sites. Default carbon fraction of peat from the IPCC 2006 Guidelines was used in calculations.

Under the Settlements and Other land categories, only emissions arising from the land conversions have been reported. Several planned infrastructure projects will significantly increase land conversion to Settlements in the period 2023–2028. Projected emissions will reach the maximum value (1 037.18 kt CO_2 eq.) in 2025 and then decline to 436.23 kt CO_2 eq. in 2050. Projects for which the effects on land use are not yet known have not been taken into account in the projections.The projected emissions from the Other land category are 99.38 kt CO_2 eq. in 2050. It was assumed in the calculations that all living biomass and dead wood stocks on the previous land use category would be lost in the same year as the land use change. In mineral soils, changes in C stocks occur over a period of 20 years; according to the 2006 IPCC Guidelines initial SOC stocks will decrease by 20% in the case of conversion to settlements and 100% in the case of other land.

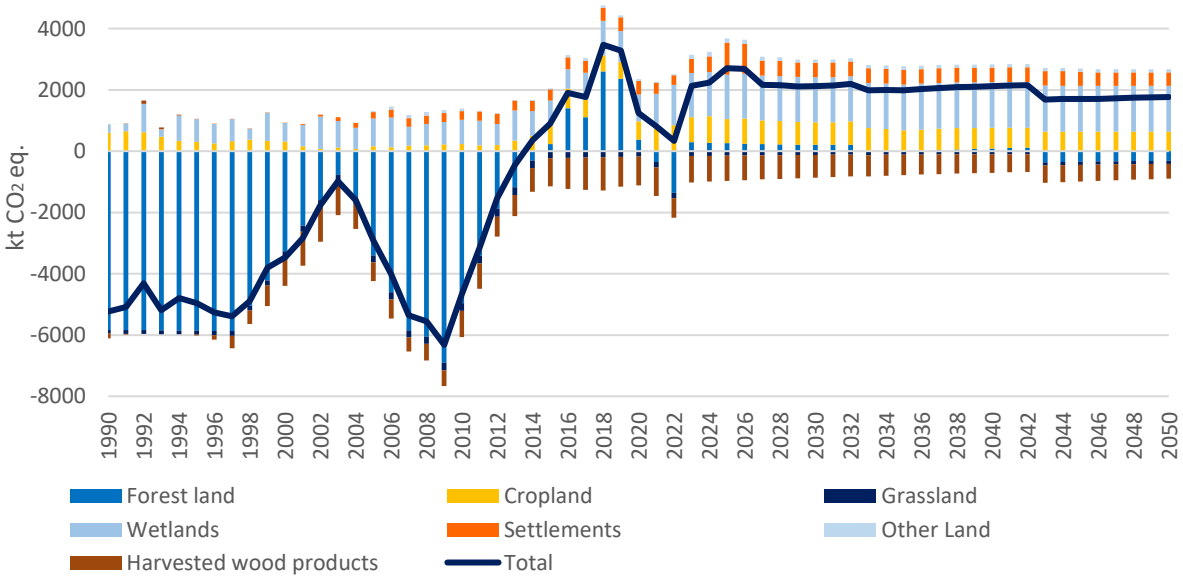

Figure 3.5. Historical GHG emissions (1990–2022) (NIR, 2024) and projected emissions (2023–2050) from the LULUCF sector by land use class according to the WEM scenario (using AR5 GWP), kt CO_2 eq.

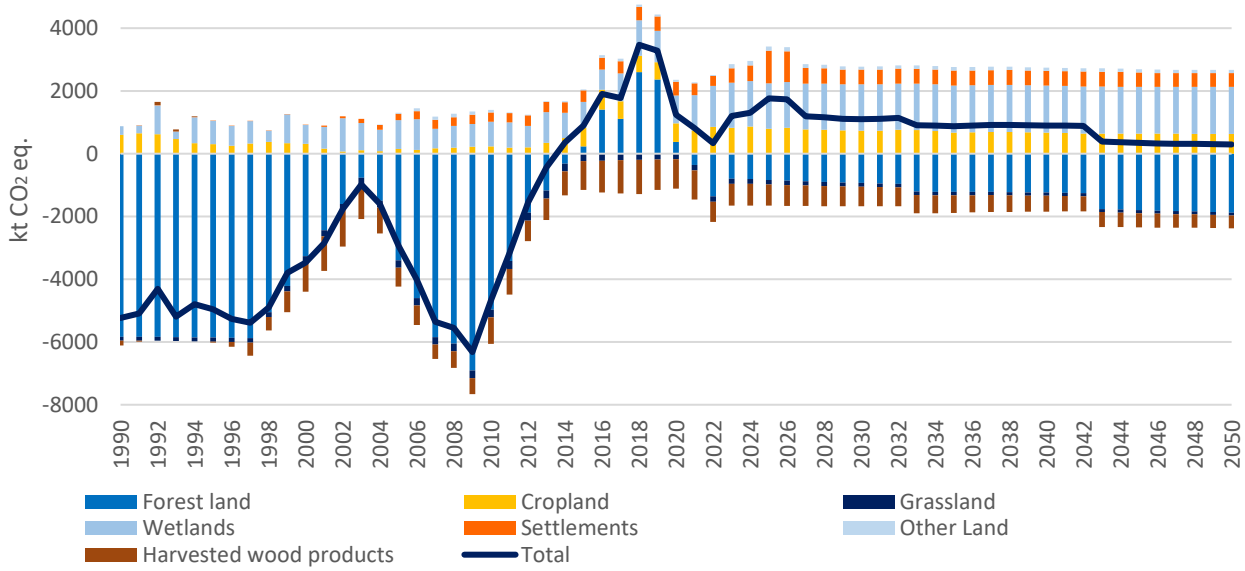

Figure 3.6. Historical GHG emissions (1990–2022) (NIR, 2024) and projected emissions (2022–2050) from the LULUCF sector by land use class according to the WAM scenario (using AR5 GWP), kt CO_2 eq.

3.2.6. Waste

Waste sector projections were not updated in 2024 and therefore the projections information presented below is the same as was for the 15.03.2023 submission.

3.2.6.1. Methodology

Waste sector 'With Existing Measures' (WEM) scenario GHG projections have been calculated for the period of 2020– 2050. The reference year 2020 used in projections is consistent with Estonia's 2022 submission to the UNFCCC on 15th of April 2022 (National Greenhouse Gas Inventory Report 1990–2020, 2022). The WEM scenario evaluates future GHG emission trends under the current policies and measures.

GHG emissions emitted from the Waste sector include CO_2, CH_4 and N_2O. CO_2 is emitted from the Waste incineration category. The main share of CH_4 from the Waste sector comes from Solid waste disposal on land. CH_4 and N_2O emitted from Wastewater treatment and discharge, Biological treatment and Waste incineration.

CH_4 emission projections in the Solid waste disposal on land (SWD) subcategory are done using the 2006 IPCC Waste Model, which has been developed by the IPCC for estimating CH_4 emissions from solid waste disposal sites, for projections, additional sheets have been interlinked with the existing Waste model template sheets which are easy to adjust the to reflect the country specific needs. Also it is possible to interlink cells making the calculations easy. It is difficult to point out the weakness of the model as the calculations difficulties depend on the adjustments and activity data. In the IPCC 2006 Waste Model, synergies of waste decomposition over time period is taken into account in the calculation. There are no overlaps, because the input data is clearly divided to different waste groups.

The MSW generation projections take into account population projection (Statistics Estonia) and the long-term real GDP growth rate (the Ministry of Finance). The composition and the amount of generated MSW is taking into account, that from 2035 at least 65% of the municipal waste shall be prepared for re-use and recycled. In addition, starting from 2030 it is prohibited to deposit waste suitable for recycling or other recovery, in particular municipal waste. Also, from 2030 the quantity of municipal waste deposited in a landfill shall not exceed 10 % by weight of the total quantity of municipal waste generated in the same year. For textile waste, local governments will start separate collection of textile waste no later than 2025 and implement separate collection or recycling at source no later than 2023, which decrease the amount of degradable waste at landfills. Projections also take into account the amount of waste incinerated MSW in Iru CHP plant (emissions from this activity is included in the Energy sector projections).

Mixed Municipal Solid Waste Composition Study carried out in 2020 (SEI-Tallinn, 2020) was used for a MSW composition projection. Real GDP growth rate was also used for projecting industrial waste generation.

Projections in the subcategory Biological treatment of solid waste are based on the long-term real GDP growth rate projections by the Ministry of Finance applied to the previous year's biologically treated solid waste amount. While calculating, it is considered, that more biological waste is separated from the municipal solid waste and that there will be additional biodegradable waste from industrial sources (calculated under Solid waste disposal subcategory).

Only a small amount of waste gets incinerated without energy recovery. Projections in the subcategory Waste incineration and open burning were done using the assumptions of no open burning taking place after 2030 and that a small amount of waste will be incinerated without energy recovery (for burning contraband, utilising hazardous waste, etc.). Open burning of municipal solid waste is prohibited, nevertheless an expert judgment is used to evaluate the amount of waste that might be open-burned based on the amount MSW generated. The MSW generation is in accordance with the subsector Solid waste disposal on land. Activity data about generated MSW is projected under the SWD subcategory.

Projections of GHG emissions in Wastewater treatment and discharge subcategory account for population projection (Statistics Estonia) and an expert judgement given by the MoE on the usage of different wastewater treatment types and the coverage of centralised wastewater system. Different wastewater treatment systems are covering both high and low density settlements. GHG emissions from Industrial wastewater was conducted using stable production throughout the time series of 2021–2050.

3.2.6.2. GHG emissions projections

Since there are no additional measures intended in the Waste sector then the WAM scenario emissions are equal to the WEM scenario emissions (Figure 3.7).

Compared to 2020, the 2050 WEM scenario CO_2 eq. projections from the Waste sector are projected to decrease by 40.8%. Emission decrease is mainly related to the increase of reusing and recycling waste materials, decreasing amount of biodegradable waste deposited in landfills and to waste incineration in the Iru CHP plant. The decrease of 2050 emissions from the Solid waste disposal subcategory are projected to decrease by 83.9% compared to base year emissions.

Increase in GHG emissions from biological treatment of solid waste (121% increase in 2050 compared to 2020) is correlated to the decreased amount of biodegradable waste in the total amount of solid waste disposed in landfills.

Open burning of waste will end by 2030 and a marginal amount of waste will be incinerated without energy recovery, the emissions will decrease by 99.9%.

The emission decrease from wastewater treatment and discharge (11.8% in 2050 compared to 2020) is connected to the expanding sewerage network and upgrading wastewater treatment systems in low-density settlements.

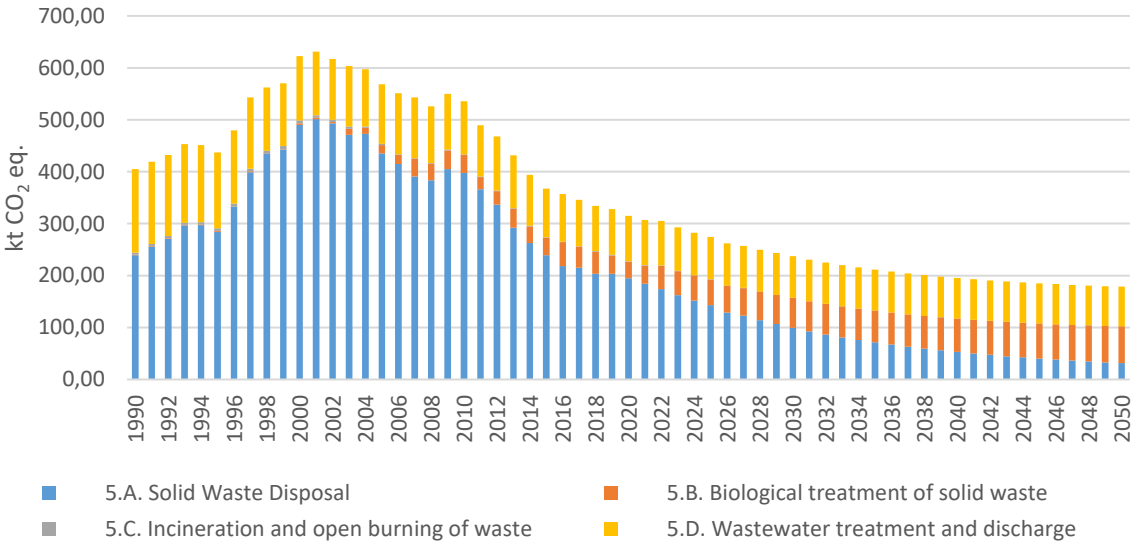

Figure 3.7. Historical GHG emissions (1990–2020) (NIR, 2022) and projected emissions (2021–2050) from the Waste sector according to the WEM=WAM scenario (using AR5 GWP), kt CO_2 eq.

3.3. Total projected GHG emissions of Estonia

Estonia's total projected GHG emissions using AR5 GWP are presented in Figure 3.8 and Figure 3.9. The GHG emission reduction compared in 2050 compared to year 2020 is included in Table 3.1.

Table 3.1. GHG reduction in WEM and WAM scenarios in 2050 compared to 2020, (using AR5 GWPs)

	Scenario	Reduction in 2050 compared to 2020, kt CO2 eq.	Reduction in 2050 compared to 2020, %
Without LULUCF	WEM	-7048,81	-62,1%
	WAM	-7279,99	-64,2%
With LULUCF	WEM	-6522,97	-51,8%
	WAM	-8228,96	-65,4%

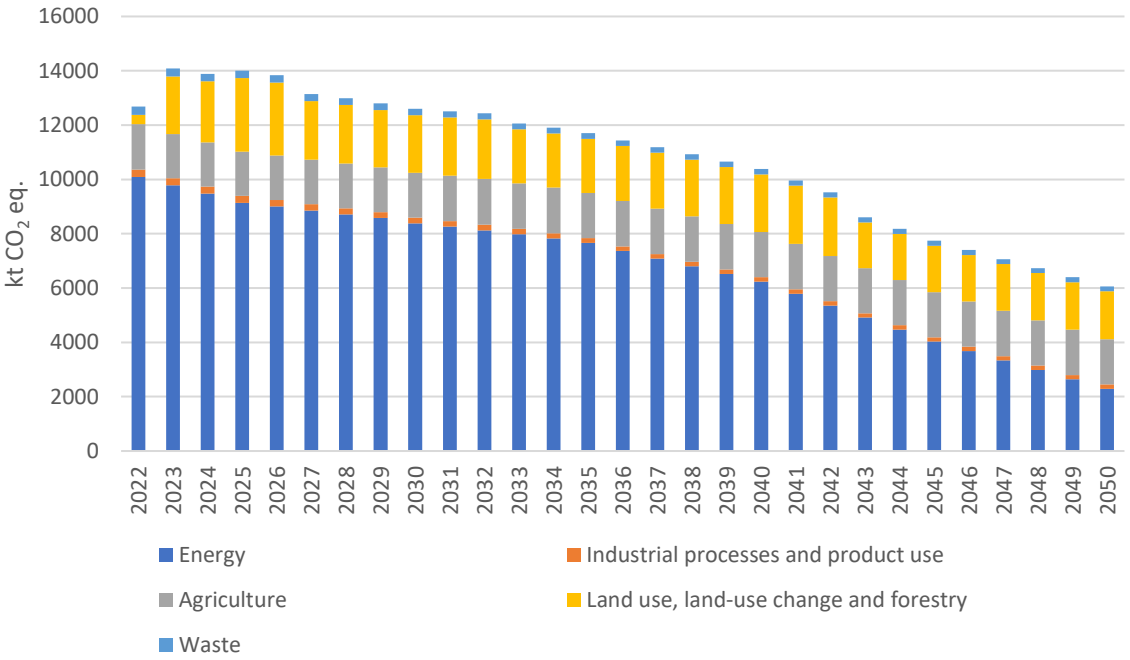

Figure 3.8. Projected GHG emissions (2022–2050) for the WEM scenario, kt CO_2 eq. (using AR5 GWP)

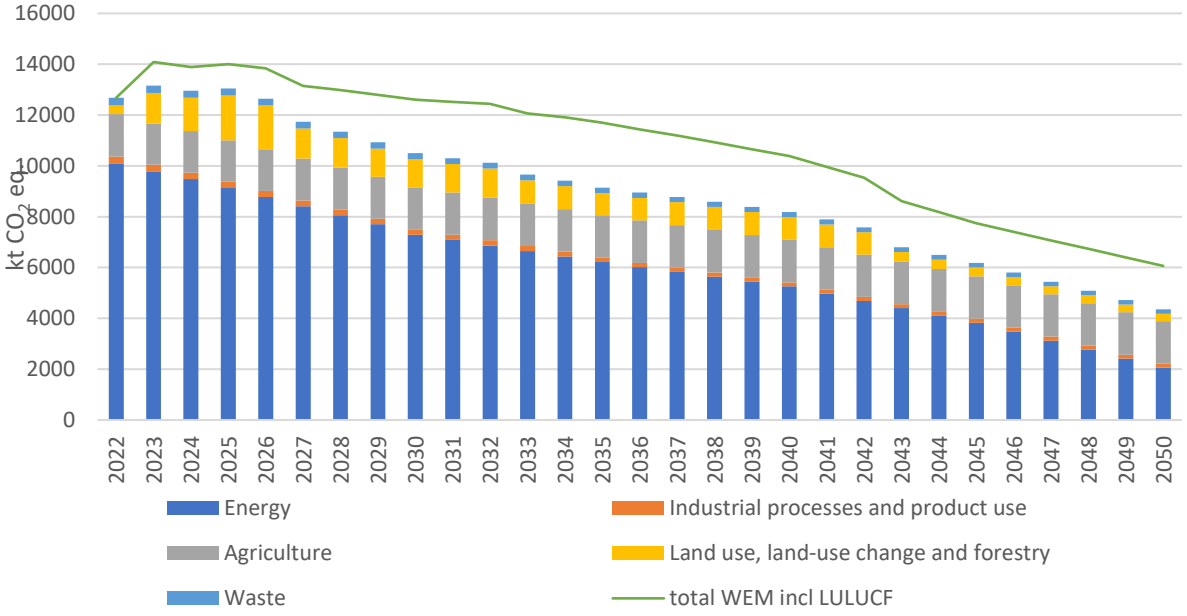

Figure 3.9. GHG projected emissions (2022–2050) for the WEM and WAM scenario, kt CO_2 eq. (using AR5 GWP)

Estonia's GHG emissions are expected to decrease by around 62.1% in the WEM scenario (without LULUCF) and about 64,2% in the WAM scenario (without LULUCF) by 2050 compared to the year 2020. GHG emissions in the WEM scenario (with LULUCF) are expected to decrease by around 51.8% and in the WAM scenario (with LULUCF) about 65,4% by 2050

compared to the year 2022.Comparison has been made with 2020 as Waste and IPPU sector projections start from 2021.

While the Energy sector´s subcategory Energy industries dominated total emissions in 1990, its emissions decreased sharply in the beginning of the time series and fluctuate but are projected to continue on a decreasing pathway, reaching a reduction of approximately 99% in both WEM and WAM scenarios by 2050 compared to 1990.

Emissions from the Transport sector are driven by the Road transport category, as the share of it from the total transport sector has been in recent years consistently over 96%. Therefore, it will also be the biggest driver for the decrease of GHG emissions in the road transport sector due to the uptake of electric vehicles. The total decrease of emissions by 2050 compared to 1990 is projected to be 61.4% in the WEM scenario and 70.9% in the WAM scenario.

Historically, the IPPU sector emissions were driven by the Mineral industries subcategory, however the cement industry ceased burning clinker in wet process kilns and does not foresee future production, which will already decrease starting from 2020. HFC emissions projection will decrease and it is projected that the majority of R-404A containing equipment and old split-type air conditioners and heat pumps are gradually decommissioned. The total decrease of emissions by 2050 compared to 1990 is projected to be 83.771% in the WEM scenario and 83.774% in the WAM scenario.

In the WEM scenario agriculture emissions are projected to decrease by 38.8% compared to 1990 by 2050 but compared to the year 2021 the emissions are projected to increase 5.6% by 2050. Estonia´s agriculture sector is driven by the Enteric Fermentation and Agricultural soils (including the use of mineral and organic fertilizers) subcategories that are an important food source.

According to the projections, the LULUCF sector is expected to remain a source of GHGs in the WEM and WAM scenarios from -5235.3 kt CO_2 eq. total sequestration in 1990 to 1768,7 kt CO_2 eq. and 293,9 kt CO_2 eq. in 2050 according to the WEM and WAM scenarios, respectively. Growing stock changes were projected as ten-year averages. Due to the high proportion of mature and premature forest stands and increasing proportion of forest area belonging to the first development classes (treeless area, area under regeneration and young stands), the capacity of carbon sequestration in tree biomass has decreased in recent years and the decline is expected to continue during the next decades. According to the WEM scenario (total felling volume is 11 mln m^3 $year^{-1}$), total forest growing stock will be approximately 5% lower in 2050 than it is now.

In the WAM scenario (total felling volume is 9.9–10.2 mln m^3 $year^{-1}$), Forest land will sequester carbon.

The increasing trend of waste sector emissions in 1990– 2001 is linked to low rate of waste recycling. However, the emission decrease until 2050 is mainly related to the increase of reusing and recycling waste materials, the decreasing amount of biodegradable waste deposited in landfills and to waste incineration in the Iru CHP plant in 2013. The decrease of emissions by 2050 is reaching 55.9% compared to 1990 in WEM=WAM scenarios.

3.4. Changes with respect to the 2023 submission

As also written unde chapter 2, when updating the GHG projections in 2024, the definitions of the WEM and WAM scenarios were reviewed specifically for Estonia, so it would be clear for everyone which measures were considered part of the WEM and which for WAM scenarios. As an agreement between the ministries, the existing measures (adopted and implemented) in the context of the WEM scenario of GHG projections are considered to be:

4) measures that have been approved/decided by the government or other national institution (including in the margins of the State Budget Strategy and/or in the State Budget, and in the implementation plans of strategic development plans).

5) in the case of the measure type "economic incentives", the measure has an approved regulation on the conditions of the measure or one that will be approved in the near future.

6) measures other than "economic incentives" (e.g. updating standards and/or rules, advice or information etc.) that have a dedicated or clearly planned workstream are also accounted as an existing measures.

As an agreement between the ministries, additional measures (planned) in the context of the WAM scenario of GHG projections are considered to be:

3) Planned measures from sectoral development plans (including those that do not yet have a decision on the specific amount of funding or time scale).

4) goals reflected in the draft directives (if these goals are very likely to be adopted as they are).

Due to this clarification a number of policies and measures considered previously under the WAM scenario were removed as they were mainly from studies and/or strategies commissioned by ministries and therefore they didnt have a realistic chance of being adopted and implemented after the date of submission of the integrated national energy and climate plan or of the integrated national energy and climate progress report (definition of planned measures in the Regulation (EU) 2018/1999). Also number of measures previously reported under the WEM scenario were moved to WAM scenario due to change of scope of the WEM and WAM measures in Estonia (see above clarification).

Other reasons for changes with respect to the 2023 submission were:

- updated projections were prepared based on updated GHG inventories therefore methodologigal changes done in the past years in GHG inventories are also affecting GHG projections;
- updated information from companies under Energy sector;
- updated parameters;
- inclusion of new measures.