National Forestry Accounting Plan
2021-2025
Estonia

2019

OVERVIEW

This National Forestry Accounting Plan (NFAP) has been prepared according to requirement by "LULUCF Regulation", *Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU*[1].

The LULUCF Regulation requires the EU Member States to submit their NFAPs, including a proposed forest reference level (FRL), to the Commission by 31st of December 2018 for the period from 2021 to 2025. The LULUCF Regulation also requires the EU Member State to submit their revised NFAPs to the Commission by 31st of December 2019.

This revised Estonian National Forestry Accounting Plan for the period of 2021-2025 has been prepared in cooperation by Forest Department of the Ministry of the Environment and Estonian Environment Agency (EstEA).

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[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0001.01.ENG&toc=OJ:L:2018:156:TOC

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ACRONYMS

BAU	business as usual
BAWS	biomass available for wood supply
C	carbon
CCADP	Climate Change Adaptation Development Plan
CO_2	carbon dioxide
CP	compliance period
EstEA	Estonian Environment Agency
EU	European Union
EFDP	Estonian Forestry Development Plan
FAWS	forest available for wood supply
FNAWS	forest not available for wood supply
FMP	forest management practice
FRL	Forest Reference Level
GHG	greenhouse gas
GHGI	Greenhouse Gas Inventory
HWP	harvested wood product(s)
IPCC	Intergovernmental Panel on Climate Change
IPCC GL	IPCC Guidelines
IRW	industrial roundwood
LULUCF	Land Use, Land Use Change and Forestry
MFL	managed forest land
NA	not applicable
NCDP	Nature Conservation Development Plan
NDPES	National Development Plan of the Energy Sector
NFAP	National Forestry Accounting Plan
NFI	National Forest Inventory
NIR	National Inventory Report
RP	reference period
SOM	soil organic matter
SQC	site quality class
t	tonne
T1, T2, T3	Tier 1, Tier 2, Tier 3
UNFCCC	United Nations Framework Convention on Climate Change

1. GENERAL INTRODUCTION

1.1 General description of the forest reference level for Estonia

According to the LULUCF regulation[2], Forest Reference Level (FRL) is an estimate, expressed in tonnes of CO_2 equivalent per year, of the average annual net emissions or removals resulting from managed forest land within the territory of an Estonia in the period of 2021 to 2025, based on the criteria set out in the Regulation.
The FRL for the period of 2021 to 2025 was calculated by Estonian Environment Agency. The data used for FRL calculations mostly originates from NFI (National Forest Inventory), FAOSTAT and Statistics Estonia.
For the calculation of FRL, all forest land is considered managed in Estonia – the whole forest land in Estonia is or has been covered with forest management plans. Protected forests are covered with the protection scheme. Managed forest land was distributed into 3 different strata: forest category, dominant tree species and site quality class. Forest reference level with and without HWP was calculated. FRL for Estonia for the period 2021-2025 has been estimated to -1.75 Mt CO_2 eq per year (Table 1.1).

Table 1.1 Average annual carbon stock changes, other emissions and the resulting FRL for managed forest land in Estonia 2021-2025

[Mt CO_2 eq per year]	*2021-2025*
Living biomass	-0.60
Dead wood	-0.17
Mineral soils	-1.18
Drained organic soils	+0.31
Non CO2 emissions from drained forest	+0.30
Non CO2 emissions from biomass burning in forest areas	+0.0014
HWP	-0.42
TOTAL without HWP	**-1.33**
TOTAL with HWP	**-1.75**

1.2 Consideration to the criteria as set in Annex IV of the LULUCF Regulation

Annex IV of the LULUCF Regulation lists the criteria a Member State's FRL determination has to be in accordance with.

Estonian FRL is consistent with the goal of achieving a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of this century, including enhancing the potential removals by ageing forest stocks that may otherwise show progressively declining sinks. The above-mentioned goal is in line with sustainable forest management practises in Estonia which are supported by long-term forest policies in order to meet future demands for energy and timber and to substitute fossil based energy production while maintaining biodiversity. According to Climate Policy until 2050 impact assessment

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0001.01.ENG&toc=OJ:L:2018:156:TOC

analysis[3] and a study[4] by Estonian Environment Agency a forest growing stock is expected to decrease until 2050 according to scenario BAU-EFDP2020. Nevertheless, forest growing stock is expected to increase again in the second half of this century (Table 2.4). The age structure of managed forests of Estonia is dominated by mature stands. Therefore the rejuvenation of forests by final fellings in the coming years is reasonable to harmonise the age structure in forest available for wood supply.

In order to find ways to compensate prognosed CO_2 emissions caused by declining forest growing stock, Estonia has analysed different measures. A recent study by Stockholm Environment Institute (Tallinn Office) titled "Reaching climate neutrality in Estonia[5]" highlights two LULUCF sector measures: afforestation and conversion of cultivated peat soils into natural grasslands. Afforestation as a measure provides potential use for a land out of active management (mostly natural grasslands) and enhances forest carbon stock significantly by the year 2050. Felling rates in 2021-2030 will also have a strong impact on the development of forest carbon stock by 2050 and beyond. Allowable felling rates for the period of 2021-2030 will be stipulated in the Estonian Forestry Development Plan in 2020. It is possible to meet the goals of the long-term strategy required under Regulation (EU) 2018/1999 by regulating forest felling rates and enhancing afforestation during the coming decades.

FRL ensures that the mere presence of carbon stocks is excluded from accounting. The same principle was affirmed in Decision 16/CMP.1 under the Kyoto protocol[6]. Its objective is related to enhancing the carbon stocks and the net carbon sinks where possible instead of just preserving already existing carbon stocks. The FRL is calculated in order to support accounting for differences in net changes in forest carbon stocks.

Also, the FRL ensures a robust and credible accounting system which assures that emissions and removals resulting from biomass use are properly accounted for. FRL is consistent with national GHGI reporting system as all C stock changes on MFL are accounted for in LULUCF sector. All C pools are included in the calculation of FRL and in the reporting for Estonia.

A carbon pool of HWP is included in FRL calculations. FRL provides a comparison between assuming instantaneous oxidation and applying the first-order decay function and half-life values as presented in Chapter 4.1.

For calculation of FRL, a constant ratio between solid and energy use of forest biomass as documented in the period from 2000 to 2009 is assumed. Same share of HWP commodities as for the RP was used to determine the projections for the CP. This means continuing with the same share of energy vs non-energy use of wood as documented in the historical RP.

The calculated FRL is consistent with the objective of contributing to the conservation of biodiversity and the sustainable use of natural resources, as set out in the EU forest strategy, Estonia's national nature conservation and forest policies, and the EU biodiversity strategy. In the calculation of FRL for Estonia biodiversity objectives and restrictions for sustainable use of forest resources have been taken into account. Biodiversity and timber production among others are important components of sustainable forest management according to Estonian

[3] https://www.envir.ee/sites/default/files/kpp_2050_mojudehindamise_lopparuanne_25.05.pdf
[4] https://www.envir.ee/sites/default/files/e_part_-_uuendusraie_arvutus_eesti_riikliku_metsanduse_arvestuskava_koostamise_toetamiseks.pdf
[5] https://www.sei.org/wp-content/uploads/2019/10/eesti-kliimaambitsiooni-t%C3%B5stmise-v%C3%B5imaluste-anal%C3%BC%C3%BCs-1.pdf
[6] FCCC/KP/CMP/2005/8/Add.3

Forest Act. Forest biodiversity protection follows the principle to protect forests that have high conservation value.

Total protected forest area (25.6% of total forest land area in 2017) is divided into 2 basic categories:

- protection forests where forest management activities are limited but not prohibited (12.5%);
- strictly protected forests where all forest management activities are prohibited (13.1%).

In order to contribute to the conservation of biodiversity in forest available for wood supply there are several requirements and possibilities according to Forest Management Regulation[7] and Forest Act[8]:

- Forest Act sets minimal rotation ages for tree species that are not based only on economic principles but are a compromise between economic and ecologic goals. Forest Act also sets restrictions to final felling maximum areas that are site specific and range from 2-7 hectares for clearcuts and up to 10 hectares for shelterwood cutting. Establishment of new final felling areas bordering an existing final felling site is only allowed if the previous felling site has regenerated or the maximum felling area has not been reached.
- According to Forest Management Regulation there are requirements for leaving retention trees[9] on clear-felling sites in order to ensure biodiversity. It is also forbidden to damage retention trees, forest ecosystem, water regime and forest soil during forest management.
- Forest Act regulates the protection of woodland key habitats[10]. The regulation allows to restrict or prohibit economic activities in a key habitat on the basis of the key habitat protection objective. The fellings in key habitats are allowed only in exceptional cases in the forest owned by a legal person governed by public law and in the state forest. In private forests the protection of a key habitat is on voluntary basis or regulated with notarised contract[11].
- There is also a recommendation that is communicated via state forest register website and elsewhere not to cut forest during birds nesting season from April 1st until July 31st. State Forest Management Centre has established a spring period where final fellings in state forest are prohibited.
- The European Commission has evaluated the sufficiency of Habitats directive species and habitat types protected in Estonian Natura 2000 network. The conclusion is that all

[7] https://www.riigiteataja.ee/akt/12771900?leiaKehtiv
[8] https://www.riigiteataja.ee/en/eli/521032019004/consolide
[9] Old crop trees, i.e. trees that are necessary to ensure the biological diversity, or the preserved standing parts of such trees, with the total volume of stem wood of at least five solid cubic metres per hectare or, in the case of a clear-cutting area sized over five hectares, at least ten solid cubic metres per hectare. Retention trees are selected from the trees with largest diameter of the first storey of stands, preferring hardwood species, pines and aspens.
[10] A key habitat is an area where the probability of the occurrence of narrowly adapted, endangered, vulnerable or rare species is high
[11] For the protection of a key habitat a notarised contract may be concluded with the owner of a privately owned immovable, on the basis of which the immovable is encumbered with a personal right of use in favour of the state via the Ministry of the Environment for a term of 20 years. The contract can be concluded for the protection of a key habitat located outside a protected natural object, which has been entered in the environmental register. The state has the right to prohibit or restrict economic activities in a key habitat arising from the objective of the protection of the key habitat and the forest owner must ensure preservation of the key habitat.

species and habitat types including 9010 and 9020 are sufficiently represented in Estonian Natura 2000 network.

Big share of mature forest, relatively high share of strictly protected forest and woodland key habitats contribute to the conservation of biodiversity, in particular of old-growth forest stands.

The FRL is consistent with the national projections of anthropogenic GHG emissions by sources and removals by sinks reported under Regulation (EU) No 525/2013 (Figure 1.1). Both, the FRL and the projections under regulation (EU) 525/2013 include the same C pools. The reporting under the named regulation is a business as usual projection which may deviate to some extent from the FRL because of assumptions made.

FRL slightly differs from projections under regulation (EU) 525/2013 because:

- the projection is based on total forest land area but FRL on category forest land remaining forest land.
- projections were made with preliminary data.

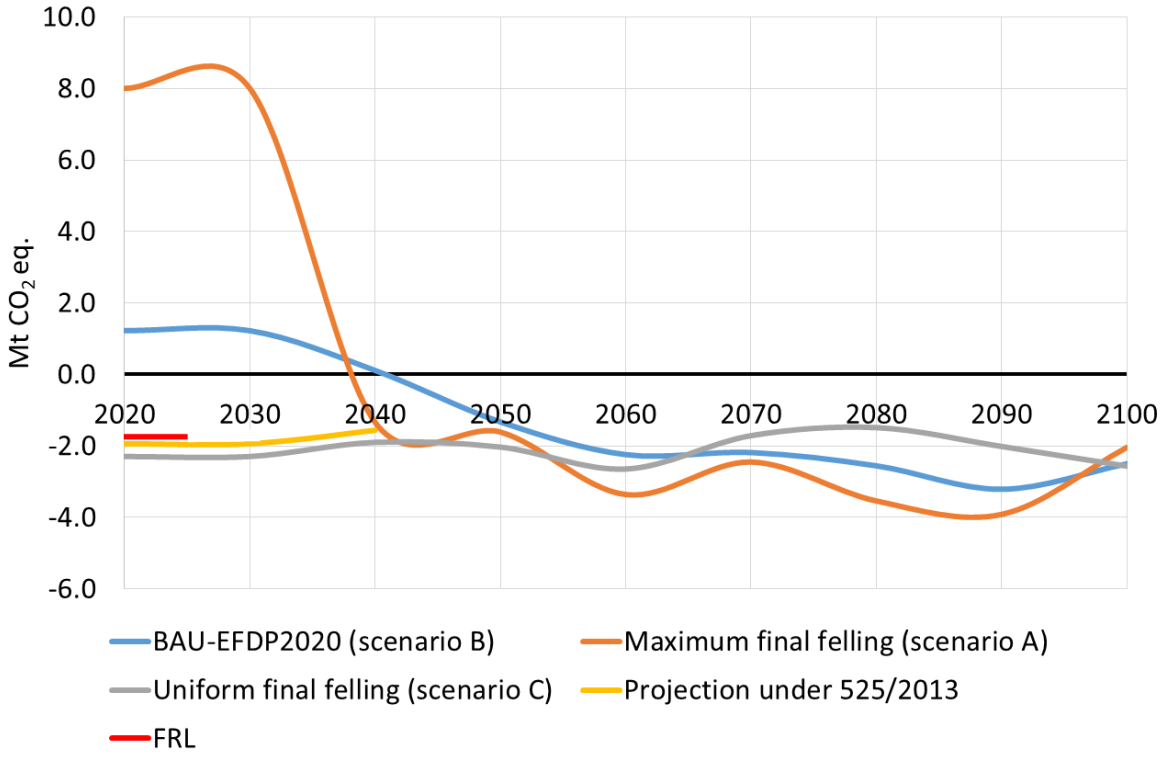


Figure 1.1. Projections of GHG emissions and removals from forest including HWP (see section 2.3.2).

In addition, the FRL is consistent with GHGI and relevant historical data based on transparent, complete, consistent, comparable and accurate information. The model that is used to construct the FRL is able to reproduce historical data from the GHGI as the same data sources and similar methodology (same definitions of C pools, same guidelines, etc) has been used for calculating FRL.

1.3 An explanatory note

An explanatory note can be found in Annex IV. In an explanatory note one can find answers and comments to technical recommendations on Principals, Criteria and Elements that were provided for Estonia in Commission Staff Working Document (SWD)[12] and conclusions of LULUCF EG Synthesis Report (SR)[13]. An explanatory note will also provide information on revised parts of Estonian NFAP that were not noted in SWD or SR.

[12] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019SC0213&from=EN
[13] https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupMeetingDoc&docid=30965

2. PREAMBLE FOR THE FOREST REFERENCE LEVEL

For the calculation of FRL, Estonia has taken into account all requirements set out in LULUCF regulation and has also used suggestions in guidance document[14] shared by the European Commission on developing and reporting the FRL in accordance with the regulation. FRL for the period of 2021-2025 takes into account all relevant carbon pools and GHGs. Consistency between carbon pools have been demonstrated in chapter 2.2. General approach for estimating the forest reference level is based on forest management planning regulation and felling coupe calculations. Forest management practices for the reference period and documentation of data sources are described in chapter 3.1. Managed forest land was designated into three different strata: forest category, dominant tree species and site quality class (chapter 3.2.1). Modelling steps of the FRL are listed and described in chapter 3.3. Check list for the elaboration of Forest Reference Level is presented in Annex I.

2.1 Carbon pools and greenhouse gases included in the forest reference level

The same C pools and gases have been estimated in the managed forest land (Managed forest land) in GHGI category as were used in the construction of the FRL. In line with the LULUCF regulation, the following pools are included in the calculation of forest reference level: above- and below-ground biomass, dead wood, mineral and organic soils (emissions from mineral soils and drained organic soils), non CO_2 gases and harvested wood products. Litter pool will be added with the technical correction during the commitment period.

2.2 Demonstration of consistency between the carbon pools included in the forest reference level

All carbon pools are calculated corresponding to the IPCC GL and consistent with the GHGI[15] thus only a summary is provided in this document. Activity data is derived mostly from NFI but FAOSTAT and Statistics Estonia data is also used for HWP calculations.

For estimating carbon stock changes in living biomass and dead wood for the Managed forest land, the *Tier 2* approach and *Method 2* – the stock-difference method was applied. Stock-difference method for biomass also comprises carbon loss from biomass burning and natural disturbances.

Soil carbon estimates are calculated using the emission factors from Sweden[16] both for mineral and drained organic soils; this approach was suggested for Estonia by ERT[17]. Estonia is currently working on projects to provide country specific emission factors for soils.

[14] https://publications.europa.eu/en/publication-detail/-/publication/5ef89b70-8fba-11e8-8bc1-01aa75ed71a1/language-en
[15] https://www.envir.ee/sites/default/files/content-editors/Kliima/nir_est_1990-2017_15.01.2019.pdf
[16] Sweden NIR 2017, Annexes, Table A3:2.2, p. 106
[17] FCCC/ARR/2012, para. 94.

The carbon estimate for HWP has been calculated using the production approach[18]. HWP calculations include following products: solid wood (sawnwood and wood panels), paper (paper and paperboard) and semi-chemical wood pulp. The changes in roundwood stocks and their carbon balance are not taken into account in the reporting. The CO_2 emissions form HWP in solid waste disposal sites are also excluded from the calculations.

Estonia does not have sufficient data regarding litter stocks, thus the Tier 1 method was implemented, assuming that carbon stocks are in equilibrium. The changes in the litter pool are assumed to be zero. The results from a project "Forest litter, research and modelling" aim at elaboration of country-specific litter model (dependent on the main tree species and site type) in coming years. The model will be tested and controlled before it is used. Litter pool will be added with the technical correction during the commitment period.

2.3 Description of the long-term forest strategy

Estonian Forest Policy was approved by the parliament in 1997[19]. Long-term forest strategy in Estonia is determined by different adopted national policies. One of the most important and direct forest strategy documents is Estonian Forestry Development Plan (EFDP) compiled for every 10 years. In addition to EFDP and other policies there are also Estonian Environmental Strategy 2030, Climate Change Adaptation Development Plan until 2030, National Development Plan of the Energy Sector until 2030, Nature Conservation Development Plan and Climate Policy until 2050 that play an important role in long-term forest strategy.

2.3.1 Overall description of the forests and forest management in Estonia and the adopted national policies

Forests and forest management

According to Estonian Forest Act[20] forest and forest land are being separated. Forest is an ecosystem that consists of forest land that is covered by vegetation and where living fauna is present. Forest land on the other hand, is land that meets at least one of the following requirements:

1) is registered in land cadastre as forest land;
2) has an area of 0.1 hectares of land, growing woody plants with a minimum height of 1.3 meters and the tree crown cover at least 30 per cent.

Forest land that is entered into land cadastre and where woody plants are not grown is forest land without forest. If forest land meets the criteria described in point 2, it is called forest land with forest.

GHGI definition of forest land differs from the one by Forest Act. Parameters for managed forest land according to the LULUCF regulation are shown in Table 2.1.

Table 2.1. Parameters for forest definition

Minimum tree crown cover	30%
Minimum land area	0.5 ha
Minimum tree height	2 m

[18] 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, Chapter 2.8. p. 2.109.
[19] https://www.riigiteataja.ee/akt/73663
[20] https://www.riigiteataja.ee/en/eli/ee/528062018009/consolide/current

Based on the GHGI definition of forest land 2017 National Forest Inventory (NFI) data and information from Estonian Environment Agency, there were 2.35 million ha of forest land in in Estonia that made up to 51.9% of the whole terrestrial area. 2.2 million ha of the forest land was covered by forest. Total area of forest land has slowly increased in Estonia. 51% of the forest land belongs to the state and privately owned forests make up to 49%. There is 1.8 ha of forest land per capita in Estonia.

In recent years area of forest under protection has increased as well. In 2017 there was 13.1% of forest land that was strictly protected and 12.5% of forest land was determined as with management restrictions. Total protected forests therefore form 25.6% of Estonian forest land. The share of forest land area that is strictly protected, has increased but the share of forest land area with management restrictions has decreased in this century.

After Estonia restored its independence land reform was initiated and after 25 years it is in final stages by 2017. Significant part of the land that had no owner was finally privatized or obtained by state.

There is a lot of mature forest stands in Estonia[21]. Approximately 39% of forest stands are more than 60 years old. The total area of Estonian forest stands is 2.2 million ha of which the biggest part – 551 800 ha – constitute of stands in age 41-60 years. The most common tree species in Estonian forests are pine, birch, spruce, grey alder, aspen and black alder. Based on NFI the annual increment for the whole forest land was 16.1 million m^3 in 2017. Felling rates in 2017 (NFI) and 2018 (expert evaluation) were 12.5 m^3 (both years)[22].

Policies

Estonian Forest Policy

Estonian Forestry is based on Estonian Forest Policy[23] (1997). According to Estonian Forest Policy, forestry development has two general objectives that are inseparable and come from each other. Those objectives are:

1) sustainable (steady, continuous and versatile) forestry which means maintenance and usage of forests and forest land in a way and pace that ensures their biological diversity, productivity, regeneration ability, viability and potential today and also in the future without damaging other ecosystems to fulfil ecological, economic and social functions on local, national and global level;
2) efficient management of forests which means economical production and usage of all forestry related goods in both short and long term perspective.

Estonian Forestry Development Plan

The most important long-term forest strategy document is Estonian Forestry Development Plan that is compiled in every 10 years. The valid EFDP was adopted by parliament in 2011. Its main goal is to ensure productivity, vitality and diverse and efficient use of forests. In order to achieve this goal several activities are determined. In the long term, it is determined, that wood is used as renewable natural resource in wood industry and energetics up to increment. Also, in order to maintain forest productivity, forest renewal activities will be carried out at least on half of the renewal cutting sites. And, in order to maintain good state of populations of endangered

[21] https://www.keskkonnaagentuur.ee/et/uudised/eesti-metsad-2017
[22] Eesti Metsad 2018, https://www.keskkonnaagentuur.ee/et/aastaraamat-mets-2018
[23] https://www.riigiteataja.ee/akt/73663

species and species most common for Estonia, at least 10% of the area of forest land has been taken under strict protection and representativeness of protected forests have been improved.

More precise activities and goals of EFDP until 2020 can be found in the document[24]. EFDP for the period of 2021-2030 will be compiled in 2019 and 2020.

Nature Conservation Development Plan until 2020

Nature Conservation Development Plan until *2020*[25] (NCDP 2020) was adopted in 2012. From the NCDP 2020 standpoint the most important principle is that wood is harvested in a way and extent that ensures biodiversity, productivity, regeneration ability, viability and potential of forests today and also in the future. In managed forests where are no nature conservation restrictions, key habitats where probability of appearance of endangered or rare forest species is high are protected according to Forest Act. In managed forests it is important to follow additional restrictions like leaving seed trees, dead and retention trees, avoiding monoculture stands, giving up forest fertilization, not using dangerous plant protection products (glyphosates) and avoiding construction of new drainage systems in order to support conservation of forest biota.

Estonian Environmental Strategy 2030

Estonian Environmental Strategy 2030 describes forest related trends, objectives and measures in Estonia[26]. The document supports the conception of diverse use of forests that is emphasized in Forest Policy. Subchapter 5.1.4 "Forest" of the Environmental Strategy has an objective of balanced satisfaction of ecological, social, cultural and economic needs in the course of utilisation of forests in a long perspective (longer than the period of 25 years). Forests must offer economic benefits (timber, mushrooms, berries and other forest products) and socio-cultural benefits like recreation and hiking possibilities and cultural-historical sites (such as sites of ancient sacred groves, etc.). At the same time, the diversity, balance and regeneration capacity of forest ecosystems must be preserved. The strategy also supports the development of a system of incentives, benefits and regulations with a view to encouraging the management and sustainable utilisation of multifunctional forests.

Climate Change Adaptation Development Plan until 2030

According to Climate Change Adaptation Development Plan until 2030[27] (CCADP 2030) the objective of forestry is to ensure sustainable forest management in changing climatic conditions. Due to higher temperatures and increased precipitation primary production of ecosystems are estimated to enhance in the future but at the same time degradation of organic matter and thus greenhouse gas emissions related to this process will also increase. Estonian winters are expected to be warmer due to climate change and soils would not freeze up which would make forest harvesting difficult and increases occurrence of winter storm damage in excessively moist forests with surface root systems. Climate change affects the spread and coherence of forest habitats, biological diversity, inter-species relationships and forest habitat types.

[24] Estonian Forestry Development Plan until 2020,
https://www.envir.ee/sites/default/files/elfinder/article_files/mak2020vastuvoetud.pdf
[25] https://www.cbd.int/doc/world/ee/ee-nbsap-v2-en.pdf
[26] Estonian Environmental Stragegy 2030,
https://www.envir.ee/sites/default/files/keskkonnastrateegia_inglisek.pdf
[27] Climate Change Adaptation Development Plan until 2030,
http://www.envir.ee/sites/default/files/national_adaptation_strategy.pdf

According to CCADP 2030, climate change may affect functioning of important bio-economy sectors in Estonia, including the forest sector through i.e. changes in species composition, production capacity and ecological status. CCADP 2030 emphasizes the need for increased investments in sustainable forest management and public awareness raising about the benefits of forests and wood, to secure viability of forests and its productive functions, long term use of wood and thus increased sequestration of CO2 by forests and storing in long term forest products.

National Development Plan of the Energy Sector until 2030

National Development Plan of the Energy Sector until 2030 (NDPES 2030)[28] was approved by the Government in October 2017. The NDPES 2030 describes the objectives of Estonia's energy policy until 2030, the vision for the energy sector until 2050, as well as the overall and specific targets and actions to meet them.

According to NDPES 2030 wood including forestry and timber industry waste, makes a significant contribution to Estonia's fuel sector. Low-quality wood and timber waste are increasingly used in heat and electricity generation. Most of the wood used in Estonian energy sector comes from Estonian forests. Due to development of renewable energy, wood based fuels (pellets, wood chips etc) have become goods traded in world markets with price that forms in balance of demand and supply. The increased use of wood in the energy sector can have a negative impact on the carbon sequestration capacity and greenhouse gas emissions, with the consequence of reducing Estonia's opportunities for meeting its international obligations and participating in the international market of greenhouse gas emissions.

Climate Policy until 2050

Climate Policy until 2050[29] was adopted by the parliament (Riigikogu) in April 2017. According to Climate Policy 2050, step by step wider introduction of domestic renewable energy sources in all sectors of final consumption is encouraged with a view to increasing the welfare of society and the need to ensure energy security and security of supply. Wide consumption of local bioenergy and other renewable energy resources are encouraged for production of electricity and heating energy as well as for transportation fuel.

Climate policy describes guidelines for forestry and land use sector. First guideline says that forest growth and the carbon sequestration capacity will be increased through productive and sustainable forest management, and the carbon stock of forests will be maintained in the longer perspective. The productivity of managed forest land will be mainly increased through improvement cutting, timely cutting of forest stands and fast renewal of forests with tree species appropriate for the habitat type. Flexible rotation ages considering the growth potential of forest stands will be implemented in managed forests, and the principles of sustainable forestry and the maintenance of biodiversity will be taken into account.

Also, timber use will be consistently enhanced and the carbon stock in wood products and buildings will be increased, thus replacing the use of non-renewable natural resources. The use and production of domestic wood products will be developed, e.g., the use of wood in construction will be increased.

Another guideline says that preservation of the current area under forest land will be facilitated, and in other categories of land use, techniques of increasing carbon sequestration and reducing

[28] https://www.mkm.ee/sites/default/files/ndpes_2030_eng.pdf
[29] https://www.envir.ee/sites/default/files/low_carbon_strategy_until_2050.pdf

emissions will be preferred. Trends in the land use sector will be monitored and considered in planning.

Also, it is determined that research, development and innovation fields that help to increase carbon sequestration and find alternative uses for wood will be preferred in the forestry and land use sector.

2.3.2 Description of future harvesting rates under different policy scenarios[30]

According to the LULUCF Regulation, a Member State has to submit information on how harvesting rates are expected to develop under different policy scenarios.

Taking into account existing measures and adopted policies that overlap the commitment period of NFAP (2021-2025) the following scenarios were analysed.

Future harvesting rates in Estonia depend on adopted and planned policies. The adopted policies that may have impact on felling rates up to 2030 are National Development Plan of the Energy Sector until 2030 (NDPES 2030) and Climate Policy until 2050. Also, the great impact on felling rates might be determined by Estonian Forestry Development Plan until 2030. The EFDP 2030 will be compiled in the next two years and therefore the impacts to felling rates are unknown at this time.

In the first half of 2018 a study[31] about possible final felling areas was carried out by Estonian Environment Agency (EstEA) and commissioned by the Ministry of the Environment. The study serves as a basis for information both in compilation of Estonian Forestry Development Plan for the period of 2021 to 2030, and also provides valuable information for the compilation of the NFAP for the period of 2021 to 2025. Additionally, in 2019 the Ministry of the Environment commissioned the study "Forest and Climate Change"[32] to analyse development of forest resources in coming 100 years.

Both studies state that the age structure of managed forests of Estonia are dominated by mature stands (average age of stands is quite high compared to rotation age). Therefore, the forests' rejuvenation by final fellings is reasonable in forest available for wood supply. The intensity of final fellings is a basis for different options to calculate optimum final felling area (allowable cut). It is assumed that felling according to BAU-EFDP 2020 (considering final felling area by years and tree species) will avoid excessive variation in total felling volume.

Calculations in the studies have been made for commercial forests and protection forests that all together are considered as forest available for wood supply (FAWS). In commercial forests the forest management is allowed according to Forest Act and other legal documents based on Forest Act. Final felling is allowed depending on the age of the stand, diameter and stocking of the stand. Minimum age and diameter of the stand where final felling is allowed are in Table 2.2 and Table 2.3. In protection forests the management activities are limited but not prohibited. There are no fellings planned for strictly protected forests.

[30] The study is conducted on the bases of Estonian forest definition and not on the GHGI forest definition. Definitions are in 2.3.1.
[31] https://www.envir.ee/sites/default/files/e_part_-_uuendusraie_arvutus_eesti_riikliku_metsanduse_arvestuskava_koostamise_toetamiseks.pdf
[32] Mets ja Kliimamuutused, Report

Table 2.2. Allowed final felling age (years) by site quality class and tree species

Species	Site quality class					
	1A	**1**	**2**	**3**	**4**	**5; 5A**
Pine	90	90	90	100	110	120
Spruce	60	70	80	90	90	90
Birch	60	60	70	70	70	70
Aspen	30	40	40	50	50	-
Black Alder	60	60	60	60	60	60
Hardwood species*	90	90	100	110	120	130

*Oak, Ash, Maple, Elm

Table 2.3. Allowed final felling diameter (cm) by site quality class and tree species

Species	Site quality class					
	1A	**1**	**2**	**3**	**4**	**5; 5A**
Pine	28	28	28	28	28	28
Spruce	26	26	26	26	26	26
Birch	26	26	24	22	18	16
Black Alder	24	24	22	22	18	16
Aspen	20	20	18	18	18	18

The method of calculations has been used for calculation of allowable cutting level scenarios for the National Forestry Development Plan until 2020. Calculation rules of an allowable cut are described in the Forest Management Planning Regulation[33].

Three different optimum final felling scenarios were calculated.

- Scenario A is maximum allowable felling. In this case there is presumption that all stands that have reached the allowed felling age or diameter will be cut during the next ten years (maturity stand).
- Scenario B presents the BAU according to EFDP 2020. This scenario represents the optimum usage of forest resources taking into account the present age structure of stands today and during the next 40 years.
- Scenario C represents long term uniform final felling. In this case an average even annual final felling area is assumed during the whole rotation period.

According to the scenario A, average annual felling for the period from 2021 to 2025 in FAWS could reach 20.1 million m^3. The same estimate for the scenario B is 14.3 million m^3 per year and for the scenario C it is 11.3 million m^3.

Scenario B is a compromise between the timely felling of mature stands and long term uniform wood harvest.

[33] https://www.riigiteataja.ee/akt/13124148?leiaKehtiv

The studies also provides information on how different final felling rates' scenarios affect forest growing stock and increment in a long run. Total growing stock figures include protected forests. Table 2.4 illustrates the named changes up to the year 2100.

Table 2.4. Changes in growing stock, increment and fellings (million m^3)

	BAU-EFDP2020 (scenario B)			Maximum final felling (scenario A)			Uniform final felling (scenario C)		
	Growing stock	Increment	Fellings	Growing stock	Increment	Fellings	Growing stock	Increment	Fellings
2020	483	16.0	14.3	483	16.0	20.1	483	16.0	11.3
2030	457	14.5	12.1	394	12.9	9.8	489	15.4	10.9
2040	445	14.3	10.8	398	13.7	10.4	494	15.1	10.7
2050	447	14.5	10.3	404	14.5	9.5	502	15.1	10.2
2060	458	15.2	10.8	425	15.4	10.8	515	15.5	11.2
2070	468	15.4	10.7	438	15.6	10.1	520	15.3	11.4
2080	481	15.7	10.4	460	16.1	10.1	524	15.3	11.1
2090	501	16.3	11.3	486	16.6	11.8	533	15.6	10.9
2100	514	16.3	12.0	495	16.3	13.8	546	16.0	11.6

Both growing stock as well as annual increment are expected to decline in the next 30 years according to the scenarios A and B; afterwards the trend will be reversed and both indicators will increase steadily. In case of uniform final fellings' scenario the growing stock is expected to increase slightly despite the moderate decrease of increment.

3. DESCRIPTION OF THE MODELLING APPROACH

Activity data for FRL calculations mainly comes from NFI but information about HWP commodity production and foreign trade originates from FAOSTAT and Statistics Estonia.

All forest land is considered managed in Estonia – the whole forest land in Estonia is or has been covered with forest management plans. In addition, protected forests are covered with the protection scheme.

Estonia applies the same forest definition for FRL as is used for National Greenhouse Gas Inventory. The main parameters of forest definition are shown in Table 2.1. Method for calculation of FRL does not consider future climate effects.

3.1 Description of the general approach as applied for estimating the forest reference level

General approach for estimating the forest reference level is based on forest management planning regulation[34] and felling coupe calculations[35]. Similar methodology has been widely used to forecast allowable cutting limits, roundwood supply, future forest age- and volume structure, (forestry development plans[36], wood supply scenarios for forestry development pan[37], felling plans for state forests[38]) Estonian forests are mostly even-aged and predominant final felling type is clear felling in forest available for wood supply. Shelterwood cuttings are being used seldom.

Forest management regulation sets rotation ages according to dominant tree species and site quality classes.[39] Final fellings for the next period include stands which exceed rotation age during the planning period. Method of shifting the areas of age classes is used for modelling the future growing stock development. The growing stock volume is obtained multiplying the area in age class with average growing stock per hectare in relevant age class. The influence of intermediate fellings (cleanings, thinnings and sanitation fellings) is reflected in the average growing stock per hectare, thus those felling types are not separately considered in calculations. The management practise of intermediate fellings has not changed compared to RP. Intermediate fellings do not alter the age of stands and it is assumed that all stands in one age class reach next age class. The natural disturbances are also indirectly taken into account according to the same logic. This method ensures robust and credible accounting, to guarantee that emissions and removals resulting from biomass are properly accounted.

[34] https://www.riigiteataja.ee/akt/13124148?leiaKehtiv
[35] https://www.riigiteataja.ee/aktilisa/1310/8201/8008/KKM_16012009_m2_Lisa18.pdf#
[36] https://www.envir.ee/sites/default/files/mak2020vastuvoetud.pdf
[37] https://www.envir.ee/sites/default/files/elfinder/article_files/puidupakkumine-arvutustearuanne.pdf
[38] https://www.rmk.ee/files/Metsavarude%20prognoos%202011_2040%20_kokkuv%C3%B5te.pdf
[39] https://www.riigiteataja.ee/akt/126022014016?leiaKehtiv

3.1.1 Management practices for reference period (RP)

Estonian management practices have been defined by limits set in Forest Act[40] and Forest management regulation. During the RP those limits were changed several times. Rotation ages differ a lot by dominant tree species and site quality classes. In addition to rotation ages there are several additional options for final fellings: final felling according to maturity diameter (by dominant tree species and site quality classes), final fellings by health reasons, clear fellings as a result of low stocking level. There are several additional requirements for final fellings: maximum felling area, recommendation to retain certain amount of deadwood, seed trees and retention trees for biodiversity reasons on the felling site.

Besides the forest available for wood supply (FAWS) there is also forest not available for wood supply (FNAWS) i.e. areas where fellings and other management activities are not possible. FNAWS areas are treated as separate category in FRL calculations. There were two main reasons to include forest land under FNAWS category during RP:

- strict protection – forest management activities are prohibited on following strictly protected forest lands: strict nature reserves, special management zones, species protection site special management zones, habitat protection forests, protected woodland key habitats;
- forest land subject to privatization (forest land without owner and management) – after Estonia restored its independence land reform took almost 25 years. Significant part of the land had no owner during the RP and thus no possibilities for management (neither for state or private owners).

In 2017 land reform was in final stages and area of forest land subject to privatization in CP can be considered as zero. But during the RP a significant part of forest land was in this category. Long lasting land reform is partly also the reason why forest in Estonia have unbalanced age structure. Therefore the forest land subject to privatization is included into FNAWS, otherwise it may unduly constrain future forest management intensity.

The share of strictly protected forest land has constantly growing: 6% from total forest land area in 2000, 9.8% in 2010 and 13.1% in 2017, average share for RP was 7.2%. The share of forest land subject to privatization has declined: 41% in 2000, 13% in 2009 and less than 1% in 2017, average share for RP was 24%.

As described above in forests available for wood supply there are several possibilities and restrictions for final fellings in Estonia. For modelling these are converted to one dimension – rotation age according to dominant tree species and site quality classes (SQC) as illustrated in Table 3.1.

Table 3.1. Rotation ages used in calculation of the RP intensity of final fellings

Dominant species													
Pine		Spruce		Birch		Aspen		Black Alder		Grey alder		Other	
SQC	Age	SQC	Age	SQC	Age	SQC	Age	SQC	Age	SQC	Age	SQC	Age
1	90	1	80	1	60	1	35	1	60	1	30	1	80
2	90	2	80	2	70								
3	100	3	90	3	70								
4	115	4	90	4	70								

[40] https://www.riigiteataja.ee/akt/130122015032?leiaKehtiv

Forest area in Estonia has a slightly growing trend in recent years. Forest area in CP is estimated considering areas of afforestation and reforestation entering in managed forest land in CP.

The growing stock change between 2020 and 2025 is modelled using management practices and harvesting intensity during RP. CO_2 stored in biomass is calculated from growing stock figures based on IPCC GL methodology[41].

CO_2 stored in soil and dead wood in CP is estimated by using average content per hectare in RP. Non CO_2 emissions from drained forest and wildfires are estimated with similar approach.

Reference level for HWP pool is based on the projected harvest level during the CP. Same fraction of harvest for the HWP commodity production as in RP is assumed. Same share of HWP commodities as for the RP is used to determine the projections for the CP. This means continuing with the same share of energy vs non-energy use of wood as documented in the historical RP.

3.2 Documentation of data sources as applied for estimating the forest reference level

The main data source for the FRL and GHGI is NFI. The Estonian NFI covers all land-use categories: forests and other wooded lands in all ownership groups, including protected areas. The first National Forest Inventory covering the whole country commenced in 1999. The main objective of the NFI is to provide the estimates about major characteristics of forests, but nowadays the NFI also gives information about subjects such as the distribution of land by land-use categories and the afforestation and growing stock of non-forest land etc.

Design of the Estonian NFI is a systematic sample without pre-stratification. The network of sample plots covers the whole country and is planned as a five-year cycle. The sampling grid is designed to meet the accuracy requirements at national level. The sampling intensity is the same throughout the whole country. The sample (cluster) distribution is based on a national 5-km x 5-km quadrangle grid. Point estimates of parameters are calculated using data from the sample plots and form the basis for inferences to the entire population. More detailed information about sampling scheme, design and density of sampling grid is described by Adermann (2010)[42] and additional information concerning GHGI is described in NIR[43]. Main characteristics of forest land according to NFI is presented in Table 3.2 and Figure 3.1.

[41] IPCC 2006, Vol 4 (AFOLU), Equation 2.8, p. 2.12.
[42] Adermann, V. (2010). Estonia. *In*: Tomppo, E., Gschwantner, T., Lawrence, M., McRoberts, R. (eds). National forest inventories: Pathways for common reporting. Dordrecht: Springer, pp. 171–184.
[43] Greenhouse gas emissions in Estonia 1990-2016 National Inventory report. (2018).

Table 3.2. Distribution of forest land area and growing stock by dominant tree species in 2017

Dominant species	Area		Growing stock			Increment
			total volume		volume per ha	
	1000 ha	%	1000 m^3	%	m^3/ha	1000 m^3
Pine	739.3	31.4	173 646	36.0	235	4800
Spruce	441.8	18.8	94 795	19.6	215	3600
Birch	694.1	29.5	123 458	25.6	178	4200
Aspen	145.1	6.2	33 797	7.0	233	1300
Black alder	87.7	3.7	18 299	3.8	209	700
Grey alder	207.1	8.8	32 629	6.8	158	1300
Others	38.9	1.7	5 858	1.2	150	200
Total	2 354.1	100.0	482 482	100.0	205	16100

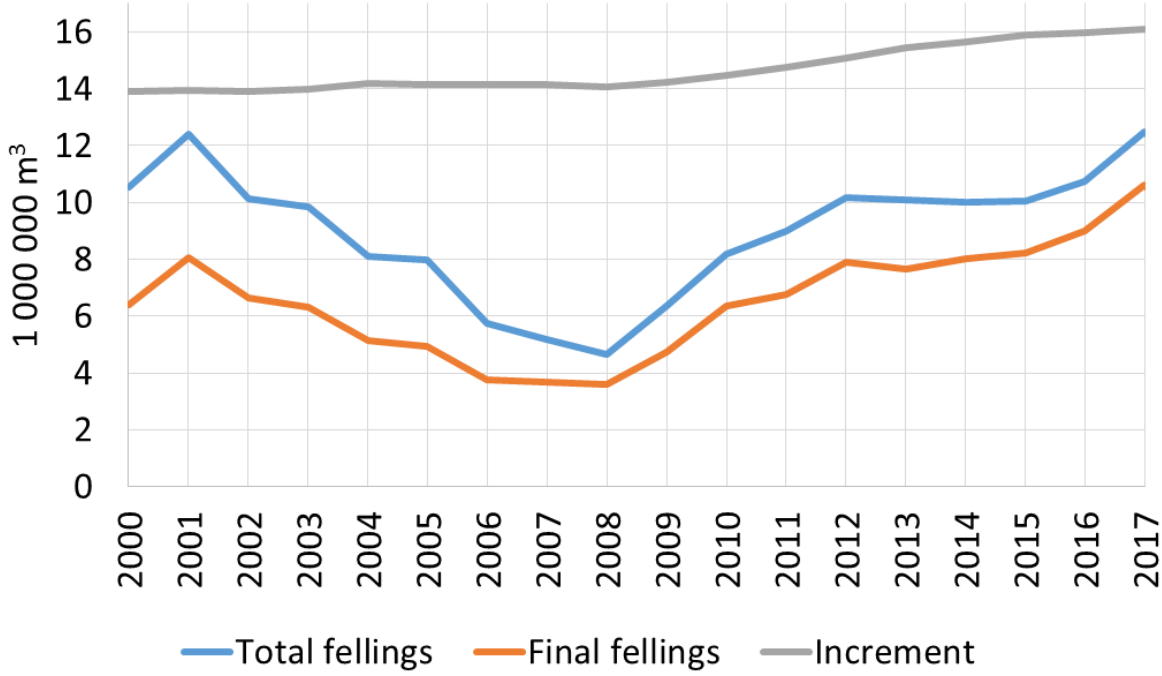


Figure 3.1. Volume of fellings and increment in 2000-2017

Information about HWP commodity production and foreign trade originates from FAOSTAT and Statistics Estonia.

3.2.1 Documentation of stratification of the managed forest land

Managed forest land is distributed into 3 different strata: forest category, dominant tree species and site quality class. Strata are divided into subcategories that are assembled in Table 3.6. Forest category contains three different subcategories: forest available for wood supply, strictly protected forests and forest land subject to privatisation. Dominant tree species are Scots pine (*Pinus sylvestris)*, Norway Spruce (*Picea Abies)*, Birch (*Betula spp)*, Aspen (*Populus tremula)*,

Black alder (*Alnus glutinosa)*, Grey alder (*Alnus incana)* and other species. Site quality class indicates the productivity of habitat and is expressed as index for all forest subcompartments or sites[44].

Corresponding to GHGI Estonia is not divided into geographic regions because the area is relatively small and homogeneous in terms of ecological conditions.

Strata: forest category (3):

- Forest available for wood supply - management is allowed according to different legal acts (Forest Act, Forest Management Planning Regulation, Forest Management Regulations, Nature Conservation Act, Water Act etc);
- Forest not available for wood supply - forest management activities are prohibited or not possible.

Strata: dominant tree species (7):

There are six main dominant species in Estonia, other species are assembled to strata other species. Main dominant species are: Scots pine *Pinus sylvestris*, Norway Spruce *Picea Abies*, Birch *Betula spp*, Aspen *Populus tremula*, Black alder *Alnus glutinosa*, Grey alder *Alnus incana*. Average distribution of forest land by dominant species and forest category in RP and in 2017 is shown in Table 3.3 and in Table 3.4.

Table 3.3. Average distribution of forest land area by dominant species and forest category in 2000-2009

	Dominant species							
Forest category	Pine	Spruce	Birch	Aspen	Black Alder	Grey Alder	Other species	Total
Forest available for wood supply	21.0%	12.7%	21.8%	4.0%	1.9%	6.4%	1.1%	68.9%
Forest not available for wood supply	11.9%	4.9%	8.7%	1.6%	1.1%	2.3%	0.6%	31.1%
Total	32.9%	17.6%	30.6%	5.6%	3.0%	8.7%	1.6%	100.0%

[44] Calculation rules for site quality classes are described in Forest Management Planning Regulation (Annex 10, https://www.riigiteataja.ee/aktilisa/1310/8201/8008/KKM_16012009_m2_Lisa10.pdf#), for practical use the site quality class tables have been calculated (Annex 8 of regulation https://www.riigiteataja.ee/aktilisa/1310/8201/8008/KKM_16012009_m2_Lisa7.pdf#). There are 7 site quality classes used in Estonia (1a, 1, 2, 3, 4, 5, 5a). Site quality class is calculated using average height and age of dominant tree species of stand.

Table 3.4. Average distribution of forest land area by dominant species and forest category in 2017

Forest category	Dominant species							
	Pine	Spruce	Birch	Aspen	Black Alder	Grey Alder	Other species	Total
Forest available for wood supply	25.2%	16.8%	26.3%	5.5%	3.2%	8.5%	1.4%	86.9%
Forest not available for wood supply	6.2%	2.0%	3.2%	0.6%	0.6%	0.3%	0.2%	13.1%
Total	31.4%	18.8%	29.5%	6.2%	3.7%	8.8%	1.7%	100.0%

Strata: site quality class (4):

Pine, spruce and birch stands are separated to four quality classes. Aspen, black alder, grey alder and others are in one quality class (see in Table 3.5). Quality classes are defined in Forest Management Planning Regulation[45]. National quality classes I and Ia are combined to class 1. National quality classes IV, V, and Va are combined to class 4.

Table 3.5. Distribution of forest land area by dominant tree species and forest categories in 2000-2009 and 2017

	Site quality class			
Pine forests 2000-2009	1	2	3	4
Forest available for wood supply	14%	20%	15%	14%
Forest not available for wood supply	6%	9%	9%	12%
Pine 2017				
Forest available for wood supply	30%	23%	14%	13%
Forest not available for wood supply	3%	4%	4%	8%
Spruce 2000-2009	1	2	3	4
Forest available for wood supply	41%	23%	7%	1%
Forest not available for wood supply	16%	8%	3%	1%
Spruce 2017				
Forest available for wood supply	67%	16%	5%	1%
Forest not available for wood supply	8%	2%	1%	0%
Birch 2000-2009	1	2	3	4
Forest available for wood supply	22%	29%	14%	6%
Forest not available for wood supply	8%	11%	7%	4%
Birch 2017				
Forest available for wood supply	44%	30%	11%	4%
Forest not available for wood supply	4%	3%	1%	2%

[45] https://www.riigiteataja.ee/akt/131082018008

3.2.2 Documentation of sustainable forest management practices as applied in the estimation of the forest reference level

Fixed rotation ages for RP used in calculations are defined in Forest Management Regulation[46]. Actual final felling ages were compared to rotation ages occurred in RP to verify the compliance of rotation ages. Additional control of felling ages was performed using the stand-wise forest inventory and forest notification data from National Register for Accounting of Forest Resources.[47]

In case of pine, spruce and birch rotation age was calculated:

- for site quality class 1 as average of domestic site quality classes Ia and I;
- for site quality class 4 as average of domestic site quality classes IV, V and Va.

In case of aspen, black alder, grey alder and other stands weighted average rotation age over the site quality classes (SQC) were used.

Table 3.6. Managed forest land stratification and management practises in RP

Strata by forest category	Strata by dominant species	Strata by site quality class	Rotation age*	% of area of stand**	Distribution between site quality class
Forest available for wood supply	Pine	1	90	100%	actual area of final fellings in pine stands is distributed between site quality classes by share of pine stands exceeding felling ages
		2	90	100%	
		3	100	100%	
		4	115	100%	
	Spruce	1	80	100%	actual area of final fellings in spruce stands is distributed between site quality classes by share of spruce stands exceeding felling ages
		2	80	100%	
		3	90	100%	
		4	90	100%	
	Birch	1	60	100%	actual area of final fellings in birch stands is distributed between site quality classes by share of birch stands exceeding felling ages
		2	70	100%	
		3	70	100%	
		4	70	100%	
	Aspen	NA	35	100%	NA
	Black Alder	NA	60	100%	NA
	Grey Alder	NA	30	100%	NA
	Other species	NA	80	100%	NA
Forest not available for wood supply	Pine	1	NA	NA	NA
		2	NA	NA	
		3	NA	NA	
		4	NA	NA	
	Spruce	1	NA	NA	NA

[46] https://www.riigiteataja.ee/akt/12771900
[47] https://register.metsad.ee/

Strata by forest category	Strata by dominant species	Strata by site quality class	Rotation age*	% of area of stand**	Distribution between site quality class
		2	NA	NA	
		3	NA	NA	
		4	NA	NA	
	Birch	1	NA	NA	NA
		2	NA	NA	
		3	NA	NA	
		4	NA	NA	
	Aspen	NA	NA	NA	NA
	Black Alder	NA	NA	NA	NA
	Grey Alder	NA	NA	NA	NA
	Other species	NA	NA	NA	NA

* Rotation age is the age when final fellings become possible. All stands reaching the rotation age are not felled in same year. FRL intensity of final fellings is applied only on stands which have reached rotation age.

** 100% share has been used in calculation despite the fact that certain amount of seed and retention trees are retained on final felling sites. Remaining volume is accounted in the stocking per hectare in age classes.

3.3 Detailed description of the modelling framework as applied in the estimation of the forest reference level

Only data from years 2000-2009 are used for stratification the forest in RP. Pine, spruce and birch stands are stratified by four site quality classes and aspen, black alder, grey alder and others by 1 site quality class. In modelling the final fellings it is assumed that all trees in one stand are felled. This assumption has been made despite the fact that certain amount of seed and retention trees are retained on final felling sites. Remaining volume is accounted in the stocking per hectare in age classes.

Starting year for the projection of the FRL is 2017 (first projected year is 2018). Reasons for the selection of the starting year are:

- Best available activity data is for 2017 as the network of NFI sample plots was extended in 2014 by 37% with primary aim to obtain more accurate results on land use.
- Land reform did not occur linearly and was in final stages in 2017. It is impossible to obtain meaningful 5-year average estimate for 2010 of forest land subject to privatization as NFI estimates are based on last 5 year measurements;
- fellings in RP fluctuated a lot (max in 2001 12.4 mil m^3, min in 2008 4.6 mil m^3). It is impossible to obtain meaningful 5-year average estimates for 2010 of distribution into age classes as NFI estimates are based on last 5 year measurements;

Modelling steps:

1. forest area in each management practise is divided into 5-year age classes;
2. calculation of forest available for final fellings in RP is carried out by dominant tree species. In case of pine, spruce and birch the area available for final fellings is calculated separately for four site quality classes. The results are summarized into one total area

available for final fellings by dominant tree species. The calculation of final felling area is applied only in case of forest available for wood supply. Protected forests and forest land subject to privatization are modelled without fellings;

3. calculation of final felling intensity for RP by dominant tree species as a share of performed final fellings from total area available for final fellings (see Table 3.7) Volume of shelterwood fellings were transponded into area of clear fellings dividing volume of shelterwood fellings with volume per hectare of clear fellings (by dominant tree species). This approach has been considered appropriate as shelterwood fellings decrease average stocking level per ha of mature stands.
4. calculation of average annual area of final fellings by dominant tree species for the period of 2017-2020 multiplying the area available for final felling by final felling intensity in RP. In case of pine, spruce and birch stands the area of final fellings in site quality classes is calculated using the distribution of mature stands;
5. modelling forest age-structure for year 2021 based on data from 2017 according to intensity of fellings during RP. For projection of age-structure development the method of shifting the areas of age classes is used. In case of a clear felled areas the dominant tree species of cut stand was used in calculations so area of the dominant species stays the same;
6. calculation of growing stock volume for 2021 multiplying the area in age class with average growing stock per hectare in relevant age class;
7. calculation of average annual area of final fellings by dominant tree species for the period of 2021-2025 according to step 4;
8. modelling forest age-structure for year 2025 based on projected data from 2021 according to intensity of fellings during RP (see step 5);
9. calculation of growing stock volume for 2025 multiplying the area in age class with average growing stock per hectare in relevant age class (see step 6);
10. calculation of annual change of CO_2 in 2021-2025 stored in biomass is calculated from growing stock figures based on IPCC methodology.

The illustrating forest biomass scheme can be found in Annex II.

Table 3.7. Area of mature forest, area of final felling and intensity of final fellings in RP

Dominant tree species	Area of mature forest (1000 ha/year)	Area of final fellings in RP (1000 ha/year)	Intensity of final fellings per year
Pine	58.2	4.9	8.4%
Spruce	44.8	5.5	12.3%
Birch	74.4	4.3	5.8%
Aspen	60.4	2.0	3.2%
Black Alder	11.9	0.5	4.0%
Grey Alder	77.2	2.3	3.0%
Other species	7.0	0.0	0.0%
Total	333.9	19.4	5.8%

CO_2 stored in soil and dead wood in CP is estimated by using average content per hectare in RP. Non CO_2 emissions from drained forest and wildfires are estimated with similar approach. Detailed description of the transparent, complete, consistent, comparable and accurate

information about the methodology used for the calculations is provided in National Greenhouse Gas Inventory[48].

Emissions from the HWP are calculated according to the methodology provided in chapter 2.8 in 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol. Forestry data originates from National Forest Inventory (NFI), foreign trade data from Statistics Estonia and production data from FAOSTAT. Reference level in HWP pool is estimated consistently with estimated harvest level during the CP. The quantity of wood products is predicted according to the RP practices.

IPCC GL default conversion factors and half-lives were used to calculate Paper and paperboard and Solid wood removals with the Tier 2 method. Tier 3 method was used to calculate carbon stock and emission from Semi-chemical wood pulp with country specific C conversion factor (0.4275 kt C/m3).

Modelling steps:

1. calculation of harvest for years 2018-2025 using previously calculated final felling areas multiplying the area of final fellings of mature stands (calculated in steps 4 and 7 in biomass calculations) in 2017-2020 and 2021-2025 with the average growing stock volume of mature stands in 2017; the result will be multiplied with coefficient 0.95 which ensures that the retained biomass of seed trees and retention trees on final felling sites is properly accounted.
2. calculation of IRW (industrial roundwood) production for years 2018-2025 using average share of IRW from harvest in RP;
3. calculation of share of IRW used for the HWP commodity production by dividing each HWP commodity with total average IRW production in 2013-2017 (Table 3.8);
4. calculation of yearly HWP production in 2018-2025 multiplying projected IRW production by share of IRW used for the HWP commodity production in 2013-2017;
5. calculation of wood originating from deforestation in 2018-2025 by multiplying the average share of deforestation from total harvest in 2000-2017 with projected harvest in 2018-2025;
6. calculation of share of domestic IRW in RP according to equation 2.8.1[49] (Table 3.9);
7. calculation of share of domestically produced wood pulp in RP according to equation 2.8.2[50];
8. calculation of average annual CO_2 stock change in HWP for the period 2018-2025 according to IPCC GL[51] for annual carbon stock changes in HWP pool with the shares from steps 5, 6 and 7.

The illustrating HWP scheme can be found in Annex III.

[48] Greenhouse gas emissions in Estonia 1990-2017 National Inventory report. (2019).
[49] 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, Chapter 2.8.1.2, p. 2.115.
[50] 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, Chapter 2.8.1.2, p. 2.115.
[51] 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, Chapter 2.8, p. 2.109-2.134.

Table 3.8. Volume of total fellings and industrial roundwood in 2000-2025

	Felling volume	Industrial rounwood	Share of industrial roundwood from total fellings
	1000 m^3	1000 m^3	share
2000	10556	7270	69%
2001	12403	8320	67%
2002	10134	8600	85%
2003	9834	8400	85%
2004	8102	5500	68%
2005	7962	4450	56%
2006	5737	4300	75%
2007	5168	3510	68%
2008	4639	3708	80%
2009	6350	4278	67%
2010	8165	5622	69%
2011	8991	6052	67%
2012	10182	7124	70%
2013	10092	7060	70%
2014	10007	7052	70%
2015	10049	7290	73%
2016	10739	7952	74%
2017	12489	7740	70%
2018	10489	7565	72%
2019	10489	7565	72%
2020	10489	7565	72%
2021	10025	7230	72%
2022	10025	7230	72%
2023	10025	7230	72%
2024	10025	7230	72%
2025	10025	7230	72%

Table 3.9. Share of domestic industrial roundwood from total industrial roundwood 2000-2025

Year	Share	Year	Share	Year	Share
2000	88%	2009	92%	2018	77%
2001	89%	2010	91%	2019	77%
2002	89%	2011	91%	2020	77%
2003	86%	2012	94%	2021	77%
2004	69%	2013	94%	2022	77%
2005	59%	2014	95%	2023	77%
2006	60%	2015	94%	2024	77%
2007	59%	2016	96%	2025	77%
2008	80%	2017	96%		

3.3.1 The ability of the model used to construct the FRL to reproduce historical data from the national GHG inventory

Used method was controlled for two periods:

- 2012-2017. Using forest characteristics from year 2012 forest growing stock in 2017 was estimated (using actual final felling data from years 2012-2017). Estimated growing stock and real growing stock in 2017 differed only 0.7%.
- 2005-2009 (inside RP). The average yearly emission from living biomass was reported in GHG inventory as -3.11 Mt CO_2; the relevant estimate according to the model was -3.21 Mt CO_2. The difference was assessed as insignificant due to the higher uncertainty of NFI estimates and it was decided not to perform ex post calibration. Control is consistent with NIR 2019 data (Figure 3.2).

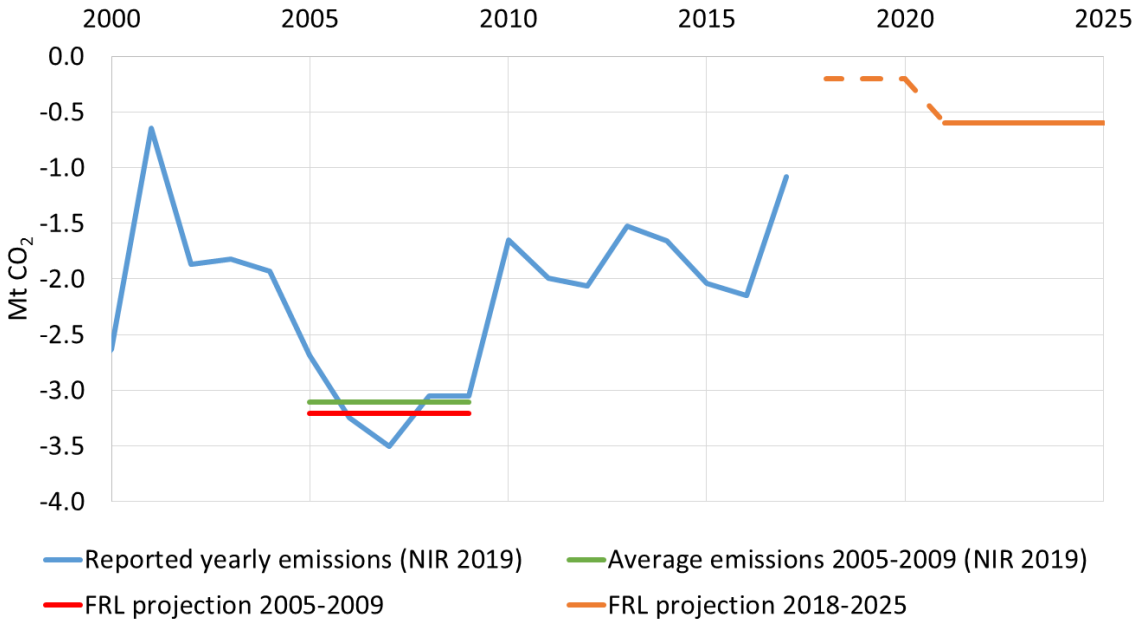


Figure 3.2. Reported and projected emissions from living biomass

3.3.2 Assumptions concerning the development on MFL area during CP

Area of land allocated to each stratum remains constant from starting year (2017) of the projection. Dynamic development of managed forest land is assumed. Estimation of area gains is based on the historical area of land classified as “afforested land” reported in NIRs. If area reached the end of 20-year transition period it will be moved to MFL category. To estimate area losses the average area of deforestation in 2000-2017 is used. There is not enough accurate information about forest characteristics for gained forest land area; therefore it is not divided into strata (for clarity it was considered as separate strata using average shares). This approach is used for its simplicity and transparency and thus it is easier to compare CP yearly emissions

to FRL. After CP technical correction will be presented to remove any erroneous estimates of carbon development simply caused by differences between the assumed area development and the area development that actually took place during the CP. MFL area development in Figure 3.3.

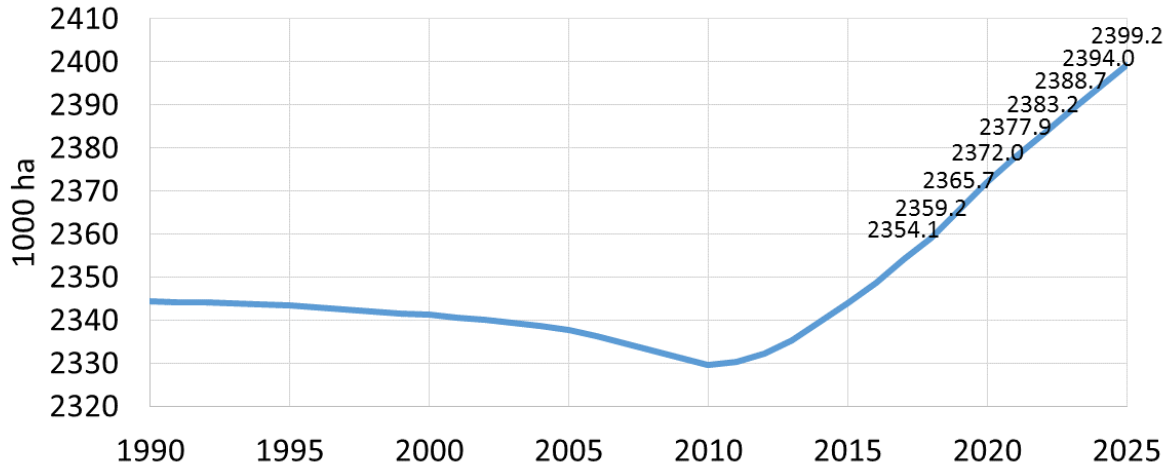


Figure 3.3. MFL area development in 2000-2025

4. FOREST REFERENCE LEVEL

4.1 Forest reference level and detailed description of the development of the carbon pools

The main driver behind the managed forest land carbon pool is harvest rate. From 1999 to 2004, the rate of logging was more than twice as high as in the previous 10 years and the harvest rate peaked in 2001, which can be explained by the outcome of land reform (active management by new owners on resituated and privatised forest land) and the economic boom taking place in the early 2000s.

In coming years forest growing stock is expected to reach the peak and then will begin to decrease (table 2.4). Therefore, it is also expected that CO_2 sequestration from forest land is going to decline (Figure 4.1). The increment is following similar trend (figure 4.2) due to the increasing share of very young and old stands (where sequestration is lower). The ageing of stands will cause higher mortality rates.

The decrease of sequestration according to FRL is caused also by higher intensity the final fellings of mature coniferous stands where average increment is higher compared to broadleaved stands.

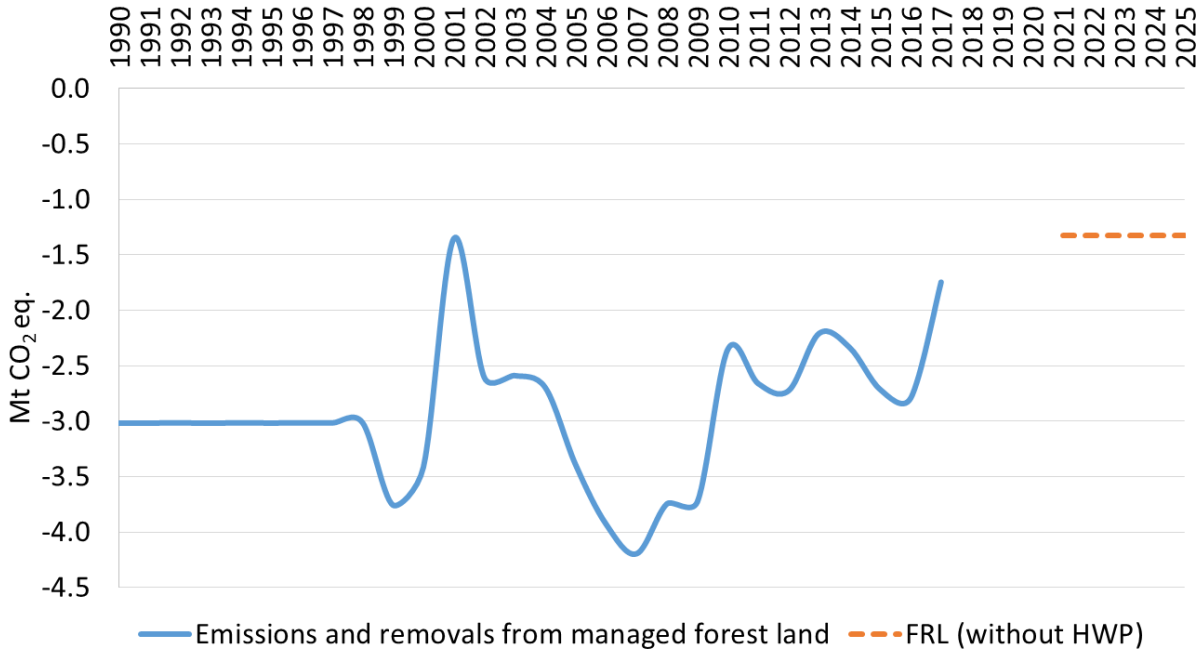


Figure 4.1. GHG emissions and removals from MFL (NIR 2019) and FRL without HWP

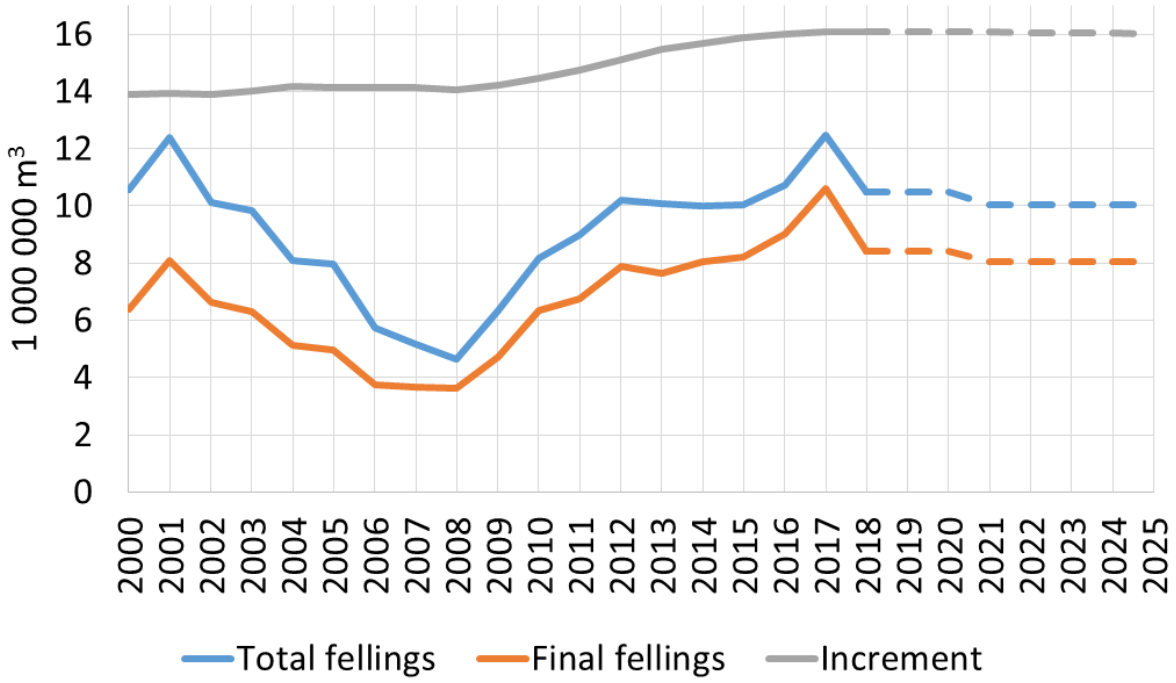


Figure 4.2. Volume of fellings and increment in 2000-2025 (2018-2025 according to FRL)

CO_2 stock in HWP is expected to grow. Reference level for HWP is strongly influenced by the share of domestic IRW in RP. In RP average annual fraction of feedstock for HWP production originating from domestic harvest[52] was 77%, in 2015-2017 the relevant share was 96%. It is projected that the production of HWP products will not increase in CP. Due to those reasons the reference level for HWP is also above the direction of trend (Figure 4.2).

[52] 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, Chapter 2.8.1.2, p. 2.115.

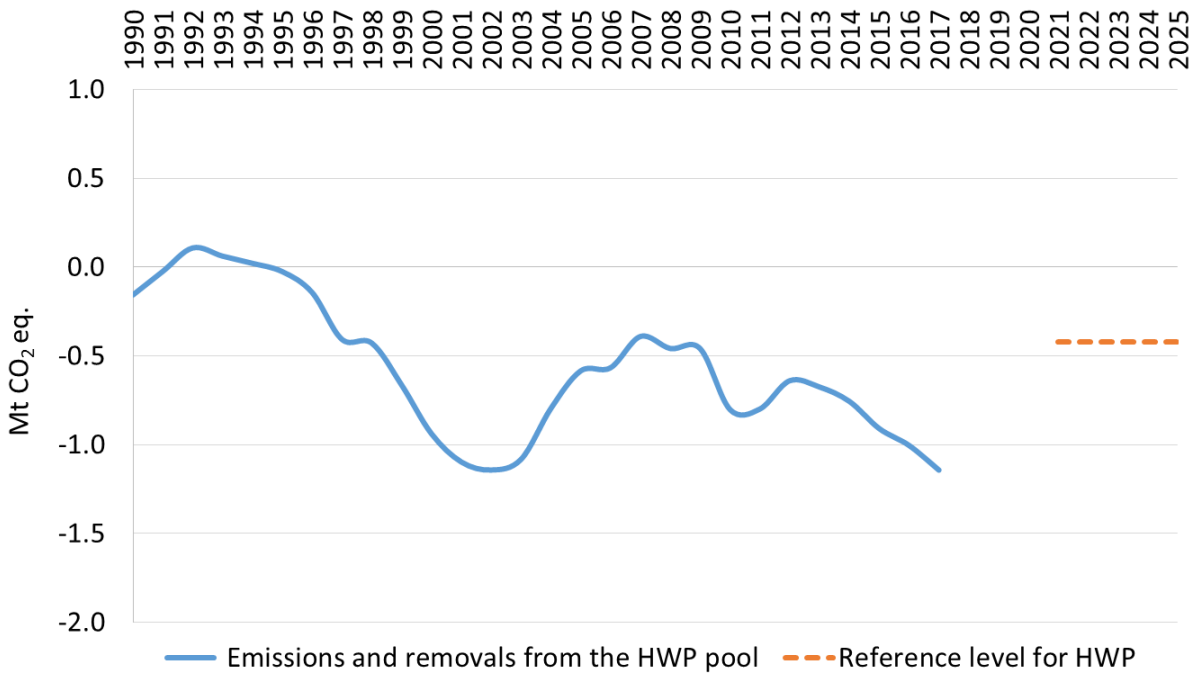


Figure 4.2. GHG emissions and removals from HWP pool (NIR 2019) and FRL for HWP

4.2 Consistency between the forest reference level and the latest national inventory report

Same methodology and emission factors are used for the calculation of FRL carbon pools as are used in the GHGI, maintaining consistency between those two documents. The only difference is that GHGI calculations are not stratified, but it does not affect the consistency.

4.3 Calculated carbon pools and greenhouse gases for the forest reference level

Estonia has proposed an FRL of -1.75 million tonnes of carbon dioxide equivalent (Mt CO_2 eq.) per year applying the first-order decay function for harvested wood products (HWP) and -1.33 Mt CO_2 eq. per year assuming instantaneous oxidation of HWP.

Annex I

Check list for the elaboration of Forest Reference Level

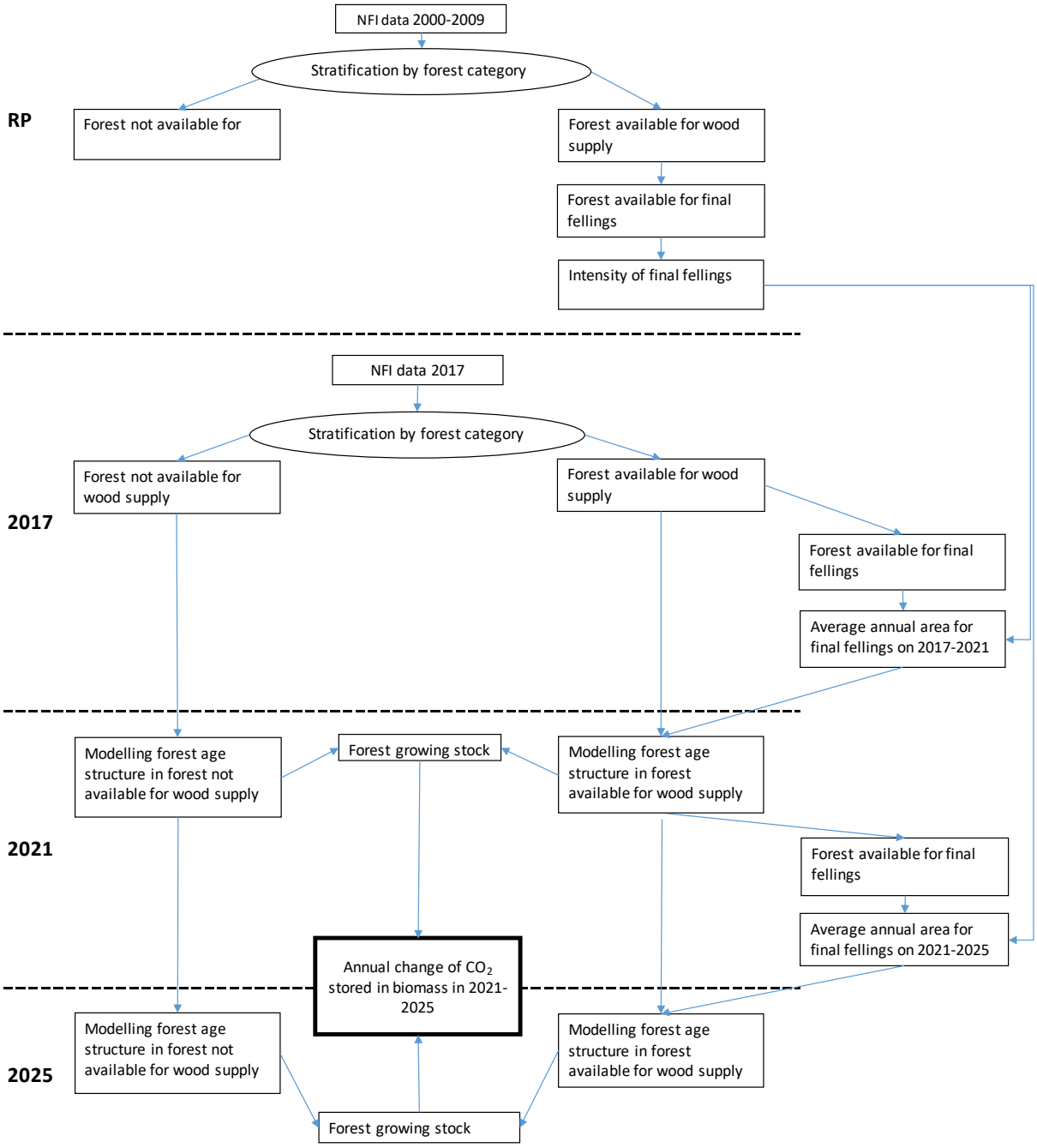
Step 1: Stratify the area of MFL, according to country-defined criteria, and apply the stratification in a consistent manner over time, including the RP 2000-2009.	
Information to be represented in NFAP	**Explanation**
Document how the area of Managed Forest Land is considered in the determination of the FRL (Annex IV B.) of the LULUCF Regulation)	Chapter 1.1
Document how large a share of the national forests was covered by a given FMP in the period from 2000 to 2009	Table 3.3 and Table 3.6
Document each criterion used for the stratification of the MFL.	Chapter 3.2.1
Document data sources used to perform the stratification.	Chapter 3.2 and Chapter 3.2.1
Document and justify any deviation between the stratification for the FRL and any stratification already used in the GHGI or NFI.	Chapter 3.2.1
Document the sources of information used to determine the forest characteristics for each stratum (see Table 2 for an example of this can be documented).	Chapter 3.2
Document the forest definition used for the construction of FRL and explain whether it differs from that used in the national GHGI.	Chapter 2.3.1 and Table 2.1
Step 2: Identify and document the FMPs in each strata for 2000-2009 based on country-defined operational criteria and quantifiable data.	
Information to be represented in NFAP	**Explanation**
Document the sources of information used to identify and specify the FMPs.	Chapter 3.1.1
Describe in qualitative terms each FMP as applied during the RP (see Table 3 for an example of how this can be documented).	Chapter 3.1.1 and Table 3.6
Describe in quantitative terms each FMP as applied during the RP (see Table 4 and Table 5 for examples of how this can be documented).	Chapter 3.1.1 and Table 3.6
Document the use of FMPs according to the stratification of the forest land (see Table 6 for an example of how this can be documented).	Table 3.6
Verify that the documentation of the FMPs include specifications about: (i) how each management activity is performed, and (ii) when is each management activity being carried out.	Chapter 3.2.1 Table 3.6
Check that the above descriptions of FMPs and forest characteristics include a description of the following forest characteristics (Annex IV B.): - dynamic age-related forest characteristics - increments - rotation length	Chapter 2.3.1 and

- other information on forest management activities	**Table 3.2** Table 3.1
Confirm that any trends in when an management activity is carried as observed during the period from 2000 to 2009 are not projected to continue during the CP	Chapter 3.1.1
Document and confirm that only data sources from the period 2000 to 2009 are being used to define the FMPs. If data sources outside the period from 2000 to 2009 are used, document and justify this deviation. Also, document an assessment of the impact of this deviation on the FRL.	Chapter 3.3
Document how the principles of sustainable FMPs are being applied within the country.	Chapter 1.2
Document the use of the FMPs in each strata of the MFL (see Table 6 for an example of this can be documented).	Table 3.6
Step 3: Select the appropriate methodology to project the development of carbon pools based on available data and national circumstances.	
Information to be represented in NFAP	**Explanation**
Document the methodology as selected to project to the development of carbon pools.	Chapter 3.3
Document the 'Age structure module'	Chapter 3.3
Document the 'Harvest module'	Chapter 3.3
Document the 'C pool variation module'	Chapter 3.3
Document how natural disturbances have been estimated in the projection of the FRL, including data sources as applied.	Chapter 3.1
Document how the HWP pool has been estimated in the projection of the FRL, including data sources as applied.	Chapter 3.3
Step 4: Calibrate the selected methodology based on real observed data and show that the methodology is able to reproduce the GHGI estimates.	
Information to be represented in NFAP	**Explanation**
Document the model estimates of Biomass gains, Biomass losses, and Net GHG emissions/removals from the year 2000 until the starting year of the projection of the FRL.	Figure 4.1 Chapter 3.3.1
Document the emissions and removals from forests and HWP as shown in GHGIs and relevant historical data (Annex IV (B)), from the year 2000 until the starting year of the projection of the FRL.	Figure 4.2 Chapter 3.3.1
Step 5: Select the appropriate methodology to project the development of carbon pools based on available data and national circumstances.	
Information to be represented in NFAP	**Explanation**
Specify the assumptions taken concerning climate change and documentation of data sources applied.	Chapter 3

If a projection of future climate conditions are used (Alternative 2 in Box 17), document: - Assumptions and projections for future climatic conditions as applied - Document the potential impact on the FRL by not considering the future climate effect (i.e. applying Alternative 1 instead of Alternative 2 (see Box 17))	Chapter 3
Specify and justify the assumptions taken concerning the area development of MFL and documentation of data sources as applied.	Chapter 3.3.2
Specify the assumptions taken concerning the area development of MFL and documentation of data sources as applied.	Chapter 3.3.2
Document and justify the selected starting year for the projection of the FRL.	Chapter 3.3
Document and justify the assumptions taken concerning the period from 2010 to 2020.	Chapter 3.3
Specify the data sources used to describe the State of the forest as of the starting year of the projection of the FRL.	Chapter 3 and **Table 3.2**
Confirm that area of land allocated to each stratum remains constant from the starting year of the projection	Chapter 3.3.2
Confirm that the FMPs as defined and documented in Step 2 for the RP are consistently applied from the starting year of the projection onwards.	Chapter 3.3 Table 3.8
Describe the historical and future harvesting rates disaggregated between energy and non-energy uses. (Annex IV B.)	Chapter 3.3 Table 3.8
Step 6: Calculate the FRLs as average of emissions and removals during 2021-2025 and 2026-2030.	
Information to be represented in NFAP	**Explanation**
Document the 5-year average of projected values for the periods 2021-2025 and 2026-2030.	Table 1.1

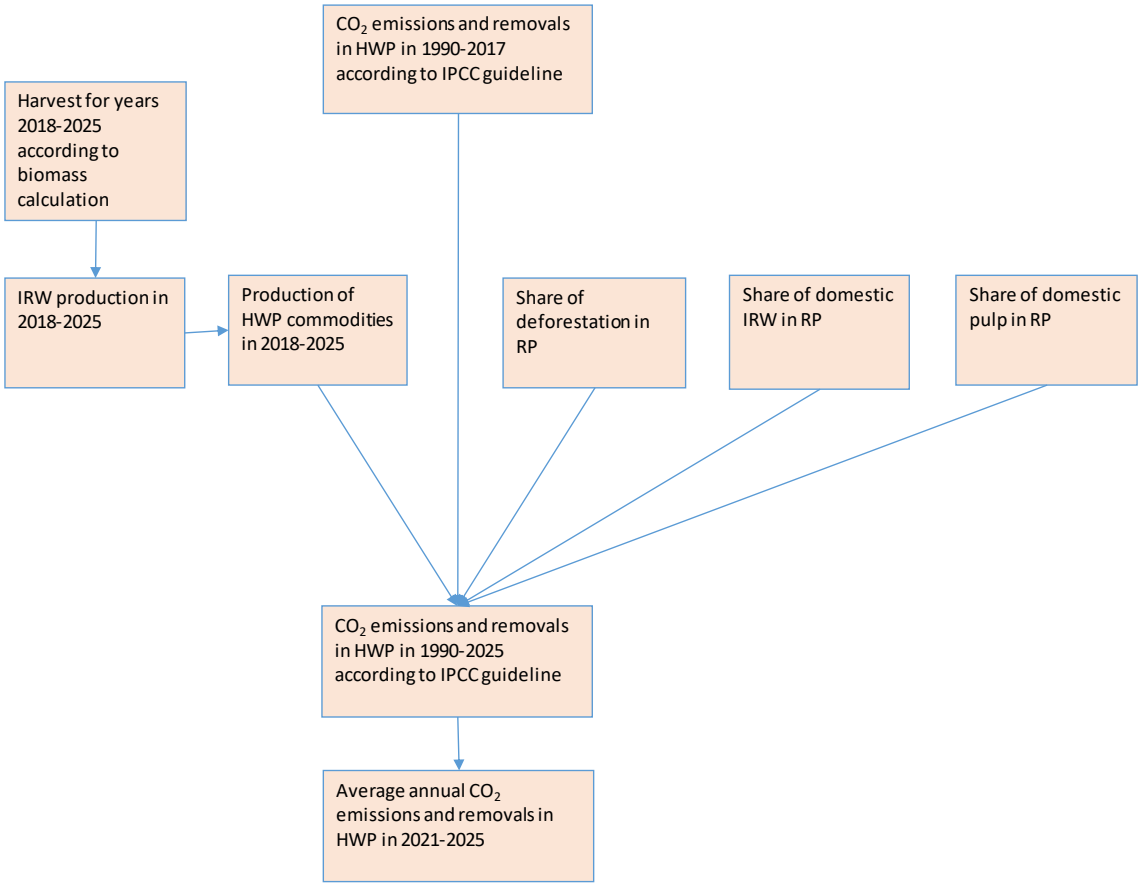
Annex II

Forest biomass scheme



Annex III

HWP Scheme



Annex IV

An Explanatory note

SWD recommendations for Estonia	Comments by Estonia
Technical recommendations on Article 8(5) Principles	
Noting the projected decrease in sink in the compliance period, demonstrate that the approach used in the determination of the FRL ensures the continuation of forest management practices as documented in the period 2000-2009, and revise the FRL if applicable. Clarify that those practices applies to all forest lands including those being subject to privatization. Provide detailed information on the consistency between the actual felling ages and the legally allowed felling ages.	For clarity in strata "forest category" the subcategories "strictly protected forest" and "forest land subject to privatization" were merged into subcategory "forest not available for wood supply (FNAWS)" It does not change the result. Verification on rotation ages is described in section 3.2.2. Although the model was controlled as described in section 3.3.1 subsection "controlling the model" If the rotation ages were wrong the model doesn't work properly.
Technical recommendations on Annex IV, Section A Criteria	
a) Demonstrate how the goal of achieving a balance between anthropogenic emissions and removals will be achieved in the second half of the century. Provide qualitative and quantitative information until at least 2050 consistent with the long-term strategy required under Regulation (EU) 2018/1999.	Information added in section 1.2 and figure 1.1.
e) Provide a ratio between solid and energy use of forest biomass as documented in the period from 2000 to 2009 used for the estimation of the forest reference level and demonstrate it remains constant throughout the projection.	Information added in table 3.9.
f) Provide information on how the projected increase in harvest rates is consistent with the objective of contributing to the conservation of biodiversity, in particular of old-growth forest stands.	Information added in section 1.2
g) Demonstrate the consistency with the national projections of anthropogenic greenhouse gas emissions reported under Regulation (EU) No 525/2013. Provide explanations for possible differences between national projections and the proposed FRL.	Information added in section 1.2 and figure 1.1.
h) Estimate the FRL based on the area under forest management as indicated in Annex IV, Part B (e) i. Estimate the FRL based on carbon pools and greenhouse gases as indicated in Annex IV, Part B (b). Demonstrate the ability of the model used to construct the FRL to reproduce historical data from the national GHG inventory. Demonstrate the consistency between historical data from the national GHG inventory and modelled data for estimating the FRL for the reference period.	Section 3 Table 3.2 Information added in section 3.3.1.
Technical recommendations on Annex IV, Part B Elements	
a) Include the greenhouse gases consistent with those applied in the latest national GHG inventory.	Information added in table 1.1
e)i Provide the area under forest management consistent with Table 4.A ("Forest land remaining Forest land") from the latest national GHG inventory using the year preceding the starting point of the projection.	Updated table 3.2
e)iii Provide additional information on increments, dynamic age-related forest characteristics, actual	Information in tables 3.1, 3.2, 3.6, 3.7, 3.8; figure 3.1, 3.2; section 3.2.2.

management activities, harvesting rates and rotation lengths.	
e)iv Provide historical and future harvesting rates disaggregated between energy and non-energy uses.	Information added in table 3.8

List of other revisions compared to 31.12.2018 submission

Description	**Comments**
Adding of non CO2 emissions	Table 1.1
Adjusted figures of dead wood, mineral soils, drained organic soils and HWP	Table 1.1. Minor changes due to the fact that initial calculations were made with preliminary data. Now data is matching with NIR 2019
Comments on litter pool	Description can be found in section 2.2
Felling statistics updated	Section 2.3.1
Recalculated long-term scenarios	Updated section 2.3.2
In strata "forest category" subcategories "strictly protected forest" and "forest land subject to privatization" were merged into subcategory "forest not available for wood supply (FNAWS)"	Description can be found in section 3.1.1and new subcategory is used throughout the document.
Forest resources statistics updated	Table 3.2.Minor changes due to the fact that initial calculations were made with preliminary data. Now data is matching with NIR 2019
Verification of rotation ages amended	Description can be found in section 3.2.2
Reasons for starting year of projections amended	Description can be found in section 3.3
Assumptions concerning the development on MFL area during CP amended	Description can be found in section 3.3.2
Share of domestic industrial roundwood from total industrial roundwood 2000-2025 added	Information added in table 3.9
Changes according to correction sheet presented to LULUCFEG in April 2018	Corrections in section 3.3 and section 4.1

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