Drax Power Limited

Catchment Area Analysis in Estonia

Final Report

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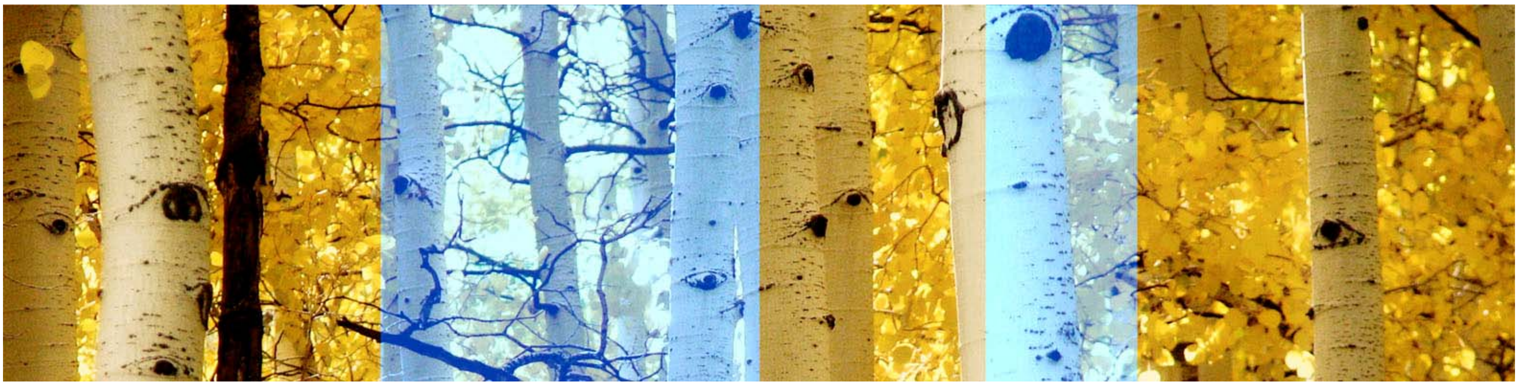

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ABBREVIATIONS

BCTMP	Bleached Chemi Thermo Mechanical Pulp
NFI	National Forest Inventory
RMK	Riigimetsa Majandamise Keskus, Estonian State Forest Company
SWP	Solid Wood Products
WBP	Wood-Based Panels
SOC	Soil Organic Carbon
NCEP 2030	Estonian national energy and climate plan

EXECUTIVE SUMMARY

Objective

The objective of this study was to give an overview of forest management, roundwood market and wood product market trends affecting forest structure and use in Estonia and to provide the Consultant's view on Drax's impact on the observed developments.

Background

During 2014–2018, wood pellets manufactured in Estonia have accounted for 2–11% of Drax's woody biomass imports to the UK. Drax's main partner in Estonia is Graanul Invest, the biggest pellet producer in the country. Approximately 294 000 tonnes of wood pellets were purchased from Graanul Invest by Drax in 2018. According to Drax, 69% of Graanul Invest's pellet production feedstock originates from roundwood thinnings in Estonia, while 31% consists of sawdust, shavings and chips mainly from sawmills in Estonia and Latvia.

Woody biomass has been becoming increasingly important for Estonian energy production. During 2009–2010, two new wood-consuming (mainly chips) CHP plants started in Tarto and Pärnu, while in 2017, another three CHP mills started to consume woody biomass. Estonia, despite the small size of the country, is the 7th largest pellet producer in Europe. Pellet production in Estonia is very export-oriented, while only 4% of wood pellets are consumed domestically. Drax sources approximately a quarter of the wood pellets that are exported from Estonia. Denmark is the largest importer (45%) of Estonian wood pellets, while the UK is the second largest.

Changes and Trends in Forest Resources

The main factors affecting the forest structure in Estonia are the system-level changes in forest ownership, major differences in forest management objectives between private small-holders and other forest owner groups and the industry's increased demand for wood.

Forest area and forest cover have been growing during 2000–2018, due to afforestation of previously non-forest lands, mainly abandoned agricultural lands. Forest cover growth has been lower than forest area growth, due to increased area of clear-cuts leading to temporarily non-stocked forest lands. Despite this, forest cover has not decreased. Annual increment in Estonian forests has grown almost continuously, likewise the total growing stock. 2018 was an exception when the total growing stock was reported as 5.8 million m^3 less than in 2017. However, this is due to statistical sampling error, and the volume of total growing stock has likely slightly increased compared to 2017 or remained the same. 2018 was an exceptional year in terms of Nordic wood demand. High pulp prices motivated Finnish and Swedish pulp producers to ramp up production. This, in turn, was experienced as increasing demand and raw material prices also in Estonia, which supplied an increasing amount of feedstocks to the two countries.

Tree species distribution has not undergone major changes in terms of area or volume, but minor changes have been occurring in private small-holder forests. Due to the history of collective ownership, the now privatized small-holder forests often have only little tradition of forest management. Plantings, pre-commercial thinnings and other investments to the future productivity of the forest are often seen as too expensive or the payback of the investment is considered uncertain. This lack of management activities has led to a small increase in forest area dominated by alder and aspen. Subsidies and other government policies have been implemented in order to re-activate private small-holders' forest management or to incentivise them to sell their forest properties to more active forest owners. The effects of these policies are already seen in the growth of corporate forest ownership. Thus it is expected that the significance of smallholder forests will somewhat reduce in the future. The conversion from softwood to hardwood is also expected to slow or possibly even be reversed. Existing legislation already controls which species are allowed per site type. The aim of this legislation is not to steer hardwood-softwood distributions, but rather to ensure the suitability of used species for site's fertility and moisture.

Changes and Trends in Forest Management Practices

The forest law in Estonia sets definitive boundaries and requirements for forest management practices. In addition to the law, no separate forest management recommendations are given by the government. The forest law changed in 2017, increasing the size of allowable clear-cut and loosen the requirements for spruce harvesting. The Ministry of the Environment (MoE) justified the change with the need to "allow forests to capture the maximum amount of carbon while producing maximal income for their owners".

Forest management in state forests has typically been of good quality, while private small-holder-owned forests have been inactively managed and even neglected. The trend in state-managed forests is likely to remain, but some increased activity can be expected in private forests. The reasons for increased activity in private forests are government policies to incentivize forest management, but also to increase the share of corporate ownership. According to interviews, planting, especially of birch, has increased popularity as a regeneration method in private forests.

Increased demand and price of small-diameter roundwood has created markets for thinnings of previously unmanaged alder forests. According to interviews, there are still plenty of small-holder forest owners with unmanaged forest stands that have naturally regenerated to alder and aspen.

In recent years, there has been plenty of debate about the use of Estonian forests. One of the most notable results of this debate is the cancellation of Est-For pulp mill investment. The opposition was based on fears of the mill's wood consumption resulting in over-exploitation of the country's forest resources and its effluent discharge degrading the adjacent Emajõgi river. The large size of the mill was a large driver for the opposition, as the mill's annual wood demand would have been approximately 3.3 million m^3. However, the fears of overexploiting forests were perhaps irrelevant. Estonia is a large exporter of wood raw materials, and by reducing exports of raw materials and redirecting these streams to the domestic pulp mill, total domestic raw material sourcing could have been maintained at a sustainable level.

Changes and Trends in SWP Production, Raw Material Prices and Cross-Border Trade

Sawmilling capacity and sawnwood production in Estonia has increased during the last 10 years. According to interviews, the main drivers for the investment activity have been industry's confidence in raw material sufficiency, confidence in the product markets and the need to keep up with competitors in the sawmill technology development. Swedish-owned Toftan inaugurated a modern new sawmill in 2017, which uses small-diameter logs that were underutilized in the past, due to a small domestic P&P industry. From the current two P&P mills located in Estonia, AS Estonian Cell uses only aspen pulpwood, while Horizon uses mainly coniferous pulpwood.

Wood-based panel capacity and production have grown during 2010–2018, growth explained by investments from UPM, Metsä Wood (FIN) and Latvias Finijeris (LVA). All of the three investments are related to birch plywood production, increasing the demand for high-quality birch veneer logs. Pellet production has tripled during the last ten years, while domestic consumption of pellets has remained low.

Sawlog prices have increased since 2010, with a sharp increase during 2017–2018, due to increased sawmilling capacity and production, but also due to difficult harvesting conditions resulting from mild winter temperatures. Sawlog prices have been driven by the increasing demand for sawnwood, which has also driven up sawnwood prices. Pulpwood prices have been more volatile than sawlog prices. They have mainly decreased between 2011–2017 and similar to sawlog prices, surged during 2017–2018 to a record-high. Due to the small size of the domestic P&P industry and relatively large consumption of aspen, the Finnish and Swedish pulp industry is a major driver of pine, spruce and birch pulpwood price. This was emphasized in the 2018 price hike; global pulp prices were high, which motivated Finnish and Swedish pulp producers to maximize production, which in turn significantly increased their sourcing from Estonia. As a result, harvests in Estonian forests reached a record high. However, it is unlikely for the high harvesting level to remain in the following years, due to minimum clear-cut age restriction and decreased sawnwood price resulting from Central Europe's bark beetle infestation that increases sawlog volumes entering the markets.

Wood-based bioenergy has not been a significant driver for Estonian wood prices, due to previously underutilized assortments, such as harvesting residues and small-diameter roundwood being used now. Wood-fuelled CHP capacity has increased significantly during the past decade, which drives demand for wood chips, especially forest chips. This has enabled the utilisation of harvest residues economically. Pellets are however a more significant price driver for wood raw materials according to interviews, as they warrant a higher price at end-use markets and producers pay a higher price for raw materials than what CHP plants pay for forest chips. Noting that feedstock of Drax's Estonian pellets is mainly sourced at fuelwood price supports the conclusion that Drax's activities have had little to none impact on Estonian wood prices.

CHP has created a new demand for harvesting residues and new income for forest owners. This may show only slightly in wood prices because residue collection is not a significant added expense in harvesting in general. Pellet production together with CHP is an important end-use segment for raw material which is not suitable for sawmilling, thus compensating for the absence of a wider P&P sector in Estonia.

Throughout 2010–2018, Estonia has been a net exporter of both roundwood and wood chips. The main export destinations have been the P&P industry in Finland and Sweden. Roundwood exports have comprised mainly of pulpwood, while birch pulpwood has accounted for 40% of all roundwood exports. 2018 was a peak year in exports, mainly driven by record-high wood demand in Finland. In addition to roundwood, Finland and Sweden are also the main export destinations for wood chips.

Latvia was the only considerable wood exporter (chips) to Estonia during 2010–2015, but since then, Russia has gradually taken Latvia's place as a wood chip source to Estonia. However, the imported wood chip volumes are only a minor proportion of what is exported from Estonia.

Impacts of Wood-Based Bioenergy Demand to Forest Resources

Forest Area / Forest Cover	
Impact: No negative impact	• Regardless of increasing domestic biomass utilization for energy and exports, forest area has increased due to afforestation programs. • Forest cover is not as high as forest area, due to temporarily unstocked area after clear-cut. Despite this, forest cover has continuously increased from 2010–2018.
Forest Growing Stock	
Impact: No negative impact	• The total forest growing stock has been increasing for the last two decades. In 2018 the growth has slowed or halted; official statistics show a decrease, but this is due to sampling error. In 2018 there was record-high wood demand from Finland, which was driven by high global pulp prices motivating maximal pulp production. This increased harvests to a previously unseen level.
Harvesting Levels	
Impact: Slight increasing impact	• During 2004–2011, harvesting levels in Estonia were less than half of the estimated maximum sustainable level. This resulted in an increase in the maximum sustainable harvesting level for the 2011–2020 period. In 2018, the harvesting volumes were at the maximum sustainable level. The main drivers increasing the harvesting volumes have been increased sawmill capacity and production, high demand for pulpwood in Finland and Sweden and improved demand for energy wood. This was a temporary peak and demand has already slowed. Softwood lumber prices have decreased significantly in Europe due to an abundance of wood supply from Central Europe, which has been created by widespread bark beetle and other forest damages. Global pulp prices have also decreased to below 2017 prices.
Forest Growth / Carbon Sequestration Potential	
Impact: Ambivalent impact	• The annual increment has grown throughout the 2000–2018 period. • Increased fuelwood price has enabled forest management in some of the alder forests that were completely unutilized in the past. Thinnings, both commercial and pre-commercial, accelerate long-term volume growth in forests, leading to increased carbon sequestration. • Removal of harvesting residues decreases carbon sequestration since the residues are input to the soil carbon pool. However, the majority of the harvesting residues' carbon is released to the atmosphere when the biomass decays, so the ultimate impact of harvesting residue collection is minimal if the collection is done on a sustainable level. The sustainability of the collection is determined by how the soil nutrient balance is impacted by collection. This is not accounting for the substitution effect that the harvesting residues may have, by e.g. reducing the need to burn fossil fuels. • Utilization of sawmill by-products does not directly impact forests' carbon sequestration potential, but it can increase harvesting through improved sawmill overall profitability.

Impacts of Wood-Based Bioenergy Demand to Forest Management Practices

Rotation Lengths	
Impact: Neutral	• Forest law regulates minimum forest age for clear-cuts. According to interviews, RMK often conducts the final felling at the minimum age. Due to the regulation, an increase of wood-based bioenergy demand has not shortened rotations at least in state-managed forests. In forests that are older than the minimum final felling age, sawlog price is a more important driver for final-felling decisions than wood-based bioenergy demand.
Thinnings	
Impact: Increasing impact	• The increase of bioenergy demand has increased the demand for small-diameter hardwood, which in turn has increased thinnings in previously unmanaged forest stands. This will increase the availability of good quality sawlogs and will also accelerate the carbon sequestration (tonnes/ha/year) of the forests. However, the total forest carbon stock (tonnes/ha) will be reduced; in unmanaged (e.g. no thinnings) mature stands, the carbon stock is larger than in managed stands of similar age. The carbon stock of a thinned stand will remain below that of an unthinned stand regardless of post-thinning accelerated growth.
Conversion from Hardwood to Softwood	
Impact: Neutral	• No indication of hardwood conversion to softwood was found.

Impacts of Wood-based Bioenergy Demand to Solid Wood Product (SWP) Markets

Diversion from Other Wood Product Markets	
Impact: Neutral	• Production of sawnwood, wood-based panels, pulp and paper products have increased or remained steady, i.e. no evidence of diversion.
Wood Prices	
Impact: Slight increase / Neutral	• During 2017–2018, the price of all roundwood assortments increased notably. The increase was strongest in pulpwood assortments, especially those that are not further processed domestically but are exported to mainly Finland and Sweden. Finnish demand for pulpwood was at a very high level in 2018. This was a temporary trend, however, and prices and demand have since decreased. • The price increase for fuelwood was less dramatic, no sharp increases are observed. According to interviews, pellet production was the most important driver of fuelwood prices.

1. INTRODUCTION

Drax Group (the Client) is a large British electrical power generation company that was founded and listed at the London Stock Exchange in 2005. Its roots extend back to 1967 when the construction of Drax Power Station began under the Central Electricity Generating board. This is still the Group's key asset and is the largest single-site renewable generator in the UK. The Group is composed of Drax Power, Drax Biomass, Haven Power and Opus Energy. The Group places much emphasis on sustainability and decreasing its carbon footprint, which is evident from the Group's previous and planned investments. Drax is one of the world's largest single point consumers of wood and is committed to sourcing that wood sustainably.

Drax wants to further the sustainability of its wood sourcing by implementing a forest resources and management monitoring program. Before rolling out a full-scale program on the Group's pellet mills (in the US South, Canada, the Baltic States and Portugal), the company wants to pilot their approach in selected locations, including the Amite pellet mill in Mississippi, the US, and Graanul Helme and all other mills in Estonia.

1.1 Brief History of Estonian Forests

Estonian forestry and forests have been molded into their current state by a turbulent history. The country first gained independence from Russia after the First World War in 1918, which gained rule over the country from Sweden as a result of the war in 1709. During the Swedish and prior Danish rule, German nobility amassed large estates and wealth in the country. In 1804 under the Russian Tsar Alexander I, Estonian peasants gained the right to private property and inheritance, and by the end of the 19th century, peasants owned two-fifths of the privately-owned land in the country.

In 1920, manor forests were nationalized, further reducing the German nobility's importance in Estonian forestry. The state's forest ownership increased to 88%. In 1940, Estonia was once again occupied and then incorporated into the USSR. All private lands were nationalized. 60% of the forests were managed by the state and the remaining 40% by collective farms. The state-managed forests were well-managed, while forests in the hands of collective farms were widely neglected and were mainly used for harvesting firewood and some raw materials for the construction on the collective farms. The quality of these forests declined during this period.

Estonia regained independence in 1991, and the privatization of forests began. The restitution of forests was completed by 2017, with private forest owners currently holding approximately 48% of the forests. The past 28 years of independence have seen the country rapidly develop, adopt new technologies and prosper. Forests have been intensively managed and utilized, and the forest industry has grown to account for up to 5% of the country's GDP. Annex 1 provides a simplified timeline of the history of the past century of Estonia from a forestry point-of-view.

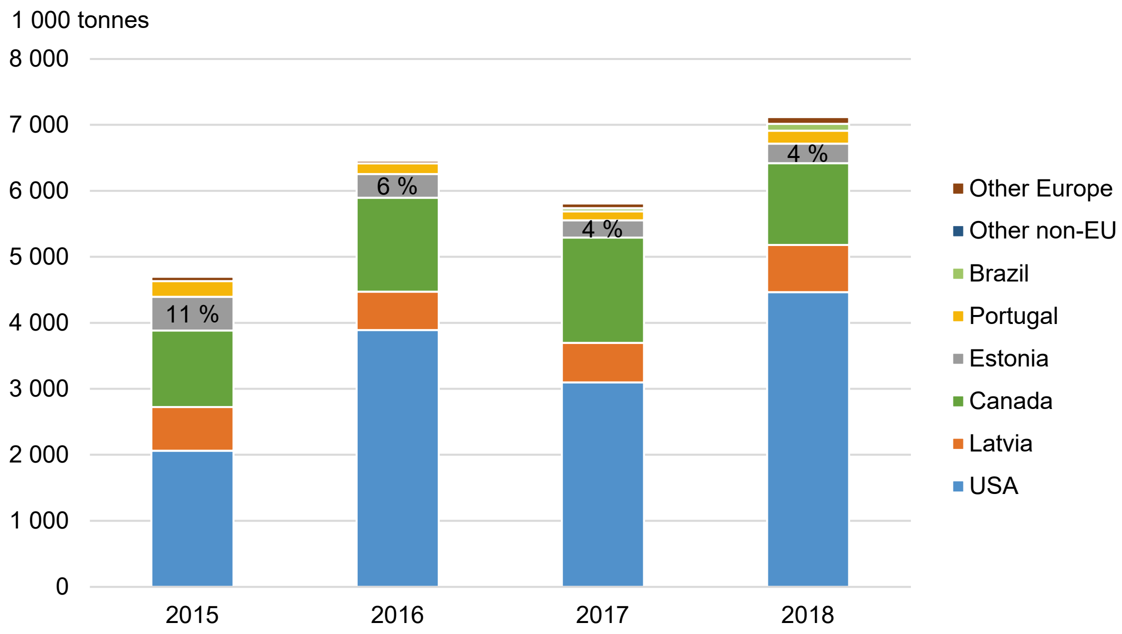
1.2 Drax in Estonia

Since 2014, Estonia has been one of the biomass sources for Drax power production in the UK. Estonia's share of Drax's biomass sourcing is currently only 4%, while in 2015 it was 11% (Figure 1.1).

Drax's long-term supplier in Estonia is Graanul Invest, which is the biggest pellet producer in the country. In addition to Graanul Invest, Drax has also other pellet suppliers in the country, but their deliveries are not regular.

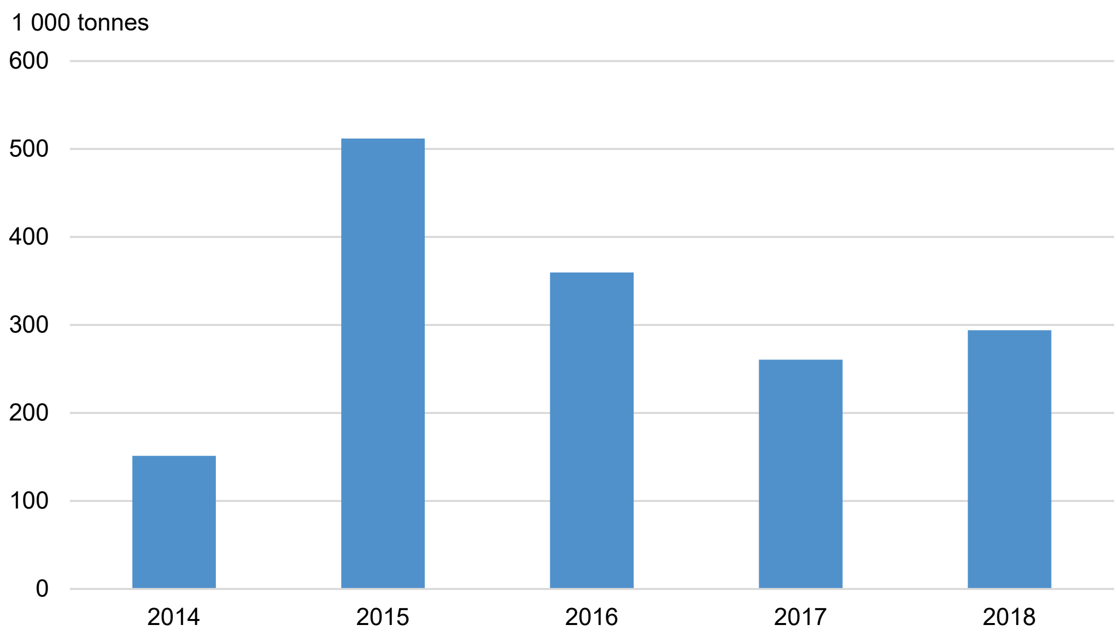
According to Drax's annual reports, approximately 294 000 tonnes of wood pellets were purchased from Graanul Invest in 2018. Also, according to Drax, 69% of Graanul Invest's pellet production feedstock originates from roundwood thinnings in Estonia, while 31% consists of sawdust, shavings and chips mainly from sawmills in Estonia and Latvia.

Figure 1.1 Drax woody biomass sourcing by country or region



Source: Drax Annual Reports

Figure 1.2 Drax woody biomass sourcing from Estonia



Source: Drax Annual Reports and private communications

1.3 Objective of the Assignment

The objective of the assignment is to give an overview of the forest management, roundwood market and wood product market trends affecting forest structure and use in Estonia and to provide the Consultant’s view on Drax’s impact on the observed developments.

2. WOOD-BASED BIOENERGY IN ESTONIA

2.1 Role of Wood in Estonian Energy Production

Box 2.1 Chapter Highlights

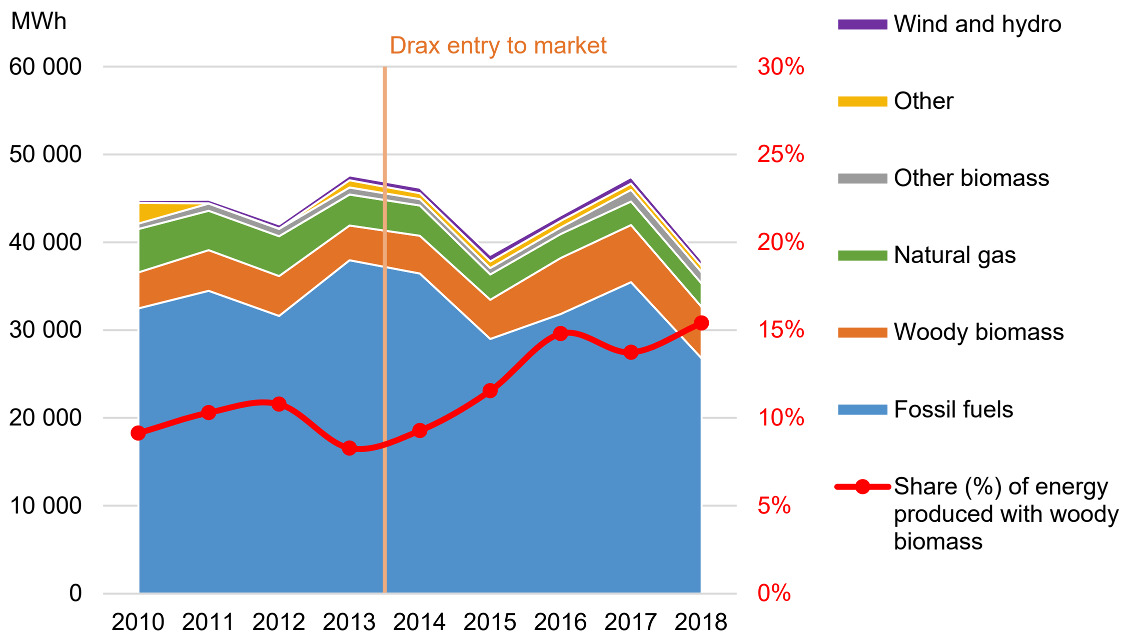
General

- Wood is becoming increasingly popular in energy production, especially in heat production. Oil shale still dominates in electricity production.
- Estonia is a net exporter of wood chips and pellets.
- The main wood fuel used domestically is wood chips.
- Pellets are mainly exported. Households are the largest domestic user.
- The energy use of wood is likely to increase in the near future, due to national plans aiming to increase the use of wood and the desire to decrease dependence on oil shale.

2.1.1 Energy Mix in Estonia

The importance of wood as an energy source in Estonia has been increasing across total energy generation (heat and electricity) over the past decade (Figure 2.1). Even though woody biomass still currently accounts for only a rather small portion of all energy generation, it is likely to continue growing in importance. The Estonian national energy and climate plan (NCEP 2030) estimates that 80% of heat and 30% of electricity would be produced with renewable sources by 2030. This increases the demand for woody biomass in all energy production, alongside other renewable sources, such as wind energy. The Estonian forestry development plan until 2020 also aims to reduce environmental impacts related to the use of fossil fuels and non-renewable resources by increasing the use and production of Estonian timber.

Figure 2.1 Total domestic electricity and heat generation by source

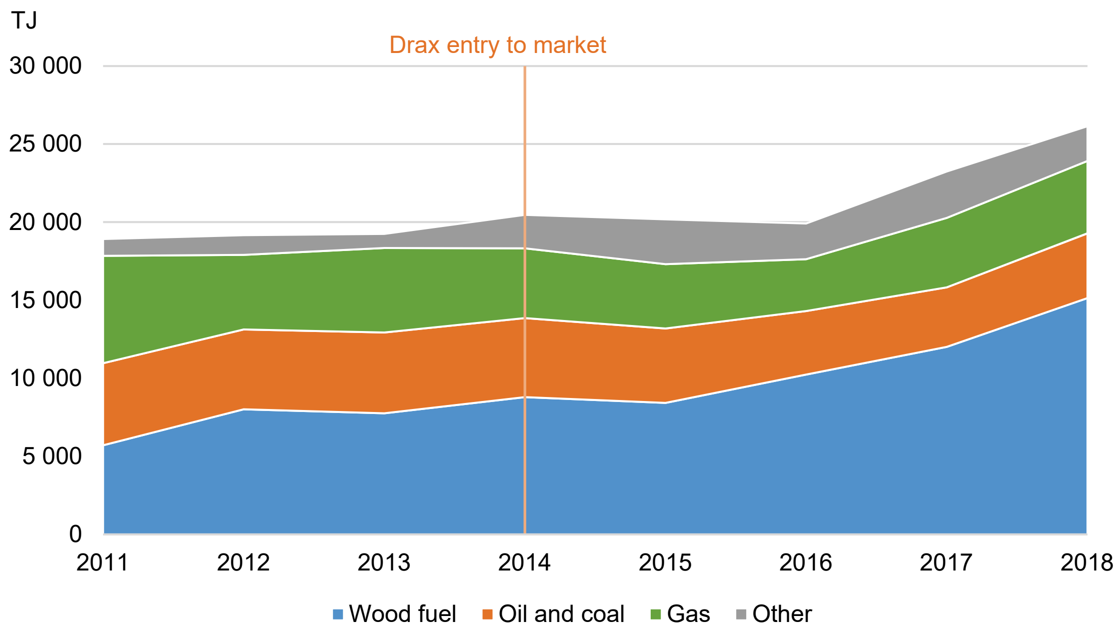


Note: Pellet exports not included. Source: Statistics Estonia.

Total energy generation has fluctuated quite notably in 3–4-year intervals over the past nine years. Natural gas and other fuels have been losing their significance in energy generation. Estonia continues to be strongly dependent on fossil fuels in energy generation, with oil shale being the most commonly used fuel in electricity production. Electricity production consumes approximately 73–76% of fuels used in total for all energy generation. Oil shale accounted for over 89% of electricity generation in 2018. However, the amount of oil shale used for electricity generation has been decreasing in recent years. The situation is quite different in heat generation, where woody biomass, mainly wood chips, accounts for over 40% of all energy generated and natural gas for 25%. Oil shale only accounts for just over 7%.

The importance of wood as a fuel for CHP plants has been growing in recent years, with the portion of the energy produced from wood fuels in CHP plants increasing from 30% in 2011 to 58% in 2018 (Figure 2.2). The use of especially oil shale and natural gas has been decreasing during this period.

Figure 2.2 Fuel consumption in CHP plants



Source: Statistics Estonia

New CHP plants have been constructed in Estonia, specially designed to burn biomass, which explains the increased share of wood fuels used. Fortum began operations in its Tartu and Pärnu plants already in 2009 and 2010 respectively. Later additions to the roster of biomass burning CHP plants are for example the Graanul Invest CHP plants Osula and Imavere, both of which began operations in 2017. Also in 2017, OÜ Utilitas Tallinna Elektrijaam inaugurated a new biomass-fired CHP plant, which powers approximately 20% of the Tallinn region. This was the largest biomass-fired plant in Estonia at the time of the inauguration and burns an estimated 530 000 m^3 of wood chips annually. The government of Estonia is also allowing oil shale to be replaced partially by biomass in the Narva power plants. The three newer units of the Narva power plants are able to utilize up to 50% biomass. The changes are expected to be in force within a year. Estonian CHP plants burn both harvest residues and residues from sawmilling and other mechanical woodworking industries.

Capacity increases have driven demand for, especially forest chips. This has enabled the utilisation of harvest residues economically. CHP has created a new demand for harvesting residues and new income for forest owners. This may show only slightly in wood prices because residue collection is not a significant added expense in harvesting in general. Pellet production together with CHP is an important end-use segment for wood raw material which is not suitable for sawmilling, thus compensating for the absence of a wider P&P sector in Estonia.

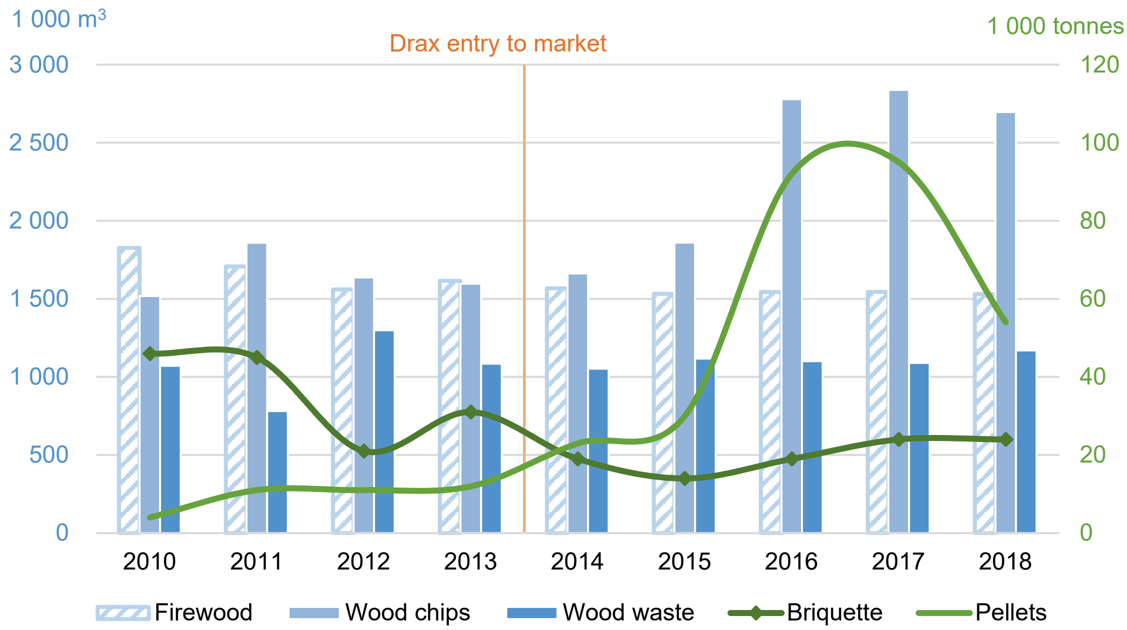
2.1.2 Domestic Consumption of Wood Fuels

Domestic consumption of wood fuels is mainly concentrated on wood chips, firewood and wood waste (Figure 2.3). Only a small fraction of the pellets produced in Estonia are consumed locally. Briquettes are mainly produced for domestic use, which is minimal. The large increase in wood chip consumption between 2015–2016 is due to new CHP plants which were inaugurated in 2017[1], as they have begun collecting stores of wood chips in advance, to allow for a smooth start of production.

Wood chips are the main wood fuel used in heat generation in Estonia. Pellet consumption experienced a relatively large spike between 2015–2018, peaking in 2017 and decreasing in 2018 again, nearing 2015 levels. In absolute terms, the increased pellet consumption accounted for only a very small share of the total domestic pellet production. Wood chip consumption also increased by nearly 70% in 2016 compared to 2015 levels but has slightly decreased again since then.

Wood fuel used in electricity generation has also been mainly wood chips, and consumption has been increasing quite steadily since 2013, doubling by 2018. Small volumes of wood waste have also been sporadically utilized in electricity generation, but this is more of an exception, rather than the rule. Firewood use in electricity generation is extremely rare and small-scale, with only a few thousand cubic meters in total utilized since 2010. Overall, the use of wood fuels in electricity production is comparatively marginal, as most electricity is produced with oil shale.

Figure 2.3 Domestic consumption of wood fuels

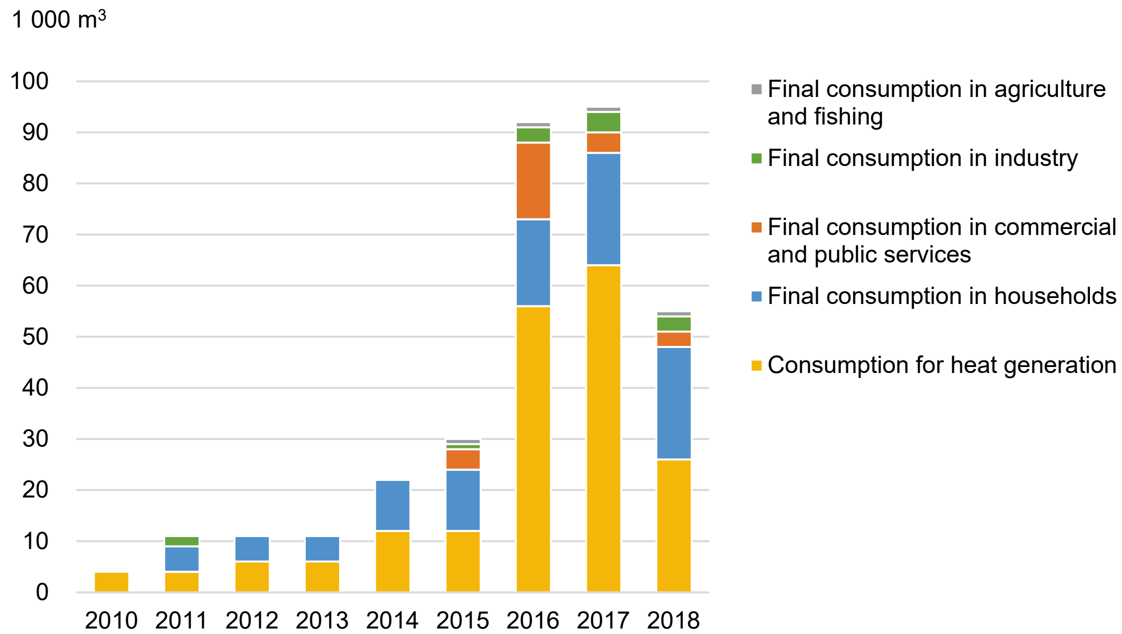


Source: Statistics Estonia

[1] Estonia Renewable Energy Association, 2017. Renewable Energy Yearbook 2016. Available: http://www.taastuvenergeetika.ee/wp-content/uploads/2017/08/Renewable-energy-yearbook_2016.pdf.

Households are the second-largest domestic consumer of pellets after CHP plants (Figure 2.4). Other uses are marginal, except for in 2016, when consumption in commercial and public services experienced a temporary increase and was nearly as large as household consumption.

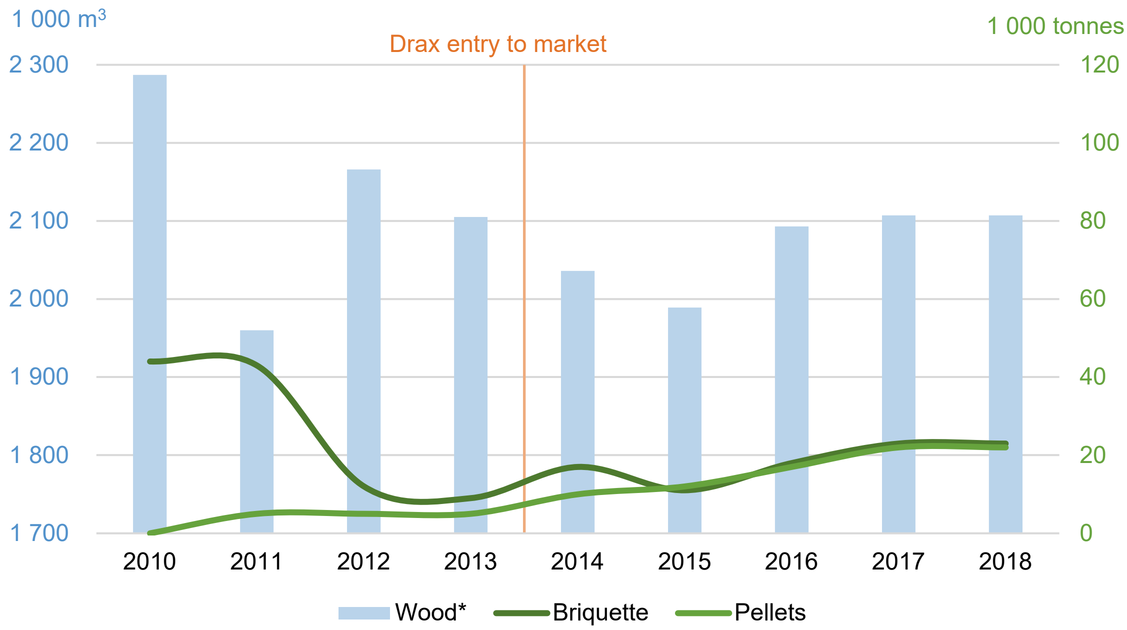
Figure 2.4 Pellet consumption by end-use segment



Source: Statistics Estonia

Pellet consumption by heat producers was similar in scale to household use for many years but increased fourfold between 2015–2016. Household consumption of pellets has been rising steadily since 2010 when consumption was non-existent (Figure 2.5). Consumption reached 20 000 tonnes in 2017 and remained steady over 2018. Household consumption of briquettes decreased between 2010–2012 but has been developing in line with pellet consumption since 2015, and consumption levels have been nearly identical since then. Overall household wood use for energy has steadily decreased between 2011–2015 if 2011 is regarded as an outlier. This development was reversed in 2016 when consumption bounded back to the levels of 2013 and has since remained stable with some small increases in 2017–2018.

Figure 2.5 Final consumption in households



* Wood includes firewood, wood chips and wood waste, excludes pellets and briquettes

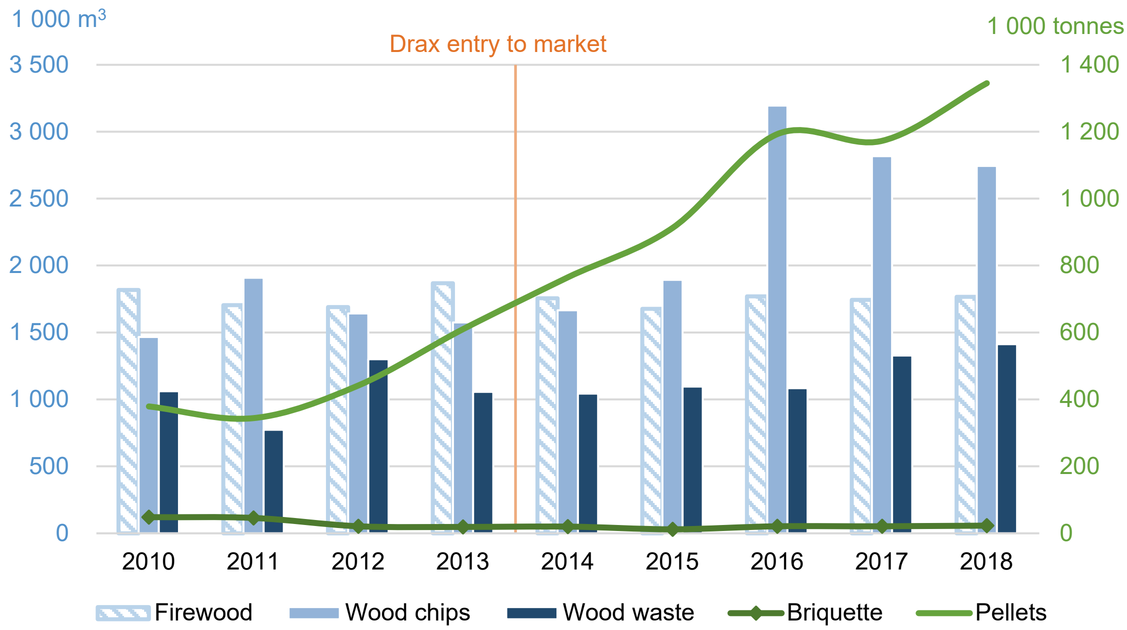
Source: Statistics Estonia

2.1.3 Production and Trade of Wood Fuels in Estonia

Raw material sources for wood-based energy are the side streams of the wood products industry, energy wood from thinnings, low-quality logs and other roundwood and harvest residues. Harvest residues are a significant raw material for e.g. Graanul Invest, which harvested 500 000 and 850 000 tonnes of residues in 2017 and 2018 respectively, for energy production in CHP plants.

Pellet production has grown 350% between 2010–2018 (Figure 2.6). This translates to a cumulative annual growth rate of 17.1%. Production of other wood fuels has not experienced comparable growth, but the production of wood chips did increase by 60% from 2015 to 2016. Production has since declined in both 2017 and 2018. Wood waste production for energy has been increasing since 2014. Firewood production has remained quite stable at around 1.7 million m^3.

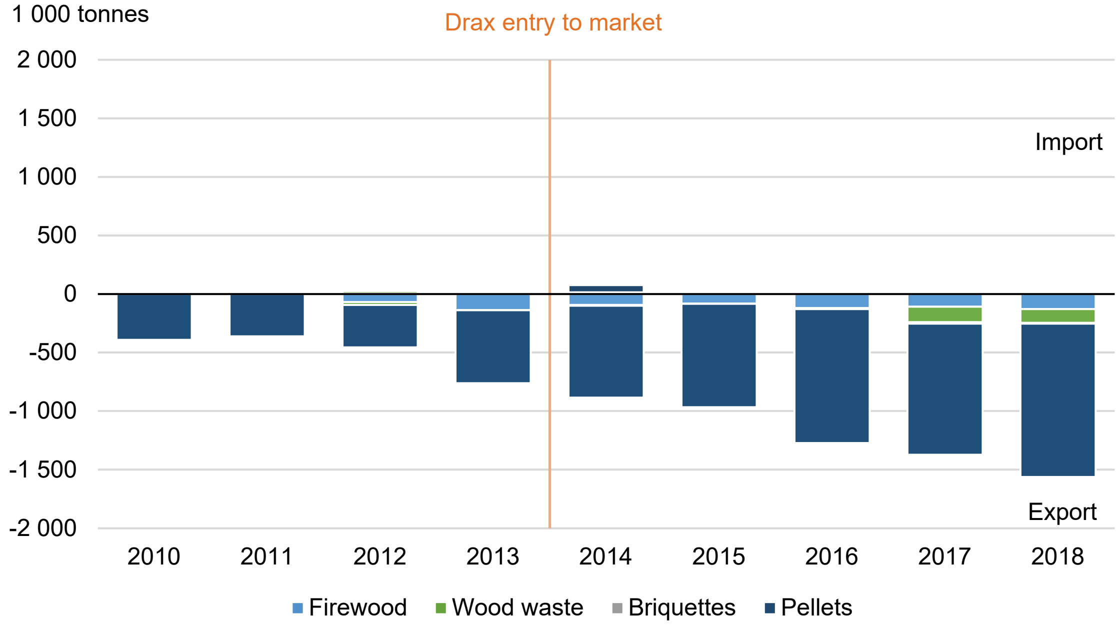
Figure 2.6 Production of wood-based primary energy sources in Estonia



Source: Statistics Estonia

Wood fuel imports are marginal in comparison to domestic production and exports. (Figure 2.7). On closer inspection, they have undergone notable changes since 2010. Wood chip imports more than doubled from 2010 to 2011. By 2018, wood chip imports have decreased to nearly a third of the level in 2011. Between 2011 and 2014, import volumes decreased steadily, but this trend was reversed in 2015. Imports rose annually between 2014–2017, and in 2018 dropped again. Imports of wood waste and briquettes increased steadily between 2010–2014 but have since decreased once more. Pellet imports have been fluctuating strongly. It seems that only a small supply is imported regularly, with larger quantities being imported sporadically. Due to the small scale of imports, small absolute changes result in large percentage shifts.

Figure 2.7 Imports and exports of wood fuels



Source: Statistics Estonia

Estonia is a net exporter of wood fuels. Pellets have become the main form of wood fuel being exported from the country. Between 2010–2012 pellet exports remained steady at approximately 360 000 tonnes but increased to over 1.3 million tonnes by 2018. This is largely attributable to the growth of Graanul Invest. Even though domestic consumption of pellets increased notably in relative terms between 2015–2017 (see the previous chapter), it does not seem to have had a noticeable impact on the exports of pellets, which grew concurrently with domestic consumption. Firewood and wood waste are exported in only comparatively small quantities. In 2018, a total of under 250 000 tonnes of firewood and wood waste was exported. Briquettes are an even smaller export item and quantities are marginal. Wood chips are not exported for energy use.

Over 90% of Estonian pellets exports are directed to just five European countries; Denmark (45%), the UK (13%), Germany (13%), the Netherlands (11%) and Sweden (9%). Extra-EU exports account for just over 0.5% of all pellet exports.

3. FOREST RESOURCES AND FOREST MANAGEMENT

3.1 Development of Forest Resources

Box 3.1 Chapter Highlights

Forest Area

- Forest area and cover in Estonia has increased continuously for the last decades due to afforestation of abandoned agricultural lands.
- Increased harvesting levels lead to an increased proportion of temporarily unstocked forest area.

Forest Quality

- In the long-term, the area of deciduous forest has increased, due to neglection of artificial regeneration in some of the private forests that have been clear-cut. This has not had a noticeable effect on the production of wood products, as most forests have been managed well and have supplied enough roundwood to satisfy the market.
- Thinnings have often been neglected in private smallholders' forests, because the markets for small-diameter roundwood (e.g. pulpwood) have been non-existent. Also, the confidence in profitability of long-term forest management has been weak among the smallholders.
- Spruce is the most intensively managed species with a fairly equal area in all age classes, while pine forests, in general, are older.
- Forest management has and is expected to improve along with the concentration of forest ownership to companies.

Forest Ownership

- Over half of the forest area is managed well by the state company RMK.
- Private individuals own ca. 30% of the forest land, but often hold small areas and are inactive in forest management.
- Private companies are increasing their ownership share of Estonian forests. This development is also supported by government policies, in order to improve overall forest management efficiency and utilization of the resources.
- Land privatization after the collapse of the Soviet Union has been the main driver of ownership change.

Over half of Estonia's land area is covered with forests, which makes Estonia the fourth most forested country (by %) of the EU. Estonia's history as part of the Soviet Union has had a heavy impact on the structure and management of Estonian forests. Prior to 1991, forest management in Estonia was characterized by state ownership of forests and centralized planning, with only little forest industry production compared to the present. Estonia's forest area has grown significantly for almost half a century, which mainly results from the afforestation of un-utilized farmlands.

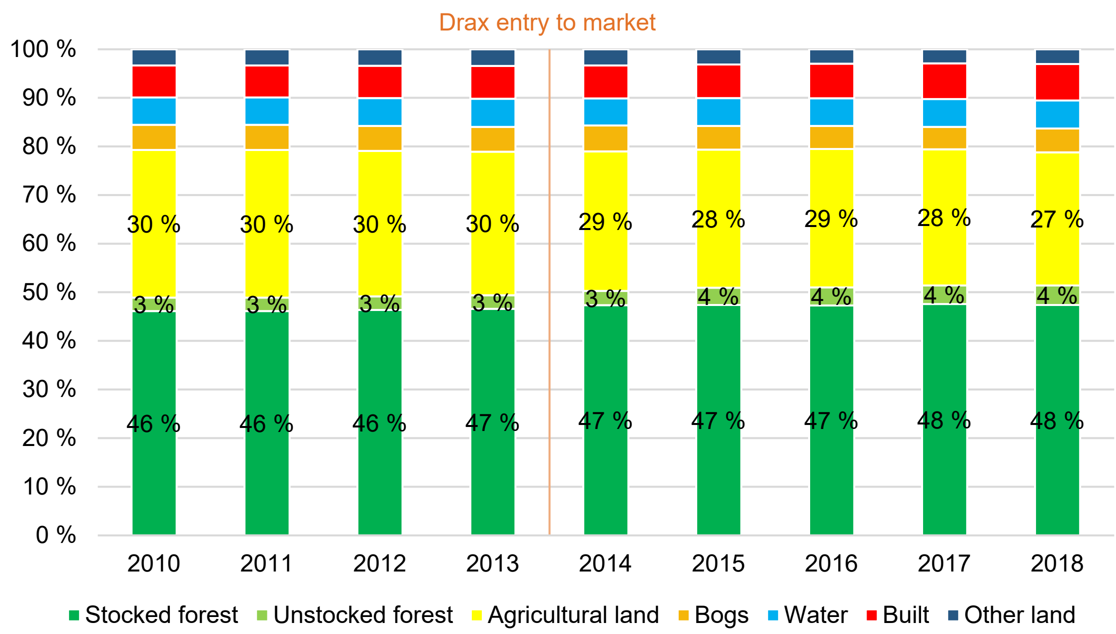
3.1.1 Land Use

Land Use Change

Of Estonia's total area of 4.53 million ha, the area covered by forests has gradually risen through the last 10 years. An area classified as unstocked forest has increased, which is a sign of increased harvesting. Estonia's forest area has grown during the last decades, as a result of afforestation programmes on abandoned agricultural areas. Over the past twenty years, the afforestation of quarries and agricultural and other land totals over 7 500 ha of land.

As the area allocated for forests and forestry has grown, also clear-cuts have become more common, which can be seen as the growing proportion of class "Unstocked forest" in Figure 3.1. Despite the growth of unstocked forest areas, also the stocked forest area, i.e. forest cover has increased from 46% to 48% between 2010–2018. Since Drax initiated sourcing from Estonia in 2014, the share of stocked forests has continued to increase. Spruce-dominated forests have the highest share in the class "Unstocked forest", due to spruce being the most intensively managed species.

Figure 3.1 Land use in Estonia



Source: National Forest Inventory

Transition from Natural Forest to Intensive Management Areas

Estonian forests have a long history of human influence. During the Soviet era, large forest areas under the control of collective farms were inactively managed. Management in these previously collectively owned, but nowadays privatized, forests are becoming more active and intensive, which is also the goal of government policies. However, these forests have been influenced by people in the past and thus should not be considered as natural forests. This increased management activity improves the availability of higher-quality sawlogs and other roundwood. Impacts on carbon stock may vary; initially harvesting unmanaged forests may result in decreased carbon stock, but in the long-term carbon sequestration is likely to improve and stock levels will begin to rise and possibly surpass previous levels. The actual development is heavily dependant on the species composition of the understorey vegetation, as well as on the site-specific soil biogeochemistry. Tree species also have an impact on the soil organic carbon (SOC); coniferous trees have been found to have a positive effect on the SOC in Estonia[2].

Estonian Forestry Development Plan for 2011–2020 sets a goal to place 10% of the nation's forest area under strict protection by 2020, focusing on areas with high biodiversity values and rare habitats. This goal was already achieved in 2015, when 10.3%, i.e. 238 800 ha of forest were under strict protection.

3.1.2 Forest Resources

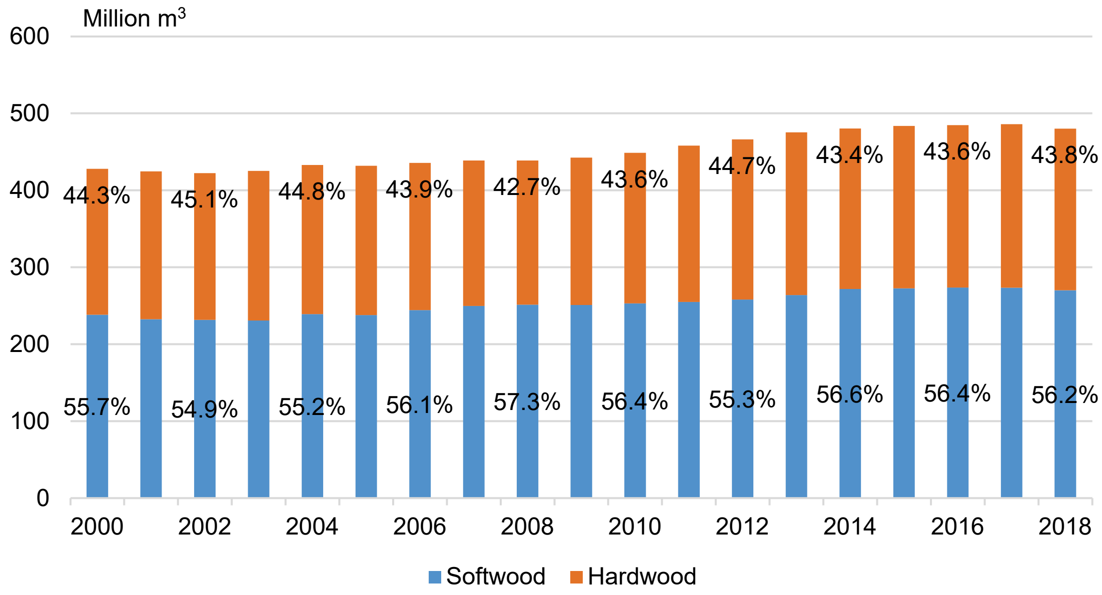
Development of Forest Area and Growing Stock

The total growing stock in Estonia has increased during most of the last two decades. Between 2010 and 2017, the total growing stock increased on average 5. million m^3 per year, while in 2018, statistics show that the total growing stock decreased ca. 5.8 million m^3. This decrease was however due to statistical sampling error, as the number of sample plots was increased. No actual decrease in the growing stock is perceived to have occurred and is understood to have remained steady or increased slightly. Softwood species have been accounting for 54–56% of the total growing stock, while no clear distribution-changing trends are visible in Figure 3.2.

Pine, birch and spruce are the dominant species in Estonia, together accounting for some 80% of the total forest area and growing stock (Figure 3.3). During 2000–2018 the largest increase in volume has occurred in birch-dominated forests, accounting for over 30 million m^3, followed by pine (29 million m^3) and spruce forests (17.6 million m^3). Birch has been gaining popularity amongst forest owners in recent years, contributing to the large volume-increases of birch. Active forest owners have regenerated forests to spruce and birch and to a smaller extent to pine, whereas non-active smallholders have not regenerated actively after harvesting coniferous forests, which has resulted in natural regeneration to hardwood species. Currently, pine forests account for 29% of the total annual volume increment in the country, while spruce and birch account for 23% and 27%, respectively.

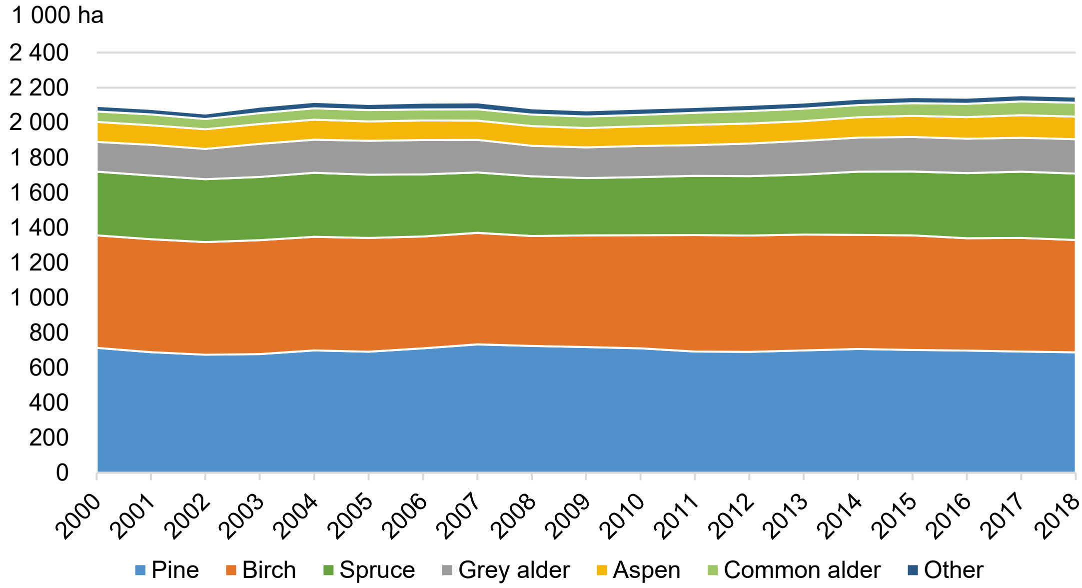
[2] Lutter, R., Kõlli, R., Tullus, A. and Tullus, H., 2018. Ecosystem carbon stocks of Estonian premature and mature managed forests: effects of site conditions and overstorey tree species. European Journal of Forest Research. https://doi.org/10.1007/s10342-018-1158-4

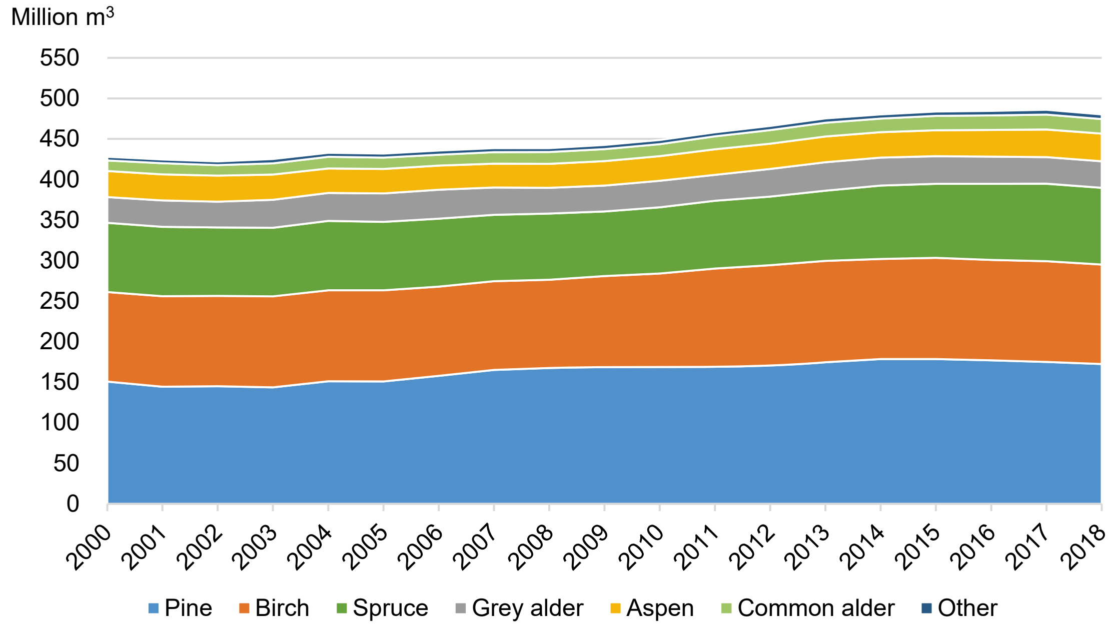
Figure 3.2 Development of total growing stock



Source: National Forest Inventory

Figure 3.3 Forest area and volume of standing stock in Estonia by tree species





Source: National Forest Inventory

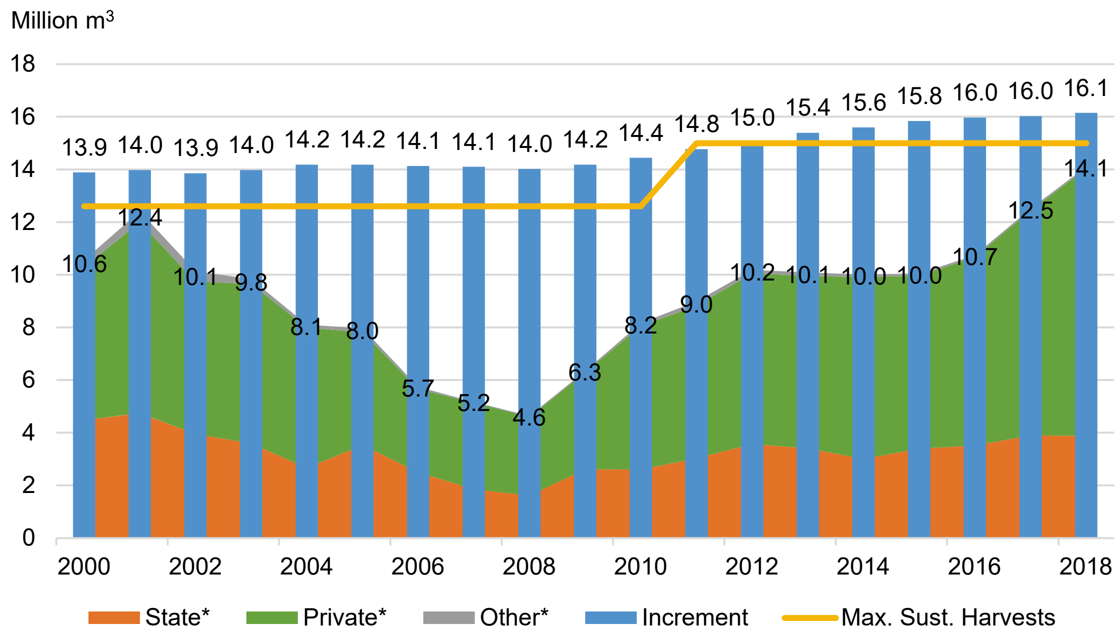
The total annual increment of Estonian forests has increased by 2 million m^3 during the last two decades. Spruce-dominated forests account for the largest increment growth, and a driver for the increment growth has also been the relatively low harvesting level during 2003–2011.

Comparison of annual increment, harvests and the maximum sustainable harvesting level is presented in Figure 3.4. The Forest Development Plan for 2011–2020, approved by the Estonian Parliament, stated that due to the low level of harvesting during 2000–2010, the optimal sustainable harvesting level for the years 2011-2020 is increased to 12–15 million m^3. As seen in Figure 3.4 and learned during interviews with Estonian forest sector operators, the actual harvesting level has reached the maximum level during the last few years. Drafting of the

Forest Development Plan for 2021–2030 is currently in progress and the draft will be subject to parliament discussions during the spring of 2020 and will be approved by end of the year. The outcome of the process might contain restrictions for further harvesting increases.

Private forests are the largest source of wood in Estonia (Figure 3.4). The total yield from fellings in private forests has been rapidly increasing since 2008 and is currently at an all-time high. The yield from fellings in state-owned forests has also been increasing since 2008, though the current level in state-owned forests is not unheard-of during the last decades. The increased harvesting in private forests has mostly resulted from an increased share of land managed by companies. Private small-holders' activity in forest management is slightly increased but does not explain the bulk of the growth in the volumes harvested from private land.

Figure 3.4 Total annual increment and fellings by forest ownership type



* Harvesting level. Source: National Forest Inventory, Forest Development Plan 2011-2020

Development of Age Class Distribution by Tree Species

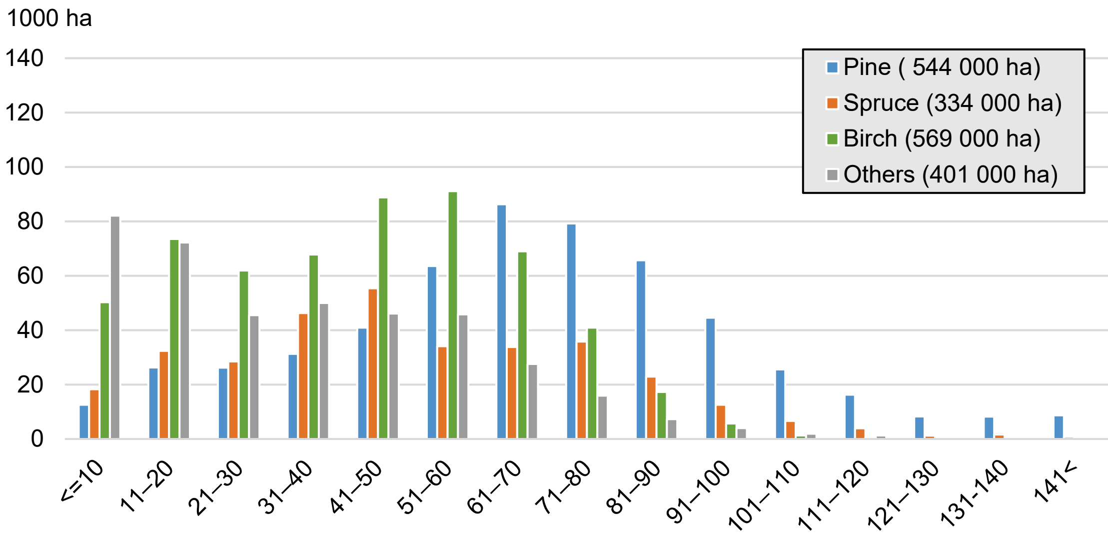
Long-term analysis by the Estonian Environmental Agency states that the share of deciduous species has increased in Estonian private forests during 1998–2018. The main reasons for the development are the following:

- Private forest management is fairly new in Estonia. During 1991–2000, forest inventory was conducted only in the best-managed private forests, while during later times the inventory coverage in private forests has increased.
- Coniferous forests have been harvested with a higher intensity than deciduous forests. However, in private forests the regeneration was often not organized, leading to natural regeneration with several deciduous species.

Figure 3.5 presents the species-specific age distribution in working forests (i.e. forests available for wood supply). Birch and other deciduous species cover a significantly higher share of the working forest area in age classes 1–20. The temporarily unstocked area is excluded from the charts since it does not yet have a dominant species. Due to the highest intensity management, spruce has the highest share of temporarily unstocked forest areas (ca. 182 000 ha), while other deciduous species have the lowest share.

Rotation length is typically longer for coniferous trees than deciduous trees in Estonian forests. Spruce and pine trees are generally older than broadleaves. Figure 3.6-Figure 3.9 present the age class development during 2010–2017 for all Estonian forests, while Figure 3.5 presents the latest age class distribution for working forests only. Similar statistics for working forests in 2010 were not available. Also, pre-2010 inventories utilise a different age class division, which prevents direct comparisons.

Figure 3.5 Forest area by age class and species in working forests, 2018

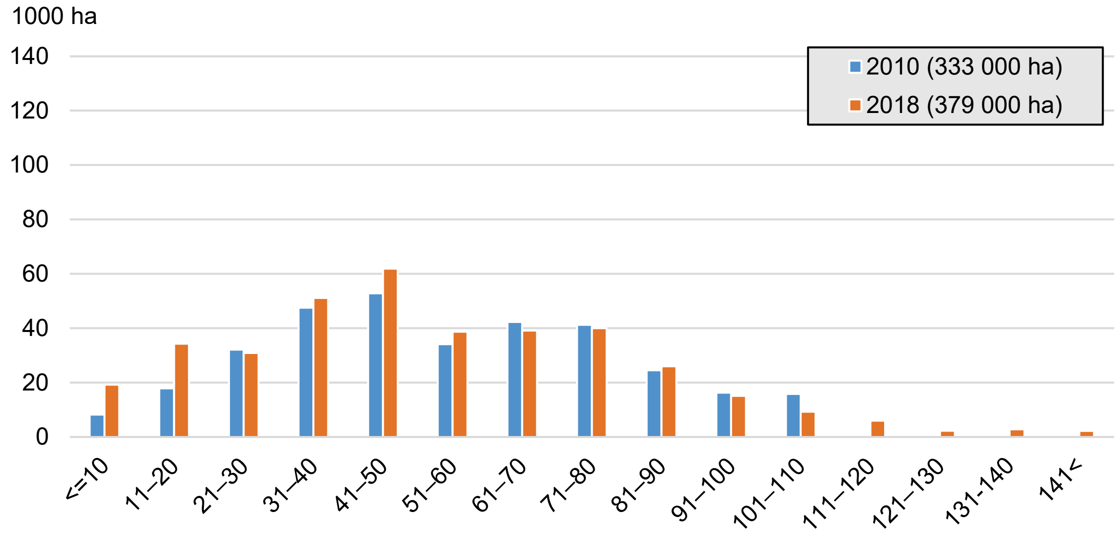


Source: National Forest Inventory. The chart excludes temporarily unstocked forests.

When looking at the first age class of each species (<=10) in Figure 3.6-Figure 3.9, the first observation is that during the last 10 years, the total area regenerated to birch has decreased, while for spruce the regenerated area has increased. Also, for the class "Other species" in Figure 3.9, the regenerated area has increased. The increased area in the younger age classes does not necessarily signify decreases in the older classes, but rather it is due to land afforestation.

In the context of Estonia, the age structure between different species is also somewhat a result of the local forest legislation, which stipulates the ages at which different species are eligible for harvest, and allowed species for different site types. The minimum age requirement for final felling is presented in Annex 2, along with the species specifications by site class.

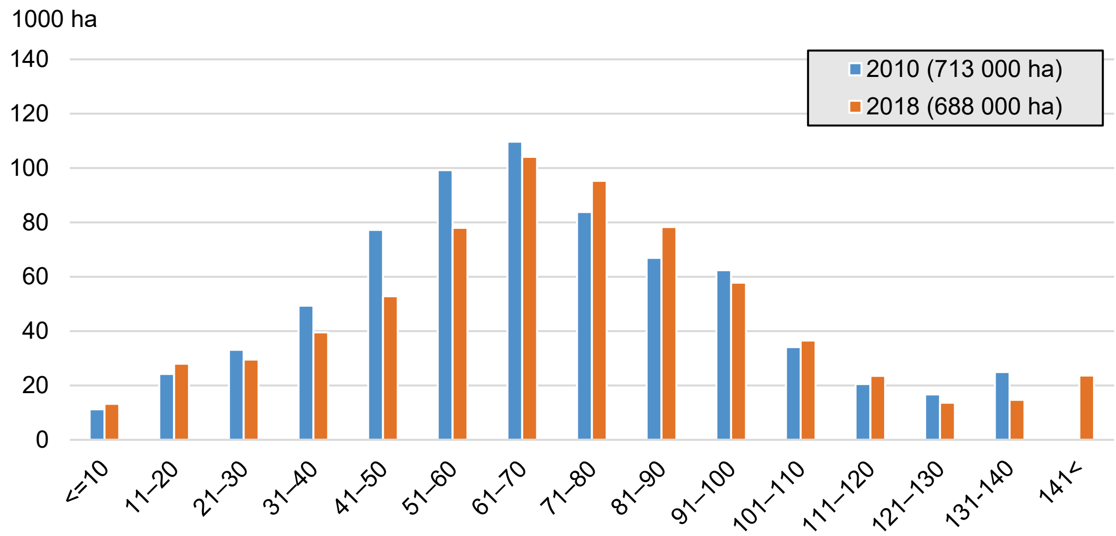
Figure 3.6 Total forest area by age class, spruce



Source: National Forest Inventory. The appearance of older classes in the 2018 age class distribution is mostly resulting from increased inventory coverage in private forests. The chart excludes temporarily unstocked forests.

For spruce (Figure 3.6), the age class distribution has not changed remarkably during the past decade. It should be noted, that the granularity of the 2010 data was lesser than that of the 2018 data, and did not include divisions into the oldest age classes. Spruce is the most-intensively managed species in Estonia, while pine forests are facing fewer harvests. Therefore, the age distribution in pine forests has shifted slightly towards older classes (Figure 3.7).

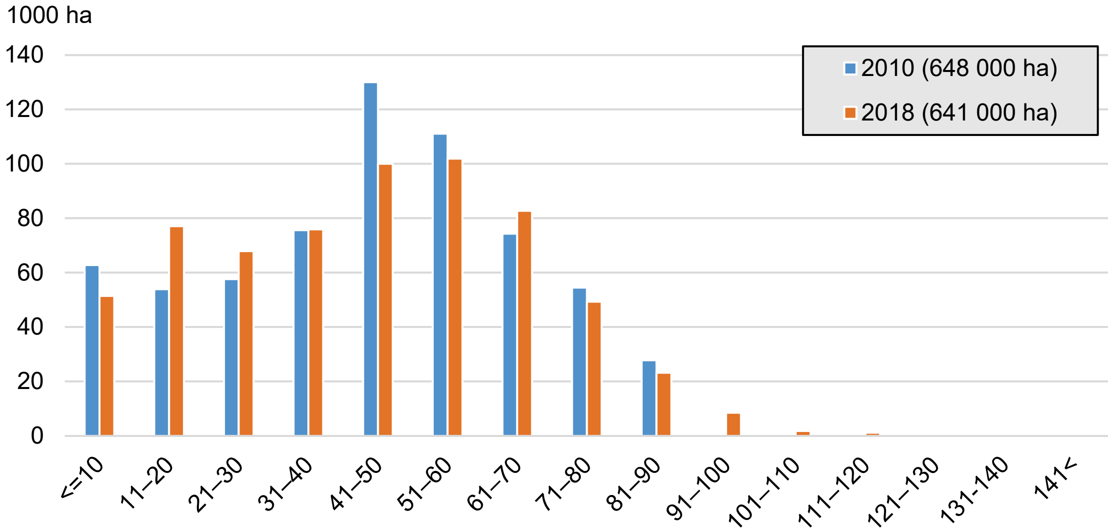
Figure 3.7 Total forest area by age class, pine



Source: National Forest Inventory. The chart excludes temporarily unstocked forests.

In birch forests (Figure 3.8), it is difficult to distinguish any clear trend from the age distribution. However, the largest age classes 41–60 years are partly matured to older classes and partly harvested. According to interviews, planting of birch has become more popular during the most recent years, but this development is not yet visible in Figure 3.8.

Figure 3.8 Total forest area by age class, birch

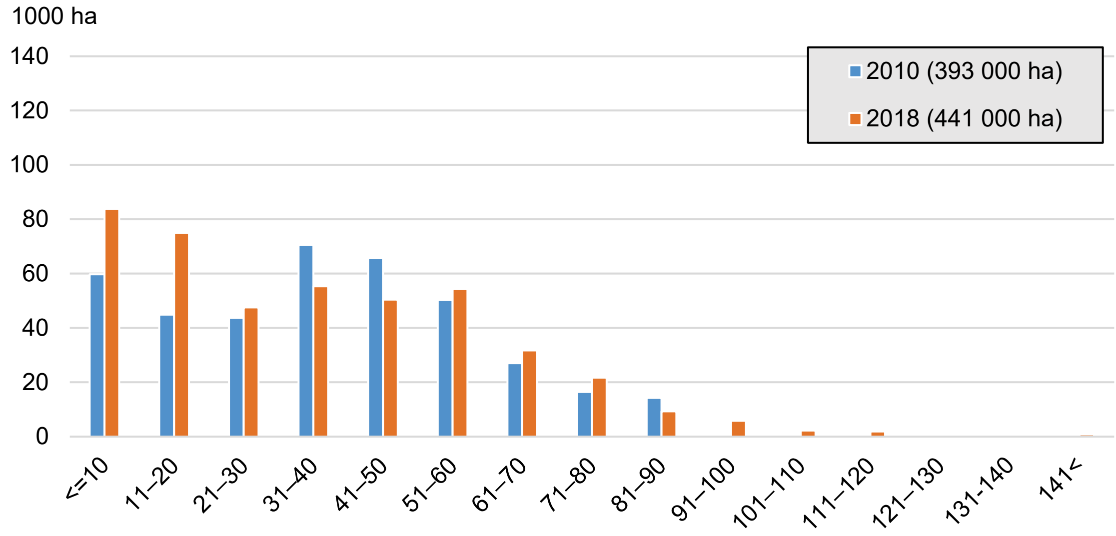


Source: National Forest Inventory. The chart excludes temporarily unstocked forests.

The most important species in the class "Other Species" are aspen, grey alder and common alder (Figure 3.9). As a result of the poor organization of regeneration in private forests, the area of other deciduous species in the youngest age classes has grown since 2010. This development has been possible because of the good natural regeneration conditions in Estonia. The increase and development of forest management practices cannot be seen in statistics, yet. Also, some part of the increase can be explained by improved inventory coverage in private forests. The spread of these hardwood species has not been completely unregulated or unrestrained; legislation stipulates which species of trees are permitted to be regenerated on different forest site types[3].

[3] See Annex 2 for more detail.

Figure 3.9 Total forest area by age class, other species



Source: National Forest Inventory. The chart excludes temporarily unstocked forests.

Forest Ownership

Approximately half of the forests in Estonia are owned by the public sector and half by private persons or legal entities (Figure 3.10). The majority of the public forest is managed by a public company Riigimetsa Majandamise Keskus, often abbreviated as RMK (Estonian State Forest Management Centre).

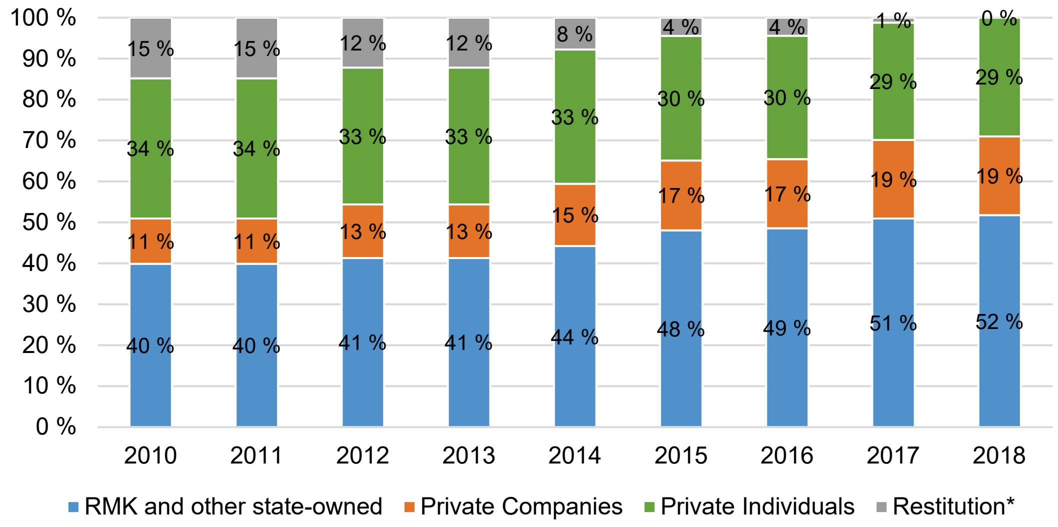
During the era of Soviet rule in Estonia, ca. 40% of forests were managed by collective farms, which in general were considered as poorly managed. After Estonia's new independence in 1991, these previously collectively-managed areas were put in restitution/privatization program. The privatization progress is now close to being complete and the result is that ca. 52% of forests are managed by the state, while the rest is distributed to individuals and companies.

Roughly two-thirds of private forests are owned by private individuals, while one third is owned by legal entities, most companies, such as Finland-based Tornator. However, a private person is behind many of the legal entities owning forest, as historically the taxation has provided incentives for ownership through a company.

Forests managed by RMK have long been recognized as well-managed forests, while for private individuals, the management activity has been poor. Currently, there are over 105 000 private individuals who own forest area. For private individuals, the average holding size is 6 ha and almost half of the properties are smaller than 2 ha. Private forest owners have typically been reluctant to perform plantings and pre-commercial thinnings, which has led to the poor condition of young forests and slow regeneration. Forest owners who own smallholdings may also place more emphasis on other objectives than economic ones, e.g. recreational values.

The government has recognized the management inactivity and fragmentation of private forest properties as a problem leading to sub-optimal utilization of Estonia's forest resources. Policies have been put in place to improve the private forest utilization, including subsidies for pre-commercial management measures and removal of property tax of forest estate sales. The removal of property tax aims to concentrate forest ownership to larger units, leading to more active forest management and better resources for investments into forestry.

Figure 3.10 Forest ownership development



* Forests awaiting restitution; planned restitution. Source: National Forest Inventory

3.2 Forest Management Practices

Box 3.2 Chapter Highlights

General

- Forest law sets definitive boundaries and requirements for forest management. No additional official forest management recommendations exist.
- State forests have traditionally been well-managed, while private forests, especially small-holder owned, have been inactively managed and even neglected.
- In Estonia 1.5 million ha of forest area is FSC certified and 1.3 million ha PEFC certified. Most of the certified forests are dual-certified.
- In recent years environmental concern has arisen about the use of forests in Estonia. One of the results has been the cancellation of the Est-For pulp mill project.
- Changes in the forest law during the last decade have been favorable from the viewpoint of harvesting (e.g. larger felling areas are allowed and final felling criteria for spruce stands have been eased). The Forestry Act currently restricts the maximum clear-cut area to 7 ha. The average size of a clear-cut is only between 1 and 2 ha.

State forests

- The quality of forest management has remained on a good level and is likely to remain so as the government is committed to supporting the local wood product industry.

Private forests

- Planting of birch has become more popular.
- Thinnings, especially pre-commercial thinnings, have been considered often purely as costs. Recently, however, private forest owners have increasingly taken thinnings into their forest management toolbox.
- The growth of energy wood demand has made the thinning of previously unmanaged hardwood (especially alder) stands economically sensible. Also, subsidies have been made available to motivate pre-commercial forest management activities.
- Domestic and export price of pulpwood are major drivers for thinnings.
- The company-owned forest area is growing and is likely to increase forest management activity.

This chapter will provide background information on the major change drivers of forest management practices in Estonia and will describe the recent changes that have taken place in forest management. In addition, this chapter includes analysis of the impacts of these changes on the production of sawn timber, the growth rate of forests and their carbon sequestration potential, as well as on the revenue generation of forest owners.

3.2.1 Change Drivers of Forest Management

The direction of forest and forestry development is determined by factors both internal and external to the sector. The impact of external factors on forests and forestry can be direct or indirect. External factors may include changes in demographics, the economic situation, policies and institutions, advancements in science and technology and the responses of society to critical environmental changes; these often have a significant impact on how forests are managed.

Political, Institutional and Economic Environment

In small-holder private forests, the general level of forest management has been relatively low in recent decades, and the fertile land combined with limited forest management has led to overly dense forests. In Estonia, forest management practices have faced many changes during the past century. Changes in the role of forests and forest ownership structure have influenced prevailing forest management practices. The distinctive feature of the 1990's was the rapid growth of harvesting volumes and the transition from tree-length method to the cut-to-length method in harvesting. These were mainly driven by the re-independence of Estonia, rapid economic growth and the privatization of forests, which led to the formation of capital which allowed new investments into new equipment and increased demand for also wood-based products.

The historical set-up and implementation of land reform principles have led to a higher fragmentation of land use and ownership in Estonia. Forest management activities were prohibited in former private forests until legal owners or their successors were found. Since independence, a privatization process of the state forests has taken place and there have been some improvements. Today Estonia is Europe's fourth most forested country, and the state forests are generally in better condition than privately owned forests, as forest management practices are carried out in them more frequently.

There is no dedicated green growth strategy in Estonia, but several sectoral plans and programmes address environmental concerns, and green tax reform is underway. Energy development plans encourage renewable energy, although they lack specific measures to minimize reliance on fossil fuels.

In the 2000's the arrival of foreign forest investment institutions (e.g. Tornator and Dasos) has locally positively affected the forest management regime in privately owned forests, as forest management practices, such as tending of seedling stands and regeneration, have been given more emphasis.

In recent years there has been plenty of debate about the use of forests in Estonia. Local conservation organisations, activists, green party members and even some scientists have expressed their concerns about the current state and future of Estonian forests. Estonia's logging volumes are currently at a record-high level. In 2015, the European Commission expected Estonia's forests to become a net carbon source by 2030, rather than a sink, as they are today. However, Estonia's more recent UNFCCC reports indicate, that the LULUFC sector, including forest land, is expected to remain a carbon sink until 2035 and beyond, even though the size of the forest carbon sink is forecasted to shrink significantly, possibly by as much as 60% compared to the 2015 level. The projections have been based on the historical development of emissions and carbon sequestration in the sector since 1990, and do not account for changing goals, competencies and awareness of forest owners. In 2010 the Conservation Act had placed management restrictions on roughly one-third of Estonian forests.

Since 2000, the country has made significant progress in decoupling its strong economic growth from the primary environmental pressures. However, it has the most carbon-intensive and the third most energy-intensive economy in the OECD, largely due to its heavy reliance on oil shale. In 2016 Estonia had achieved the Aichi target on biodiversity protection. The status of species has improved since 2007, with more than half of habitats and species in a favourable condition (compared to the EU average of 16% of habitats and 23% of species). 18% of the terrestrial area is protected. Estonia has the largest budget for Natura 2000 private forest land support among the EU Member States; EUR 28 million for 2014.

In 2010, the Estonian FSC was granted the status of the FSC National Office. In Estonia 1.49 million ha of forest area is FSC certified and 1.29 million ha PEFC certified. Quite a notable share of Estonian certified forests are dual-certified, as the State Forest Management Centre, RMK, has both FSC and PEFC management certificates. The largest private forest owner in Estonia, Tornator, also has dual certification for its forests. An estimated 13% of private forests are FSC certified and 20% PEFC certified. Along with the increasing corporate forest ownership in Estonia, the popularity of FSC certification has been increasing in recent years.

Annual population change in Estonia has been quite stable in the last two decades including modest inclines and declines. Urbanization is commonly regarded as a change driver for forest owner attitudes, thus affecting forest management practices. In Estonia, the share of the urban population has remained the same in the last decade (approximately 69% of the total population).

Legal framework of Estonian forest management

Forest legislation in Estonia can be described as strict and it regulates many aspects with specific threshold values, which can be noticed in final felling requirements; final felling is age and diameter driven (Table 3.1, Table 3.2). In practice, the diameter is often the first criteria to be met.

Table 3.1 Rotation ages (in years) per tree species and quality class

Tree Species	Quality class					
	1A	1	2	3	4	5;5A
Scots pine	90	90	90	100	110	120
Norway spruce	60	70	80	90	90	90
Silver and downy birch	60	60	70	70	70	70
Aspen	30	40	40	50	50	-
Black alder	60	60	60	60	60	60
Hard broadleaved trees	90	90	100	110	120	130

Source: Rules of Forest Management

Table 3.2 Average diameter (in cm) at breast height requirements for the dominant tree species to allow for clear-cutting

Tree Species	Quality class					
	1A	1	2	3	4	5;5A
Scots pine	28	28	28	28	28	28
Norway spruce	26	26	26	26	26	26
Silver and downy birch	26	26	24	22	18	16
Black alder	24	24	22	22	18	16
Aspen	20	20	18	18	18	18

Source: Rules of Forest Management

These threshold values are determined by the Environmental Board of the Ministry of the Environment. It is somewhat unclear how the values are designated, as published studies on the optimal rotation length and harvesting schedules in the Estonian context are limited. The restrictions set by forest regulation lead at the very least to an economically suboptimal rotation length in forestry. It is likely that MAI is also suboptimal with these restrictions[4].

The forest act has been amended on several occasions in the 1990s and 2000s. Forest and conservation acts are the most focal laws that stipulate the use of forests in Estonia. In forest law, forest management is regulated quite strongly. The *Rules of Forest Management* ("the Rules") act as the guide for forest owners on what is permitted and what is required in terms of sustainable and good forest management. The law aims to secure the protection of forest ecosystems and sustainable use of forests. Sustainability in forest management is achieved through practices that ensure biodiversity, productivity, regeneration capabilities and vitality of forests while fulfilling ecological, economical, societal and cultural needs. The Rules stipulate, among other things, the size and amount of permissible drag roads in forests, the types of timber landings that are allowed and how they must be arranged, the procedures and methods for collecting harvest residues, requirements for seed trees, reforestation requirements and how to handle regeneration on a site with root rot. The Rules include further thresholds and requirements for still further management procedures. For example, the Rules provide the thresholds regarding age and diameter at breast height (dbh), one of which must be fulfilled for a clear-cut to be permitted (Annex 2). The Rules also provide methods for correctly determining the average age and dbh of a stand. Harvests are not restricted as long as they comply with forest legislation, and as such, the AAC is not specifically allocated amongst forest owners. Restricting harvests would be a largely political decision, and if harvests would be restricted, this would likely happen in state-owned forests first; restricting private forest owners' rights to harvest their own forests would result in notable dissatisfaction and maybe an impossible decision for politicians to make and enforce. Instead, the minimum requirements for final felling diameter and age are the tools for guiding harvesting levels.

Cleaning is permitted in all forests in which the average dbh is eight centimetres or more. Thinnings are subject to the same requirement. In addition, a basal area requirement must be fulfilled, and the thinning may not result in a basal area that is lower than stipulated in the Rules.

Selective cutting is permitted, but it may not result in a basal area lower than the provided threshold values (Annex 2).

The Rules provide the following requirements and restrictions for collecting harvest residues:

- Regeneration cutting areas shall be cleaned of slash not later than in one year from the expiration of the forest notification if it is necessary for ensuring forest regeneration
- Slash includes branches, treetops, stem wood remaining in the cutting area, cut undergrowth and cut underwood
- The following cleaning methods of cutting areas are permitted, if these do not cause damage to growing trees (including undergrowth): 1) rotting or burning of slash collected into piles or heaps; 2) burning slash in the whole area; 3) strengthening drag roads with slash; 4) chopping and spreading of slash; 5) removal of slash from the cutting area
- Removal of slash from the cutting area is not permitted in alvar forests and boreal heath forests
- Burning of the slash is prohibited during a period of fire hazard
- Burning slash in the whole area is permitted outside a period of fire hazard, provided that the alarm centre of the rescue service has been notified
- Slash left rotting in piles or heaps may not cover more than 20% of the cutting area.

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[4] Virkkunen, E., 2017. Economic Optimization of Harvesting Schedules for Main Tree Species in Estonia. Master's thesis. Department of Forest Sciences, University of Helsinki. 104 p.

A forest owner must submit a forest notification to the Environmental Board in case of planned harvesting (excluding cleaning) and concerning serious forest damages. The forest notification must include:

- Identifying details of the forest owner
- Cadastral code and location of the planned harvest area
- Details about a planned harvest and/or serious forest damages, including:
    - Inventory data:
        - Estimated volume and area of the harvest
        - Species
    - Method of harvesting
- A map depicting the planned harvest area.

The Environmental Board verifies the compliance of the information in the notice with the applicable legislation and either approve or bans the planned harvest. A permit is valid for 12 months after the owner has been issued the approval. Environmental supervision agencies are responsible for supervising the lawfulness of forest management. Noncompliance with legislation will result in fines determined in the Forest Act.

In addition to forest notices, the Environmental board conducts randomized checks in forests, to verify compliance with legislative requirements.

3.2.2 Changes in Forest Management Practices

Forest management practices include actions, such as thinning, regeneration, fertilization and tending, that are undertaken to reach desired outcomes in a forest stand. As mentioned previously, there are differences in forest management practices between private – especially private non-industrial – and public forest owners. The state-owned forests have been managed more professionally, baring in mind the longevity of tree production, while non-industrial private forest owners (NIPF) have mostly been neglecting forest management due to various reasons.

Fellings

Since 2010, there have been quite a few changes in forest management in Estonia. Some changes are due to changes in legislation, while others have been driven by markets and changes in ownership.

Over the last three decades, logging has increased considerably which has led to the previously mentioned environmental concerns. In 2009, Estonian forestry was not perceived to be on a sustainable path regarding logging and regeneration activities[5]. According to the OECD Environmental performance review (2017), further promotion of sustainable forestry practices through co-operation between relevant ministries, and dissemination of knowledge among private forest owners, is needed. However, the situation is not overly alarming, as harvests have remained below the annual increment, and the total area of protected forests has increased.

After 2008, felling area started to return to its previous levels of the early 2000s, plateaued at around 70 000–80 000 between 2014–2017, and increased notably again in 2018 (Figure 3.11). Maintenance fellings account for half of the total harvested area and final fellings slightly below half The majority of regeneration fellings are conducted as clear-cuts, whereas maintenance felling consists mainly of thinning.

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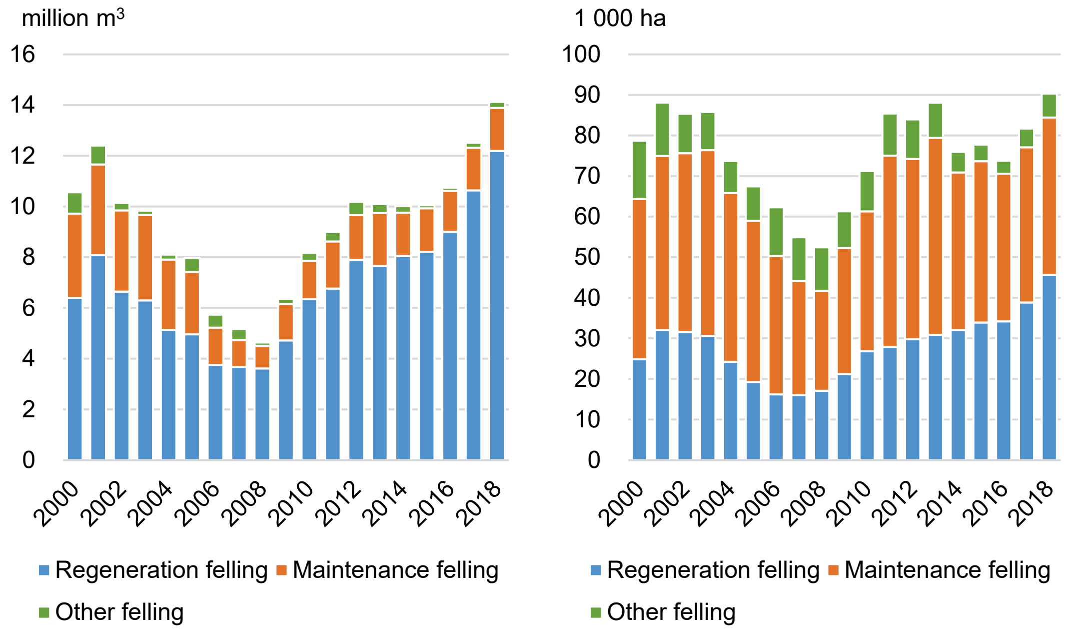
[5] Urbel-Piirsalu, E. and Bäcklund, A.-K., 2009. Exploring the Sustainability of Estonian Forestry: The Socioeconomic Drivers. Royal Swedish Academy of Sciences, 38(2):101–108.

Figure 3.11 Felling types



Source: Statistics Estonia, 2019

The reasons behind increased harvesting levels lie in situational aspects (e.g. Gudrun storm in 2005), market interventions (subsidized thinnings since 2006) and changes in the legislative environment e.g. in 2009 forest management plans were no longer compulsory and the state ceased requiring a reforestation deposit. However, the removal of the requirement for a forest management plan has only had very minor impacts. Forest inventory data is required for conducting final fellings and thinnings (must be included in the forest notification), and companies carrying out inventory work are obliged by law to devise a forest management plan for the forest owner unless the owner specifically declines this service. This does not apply to corporate owners with holdings up to 2ha and private owners with holdings up to 5ha. The requirement for a reforestation deposit was removed because it was never actually enforced and because it was perceived to be overly bureaucratic. Instead, subsidies for forest regeneration and support for forest owners' associations were taken into use. Also, in the 1990s and early 2000s, illegal logging was a major problem, but through increased control of logging, illegal logging has been nearly rooted out. In 2003 illegal logging accounted for approximately 0.8% of the total logging volume. The majority of illegal logging took place in private forests, in equal part by the forest owners themselves and by thieves.

One of the underlying reasons behind the increase in fellings and thinnings after the low point in 2008 was the granting of subsidies to energy producers to utilize woody biomass. The bottom was reached after the global recession, because there was no demand for pulpwood, and harvests nearly stopped completely for 6 months. These subsidies have been discontinued, but state and EU subsidies are still available for private forest owners for e.g. planting, soil preparation, pre-commercial thinnings and pruning, among others.

Changes in forest law have caused some opposition by especially green party supporters. Restrictions on fellings have been reduced in a few different ways. The minimum stand age for clear-cutting has recently been reduced. Typically, the age of the stand is not the indicator that determines the time of a clear-cut, rather the size of the trees. The minimum felling age of spruce was also reduced, which led to some public uproar and inflated claims, that spruce would soon disappear from Estonia due to overharvesting. Conservationists see that commercial demand for wood, i.e. clear-cutting, is already showing a change in the landscape, e.g. as more unstocked land. In addition, the maximum clear-cut area was increased to the current 7 ha (previously 5 ha), and the requirement for a forest management plan and forest inventory in privately held forest stands of under 5 ha in size has been removed. The average size of clear-cut areas is between 1 and 2 ha regardless of the much higher possible limit. The smaller actual area is however mainly due to the small average size of private holdings (approximately 6-7 ha).

Thinnings are common practice in state-managed forests and are conducted in a timely manner. Typically, three thinnings are conducted during a rotation, including pre-commercial thinning. The situation is quite different in private forests, especially those of smallholders. Smallholders often view thinnings as an undue cost, which should be avoided. One of the main causes is a very limited local market for pulpwood, and especially pre-commercial thinnings do not yield enough wood to cover the costs. Another factor affecting the thinning activity of individual private forest owners is the lack of attachment to their assets. During the Soviet era, forests were nationalized and many current forest owners who have had their family properties returned to them, do not regard it as their legacy. This is in contrast with e.g. Finnish non-industrial forest owners, who have perhaps had the same forest asset in their family for many generations and feel obliged to care for it responsibly. Industrial forest owners are more active in thinning their forests, and typically there are no delayed thinnings in these assets. According to interviews, despite thinning inactivity of smallholders there has been a positive shift in recent years (although this is not yet seen in the statistics). Traditionally domestic pulpwood prices and foreign demand are a strong driver of thinning activity in Estonia. In 2017–2018, most necessary thinnings were conducted in nearly all forests, because the price of pulpwood skyrocketed. Pulpwood demand in the Baltic region influences also thinning activity in the country.

Statistics of thinning activity do not include all thinnings after 2009, because forest owners were permitted to harvest 20 m^3/year per property for household use without submitting a forest notification. In a smaller stand, this volume of wood can already mean that a proper thinning has been conducted, but this will not show in the official statistics. This causes difficulties in assessing the actual level of delayed thinnings.

Even though maintenance fellings account for half of the harvested area in Estonia, over 80% of all harvesting volume is accumulated from clear-cuts. The share of clear-cuts has risen steadily during the last decade. In 2000 it was only 59%, whereas in 2016 it had increased to 84%. This is partly a result of forests reaching maturity, but also due to changes in the ownership structure of forests. The share of forests owned by corporate owners has increased, which has to lead to increasingly active and intensive forest management in private forests.

Cut-to-length (CTL) has been the dominant harvesting method for decades. In 2017, the share of manual chainsaw harvesting accounted for only 13% of the harvests, while the rest was fully mechanized CTL. In 2005, the share of manual chainsaw harvesting accounted for 38% and fully mechanized 62%. 95% of clear-cuts are done by mechanized cut-to-length harvesters, while the share is somewhat lower (80%) in thinning operations.

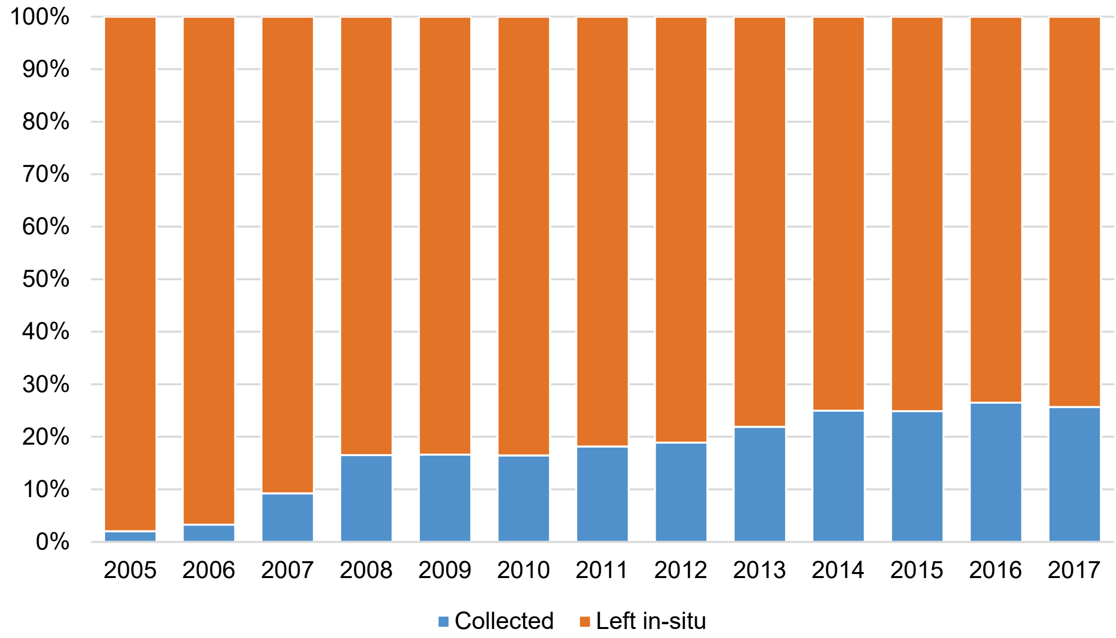
Low management activities in non-industrial private owners' forests have been due to lack of knowledge and low profitability of forest management. As private forest ownership is very scattered, the indirect and direct costs are higher compared to larger-scale management.

Although forest management activity of NIPF owners has been low, there has been a notable change as overall management activity in private forests has increased. Private forest owners have become more aware of the benefits of actively managing their forests. High prices of energy and fibrewood have motivated also smallholders to conduct thinnings in their forests. The government has also begun to subsidize thinnings in private forests. This allows for smallholders to potentially gain incomes from thinnings already, which has been a problem previously. Due to poor income potential, thinnings have usually been considered purely an expense by smallholders. The concentration of ownership to companies has also had a large impact. Companies have clearer financial objectives for their assets, which motivates more active forest management.

Collection of Felling Residues

Collection, chipping and utilization of harvesting residues (branches and treetops) is an increasing trend in Estonia (Figure 3.12). The majority of harvesting residues are left in-situ to improve the bearing capacity of logging tracks in the forest. Up to 70% of the forest soils are so wet that the residues have to be used in-site to improve the bearing capacity. The material used to build logging tracks cannot be used for burning due to compression and high mineral content. Foliage is not utilized and as such not included in the estimation of the utilisation of harvesting residues. Tree stumps, especially coniferous stumps after a clear-cut, could be collected and utilized for energy. However, the utilization of tree stumps is not a common practice, especially as there is the capacity to increase the utilisation rate of other, more easily available harvesting residues. Tree stumps are not included in the estimation in the chart below.

Figure 3.12 Utilisation of harvesting residues (branches and treetops)



Sources: Sources: Statistics Estonia, 2019; Padari, A. et al, 2009; Estonian University of Life Sciences, 2009; Erametsakeskus, 2016; Erametsakeskus 2018; expert interviews, Indufor analysis

As cut-to-length harvesting is by far the dominant harvesting method in Estonia, most of the harvesting residues are produced on-site, not dragged out of the forest during harvesting. One of the main measures for the reduction of the production cost of wood chips from harvesting residues is the further increase in the level of mechanization of forest harvesting. Harvesting becoming increasingly mechanized in Estonia is further enabling the collection of harvesting residues. Especially during the early and mid-2000’s a major factor interfering with the further growth of harvesting residue utilization has been small felling areas, which cause logistical problems.

Until the 2010s there was little-to-no demand for harvesting residues because there were still wood processing residues available for the production of wood chips. However, the use of harvesting residues has grown since due to the start-up of large CHP plants in Estonia. The energy market is the only real market for harvesting residues currently. The use of harvesting residues for energy became more common during 2005–2010 when the price of forest chips rose to a level that made a collection of residues worthwhile. Investments, such as Fortum Tarto (2009) and Fortum Pärnu (2010), have increased the demand for wood chips, which can be made from forest residues. According to interviews, the harvesting residues are collected from less than half of the clear-cuts, and only a relatively small portion of all residues are collected even from these sites. The current collection of residues is however close to the maximum that can be collected, as residues are in many cases needed to improve the bearing capacity of the land, to protect it from damages by harvesting equipment. The utilisation of harvesting residues is also restricted by the fact that their collection and utilisation is economically sound only if the point of consumption is approximately at a maximum distance of 70km.

Today residues are collected in Estonia when:

- The stand has a suitable site for storing the slash piles
- There are enough of residues after using the slash in improving the bearing capacity of the within-stand logging trails
- It is in the proximity of a demand point
- The nutrient balance is not significantly affected.

A lacking forest regime that has led to thickets and overly dense forests, has resulted in the growing potential for increasing the collection of forest-based bioenergy.

From a forest residue utilization perspective, the final felling area is a potential area for the collection of harvesting residues. Meanwhile, harvesting residues from maintenance felling are seldom utilized, as the residues are primarily left on site to fertilize forest growth. In addition, they are technically more difficult and expensive to collect from the site.

Forest Regeneration and Other Forest Management Practices

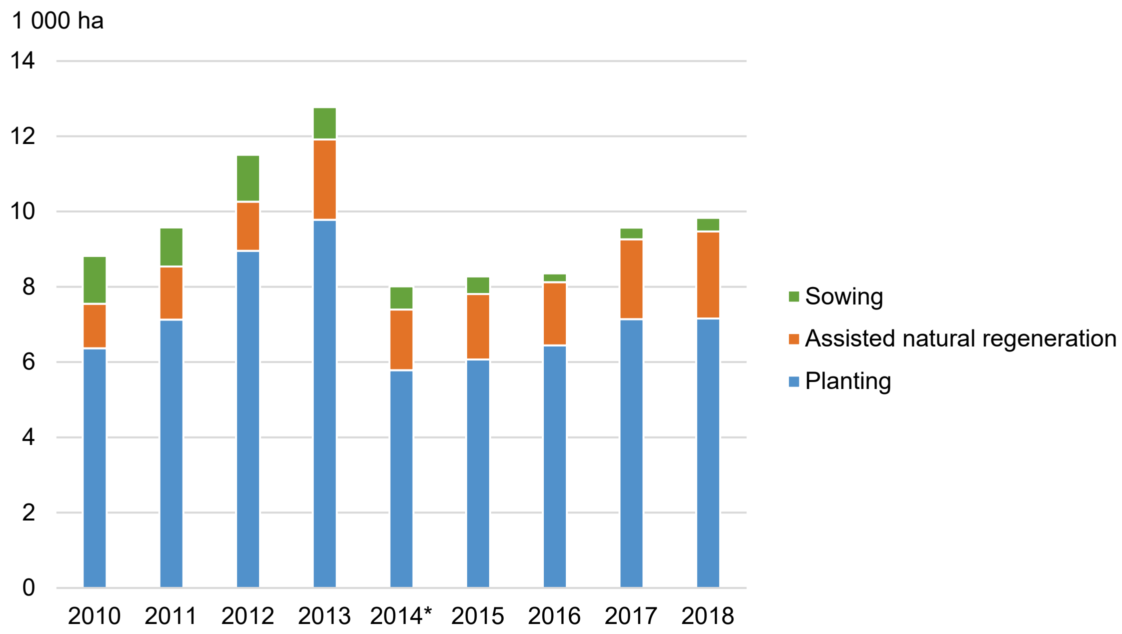
In public forests, planting is the dominant method for regeneration. 60% of stands are planted, 15–20% are sowed, 15–20% is naturally regenerated with supplementary planting, and the remainder is naturally regenerated. This is in stark contrast with private forests, where only 20% of stands are regenerated by planting or sowing. 3–4 years ago, planting was even scarcer in private forests. However, only approximately 10% of clear-cut areas would not naturally regenerate without human intervention, meaning that planting or sowing is typically not even necessary; stands will mostly regenerate in any case.

Forest regeneration by planting has become more popular over the past decade. During 2018, private forest owners planted between 8–10 million seedlings while 3–4 years ago this figure was between 3–4 million seedlings. Natural regeneration and assisted natural regeneration have been and still are the most common regeneration methods in private forests but are slowly giving way to planting and sowing. Subsidies have also played a part in the increasing popularity of planting, as budget allocations for subsidizing planting have been increasing over the past decade. In addition, the network of forest management associations in the country has been improving, and it is better equipped to obtain seedlings and offer planting services.

Public forests have long been managed in a similar fashion. Stands are regenerated after felling by either planting or sowing and some are naturally regenerated. Usually, the stand is regenerated with the same species that were harvested. One notable change in the management of public forests is the decreased planting density during regeneration. As seedling quality has improved over the years, mortality has reduced, and a sparser planting density has become sufficient. Previously the standard planting density of birch in public forests was 2 500 seedlings/ha, while nowadays it is 2 000 seedlings/ha.Reforestation in Estonia has been increasing during the past decade in line with increased fellings. Planting is the preferred method for reforesting in Estonia, accounting for over 70% of all active reforestation (Figure 3.13) Assisted natural regeneration is also rather common and is the preferred method usually for deciduous trees. However, in recent years planting birch has been gaining increasing popularity. Planting is most often conducted with spruce. The planting area of pine is approximately half or a third of that of spruce in a typical year. Pine is usually sowed on sandy soils, where weeds are not expected to overpower the seedlings.

Measures must be taken within 2 years after clear-cutting to establish a new stand. Regeneration must occur within 5 years of the clear-cut. This applies to regeneration by planting, sowing and natural regeneration alike. In 2017 the Environmental Board found that the majority of forest owners regenerate their forests in accordance with the mentioned requirements. If the Board finds regeneration measures lacking or neglected, they will first notify the forest owner of the noncompliance and inform them of the legal requirements. If notices are disregarded, sanctions may be applied.

Figure 3.13 Reforestation in Estonia by type



* Since 2014 it has not been compulsory for private and other forest owners to submit reforestation data.

Note: Data excludes naturally regenerated areas in which no human interventions have been made to assist the regeneration process after harvesting and reflects only the area on which reforestation activities have been carried out, not the actual result of activities. The majority of private forests are left to regenerate naturally without any human intervention after clear-cutting and as such are not included in the above statistic.

Source: Statistics Estonia, private communication from a representative of the Estonian Ministry of the Environment.

In addition to the previously mentioned, there are other smaller factors that have affected forest owners' behaviour, and thus the realized forest management practices. For example, currently, the sale of forest estates is tax-free, but wood sales are not. Also, forest management plans have been varyingly mandatory in previous decades.

3.2.3 Impacts of Changes

Production of Sawn Timber

Production of sawn timber and other wood products have been growing in the last decade in Estonia, as the country has been able to create a functioning cluster for the wood products industry. This has been supported by the government, for example by the Ministry of the Environment.

Increasing fellings have provided the raw material for the sawmill industry. Increasing forest ownership of companies, which manage forests professionally, has also increased the number of good quality logs in the domestic markets.

As forest management becomes more active it is likely to increase the availability of logs and pulpwood. The increasing trend in thinnings will increase the yield of both of these assortments. As the state forests are already mainly well managed, the small-holders play a crucial role at the moment and in the future. Especially the activation of smallholders will support wood availability for wood processing, which can strengthen the already strong wood product industry in Estonia. The increasing popularity of thinnings will likely increase rotation times, as well. On the other hand, the increasing importance of climate change mitigation goals may create pressure for avoiding fellings in the future.

Forest law regulates minimum forest age for clear-cuts. According to interviews, RMK often conducts the final felling at the minimum age. Due to the regulation, an increase of wood-based bioenergy demand has not shortened rotations at least in state-managed forests. In forests that are older than the minimum final felling age, sawlog price is a more important driver for final-felling decision than wood-based bioenergy demand. Decreasing the felling age of spruce was not driven by the demand for biomass. The Ministry of the Environment (MoE) justified the change with the need to “allow forests to capture the maximum amount of carbon while producing maximal income for their owners”. The MoE based this on an analysis by the Institute of Forestry and Rural Engineering of the Estonian University of Life Sciences, which found that the difference between the current maturity and so-called *economic maturity* was 25 years; during this 25-year-period the productivity of forest stands decreases and the quality of the wood deteriorates due to e.g. root rot.

Growth Rate and Carbon Sequestration Potential

As mentioned in 3.1.2, the growing stock of forests has increased steadily in the past decades. Clear-cuts increased notably in 2018, which along with improved inventory sampling lead to statistics indicating a decrease in the growing stock. However, a decrease is not perceived to have occurred in reality, rather the stock has remained steady or slightly increased. This, at any rate, slowed the growth of the total carbon stock, which has been increasing for the past decade.

The carbon sequestration of forests depends on the growth of forests and the intensity of harvests. As the growing stock of Estonian forests has been expanding, also carbon stocks have increased, since harvests have not exceeded the total annual increment. Thus, Estonian forests have been carbon sinks. Increasing awareness of forest management practices combined with climate change mitigation aspirations is likely to increase forest growth, and thus also the carbon sequestration potential of Estonian forests in the future. It is noteworthy, that the carbon sequestration capability of forests peaks approximately as the stand reaches the age of 25-30 when growth is at its highest. Section 3.1 presented age distributions of different tree species in 2010 and 2018. There have not been any major changes in the age distributions, thus no indication of a decline nor increase in the forests’ ability to sequester carbon is detected.

Harvesting of energy wood in thinnings decreases the carbon stock temporarily but may increase carbon sequestration through improved volume growth of the remaining trees. The collection of harvesting residues decreases the carbon stock but is also likely to decrease the carbon sequestration potential of the felling area as the removal of felling residues will affect the future carbon input of the soil[6,7,8,9,10]. However, the effects of a collection of residues vary between different energy wood fractions[11]. The substitution effects of forest residues should also be accounted for. Substituting fossil fuels with biofuels (e.g. forest residues) has the potential to reduce total carbon emission, thus justifying decreasing soil organic carbon (SOC) levels resulting from collecting harvesting residues. This is however strongly affected by the chosen management regime (e.g. continuous cover forestry or clear-cutting and regeneration)[12].

Within the increasing thinning popularity in Estonia lies a potential for increasing carbon sequestration, if the volume of forests is increased.

Revenue Generation of Forest Owners

The profitability of forestry is namely based on the timber production capacity of forests and the demand for wood raw material. Forest management aims to promote the growth of valuable stands and improve the quality of roundwood. In addition to wood production, today's forest management focuses on the preservation of natural values, landscape management and recreational needs.

Although forest management practices per se have not directly affected the revenue generation of forest owners, positive development has occurred due to other drivers.

Some private forest owners have presented that they ought to be compensated for their foregone income due to restricted forest management by strict forest legislation. However, this is unlikely to take place.

If forest holdings become more fragmented and smaller, the economic importance of these forests might decrease. Thinnings have been financially supported since 2006. In 2010–2012 the net revenue of private forests was 90–112 €/ha. As private forest management has been very short-sighted (neglecting reforestation and tending), the long-term profitability of private forestry has been jeopardized. The potential average long-term net revenue has been estimated to be around 130€/ha which could decrease by up to 24% if management restrictions were applied as well (e.g. if restrictions due to forest conservation are applied).

Generally, the revenue generation of forests has become better as the demand for different assortments (sawlogs, pulpwood, energy wood) has grown. Without significant markets for energy wood and pulpwood, thinnings have not been economically lucrative for forest owners. For example, previously there was no demand for energy- and pulpwood from alder forests.

The state has provided assistance to create larger forest management units in order to alleviate the low-profitability of forestry among smallholders. Forest owner associations (FOA) have been formed from the beginning of the 1990s. FOA memberships have been growing during the 2010s. There are currently around 30–40 FOAs in Estonia. The state subsidizes FOAs based

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[12] Pukkala, T., 2014. Does biofuel harvesting and continuous cover management increase carbon sequestration?. Forest Policy and Economics, 43:41–50.

on their activity, partly monitored through joint timber sales. Since 2014 only larger FOAs are eligible for these subsidies. As mentioned before, subsidies for pre-commercial thinnings have improved the profitability of forestry and have motivated more active forest management. As thinnings become more common, it positively affects the diameter growth of trees, which in turn has the potential of increasing the value of harvested logs leading to increased revenues of forest owners.

4. SOLID WOOD PRODUCT MARKETS

4.1 Domestic Production

Box 4.1 Chapter Highlights

Production

- Sawmilling capacity and production have increased strongly since 2010.
- Roundwood consumption has likewise increased, mainly due to increased demand from sawmills.
- Estonia has only two pulp and paper mills; one of these uses only aspen pulpwood. Large volumes of birch and softwood pulpwood are exported for Finnish and Swedish P&P industry.
- Estonia is a notable producer of wood pellets, of which over 90% is exported. The production of pellets has increased continuously for the last 10 years, providing markets for both small-diameter roundwood not utilized by the P&P industry and for sawmill by-products.

Estonian Forest Industry

Estonian forest industry consists of 13 industrial sawmills, fibreboard and plywood production, two pulp and paper mills and a significant pellet industry. Estonian sawmills, which have made modernization and capacity investments in recent years, provide stable markets for sawlogs harvested from the Estonian forests.

The two P&P mills are located in northern Estonia. AS Estonian Cell (label no. 21, see Figure 4.1, Table 4.1) produces BCTMP using only aspen, while Horizon (label no. 7) is an integrated P&P mill, producing softwood pulp and paper. Horizon uses wood chips and small-diameter roundwood. Est-For, a greenfield pulp mill project, was under planning until November 2018, when the project was terminated. A new pulp mill would have increased the domestic use of Estonia's small-diameter roundwood and likely decreased the exported volumes, but due to strong environmental concerns and local opposition, the investment plan was canceled. The opposition was based on fears of the mill's wood consumption resulting in over-exploitation of the country's forest resources and its effluent discharge degrading the adjacent Emajõgi river, The large size of the mill was a large driver for the opposition, as the mill's annual wood demand would have been approximately 3.3 million m^3. However, the fears of overexploiting forests were perhaps irrational. Estonia is a large exporter of wood raw materials, and by reducing exports of raw materials and redirecting these streams to the domestic pulp mill, total domestic raw material sourcing could have been maintained at a sustainable level.

The wood-based panel industry has grown during the last 10 years. Finnish Metsä Wood and Latvian company Latvijas Finieris have invested in new birch plywood production sites during the last two years. In addition to plywood and veneer production, there are three fiber/chipboard mills in Estonia, mainly consuming domestic-produced conifer wood chips.

There are 11 industrial pellet mills in Estonia, making it the 7th largest pellet producer in Europe. The pellet industry has good operating conditions in Estonia due to the sawmill industry and relatively low domestic wood demand from the P&P industry.

In addition to sawmills, P&P mills, WBP mills and pellet mills, there are engineered wood product (EWP) mills and prefabricated wooden house production in Estonia, which further process and add value to the sawmill products.

Figure 4.1 SWP mills in Estonia

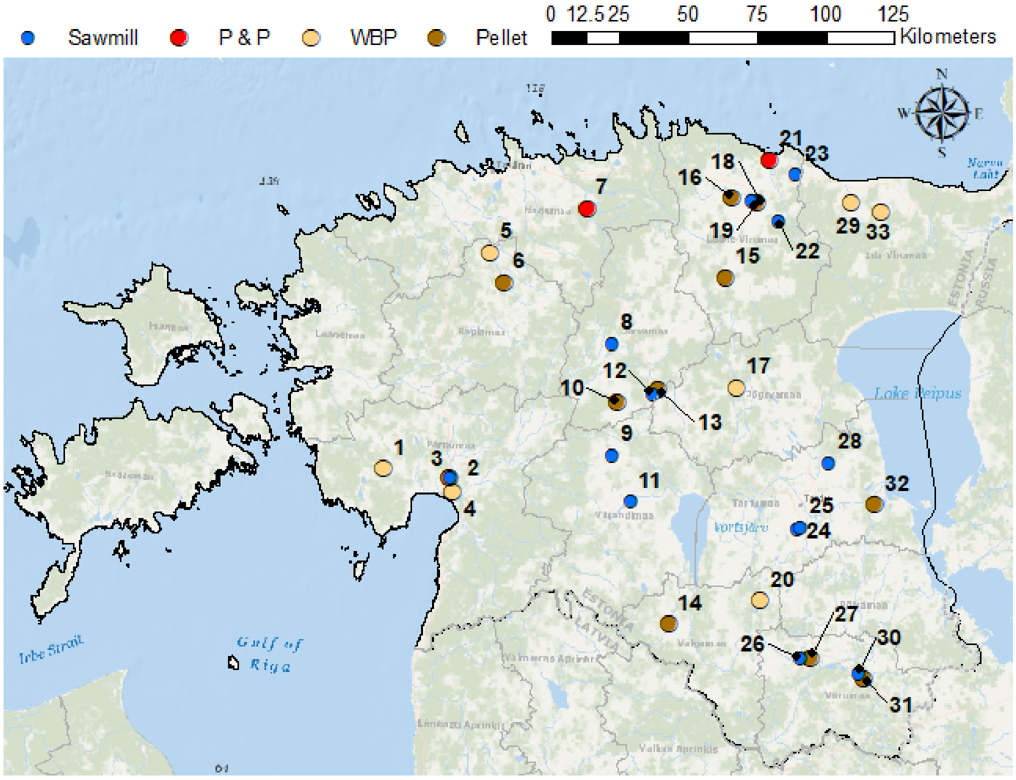


Table 4.1 Legend for SWP mill map

Label	Type	Company	Label	Type	Company
21	P & P	AS Estonian Cell	11	Sawmill	Lemeks Group
7	P & P	Horizon	22	Sawmill	Lemeks Group
10	Pellet	AS Graanul Invest	23	Sawmill	Lemeks Group
14	Pellet	AS Graanul Invest	3	Sawmill	Norvik/Bergs Timber
15	Pellet	AS Graanul Invest	24	Sawmill	Raitwood
27	Pellet	AS Graanul Invest	12	Sawmill	Stora Enso
32	Pellet	Palmako	18	Sawmill	Stora Enso
13	Pellet	Stora Enso Imavere	26	Sawmill	Toftan
16	Pellet	Stora Enso Näpi	28	Sawmill	Vara Saeveski OÜ
2	Pellet	Warmeston	5	WBP	Latvijas Finieris
6	Pellet	Warmeston	17	WBP	Lemeks/Tarmeko
19	Pellet	Warmeston	4	WBP	Metsä Wood
31	Pellet	Warmeston	33	WBP	Repo Vabrikud AS
30	Sawmill	Barrus	1	WBP	Skano Fiberboard
8	Sawmill	Combimill Group	29	WBP	Skano Fiberboard
9	Sawmill	Combimill Group	20	WBP	UPM
25	Sawmill	HaServ			

Production and Wood Consumption

Domestic production of sawnwood has increased from 2010–2018 by almost 400 000 m^3.

Domestic roundwood demand for SWP production has increased mainly due to increased sawmilling (Figure 4.2). Sawmills have been investing in capacity strongly over the period 2010–2018. In addition to expansions, completely new capacity has also been introduced to the market. A clear jump in softwood sawnwood is visible in 2017, which is attributable to Toftan's sawmill expansion (owned by Swedish AB Karl Hedin) coming online in 2017. Some sources speculate that there is currently overcapacity in sawmilling and expect some capacity declines to occur in the near future.

Figure 4.2 Production and roundwood consumption of SWPs

Source: Statistics Estonia, Indufor

Plywood manufacturing has tripled in size between 2010–2018, driving demand for especially birch logs. Jumps in production were experienced between 2016–2017 and 2017–2018, which has also been reflected in birch veneer log prices increasing during this time (Figure 4.3). The UPM Otepää plywood mill expansion was completed in 2016, explaining the increases in production.

Pulp production and domestic pulpwood demand have remained relatively stable over the past decade. This is due to only two pulp & paper mills being located in Estonia. A third large pulp & paper mill was planned (Est-For), but the plans were abandoned due to strong opposition by local residents.

4.2 Raw Material Prices

Box 4.2 Chapter Highlights

Prices

- There are no notable differences in private and public forest wood prices.
- Sawlog prices have been rising since 2010, with a sharp increase from 2017–2018. The strong increase in sawmilling capacity and production had been driving this development.
- Pulpwood prices have been more volatile than sawlog prices. They have mainly decreased between 2011–2017 and similar to sawlog prices, surged during 2017–2018 to a record-high.
- The domestic market mainly consumes aspen pulpwood; the Finnish and Swedish pulp market drives the development of other species' prices.
- Wood-based bioenergy (incl. pellets) is not a significant driver for Estonian wood prices, due to previously underutilized assortments, such as harvesting residues and small-diameter roundwood being used now. Harvest residue utilisation is on a low level in absolute terms, but has grown drastically, relatively speaking, and is close to the potential maximum.

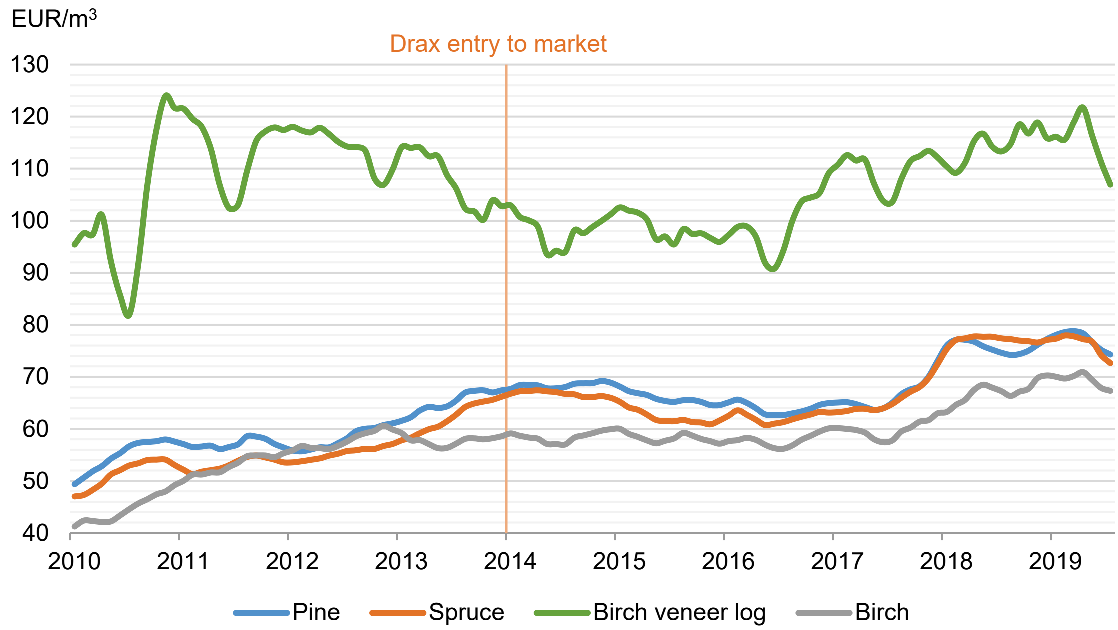
Sawlog prices in Estonia have increased significantly since 2010 (Figure 4.3-Figure 4.4). In-state forests, the roadside prices of pine, spruce and birch sawlogs have increased between 50–63%. Prices increased quite steadily between 2010–2014, after which they plateaued or decreased gradually until mid-2017. In mid-2017, wood prices jumped. Within a year (06/2017–06/2018), the prices of birch, spruce and pine logs all increased by 10–14 EUR/m^3 (17–21%). A similar development has taken place in the prices of sawlogs from private forests, where mill gate prices jumped by 12–21% during the same period. Recently sawlog prices have been decreasing.

The 2017 surge in prices is attributable to a poor winter, during which the land did not properly freeze, which in turn restricted the number of harvests that could be done without damaging soils. The price of birch veneer logs has been much more volatile than the prices of other logs. Prices were in decline between 2011 to mid-2016 but have since increased to 2011 levels once more. Recently in 2019 prices have experienced a sharp decline. This is however not alarming compared to historical development, and birch veneer log prices have typically decreased during H1 and recovered again in H2 of any given year.

Along with poor harvesting conditions, sawnwood exports increased strongly between 2016–2018. With increasing demand, sawnwood prices have also steadily increased. This has also motivated active harvesting in Estonia's forests.

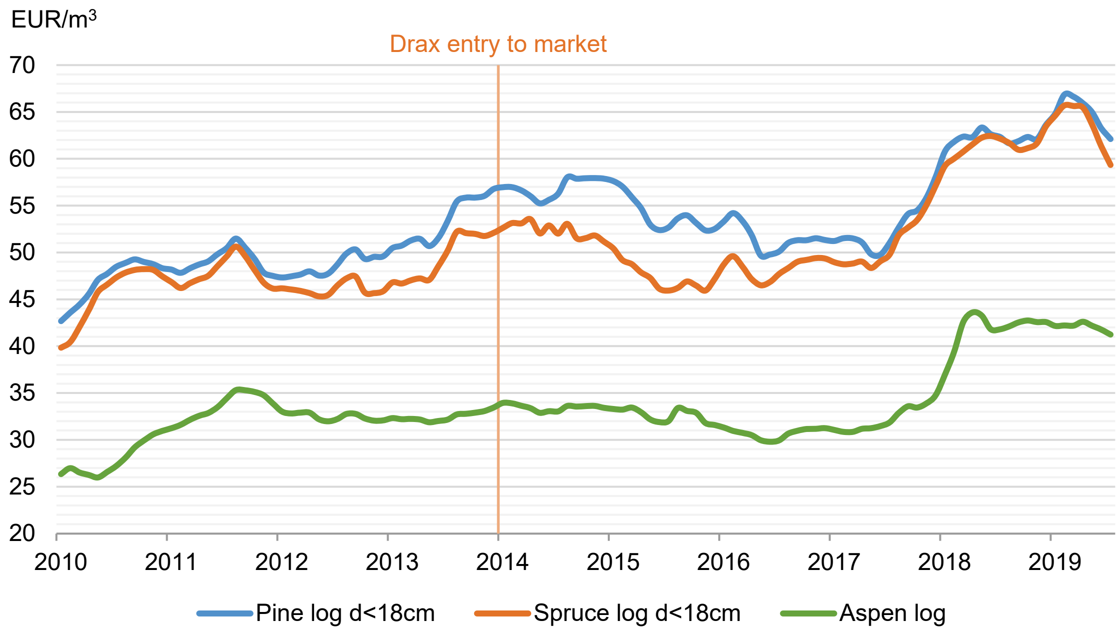
The pricing of small-diameter logs has followed a similar trend to that of larger logs, with slightly more volatility and at a lower level. Swedish company Toftan inaugurated a new large sawmilling line in 2017, which increased the demand for small-diameter logs (12–18 cm diameter) remarkably.

Figure 4.3 Roadside prices of saw- and veneer logs in Estonian state forests



Source: Estonian State Forest Management Centre

Figure 4.4 Roadside prices of small-diameter and low-value logs in Estonian state forests

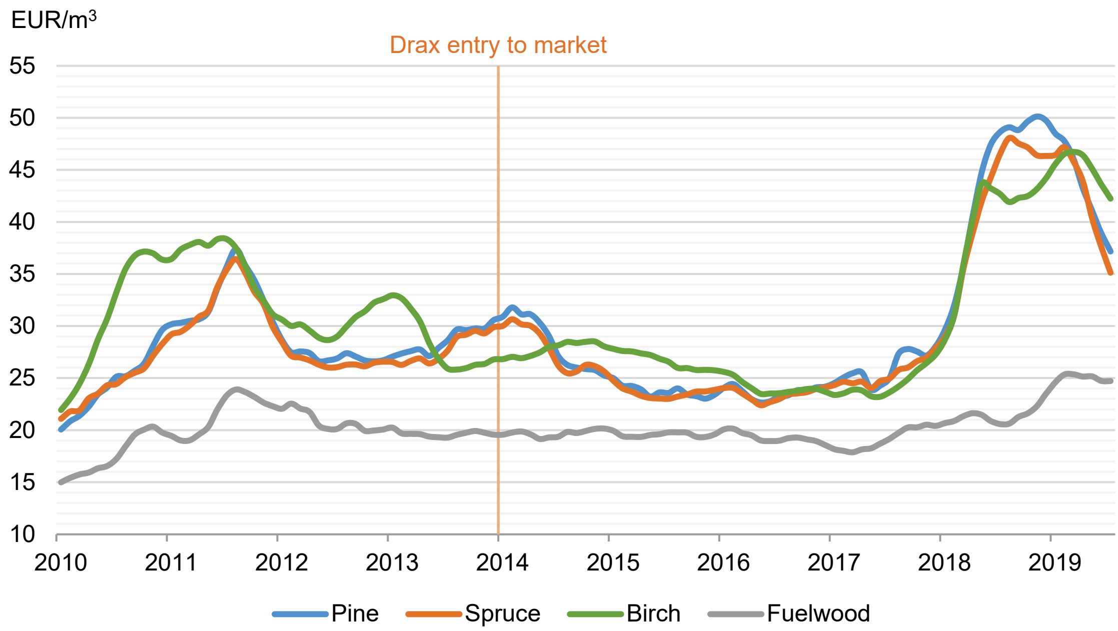


Source: Estonian State Forest Management Centre

As with sawlogs, a large increase in pulpwood prices is seen in 2018–2019, also due to the poor winter harvesting conditions (Figure 4.5). Due to poor soil bearing capacity caused by the wetness of the soils in many areas, winters are the main time for fellings. As the land freezes, bearing capacity is improved and the soil is protected against the weight of the harvesting equipment. In addition to difficult harvesting conditions, pulpwood demand in Finland and Sweden was a major driver for pulpwood price peak. The global market price of long-fiber (softwood) pulp was high in 2018, mainly driven by Chinese demand.

Pulpwood prices have dropped notably from the peak experienced at the end of 2018. This trend is expected to continue until pre-2018 prices are met.

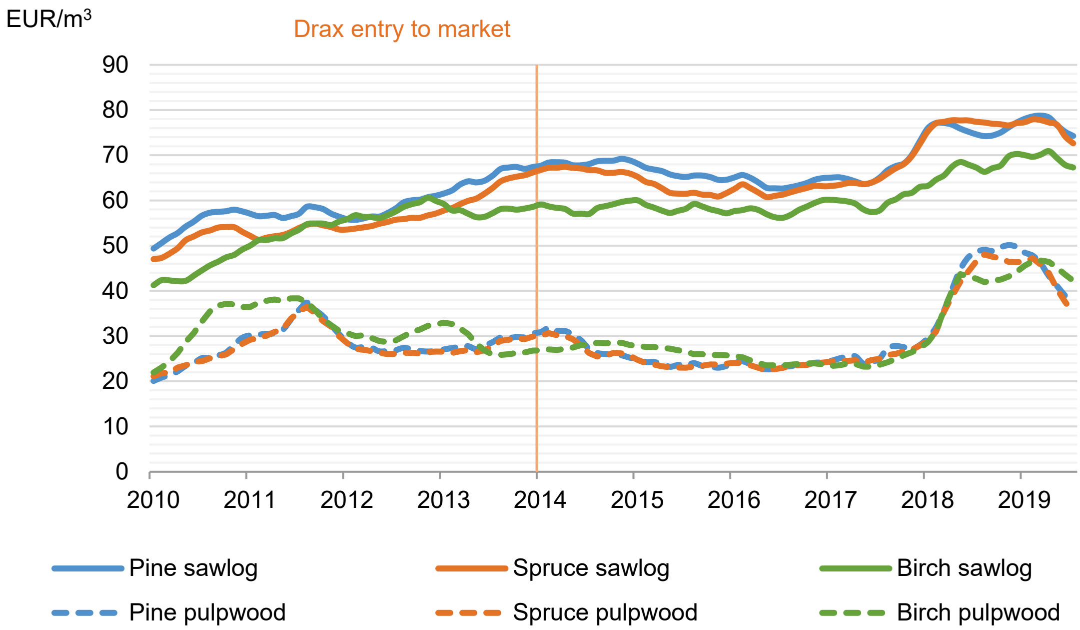
Figure 4.5 Roadside prices of pulpwood and fuelwood in Estonian state forests



Source: Estonian State Forest Management Centre

Pulpwood prices have typically been notably below sawlog prices, which is desirable in the sense of increasing carbon sequestration by forests (Figure 4.6). On average, pulpwood prices have been 48% of sawlog prices, which should provide sufficient incentive for forest owners to manage forests to produce sawlogs, instead of reducing rotation lengths and focusing on pulpwood production. Theoretically increasing pulpwood prices decrease rotation lengths and increasing sawlog prices increase rotation lengths. However, regardless of the price development of different assortments, in Estonia, clear-cutting and other final fellings are subject to strict diameter and age requirements as shown previously. These requirements ensure that rotation lengths cannot significantly decrease even if pulpwood and/or energywood prices surge.

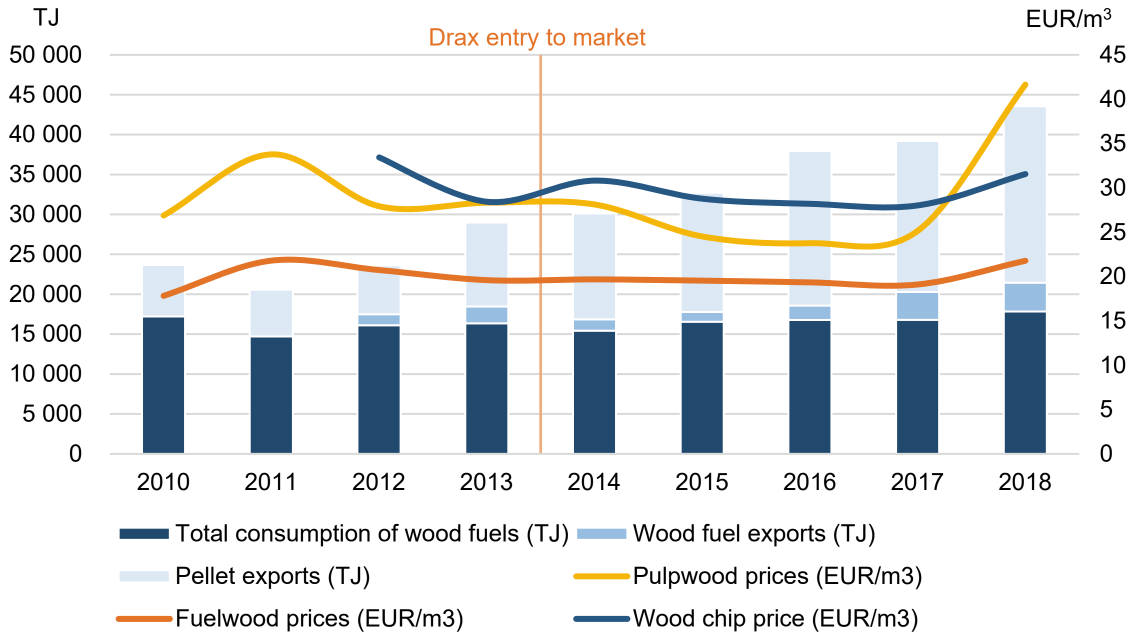
Figure 4.6 **Comparison of sawlog and pulpwood prices**



Source: Estonian State Forest Management Centre

Price development of pulpwood, fuelwood and wood chips together with domestic wood-based bioenergy and pellet exports is presented in Figure 4.7. Wood pellet exports have increased significantly during 2010–2018, but the price of fuelwood has not followed the trend. The price of pulpwood increased remarkably, but wood-based bioenergy was not the main driver for the development. The volume of pellet exports has surpassed the domestic consumption of wood for energy production when measured in terajoules (TJ).

Figure 4.7 Wood-based bioenergy production, pellet exports and raw material price development



Source: Statistics Estonia, Estonian State Forest Management Centre

4.3 Cross-border Trade

Box 4.3 Chapter Highlights

General

- Estonia is a net exporter of both roundwood and wood chips.
- Finland and Sweden are the main export partners, Latvia is the main import partner.

Roundwood

- Roundwood exports comprise mainly of pulpwood, with birch pulpwood representing 40% of all roundwood exports.
- Exports have increased significantly during 2018 compared to 2017, reaching the highest level of the 2010s.
- Export prices were low in 2015–2017 but increased drastically in 2018. A similar trend is seen in import prices

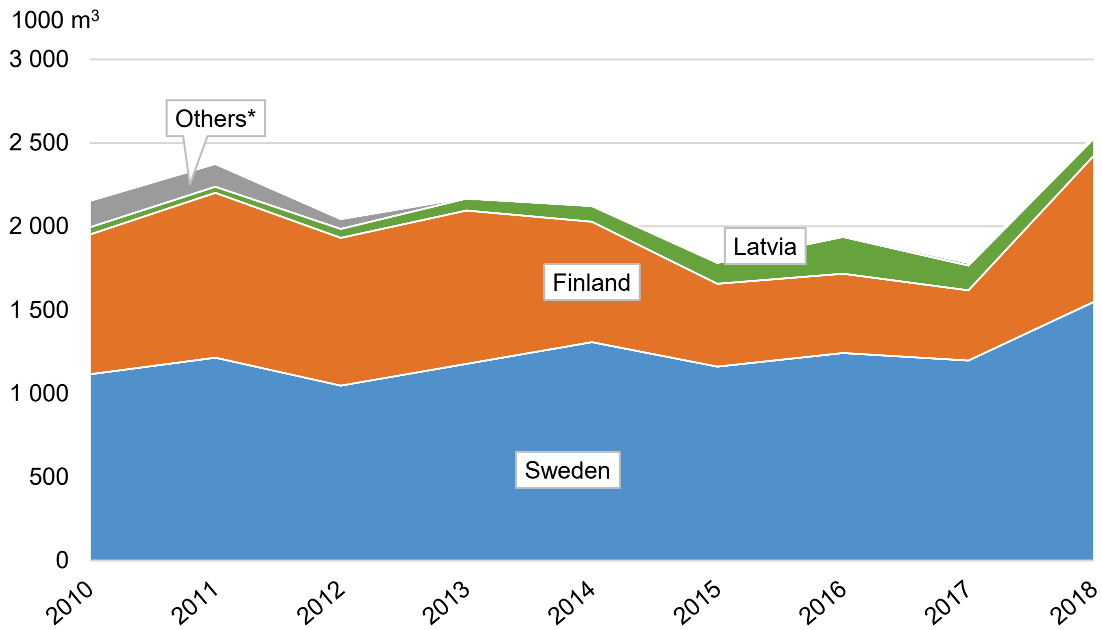
Wood Chips

- Export volumes have been increasing since 2015, when volumes temporarily dropped, reaching a 10-year high in 2017.
- In recent years, Russia has surpassed Latvia as the largest wood chip importer to Estonia; compared to exports, quantities are still very small, however.

Estonia is a significant wood supplier in the Baltic Sea region. Finland and Sweden are the largest importers of Estonian roundwood (Figure 4.8), while Latvia is the only significant exporter of roundwood to Estonia (Figure 4.9). Norway and Denmark only import small quantities of Estonian roundwood, and export even smaller quantities of roundwood to Estonia. Russia mainly exports roundwood to Estonia, with only very rare and small shipments made in the reverse direction.

In 2018, Estonian roundwood exports to the Baltic Sea region surpassed 2.5 million m^3, the highest volume reached during 2010–2018. This increase followed a gradual decline in export volumes between 2011–2017. In 2018, exports consisted mainly of coniferous wood, while in 2017 exports consisted of mainly non-coniferous wood. Prior to this, the division between coniferous and non-coniferous has been quite even, the share of each fluctuating at around 50%.

Figure 4.8 Roundwood exports from Estonia to the Baltic sea region

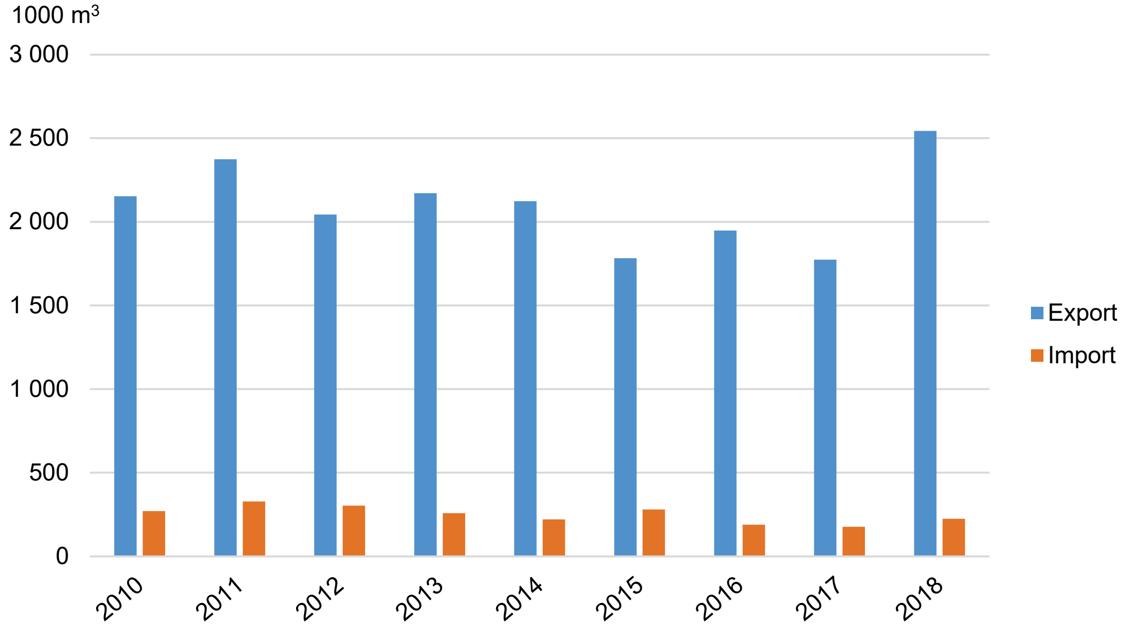


* Denmark, Norway, Russia

Source: Comtrade

The majority of exported roundwood is pulpwood, accounting for up to 80 % of roundwood exports. The single largest exported pulpwood species is birch, accounting for over 40% of all roundwood exports, followed by spruce (25%) pine (7%) and aspen (7%). Sawlog exports are dominated by spruce and birch in approximately equal shares, with pine sawlogs accounting for only a marginal share of all roundwood exports.

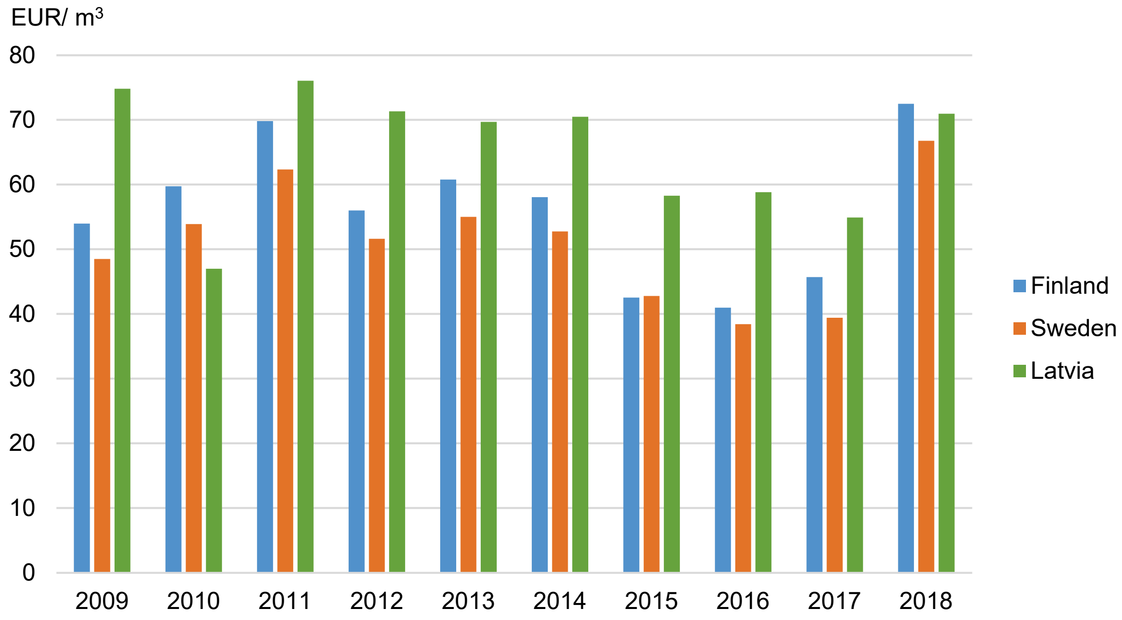
Figure 4.9 Estonian roundwood exports and imports to and from the Baltic sea region



Source: Comtrade

Prices of Estonian roundwood have fluctuated quite strongly (Figure 4.10). Prices paid in Finland for Estonian roundwood decreased between 2011–2016 but rose slightly in 2017 and jumped by approximately 28 EUR/m3 between 2017–2018. A similar trend is visible for prices paid in Sweden, but these prices are 5–6 EUR/m3 lower than those paid in Finland. Prices in Latvia for Estonian roundwood are the highest of large importers, regardless of the vicinity. A similar trend in prices is however visible as for Finland and Sweden, only just 10–20 EUR/m3 higher. Export prices follow the trend of domestic roundwood prices. These also rose sharply between 2017–2018, due to poor weather conditions complicating and restricting harvests. The price was also increased by strong demand for pulp and the high market price for pulp, which drove the Finnish and Swedish pulp industries to source wood from Estonia at increasing prices.

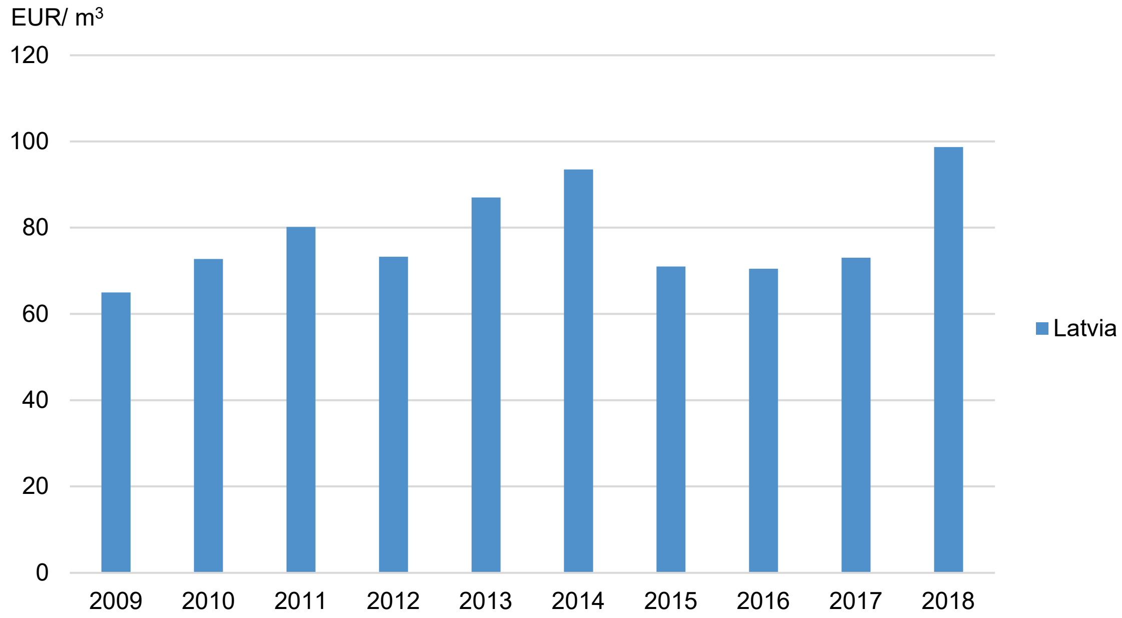
Figure 4.10 Price of roundwood exported from Estonia (FOB)



Source: Comtrade

As with export prices of Estonian roundwood, also import prices have experienced strong shifts; especially prices of roundwood from Russia and Finland (Figure 4.11). However, import prices of Russian and Finnish roundwood are negatively correlated with the trade volume and do not give a true understanding of the price level. These are both small suppliers in comparison to Latvia. Latvian prices have been notable steadier, due to the fact that Latvia is the largest source of imported wood in Estonia. Prices of Latvian roundwood have remained relatively steady at approximately 72 EUR/m3, with some exceptions. For example, in 2018, prices rose to nearly 100 EUR/m3, setting a record for the period 2010–2018. The previous peak was reached in 2014 when prices surpassed 93 EUR/m^3.

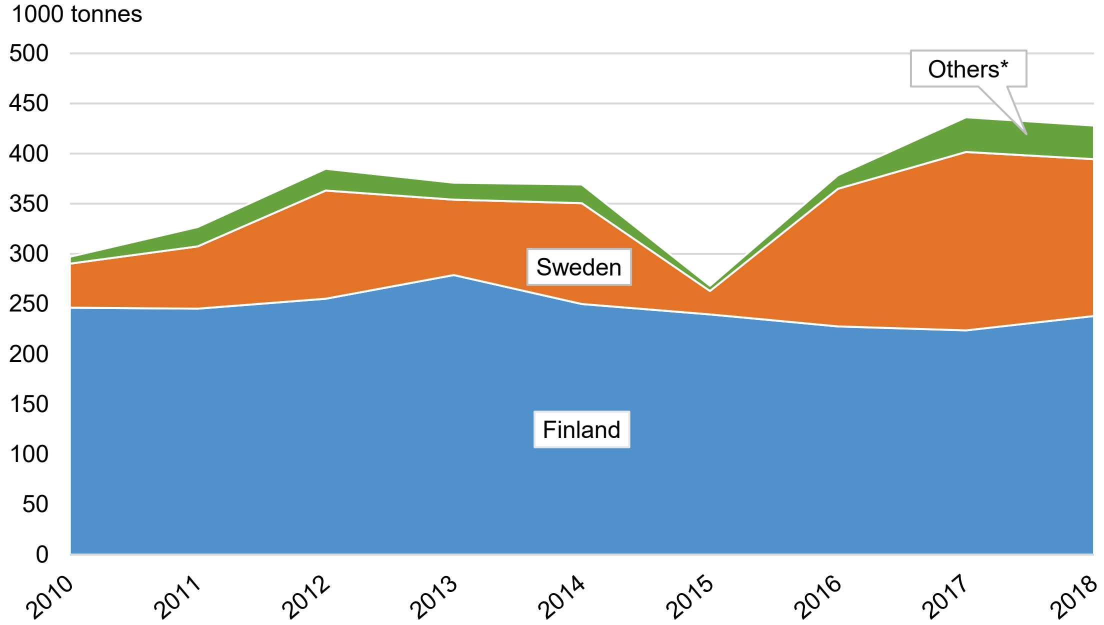
Figure 4.11 Price of roundwood imported to Estonia



Source: Comtrade

In the Baltic Sea region, the main export destinations of Estonian wood chips are Finland and Sweden consecutively and together accounted for nearly 400 000 tonnes of Estonian wood chip exports (Figure 4.12). Other countries in the region have received only occasional and small shipments from Estonia. Exports to Sweden plummeted in 2015. The Cascades Djupafors pulp mill in Sweden ceased production in June 2014. In addition, domestic wood chip prices were low in 2014, likely resulting in increased stocks which in turn decreased the need for imported raw material in 2015. Historically the largest wood chip import partner for Estonia is Latvia, which in the peak year 2011 supplied over 85 000 tonnes of wood chips to Estonia (Figure 4.13). However, in most recent years, Latvia's importance for Estonia has dwindled and Russia has been growing its export volumes to Estonia, becoming the largest supplier of wood chips in 2018. However, Estonian wood chip imports are very small in comparison to exports, the former not even reaching 50 000 tonnes in 2018, while the latter surpassing 400 000 tonnes in both 2017 and 2018.

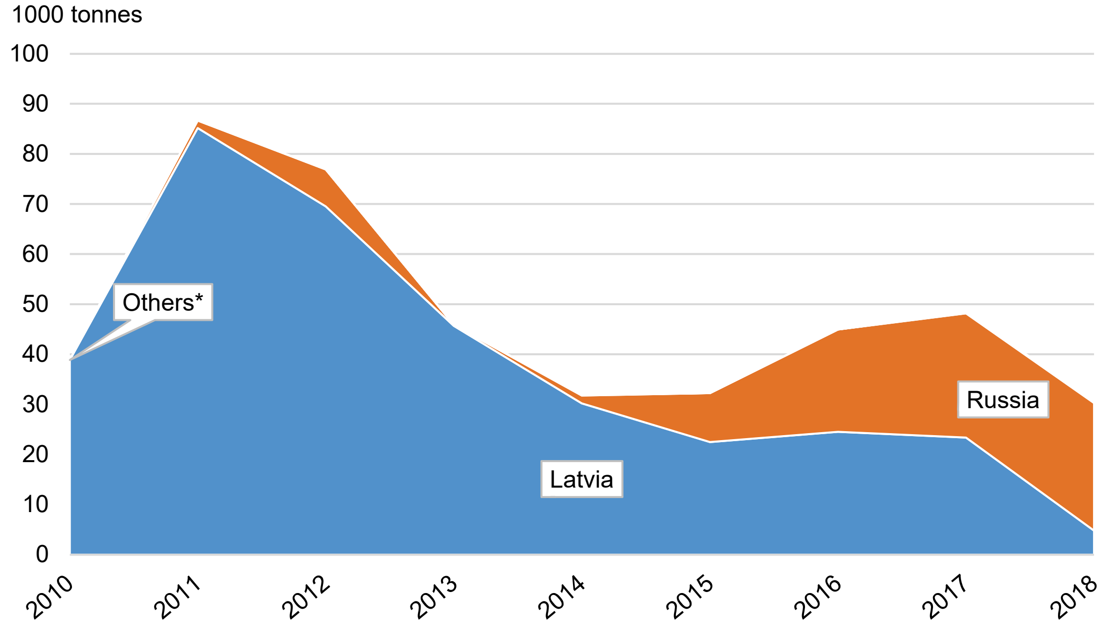
Figure 4.12 Wood chip exports from Estonia to the Baltic sea region



* Denmark, Norway, Latvia, Russia

Source: Comtrade

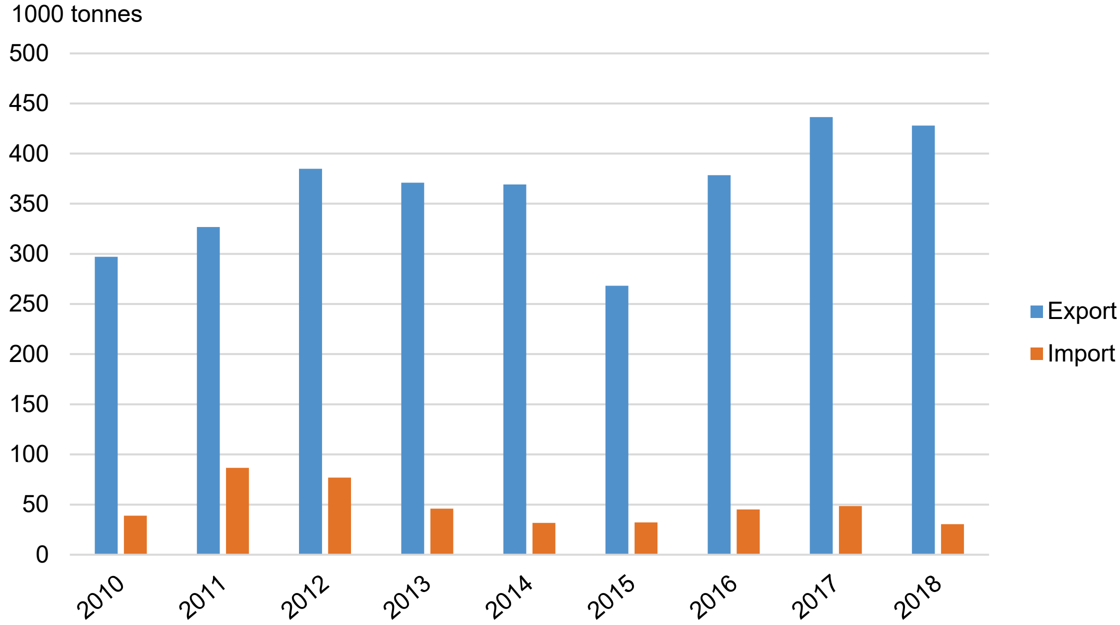
Figure 4.13 Wood chip imports to Estonia from the Baltic sea region



* Finland, Sweden, Norway, Denmark

Source: Comtrade

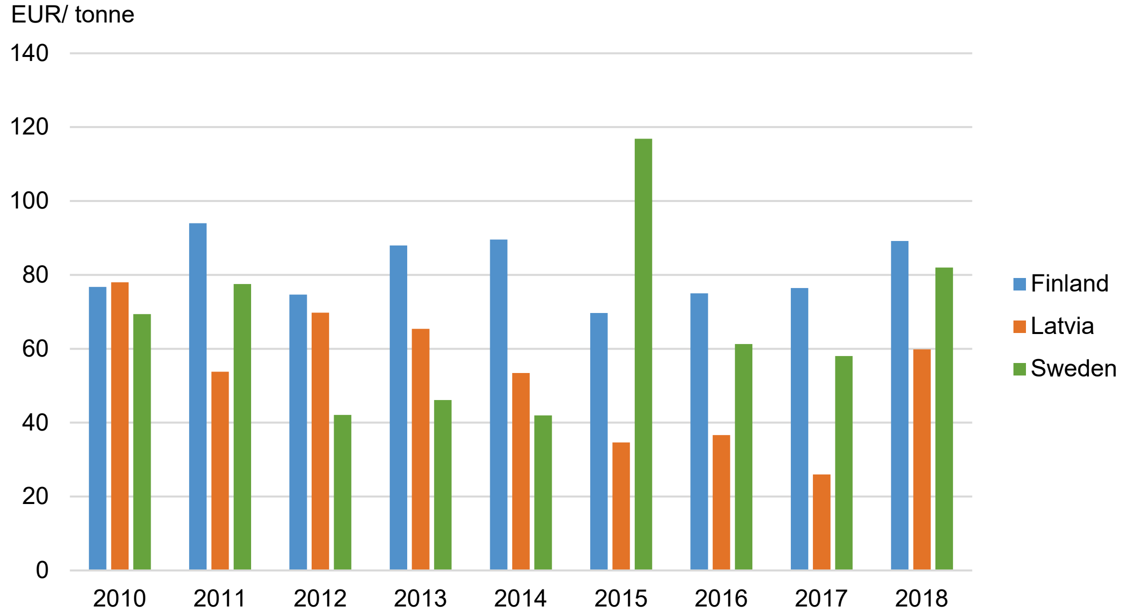
Figure 4.14 Total wood chip exports and imports to and from the Baltic Sea region



Source: Comtrade

Export prices of wood chips generally decreased between 2010–2015 with some fluctuations but have begun to increase since then (Figure 4.15). Typically, the highest price for Estonian wood chips is paid in Finland. Between 2010–2014 wood chips exported to Latvia yielded the second-highest prices, but since then, the second-highest prices have been gained from exports to Sweden, which has also significantly increased wood chip imports from Estonia since 2015.

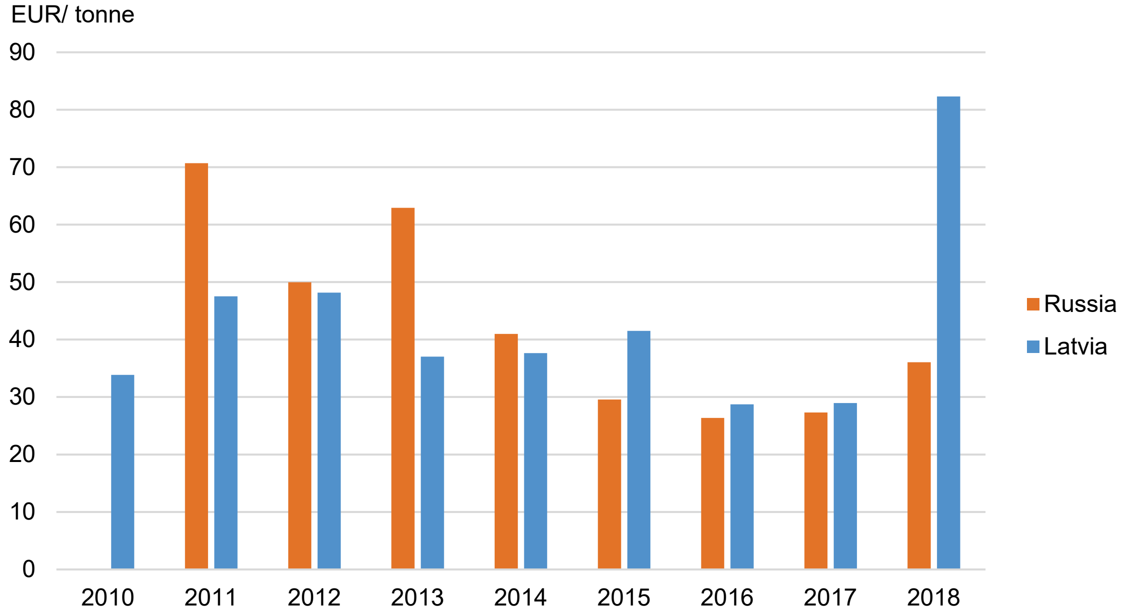
Figure 4.15 Export price of wood chips from Estonia to selected North-European countries



Source: Comtrade

Prices of imported wood chips declined between 2010–2016 but began recovering in 2017. This follows the same trend as import volumes. Import prices are notably lower than export prices, which is mainly explained by the differences in the quality of imported and exported wood chips. Wood chips exported to Finland and Sweden are widely used in the pulp industry, while imported chips are mainly used for energy.

Figure 4.16 **Import price of wood chips from selected North-European countries to Estonia**



Source: Comtrade

5. IMPACTS OF WOOD-BASED BIOENERGY DEMAND

Table 5.1 Impacts of Wood-based Bioenergy Demand to Forest Resources

Forest Area / Forest Cover	
Impact: No negative impact	• Regardless of increasing domestic biomass utilization for energy and exports, forest area has increased due to afforestation programs. • Forest cover is not as high as forest area, due to temporarily unstocked areas after the clear-cut. Despite this, forest cover has continuously increased from 2010–2018.
Forest Growing Stock	
Impact: No negative impact	• The total forest growing stock has been increasing for the last two decades. In 2018 the growth has slowed or halted; official statistics show a decrease, but this is due to sampling error. In 2018 there was record-high wood demand from Finland, which was driven by high global pulp prices motivating maximal pulp production. This increased harvests to a previously unseen level.
Harvesting Levels	
Impact: Slight increasing impact	• During 2004–2011, harvesting levels in Estonia were less than half of the estimated maximum sustainable level. This resulted in an increase in the maximum sustainable harvesting level for the 2011–2020 period. In 2018, the harvesting volumes were at the maximum sustainable level. The main drivers increasing the harvesting volumes have been increased sawmill capacity and production, high demand for pulpwood in Finland and Sweden and improved demand for energy wood. This was a temporary peak and demand has already slowed. Softwood lumber prices have decreased significantly in Europe due to an abundance of wood supply from Central Europe, which has been created by widespread bark beetle and other forest damages. Global pulp prices have also decreased to below 2017 prices.
Forest Growth / Carbon Sequestration Potential	
Impact: Ambivalent impact	• The annual increment has grown throughout the 2000–2018 period. • Increased fuelwood price has enabled forest management in some of the alder forests that were completely unutilized in the past. Thinnings, both commercial and pre-commercial, accelerate long-term volume growth in forests, leading to increased carbon sequestration. • Removal of harvesting residues decreases carbon sequestration since the residues are an input to the soil carbon pool. However, the majority of the harvesting residues' carbon is released to the atmosphere when the biomass decays, so the ultimate impact of harvesting residue collection is minimal if the collection is done on a sustainable level. The sustainability of the collection is determined by how the soil nutrient balance is impacted by collection. This is not accounting for the substitution effect that the harvesting residues may have, by e.g. reducing the need to burn fossil fuels. • Utilization of sawmill by-products does not directly impact forests' carbon sequestration potential, but it can increase harvesting through improved sawmill overall profitability.

Table 5.2 Impacts of wood-based bioenergy demand to forest management practices

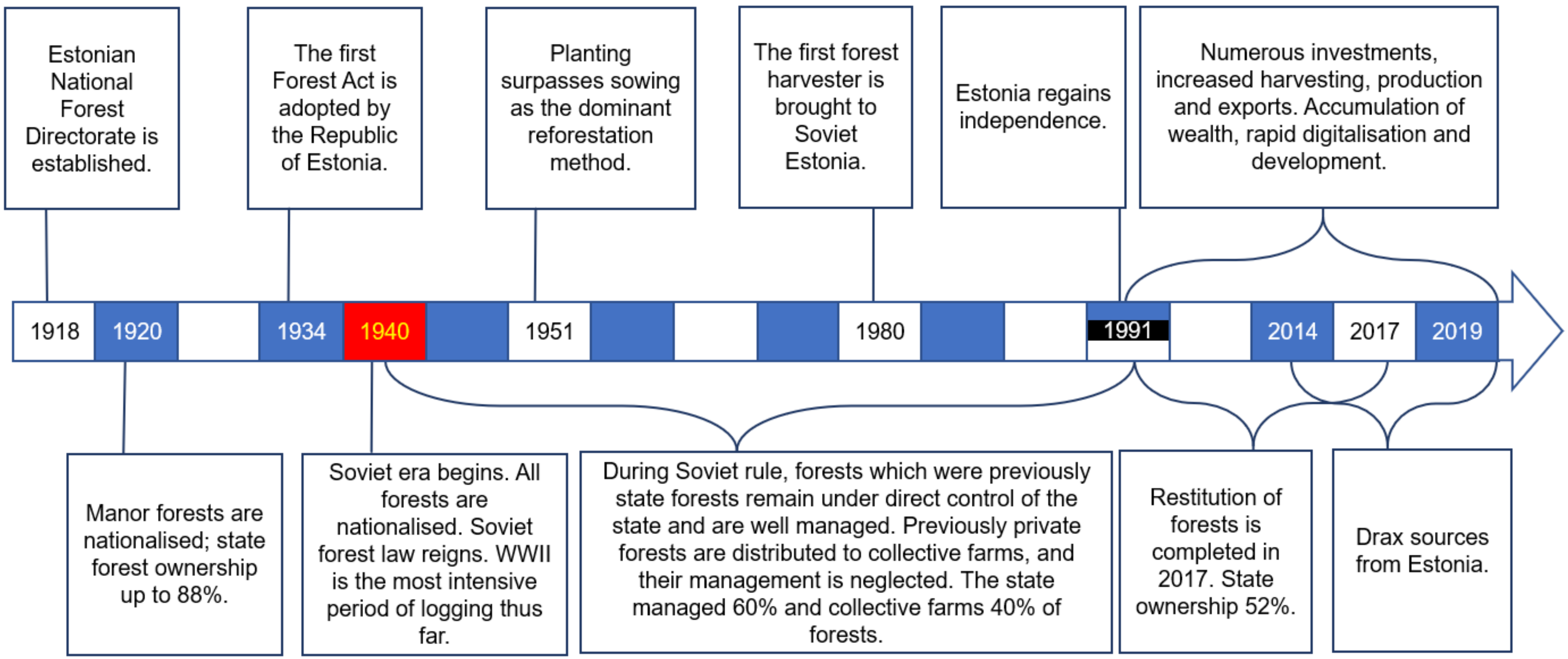
Rotation Lengths	
Impact: Neutral	• Forest law regulates minimum forest age for clear-cuts. According to interviews, RMK often conducts the final felling at the minimum age. Due to the regulation, an increase of wood-based bioenergy demand has not shortened rotations at least in state-managed forests. In forests that are older than the minimum final felling age, sawlog price is a more important driver for final-felling decisions than wood-based bioenergy demand.
Thinnings	
Impact: Increasing impact	• The increase of bioenergy demand has increased the demand for small-diameter hardwood, which in turn has increased thinnings in previously unmanaged forest stands. This will increase the availability of good quality sawlogs and will also accelerate the carbon sequestration (tonnes/ha/year) of the forests. However, the total forest carbon stock (tonnes/ha) will be reduced; in unmanaged (e.g. no thinnings) mature stands, the carbon stock is larger than in managed stands of similar age. The carbon stock of a thinned stand will remain below that of an unthinned stand regardless of post-thinning accelerated growth.
Conversion from Hardwood to Softwood	
Impact: Neutral	• No indication of hardwood conversion to softwood was found.

Table 5.3 Impacts of wood-based bioenergy demand to solid wood product (SWP) markets

Diversion from Other Wood Product Markets	
Impact:	• Production of sawnwood, wood-based panels, pulp and paper products have increased or remained steady, i.e. no evidence of diversion.
Wood Prices	
Impact: Slight increase / Neutral	• During 2017–2018, the price of all roundwood assortments increased notably. The increase was strongest in pulpwood assortments, especially those that are not further processed domestically but are exported to mainly Finland and Sweden. Finnish demand for pulpwood was at a very high level in 2018. This was a temporary trend, however, and prices and demand have since decreased. • The price increase for fuelwood was less dramatic, no sharp increases are observed. According to interviews, pellet production was the most important driver of fuelwood prices.

Annex 1

Timeline of Estonian Forests



Estonian National Forest Directorate is established.
The first Forest Act is adopted by the Republic of Estonia.
Planting surpasses sowing as the dominant reforestation method.
The first forest harvester is brought to Soviet Estonia.
Estonia regains independence.
Numerous investments, increased harvesting, production and exports. Accumulation of wealth, rapid digitalisation and development.
1918
1920
1934
1940
1951
1980
1991
2014
2017
2019
Manor forests are nationalised; state forest ownership up to 88%.
Soviet era begins. All forests are nationalised. Soviet forest law reigns. WWII is the most intensive period of logging thus far.
During Soviet rule, forests which were previously state forests remain under direct control of the state and are well managed. Previously private forests are distributed to collective farms, and their management is neglected. The state managed 60% and collective farms 40% of forests.
Restitution of forests is completed in 2017. State ownership 52%.
Drax sources from Estonia.

Annex 2

Forest Law Requirements

Rotation ages (in years) per tree species and quality class

Tree Species	Quality class					
	1A	1	2	3	4	5;5A
Scots pine	90	90	90	100	110	120
Norway spruce	60	70	80	90	90	90
Silver and downy birch	60	60	70	70	70	70
Aspen	30	40	40	50	50	-
Black alder	60	60	60	60	60	60
Hard broadleaved trees	90	90	100	110	120	130

Source: Rules of Forest Management

Average diameter (in cm) at breast height requirements for the dominant tree species to allow for clear-cutting

Tree Species	Quality class					
	1A	1	2	3	4	5;5A
Scots pine	28	28	28	28	28	28
Norway spruce	26	26	26	26	26	26
Silver and downy birch	26	26	24	22	18	16
Black alder	24	24	22	22	18	16
Aspen	20	20	18	18	18	18

Source: Rules of Forest Management

Minimum permissible stand basal area (m^2/ha) after selective cutting

Tree Species	Quality class						
	1A	1	2	3	4	5	5A
Conifer and hard broadleaved tree stands	19.0	18.0	17.0	16.0	14.0	12.0	9.5
Soft broadleaved tree stands	16.0	15.0	13.0	11.5	10.0	8.0	6.5

Source: Rules of Forest Management

Tree species permitted for the use of reforestation by forest site type

Site type	Tree species permitted for reforestation and taken into account in assessing regeneration
Arctostaphylos	Scots pine, Norway spruce, silver birch
Calamagrostis	Scots pine, Norway spruce, silver birch, aspen
Sesleria	Scots pine, Norway spruce, silver birch, aspen, black alder
Cladina	Scots pine
Calluna	Scots pine, silver birch
Oxalis-Vaccinium vitis-idaea	Scots pine, Norway spruce, silver birch, aspen
Vaccinium vitis-idaea	Scots pine, Norway spruce, silver birch
Oxalis-Vaccinium myrtillus	Norway spruce, Scots pine, silver birch, black alder, aspen
Vaccinium myrtillus	Scots pine, Norway spruce, silver and downy birch, aspen, black alder
Polytrichum-Vaccinium myrtillus	Scots pine, Norway spruce, silver and downy birch, aspen, black alder
Hepatica	Norway spruce, Scots pine, silver birch, aspen
Oxalis	Norway spruce, silver birch, Scots pine, aspen
Aegopodium	Silver birch, Norway spruce, aspen, black alder
Dryopteris	Norway spruce, silver and downy birch, black alder, aspen
Filipendula	Silver and downy birch, Norway spruce, Scots pine, black alder, aspen
Carex-Filipendula	Silver and downy birch, Norway spruce, Scots pine, black alder, aspen
Carex	Scots pine, silver and downy birch, Norway spruce, black alder, aspen
Equisetum	Silver and downy birch, Scots pine, Norway spruce, black alder, aspen
Polytrichum	Scots pine, Norway spruce, silver and white birch
Vaccinium uliginosum	Scots pine, silver and white birch
Marshland	Silver and downy birch, Norway spruce, black alder
Vaccinium myrtillus drained peatland	Silver and downy birch, Scots pine, Norway spruce, black alder
Drained peatland forest	Scots pine, silver and downy birch, Norway spruce, black alder, aspen
Mesotrophic mire	Scots pine, silver and downy birch, Norway spruce
Bog	Scots pine
Heap	Scots pine, silver and downy birch, aspen, Norway spruce, black alder

Annex 3

Glossary

Word	Definition
Carbon sequestration	The process of increasing the carbon content of a carbon pool other than the atmosphere.
Carbon pool	A reservoir of carbon. A system that has the capacity to accumulate or release carbon.
Carbon sink	Any process or mechanism which removes a greenhouse gas, an aerosol or a precursor of greenhouse gas from the atmosphere. A given pool (reservoir) can be a sink for atmospheric carbon if, during a given time interval, more carbon is flowing into it than is flowing out.
Carbon stock	The quantity of carbon contained in a “pool”, meaning a reservoir or system which has the capacity to accumulate or release carbon.
Cleaning	Weeding, respacing, clearing understory; measures to improve the daylight and nutritional conditions of the principal tree species of a stand and shaping the composition of the forest.
Environmental Board	An entity operating under the umbrella of the Estonian Ministry of the Environment.
Final felling, regeneration felling	Harvesting all or nearly all mature trees from a stand to allow for the regeneration of a new forest stand.
Forest area	A land area classified as forest; includes also temporarily unstocked forests (e.g. following a clear-cut)
Forest cover	The portion (%) of land currently covered by forest stands.
Improvement cutting	Hypernym encompassing cleaning, thinning and sanitary cutting.
MAI	Mean Annual Increment. The volume of wood growing on one hectare of a forest during one year on average since the forest has been established (m^3/ha/year).
Manor forests	Forests largely owned by the Baltic German elite of Estonia, as part of manor estates.
Maximum sustainable harvest	A level defined by the Estonian Parliament/ Ministry of the Environment. This is based on annual increment data, but is ultimately a political decision and may not exactly reflect the actual, ecological maximum sustainable harvest.
Pre-commercial thinning	A forest management practice, which does not result in marketable wood. The aim is to reduce the number of seedlings per hectare to improve the growth of remaining seedlings.

Word	Definition
Selective cutting	The cutting down of selected trees in a forest so that growth of other trees is not affected. This is done according to criteria regarding minimum tree size for harvesting, specifications of the number, spacing and size classes of residual trees per area, and allowable cut. The cutting out of trees that are mature or defective, or of inferior kinds to encourage the growth of the remaining trees in a forest or wood. Selective cutting can also refer to a forest management system that does not include clear-cuts. In forests where selective cutting is applied, typically both young and mature trees are grown in the same stand.
Tending (of forests)	Hypernym encompassing improvement cutting, selective cutting and regulation of the water and nutrition regime of forest soil.
Working forests	Forests which are used for wood production.

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