

**Forest-based Industries 2050: a vision for sustainable
choices in a climate-friendly future**

***To be the most competitive, innovative and
sustainable provider of net-zero carbon solutions for a
climate neutral Europe***

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1. Introduction

In 2018, the European Commission presented its “A Clean Planet for All” vision, a long-term strategy for a prosperous, modern, competitive and climate-neutral economy by 2050. More recently, the von der Leyen agenda for Europe put forward the European Green Deal that should become the first European Climate Law to enshrine the 2050 climate-neutrality target into legislation.

In response to this ambitious agenda, the Confederation of European Paper Industries (CEPI), the European Confederation of Woodworking Industries (CEI-Bois), the European Panel Federation (EPF), the European Furniture Industries Confederation (EFIC), Bioenergy Europe and the Forest-based Sector Technology Platform (FTP) would like to present how the European Forest-based Industries can contribute to the 2050 climate neutrality target.

This vision is supported by the Confederation of European Forest Owners (CEPF), the European State Forest Association (EUSTAFOR), the Federation of the European Parquet Industry (FEP), the European Organisation of Agricultural, Rural and Forestry Contractors (CEETTAR), the European federation for print and digital communication (Intergraf) and COPA-COGECA, the united voice of farmers and their cooperatives in the EU. The European Forest Institute (EFI) also provided a science-based input to the chapter on raw materials.

Our vision spans the entire EU-wide value chain of forest-based products, from forest owners and managers to transformation industries, academia as well as research and development. It focuses on forest-based solutions and how they help meet the emerging expectations of Europe’s citizens. This vision addresses the challenges and possible solutions faced by the downstream value chains. It does not cover as such the manifold societal expectations on the forest sector, that should be encompassed in an updated and robust post-2020 EU Forest Strategy.

Our vision is part of the greater role foreseen for the bio-based sectors leading up to 2050. We believe that Europe’s Forest-based Industries have an important role in strengthening the European low-carbon circular bioeconomy. We provide a smart industrial ecosystem where materials, by-products and residues are supplied across the various parts of the value chain, to make the most efficient use of resources, including through re-use and recycling, and to maximise the climate change mitigation impacts of the total system while also providing other forest benefits to the society.

The circular bioeconomy provides sustainable alternatives to fossil-based materials and fossil energy, helping decouple economic growth from resource depletion and environmental impact; it brings jobs to urban, peri-urban and rural regions and revitalises development in those areas. It contributes to a zero-waste economy by processing waste and side-streams into circular added-value products, ultimately enabling Europe’s efforts to achieve the UN Sustainable Development Goals.

2. Current state of the European Forest-based Industries

The European Forest-based Industries, as defined in this document, include the woodworking industries, the industries manufacturing pulp, paper and paper products, the furniture industry¹, the printing industry and the bio-energy industry. Combined they represent around 420.000 enterprises for a total turnover of over 520 billion euros and around 3,5 million workers. Together they add value to the EU economy by around 143 billion euro each year². They are key actors of the European bioeconomy, which accounts for 18 million jobs, 2.3 trillion euros turnover and 621 billion euros in value added³.

The Forest-based Industries are an important link between urban, peri-urban and rural areas. EU forests are an essential contributor to rural development: sustainably managed and multifunctional European forests give their owners income that is necessary to keep the forests managed. At the same time, they contribute to the well-being of citizens.

Wood and wood-based products are used every day as paper, furniture, in construction, for packaging, and in many other areas, including renewable energy. A precise overview of wood flows in Europe, drawing on information developed by the European Commission's Joint Research Centre⁴ may be seen in Annex II. However, in short, today we are using much less wood compared to the growth of the forest: EU forests have been a continuously growing natural resource in the past 75 years. The average harvesting rate of the Net Annual Increment (NAI) of forests available for wood supply is officially estimated to be at 63%, with differences among the countries⁵. This means we can both develop the wood industries and, at the same time, maintain or increase our European forest resources, provided that adequate climate change adaptation policies are in place.

The Forest-based Industries are supplied essentially from European forests as import reliance for industrial roundwood was 5.6 % in 2015 and has been below 10% in the last 15 years⁶. From the point of view of supply security, this gives the industry a special position. In a more polarised world, the forest-based sector provides supply for production of both current and future products, energy and materials that can replace selected materials with lower security of supply.

The overall trade balance of the industry is positive, although marked differences exist between sectors. Extra-EU imports outweigh exports in the furniture sector by 3 billion euros, while the opposite holds for the woodworking and pulp and paper industries, whose net trade balance amounts to 2 and 7 billion euros respectively⁷.

¹ The furniture industry covers also other material providers such as metal, rubber, leather, bamboo.

² NB. Excluding bioenergy. Year 2016. See Annex I for sectoral breakdown.

³ Year 2015. Source: European Commission, Staff Working Document accompanying the document "A sustainable bioeconomy for Europe. Strengthening the connection between the economy, society and the environment. Updated Bioeconomy Strategy 2018". SWD(2018)431.

⁴ Cazzaniga N.E., Jonsson R., Palermo D., Camia A. (2019). Sankey diagrams of woody biomass flows in the EU-28. EC Joint Research Centre, Publications Office of the European Union, Luxembourg, doi:10.2760/227292, JRC115777.

⁵ Joint Research Centre 2018, Biomass production, supply, uses and flows in the European Union.

⁶ Source: European Commission, EIP on Raw Materials, Raw Materials Scoreboard 2018

⁷ See Annex I for sectoral breakdown.

In terms of climate benefits, the EU's sustainably managed forests produce today an overall climate mitigation impact amounting to 13% of European total greenhouse gas emissions. This includes both the action of forests and harvested wood products as a carbon sink and carbon stock, and the substitution effect of forest products for fossil-based raw materials and products⁸. Further mitigation is achieved through the substitution of fossil energy. The overall climate benefits of forests and harvested wood products include:

- Sequestration of CO₂ by forest growth thanks to sustainable forest management;
- The carbon storage effect of harvested circular forest-based products;
- The substitution effects of replacing carbon-intensive and fossil-based materials and fuels with forest-based materials.

On a system level, this is the most efficient carbon capture and utilisation system we have today.

The Forest-based Industries have been focusing on decarbonising its processes while providing jobs and growth in Europe. For certain mills, where there is a positive mix of different factors – such as location, energy mix, access to raw materials – we foresee production to be fully decarbonised well before 2050. Moreover, processes in sawmills, as well as in some pulp mills, are already almost entirely free of fossil energy sources and the manufacturing in the integrated paper and pulp industry to a large extent uses fossil-free energy sources.

The pulp needed to produce paper can come from wood or paper for recycling. When making paper from wood, pulp mills also produce different side-streams like bark, lignin or other biomass components. This biomass is turned into renewable heat and electricity and provides most of the energy needs of the plants. However, when it comes to recycling paper these by-products are not available, except for a limited amount, and the most competitive energy source is often natural gas. Combustion of natural gas is not a long-term solution for paper recycling, and challenges should be overcome⁹.

For these sites, solutions are far from being technically and commercially available or deployable. Likewise, it will be important to secure the availability of cost-competitive and carbon-neutral energy carriers to meet the residual energy needs of the sector.

Finally, all these sectors are closely linked to technology supplies by European engineering industries that are also global technology leaders and invest heavily in research, development and innovations made in Europe. In total, these clusters are already a flourishing ecosystem for digital economy from innovative start-ups to large multinationals, rooted in Europe due to the solid manufacturing base here, and have a great potential to grow further. Whereas these sectors are not discussed in this document, the symbiosis across these value chains should be kept in mind when reading this document.

⁸ G.-J. Nabuurs, P. Delacote, D. Ellison, M. Hanewinkel, M. Lindner, M. Nesbit, M. Ollikainen and A. Savaresi. 2015. A new role for forests and the forest sector in the EU post-2020 climate targets. From Science to Policy 2. European Forest Institute.

⁹ http://www.cepi.org/decarbonising_whilst_pioneering_in_recycling

3. Our outlook for 2050

Looking at megatrends and expected societal needs in 2050, we are confident that our industries will prosper by addressing and providing solutions to people's desire to live in greater harmony with nature and reduce their environmental footprint. We will contribute to people's good health and general feeling of well-being, satisfying many of their basic needs. Smart products designed for reuse and recycling together with sustainable use of forest resources will be the cornerstone of our industries in a smart system making the best of diverse locations and demographics across the EU Member States.

Thanks to expansion of forest areas and sustainable forest management, forest resources will be increasing. This increase will be the condition for a growing supply of renewable raw material and greater diversification of our products. Improved collection systems and recycling will close the loops in proximity to "urban forests" – that is, sources of post-consumer wood and paper – of concentrated population.

We see our sector becoming the most competitive and sustainable provider of net-zero carbon solutions, through research and innovation, break-through technologies, increasing recycling and reuse. This will all together increase value creation for our industry as well as for the forest owners supplying the wood, providing benefits for economic, social and environmental development.

With the following examples we hope to give policymakers a better understanding of how the forest and its renewable materials can contribute to a growing bioeconomy, and how this is ever-present in your everyday life.

Where do we live in 2050?

With increased global population and growing urbanisation comes the need for adequate and affordable housing, greener cities and a higher quality of life in urban areas. Cities are an important source of secondary raw material as "urban forests".

- **Our vision:** Wood becomes the most commonly used renewable construction material, with applications in both residential and non-residential buildings such as schools, hospitals and sport halls. Wood construction triples its market share in Europe but with small impact on the forest resources¹⁰. Wood-based products can also provide excellent solutions in renovation projects, improving building energy performance, air quality, aesthetics, comfort, and at the same time, ensuring low intrusiveness during renovation work. Cities create and deploy climate-neutral solutions for their development in close cooperation with architects, designers, manufacturers and builders of wood construction.

¹⁰ According to Hurmekoski, E. 2017. *How can wood construction reduce environmental degradation?* European Forest Institute, a 100% market share of wood construction of all building in Europe would translate to a maximum direct annual demand of 400 million m³ of raw wood, 54% of increment in forests available for wood supply (744 million m³ in 2010). In our vision, wood gains 30% of the market share compared to current levels (10% on average in the EU market. Source: Clean Planet for all SWD), translating into 120 million m³ of raw wood, or 16% of increment in FAWS. Figures can be lowered considering potential reuse and recycling of raw material.

- **Our solutions:** Harvested wood products store carbon. Using wood-based products from sustainably managed forests instead of fossil-based or GHG-intensive materials, reduces fossil-based emissions, boosts Europe’s carbon stock and thus helps to mitigate climate change. Building with Wood 2.0 means completely new opportunities for industrial wood construction, including the possibility to build tall buildings. In addition, the “timber on top” concept is ideal for addressing the densification of cities. It builds on lightweight wood solutions, adding space on top of existing urban infrastructure. Today’s trends in furniture and decoration already reflect a desire for sustainability with a significant positive impact on the demand of wood products, but also with a reduction of chemicals, an efficient use of materials and the remanufacturing, reuse and integration of recovered materials. The printing industry, for instance, provides environmentally friendly solutions for the decoration of wooden surfaces, wall coverings and other decorative elements.

How do we shop in 2050?

The economy is driven by the digitalisation of processes and global markets; online shopping and delivery are now a daily habit for most EU citizens. They go hand in hand with the personalisation of services and just in time delivery. This translates into the increased need for smart packaging, ensuring safe transport of goods while minimizing the environmental impact of the packaging solution.

- **Our vision:** Material collection rates, especially concerning our packaging products, have increased to at least 90% and their reuse and recycling account for 70% of all recyclable material¹¹. Paper and board will continue raising the bar and fibre-based packaging recycling rates are over 90%. This genuinely circular approach prolongs carbon storage and substitutes more energy intensive and fossil materials.
- **Our solutions:** Smart, resistant, bio-degradable, light weight, reusable and recyclable printed packaging that can be adapted to people’s needs while at the same time ensuring safety and minimizing transport emissions. Print will play an important role in the packaging by providing attractive designs and essential information. Scannable printed features will link the product to the internet and deliver additional consumer information. Larger items are also transported by bio-based packaging materials. Also transport vehicles make use of wood, paper and other bio-based materials.

What do we eat?

With the challenge of scarcity of food and water worldwide, reduction of food waste (88 million tonnes of food are wasted annually in the EU¹²) has become a priority together with the search for alternative food sources from sustainable agriculture.

- **Our vision:** To ensure that we can satisfy the needs of a hungry planet without depleting its natural resources we need to reinvent how we look at food, food packaging and the food industry.

¹¹ Sources: 84.6% paper and board packaging recycling rate in 2017 (Eurostat) and FTP Vision Target 4. Wood packaging recycling rate 2018: 40% (Eurostat).

¹² Source: FUSIONS EU project, Estimates of European food waste levels, 2016.

- **Our solutions:** Not competing with food production, forest-based flavourings, stabilisers, sustainable agriculture and fishery, wood-based packaging materials but also specialty papers such as filters to provide clean water for instance. With a growing global population and rapid urbanization, smart and recyclable packaging for food is essential to a sustainable lifestyle. Opportunities to extract or convert forest-based biomass into edible protein and other nutrients will be pursued. Forests play a vital role in ensuring sufficient supply of drinking water in high quality.

What do we wear?

Gaps between rich and poor countries in the world are increasing, Asian demography and its increased economic weight is pushing demand for more textile and tissue products. At the same time, EU consumers have become extremely conscious of the environmental impact of their clothing: they are buying differently. The EU market demands substitutes for synthetic fibres and cotton.

- **Our vision:** Wood based textiles is the area where material substitution is expected to deliver most benefits compared to other application areas, decreasing the emission of CO₂ and pollutants, curtailing the release of microplastics, reducing the application of chemicals, pesticides and fertilizers, diminishing the exploitation of potable fresh water for agriculture, and vacating fertile land area for food production.
- **Our solutions:** Textiles made from wood fibre can help meet the growing demand in fashion, furniture and industrial application, and the emerging production processes have considerably less environmental impact.

How do we stay healthy?

The ageing population in Europe and booming population in Asia and Africa increase needs in medical care and medical applications but also affordable hygiene products.

- **Our vision:** Smart services and products contribute to people's good health and general feeling of well-being. Forest-based products provide the building blocks for novel health technologies - such as cell growth matrices, bio-based wearables and biodegradable implants - and healthy ingredients extracted from forest raw materials.
- **Our solutions:** Advancements in nanocellulose-, lignin-, and biochemicals-based material technologies provide for new applications in the health and care industries as well as the domestic environment. Hygiene products, nanocellulose, bioink, lignin, biochemicals, probiotics, food additives for balanced diets. Printed electronics enabling intelligent packaging for medical products.

How do we power our way of life?

With increased mobility due to a fully global economy, more mobility means more appliances and therefore increased fuels and electricity consumption. However, decarbonisation across the globe will require more demand for carbon neutral energy sources across the whole economy.

- **Our vision:** Bioenergy will be a mainstream energy supply solution with smart and efficient production of heat, electricity and biofuels, in combination with other renewable sources of energy for a 100% renewable based economy. Smart biomass installations generating energy efficiently when and where needed.
- **Our solutions:** Renewable heat, steam and electricity, as well as secondary heat supplied to other users, biofuels for vehicles, boats and planes from by-products, side-streams and low-quality biomass from sustainably managed forests. Our sector is also active in reducing our carbon footprint in our upstream operations. By 2050, production of biofuel for own long-distance transport and harvesting machines and electrification of trucks and loaders used in mills and terminals are means to reach our decarbonisation target.

How do we spend our leisure time?

With the growing urbanization, green areas become more and more important and forests will be key for healthy recreation, leisure time and sports. At home the constant overflow of information will incite people to disconnect and relax while reading printed books or magazines. Research¹³ has shown that our brain works better with paper support and thus schools and continued education will use printed supports in connection with digital means for education.

- **Our vision:** Use of print will be continued for leisure and education.
- **Our solutions:** Forest-based based products are renewable, reusable and recyclable and contribute to the circular bioeconomy. Paper will hold its value as a tactile medium on consumer-oriented markets as an essential part of holistic and humane experiences such as that of reading books or magazines. Paper will further serve new functions in areas such as consumer electronics as templates for printed circuits, for instance. Continuous innovation in paper production technologies will continue to improve both the material and energy efficiency of printed products.

How do we create jobs?

Traditional industries face an economic transition, encountering some competitiveness issues related to the global economy, digital disruption and the increased decarbonisation costs due to rising electricity prices and investment needs.

- **Our vision:** In 2050, the Forest-based Industries are an attractive employer, known for providing highly skilled, meaningful and safe jobs in rural as well as in urban and peri-urban regions. It is well known for developing the skills of workers and managers and has significantly increased the number of employees involved in different aspects of research, development and innovation activities. The sector contributes substantially to a just transition of the European economy. In particular, the sector contributes tremendously to job and welfare creation in start-ups, SMEs, including in rural areas. It is also bustling with entrepreneurial activity.
- **Our solutions:** Given the on-going paradigm shift towards sustainability across all sectors of the economy, the Forest-based Industries and their value chains are a green and

¹³ COST Action E-READ initiative (www.ereadcost.eu)

attractive sector, with the potential to create sustainable and decent jobs. Properly designed and implemented climate mitigation options will have substantial co-benefits in terms of employment and income generation opportunities, leading to new jobs and adding more value to the economy but also requiring completely new skills. Digitalisation along the whole value chain of the Forest-based Industries will open new opportunities towards higher efficiency and sustainability as well as a more attractive place to work with improved safety and ergonomics.

4. 2050 Industry goals and contribution to EU priorities

In order to turn this vision into a reality, the Forest-based Industries are assigning for themselves 5 ambitious goals, that also represent their contribution to the EU political priority to ensure a sustainable and inclusive climate-neutral economy:

1) Help decarbonise Europe 2050 by substituting critical or CO₂-intensive raw materials and fossil energy with forest-based alternatives.

Developing new technologies and products that allow for viable substitutes of solutions that today require raw materials that have a high supply risk and are carbon-intensive, including building materials and energy carriers. The vision of the forest-based sector is that innovative fibre-based products, both in traditional and new market segments, as well as green chemicals, composites and renewable energy carriers, offer a significant decarbonisation of the European economy. For example, we envision that by 2050 wood, the most commonly used renewable construction material, has more than tripled its market share from the 2015 level¹⁴.

2) Eradicate waste in the circular economy by closing material loops with a sector target of at least 90% material collection and 70% recycling rate.

Paper for recycling and recovered wood go hand in hand with primary raw materials in the circular bioeconomy and will be an even more important part of the Forest-based Industries raw-materials supply, where it is already of significance (e.g. for paper the recycling rate is already 71.6% today). Making sure that waste is minimised wherever possible, and that valuable natural resources are used in the most efficient and economic fashion possible is core to the Forest-based Industries' vision. For instance, by-streams from tending operations, harvesting and wood working industry are fed into pulp and paper industry or they are used for bioenergy production or new biobased products. This requires mainly designing of products for circularity and improving collection, sorting and recycling systems, while reducing or eradicating the need for landfill and other waste management that do not create value.

3) Drive resource-efficiency in the F-BI industrial value chain by enhancing productivity in all areas (including materials, manufacturing and logistics).

The vision of the Forest-based Industries is a significantly reduced carbon footprint and a significantly more efficient use of natural resources in its processes, as well as responsible sourcing by precise and publicly approved traceability (chain-of-custody) throughout the value-chain, including recovery of materials. For instance, reducing the energy, material

¹⁴ Source: Forest-based Technology Platform Vision 2040.

and water volume involved in the production of any unit of final product. Important aspects in accomplishing this is the deployment of new technologies, including digitalization and AI, developing new innovative business models that for instance, allow for much smaller production units boasting the same unit production cost per unit as their much larger counterparts of today. Utilisation of side-streams, by-products and co-products; permitting for industrial symbiosis of materials, water and energy.

4) Meet the increasing demand for raw materials by maximising new secondary streams and ensuring primary raw material supply from sustainably managed forests

The European demand for raw materials is met by an enhanced use of secondary raw materials and increased supply of woody biomass from sustainably managed forests. Forest resources in the EU are growing in surface and volume. Multifunctional forest management is needed to satisfy, under changing climate conditions, both the industry demand on primary raw materials and the manifold other societal expectations on forests. With support from research and innovation, an increase in the sustainable harvesting possibilities in Europe of at least 30% by 2050 from today's levels is envisaged¹⁵.

5) Satisfy the growing demand for climate-friendly products by increasing the use of wood and wood-based products in our daily lives.

This can be done by boosting the prominence of existing Forest-based Industries materials in our homes and in how we lead our lives and through improved profitability. We will achieve this by building further on the current trend of using sustainable wood-based products in our daily activities and by developing innovative, highly added-value products. To substitute fossil-based solutions the industry estimates to grow by around 3% annually, compared to the projected EU GDP growth of 1.5%¹⁶.

5. Pathways to the goals

In order to meet our five strategic goals, we have identified three pathways that will drive the shift a low-carbon circular bioeconomy:

Develop markets,

Ensure sustainable supply of raw materials and

Boost innovation.

Cross-cutting partnerships are also identified to enhance data availability, secure skills and strengthen the sector's attractiveness.

For the challenges that we identify in each pathway, we have put forward corresponding solutions areas. Further development of these solutions and cooperation between the EU, national policymakers and the Forest-based Industries will make our vision become a reality.

¹⁵ Source: Forest-based Technology Platform Vision 2040. See also the "Increased Rest of the World Bioenergy Demand" scenario in IIASA et alia, 2016. Study on Impacts on Resource Efficiency of Future Demand for Bioenergy – Task 3.

¹⁶ See chapter 6 for further details.

6. Develop markets

Pathway description: the shift towards a low-carbon, circular bioeconomy will require actions both on the demand and supply sides of sustainable forest-based products. As for the former, consumption of F-BI products will grow thanks to a mix of increased consumer awareness and supportive product policies, based on robust assessment of GHG product footprint over the entire lifecycle. Further internal market harmonization and standardization will also facilitate market uptake of innovative forest-based product, provided that the EEA single market is safeguarded from attempts by Member States to erect new trade barriers. On the supply side, the competitiveness of the industry will be preserved by the combination of industry-led innovation and global level playing fields. The former will preserve cost-competitiveness based on maximum resource efficiency, labour productivity and value creation, while the latter will be ensured by tackling unfair trade practices and untapping the export potential to developing markets.

Increasing the use of forest-based products provides a robust solution for reaching a carbon-neutral EU economy while also delivering on societal demand for sustainable products. The key arguments for facilitating this trend are: using in an optimal way the removal potential of atmospheric CO₂ by forest growth thanks to sustainable forest management, the carbon storage effect of harvested circular forest-based products and the substitution effects of replacing energy-intensive fossil-based materials by forest-based materials.

For example, it is estimated that, on average, every cubic meter of wood used in buildings, has captured almost one ton of CO₂ from the atmosphere¹⁷. Moreover, every cubic meter of wood used as a substitute for other building materials reduces CO₂ emissions by an average of one ton. Finally, the stored energy in wood biomass can be recovered when used as renewable energy. Furthermore, wood products are made in an efficient, low-energy production system, with minimal emissions and well-established recycling systems.

At the same time, the market for forest products is global. In order to contribute to the common vision target, substituting fossil energy and carbon-intensive materials and investing in full decarbonisation of own processes, the Forest-based Industries need to be globally competitive to sustain their profitability.

In a business-as-usual scenario, the growth of the Forest-based Industries is coupled with EU GDP growth rate up to 2050, which is projected to increase at an annual rate of 1.5% (EU 2016 reference scenario¹⁸). However, in our vision, and in order to substitute fossil-based solutions, the Forest-based Industries' production value grows at a faster pace, by around 3% per year as an average for the period 2020-2050. This target builds upon projections available for the 2020-2030 decade: ÅF Pöyry, for instance, estimates the markets for forest-based products to grow by 200 billion euros in the next decade alone, translating into a growth rate of 2.3% per year¹⁹. This target is reachable provided that the industry retains

¹⁷ Average value – actual storage depends on tree species and areas. See <https://opslagco2inhout.nl/en> for calculation in different species based on EN 16449 standard.

¹⁸ EU Reference Scenario 2016 - Energy, transport and GHG emissions. Trends to 2050.

¹⁹ Pöyry, Global Markets and Growth Potential of Forest-Based Industry Products 2030. Research commissioned by the Finnish Forest Industries Federation, 2018.

competitiveness and increases market share worldwide, aligning with global markets growth rates²⁰. Additionally, our target encompasses the overall forest-fibre sector, covering existing and new high added-value products²¹, which will compensate different sub-sectoral performances²². For example, in the fibre-based sector almost half of the new added value is expected to come from other new bio-based products such as textiles and green chemicals and composites. This trend is expected to be developed in all forest-based market sectors where new technologies will lead to the development of new products and new markets. Whilst it will remain smaller than the existing product segment, it is expected to grow more quickly.

The driving forces of this trend are the increasing global demand for sustainable, climate smart products and renewable energy and the development of innovative products (such as biorefinery products and engineered wood products) that generate more value from identical or smaller production volumes. Innovative uses of side-streams will also increase the profitability of the industry. At the same time, an adequate regulatory framework ensures that the cost-competitiveness of the EU industry is not eroded compared to third country producers in the run up to 2050.

Higher value for products and services and improved resource-efficiency and recyclability will also mean that demand for virgin raw materials will not increase at the same pace as the industry's growth, and that it will remain within sustainable levels. From 1990 to 2010 (the last year of data availability from Eurostat) the net annual increment in productive forests was growing by more than 4% per year. Considering the rates of development of European forest resources and of their current use, one can assume, at least from recent trends, that the increased sustainable primary raw material supply will, together with increased secondary raw material sources, be able to sustain the F-BI needs in the future, whilst growing its market share.

This only represents the theoretical growth potential of the sector. The attainment of such a target is conditional upon meeting a number of challenges and taking advantage of current opportunities. Some suggestions on how to meet such challenges are provided below.

6.1 Grow market uptake of existing and new sustainable Forest-based products.

²⁰ The projection of annual global growth up to 2050 is 3.5% for chemicals and plastics, 3% for textiles and 1-2% for other material sectors. Source: Piotrowski, S., Carus, M., and Essel, R. 2015. Global bioeconomy in the conflict between biomass supply and demand. Nova paper no. 7 on bio-based economy. Nova-Institut GmbH, Huerth, Germany.

²¹ Textiles, construction, biochemicals, biofuels, packaging and plastics are the most promising markets for emerging wood-based products. Source: Hurmekoski et al. 2018, Diversification of the forest industries: role of new wood-based products, Canadian Journal of Forest Research.

²² See for example the trend illustrated in the EU Bioeconomy Strategy 2018, Staff Working Document, p. 43: "in the EU, between 2009 and 2015 the overall growth rate of the value added of bio-based sectors ranged between 14% for the manufacture of wood and wooden products and 23% for the manufacture of pulp, paper and cardboard. In the same period, the overall growth rate of EU value added of bio-based chemicals, pharmaceuticals, plastics and rubber has been 17%". Adding the performance of the forestry, bio-based textiles, biofuels and bio-electricity translates to average yearly growth of 3% (Source of data: <https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/index.html>)

Challenges

Although currently growing at a pace consistent with, or in some cases above GDP, the further uptake of harvested wood products and forest-based materials is hampered by some obstacles, such as:

- Insufficient recognition of the environmental and climate performance of F-BI products. This is due to the lack of reliable and comparable information tools on environmental and climate performance and the fact that existing instruments are under-used.
- Regulatory obstacles such as a lack of harmonized standards and legislation, or attempts by Member States to introduce new national requirements that modify or go beyond EU regulations. Specific needs vary depending on the subsector (e.g. paper and board, construction products, furniture).

Solution Areas

- Improve **awareness of environmental benefits of forest-based products**: define and highlight the carbon storage and substitution effect of harvested wood products and fibre-based materials and textiles as a core component of EU Climate and Environment policy development. This constitutes a prerequisite for increasing awareness on the environmental benefits of sustainable forest-based products.
- Develop **harmonised European standards and a unified assessment framework for environmental and climate performance of products over the lifecycle**, in order to enhance consumer confidence, and mainstream LCA-based approaches in product policy. Where such tools already exist their use by SMEs should be supported. Digitalisation of environmental performance declarations and of analogous tools will also be of strategic importance to adapt to changes in the market (see for example the developments in the construction sector related to Building Information Modelling).
- Reinvigorate the **internal market for sustainable products**, ensure that any infringements are immediately rejected and safeguard and strengthen the **European Standardization system**. The industries should be regarded as key players in the development of standards affecting the sectors. In addition, the EU should support the transfer of EN standards to the ISO level by supporting European companies and institutions involved in standardization financially to ensure that this important work can be adequately carried out.
- Create a **level playing field between bio-based F-BI products and fossil or non-renewable materials** by removing regulatory obstacles both at EU and national level. Create a **level playing field between bio-based and fossil energy** by phasing out fossil fuels subsidies.
- Enhance business opportunities for sustainable carbon-neutral, bio-based products through **Public Procurement** (15% of EU GDP). Use government Green Public Procurement as a model for the general public to follow.

- Establish effective policies to implement a **Circular Bioeconomy**, aiming at reducing substances of concern to a minimum, supporting circular product design and promoting and incentivizing renewable, circular and sustainable products, but also encouraging re-manufacturing, re-use and recycling.

6.2 Secure global competitiveness

EU Forest-based Industries are already competing on global markets. In our vision, the untapped potential of additional growth, both in the EU and extra-EU markets, can be unlocked provided that a number of challenges are tackled.

Challenges

- **Raw materials availability** will need to be ensured, both in quantity and quality (see chapter 7 for further elaboration and for solution areas).
- **Cost-competitiveness of EU industry** is threatened to decline in the absence of global level playing fields, while competition from low-cost imports (e.g. furniture) can hamper the growth of the sector and impact especially EU SMEs and small enterprises. Labour cost is already higher compared to third-country competitors, and energy costs are most likely to increase over the transition with major gaps in availability of zero carbon emitting energies. Regulatory costs in the fields of climate, energy and environment policies also diminish the industry's investment capability and deters international capital allocation into Europe²³.
- **Unfair trade practices** from third countries aiming to restrict market access for European companies also prevent the sector from fully realizing the economic gains from trade.

Solution Areas

- Focus on maximizing value creation from biomass and **enhancing resource efficiency** in all stages of the value chain. This will allow to optimize use of primary and secondary raw materials and create more added value (e.g. through the use of sawmilling by-products by pulp mills, biorefining side-streams of pulp mills, increasing recycling rates of wood and new fibre-based products products). This will be pursued through innovation and digitalization of some processes (see chapter 8).
- **International trade of timber** and timber products is a suitable source to cover the growing demand of raw material, provided that **legality and sustainability requirements**

²³ The cumulative cost impact assessment performed for the European Commission by Technopolis reveals the full scale of regulatory costs in the fields of climate, energy and environment policies. This real-time study on FBIs has revealed that over the past 10 years, direct regulatory costs have more than doubled. See "An assessment of the cumulative cost impact of specified EU legislation and policies on the EU forest-based industries published on: 24/11/2016", https://ec.europa.eu/growth/content/study-assessment-cumulative-cost-impact-specified-eu-legislation-and-policies-eu-forest-0_en

are met. Europe, as a global trading partner, should ensure the full implementation of existing instruments²⁴ while also strengthening the cooperation with timber producer countries to promote sustainable forest management and facilitate transparent supply chains. This results in a virtuous circle: implementing sustainable management can also actively develop markets for the resulting wood, underpinning long term viability of forest and timber businesses and associated livelihoods, ultimately incentivising forest maintenance and growth.

- **Innovation and R&D:** support is needed for SMEs for boosting innovative design, product development and new business models, while the large industry is in need of public leverage for speeding up and de-risking pilot-scale R&D investments for close-to-the-market, breakthrough innovations. Development of new industrial applications will be also key to adapt to changes in species composition mainly foreseen due to climate change.
- The success of the Forest-based Industries requires **free, rules-based and fair trade**, while maintaining or improving standards and lowering operating costs. As part of bilateral and multilateral trade negotiations, the EU must ensure that forest-based products are able to enter other markets and are not discriminated against. It should also ensure faster procedures to tackle market barriers, particularly in presence of free trade agreements, and prevent unfair trade practices by addressing market distortions with a robust implementation of the EU trade defense instruments. It is also of utmost importance to boost the involvement of SMEs in the international trade market.
- Ensure **functioning market surveillance** in conjunction with harmonised standards in the EU internal market, to prevent importers in the EU internal market to undermine the European standards and Intellectual Property Rights without consequences.

7. Ensure sustainable supply of raw materials

Pathway description: an important precondition for the Forest-based Industries to successfully reach their 2050 vision is supply of raw material in the right quantity and quality. To this aim, the provision of secondary raw materials will have to be increased by boosting material collection and recycling. At the same time, the industry will still need primary raw materials, provided sustainably from available wood resources and without compromising other forest functions and services. This can only be achieved through cooperation between all stakeholders focused at optimising woody biomass growth and through ensuring the provision of sufficient wood to the market, taking into account the effects of climate change on European forests.

In the EU, quantitative wood demand is likely to increase in the next decades due to the transition towards a circular bioeconomy and the need for more climate friendly production and consumption systems. New requirements on wood qualities are also expected from new wood-based products. In this context, forest holders' role to manage and invest in their

²⁴ Notably the FLEGT Action plan and Regulation and the EU Timber Regulation.

forests is essential for these developments to actually happen. Rising expectations on forests to provide wood and also other services to society pose questions regarding sufficient supply in view of long-term sustainability, including ecosystem conservation, competitiveness and social benefits. The growing demand of the F-BI on raw material has to be served mainly by domestic wood resources, comprising (1) secondary raw material including by-products from the wood processing industries, and post-consumer wood and, (2) primary raw material from EU forests. These categories of resources and materials are subject to different challenges.

7.1 Increase secondary raw material supply from wood-based products

The resourcing of woody biomass is not limited to primary raw material from forests. Primary residues and by-products (like chips and sawdust) and post-consumer wood represent an important part of wood consumption in the EU that will grow in the future. Industries which are responsible for the first transformation of raw-materials and for the provision of vast quantities of by-products have a strategic importance and should remain at the center of future EU industrial and environmental policies.

Post-consumer wood and by-products (like chips and sawdust) represent an important part of wood consumption in the EU that will grow in the future. For example, the usage of recovered wood has reached on average 40% of raw material needs in the European particleboard industry, with some countries using recovered wood for up to 90% of their wood procurement. The European paper recycling rate at 72% is the highest in the world and fibre-based packaging recycling at the rate of 84.6% is the highest of all packaging materials²⁵. In the wood packaging sector, the average recycling rate is lower (around 40%), with higher-than-average recycling rates being already achieved in certain countries²⁶. The European Commission's legislative framework on the implementation of the Circular Economy Action Plan in 2018 includes targets for recycling of municipal waste and packaging waste, including paper and wood, by 2030. More specifically, the targets set are:

- a common EU target for recycling 65% of municipal waste by 2035;
- a common EU target for recycling 70% of packaging waste by 2030, with specific targets for paper and cardboard packaging (85%) and wood packaging (30%).

This is expected to contribute to a sharply increased supply of secondary raw materials for the Forest-based Industries.

At the same time, the circular economy performance by sectors using such secondary material must be fully acknowledged.

Solution areas

- Evaluate the implementation of the waste hierarchy provision encompassed in the EU Waste Framework Directive; monitoring the requirements of the waste hierarchy is

²⁵ Source Eurostat.

²⁶ For example, countries already achieving a recycling rate higher than 60% are Belgium, Denmark, Ireland, Italy, Spain, the Netherlands and Portugal. Source: Eurostat, Packaging waste by waste management operations and waste flow [env_waspac].

essential in order to secure the flow of secondary raw materials. Creating indicators to follow is recommended.

- Streamline the work between EU waste industry and EU wood industry. Currently, the wood industry invests a lot of finance and resources to “clean” recovered wood ahead of its re-use in products. Streamlining this process through improved collection systems will ultimately deliver financial benefits to the EU consumer. In parallel, research and innovation will be needed to find suitable alternatives to wood treatments that diminish its final recyclability.
- Promote the role of cities as resource (and demand driver): the leadership of cities can change consumer habits to incentivise the use of recycled raw materials.
- Develop widely accepted recyclability protocols at European level; this will allow the value chain including brand owners to take recyclability into account when developing new packaging solutions for the internal market.
- Separate collection of paper waste is already common in many countries. The 2018 Waste Framework Directive specifies new requirements for separate collection, mainly based on household waste. This should be extended to public and municipal waste to secure dedicated streams of wood waste to complement the existing ones for paper.
- Issue EU guidance on separate collection; this will increase the understanding and acceptance of keeping certain waste fractions separate from each other for their further recycling.
- Implementation of landfill directive: give post-consumer wood an added value. A maximum of 10% of municipal waste may go to landfill by 2035. It should be targeted to reduce this still further by 2050, allowing for a higher supply of secondary raw materials.
- Recycling should not only concern low value products but also high value products (e.g.: improve material use of post-consumer wood). Waste should be recovered to create as much value as possible. Where economically and logistically viable, material recovery should be favoured and incineration should be the last option. Recovered waste (such as post-consumer wood) should ideally re-enter the supply chain, replacing primary raw materials, as has been done in the paper and printing industry with the promotion of recycled paper as a finished product.
- Avoid overcapacity in waste incineration facilities and end incineration without energy recovery; this will avoid recyclable materials to be attracted to lower options of the waste hierarchy
- Avoid inconsistent national and regional end-of-waste and by-product criteria hampering the internal market. Common standards would be an advantage and should encourage that waste is used for its highest material value without any market distortions from subsidies.

- Need to boost R&I in separation and sorting technologies. Innovation should be encouraged by programmes such as Horizon 2020 to develop best possible recovery systems. In addition, projects should be started to discover how to use secondary raw materials in new applications, such as medium density fibreboards.
- Raise public awareness of the positive contribution to the environment by using renewable and recyclable wood-based products.

7.2 Provide sufficient woody biomass from sustainably managed forests

With only a small fraction of imports, the main source in the EU for primary raw material for the Forest-based Industries are domestic forests, managed to provide woody biomass (forests available for wood supply). The EU is global leader in terms of managing forests sustainably for multiple purposes. Societal expectations on forests are diverse (protection against natural hazards, offering attractive space for recreation, wood supply, biodiversity enhancement, climate change mitigation, to name some of them) and their importance changes over time.

Changing climate conditions require adaptation measures in forest management and in the Forest-based Industries. Adaptation in forest management is needed to address changing growing conditions and higher occurrence of disturbances, pest and diseases. This poses challenges regarding forest management practices and correlated wood supply in the EU, not least in view of increasing demand by the industry. As the composition of forests will change, the Forest-based Industries also need to adapt to a decline of softwood species and a higher share of hardwood species in the raw material supply, depending on the area.

The forest ownership structure is one among the several factors that determine greatly current and future raw material availability. Whilst big forest ownership constitutes a minority and often is of public nature, the prevailing private forest ownership is fragmented, heterogeneous and changing. In fact, about 60% of the EU28's forests are owned by 16 million private forest owners. Some traditional rural owners with their capacity to actively manage their own forests are being replaced by new generations of forest owners who live a more modern urban lifestyle and focus on other priorities than active land management and raw material production. More urban lifestyle also influences the availability of forest workers.

Natural conditions determine the potential volume of wood and forest biomass that can be grown in a region, provided the appropriate forest management approach is implemented. For technical, economic, social and environmental reasons, only a share of this potential can be in fact provided to the industry. Therefore, the continuation or increase of primary raw material supply from domestic forest resources encompasses two main tasks: (1) optimize growing of woody biomass, and (2) ensure sufficient provision to the markets.

Primary material supply as well the other various societal expectations from forests should be encompassed in an updated and robust EU Forest-Strategy post-2020 which would provide a framework for a consistent and well-coordinated action at EU level and which would ensure a strong link between this industry vision and the forest sector.

7.2.1 Optimise growing of woody biomass

Challenges

Since the 1960s, forest resources in the EU have been growing in terms of forest area, growing stock and carbon stock in forests. Main reasons for this development are natural forest expansion following agricultural structural changes, afforestation, wider use of modern forest management practices when degraded forests has been replaced with new ones, termination of litter raking and forest grazing, harvesting levels lower than the annual increment, and climate change impacts that promote forest growth. On the other hand, in some EU regions the climate related growing conditions are expected to become less favorable for forests. In addition, growing commodity trade and changing climate conditions have increased the risks from pests, diseases and disturbances. Consequently, forest management has to address both climate change mitigation and adaptation through sustaining and increasing productivity and resilience.

Optimising forest biomass growth while answering to other societal expectations and the impacts of climate change requires more insights and knowledge on future supply potential in connection with future demand, as well support to forest owners' capacity building.

Solution areas

Knowledge on wood potential. There are already many studies on the potential of EU forests to grow woody forest biomass. They use diverse assumptions on framework conditions and address to a varying extend the different types of potential (theoretical, legal, technical, economic) and constraints by other societal interests on forests. Potential solutions build upon:

- Evaluation of the potential from trees outside forests (e.g. land care wood, wood from tree management in cities).
- Further examination on how to enhance the concept of multipurpose forestry that well ensures balance between nature conservation, social needs and economic functions instead of progressive tendency to approach forest functions in a segregative way and thus moving towards more forest to be set aside from active management.
- Evaluation and assessment of changes in forest tree species composition taking into consideration both the market's demand and the effects of climate change. Market demand should also be adjusted to future supply related to changing ecosystem potentials (i.e. change in forest composition) and research and innovation should advise on the best tree species to be planted.
- Evaluation of the impacts of forest disturbances on wood supply and definition of a long-term strategy to manage them. This strategy should address prevention, preparedness, response and recovery, financial support to forest owners, and ad-hoc support to

organize EU-wide collection of calamity-felled trees. It should also consider possible gaps when the foreseen wood supply will be lower due to previous disasters.

- Assessment of the impact of changing values of forests in the society on forest management practices and future wood supply.
- Organization of “outlook meetings” at EU level (for example following the same model as the agricultural sectors outlook meeting). These outlooks could also build on the work and activities carried out within UNECE.

Capacity building for forest owners and support to sustainable forest management. The engagement of forest owners is a key factor for better growth and production of the requested wood quantities and qualities in EU forests. For this, in addition to the need for economic perspectives, it is also important to increase interest and knowledge among forest owners and provide access to advice and training on forest management. Dissemination and implementation of innovative solutions is crucial. These tasks reach beyond the focus of this vision and are therefore not further elaborated here, with the exception of the role of forest owners in forest harvesting and logistics.

7.2.2. Ensure sufficient provision of woody biomass to the markets

Challenges

The Forest-based Industries only can use that share of woody biomass grown in EU forests that is in fact provided to the markets. This provision depends on many aspects, among them technical, logistic, environmental and social ones, as well as on market conditions and their anticipated changes. They can lead to regional shortages at some times. Specific challenges in the EU are the fragmented forest ownership and the regeneration of an aging and shrinking work force in forest operations with interested young people having the skills and investment capacities needed. Digitalisation, automation and robotics offer new solutions for precision forestry and improving the efficiency and competitiveness of forest planning, harvesting, logistics, information flow and traceability, as well as of environmental friendliness, work safety and ergonomics. This will allow a faster and more secure control of the supply chain. New vocational education and training offers, together with training infrastructures, have to be established to provide the skills for effective use of new digital technologies and to attract young generations.

Improving the provision of woody biomass to the markets will need enhanced exchange among stakeholders within and outside the forest-based value chain, incentivizing more wood on the market, ensuring the availability of a skilled labour force, and new technical solutions. These actions can build on the outcomes and findings of previous EU projects and actions on the topic of wood mobilization (e.g. EIP AGRI Focus Group Wood Mobilisation, FP 7 Project Simwood, Good practice guidance on the sustainable mobilisation of wood in Europe).

Solution areas

Evaluate the need for enhanced exchanges among stakeholders within and outside the forest-based value chain

- Encourage exchanges and concertation among national/regional public authorities and stakeholders within and outside the forest-based value chain.
- Evaluate the need for possible additional projects and studies on wood mobilization at EU level.

Incentivize more wood into the market

- Strengthen cooperation within the supply chain on wood logistics and data management to better match demand and supply, improve efficiency and competitiveness of raw material provision, and foster traceability of products. This includes innovative collaborative approaches between industry and forest holders.
- Increase the availability and access to advisory services for forest owners about markets, business and marketing.
- Improve cooperation among forest owners by developing and promoting gathering of small forest owners (forest owners' organizations; forest cooperatives, wood supply cooperatives) with novel practices to offer economically viable solution.

Better coordinate in cases of large-scale disturbances

- In case of large-scale disturbances (e.g. storm damage, bark beetle outbreaks), coordination is needed across Member States, government agencies, local councils and forest sector stakeholders regarding the necessary actions in forest management, logistics and intermediate storage of wood, considering also the wood market development.

8. Boost innovation

Pathway description: Innovation will be key for achieving the sector's 2050 targets on achieving sustainable growth through the development of carbon-neutral technologies. Specific technological challenges and solutions have been identified by the Forest-based Technology Platform in its 2040 Vision and the 2030 Strategic Research & Innovation Agenda providing the first 10-year scheme towards the realisation of the F-BI Vision for 2050. This will also require the implementation of the best framework conditions for research, innovation and development of the sector, including the need to assess the potential for strategic investment projects across Europe and additional funding required to de-risk and deploy investments.

8.1 Establish the best framework conditions for the sector's strategic research and innovation agenda

- **Focus public and private funding on the agreed research & innovation priorities:** Significant efforts have been made by the industry and the research community to identify and agree on the research and innovation challenges that require most attention and funding in the coming years, and therefore a significant funding contribution from the public and major efforts by industry and research community. These challenges are

outlined in section 8.2 and further elaborated in the FTP Strategic Research and Innovation Agenda 2030 (SIRA 2030).

Public investments: Significantly increased public funding to RD&I projects is required to reach the vision for 2050. Today, approximately 5% or €175 million of FBI-relevant RDI funding comes from the EU Framework Programmes (2018). This EU-funding is the “tip of the iceberg” of public and private investments and essential for de-risking strategic developments and creating a critical mass on a European level. An efficient and accessible funding system with efficient funding mechanisms, selection processes and relevant instruments is also essential.

Private investments: Private investments and the availability of venture capital and seed money must significantly increase, both on the European and the regional level. Economically, viable technical solutions must exist and at the time of investment decisions. The Forest-based Industries must be able to attract the attention of investors.

- **Entrepreneurship**: The sector should encourage innovative entrepreneurs and SMEs with high growth potential, especially those who offer enabling technologies that can leap-frog the deployment of new innovations.
- **Impact assessment**: To follow up on overall progress towards the Vision Targets and the efficiency of the innovation system, the FBI need to collect and evaluate research funding statistics and assess the impact of individual R&D projects.
- **Cross-industry cooperation**: Cooperation with other industry sectors is required, especially reaching demo-scale, to de-risk investments, and to allow the penetration of markets new to the FBI.
- **Technology transfer**: More efficient technology transfer mechanisms and dissemination of results from research to industry, as well as between different research projects, are required to avoid duplication of efforts.

8.2 Focus on the strategic innovation challenges identified by the Forest-based Technology Platform

Since it may take several decades before today’s technologies have been replaced with new technologies, significant investments in R&D must be successful in the coming decade in order to accomplish the necessary technology shift until 2050. It is essential focus the efforts on the most urgent problems is essential and the corresponding technological solutions. FTP’s Vision 2040 and corresponding Strategic Research and Innovation Agenda 2030 (SIRA 2030) answer to the call and are crucial steppingstones towards a prosperous and carbon neutral Forest-based Industries by 2050²⁷.

²⁷ For document access visit

These relevant technology areas and challenges are outlined below and further elaborated in the above mentioned FTP documents.

8.2.1 Towards a zero-waste, circular society

Target description: by 2050 material collection and recycling rates of forest-based products as a whole have increased to levels similar to the ones reached by paper and board today, where more than 70% of products placed on the market are recycled. This circular economy stores carbon and substitutes more energy-intensive materials.

Description of main challenges: In order to reach this objective, the Forest-based Industries need to make significant efforts in the coming decade to optimize collection, sorting and separation of materials and recycling technologies will have to be adapted to new and more complex products. Methods to optimize the economy of the recycling chain and make decisions based on well informed cost assessments will be essential. To boost the circularity of forest-fibres and wood products, a key challenge will be to design complex products in a way they can be reused and recycled. The Forest-based Industries need to analyse the role of municipalities, citizens and waste collection companies in the circular economy.

8.2.2 New fibre-based products and lower CO₂ emissions

Target description: The pulp, paper and forest fibre industry is well on its way to reaching the targets – set out in the CEPI 2050 Roadmap (2011) – to cut its carbon emissions by 80 per cent, while creating 50 per cent more added value. While established product segments, mainly paper, packaging and hygiene, have evolved and remain the main source of income, almost half of the new added value is expected to come from other new biobased products such as textiles and green chemicals; all of the above is enabling the society to substitute non-renewable materials with products from pulp and paper industry. Ability to invest in the new technologies is essential for taking the sector and the society further on decarbonisation.

Description of main challenges: To provide sustainable more high-added value, fibre-based, products to the end-consumer. To develop and launch new competitive processes for papermaking. Developing the building blocks for materials and chemicals suitable for the circular bioeconomy. Adding value to existing and new products through digitalisation and functionalization

8.2.3 Diversification of production technologies and logistics

Target description: With new technologies, such as AI, and improvements in automation and digitalization, traceability is fully implemented throughout the value-chain. Diversification of technologies also helps to make small-size production units economically feasible. They might be stand-alone or part of a regional industry ecosystem.

Description of main challenges: Innovative new concepts of industrial symbiosis need to be investigated and established. The processing industry need to research the extraction of natural compounds with high added value and continue the innovation of new biorefinery concepts which incorporates new technologies and production methods into the production system. Additive manufacturing technologies, including 3D-printing offers great opportunities and the challenge is to develop these rather immature technologies so that they are able to replace or complement traditional manufacturing technologies. A major challenge will also be to improve the traceability of raw materials and strengthen the chain-of-custody

throughout the value chain. The sector must also challenge itself to take the lead on integrating autonomous and/or electrified harvesting and transport systems solutions.

8.2.4 Efficient use of natural resources

Target description: activities to foster resource efficiency have resulted in significant improvements in energy efficiency, specific raw material input and specific water use in the Forest-based Industries. This contributes to the provision of high-added value products with a drastically reduced environmental footprint.

Description of main challenges: Research and innovation is needed to reduce the energy consumption in biorefineries, including paper mills by reducing the volume of water, that needs to be heated or steamed from the final product. For the wood manufacturing process, the amount of forest raw materials needed for a unit operation need to be reduced as much as possible. Significant efforts are also needed to innovate new and more efficient methods to separate organic and inorganic compounds from the process water. This will allow the industry to utilise the additional side-streams for value-added products and at the same time help closing the process water loop in areas where water access is scarce.

8.2.5 Renewable building materials for healthier living

Target description: Wood, the most commonly used renewable construction material in the world, has a bright future. In 2040, biobased construction in Europe has tripled its market share from the 2015 level, whilst the overall added value of the woodworking industries has doubled. Increased value will come from new products and services, as well as more widespread use of energy-saving, modular and flexible housing structures and functional furniture

Description of main challenges: There are four major areas of challenges: Two deal with new and innovative building systems and improving the wood-based products, including engineered wood and composites, that are the building blocks of said building systems. Significant efforts are also needed in the areas of harmonization and standardization, as well as in developing more intelligent digital design tools. Finally, the woodworking industries as well as architects and designers need to better understand the factors influencing people's perception of living with wood, as well as study the health benefits of living with wood.

8.2.6 Renewable energy for society

Target description: Energy will be a key sector in the decarbonized economy in 2050, knowing that energy efficiency and the phasing out of fossil fuels are essential. Bioenergy represents today 63% of renewables and will continue to play a major role in the future, maximising synergies with other renewables. Biomass is widely available, storable, and versatile. It will provide reliable energy to industry, especially for high temperature processes, flexible power and heat and transport biofuels. Sustainability and digitalisation will continue to drive the sector.

Description of the main challenges:

- Develop new and efficient production systems for advanced and clean biomass fuels and advanced biofuels, to increase energy density and drive costs down. Pre-treatment of more challenging fuels (e.g. waste streams, agricultural biomass) should become commercial.

- Improve processes towards several outputs, in a biorefinery concept, and of higher quality (e.g. higher steam parameters to decarbonize industrial processes).
- Increase plant flexibility (e.g. ramp up time, fuel flexibility) to better balance heat/electricity grids.
- Establishing integrated and holistic energy systems (including energy storage and Carbon Capture and Utilization/Storage to enable negative emissions).

8.2.7 Increased, sustainable wood production and mobilization

Target description: Research, innovation and careful, long-term sustainable and multipurpose forest management have increased harvesting possibilities in Europe by 30 per cent, between now and 2040.

Description of main challenges: To accomplish the wood-mobilization target, forest managers, forestry contractors and the industry need to use the tools provided by the digital revolution to significantly increase the precision of forest operations. Innovations in the area of novel technologies, for instance related to automation, will be essential. To steer the direction and support strategic decisions, foresight market studies and analysis of material flows is needed.

8.2.8 Purposeful, safe jobs and links between rural and urban regions

Target description: In 2040, the forest-based sector is an attractive employer, known for providing meaningful and safe jobs in rural as well as in urban regions. It is well known for developing the skills of its workers and managers and has significantly increased the number of employees involved in different aspects of research, development and innovation activities.

Description of main challenges: Improving safety and ergonomics of operators in factories, forest contracting companies and forest management is a major challenge requiring research and innovation. Creativity and creative design provide an edge for products and services but so far, the creative jobs have often been downstream of the forest-based industries. In-sourcing of creative jobs can help the Forest-based Industries to become more agile and respond quicker to new market needs. Small forest ownerships are often under-managed, which significantly reduces the market opportunities for downstream services and industries. It is a major challenge to find ways to encourage a more diligent forest management in order to grow the job market. A major challenge is to plan and adapt the companies job offers when Artificial Intelligence and automation quickly can replace whole worker categories, for instance in the transport sector.

9. Crosscutting partnerships: data, skills and attractiveness

Pathway description: a set of horizontal issues are crosscutting the three pathways on markets, resources and technology and will need to be addressed by each. These include the availability or further development of science-based data and methodologies, the social dimension and skills agenda for the workforce as well as awareness-raising and communication in the value chain.

9.1 Tackle data gaps and enhance the knowledge base on the F-BI Sector

Challenges

The availability or further development of reliable data and methodologies is essential to the achievement of the 5 goals and is horizontal to the three fields of actions described in the previous chapters. In particular:

- On the supply side, the Forest-based sector need to bring reliable information to the permanent debate on the availability of wood resources.
- On the demand side, supporting data and science-based assessments of the environmental impact over product life cycles is required.
- Moreover, filling data gaps and addressing inconsistencies in the official statistical databases would ensure better market trends assessment for forest-based products. For example, it is currently impossible to single-out the economic performance of the forest-bio-based products in existing statistics.

Solution areas

- Close cooperation between the industry and organisations like JRC is welcome to closely monitor bioeconomy and biorefinery developments in Europe. Studies should be produced and updated periodically, and data should be made public.
- Both in the PRODCOM list and in the Harmonised System separate codes to track engineered-wood products (glulam, CLT, LVL, I-joist) should be created, in cooperation with the industry. It is also important to have data at EU level regarding dwellings with a wood-frame (e.g. share on total dwellings broken down by EU country). If there are no resources to create a new database tracking wooden housing, a second-best solution would be an EU Commission study on this to be periodically reviewed.

9.2 Develop skills and improve the attractiveness of the sector

Challenges

The entire forest-based sector faces challenges related to demographical changes within the workforce and needs to improve its skills retention capacity and attractiveness. For example, 53% of the workforce in the UK timber industry is over 40 years old, and severe shortage of skills will materialize if the number of new entrants stays at current level. Moreover, 65% of children entering primary school today will ultimately end up working in completely new job types that don't yet exist. Anticipating and assessing technological change in the industry is needed in order to tackle the so called "skills-gap" and to define the new needs of the labour force. Demand for manual labour will be reduced while engineering and computer skills will be more and more sought after. Adaptation mechanisms should consequently be put in place to address the skills-gap, but also the increasing shortage of skilled workers in the production sector. This is a common need across the entire forest-based sector value chain, and solution areas will be explored by the industry.

Solution areas

- **Ensure the availability of skilled workforce and of technical solutions to wood harvesting, logistics, transport and traceability challenges:**
 - The industry should map current labour, machinery and skills capacities in forest operations and assess future gaps in human, machinery and investment capacities as well as regarding skills.
 - Support and exchange information on the development of necessary professional skills related to forest operations and transport (e.g. electric trucks).
 - Develop environment-friendly infrastructures inside and outside the forests (e.g. forest roads; rural roads) and innovative schemes to enhance the access to primary raw material.
 - Support technology developments.
 - Plan coordinated actions to improve attractiveness of the sector in colleges, high school and to the general public

- **Address the lack of skilled workforce in the pulp and paper, printing, wood and furniture sectors**
 - Strengthening in-company training by increasing the permeability of the education system, encouraging the uniform recognition of vocational qualifications throughout Europe, developing education programmes, upgrading of job profiles in the production sector by new content and digitalization are important drivers to help tackling the matter. For example, competences on new digital systems (for example, Building and Information Modeling in construction) should be mainstreamed across the sector.
 - Collaboration with Social Partners is also key to render the EU market more dynamic and to strengthen ties among schools, universities, design institutes and companies. European sectoral social dialogue in the furniture, pulp and paper, printing, wood and furniture sectors is a key platform to spur initiatives to develop and upgrade skills in the sector.

- **Increase the attractiveness of the sector**

Attractiveness of the sector towards young generations should be increased. Local communities should collaborate with the industry to improve the image of the sector and communicate to society the importance of forests and Forest-based Industries while showcasing the correlated innovative and sustainable character. As an example, the woodworking sector is working on improving its communication to young generations and has launched joint initiatives with Social partners at EU level to tackle the issue. In particular, it has started a study on the perception of the sector that also aims to issue concrete recommendations on how to bridge the gap between the industry and young workers.

- **Strengthen the F-BI research community.** The best people from academia and research and technology organisations should be encouraged to solve the RTI challenges related to the development and deployment of forest-based carbon neutral technologies.

ANNEX I – Key Statistics on Forest-based Industries

Key statistics 2016 – EU28²⁸

NACE	Sector	Turnover (M€)	Added value (M€)	Enterprises	Persons employed
16	Wood and wood products	128 373	33 885	168 484	968 084
16.1	Sawmilling and planing of wood	37 700	7 870	33 626	240 000
16.21	Veneer sheets and wood-based panels	23 346	5 483	2 267	91 818
16.22	Assembled parquet floors	2 327	n.a.	1 049	16 915
16.23	Other builders' carpentry and joinery	42 946	14 035	93 700	415 380
16.24	Wooden Containers	12 157	3 218	8 930	94 400
16.29	Other products of wood	9 897	2 712	28 912	109 571
17.1	Pulp, paper and paperboard	80 166	18 550	495	165 476
17.2	Articles of paper and paperboard	104 149	27 875	17 660	483 596
18.1	Printed products	79 505	29 882	112 000	707 403
31	Furniture products	100 000	33 000	120 000	1 000 000
	Bioenergy	31 940	n.a.	n.a.	352 500
	Total	524 133	143 192	418 639	3 594 256

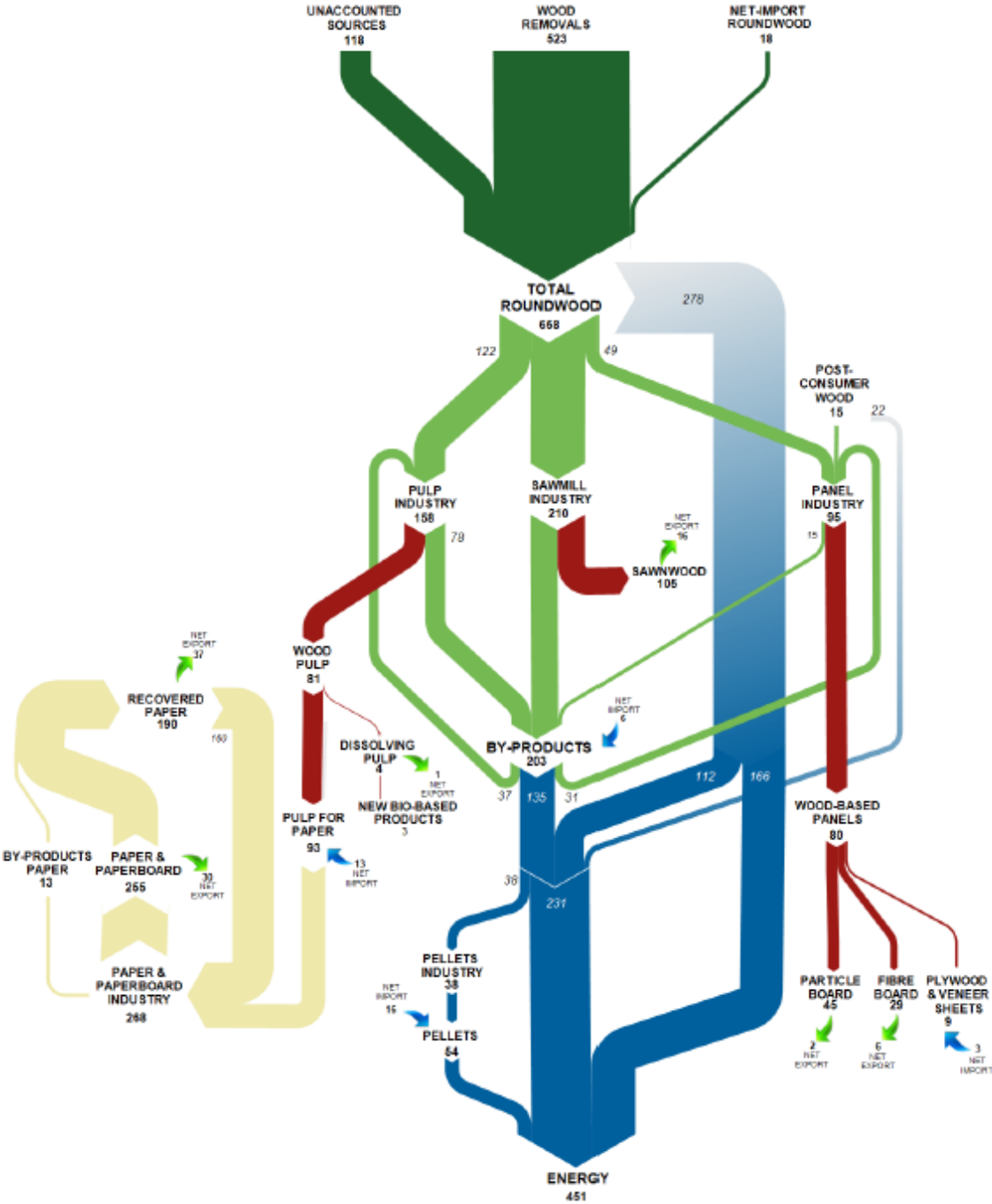
Trade flows of forest-based products (million EUR) 2016 - EU28

NACE	Sector	Extra-EU import	Extra-EU export	Net trade
16	Manufacture of wood and wood products	8 420	10 805	2 385
16.1	Sawmilling and planing of wood	2 700	4 518	1 818
16.21	Veneer sheets and wood-based panels	2 035	2 674	639
16.22	Assembled parquet floors	422	499	77
16.23	Other builders' carpentry and joinery	689	1 664	975
16.24	Wooden Containers	351	568	217
16.29	Other products of wood	2 223	882	-1 341
17.1	Pulp, paper and paperboard	9 102	16 520	7 419
17.11	Manufacture of pulp	4 631	2 307	-2 324
17.12	Manufacture of paper and paperboard	4 471	14 213	9 743
17.2	Articles of paper and paperboard	3 305	5 543	2 238
18.1	Printed products	2 791	5 552	2 761
31	Furniture products	25224	22172	-3052
	Total	48 839	60 202	11 362

²⁸ Sources: Eurostat, CEPI and Bioenergy Europe.

ANNEX II - Wood resource flows in the EU-28

For what concerns the use of roundwood (both domestically sourced and imported), 58% goes to material use (381 Mm³) and 42% to bioenergy (278 Mm³). The Sankey diagram below displays how material and energy wood flows are interlinked within the forest-based sector, including through cascading use. On top of forest removals, by- and co- products supply, post-consumer wood is used in manufacturing applications (pulp and paper and panel industries).



JRC 2018. Sankey Diagram of wood resource flows in EU 28 (year 2015). Unit: Mm³ SWE o.b.

ANNEX III - Relevant EU Policy and Vision Framework

A non-exhaustive summary of the legislative and non-legislative framework at European level is provided below, but one should also consider that national policies, such as forest policy, and voluntary market-based tools directly affect the development of the sector.

At the same time, the sector actively contributes to the attainment of the main EU policy priorities. An illustration of how the implementation of the vision and of its three focus areas would contribute to the EU agenda is provided in the table below.

EU Strategies	Markets	Raw Materials	Research&Innovation
A Clean Planet for All Communication	✓	✓	✓
Industrial Policy Strategy 2030	✓	✓	✓
Circular Economy Action Plan	✓	✓	✓
Updated Bioeconomy Strategy	✓	✓	✓
Forest Strategy	✓	✓	✓
Adaptation Strategy		✓	
Biodiversity Strategy		✓	
FLEGT Action Plan	✓		
EU Timber Regulation	✓	✓	
Strategy for the sustainable competitiveness of the construction sector and its enterprises	✓		
InvestEU package	✓	✓	
Legislation			
Research and Innovation (Horizon) Regulation			✓
Waste Framework Directive	✓	✓	
Directive on packaging and packaging waste	✓	✓	
Directive on the landfill of waste	✓	✓	
Regulation on shipments of waste	✓	✓	
LULUCF Regulation	✓	✓	
Renewable Energy Directive II	✓	✓	
General Safety of Products Directive	✓		
Construction Products Regulation	✓		
Common Agricultural Policy		✓	
Birds and Habitats Directives		✓	
Agricultural Block Exemption Regulation and Community Guidelines for State aid in the agriculture and forestry sector		✓	
EU Sustainable investments Regulation (proposal)	✓	✓	

ANNEX IV - FTP 2040 Vision Targets

1. Sustainable forest management, biodiversity and resilience to climate change

The importance of sustainable and multifunctional forest management is widely acknowledged, due to its benefits for society. Resilient and diverse European forests, managed through different types of ownership, provide a wide array of forest ecosystem services including raw material production, climate change mitigation, biodiversity conservation and protection of water-related ecosystems.

2. Increased, sustainable wood production and mobilization

Forest growth is increasing, leading to increased CO₂ sequestration. Management practices are being further optimized for even higher productivity and stand quality. The creation of climate change-resilient and stress-tolerant forests is particularly important. Research, innovation and careful, long-term forest management have increased harvesting possibilities in Europe by 30 per cent, between now and 2040.

3. More added value from non-wood ecosystem services

In 2040, we have successful new business models based on forest ecosystem services. They are often based on cross-sectoral cooperation with sectors such as food, water and tourism. The added value from new markets for non-wood forest goods (mushrooms, berries, clean water) and services (recreation, tourism, climate change mitigation) has increased tenfold.

4. Towards a zero-waste, circular society

By 2040 material collection rates of forest-based products have increased to 90 per cent and their reuse and recycling account for 70 per cent of all recyclable material. This circular economy stores carbon and substitutes more energy-intensive materials.

5. Efficient use of natural resources

Activities to foster resource efficiency have resulted in significant improvements in energy efficiency, specific raw material input and specific water use in the Forest-based Industries. This contributes to the provision of high-added value products with a drastically reduced environmental footprint.

6. Diversification of production technologies and logistics

With new technologies, such as Artificial Intelligence, and improvements in automation and digitalization, traceability is fully implemented throughout the value-chain. Diversification of technologies also helps to make small-size production units economically feasible. They might be stand-alone or part of a regional industry ecosystem.

7. Purposeful, safe jobs and links between rural and urban regions

In 2040, the forest-based sector is an attractive employer, known for providing meaningful and safe jobs in rural as well as in urban regions. It is well known for developing the skills of its workers and managers and has significantly increased the number of employees involved in different aspects of research, development and innovation activities.

8. Renewable building materials for healthier living

Wood, the most commonly used renewable construction material in the world, has a bright future. In 2040, biobased construction in Europe has tripled its market share from the 2015 level, whilst the overall added value of the woodworking industries has doubled. Increased value will come from new products and services, as well as more widespread use of energy-saving, modular and flexible housing structures and functional furniture.

9. New fibre-based products and 80 per cent lower CO₂ emissions

The pulp, paper and forest fibre industry are well on its way to reaching the targets – set out in the CEPI 2050 Roadmap – to cut its carbon emissions by 80 per cent, while creating 50 per cent more added value. While established product segments, mainly paper, packaging and hygiene, have evolved and remain the main source of income, almost half of the new added value is expected to come from other new biobased products such as textiles and green chemicals.

10. Renewable energy for society

Thanks to new and innovative production technologies, reduced overall energy consumption, increased recycling, reuse and refining of side-streams, the sector will continue to be the biggest producer of green electricity/heat/biofuels in Europe, with a capacity in 2040 to provide the equivalent of 100 million barrels of crude oil (produced from about 65 million m³ of forest and mill residues).

