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5 Hub Roadmaps on inter-regional wood mobilization solutions transfer and one cross-regional on European knowledge transfer framework and possibilities in wood mobilization

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ROSE WOOD 4.0 Sustainable Wood for Europe

NORTHERN HUB ROADMAP

https://rosewood-network.eu/

Northern Hub Roadmap

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1. Introduction

Modern information and communication technologies (ITC) continue to develop rapidly in all sectors of the economy and society. The forestry sector (compared to agriculture or manufacturing sectors) is however lagging behind in terms of adaptation and spreading of modern ICT solutions. A major challenge is the large variety of ecosystems, forest owner types, supply chain actors and stakeholders, and regional disparities of technological progress. Forest industry 4.0 solutions (including new measurement sensors, high resolution digital maps, forest planning tools, risk monitoring, realtime data exchange and control, logistical optimisation, etc.) are a major field of innovation and future market, which will enable continuous information exchange at all stages in the supply chain, tracking timber flows from forest harvesting to processed wood products and markets. Furthermore, Decision Support Systems (DSS), educational tools and marketing platforms for forest owners are more and more emerging to connect knowledge and practice, and the actors within a region. This will leverage huge benefits for resource efficiency, sustainable use and climate change mitigation. These solutions can however only be exploited to their full potential, if they are more adapted and adopted, disseminated and deployed in the various regional contexts. The need for broader sharing of ITC-driven solutions and best practices is imminent and increasing, to maintain and enhance the competitiveness of Europe's forest industry by transforming it to a forest industry 4.0.

Digitalisation is one of the most powerful drivers of change in all aspects of society. In forestry, it has the potential to enhance the information flows and the relationships between actors (owners, managers, authorities, workers, communities and society) at all steps of the value chain. It has the potential to improve decision-making, empower forest managers and workers to achieve greater sustainability and fulfilment of multi-functionality standards as well as improving efficiency and transparency. However, the adoption of digital solutions is generally slow and very uneven across Europe. Through its Roadmaps, ROSEWOOD4.0 identifies and supports the adoption of close to market solutions and the replication of success cases by stakeholders of the value-chain.

Throughout Europe, the challenges for a sustainable wood mobilisation are diverse and often a lack of specific knowledge leads to non-ideal solutions. However, international and interregional knowledge transfer offers the potential to improve this situation. Against this background, the ROSEWOOD4.0 project has initiated five regional Hubs throughout Europe bringing together 21 partners from 18 countries to steer the interregional knowledge transfer on sustainable wood mobilisation:

- Northern Europe: Finland, Sweden, Norway, Baltic countries, Denmark
- Central-West Europe: Germany, Belgium, France, Switzerland, Austria
- Central-East Europe: Czech Republic, Hungary, Poland, Romania, Slovakia, Ukraine
- Southern-West Europe: Spain, Italy, Portugal and South of France
- Southern-East Europe: Bulgaria, Croatia, Greece, Slovenia

These 5 communities within ROSEWOOD4.0 will facilitate wood mobilisation through mutual learning across European regions. ROSEWOOD4.0 builds on the insights and experience gained in recent research and innovation efforts and will implement specific activities to reinforce digitalisation of the forestry domain with a sharp focus in the most relevant innovation opportunities in the following areas which are highly impacting the sustainable wood mobilisation: (a) Engaging forest owners and overcoming land tenure fragmentation, improved forest planning and risk management, adapted silvicultural measures for increased multifunctionality and biodiversity conservation; (b) Design and maintenance of infrastructures, optimized forest operations and logistics for improved economic and environmental performance; (c) Organisation and transparency of regional wood markets; new business models and market arrangements; (d) Access to finance and business support, including through EAFRD measures and PES (payment for environmental services) type mechanisms; legal and fiscal regimes; (e) Education, training and skills development.

By creating adapted materials and extensively sharing technological and non-technological innovations, best practice cases and RDI results, **ROSEWOOD4.0 multi-stakeholders approach** closes knowledge gaps and creates new opportunities for economic partnerships within the whole wood mobilisation value-chain. ROSEWOOD4.0 focuses on tailored (user- and region-specific) **transfer of know-how and information** that enables and supports **stakeholders of the wood value-chain to exploit innovations and best-practices** and facilitates the capture of innovative ideas enhancing the development of the field. ROSEWOOD4.0 aims also to provide practitioners with development skills (educational and entrepreneurial) and facilitate organisational innovations leading to **novel exploitation actions** leveraging the uptake of new ideas and Best Practices in daily business.

The roadmaps presented here address stakeholders throughout Europe for facilitating the transfer of knowledge and collaboration between partnership regions. The roadmaps represent the collection, the analysis and strategic direction of the results from the five Hub regions including their validation. The main objective of the roadmaps on Hub level is to strengthen the regions through transfer of the gathered knowledge, experiences and circumstances. With the accurate description and assessment of well-functioning best practices and innovations as inputs, there is an active support in strengthening the local wood value-chain development thanks to newly developed digital tools. Further, the roadmaps enhance cooperations by increasing interactions between stakeholders and regions for creating opportunities to initiate further and new developments. Relying on networks , it supports the self-initiative and empowers the forestry to push new actions. For this purpose, the roadmaps highlight best practices and innovations (BPI) that have the potential to serve as tools for prosperous and sustainable wood mobilisation among European regions. ROSEWOOD4.0 has initiated a web-portal for presenting the best practices and innovations to the wider public and stakeholders. This way, new solutions can be incorporated and the transfer of best practices monitored. The roadmaps give readers insights into regional perspectives of wood mobilization, capitalizing on information and cooperation possibilities between European regions. By steering the knowledge transfer between the regions, the roadmaps aim to provide a European perspective on digitilization issues in the forestry domain. In times of structural changes, a changing climate and new technologies, the ROSEWOOD4.0 Hubs can rely on a broad knowledge base from various countries for identifying suitable approaches for their regions. For this purpose, the roadmaps shall pave the road towards more collaboration between the regions, transfer of best practices and innovations meeting the needs of the regions. All this will further develop the ROSEWOOD4.0 network and strengthen the individual regions onto their path towards a sustainable wood mobilization and the transition to a bio-based economy in Europe.

2. Interregional Roadmap for the Northern Hub

2.1 Description of the Northern Hub region

The Northern Hub of the ROSEWOOD4.0 project covers the Northern part of Europe, with a special focus on Finland, Sweden and Norway. The three countries will be briefly introduced in the next paragraphs. Most of the forests in the Northern Hub belong to the boreal forest zone, also referred to as taiga forests. Climate is subarctic with a large temperature range between seasons.

For all three countries considered, conservation of biodiversity is a priority policy issue in both scientific and operational aspects. The Northern model for protecting forest biodiversity is a combination of general conservation considerations in all forest management and the designation of more strictly protected forest areas. Even-aged forestry has been the dominant silvicultural system in Sweden, Finland and Norway since the 1950s. The silvicultural system follows a cyclic harvest-and-regeneration pattern on the stand level. To obtain a long-term sustainable flow of timber from the forest, an even age-class distribution on the regional and national level has been a long-term target in forest policy.

Finland is the most forested country in Europe. Forests cover 75 % of the land surface with 22.8 mio. hectares of forest land. The majority of the Finnish forests (85 %) are PEFC-certified, while another 10 % are FSC-certified. Private, non-industrial owners possess 61 % of the forest area, whereas 25 % is state-forest and 8 % belong to private industries. Statistically, this translates into four hectares per citizen in Finland, while the European average is only 1.3 hectares.

Forest inventories in Finland have a very long tradition, the first nationwide forest inventory was made already in the 1920s. Finland was the first country in the world which completed its national forest inventory (NFI) in 1924. The ongoing NFI cycle is 13th. The results of nationwide national forest inventories are widely used. Planning of national forest policies has been the most important motivation for funding NFIs. The collected information has been used to prepare forest sector Master Plans with an aim to increase the production of timber. In recent decades, these Master Plans or forest strategies have recognized the need for sustainable development, considering economic, ecological, and social aspects, and in recent years increasingly the need for mitigating climate change.

The dominating tree species in Finnish forests are spruce, pine, downy birch and the silver birch, Finland's national tree species. In total, approximately 30 tree species are naturally present in Finland. Most of them are deciduous, with only four conifers: Scots pine, Norway spruce, common juniper and European yew. Some of the tree species – of these conifers, juniper and European yew – often remain bush-like. These species are common throughout Finland, apart from northernmost Lapland and the highest fell areas. Additionally, many non-indigenous species are cultivated in Finland, mainly used for ornamentals, even though they are not significant in timber production. Among these, conifers have been of particular interest for Finland for a long time, due to the limited number of native coniferous tree species.

Paper production in Europe is concentrated in the Northern European countries including Finland, Russia, and Sweden. Finland is among the leading pulp and paper producers in the world, with an annual production of 11.3 mio. tons. Forest-based industry products account for over 20 % of the exported products in Finland (worth 13.1 mio. €).

In order to further increase the economic production of bio-based products, there have been plans of a biofuel factory and 1-2 biorefineries, which would rely on sustainable felling and removal of stem wood. In February 2021, the Metsä Group announced its investment decision to build a bioproduct mill in the South-western part of Lapland, Kemi. The new mill will be the historically largest forest industry investment (1.6 billion €) in Finland.[1]

The region of Finnish Lapland is a highly forested region with 90,700 km² of forestry land, meaning 98 % of the total area is forested land. The region of Lapland comprises seven national parks, 12 wilderness areas, 8 nature parks and around one quarter of the forests are under conservation. Relying on a total standing timber volume of 417 mio. m³ in Lapland, the share of forest-based bio economy in output, employment, added value and investments is much higher than in other parts of Finland. The forestry industry creates a total output of 1.3 billion € per year resulting from a utilization of 5.8 mio. m^3 of wood per year, which is mostly used locally by the forest industry, sawmills etc. Contrary to the national level, only around one third of the forests are owned privately, while the largest share of 60 % is state-owned forest, complemented by companies, parishes etc. owning 7 %. While the average size of a forest estate is 46 hectares, a total of 330,000 hectares belong to forest consolidations.

[1] Metsä Group, Investments, https://www.metsagroup.com/en/about-us/Investments/Pages/default.aspx (31.08.21).

• 90,700 km² of forestry land • Approx. 2.13 million hectares area of private forest holding • 330,000 hectares area of jointly owned forests • 32932 pcs private forests • 417 mio. m³ gross volume of the stand • 12.2 mio. m³ increment of growing stock per year • 6.33 mio. m³ cutting possibilities of commercial timber

Table 1: Facts on Finish Lapland Forestry[2]

Forests	Economic significance
• 75 % of Finland is forest land • Total volume in forest 2 482 million m^3 • The annually growth is 108 million m^3 • The annually felling is 73.3 million m^3 • 85 % of the forest land is in active use • 13 % of the forest land is protected • Forest sector is 4 % of GNP in Finland • Every year, at least 150 million trees are planted in Finland • Over the past 100 years, Finland's forest volume increased by 90 %	• World's 4th largest exporter of pulp, paper and sawn timber • Export value, 2018: € 13.2 billion • 96 % of board, 94 % of paper and 43 % of pulp are exported • Over € 700 million was invested in 2018
Production volumes, 2018	**Energy**
• 8.2 million tons of pulp (of which 4.3 million tonnes market pulp) • 6.7 million tons of paper • 11.8 million m3 of sawn timber • Employment • 41,000 employees in forestry	• 75 % of the heating energy used by the forest industry is wood-based bioenergy • Electricity consumption: 25 % of Finland's total electricity consumption.
Sustainability[3] • The purpose of forest legislation is to promote economically, ecologically, socially and culturally sustainable forest management and use in order that they produce a good output in a sustainable way while their biodiversity is being preserved. • The sustainability of forest management is assessed and monitored on the basis of the Pan-European Criteria and Indicators for Sustainable Forest Management. The National Forest Inventory (NFI), the monitoring system for forests and forest resources, produces diverse information on Finnish forests • The certification systems currently in use in Finland are the PEFC and FSC. Most of the commercial forest area in Finland, about 90 %, is certified under Finland's PEFC scheme, while about 10 % is certified under the FSC standard.	

Table 2: Facts on Finnish forests[4]

[2] https://www.metsakeskus.fi/sites/default/files/infografiikka-lapin-metsat-arktinen-alykas-eng.pdf.
[3] Sustainable forest management - Maa- ja metsätalousministeriö (mmm.fi).
[4] Natural resources Institute Finland.

Two thirds of ***Sweden's*** land surface – or some 28 million hectares – is covered by different types of forests. Of this, some 23 million hectares are considered productive forests. The forest sector's importance to the national economy is significant. More than 300,000 private individuals own forest land themselves. Family-owned forests represent around 50 % of the total forest area and some 60 % of the total annual yield. For many other people, the country's forests are also important – for hunting, for picking berries and mushrooms, for recreation, tourism and contemplation.

Sweden is a forest nation, and the forest industry plays a major role in the Swedish economy. Today, the forest industry accounts for 9-12 % of the Swedish industry's total employment, exports, sales and added value, according to figures from the Swedish Federation of Forest Industries 2014. The forest industry is heavily export-oriented and makes a significant contribution to Sweden's trade balance.

The largest landowner in Sweden is state-owned Sveaskog AB, which owns 3.1 million hectares of forest land, or almost 14 % of the country's forest land. The Swedish Church is also a large forest owner with 990,000 hectares.

The basic idea guiding Swedish forest policy and forestry-model is that forests shall be managed to provide economic, ecologic, as well as social benefits. Efficient and sustainable production of wood for different end-uses shall go hand in hand with the preservation of valuable ecological- and socio-cultural values. In Sweden, the multi-functional role of forests is safeguarded through regulations on the use of forests across the entire forest area. In addition, land with significant ecological - or other values is protected, or the management of such land is adapted.

The forest industry plays an important role for the Swedish economy. It is also heavily export-oriented and makes a significant contribution to Sweden's trade balance. Sweden is the world's second largest exporter of pulp, paper and sawn wood products combined. Of the pulp and paper production, close to 90 % is exported. As for pulp production, around a quarter of the total consumption of pulp within the EU are manufactured in Sweden. Of the Swedish industry's employment, turnover and value added, the forest industry accounts for 10-12 %.

The Region North Middle Sweden consists of three counties: Gävleborg, Dalarna and Värmland. The area borders the Baltic Sea in the east, Norway in the west and extends in a belt across the middle parts of the country and Middle Norrland in the north. The area has rich natural resources, a magnificent and varied environment, with mountainous areas in Dalarna, large areas of forest in Värmland with deep valleys and a long coastal strip in Gävleborg. North Middle Sweden has several joint business development opportunities with great potential in relation to trade and industry. There is a total of 41 municipalities with a population of approximately 826,000, giving a population density of 13 persons per km^2. North Middle Sweden is undergoing a shift from being an industrial community to a knowledge-based community, while the issue of climate change is becoming increasingly significant.

This necessitates an enhanced focus on regional growth efforts. The next Structural Funds programme for North Middle Sweden will therefore focus on renewal and sustainable growth. North Middle Sweden is near expansive growth markets such as the Mälardalen valley and Norway/the Oslo region. This presents opportunities for trade and industry in the shape of important sales markets for products and services. It also makes larger labor market regions possible. The Europe 2020 strategy emphasizes three priorities of key significance for development and growth in Europe over the next 7-year period.

- Smart growth, developing an economy based on knowledge and innovation
- Sustainable growth, promoting a more resource efficient, greener and more competitive economy and increasing the standing timber with 15 %
- Inclusive growth, fostering a high-employment economy delivering social and territorial cohesion
- 5.6 million hectares forest

• 56,000 forest owners • 685 million m^3 standing timber in the forests • 20,5 million m^3 harvested for industry in 2019 • 23,000 employees in the forests

Table 3: Facts on North Middle Sweden

Forests • 70 % of Sweden is forest land • Total volume in forest 3,533 million m^3 • The annually growth is 120 million m^3 • The annually felling is 80 million m^3 • 80 % of the forest land is in active use • Every year, at least 380 million trees are planted in Sweden • Over the past 100 years, Sweden's forest volume increased by 100 %	**Economic significance** • World's 3rd largest exporter of pulp, paper and sawn timber • Export value, 2018: € 14.5 billion • 80 % of the products are exported • A little over € 1.54 billion was invested in 2018
Production volumes, 2018 • 11.9 million tonnes of pulp (of which 4.3 million tonnes market pulp) • 10.1 million tonnes of paper • 18.3 million m^3 of sawn timber • Employment • 70,000 employees in forestry • A further 50,000 one-man businesses active in forestry	**Energy** • 96 % of the heating energy used by the forest industry is bioenergy. • Electricity consumption: 20 TWh per year – just over 15 % of Sweden's total electricity consumption.
Sustainability • Of the country's total greenhouse gas emissions, the forest industry accounts for around 1 %. • Since the start of the 1980s, pulp and paper mills have reduced the organic materials they release into the water system by 90 %. At the same time, pulp production has risen by 30 %. • Since the start of the 1980s, pulp and paper mills have reduced the sulphur compounds they release into the air by 98 %. At the same time, pulp production has risen by 30 %.	

Table 4: Swedish Forests in facts

Almost 38 % of the land area in ***Norway***, or 121,000 km^2 (12.1 mio hectares), in Norway is covered by forest.[5] Of this, around 82,800 km^2 (8.28 mio hectares) is productive forest, which means that it produces enough timber to be economically important. The total standing timber volume in the Norwegian forests is 978 mio m^3, and the annual regrowth is 24.2 mio m^3. The dominant tree species is the Norwegian Spruce with a standing volume of 428.3 mio m^3 and an annual regrowth of 12.8 mio m^3, followed by Scots Pine with 302 mio m^3 standing volume and 5.5 mio m^3 annual regrowth. The annual harvest is about 12 mio m^3, meaning that there are opportunities to increase the harvest without reducing the volume in forests over time. The export of timber increased significantly over the years 2012-2016 and is now about 3.5 mio m^3 annually.

There are more than 125,000 separate forest properties in Norway, and 77 % of the area is owned by private individuals, mainly farmers. 60 % of the properties are 25 hectares or smaller. Each year, there is conducted

[5] Statistics Norway.

harvesting on about 14,000 of the properties. While forestry is a traditional and important industry in Norway over most of the country, the largest forest county is Inland county. Around 25,000 persons are employed in the forest-based value-chain in Norway[6] . Almost all of the Norwegian forests are PEFC- or FSC-certified[7].

The Inland Region is the largest forest region in Norway; approximately 50 % of the region's area – 2.6 million hectares – is forest, and the region accounts for 26 % of both the national productive forest area and timber volume, as well as 40 % of Norway's annual harvest of timber. 37 % of the harvested timber come from properties larger than 500 hectares, 27 % from properties of 100-500 hectares and 36 % from properties smaller than 100 hectares. 87 % of the timber comes from forests owned by private persons and municipalities. 53 % of the standing volume in the forest is spruce, 37 % pine and the rest are various deciduous trees. 43 % of the national value creation in the primary forestry is made in the Inland Region, which employs 2,200 people, and provides a basis for 6,300 employees throughout the value chain. The region comprises 11 national parks and more than 300 nature reserves and other areas protected by law.

• 2,6 million hectares forest • 230 million m^3 standing timber in the forests • 4,6 million m^3 harvested for industry in 2019 • Timber sale worth €200 million • 2200 employees in the forests • 6300 employees throughout the value chain • 18000 km private forest road

Table 5: Facts on the Inland Region

Forests	Economic significance and employment
• Norwegian forests cover an area of 12.1 million hectares – 38 % of the land area • Total volume is 978 million m^3 • Annual cuttings 12 million m^3 • Annual growth 12,8 million m^3 • 43 million trees planted in 2019, the number increases annually	• Almost 6,000 employees in forestry • About 21,000 employees in forestry and wood-based industry • Export value timber and paper, 2019; € 906 million • Average annual income from forestry for forest owners, 2019: € 4,200 • Total production value of timber and wood products through the value chain is approx. € 3.8 billion, or 0.5 % of Norway's total value creation
Production volumes, 2018 • 4.4 million m^3 timber for pulp industry • 5.9 million m^3 sawn timber • Employment • 25,000 employees in the forest-based value chain	
Sustainability • 6 million hectares – 75 % of the productive forest area is PEFC-certified • 0,4 million hectares – about 100 properties – are certified by both PEFC and FSC • 70,000 key biotopes, covering about 75,000 hectares forest, are registered	

Table 6: Norway forest in facts

[6] Regjeringen.
[7] Skogeierforbundet.

2.1.1 Political Targets for Wood Mobilisation and Forestry

Under the scope and aims of the Arctic Council, climate change mitigation and reducing black carbon emissions are sought. The Arctic Council is the leading intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States, Arctic indigenous communities and other Arctic inhabitants on common Arctic issues, in particular on issues of sustainable development and environmental protection in the Arctic.[8] The Ottawa Declaration lists the following countries as Members of the Arctic Council: Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden and the United States. Climate change and environmental protection are at the core of Arctic cooperation.

Common areas of interest of the Northern Hub include capacity building, risk management, connectivity, cold-climate technologies and services, maritime transport, energy, bio economy, tourism, housing and mining. Putting into practice the commitments of the Paris Climate Agreement will be the most important contribution from the Member States in addressing climate change. At the same time, the implementation of the Arctic Council's "Framework for Action on Enhanced Black Carbon and Methane Emissions Reductions" (2015) will provide an additional measure. Northern Hub countries thus encourage projects and actions aimed at reducing emissions, facilitating adaptation, and raising awareness on climate change.

Maintaining diversity is an important part of current forest management in all Northern countries. In 2020, the European Union has published a biodiversity strategy to turn Europe's biodiversity on a path to recovery by 2030. The strategy is very ambitious, and it will have a great influence on the forest industry.

In *Finland*, forestry policy aims to steer the choices made by forest owners and the use of forests in the direction desired for society. International weightings are increasingly influencing the content of national policies. Forest policy guides forest and natural management, logging and harvesting of wood. The means of forestry policy have traditionally been divided into:

- regulation, such as forest legislation,
- economic guidance such as the Fixed-Term Financing Act for Sustainable Forestry (Kemera) and taxation, as well as
- information guidance, such as forest owners' advice and forest planning.

As the emphasis on the use of forests in society changes, efforts are being made to guide forest owners and the use of forests by changing the above instruments.[9]

In *Sweden*, forest policy equates environmental goals with production goals. Current forest policy has two overarching and equal goals, namely a production goal and an environmental goal.

The production goal means that the forest and forest land must be used efficiently and responsibly so that it provides a sustainable good return. The focus of forest production must give the forest owner the freedom and responsibility to decide for herself/himself on the use of what the forest produces.

From the environmental aspect, the natural production capacity of the forest land must be preserved. Biodiversity and genetic variation in the forest must be ensured. The forest must be farmed so that plant and animal species that naturally belong in the forest can survive under natural conditions and in viable stands. Endangered species and habitats must be protected. The forest's cultural environment values and its aesthetic and social values must be protected.

The five policy focus areas are:

- Sustainable forestry with increased climate benefits

[8] https://arctic-council.org.

[9] www.luke.fi/tietoa-luonnonvaroista/metsa/metsapolitiikka/.

- Multi-use of forests for more jobs and sustainable growth throughout the country
- Innovations and world-class processed forest raw materials
- Sustainable use and conservation of the forest as a profile issue in Swedish internationally
- A knowledge step for the sustainable use and conservation of the forest

Today's Swedish forest policy and forestry model is based on the idea that forests shall be used for multi-functional purposes. That is, forests shall be managed to provide economic, ecologic, as well as social benefits. Efficient and sustainable production of wood for different end uses shall go hand in hand with the preservation of valuable ecological and socio-cultural values. The practical challenge lies in establishing a balance between the different interests in Swedish forests.

The ***Norwegian*** policy aims to ensure a sustainable forestry, both ecologically, economically, socially, and culturally[10], considering the forest's importance in the ecosystems, as recreation area for humans, and as a carbon sink and storage. To be able to reach the goals in the Paris Agreement – as well as the Norwegian Climate Change Act, which states that Norway should reduce its greenhouse gas emissions by 40 % by 2030 and 80-95 % by 2050[11] – Norway must change from a petroleum-dependent economy to a sustainable bioeconomy, and forestry plays an important role in this change[12]. The government seeks to facilitate a better utilisation of the forests, and to support the forestry and forest industry by investing in R&D and infrastructure[13].

To ensure a sustainable and profitable forest-based industry, the government has defined some focus points for their forest policy:

- Develop infrastructure (roads and railways), both public and private
- Profitable use of forestry for employment and value creation
- Increase R&D to improve profitability and climate change mitigation
- Stimulate the demand for green, wood-based products; increase the domestic processing of raw material (reduce export), ensure sustainable forestry, document the properties of the wood, knowledge sharing, standardise and industrialise competitive building systems in wood and develop policy and regulations to strengthen the framework conditions
- Gain knowledge on climate change and climate adaptation within forestry to develop measures to reduce greenhouse gas emissions

The strategy for increased R&D includes creating arenas for collaboration and dialogue e.g. through clusters, collaboration between industry and research institutes, and international cooperation, build the right competence at all levels from vocational education to PhDs, and business-oriented instruments for R&D offered by e.g. Innovation Norway and The Research Council of Norway.[14]

To stimulate the demand for wood-based products, the strategy includes ensuring sustainable forestry, mainly by financial instruments such as forestry funds and grants for environmental measures in the forests, to document the properties and environmental benefits of wood-based products and make guides for the use of wood, to standardise and industrialise the forest-related measures and innovation, sharing of knowledge to

[10] Regjeringen, Meld.St.6 2016-2017.
[11] Lovdata 2020 https://lovdata.no/dokument/NLE/lov/2017-06-16-60.
[12] Green shift, https://www.regjeringen.no/en/topics/climate-and-environment/climate/innsiktsartikler-klima/green-shift/id2076832/.
[13] Regjeringen, Meld.St.1 2020-2021.
[14] The Green Platform Initiative, https://www.forskningsradet.no/en/apply-for-funding/the-green-platform-initiative/.

encourage builders to build with wood, e.g. by using model projects, and the use of political measures and legislations.

Sintef [15] (2018) states that **The Inland region** has the potential to create 25,000 new jobs within the bioeconomy by 2050. The region's county council and County Governor has adopted a Bioeconomy Strategy, which aims to "contribute to greater competitiveness and value creation in the Inland Region"[16] . The vision of the strategy is "The Inland Region – a leading powerhouse for a sustainable bioeconomy in Norway", and it consists of five goals and 13 associated strategies, related to K*nowledge and expertise, Market and competitiveness, Biological resources and return streams, Cooperation*, and *Visibility and communication*. The strategy's action plan will be revised during the winter of 2021. The region has established the project Biovalley to help establishment, investments framework conditions and competence sharing within the bioeconomy sector.

2.1.2 Structures of Decision Making

In ***Finland***, decision-making in forestry is implemented on the federal level. However, nowadays there is a lot of space for individual decisions made by forest companies, forest owners or by forest contractors under the Forestry Act, for instance. Against this background, the government program in Finland, as well as in Sweden and Norway, puts special attention on bioeconomy and wood mobilisation. The current EU strategy "Green Deal" points the way to sustainable development in EU societies, emphasizing reduction in the use of fossil fuels and fostering carbon neutral achievements as well as nature diversity goals. From this basis, Finland's goal is to improve the utilization of renewable natural resources. Forest-based bioeconomy is seen as one of the biggest strengths of Finland. The imported fossil energy shall be replaced with renewable, domestic energy sources.

The above-mentioned actors play a key role for implementing the national and regional forest strategies in Finland. The National Forestry Strategy 2025 implements the UN Agenda 2030 goals for the Finnish forestry. According to its objectives, Finland is a competitive operating environment for forest-based business and activities and their structures are renewed and diversified. Forests are in active, economically, ecologically, socially and culturally sustainable, and diverse use. The strategy is linked to other national strategies and programmes, such as the National Bioeconomy Strategy, the National Biodiversity Programme, the National Energy and Climate Strategy, LULUCF, and the Regional Forestry Programmes.

The current Forestry Act (1093/1996) was adopted in 1997. The latest change in the current Forest Act entered into force in 2015. The new Forest Act significantly increased the freedom of choice and responsibility of forest owners in the use and management of their forests. The purpose of the Forest Act is to promote the economically, ecologically and socially sustainable management and use of forests. The Act on the Financing of Sustainable Forestry promotes forest improvement and environmental management of private forests and the use of wood energy. The act of the Financing Sustainable Forestry will be in force until the end of 2023.

In ***Sweden***, the usage of forests is principally regulated by the Forestry Act which sets out the demands placed upon forest owners by society. These include for example the requirement to notify forest felling to the Forest Agency, to reforest after felling, and to show consideration for natural and cultural values at forestry operations. Apart from the Forestry Act, parts of the Environmental Code, as well as other legislation, is also applicable to the forestry sector. The Forest Agency is responsible for supervising compliance with the Forestry Act and those parts of the Environmental Code applicable to forestry.

[15] SINTEF, 2018 https://www.sintef.no/contentassets/d46b0e74d4284fcd8ec2a038312464f2/gull-i-gronne-skoger.pdf.
[16] Inland Region, 2017 https://www.statsforvalteren.no/siteassets/fm-innlandet/07-landbruk-og-mat/skogbruk/trebruk/biookonomistrategi-for-innlandet_feb18.pdf.

The current forest policy was adopted in 1993 and reinforced through parliamentary decision in 2008. Swedish forest policy builds to a large extent on voluntariness and is often summarized in the wording "freedom with responsibility". This means that forest owners have a liberty of choice regarding the management of forests, within the frames set by the forestry legislation and other relevant legislation. However, with this freedom of choice also come responsibilities. What is referred to as "sectoral responsibility" implies that preservation of valuable natural and cultural environments is regarded as a common responsibility of the forestry sector and concerned authorities. In practice, this is for example evident in considerable areas being set aside voluntarily by forest owners for conservation purposes, without economic compensation by the state. A large number of forest companies and private forest owners have also chosen to certify their forestry to one or both of the two forest certification systems applied in Sweden, the FSC and the PEFC.

For ***Norway***, the Norwegian Forestry Act states that the forest owner must have an overview of environmental values in the forests, and that for these reasons, there may be forestry measures that cannot be implemented. Furthermore, the forest owner must ensure that all measures taken in the forest are in accordance with the legislation, which, among other, includes regulations for *harvest*; pathways and trails, as well as the property's production capacity, should not be damaged or reduced due to the harvest, *rejuvenation* should be ensured that occur within three years, *road construction* requires approval from the municipality, *preventive measures* to prevent insect and fungal infestations.

The purpose of the forestry act is "to ensure a sustainable management of the forest resources in the country, with a view to active local and national value creation, and to ensure biological diversity, consideration for the landscape, outdoor life and the cultural values in the forest", but gives no strict guidelines on how, when, or by whom harvesting or silviculture is to be done – these considerations are left to the forest owner, or the professionals who manage the forest on behalf of the owner. However, it is the forest owner's responsibility to ensure that the legislation is complied with.

Besides adopting legislations, the government, County Governor or municipalities may use financial subsidies and tax systems to influence the forest owner's decisions on measures taken in their forests.

2.1.3 Main actors in forestry in the Northern Hub

The main actors in the forestry sector in partnership countries of the Northern Hub are the following.

Type of Actor	Finland	Sweden	Norway
Forestry companies	Stora Enso, Metsä Group, UPM, VAPO/ bioenergy, Keitele Group, Pölkky, Koskisen, Versowood, CrossLam Kuhmo, CLT Finland, CLT Plant, Kotkamills Group, Valmet, Andritz, HewSaw/Veisto, Heinola Sawmill Solutions, Raute Industries, Ponsse, John Deere, Logset, ProSilva, Sampo Roselew	Stora Enso, SCA Setra Group, Holmen, Södra Skogsägarne, Moelven, Billerud Korsnäs, Karl Hedin, Siljan Timber, Fiskarheden, Martinsson, Norra Skogägarne, Bergs Timber, Komatsu Forest Machines	Moelven Industrier, Bergene Holm, Inntre Kjeldstad, Norske Skog, Borregaard, Forestia, Hunton
Forestry Associations: services for forest owners	Forest Owners Association	Norra Skogsägarne, Mellanskog, Södra Skogsägarne	The Norwegian Forest Owners' Federation (Norges skogeierforbund), Norwegian Forestry Association (Norskog)
State Forest Enterprises	Metsähallitus	Sveaskog	Statskog

Supervisor of the Forest Act, education of forestry professionals, forestry development	Finnish Forest Centre	Skogsstyrelsen	The **Norwegian Agriculture Agency** is the supreme supervisory authority of the Forest Act, but much of the supervisory is delegated to the County Governor and the municipalities. Considering education, the vocational schools are owned by the counties or by private ownership, and the supervisory authority is The **Norwegian Directorate for Education and Training**, while the universities offering higher education within forestry are owned by the state and supervised by **NOKUT** (The Norwegian Agency for Quality Assurance in Education).
Forest Research Centre	Natural Resources Institute Finland (LUKE)	SLU, Skogforsk	NIBIO
Educational Institutes	University of Helsinki (BSc, MSc, PhD), University of Eastern Finland (BSc, MSc, PhD), Lapland university of Applied Sciences (BSc, MSc), Häme University of Applied Sciences (BSc, MSc), South-Eastern Finland University of Applied Sciences (BSc, MSc), Karelia University of Applied Sciences (BSc, MSc), Novia University of Applied Sciences (BSc, MSc), several schools for vocational education	Linne Universitetet, SLU, Umeå University, Luleå University, several schools for vocational education, BsC, MsC, PhD	NBMU and HINN Evenstad (bachelor's and master's degrees, and PhD), several schools for vocational education (e.g. Solør VGS Sønsterud). Skogkurs (The Forestry Extension Insitute) offers shorter courses and training for forest owners and professionals
Clusters	Industry and Circular Economy Cluster, Smart Arctic Forestry Network, Arctic Smart Rural Communities Cluster (renewable energy), Arctic smartness clusters	PaperProvince, Bothnia Bioindustries Cluster, Biofuel Region, Smart Housing	Norwegian Wood Cluster, Wood Works, Circular Packaging Cluster and Heidner Biotech

Table 7: Main actors in the forestry sector in Northern Hub countries

2.2 Main findings

2.2.1 SWOT-analysis

All the three regions were first analyzed in a local SWOT analysis and then merged into one joint SWOT analysis for the Northern Hub. The main points were selected by experts and partners of the Northern Hub and are displayed in table 8.

Strengths	Weaknesses
• Strong forest industry • Developed Digitalization systems in forestry • Multiple and sustainable use of forests • Open and accurate forest inventory data • Developed enterprises for harvesting and logistics Highly mechanized supply chain. • High degree of work safety • Well organized education system for the value chain (vocational schools, technical school, university of applied sciences) and training for all workforce • Very competitive pulp and sawmill industry using new technology	• High amount of small forest owners and decreased interest in forestry • Lack of qualified and local forestry labor, especially for harvesting operations, planting and silviculture • Poor condition of forest road network • Shortages in tending of young forests • Lack of knowledge on recycling and circular business models
Opportunities	**Threats**
• New forest management alternatives for forest owners • Stronger cooperation between forestry and R&D • Forest consolidations and rearranging of forest estates • Increased gender equality/be more attractive for all interested workforce independent of gender • Development of new wood-based products and utilization of side stream • Continous counseling of forest owners • Upgrading of workforce (especially on digital solutions) • Development of the road transport, wood terminals and collecting small amounts of timber	• Urbanization and lack of attractivity for jobs in the value chain and for jobs in rural areas • Climate change (eg. forest damages, pests) • Lack of funding for R&D and efforts to find new opportunities • More national/EU restrictions on harvesting and other use of forests • Aging of forest owners • Social acceptance of forestry

Table 8: Northern Hub Joint SWOT

The Northern Hub regions have a high availability of wood, and especially in Sweden and Finland the forest industry is strong. The main strengths in forestry are based on the intensive, but sustainable silviculture measures. These actions have led to a high and accelerating increase in stem volume. A positive impact of climate change on the growth of Northern forests can also be detected. Forests in all the Northern Hub regions are healthy and a high number of young stands ensures that there will be enough forest resources in the future. However, **shortage in tending of young forests** is a huge weakness in the Northern Hub. Forest subsidies, funds and accurate forest inventory data offer tools for tackling this problem. Forests in all the regions are largely certified and operated under certified environmental management systems.

The Northern Hub regions are equipped with advanced infrastructures for forestry, and all three countries have a dense network of forest roads. Some challenges in Norway vary from the ones in Sweden and Finland. For example, the high costs for infrastructure development (mountains, fjords etc. and low population)

combined with high road/rail taxes and lower loads, result in generally higher logistic costs than elsewhere in northern Europe. In Finland and Sweden, several sawmills, bioenergy power plants, wooden house, and CLT (Cross Laminated Timber), gluelam beam and plywood factories, biorefineries and pulp/paper factories can be found. In addition, several manufactures of logging machines, sawmill technology, and pulp and paper mill technology are located in Finland. In Norway, an area with high-capacity sawmills and industrial production of wood houses can be found, but less pulp and paper industry. Much of the fiber (pulpwood and chips) which is not used for particle boards, fiber board or bioenergy, is mainly exported to Sweden and especially to the Karlstad area. Norway can be considered a pioneer in wood construction, but the use of wood as a building material is growing fast in all the northern countries.

Forest industry generates a wide range of different side streams. By aligning these production side streams and waste utilization for new products, the wooden material is utilized almost entirely. Products from utilization of side streams are e.g. pellet production, bioenergy, pine oil and wood ash. The development of new wood-based products and the utilization of side streams offers huge opportunities for the forest industry and for entrepreneurs in circular economy. For example, biochar production is growing and it also offers business opportunities for entrepreneurs. Concerning the development of new products, there is a need for stronger cooperation between forestry and R&D. In Sweden and Norway, forest industry clusters can be found , but there is a need for developing cluster co-operation in Finland.

Both the weaknesses and threats are related to a **high age, urbanization and continued passiveness of forest owners, and fragmentation of forest estates.** Private forest owners will be a more and more diversified group in the future. The biggest threats will be a higher average age, and a growing share of city-dwellers and distant forest owners. Considering these changes, there should be more ways available to make forestry attractive for a younger age group .

One of the biggest weaknesses in the Northern Hub is **the fragmentation of forest owners and small forest properties.** Opportunities have been identified in forest consolidation, creating collective forests for easier and more efficient forest management. The rearranging of forest estates is also a great opportunity to create larger forest units instead of small-scale ones. With the continuing counseling of forest owners the passiveness of forest owners has partially been addressed, while digitalization might offer further opportunities through interdisciplinary approaches and developments. For private forest owners, there is also a variety of advisory services available. In all the Northern Hub countries, forest owners have their own national unions, which have been organized regionally. Local forestry associations are endorsing forest owners by offering many kinds of services.

Forest education is of high quality and it covers all the Hub regions. With new kinds of implementation utilizing digital connections, education is nowadays more accessible to everyone regardless of the place of living or the life situation. In addition, there are plenty of new short training programs for forestry issues available. High work safety can be highlighted ensured in the Northern forestry, and it is very closely legislated and monitored by the authorities.

Finding skilled workforce is one of the biggest challenges faced by the forest industry at the moment. The forest industry in the Northern Hub area is especially concerned about the sufficiency of forest machine operators and other forest workers, as harvesting volumes increase in the future. The shortage of labor also applies to timber transport. A part of the problem is that the graduated forest machine drivers are not motivated to stay in the forestry field. Transitions to other industry occurs in all sectors, however forest machine training is one of the most challenging allowing employees to move easily to other transportation industries with higher income, better working conditions and other benefits.

Unused-wood potential creates opportunities for forest industry in Finland, Norway and Sweden. However, the increasing harvesting amount is putting more pressure on moving to year-around felling, which underlines the importance of a well-maintained forest road network. There is a crucial need for **better maintenance of the forest road network** and the organization of private road cooperatives. Developing the road transport, wood terminals and collecting small amounts of timber are important opportunities in all Northern regions.

The impacts of **climate change** are a serious problem for forestry as well as they are for the whole planet. Among the potential impacts are forest fires, storms and pest damages. On the other hand, the growing season might extend and lead to increasing growth of forests. Some pest insects cause more damage, and new species can spread to Northern areas. Climate change also results in less ground frost in winter, leading to problems in forest harvesting because of lower bearing capacity of forest soils. Finland already deals with the challenge of forest harvesting on peatlands, and climate warming will deepen this challenge. This means that there isa crucial need for new innovations for harvesting on peatland forests. A large amount of peatland forests is one of the differences between Finland and the other Northern Hub countries.

Social acceptance of forestry is a problem in all Northern countries. Forests are expected to meet a growing number of interests. Not only should the forests be used to produce sustainable products, but also to protect environmental assets, offer tourists exciting experiences and give opportunities for recreation. The discussions about how widely forests should be protected have become even more intense, as well as the fear that regulations from the EU will prevent forest owners from using the forests to their full potential.

The value of forest varies with what is identified as valuable by whom. From a holistic perspective, the forest as a whole has the most value, from an anthroposophical perspective the value is isolated to what benefits human needs. Between a holistic and an anthroposophical view there is the multifunctional aspect of the forest. The multifunctional value of the forest implies that there is a multitude of interests at play at any given time concerning forest use. Serving a wide range of economic, environmental and social purposes, the forest has different significance to different groups of interest. Wood remains the main source of financial revenue and forest biomass represents the most important source of renewable energy in the EU, however there are conflicting interests with regard to the forestry industry. The forest is also home to an intricate web of life and is essential for CO_2 sequestration and as a provider of ecosystem services. To protect and utilize at the same time can be challenging.

Several certification standards have been employed to the forest industry to ensure a wide scope of interests is being maintained in the forest value chain, complicating the forest owner's ability to use theirforests to the full potential, but also reducing the potential for conflict (FSC, PEFS, Levende Skog). Developing sustainable management to balance the economic, ecological and social roles might be a way to mitigate potential future conflicts.

Concerning politics, the challenge in all Northern hub countries is that the government has its own opinions and development goals. The long-term planning is risky and non-existing, since the goals, politics and subsidies are changing with every change of government. This makes forestry less attractive for foreign investors and discouraging for domestic investors. In addition to the national forest politics, the EU forest politics are appearing as confusing and do not encourage making new investments in bio-based renewable energy.

Many of the strengths in the Northern Hub are linked to digitalization. Exploiting digitalization is seen as a vital requirement for improving the productivity, quality and working conditions in the forestry sector and therefore many assets are being directed to the digitalization related to bioeconomy. Interdisciplinary co-operation is required by the funders to continue exploiting all possible benefits of digitalisation.

The growth of the bioeconomy is dependent on forest industry, securing the supply of forests, and the Northern Hub SWOT reflects this. However, for finding solutions to weaknesses and threats, there is a crucial need for a strong co-cooperation between the Northern countries and other Hubs.

2.2.2 Best Practices and innovations identification

There is a strong will in the Northern countries to utilize forest assets as a source of income and for the welfare of local people. Various digital systems including mobile applications have been developed to advance co-operation and engage forest owners to take care of and manage their forests. Forest work productivity is on a high level since the harvesting chain is completely mechanized and digitalized, while stakeholders are granted free access to forest data. The forest road network gives value not only to forestry but enhances recreational utilization of forests and serves for preventing forest fires.

The best practices and innovations (BPI) identified were developed by forestry companies through co-operations in the forestry and IT sector. The main BPI in the Northern Hub mostly answer to the needs and means of forest management as well as harvesting and logistics. The goal is to increase productivity and co-operation in the supply chain. Naturally, the resources of wood are in focus. Environmental aspects are taken into consideration and in addition, the BPI focus on cascading use of wood and design for recycling and value chain(s) for reuse and material recycling (upgrading).

Most of the BPI are implemented in practice by local or international companies, meaning some are specifically adapted to northern conditions. A continuous development process ensures that the BPI target the increase of productivity, e.g. by utilizing digitalization. Some of the BPI were developed decades ago and implemented already some years ago, while being adapted for addressing current forestry needs and changes. Digitalization has brought about some recent modifications boosted by the provision of open big data in Scandinavia. The utilization of production side streams is at a high level, which leads to full utilization of raw wood material and waste for new products. This way, the cascade use of wood material could be organized efficiently leading to an overall high resource efficiency.

As result from the last validation workshop with experts, there were ten best practices from other hubs selected as most promising. These best practices are presented in table 9. The most relevant best practices from Northern hub are presented in table 10. The next step is the implementation of some of these practices to Northern hub region. There were many digital best practices available which represent newest technology, e.g platforms. Similar best practices can be found from several countries, and with very limited information, it is difficult to define suitability. We should be able to study whether these best practices offer anything new to us, compared to those we have in use.

Hub	***BP title***	***Description***
CWE Austria	Festmeter	Festmeter offers vitality analyses about berk beetle detection in conifer forests
CWE Austria	Application of drones for seedling transport in steep terrains/mouintanous areas	Application of drones is used for seedling transport in steep terrains and mountains
CWE Austria	Evergreen - Innovation camp	Evergreen innovation camp is a hackathon for finding innovative solutions for tracing timber
CWE Germany	Virtual forest	The virtual forest is a platform for forestry and timber industry. Decision support tool for forest growth and wood mobilization.
CWE Switzerland	Road condition monitor	The Road condition monitor has an ultrasound center to capture information on road segments
CWE EU	Avatar	Avatar is an advanced virtual aptitude and training application for harvesting
SWE Spain	C.A.F.E	C.A.F.E (Carbon, Aqua, Fire & eco-resilience) is a decision support system for a multiple criteria forest management

SWE Spain	CrossForest	Cross forest is a project aiming to develop Digital Service Infrastructures for combining Forest Inventory Datasets and Forestry Maps to create and integrate models supporting forest management and forest protection.
CEE Poland	ReGap	Regap is a recycling model of used Wood in Germany and Poland.
CEE Poland	Prozel	Prozel forecasting threats to forest ecosystems through the implementation of an innovative electronic system for the recognition of odors

Table 9: Most relevant best practices from other Hubs

Country	***BP title***	***Description***
Norway	FeltGIS	Data collection of production data to cloud services. FeltBoks and FeltLogg transfer maps and data from harvester and forwarder to ensure easy access to the forest operations for all collaborators.
Norway	The forestry extension institute	The Forestry Extension Institute is a NGO organised as a partnership between 37 forestry organisations and scientific institutions. The main purpose of the institute is to provide continuing education and training in the forestry sector and related fields.
Norway	Women in forestry	Women in Forestry is an independent organisation whose purpose is to motivate and stimulate women of all ages to participate and engage at all levels in the forestry, and emphasize unity and collaboration.
Norway	Forestry Fund	The Forest Fund consists of funds that forest owners are obliged to dispose of in all sales of timber and biofuel. The purpose of the scheme is to secure financing for sustainable management of forest resources.
Norway	Use of drones in vocational education	The vocational school of forestry uses drones in training to plan and control harvesting, thinning and forwarding of timber, as well as filming students while running forestry machines to evaluate their working methods, and making instructions movies for silviculture.
Sweden	HiVision	Operate your crane from inside the truck cabin, without having to step out of the truck. Instead of a crane cab VR-glasses and cameras are used to load the truck. Can load 400 kg more and safer.
Sweden	Arboair	Arboair offers a service that with the help of a 4K camera and IR camera connected to a drone can detect infected or stressed trees.
Sweden	Bark beetle risk map	Digital map of high risk areas for bark beetle where you forest owners can look at thei own forest. Open access for all.
Sweden	Nordluft	The company has developed a proprietary highly advanced drone swarm control system for use in its spreading systems, the Nordluft Ground Control (NGC). The system is built to be easily customizable for other applications.
Sweden	Simulation-based design for off-road driving and driverless machines	By simulating machines and terrain, researchers at Umeå University develop decision support for drivers of forest machines and, in the long run, driverless machines. The research has also resulted in the company Olofsfors starting to experiment with the design of ties for forest machines in a simulation environment.
Finland	Metsään.fi	Metsään.fi provides eServices for forest owners and forestry service providers. The online application shows the silvicultural possibilities of each forest estate and their compartments.
Finland	Kemera	Government subsidies (KEMERA support) are available for safeguarding sustainable wood production, maintenance of forest biodiversity and improvement of the health of forests. The purpose of the Act is to bring to market wood from sites where the profitability of harvesting is poor due to circumstances and the size of the trees.
Finland	Virtual Forest 2.0 innovation	Virtual forest is a 3D application, which can be used in participatory planning of land use, guidance of forest owners and for combining interests of different stakeholder groups concerning utilization of natural resources and areas.
Finland	Forest Finland	Forest Finland is the joint communication project of the Finnish forest sector. The campaign will awaken and raise peoples' interest and encourage discussion about the forests' role in everything we have in Finland. Forest Finland talks about the sustainability of the use of the northern forests and about the solutions the sustainable use of them offers. The forest will be seen on TV and heard on the radio, in outdoor advertising and in social media.
Finland	Simulators in forest machine education	Simulators can be used in forest machine training by speeding up the learning of the technology used in forest machines, and at the same time saving costs by reducing the training time required in terrain for the basic use of the machine.
Finland	Finnish Forest Association	The Finnish Forest Association is a cooperation and communications body dedicated to its members and stakeholders, established in 1877. It supports the promotion of forests, their sustainable and responsible use, and their potential to assist in the development of society. To support its activities, it gathers, refines and publishes information.
Finland	Ash in forest road maintenance	The ashes can be used in a road building among gravel. The use of ash from neighboring heat plants reduces the use of natural aggregates. The use of ash in the construction of the road in Finland has been limited, as it is currently subject to environmental permits.
Sweden	Industry 4.0/DigiWood	The main idea of the digital sawmill project was to enable more efficient and value-creating forest, wood and bioproduct production through digitization.

Table 10: Most relevant best practices from the Northern Hub

2.2.3 Needs Analysis

In *Finland*, **needs of forest owners** are quite concrete and linked to supporting the decision-making processes in forest management. This means guidance from forest professionals and includes presenting different forest management options equally, as well as demonstrating forest management results now and in the future. Guidance should include objective recommendations from forest professionals and arguments for and against different forest management options. Forest guidance discussions should be supported by illustrative examples, calculations and visualizations. In the decision-making process, the forest owners highly value the ease of the process. They prefer to have multiple services to choose from rather than one service provider (guidance, forestry planning, timber trade, harvesting services). They highly value a centralized source of information instead of scattered information, and easy access to information. The roles of different forest-related organizations should be clearer to forest owners in order to identify the right service providers for their requests.

Needs of forestry companies have to do with operational infrastructure and predictable forest policy. Support is needed from the state and the EU, rather than obstacles and restrictions. The decision-making should be more flexible and faster in order to target funding according to changing needs. Infrastructure needs refer to maintenance of forest road networks as well as the higher road network in order to secure wood transportation possibilities. In addition, there is a need to find new tools to activate private forest owners to unlock their wood potentials. The digital systems (Metsään.fi) that are accessible by all the stakeholders should be developed further to include the current and actual status of the forest. Needs of the forest companies in business focus on marketing, technology transfer (e.g. digitalization, new machinery & tools), logistics and product / service development in order of importance.

Regarding the future of the wood market in Europe, companies accentuated the retention of competiveness, currency rates, price (which can be dropped e.g. by storm damages in Europe), expenses of transportation in Scandinavia and logistics in Europe, as well as political stability. Companies consider the impact of climate change prevention for forestry quite prudently. It will depend on how EU decision makers will understand the influence of cuttings and silviculture from the point of view of carbon sinks and storages. FSC certification is more important for the customers in the future.

Needs of the contractor enterprises relate mainly to human resources, business expansion and technology transfer. Financing, service development and cooperation with business partners should also be developed further. Contractors were satisfied with engineer recruitment, but they reported a lack of lumberjacks and skilledl harvester and forwarder drivers. Climate change might affect the harvesting conditions. If winters will be milder in future, it will weaken the carrying capacity in peatlands and cause more difficulties for machinery operations. According to contractors, the incentives needed to encourage the mobilisation are taxation politics, dissemination of information and obligation of proper silviculture to forest owners, more price to pulpwood, better reputation of forestry, professional labor force and more women to forestry.

In the *Swedish* forest industry, two main needs have been highlighted:

1. Access to raw materials
2. Access to a competent and a skilled workforce

In the light of climate change, Agenda 2030 and the transition to a climate-smart society, the insight that the forest may eventually become a scarce commodity has increased among involved actors. Even though there is twice as much forest in Sweden now as 100 years ago, the forest is expected to meet several interests. In addition, the amount of forest that needs to be protected is under discussion and the restrictions put on forest owners by EU regulation is met with concern. But it is not only nature conservation and the EU that can reduce

the amount of available forest, at the time of writing we also see how bark beetles and fires pose major threats to forestry and destroy enormous values in the forests. While forest management appears a strong field in the Nordic SWOT, this is also the area where most threats and weaknesses have been identified.

The other challenge threatening the growth of the Swedish forest industry is the supply of competence. This point of concern is present along the entire value chain, from forestry, via transport to the industry out to the individual citizen. Urbanization is part of the problem, however, the need for new skills with regard to, for example, digitization is another. This challenge is represented in several different parts of the SWOT and is clearly identified as a common challenge among the Nordic countries. Here, measures can be easier to handle and the opportunities to make a difference in the short term could potentially be big.

As many forest properties in *Norway* are small, forest owners lack the needed knowledge about forestry to make decisions on forest management. Thus, guidance for decisions is a basic need for many forest owners. Forest owners also need information on the financial grants and funds, as well as an easy way to apply for these.

Forest contractors need skilled workers, both machine operators and workers for planting and silviculture. The lack of skilled workforce might be linked to the relatively low wages and poor working conditions in forestry compared to other occupations requiring a similar education, e.g. a machine operator in other industries, which causes forest workers to leave forestry in favour of other industries. There is also a need for more timber truck drivers.

The wood-based industry needs a stable, year-round access to timber to prevent unnecessary stops in the production. The ongoing climate change makes the weather, and thus the conditions for running forest machines and timber trucks, more unpredictable with more rainfall and lack of frozen ground in the winters. Like the forest contractors, the industry also needs a skilled and stable workforce.

Both forest contractors and wood-based industry need better infrastructure, forest roads for transport of machinery, workers and timber, and railways for more efficient transport of timber over longer distances.

The Norwegian fiber industry has been significantly reduced in recent decades and the entire value chain has become highly dependent on large exports. In order to maintain a robust value chain over time, it is desirable to establish a new fiber-consuming industry in Norway that can complement the strong sawmill industry. This can also be seen in connection with the fact that an already sustainable and renewable value chain must become more circular.

2.3 Development targets for sustainable wood mobilisation

The development needs identified in the ROSEWOOD4.0 project match the regional and national strategies in all Northern Hub countries. The European Union Forest Strategy promotes the role of forests in attaining economic, ecological and social sustainability. The European Union Biodiversity Strategy underlines the importance of actions of conserving biodiversity and natural ecosystems. Increasing demand for biomass creates new challenges for these issues. It is crucial to find a balance between the use of forests and the protection of biodiversity in all regions.

In *Finland*, the European Union Forest strategy is linked with other national strategies and programmes, such as the National Forest strategy, the National Bioeconomy Strategy, the National Biodiversity Programme, the National Energy and the Climate Strategy, LULUCF, and the Regional Forestry Programmes. At the local level in Finland, the Regional Forest Program 2021–2025 is a joint program of the entire forest sector and the province. The strategic guidelines of the Lapland regional forest program present well the development targets in Lapland. The main needs identified with the ROSEWOOD4.0 SWOT analysis are similar with these goals.

Generally, there is a need for a stronger cooperation between Nordic countries, as it has a positive influence on European Commission policy making.

In ***Sweden,*** the national bioeconomy strategies are linked with the European Union Forest and bioeconomy strategy. The Swedish Parliament has stated that "The value of forests and forest land for biological production must be protected at the same time as biological diversity is preserved and cultural environmental values and social values are protected."
The single most important prerequisite for the effectiveness of the strategy is the common desire to take advantage of the important natural resource that the forest constitutes. For new sustainable businesses in the circular bioeconomy, for more jobs in the forest industries, for more efficient production methods and more forest raw materials as well as an attractive countryside, for the benefit of both entrepreneurs and citizens.
With the forest strategy we want to take advantage of strengths and traditions, have an eye on both threats and opportunities as well as formulate our quest to think and do new.

The transition to a more bio-based economy is already underway and will be significant for the development of the Region. Success presupposes higher competence levels, a greater access to forest raw materials and an attractive forest area. Strategic collaboration and dialogue between new and existing actors and stakeholders drive the development towards increased entrepreneurship with the forest as a base.

Objectives of the Swedish Bioeconomy strategy:

- Leading in circular bioeconomy
  - Innovations, development and new business in industry and new companies
  - Collaboration between forest owners, industry and academia
- More forest raw material
  - Increased productivity in forestry
  - Increased growth of forest raw materials by 10-15% by 2030
- Industrial strategy
  - The industrial strategy must optimize the industry's opportunities to develop solutions to today's and tomorrow's societal challenges through new technology and innovation. This requires, among other things, strong investments in research and development as well as an innovation-friendly regulatory framework.
- Attractive forest area
  - Viable forest companies with innovative business development
  - Health and recreation for residents and visitors

In accordance with the Paris Agreement and Norwegian Climate Act, ***Norway*** seeks to become a low-emission society by 2050. To achieve this, increased focus and investment in the bioeconomy – including forestry – is crucial. The forestry must be sustainable, considering both environment and climate. As much of the wood processing industry in Norway has been closed down in the last 10-20 years, much of the timber that is suitable for this industry is exported. Thus, it is necessary to develop a new forest industry in Norway, most likely based on new products ().[17] A better structure of the forest properties, where small properties are merged into larger units can provide more rational operating units, increase the profitability of forestry, and thus lead to more activity in the forests.

[17] Regjeringen, 2016 https://www.regjeringen.no/no/dokumenter/meld.-st.-6-20162017/id2515774/.

Improved infrastructure is a focus area both nationally and regionally in the Inland Region. The County Governor of the Inland Region also focuses on forestry inventories, as updated information about the forests increases both harvesting and silviculture.

Some municipalities also take measures to increase the use of timber and wood. An example is the municipality of Elverum, which in 2008 made a guide on the use of timber in buildings and city planning. This guide is currently being revised and will be completed in the spring of 2021.

2.4 Presentation of the interregional Roadmap

The goal of the ROSEWOOD4.0 project is to establish an exchange of knowledge based on best practices and innovations (BPI) from other regions in Europe. Based on the findings, suitable BPI shall be transferred to other regions to turn weaknesses into opportunities or strengths. When screening the list of BPI from all over Europe, the strong position of the Northern Hub was confirmed by the large number of BPI that are already in place in the Hub regions in similar ways.

During the validation process, 18 BPI from the Northern Hub and 18 BPI from other Hubs were selected to be the most promising. The selected BPI with matching main needs identified in the Northern Hub are presented in Table 11. The BPI are not in prioritized order in the lists.

Main WEAKNESSES	**Finland**	**Sweden**	**Norway**	**CWE** (Germany, Belgium, France, Switzerland, Austria)	**SWE** (Spain, Italy, Portugal)	**CEE** (Poland, Romania, Slovakia, Ukraine)	**SEE** (Croatia, Greece, Slovenia)
High amount of small forest owners and decreased interest/ competence in forestry for owners.	Virtual forest, Metsään.fi, Forest Finland, Finnish Forest Association		Women in Forestry, FeltGis, Forestry Extension Institute	Forest women network, Forest Land Consolidation, KomSilva			
Lack of qualified and local forestry labor, especially for harvesting operations, planting and silviculture.	Simulators in forest machine education	Simulation-base design for driverless machines, HiVision	Use of drones in vocational education, Forestry Extension Institute	DroneMapper, SilviSmart, Evergreen-Innovation Camp, Drones for seedling transport, EldatSmart, SmartGiga Wood, Avatar, Forwarder			
Poor condition of forest road network	Ash in forest road maintenance		The Forestry Extension Institute	Road condition monitoring			
Shortages in tending of young forests	Kemera		Forestry Fund	Marteloscopes			
Lack of knowledge on recycling and circular business models						ReGap	

MAIN THREATS	Finland	Sweden	Norway	CWE	SWE	CEE	SEE
Urbanizing and lack of attractivity for jobs in the value chain and for jobs in rural areas.	Virtual forest, Metsään.fi		Women in Forestry, Forestry Extension Institute	Virtual Forest, Forest Women Network			
Climate change (eg. forest damages, pests)		ArboAir, Bark Beetle risk		FestMeter	C.A.F.E, CrossFore		
Lack of funding for R&D and efforts to find new opportunities				Evergreen-Innovation Camp			
Social acceptance of forestry	Finnish Forest Association, Forest Finland		The Forestry Extension Institute				
More national/EU restrictions on harvesting and other use of forests.	Virtual forest	Nordluft					
Aging of forest owners	Virtual forest			Virtual Forest			

Table 11: Validated Best Practices and Innovations matched with Main Needs (Weaknesses and Threats)

During all workshops there were excellent discussions for tackling the weaknesses and threats of the Northern Hub. One of the key problems is *the high amount of small forest owners and decreased interest/ competence in forestry for owners.* Foresters have tried to solve this challenge through events and networking, which often proves unsuccessful. There were many BPI from the other regions which could be identified to solve this issue. One of the best solutions for a high amount of small forest owners is a forest consolidation network, which can already be found in Finland and Sweden. However, the BPI from Germany **Forest land consolidation of community forests in NRW** was found to be interesting. More information about this practice should be obtained and it should be examined whether the practice can offer any new solutions for developing the forest consolidation activity in the Northern regions.

The most promising solutions for the weakness *decreased interest/ competence in forestry for owners* were the **Forestry Extension Institute from Norway, Finnish Forest Association and Forest Finland from Finland, and KomSilva** from Germany. Education is the best tool for raising the competence, and the Forestry Extension Institute and Finnish Forest Association are great examples how all stakeholders can work together for addressing this weakness. KomSilva offers a modern platform for raising awareness on forestry, especially for forest owners. Forest Finland is a versatile project launched in 2020 for dissemination of forest and forestry information, using different digital media (e.g. TV and radio) and roadshows. All the four above-mentioned BPI will be highly important in tackling the challenges concerning the threat *Social acceptance of forestry in future*, common to all the three hub partners.

BPI for *managing the data flow* are found both inside – **FeltGIS** – and outside the hub –**SilviSmart**. As far as we know, FeltGIS is the only one of these that uses the StanForD standard for data flow, which is the standard used by the producers of forestry machines. Thus, this technology will be much easier to implement than the others.

The platform *Virtual Forest* is available in Finland and Germany. The Finnish version is a 3D forest visualization combining actual forest data, GIS and game technology. German Virtual Forest was selected to find out whether it includes new features to learn from. **Metsään.fi** is another innovative platform from Finland, which has been found to encourage forest owners to carry out silvicultural works and it shows the cutting possibilities of each forest estate. The online application shows the silvicultural possibilities of each forest estate and their compartments.

There were two other examples of similar practices which are offered by different countries: **Women in Forestry** from Norway and **Forest Women Network** from Austria. These practices were selected because in Finland there is no Forest Network for Women and general activity between these already existing networks

should be strengthened. It is widely recognized that the forest sector must be changed to be equal and a more attractive workplace for women.

The usage of drones has become popular almost in every field, including forestry. Even though there is a high degree of technology around drones already in the Northern Hub, a couple of best practices on this topic were selected. From Sweden, **Arboair** was chosen, a tool for detecting bark beetles by drones. From the other hubs, **Dronemapper, Festmeter and Application Drones for seedling transport** were selected. Dronemapper from Germany is a high-resolution drone imagery for timely information about impacts and forest dynamics.

Festmeter from Austria also offers detection of bark beetle infestation by drones. Application Drones for seedling transport from Austria are designed for the usage in mountainous areas, but similar circumstances can be found in Norway. Also, in Finland there are often planting sites located behind swamp areas, where the seedling transportation is very difficult to accomplish. Drones are also used in forest education; the BPI **Use of drones in vocational education** was selected from Norway. In Sweden, **NordLuft** has developed a proprietary highly advanced drone swarm control system for the use in its agricultural spreading systems.

A serious threat today is climate change which can affect many problems in forestry. Pest damages will be a growing problem in the future, even in the Northern countries. Drones offer many solutions which should be examined carefully. The Swedish BPI **Bark beetle risk maps for forest owners** offers a potential solution. In addition, the BPI **C.A.F.E** from Spain and **DetectIt** from Croatia were identified as promising solutions for tackling the challenges of climate change. C.A.F.E is a tool which enables the decision-making process of forest managers when dealing with multiple criteria forest planning. DecectIt is a forest fire detection device which detects fire by using different sensors.

The *lack of qualified and local forestry labor, especially for harvesting operations, planting and silviculture* is one the main needs, which was matched with many best practices. The Covid19 pandemic has shown the importance of using more local workforce, although the costs are sometimes higher. Examples of selected BPI include the **Simulation-based design for off-road driving/ driverless machines** from Sweden, and the European Union project **AVATAR** which has developed a digital coaching, assistance, and feedback system for improving productivity and job satisfaction for forest machine operators. However, none of the selected best practices offers a solution to the actual problem, i.e. finding more qualified labor. Selected BPI apply to education or they are practices for using technology to make the work more efficient, namely **HiVision** from Sweden, **Simulators in forest machine education** from Finland, **Smart GigaWood** from Austria, and **EldatSmart** from Germany.

One of the main weaknesses for forestry infrastructure in the Northern Hub is the poor condition of the forest roads. The current condition of forest roads should be available for wood and transportation companies in order to gain resource efficiency in wood mobilization. The only truly promising best practice for this weakness is the **Road Condition monitoring** from Switzerland. Finland and Sweden both have a best practice about using the Ash as construction material on roads/surfaces at industries. The utilization of ash as material for road construction and maintenance has produced excellent results in terms of both the technical suitability and the environmental impact. In Sweden, ash products are already used as surfaces at construction sites/industries. In Finland, the use of ash in the construction of the road has been limited, as it is currently subject to environmental permits. There is a need for exchanging BPI already between these countries.

Shortages in tending of young forests is a weakness in the Northern Hub. Forest subsidies/funds like **Kemera** in Finland and **Forestry Fund** in Norway, offer tools for tackling this problem, however there is still a need to find more solutions. The only suitable practice from other hubs was a **Marteloscopes tool** from Switzerland. The demonstration sites serve for virtual tree selection exercises as well as show cases for field visits. The main goal is to train and improve decision-making capacities related to the integration of biodiversity aspects into forest management.

A challenging weakness to find new solutions for is the lack of knowledge on recycling and circular business models. This is a topic where the Northern Hub has a very high technology in some regions, but there is still a lot of new business possibilities to be found in the future. The most promising best practice was ReGap from Poland, which offers wood waste disintegration technology, new sorting techniques for waste wood, and technological guidelines ensuring the rational management of used wood.

The *lack of funding for R&D and efforts to find new opportunities* is one of the threats in the Northern Hub. Evergreen Innovation Camp – a Hackathon from Austria – was selected as the only possible solution for this need. These innovation camps have been used in other business areas, but not so much in forestry.

During the roadmap process there were also many gaps identified. These gaps include those weaknesses and threats for which no suitable solutions were found from other regions.

Only a few BPI were found for *poor condition of the forest roads and shortages in tending young forest*. They are both big challenges in all Northern hub countries, and each country has already many existing practices to solve them. However, there is a need for new solutions. Other gaps identified are the *lack of knowledge on recycling and circular business models, the lack of funding for R&D and efforts to find new opportunities and more national/EU restrictions on harvesting and other use of forests*.

If one of the threats has a higher priority compared to the others, it is the *social acceptance of forestry*. This challenge is recognized in all Northern Hub countries and there is a crucial need to find completely new ways of communicating about forestry.

It is clear that the selected practices include those that can really be implemented in the Northern region. However, this requires a long-term work process with stakeholders, but the Northern hub partners believe that the ROSEWOOD4.0 project will take these actions forward.

2.5 Implementation of the roadmap

The ROSEWOOD4.0 roadmap can be seen as an addition to national and regional forest strategies in the Northern Hub countries. It highlights the development needs of member states based on the threats and weaknesses identified in the SWOT analysis. Solutions for them have been sought from within the Nordic countries and widely from Europe, based on the BPI offered by the participating countries. Their realization and utilization largely depend on how well they serve the needs of each organization or company. It is also worth noting that even if they are not implemented as such, they can be valuable for learnings that can be applied to these circumstances.

In Finland, the Finnish Forest Centre constitutes the regional Forest Programs by running a process of conducting several workshops with all the relevant interest groups. The Forest Program includes the present state of forestry and land use in Lapland and other counties as well as the identified challenges and recommendations to overcome them. The recommendations and responsibilities are directed at specific stakeholders in the forest field: research, forest industry, education, communities, municipalities, county, forest consolidations, state forest enterprises, private forest owners and NGOs. Provincial forestry councils are in charge of preparing the regional forestry programs in co-operation. The best channel to put the ROSEWOOD4.0 roadmap into action in Finland is through cooperation with these regional councils.

In *Sweden*, Paper Province will cooperate with the County of Värmland, Skogsstyrelsen and The Midde North Region to put the ROSEWOOD4.0 roadmap in action for fulfilling the Bioeconomy strategy for the region and for realizing the goals for the clusters.

We will also use our own cluster there we have research, forest industry, education, communities, municipalities, forest consolidations, state forest enterprise, private forest owners to organize meetings and events. Involvement of businesses will also be needed for some of the selected BPs. We are working with a

action plan for the implementation process and will have it ready till summer holiday. We have already had experience of surprising new knowledge when we start working with and start to learn more about specific BPs.

In order to put the ROSEWOOD4.0 roadmap into action in ***Norway*** it seems to be relevant to cooperate both with the County of Innlandet (Innlandet fylkeskommune) and the County Governor of Innlandet (Statsforvalteren I Innlandet) which together are responsible for the regional bioeconomy strategy, and with the clusters Wood Works and Norwegian Wood Cluster which involve businesses and other stakeholders. We will work hard for having the implementing activities as integrated part for fulfilling the Bioeconomy strategy for Innlandet and for realizing the goals for the clusters. We will organize meetings with these important partners and other stakeholders (e.g. Forest extiontion institute (Skogkurs) and secondary school (Solør VGS)) that can support the implementation process. Involvement of businesses will also be needed for some of the selected BPIs. We plan to have an action plan for the implementation process ready until summer holidays. We have already had experience of surprising new knowledge when we started working with and start to learn more about specific best practices. This may make changes in our plans. We will update the roadmap if important changes occur. Finally, we will highlight the unique possibility we have to make the implementing activities transnational since Värmland with Paper Province is our neighbor and there is a well-established cooperation between the regions. This could be done by cooperating with already established transnational projects like the Interreg Sweden Norway "The Bioeconomy Region in Scandinavia" and the "ecoINSIDE2" and by establishing new, joint actions and projects.

A high amount of forest owners and decreased interest / competence in forestry for owners is a common weakness and social acceptance of forestry a common threat to all the three countries in the Northern Hub. For both needs the dissemination and training organisations like the Forestry Extension Institute in Norway and the Finnish Forest Association in Finland could bring digital solutions. The Forest Finland information campaign launched in 2020 is a good example of already existing solutions spreading versatile information on forests and forestry in Finland. However, there is a clear need for joint projects and campaigns among the organisations in the Northern Hub and possibly also other hubs in the future. The ROSEWOOD4.0 network provides an excellent basis for further actions in the collaboration.

One of the main needs regarding the forestry infrastructure in the Northern hub is the poor condition of forest roads. The current condition of forest roads should be available for wood and transportation companies in order to increase the resource efficiency in wood mobilisation. In Northern Finland, the newest forest industry investment by Metsä Group will require better maintenance of roads and other infrastructure in the future. From the best practices of other Hub regions, the Road condition monitoring system could offer an opportunity for a new development project in the Northern Hub. A system of this kind could prove a suitable tool for tests for example with the Finnish Forest Centre, which coordinates many similar projects. In addition to maintaining the infrastructure of forest roads, there is a need for developing the expertise of forest road construction and maintenance. Here, Skogkurs (Forest extension institute) is a natural partner for cooperation in Norway together with other regional expertise. However, there are already companiesin the Northern countries like Roadscanners Oy and Road Consulting Oy, which have specialized in developing tools and services for traffic infrastructure condition monitoring and management. Cooperation with these companies is in needed to be able to find possible solutions concerning forest roads management in all hub countries.

Another identified main weakness in the Northern Hub is the lack of a qualified labor force, especially in harvesting and silviculture, even though forestry education is relatively intensive in nordic countries. An interesting solution from Austria is an Application Drones for seedling transport. This should be presented to local forest service entrepreneurs in order to find out whether it is of interest to them. Drones are also used in forest education in many countries, but the best practice Use of drone in vocational education should be presented in Finland to local vocational education Centre REDU.

The best practice **C.A.F.E** (Carbon, Aqua, Fire & Eco-resilience) is a Decision Support System for a multiple-criteria forest management from Spain. This tool determines the optimum silvicultural activities to manage multiple products, goods and services such as biomass production, CO_2 sequestration, fire risk, water provisioning, climatic resilience or biodiversity, which are simultaneously quantified in time and space for a selected solution. Especially Finland is very interested to present this best practice to local stakeholders, but also Sweden and Norway would like to learn more about this tool. This best practice will also be introduced to Swedish and Norwegian partners from the former Interreg Sweden Norway project called INGO. We think this best practice could be a part of the revitalization process for this consortium that is now on hold.

Climate change will also increase insect damages in the Northern forest. As a solution there were many best practices available. The most promising ones were **Festmeter** from Austria and **Arboair** from Sweden. Festmeter offers a vitality analyses made by drones regarding bark beetle detection in conifer forests. Arboair has also created camera and drone-based solutions to quickly and efficiently identify pest affected areas. Finland would like to learn more especially about the Arboair application and present this tool to its most relevant stakeholders. In Finland, the company BitComp has an AI based forest change detection service, which uses this information for example by assisting the officials to supervise illegal cuttings, and to estimate the extent of fire or storm damages that have occurred in different areas. Cooperation with this kind of company would be a first step to find out, if these best practices offer anything new for the region.

The forest industry in the Northern Hub area is concerned about the sufficiency of forest machine operators. A part of the problem is that the graduated forest machine drivers are not motivated to stay in the forestry field. The Best practice ***AVATAR*** has developed a digital coaching, assistance, and feedback system for improving productivity and job satisfaction of forest machine operators. All Northern hub countries are interested to learn more about this tool and to present it to local forest education centers. Skogkurs in Norway is already involved in this best practice and it will be natural to cooperate closely with them in the work for a broader implementation.

Sweden is also interested in further best practices from the Northern hub like DigiWood, and Women in Forestry.

Correspondingly, **Norway** is interested in the following Northern Hub best practices: **Industry 4.0/DigiWood**. This technology is already fully implemented in one of the Swedish Sawmills for Moelven Industries and we know that Norwegian sawmills in the same company want to learn more about the opportunities found in this best practice. The Norwegian Wood Cluster has a great focus on the reuse of wood and increased knowledge about the **ReGap** will fit well in their work where Forestia is one of the mayor players. Norwegian and Swedish partners in Rosewood4.0 have already started to discuss if the implementation of the best practice **Evergreen Hackathon** could be a joint action for the Norwegian Wood Cluster and Paper Province. Both will have some experience with the Hackathon methodology from their work in the Interreg BSR Connected by the Biobord project.

2.6 Conclusions and Outlook

The ROSEWOOD4.0 network is enabling the exchange of best practices and innovations between regions in Europe. The Northern Hub has already received many new ideas for overcoming the challenges of wood mobilisation, especially related to climate change, lack of qualified labor and fragmentation of forest owners. This interregional roadmap presents recommendations for tackling the weaknesses of the Northern Hub with knowledge and practical experience from other regions in the form of best practices and innovations, which have proven successful in other regions.

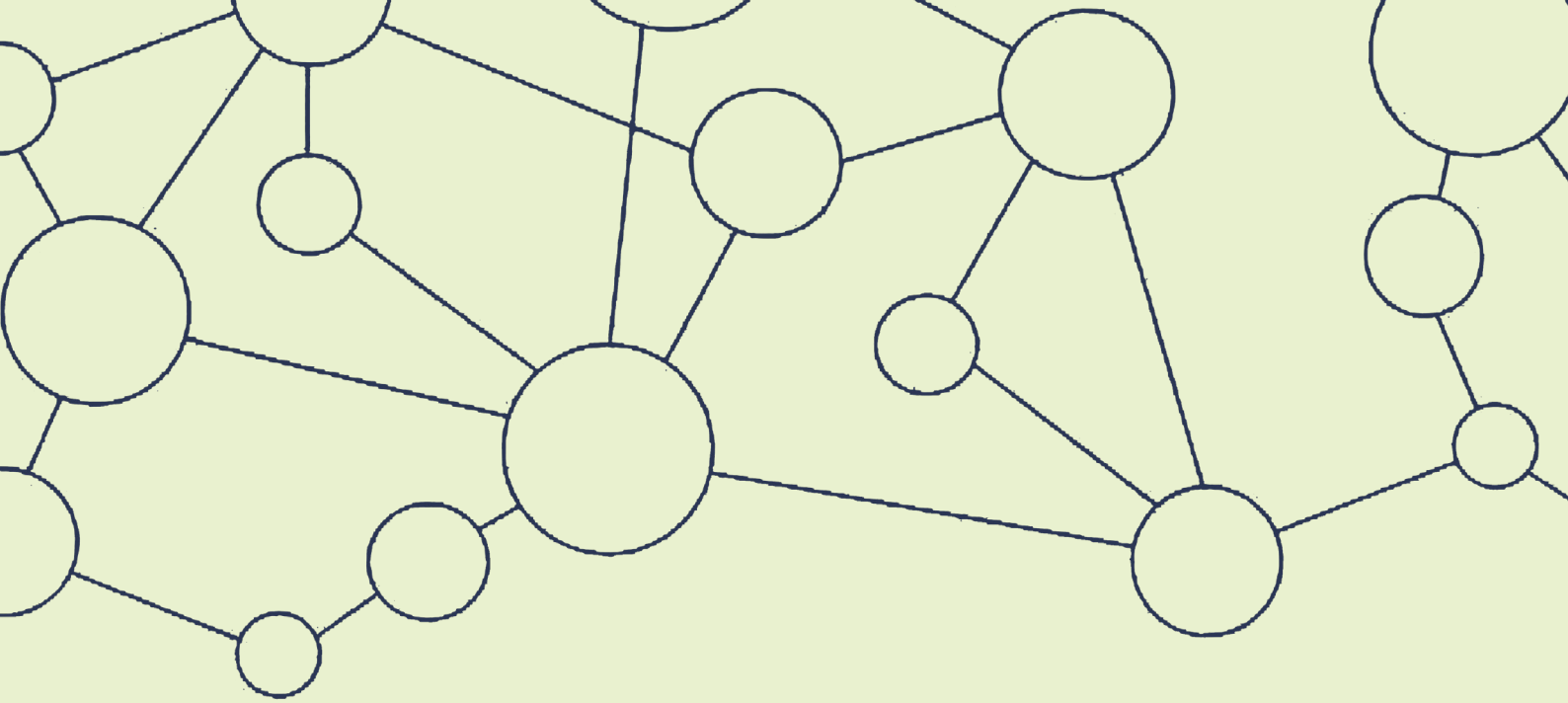
Nevertheless, it is not possible to fullyaddress all the present challenges, but we must continue to look for new solutions within the forestry field and beyond. Forestry is an important industry for the members of the

Northern Hub, and support must also be sought from political decision-makers in order to maintain the competitiveness of the field.

In this project, we can also contribute to our interest through information, which can be done within the limits that the current pandemic situation allows. On the other hand, the change in the operating environment through EU, national and regional instruments indicates the direction of development steps and contributes to the operation and development of forestry. Their concrete tools are various forms of support and taxation, which can effectively influence the activity of forest owners and their willingness to sell wood.

Correspondingly, the activity of large forest companies and competition in timber purchasing can activate forest owners as a result of better wood price development. At present, the forest industry is undergoing structural change, with the production of paper industry products declining and the production of pulp continuing at least as before. In anticipation of the breakthrough of new pulp-based products and the acceleration of wood construction, there will be a simultaneous debate on the adequacy of wood raw material and the conservation of forests among the participating countries committed to carbon neutrality.

The communication for the improvement needs of challenges in forestry should come from the whole forest sector. Therefore, the ROSEWOOD4.0 network can bring together various stakeholders from all Northern hub countries. Generally, when initiating new projects, the project consortium should include all relevant stakeholders. In the Northern Hub, the co-operation within the forest sector is active and functioning due to multiple joint projects, so there is a good opportunity to implement the roadmap in the regions.



ROSE WOOD 4.0 Sustainable Wood for Europe

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ROSE WOOD 4.0 Sustainable Wood for Europe

SOUTH-WESTERN HUB ROADMAP

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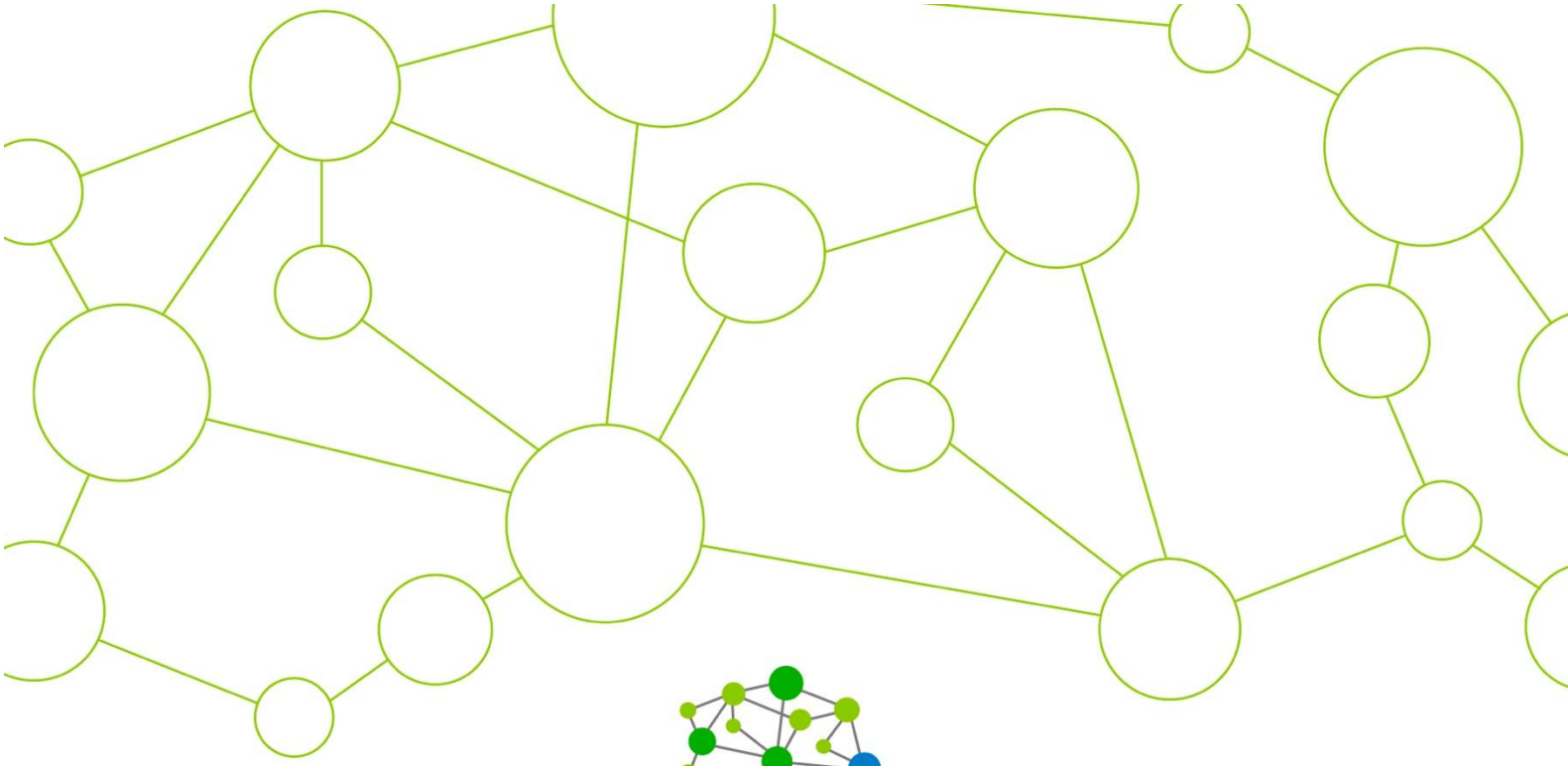

ROSEWOOD 4.0 Sustainable Wood for Europe

South-Western Hub Roadmap

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1. Introduction

Modern information and communication technologies (ITC) continue to develop rapidly in all sectors of the economy and society. The forestry sector (compared to agriculture or manufacturing sectors) is however lagging behind in terms of adaptation and spreading of modern ICT solutions. A major challenge is the large variety of ecosystems, forest owner types, supply chain actors and stakeholders, and regional disparities of technological progress. Forest industry 4.0 solutions (including new measurement sensors, high resolution digital maps, forest planning tools, risk monitoring, realtime data exchange and control, logistical optimisation, etc.) are a major field of innovation and future market, which will enable continuous information exchange at all stages in the supply chain, tracking timber flows from forest harvesting to processed wood products and markets. Furthermore, Decision Support Systems (DSS), educational tools and marketing platforms for forest owners are more and more emerging to connect knowledge and practice, and the actors within a region. This will leverage huge benefits for resource efficiency, sustainable use and climate change mitigation. These solutions can however only be exploited to their full potential, if they are more adapted and adopted, disseminated and deployed in the various regional contexts. The need for broader sharing of ITC-driven solutions and best practices is imminent and increasing, to maintain and enhance the competitiveness of Europe's forest industry by transforming it to a forest industry 4.0.

Digitalisation is one of the most powerful drivers of change in all aspects of society. In forestry, it has the potential to enhance the information flows and the relationships between actors (owners, managers, authorities, workers, communities and society) at all steps of the value chain. It has the potential to improve decision-making, empower forest managers and workers to achieve greater sustainability and fulfilment of multi-functionality standards as well as improving efficiency and transparency. However, the adoption of digital solutions is generally slow and very uneven across Europe. Through its Roadmaps, ROSEWOOD4.0 identifies and supports the adoption of close to market solutions and the replication of success cases by stakeholders of the value-chain.

Throughout Europe, the challenges for a sustainable wood mobilisation are diverse and often a lack of specific knowledge leads to non-ideal solutions. However, international and interregional knowledge transfer offers the potential to improve this situation. Against this background, the ROSEWOOD4.0 project has initiated five regional Hubs throughout Europe bringing together 21 partners from 18 countries to steer the interregional knowledge transfer on sustainable wood mobilisation:

- Northern Europe: Finland, Sweden, Norway, Baltic countries, Denmark
- Central-West Europe: Germany, Belgium, France, Switzerland, Austria
- Central-East Europe: Czech Republic, Hungary, Poland, Romania, Slovakia, Ukraine
- Southern-West Europe: Spain, Italy, Portugal and South of France
- Southern-East Europe: Bulgaria, Croatia, Greece, Slovenia

These 5 communities within ROSEWOOD4.0 will facilitate wood mobilisation through mutual learning across European regions. ROSEWOOD4.0 builds on the insights and experience gained in recent research and innovation efforts and will implement specific activities to reinforce digitalisation of the forestry domain with a sharp focus in the most relevant innovation opportunities in the following areas which are highly impacting the sustainable wood mobilisation: (a) Engaging forest owners and overcoming land tenure fragmentation, improved forest planning and risk management, adapted silvicultural measures for increased multifunctionality and biodiversity conservation; (b) Design and maintenance of infrastructures, optimized forest operations and logistics for improved economic and environmental performance; (c) Organisation and transparency of regional wood markets; new business models and market arrangements; (d) Access to finance and business support, including through EAFRD measures and PES (payment for environmental services) type mechanisms; legal and fiscal regimes; (e) Education, training and skills development.

By creating adapted materials and extensively sharing technological and non-technological innovations, best practice cases and RDI results, **ROSEWOOD4.0 multi-stakeholders approach** closes knowledge gaps and creates new opportunities for economic partnerships within the whole wood mobilisation value-chain. ROSEWOOD4.0 focuses on tailored (user- and region-specific) **transfer of know-how and information** that enables and supports **stakeholders of the wood value-chain to exploit innovations and best-practices** and facilitates the capture of innovative ideas enhancing the development of the field. ROSEWOOD4.0 aims also to provide practitioners with development skills (educational and entrepreneurial) and facilitate organisational innovations leading to **novel exploitation actions** leveraging the uptake of new ideas and Best Practices in daily business.

The roadmaps presented here address stakeholders throughout Europe for facilitating the transfer of knowledge and collaboration between partnership regions. The roadmaps represent the collection, the analysis and strategic direction of the results from the five Hub regions including their validation. The main objective of the roadmaps on Hub level is to strengthen the regions through transfer of the gathered knowledge, experiences and circumstances. With the accurate description and assessment of well-functioning best practices and innovations as inputs, there is an active support in strengthening the local wood value-chain development thanks to newly developed digital tools. Further, the roadmaps enhance cooperations by increasing interactions between stakeholders and regions for creating opportunities to initiate further and new developments. Relying on networks , it supports the self-initiative and empowers the forestry to push new actions. For this purpose, the roadmaps highlight best practices and innovations (BPI) that have the potential to serve as tools for prosperous and sustainable wood mobilisation among European regions. ROSEWOOD4.0 has initiated a web-portal for presenting the best practices and innovations to the wider public and stakeholders. This way, new solutions can be incorporated and the transfer of best practices monitored. The roadmaps give readers insights into regional perspectives of wood mobilization, capitalizing on information and cooperation possibilities between European regions. By steering the knowledge transfer between the regions, the roadmaps aim to provide a European perspective on digitilization issues in the forestry domain. In times of structural changes, a changing climate and new technologies, the ROSEWOOD4.0 Hubs can rely on a broad knowledge base from various countries for identifying suitable approaches for their regions. For this purpose, the roadmaps shall pave the road towards more collaboration between the regions, transfer of best practices and innovations meeting the needs of the regions. All this will further develop the ROSEWOOD4.0 network and strengthen the individual regions onto their path towards a sustainable wood mobilization and the transition to a bio-based economy in Europe.

2. Interregional Roadmap for the South-Western Hub

2.1 Description of the South-Western Hub region

The South-Western Hub's (SWE) aim is to find specific digital solutions and innovations that help increase the wood mobilisation rate in the region, and ease the management for a higher efficiency. Its focus is on sustainable wood resource management and the question how to serve both, the demands of the industry and the protection of the region’s sensitive biodiversity, especially regarding the effects of climate change. Europe is full of solutions, sharing them through interregional cooperation is mutually beneficial.

The SWE Hub is formed by four partners from four different regions: Instituto Superior de Agronomia (ISA) from Lisbon (Portugal), Centre National de la Propriété Forestière (CNPF) from Aquitaine (France), Associazione Italiana Energie Agroforestali (AIEL) from Veneto (Italy) and Fundación Centro de Servicios y Promoción Forestal y de su Industria de Castilla y León (Cesefor) from Castilla and León (Spain). These are four regions with a high wood mobilization so they can act as leaders inside their countries:

Despite a strong potential in terms of wood volume, the region faces many challenges concerning the mobilization of wood due to very fragmented forest property and the threat of serious forest fires, pests and forest diseases.

Another common characteristic in the South-Western region is the complex orography with diverse climates that favour the rich flora, a wide variety of forest species different to manage with different needs for transportation and logistics, therefore, specific digital solutions are needed.

Challenges to wood mobilisation furthermore lie in the development of tools for the establishment of joint management models and the conception of more efficient utilization systems for low-value products, allowing their profitable use.

The forestry sector in ***Castilla y León, Spain***, is one of the most important in the national context in terms of magnitudes, both in terms of production area, production and production potential, as well as the variety and type of products.

The regional wooded forest area amounts to 2,982,000 hectares, according to the most recent National Forest Inventory, to which must be added 1,825,000 hectares of treeless forest land, making a total of 4,808,000 hectares of forest area. In contrast, cropland totals 3,509,000 hectares, which in recent decades has been gradually decreasing as less productive land is abandoned.

Sub-sector	Primary production (€ million)	Industrial production (€ million)	Total (€ million)	% of total forest production
Pine sawnwood	55	121	176	26.07 %
Poplar wood	26	28	54	8.00 %
Board	40	212	252	37.33 %
Biomass	15	26	41	6.07 %
Total Wood products	136	387	523	77.48 %
Non Wood products	35	117	152	22.52 %
Total	**171**	**504**	**675**	**100%**

Table 1: Forest production in Castilla and León.

Forests	Economic significance
• 55 % forest area of Spain's surface territory • 36 % forest area with woods of the national total • 56 % of broadleaved trees, 37 % conifers, and 7 % mixed • Types of formations: 15 % of dehesas, 14 % holm oak forests, and 11 % Pinus halepensis forests • In terms of stocking, the two species that contribute the most cubic meters are still Pinus pinaster and Pinus sylvestris • In the last 10-12 years the timber volume has increased by 43 % • 28 % of forests are public forests • 72 % of forests are privately owned forests	• Roundwood exports have increased from a deficit of over two and a half million cubic meters in 2000 to a peak surplus of just under one million cubic meters in 2020. • For both imports and exports, the highest economic value comes from paper and paperboard. In imports it accounts for 59 % of the total and in exports for 55 %

Production volume	Energy
• In 2018, 19.7 million m^3cc were harvested, 12 % more than the previous year. • Softwood harvests exceeded 10.6 million and hardwood harvests exceeded 9 million • Eucalyptus and radiata pine are the main productive species • 97% of hardwood harvests were on private property and 89 % of harvests on public property were of coniferous species. • 1.32 million tons of firewood.	• Bioenergy continues to be the sector with the highest wood consumption, 38 %, followed by pulp with 21 % and board with 20 % (considering roundwood plus equivalent roundwood that is burned from industrial wastes or by-products)
Employment	**Sustainability**
• 0.30 % of contracts in the primary forestry sector compared to the total number of contracts • 2.43 contracts in the primary forestry sector per 1,000 ha. of forest land. • 8,966 forestry businesses: • 3,865 forestry companies • 5,101 self-employed in the forest sector • 67,312 contracts/employment: engineers, qualified workers, laborers	• 18.5 % of the total forest area is managed • Average increase of just over 140,000 ha/year for the last 12 years, representing 1.7 million hectares • 43 % of the public forest area is managed. • The area certified by PEFC in 2018 represents 12 % of the forested area and that certified by FSC 1.6 %. • The protected area represents 41 % of the total forest area, 40 % of the forested area and 41 % of the unlogged area. • 80 % of the Natura 2000 Network is forested and the percentage of forested area in Protected Natural Spaces is 87 %

Table 2: Spanish Forests in Numbers.[1]

Forest covers one third of metropolitan ***France***, with approximately 16.5 million hectares of forested lands. The diversity of landscapes and climates over the country creates a very diverse forest, most of which is dominated by broadleaved trees. Coniferous trees represent a third of the national forest and are particularly represented in plantation forests. A big part of the national forest (75 %) is privately-owned.

The New Aquitaine region, resulting from the fusion of Aquitaine, Limousin and Poitou-Charentes in 2016, is one of the first forest regions in France and hosts the largest man-made woodland of western Europe, the Landes of Gascony. In New Aquitaine, the forest has the originality of being owned by more than 90 % of private owners (250,000 owners of more than 1 hectares), representing 21 % of the surface area of the national private forest. The forest area in New Aquitaine is about 2.8 million hectares (17 % of the national

[1] Ministry for the Ecological Transition and the Demographic challenge (2018); Asemfo: National Association of Forestry Companies (2018).
Foreign trade of roundwood. Source: Ministry of Economy, DataComex, 2021.

forest). Forests cover 34 % of the region's surface area. The area of private forest managed according to a sustainable management document represents 30 % of the area with such a document at the national level.

The forest in New Aquitaine is very diverse in terms of species and stands. Hardwood trees (Oak, Chestnut...) occupy nearly 62% of the forest area (1.73 million hectares). Coniferous trees (Pines, Spruces, Douglas fir...) occupy 38% of the regional forest area, or 1.08 million hectares. The standing volume of the New Aquitaine production forest amounts to 383 million m^3 (excluding poplar plantations). From forestry and logging to finished products and retail, the wood-forest sector plays an essential role in the local economy and job market: 28,300 establishments employ 56,300 people; 31,000 of whom work in the four main segments: forestry and logging, sawmill and wood processing, paper and board industry and carpentry work.

Forests	Economic significance
• 16.5 millions ha of forest land • +0.7 % of increase per year, +40000 ha/yr • 75 % privately owned forests • 25 % public forests • 166 m^3/ha • 65 % broadleaved trees	• EU 6st paper pulp importer • EU 5th firewood exporter • EU 3rd largest stock of standing timber • Mostly exporter rather than importer • Forest sector accounts for 12.7 % of industrial job market, at national level
Production volume, 2018	**Energy**
• 37.5 million m^3 harvested per year • Approximately 25 million m^3/year of firewood • Main production is lumber	• Firewood consumption is 344000 GWh/yr • EU 1st consumer of wood for energy • Wood is 47 % of renewable energies in France
Employment	**Sustainability**
• 425,000 employees • 2/3 of the workers are in timber transformation, paper industry • 1.7 % of employment in France	• 1.7 % of the forest is protected area • 35 % of forests certified PEFC, 8.2 million ha

Table 3: French forests in numbers.

Veneto is an Italian region located in the north-eastern part of the country, with a total area of 18,398.9 km^2, and a population of more than 4.8 million inhabitants.

The north–south extension of Veneto is 210 km from the Austrian border to the mouth of the River Po. By area, 29 % of its surface is mountainous (Carnic Alps, eastern Dolomites and Venetian Prealps).

The climate changes significantly from one area to another: while it is continental on the plains, it is milder along the Adriatic coast; around Lake Garda and in the hilly areas. The whole forest area covers more than 400,000 hectares, and managed forests cover an area of about 270,000 hectares. Private ownership is about 60 % of the regional forest area, and public ownership (70 %) consists mainly of high forests. In Veneto, the forest area is steadily increasing due to the abandonment of the traditional agricultural activities, forest

management is the fundamental tool to guarantee multi-functional ecosystems. The regional policy is focused on the concept of sustainable forest management: to guarantee natural ecosystem conservation and to supply multiple services.

Forests	Economic significance
• 10,982 ha total of forest land • +0.2 % increase every year for a total of 77,000 ha/yr • 41.8 % coppices • 34.4 % high forests • 66.2 % privately owned forests • 33.5 % public forests • Over a billion of m^3 of woody biomass • 144.9 m^3/ha	• EU 1st firewood importer • EU 4th pellet importer • Net importer of timber products and pulp and paper • Export value of 5 billion euros • Total revenue of the second processing sector is 13 billion euros
Production volume, 2018	**Energy**
• Harvesting levels between 18 % and 34 % • Approximately 8 million m^3/year • 60 % of production is firewood	• Energy production: 4 TWh (source TERNA) for 1.4 % out of all renewables • Heat production 86 TWh (elab. RSE),for a total of 24 % of domestic heating requirements
Employment	**Sustainability**
• 1 forest worker/2000 employees • Average dimension of a forest enterprise is 2 employees • 6471 forest enterprises in total	• Approximately 3000 CoC in Italy for timber products • Approximately 4000 certified (FSC and PEFC) enterprises

Table 4: Italian Forests in Numbers.[2]

Forests in ***Portugal*** cover 3.2 mill. hectares of the country (36 %) with cork and holm oaks, managed as multifunctional systems, covering 1/3 of the forest area.[3] Portugal is the European country with the highest share of privately owned forests (97 %). Despite small-forest owners playing a significant role in the management of the country's forests, the majority of certified forests (81 %) are managed by two large pulp and paper industries.

[2] Rapporto sullo stato delle foreste e del settore forestale in Italia (RaF) 2017-2018 (2019), accessible online: https://www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/19231 (17.06.21).
[3] ICNF, 2019. IFN6 – 6º Inventário Florestal Nacional, 2015 Relatório Final. Instituto da Conservação da Natureza e das Florestas, Lisboa, 284 pp.

The small-sized fragmented properties originated a slow increase in sustainable forest management certification. By 2019, forest areas certified under FSC® and PEFC™ covered 473200 mill. hectares and 288300 hectares, respectively.[4] However, certified maritime pine area is estimated in 4.5 % and 2.3 % by FSC and PEFC respectively, making it possible to have the same area certified under the 2 different schemes.[5]

National forests have a limited number of tree species with considerable representativeness. According to the last NFI Eucalypt (26.2 %), maritime pine (22.1 %) and cork oak (22.3 %) dominated stands are the most representative tree species, followed by holm oaks (10.8 %), stone pine (6.0 %), other oaks (2.5 %) and chestnut (1.5 %).[3] Pine and Eucalypt forests, the traditional wood production species, cover around 77 % of the forests North of the Tagus river and 25 % of the forests to the South, where multifunctional agro-silvopastoral systems (holm and cork oaks) represent close to 55 % of the forest area. Typically, eucalypt and pine forests to the North are small-sized (~ 0.5 hectares) and characterized by fragmented ownership. Pine forests are mainly composed of maritime pine with stone pine share (managed for fruit production) increasing to the South. The southern part of Portugal is characterized by large holdings where wood harvesting and extraction (resulting from thinning and pruning) from oak and stone pine stands only takes place on a small scale being used as fuelwood by local populations and for charcoal. Forest areas managed by private non-industrial owners lack professional forest management throughout the country.

The National Forest Inventory is carried out every 10 years and is in its current 6th cycle (reference year 2015) with the aim of producing national and international statistics and assisting policy-making strategies. Forest management must be in line with the regional forest management plans (PROF) developed for 7 different regions in Portugal: 2 in the north, 3 in the center and 2 in the south.

The major disturbances affecting Portuguese forests are pests and diseases and recurrent wildfires. The inland forests of pine and eucalypt in central Portugal were severely damaged after the wildfires in June and October 2017 that took place while the second revision of the PROFs was in course. These fires triggered the development of several instruments for the recovery of burnt areas such as the Landscape Transformation Program that considers a mid-term transition from the existing landscape toward resilient forests focusing on the economic valuation of all ecosystem services. The funded program aims to operationalize changes on Integrated Landscape Managed Areas (AIGPs) covering areas from the North of Portugal to the Tagus river Portugal.[6]

In 2016, total harvests rose up to 11985000 m^3 (underbark) with 9144 000 m^3 of hardwoods harvested wood.[7] Portugal is among the top European producers of pulp and paper having produced 2.8 mill. tons of pulp and virgin fibers and 2 mill. tons of paper, cardboard and tissue in 2019.[8] In 2018, the forest sector contribution to GVA was 2471 mill. € (1225 M€ maritime pine, 895 mill. € eucalypt and 351 mill. € cork oak).[9]

Forest area is the predominant land use in the Centre Coastal PROF region (48.3 %) followed by shrubs and pastures covering 23.6 % of the area. In 1991, the population was close to 1,400,000 but by the end of the

[4] CELPA, 2019. Boletim Estatístico 2019 – Indústria Papeleira Portuguesa, Associação da Indústria Papeleira, Lisboa, 112 pp.
[5] Calado N., Porta M., Carneiro S., Teixeira P. (2020). Politica de apoio ao investimento para o Pinheiro-bravo no horizonte 2021-2027 e 2028-2034. Centro Pinus,84 pp.
[6] https://www.dgterritorio.gov.pt/paisagem/ptp/prgp (18.06.2021).
[7] INE 2018. Estatísticas Agrícolas 2017, Instituto Nacional de Estatística, Lisboa 2018
[8] CELPA, 2019. Boletim Estatístico 2019 – Indústria Papeleira Portuguesa, Associação da Indústria Papeleira, Lisboa, 112 pp.
[9] Calado N., Porta M., Carneiro S., Teixeira P. (2020). Politica de apoio ao investimento para o Pinheiro-bravo no horizonte 2021-2027 e 2028-2034. Centro Pinus,84 pp.

decade migration to coastal and urban areas led to the aging and abandonment of inland areas. Over the last 2 decades, agricultural land has been converted to forests, particularly in fertile areas. However, small-scale agriculture abandonment has mostly contributed to the shrubs and pastures increase. Private and communal ownership represents 90 % of the ownership structure and public forest areas cover 9.7 % of the region with an average property size between 1 and 2 hectares.

Before the 2017 wildfires, maritime pine covered 324100 hectares, (34.1 % of forest space), eucalypt 254450 hectares (26.8 % of forest space). Maritime pine and eucalypt forest stands are mostly pure (81 % and 87 % respectively. Timber, sawn-wood and pulp are the most important forest products in the region. Forest productivity ranges between 3-11 and 7-16 m^3 ha^{-1} yr^{-1} for maritime pine and eucalypt, respectively; with the latest reaching higher productivity in some areas. Despite the importance of the forest sector, GDP evidenced fluctuations over the last 2 decades. Total forest value was estimated in 125 x 10^6 €, with the biggest contribution from wood production (70 %), followed by protection functions namely along the coastline (9.4 %), biodiversity (6.9 %), desertification combat (4.4 %), pastures (3.0 %), game management (3.0 %), wild mushrooms aromatic and medicinal plants (2.0 %). The contribution of other products/functions (e.g. resin, honey, water regime) is marginal.

Forests	Economic significance
• Forest land, 2015: 36 % of Portugal • Total volume in forest, 2015: 172.6 mill. m^3 (38.5 % maritime pine, 25.1 % eucalypt) • Protected land (Natura 2000), 2015: 599800 ha • GVA of the Portuguese forest sector, 2016: 0.5 % • Over the past 100 years, Portuguese forest area increased by 2.584 mill. ha	• Europe's 3rd largest exporter of pulp and 2nd top producer of paper and uncoated paperboard. [10] • Export value, INE 2017: € 4 896.5 million € • 37.8 % paper and cardboard, 13.3 % pulp, 12.2 % wood, 14.4 % furniture, 20.1 % cork • Forest sector contribution to GDP: 2471 M€ (1225 M€ maritime pine, 895 M€ eucalypt, 351 M€ cork oak) [11]
Production volumes [12]	**Energy**
• 2017: Paper and cardboard (2095200 tons) • 2017: Pulp (2752900 tons) • 2017: Sawn wood (848016 m^3), wood panels (1129000 m^3), Pellets (709218 tons)	• 2017: 4th EU country with the highest share of Renewable Energy Production (39.7 %), (22 % wind, 11 % hydroelectric power, biomass ~5 %) • 2018: Primary energy consumption: renewables represent 24 % with biomass taking the lead (49 %) followed by hydroelectric (22 %) and wind (21 %)

[10] CELPA 2019. CELPA, 2019. Boletim Estatístico 2019 – Indústria Papeleira Portuguesa, Associação da Indústria Papeleira, Lisboa, 112 pp.
[11] Calado N., Porta M., Carneiro S., Teixeira P. (2020). Politica de apoio ao investimento para o Pinheiro-bravo no horizonte 2021-2027 e 2028-2034. Centro Pinus, 84 pp.
[12] http://www2.icnf.pt/portal/florestas/fileiras/econ#relatorio-sintese.

Employment[12]	Sustainability
• 2016: 68700 employees in forestry (94300 if trading activities are included)	• In order to promote the economic valuation of forest under sustainable management targets according to the criteria and indicators approved at the 3rd ministerial conference (1998), the Portuguese government, at national and regional level, recommends forest owners to implement Sustainable Forest Management Plans in their areas which must be developed in accordance with the specifications in the Regional Management Plans defined. Additionally, certification ensures meeting a set of criteria and Indicators for Sustainable Forest Management. • In 2019, certification systems currently in use in Portugal were the PEFC (288300 ha) and FSC (473200 ha). Over the past decade FSC has been increasing its area (250000 ha in 2010).

Table 5: Portuguese Forests in numbers.

2.1.1 Political Targets for Wood Mobilisation and Forestry

In *Castilla y León, Spain*, the Forest resources mobilization program is based on the following principles of action:

- Diversification and complementarity of production and forest functions;
- Business internationalization and opening up to the global market. Integration of the region into the commercial forestry development pole of Southwest Europe (SUDOE region) and, more specifically, into its Atlantic Arc. Commitment to quality and sustainability as a production strategy, seeking final productions with greater added value and ecological orientation;
- Importance of traceability links between stakeholders in the sector and integration into value chains;
- Clarity, simplicity and strength in regulatory frameworks; and
- Sectoral transparency and improvement of commercial information.
- Forest-based sector Technology Platform (FTP) 2040.
- Mature forests protection combined with forest management.
- Ministry MITECO strategy of long-term Decarbonization (ELP 2050)

In addition, the national Ministry of Agriculture, Fisheries and Food developed **PASSFOR** (Plan for Socioeconomic Activation of the Forest Sector). The objective of the plan is to profit from the forest sector ability to promote socioeconomic activity. Despite its relevance, it is not fully implemented due to lack of vision and knowledge at the political and administrative levels. It is necessary to continue evaluating and reviewing the development of projects, strategies and policies, establishing clear purposes and agreements.

The wood resource and industry is very important in the ***New Aquitaine region, France***. Softwood lumber accounts for 50 % of the harvest, pulpwood and energy wood for 39 % and 11 % respectively. New Aquitaine is France's leading surplus region in terms of external trade, with nearly 250 million euros released in 2016. Primary transformation (sawmill industries, wood-based boards and pulp) produced 11 million tons of goods in 2014. Secondary transformation produced more than 20 million tons of wood and paperboard products in

2014, 70 % of which goes to the paper industry. As with pulp, the furniture industry's resources come from both domestic production and imports. Wood waste is used to supply the wood-energy sector, which has seen rapid growth over the period: the production of wood pellets reached a peak of 1 million tons in 2014.

With this in mind, the two main political axes for wood mobilization are:

1) strengthening the competitiveness of the sector, and

2) stimulating silviculture and sustainable forest management.

Indeed, strengthening the competitiveness of the forestry sector is essential to enhance the value of local wood resources and create jobs in rural areas. This involves supporting companies in their positioning on new markets, stepping up research and innovation, and finally encouraging partnerships between stakeholders. Concerning sustainable forest management, the diversity of forest areas and species implies a diversity of silvicultural practices. Hardwood forests generally have little wood mobilization, while softwood forests are managed more intensively. The stimulation of silviculture in New Aquitaine's forests must include sustainable practices to tackle the challenges due to the multiple functions of the forest. Boosting sustainable management requires complementary actions, such as reinforcing present efforts and certification of sustainability, grouping forests, and updating the silvicultural techniques and education for forest owners.

These political targets of sustainability together with competitiveness are encouraged by the 2020 recovery plan ("France Relance") presented by the French ministry for agriculture and food. Thanks to this plan, financial support will be given to forest owners and operators who wish to invest and adapt their forest to climate change in the year 2021 and 2022. This concerns poor, unmanaged or vulnerable forest lands, and the requirements include for example that 20 % of the forest should be diversified for surfaces above 10 hectares. Moreover, New Aquitaine contributes to mitigating climate change in additional ways. Plantation forests offer a resource and substitute for other more carbon-producing materials. and mixed hardwood forests are more likely to store carbon in the forest ecosystem. The adaptation of the forests of New Aquitaine is a major concern because they are at the interface between the temperate zone and the Mediterranean zone, with species at the edge of their range and would therefore be particularly sensitive to climate change.

The regional forest policy *in* ***Veneto, Italy,*** can be summarized in the following five main objectives:

- To improve the competitiveness in the long-term of the forest sector through the sustainable use of forests
- To maintain and increase the protection function to tackle natural hazards (wind, snow damage, flood...) due to climate change and human pressure
- To protect biodiversity, preserve landscape and enhance carbon sequestration and ecosystems health
- To increase the social and cultural value of forests
- To improve the coordination and relation between regional/local authorities and stakeholders

Starting from these objectives, four main priorities have been identified:

- structural priorities,
- conservation and preservation priorities,
- defence of the territory priorities, and
- coordination priorities.

In the Centre Coastal PROF region of ***Portugal***, forest policy is implemented through the corresponding Regional Forest Management Plan (PROF) defined as a sectoral instrument for territorial management[13] establishing specific norms for the use and exploitation of forest areas. PROFs aim to evaluate the potential dominant use of forest spaces by defining the list of species to be prioritized in afforestation and reconversion

[13] Forestry Policy Law 33/96 of August 17 regulated by Decree Law 16/2009 of January 14.

programs and proposing the most suitable forest management models and silvicultural prescriptions. At a higher scale, the "Landscape Transformation Program" comprises a strategy for an integrated intervention in fire-prone forestry areas with the aim of potentiating the economy in rural areas creating resilient forests through cooperative and participative approaches. This program was planned to address different targets:

- Integrated Landscape Management Areas - assist in the development of a grouped management model under the responsibility of a management entity and supported by a long-term multi-fund program that provides support for initial investment, maintenance and management actions over time and remuneration of ecosystem services.
  (to be implemented by local administrations, forest owners associations, etc)
- Village Condominium Program - encourage owners to change the use and occupation of the land and the management of fuels around the settlements while promoting an income-generating land occupation.
  (based on a strong participatory component and involvement of the local community)
- Land Consolidation for Planning - encourage an increase in the physical size of rural properties and thus give more scale to the properties, contributing to the economic viability and sustainability of farms that are or will be established there. The program introduces management and investment factors in rural properties, with direct positive impacts on the resilience of the territories and on the dynamization of agroforestry activities.

The Centre Coastal PROF region comprises priority areas for the operationalization of the "Landscape Transformation Program" where some projects are already ongoing and more are expected until 2025.

2.1.2 Structures of Decision Making

In *Castilla y León, Spain*, decision-making is performed at two levels: national and regional (Autonomous Community of Castilla and León). On the national level, the Ministry of Agriculture, Fisheries and Food is the competent entity for the all the forestry issues, whose Directorate-General of Rural Development, innovation and forestry policy has specifically the following competencies:

- The promotion and development of the competences of the Department in matters of innovation and knowledge systems and innovation;
- To develop the functions of the Department in the area of digitization, and of the digitization agenda;
- To exercise the competences of the Department in terms of training, advice, exchange of knowledge and information for professionals, as well as the promotion of new technologies;
- The development of the competences of the Department in rural infrastructures of general interest and, in particular, the planning, coordination, implementation, modernisation and monitoring of irrigation plans, rural communication infrastructures, forest fire prevention and other types of infrastructure; as well as emergency actions and repair of catastrophic damage, produced in the field of action of the Directorate;
- The functions attributed to the General State Administration by the legislation on forests and forest harvesting, and in particular the deployment of state resources to support the autonomous communities for the coverage of fire-fighting forests.

On the regional level, the *Junta de Castilla y León (JCYL)* is the regional government. As a part of the government, the General Directorate of the Natural Environment of the Department of Development and Environment is responsible for the industrial and commercial promotion of products derived from forests. It is also competent in the planning and programming of forest policy and in the management of forests and forest uses, and it is responsible for both the administration of forests owned by the Autonomous Community and the management, in agreement with the owners, of public forests.

In addition, the Department promotes relations between the forest production sector and the industry dedicated to the first processing of forest products, and is responsible for the Registry of Forest Enterprises and Industries.

The *Junta de Castilla y León* has developed the Castilla y León Forest Plan and specifically the Castilla y León Forest Resources Mobilization Program. Its first objective is to increase the value of sustainable production, the productivity of the forests and the sector in the region. This would improve the main economic and employment parameters linked to the regional forestry sector.

For the ***New Aquitaine region,*** many French laws and regulations govern forest policy. Introduced by the Law on Management, Agriculture and Forestry in 2014, the National Forest and Wood Programme sets out the orientations of forestry policy in public and private forests for a period of ten years. The four main goals are:

- Create value in France by mobilizing the resources in a sustainable way
- Meet citizens' expectations and integrate them into territorial projects
- Combine forest mitigation and adaptation to climate change
- Develop synergies between forest and industry

Each region must develop a Regional Forest and Wood Programme within 2 years of approval of the national plan, under the aegis of the Regional Forest and Wood Commission. The law on Energy Transition for Green Growth (2015) also helps to mobilize more resources under sustainable conditions thanks to several programs and strategies, namely the Multi-year Energy Programming, National Low Carbon Strategy, and the National Biomass Mobilization Strategy.

A significant proportion of national measures are divided into regional strategies in order to adapt to specific territorial characteristics, but also to resonate with the competences of local authorities, and regional councils. The Regional Forest and Wood Programme should serve as a framework for ensuring consistency between all other regional documents.Regarding ***Italy,*** the Italian Constitution states that the Regional Government has direct legislative competences, thus allocating resources, fostering innovation and selecting innovative projects and initiatives on its own initiative. In addition, the implementation of a National Law for forests (TUFF – Testo Unico Forestale) that will implement new national regulations is under preparation on the national level.

In ***Portugal***, the Instituto da Conservação da Natureza e das Florestas (ICNF), integrated in the Ministry of Environment and Climatic Action, is the forest authority, with much of the supervision delegated to the 5 regional offices distributed across the country. However, the Landscape Transformation Programme, comprises instruments for landscape management, and consequently forest management, that aim at combining efforts from different entities (allocated to the ministries of Agriculture and Fisheries, Environment and Climatic Action and Civil Protection).

2.1.3 Main actors in forestry in the South-Western Hub

The main actors in the public sector for ***Castilla y León, Spain***, are:

- Directorate General of the Natural Environment of the Department of Development and Environment in Castilla y León
- Ministry for the Ecological Transition of Spain
- Sociedad Pública de Infraestructuras y Medio Ambiente de Castilla y León, S.A (SOMACYL).
- Regional Energy Body (EREN)

Regarding associations, the main institutions are:

- Regional Federation of Municipalities and Provinces of Castilla y León

- Mesa Intersectorial de la Madera de Castilla y León
- CEMCAL

The main nonprofit organizations (NGOs) are:

- FAFCYLE
- CESEFOR

In terms of Universities, the main actors are:

- University of Valladolid
- University of León
- Catholic University of Ávila

The main actors in the wood industry are both large and small companies: (Losán, Maderas García Varona, Maderas Pascual Vinuesa, Pallet Tama, Maderas HTM, etc.)

The public institutions serving the State in the ***New Aquitaine Region, France***, are the Regional Directorate of Food, Agriculture and Forestry (DRAAF) and the Departmental Directorates of the Territories (DDT). The organizations that implement public policies related to sustainable forest management are:

- CNPF: the National Forest Ownership Center, a public institution under the supervision of the Ministry of Forests in charge of developing sustainable management of privately owned forests.
- ONF : the National Forestry Office of France, a public industrial and commercial institution created which manages nearly 11 million hectares of public forests, owned by the State and local authorities.

The main actors of the forestry sector are independent groups of forestry contractors, cooperatives and forestry experts. Sawmills also play a big part in the industry. Professionals' education and forestry development is taken care of by IGN (National Institute for Geographical and forest Information), FNB (National Wood Federation) and interprofessional associations such as FIBOIS. Different bodies carry out research on forest and innovation, the most important one being INRAE (National Research Institute for Agriculture, Food and Environment).

As for ***Italy, Veneto***, the main actors are:

<u>Universities/RTOs</u>:

- University of Padua – TESAF
- CREA
- University of Florence
- University of Tuscia
- CNR IVALSA
- ISPRA

<u>Other Public Bodies at National level</u>:

- Environmental, Agrifood and Forestry Police army (Comando Unità per la tutela forestale, ambientale e agroalimentare - Carabinieri)
- Guardia di Finanza (National Finance police force)
- Italian Ministry of Agriculture – Forest Directorate
- Accademia dei Georgofili
- SISEF

- Accademia di Scienze Forestali
- Fire brigades

Other Regional actors:

- Unione dei Comuni
- Parchi regionali
- Parchi nazionali
- Cooperatives
- CIFORT
- Veneto agricoltura

Other private actors:

- Forest owners and enterprises' associations
- Forest industry actors
- Private associations (Confartigianato, Confagricoltura etc etc)
- Compagnia delle Foreste
- FederlegnoArredo
- FederForeste
- CONAIBO
- UNCEM (Unione Nazionale dei Comuni Montani)
- AIEL

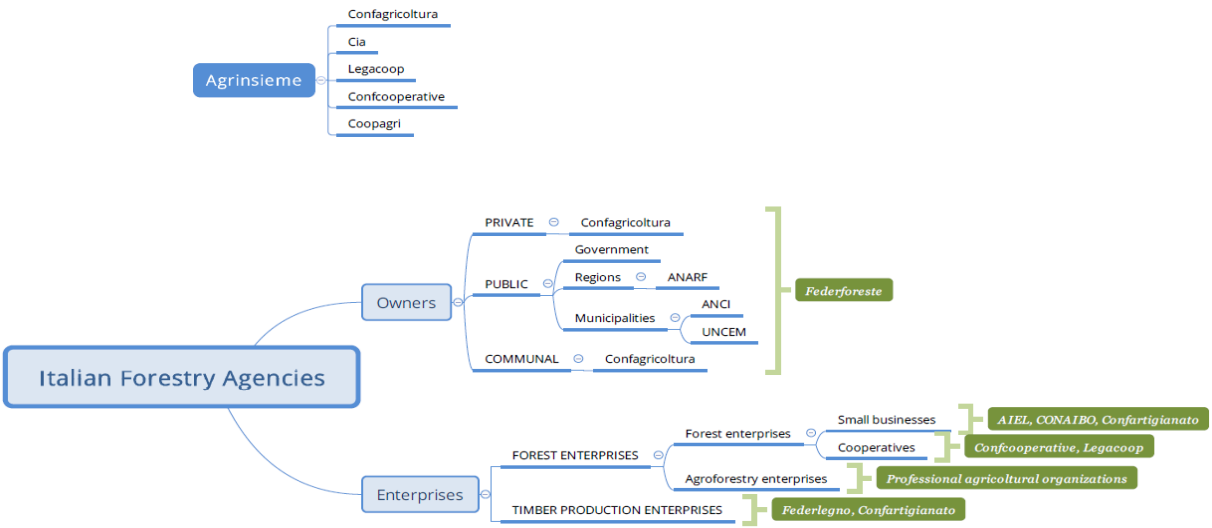


Figure 1: Main forestry actors in Italy.

The main actors in the forestry sector in *Portugal* are the following.

Forestry companies:

- ALTRI Florestal, the Navigator Company, Sonae-Arauco, Unimadeiras

Forestry Associations: services for forest owners

- Forest Owners Associations (including unions of associations e.g. UNAC, FORESTIS), Forest Intervention Zones (ZIFs), Portuguese Pulp and paper Companies Association (CELPA), Portuguese Wood and Furniture Industries Association (AIMMP)

State Forest Enterprises:

- Companhia das Lezírias, Floresta Atlântica, GESFLOPOR

Supervisor of the Forest Act, education of forestry professionals, forestry development:

- Instituto da Conservação da Natureza e das Florestas (ICNF), integrated in the Ministry of Environment and Climatic Action
- The forest guard's training is under the responsibility of several entities including universities who are also responsible for the organization of workshops promoting the use of forest simulators to assist forest managers. Adding to universities, other entities such as CELPA promote the organization of technical events to disseminate knowledge among private owners.

Forest Research Centres:

- There are several research centres linked to forestry mostly associated to Universities (e.g. CEF/ISA, CEABN). RAIZ, the research institute of The Navigator company is also responsible for forest research as well as the National Institute for Agricultural and Veterinary Research (INIAV) that is also dedicated to research in the field of forestry systems.

Educational Institutes:

- University of Lisbon, School of Agriculture (BSc; MSc, including an international Master; PhD). Other universities, institutes and schools are also responsible for education in the field of forestry or related (e.g. University of Vila Real, Escola Superior Agrária de Castelo Branco, Escola Superior Agrária de Coimbra, Universidade de Évora, Instituto Politécnico de Bragança, professional schools). The educational level in these institutions has been changing over the past years as a result of the decrease in the number of students.
- Clusters: Out of a total of 113 Operational Groups, 8 are related to forestry and can somehow be related to wood mobilization. As for Competences' Centres, the Centre of Competences for maritime pine aims primarily at increasing wood production to meet the demand. There are other 3 Competence Centres with aims that can be indirectly related to forestry/wood mobilization (out of a total of 22 Competences' Centres).

2.2 Main findings

2.2.1 SWOT-analysis

All the four regions were first analyzed in local SWOT-analysis with the advice of expert advisors and partners, merging to one joint SWOT analysis for the South-Western Hub:

STRENGTHS	WEAKNESSES
• Large forest areas including potentially productive ones in the future • Different forms of grouping of owners (France) • High mechanization for harvesting wood in softwood stands • Strong network of forest roads • Abundance of raw materials and large extension of forests (availability and diversity) • Certificated forest • Great value of biodiversity in the Mediterranean environment • Multifunctional raw material • Strong industrial network in certain areas • Tax incentive and forest investment (France)	• Fragmentation and disconnection of private forest ownership • Lack of interrelation between the different actors in the supply chain • Little mechanization for hardwood harvesting • Difficulty of access to raw material • Lack of demand, especially for hardwoods and quality softwoods • Lack of management in large areas of forest • Public opinion against forest production • Lack of qualified forestry labor • Poor structuring of market • Poor development of value chains at the local level • Lack of market transparency • Imported wood used for construction and furniture • Too many administrative constraints
OPPORTUNITIES	**THREATS**
• Tax benefits: tax credits for the purchase of plots of land (France) • Possibility of integration with the agricultural food production (agroforestry) • Availability of new collection systems more efficient and sustainable • Very specific but very high value productions (cooperage) • New market requirements: traceability of wood, wood from sustainably managed forests • Bio economy in general and the growing social demand for renewable natural products that contribute to the fight against climate change • Growing offer of technified products, good solutions, a big change in the last 20 years. • Market internationalization • Public policy for the development of wood in construction and other uses • Increase of wood demand • Development of new wood-based products • EU Directive on the use of biomass that supports new biofuels production, second generation biofuels. Opens opportunities in biorefinery.	• New forest owners live far from the forest • Supply difficulties in small-scale, low-volume businesses • Public aid not sufficient to trigger work in poor stands • Increased susceptibility of forests to natural disasters linked to intense and particularly destructive climatic events • Increased biotic and abiotic adversities • Restrictions on wood mobilization in protected areas • Competition from new industrial countries • Reduction in the public budget for forestry

Table 6: South-Western Hub SWOT.

Based on the SWOT analysis, the following categories have been identified as critical for the South-Western Hub:

- **Forest Management**: Ownership structure and land tenure (fragmentation, urban areas…); Cooperation of owners/foresters, supply chain; Mechanization; Digitalization (digital networking); Access to terrain; Resource (wood); Sustainability concerns; Environment / Biodiversity; Forest management skills
- **Harvesting and logistics**: Mechanization; Availability of skills and personnel; Wood logistics
- **Infrastructure**: Forest roads (construction and management)
- **Markets**: Wood sale market; Development of new wood products; Market fluctuations; Wood-processing sector (construction, furniture…); Networking
- **Legal framework:** Enabling legislation for ownership

2.2.2 Best Practices and innovations identification

The South-Western Hub has identified best practices and innovations (BPI) related to wood mobilization in the involved countries. Most of them are related to **forest management**, probably the more active part within the wood mobilization value chain. **Cooperation among owners** and/or foresters, **technical developments**, **wood resources** and **sustainability** were the most common issues addressed by the best practices. Wood logistics and wood sale markets are other topics that have been researched in the Hub. On the other hand, legal framework, financing, education and training do not present relevant best practices or innovations, also weaknesses as mentioned above.

Country	*BPI Title*	*Description*
Spain	Cross-Forest	Cross-Forest aims to develop Digital Service Infrastructures – DSI – services, to integrate models supporting forest management and forest protection, oriented towards: (i) forest fires control through precise information on combustible materials, forestry maps and propagation models that need HPC resources to run properly and (ii) forestry evolution models on Country-Level. The foundations of those services will be forestry and GIS datasets that come from Portugal and Spain.
Spain	SISREP	Information system for the afforestation of agricultural land for Castilla y León gathering data from inspections in agricultural land afforestation. Objectives: 1. Create an information system that (1) improves data collection with mobile terminals, (2) digitally stores information in easily maintainable formats, and (3) provides advanced tools for consultation, updating and operation. 2.Use the knowledge of historical "in-situ" visits to predict the probability of success of future plantations using automatic learning techniques.
Spain	Forest LiDARioja	Updating and enhancement of forest information in La Rioja obtained from remote sensors: LiDAR and satellite data. Creating an updated cartography of the main forest species in La Rioja, collecting data such as the volume of wood, tree heights and vegetation structure for every 25x25m of land, with a very high level of resolution.
Spain	C.A.F.E	C.A.F.E. (Carbon, Aqua, Fire & Eco-resilience) is a Decision Support System for a multiple-criteria forest management. This tool determines the optimum

		silvicultural activities to manage multiple products, goods and services. It allows selecting the optimum solution while answers the four main questions of forest management: How much? Where? When? And How? In other words, the management intensity, forest working units selection, frequency and type of management (thinning/plantation).
Spain	CHAINWOOD	Blockchain for Inmutable Timber. The ChainWood operational group brings together the capabilities of the timber and forestry sector with companies and technology centers to develop software based on blockchain and IoT technology that will contribute to improving traceability, competitiveness and efficiency in the sector.
France	Je me forme pour mes bois	"I'm training for my woods" is a forest vulgarization website intended for private forest owners, teachers as well as the general public. It contains simple and attractive educational tools to learn about good management and protection practices for private forests in France. Topics cover administrative procedures, knowledge on forest management, understanding the wood market, and the content includes videos (5-10min).
France	NEOSYLVAQ	The project aims to use new technologies to make the wood sales system economical and dynamic, and to better spread information to increase wood mobilization and get forest owners involved in management. Two tools are available: a computerized wood auction sale system coupled with an online sales platform (SYLVATRADE) and a digital GIS data sharing platform for optimized management accessible to all stakeholders (NEOSYLVAQ).
France	La Forêt Bouge	The aim of this platform is to propose a simple tool with adapted services for the novice forest owners and allow the mobilization of wood from small private forests. Professionals in the forest and wood sector will also be able to access it to find information on the legislation and manage forest worksites by completing online procedures.
France	CLIMAFOR	As forest carbon issue has an increasing importance in France, Climafor is a software that allows advanced calculations on carbon rates based on production tables and coefficients. Improving through continuous updates, this software is time-saving, instantaneous and requires no training.
France	Sylv'valor	Sylv'valor is a pilot project aiming towards a better valorization of the forests of New Aquitaine. Its two main axis are better documenting and understanding of the ecosystem services provided by the forests, experience of owners, and creating experimental forests (living labs) to try out different ways of working with ecosystem services in an innovative way.
Italy	IT FOR II	Online marketing platform for local/regional wood supply chain. Municipalities and forest owners together with forest enterprises can sell their timber to the forest industry. Different sections will be available in the platform such as biofuels, roundwood, broadleaves and conifer. The platform will give the possibility to register and to place a bet in the auction.
Italy	LegnOK	LegnOK is a web platform that helps in the traceability of timber. The platform itself will provide the registered enterprise useful information about the Risk

		Assessment and will help the enterprise on how to roll a proper Risk Mitigation activity.
Italy	LogistiCIPlus	High efficiency logistic solutions for biomass sector. The efficiency of the process goes through the emission of GHGes that are continuously measured. Given this data the aim is to provide policy makers and local managers a specific and punctual analysis on the situation in order to: 1) Improve the logistics structures of the area 2) create a weighted biomass demand starting from the biomass offer.
Italy	RILEGNO	National wood waste collection and recycling platform. In Italy used and treated wood are considered waste and hardly can be reused becoming an expense for most forest industries. The RILEGNO system collects used and treated wood in order to recycle it, reuse it or refurbish it.
Italy	WoodChain	The project, coordinated by Replant srl, aims at testing the application of Blockchain technology in the frame of a PEFC certified supply chain in Piedmont Region. The solution can be applied both as part of the obligations of Due Diligence and in the PEFC Chain of Custody management
Italy	Cippato Calibrato	"Cippato calibrato" is a new type of woodchip specific for small scale boilers and stoves. The material is dessicated, sieved and dedusted in order to have a high quality and homogeneous material. The product aims to have a niche in the firewood market on a small scale bound to the forest operator that is technically able to produce that type of material.
Portugal	Areas Florestais Agrupadas	Small-size private-owned unmanaged forest areas are common in the North of the Tagus River in Portugal, making them prone to wildfilres, pests and deseases. This program promotes the grouping of contiguous areas for management purposes with the overal aim to reduce the occurrence of hazard, improve and increase well-managed areas, increase investment and reduce investment risk.
Portugal	e-globulus	The project aims at technical and scientific knowledge transfer on silvicultural practices of eucalypt stands to forest owners and managers. The forest owner has to register to the platform in a process that involves only 3 steps. First, the owner adds his property delimiting it directly on Google Maps or importing a shapefile. Second, he is asked to characterize his property and forest (e.g age stand rotation, soil details, topography). Finally, he is asked to specify if he wants to establish a new stand or maintain an existing one and he is immediately provided an immediate technical prescription.
Portugal	FCTools & sIMfLOR platform	sIMfLOR is a platform that integrates several simulators developed for the main portuguese forests species. The platform aims to encourage users from research fields, managers and owners to make use of the forest growth and yield models in user-friendly way. Different stand and regional level simulators have been integrated in a common environment as well as other tools.
Portugal	Forscope	The Forscope is a prototype of an advanced planning system whose main functionalities include: (i) a digital marketplace for non-used forest-based

		biomass; (ii) support supply chains design; (iii) support the optimization of logistics processes; (iv) planning and control of operations from forest-to-mill.
Portugal	Limpa e aduba	Program integrated in the Better Eucalypt project. The forest owner applies and a forestry technician then visits him. Afterwards, he carries out weed control and shoot selection operations according to sustainability principles. The Program offers the forest owner the fertilizer as well as financial support for the fertilization service. In order to have his application approved the owner has to meet some eligibility criteria, e.g. pure even-aged eucalyptus between 2 and 6 years not past the 3rd rotation with proper stand densities (> 800 living stumps / ha), covering areas > 0.25 ha per plot but that don't sum-up more than 25 ha in total.

Table 7: Most relevant BPI from SWE Hub.

2.2.3 Needs Analysis

The following needs and problems have been detected as common in the 3 regions of the South-Western Hub:

- The general wood mobilization problem could be summarized by the diagnostic "prices are still too low". To overcome this strong constraint, there are many practices addressed to improve the valorization of forest products, integrating them in the bioeconomy new production cycles. It is a priority to develop ways to increase the added value through the forest supply chains, including the biomass for energy.
- There is a strong need for professional agents offering forest management services (as part of a rural land management policy) addressed to owners that are more and more absent or far from the territory. Small forest owners' aggrupation is a need to this end.
- An important degree of standardization is needed regarding the offer description. It is essential to have European common requirements of forest workers' competences to be qualified and mutually recognized.
- As a major market problem, the crisis of quality timber sawmills has been identified as an essential challenge for wood mobilization.
- Some tax policy problems have been pointed out, such as the lack of taxation on the abandonment of land or the fiscal regimes that penalize companies offering management services to forest owners.
- Funding problems are a main constraint to forest mobilization, and the role of CO2 funds needs to be developed. This lack of financial resources also affects forest research in the fields related to forest products mobilization.
- There is a lack of intersectoral communication or joint actions, particularly in the Italian and Spanish cases. The French initiative FuturBois might be a reference to be used in the Hub.
- Lack of communication with society.
- The abandonment of the rural environment leads to the evolution of a series of vegetation that can cause disasters in case of fire and hydrogeological instability. There is a high probability of increasing the forest area in peri-urban areas.

- Despite being forest regions due to their surface area, production and productivity of some species, they have great potential for growth in new areas and owners, but with little forest culture/tradition, which must be transferred.

*In **Spain***, changes in the forest sector are mandatory to be competitive in the international market; digitalisation and investment in sawmills, factories and forest management have been minimum in the last 50 years. This has led to a situation of low profitability of interventions, a lack of well-developed value chains for local species and weak markets for forest products. Also, there's a lack of advisory capacity and local cooperation, and as a result, small-holding owners are no longer interested in forest management, and workers do not have the adequate qualification plus the profession is not socially valued. These factors lead to the abandonment of the regions and aging of the population in rural areas, making the situation in the forest sector worse, and complicating the solutions in the short term. Cooperation between actors and the implementation of digital solutions is mandatory to reach a competitive level in the market.

To summarize, the main needs in Spain are the following:

- Improve advisory capacity and cooperation between forest owners and stakeholders and administration
- Effective solutions for smallholding management in order to get profitability from interventions
- Boost digitalization improvement in companies to manufacture high value products
- Professionalise the forest worker employment for a better qualification and social appreciation
- Adequate regulations and information for forest owners and stakeholders.
- Communicating with society: making forest management understood by urban society
- Industrial development of technological products for the ecological transition/bioeconomy.
- No favorable management framework in land management: not only because of smallholding, business model fails. Complication due to autonomous management, diverse decisions, areas without any type of management.
- Restrictions due to protection and conservation regulations. Large areas included in protected areas. Environmental restrictions on forest management, this discourages possible investment. In addition, each territory has a different management.
- Lack of added value to wood (good wood for packaging). In Spain little wood is destined for construction compared to other countries, due to lack of culture and promotion.
- Internal weaknesses but also structural problems (of the sector).

The needs that have been identified for ***France*** and more particularly for the ***New Aquitaine region*** concern mainly wood mobilization and better tools and resources given to the private owners. The need for a boost in using the existing trees may help to raise interest and concern of a certain category of owners into their forest, and this could be a way to reduce the fragmentation of the forest (a high number of small and scattered parcels).

Forest owners need new tools and a knowledge database to get empowered in managing their forest. Improving wood mobilization should nonetheless be done in a very conscious way, encouraging the development of the local economy, the creation of jobs and short production circuits. There is indeed a need to make the forestry sector more attractive to young workers, and also more consistent with the current expectations of the society: forest products need to be made with resilience, carbon footprint and sustainability in mind.

The need for wood mobilization reflects the necessity for a valorization of hardwood, ecosystem services and also a valorization of the multi-functionality of the forest. This includes a better measurement and recognition of the services that forest lands offer, such as recreation, contemplation, providing resources and storing carbon.

Forest companies need to be more transparent and to communicate more on their practices, as a lack of trust from the general public has been identified. Improving the communication for the general public but also between different stakeholders is of key importance. This would allow a better understanding between the rural and the urban population.

In a nutshell, the five main needs based on the French SWOT analysis are:

- improving the communication between actors
- empowerment of new private owners in the mobilization of their forest
- strengthening the local economy and short circuits
- improve the hardwood value chain and traceability
- improve the communication about forest practices to the general and urban public

Given the SWOT analysis on the *Italian* situation, several issues were identified. Starting from the beginning, on forest ownership, the fragmentation of forest parcels and the related abandonment of rural areas. These two aspects are combined and strictly related to each other.
The abandonment of rural areas caused a lack in management. With different heirs, most of them living far from their forest parcels, inheriting smaller portions of a bigger parcel, any type of management is close to impossible. The lack of management is also a direct consequence of the low profitability of timber and the lack of sawmills at a territorial level. In addition, forest owners and managers also lack an awareness that forest needs to be managed not only for timber products.

Another important issue is, in fact, the lack of properly sized sawmills, as they're getting fewer and bigger; together with logistic platforms to stack, manage and transform what comes out of the forests. Diffuse sawmills and logistic platforms would provide a helpful structure to increase quality, offer and profitability of high value timber products. At the moment, a big part of conifer roundwood extracted from Italian forests is exported to other countries to be processed and then sold back in Italy as timber, with a great loss in profitability, opportunity and sustainability.

The lack of sawmills in Italy and specifically some part of it is also related to the forest structure. In fact, in the Apennines coppice represents the great majority of the forest covered areas. This affects the products that a big share of Italy is able to produce, which is mostly firewood. In addition, the sale of firewood happens to be on a hobby level, fuelling a big share of submerged market increasing problems with work safety and soundness together with, obviously, timber legality.
The forest operators in Italy are one in two thousand workers and the average forest enterprise has approximately 2 workers. Specifically, the majority of timber in Italy is extracted and processed by few very large companies. For this reason, an action to increase and develop the skill level of all forest workers, both on a technical level and on an entrepreneurial level in order to increase the number of actors involved in the sector working also on niches of the supply chain is needed. Lastly, communication to the end user, public, citizen is necessary in order to have them aware of the real world that operates behind the world forests, as much as the different actors involved. The communication must be implemented also between policy makers and regional administrators in order to boost and implement effective initiatives, law and regulations.

Summarizing what Italy needs, the following points can be made:

- Effective solutions for smallholding fragmentation. Both technical and political.
- Small and medium sawmills on a territorial scale paired with logistic platforms.

- Increase the offer of timber related products in order to diversify the offer and increase the profitability
- Increase the skill levels for operators, forest workers and forest enterprises
- Educate the public and local administrations

Portugal is the EU country with the highest share of privately owned forests (97 %). North of the Tagus River, properties tend to be small-sized with each owner having several disjoint patches of land, which represents a major drawback for forest management. There are other weaknesses adding to the size-related one though:

- the inexistence of cadaster records leads to a considerable share of unidentified owners (UFOs) expressed by absence of management;
- the abandonment of rural areas that lead old, unprepared farmers with limited technic and economic resources for forest management;
- the extremely high costs for silvicultural operations, in particular site (re-)installation operations;
- the increasing complexity involving adaptive forest management required to build forest landscapes resilient to disturbances (fire and pests and diseases) only possible with the support of professionals;
- the lack of assistance to deal with extremely high availability of wood after the recurrent wildfire events, burnt trees left waiting to be harvested or harvested wood left on the side of the road;
- the need for diversifying production and revenues in rural areas such as support/funding schemes for creating and developing markets for new products;
- support/funding schemes to promote noble maritime pine wood uses other than for energy purposes (already represents 20% of annual wood consumption)[14]
- Wood to be paid based at fair prices

Thus, there is the need to:

- minimize the impacts of small-sized fragmented ownership and improve forest management
- provide technical assistance to non-industrial private owners/ managers with the aim of increasing forest areas under sustainable adaptive forest management and if possible developing funding schemes for supporting non-industrial owners financially
- rethink forest management and planning at the landscape level in an attempt to diversify forest areas and build ruptures in the vast homogeneous areas of continuous forests in order to minimize the impacts of disturbances.
- develop user-friendly support systems to assist forest owners and/or managers, loggers and industries to handle the extremely high amounts of wood left available after wildfires or to assist forest managers in assessing the profitability of forest investments over time (growth simulations under alternative scenarios of management and/or disturbances. Due to their reduced funding capacity, local owners tend to invest little, so it is important to diversify forest products and their income sources as well as developing new markets for the new products.

[14] Centro pinus (2019): https://www.centropinus.org/files/upload/pinuspress/pinus-press41.pdf

2.3 Development targets for sustainable wood mobilisation

The main objectives for the forest sector in ***Spain*** are:

- Cooperation between actors

The administration and the research entities have the knowledge and the experience to advise forest owners and find solutions for their needs, but there's a lack of communication between actors and these solutions are rarely implemented. It is important to emphasize the lack of communication with society.

- Lack of updated and availbale data and information.

Most forest companies are outdated, their products are not competitive in the international market and the lack of knowledge and experience widens the gap. Digitalization is mandatory to adapt the factories to present and future needs.

- Investment of money and knowledge

To reach these goals it is necessary to invest in forest companies and in cutting edge projects, to bring the local sector up to the international standard and become profitable and competitive. This development must be accompanied by knowledge advice to make the most of the new technologies acquired in the companies. It is also necessary to ensure that the political will of decision-makers is at least partially directed towards improving the forestry sector, and is it urgent to facilitate administrative management

- More than half of the resources are managed by public entities/administration. A way must be found to approach it so that it does not become a hindrance, to find market harmony.

The three main development targets of ***New Aquitaine, France***, are:

- A better wood mobilization

Based on the observation that much forest lands were undervalued or barely managed, the region wants to mobilize more wood. Not only is volume discussed (the National Programme for Wood and Forest aims to an increase of 20 millions m^3 wood per year, between 2016 and 2026), but a big attention is also given to the quality and ethics of the mobilization. Among the key elements for the wood mobilization are the valorization of broadleaved trees, a production chain that maintains a low carbon footprint, and the preservation of the ecosystem services offered by the forest.

- Adding more value to ecosystem services

Some ecosystem services are of paramount importance in the forest of New Aquitaine, such as the recreational value (for hunting, picking mushrooms), tourism, the regulation of water, and carbon storing. The carbon balance is one of the main targets for the French forest in the upcoming years, and efforts are made already now to work on low carbon certification (Label Bas Carbone), promoting the use of wood as a building material and reducing the fossil energies. This development target is in line with ongoing projects such as Sylv'valor, setting up a procedure for valuing forest ecosystem services in addition to PEFC certification.

- Improving knowledge platforms

Another important target is a better information and knowledge exchange in the forestry sector. The aim is to encourage projects and new tools such as La Forêt Bouge, an online platform dedicated to forest owners. This is in order to make the owners more aware of the potential of their forests, and also to make it easier to buy and sell wood.

Given the SWOT analysis for ***Italy*** and the need of the forest sector these are the current development targets:

- On Government level:
    - The government is working on several different paths also thanks to the TUFF (Testo Unico per le Foreste e Filiere Forestali - Only Law for forests and forest's supply chains) that aims to reform the entire sector giving specific guidelines and strive to imagine forests in a twenty years' time. The TUFF is also trying to solve different problems and needs with specifics implementing decrees that are being published recently trying to ease the bureaucratic burden in the cutting authorization, aggregations and general requests related.
    - The government also provided 5 million euros to associations in forestry in order to boost the aggregation of different actors involved in the forestry sector, such as forest owners.
    - In light of the extreme climatic event involving forests, a number of different initiative blossomed on the forest disturbances niche. The government identified three main activities for the forestry sector in order to support the entire forest sector with the subsidies coming from the Next Generation EU fundings. These important aspects are:
        1. Support to the technological development of forest enterprises with the support measure of the purchase of technologically sound and advanced machinery and tools.
        2. Intervention in the support of the enhancement of the value of low profitability timber products
        3. Support for the development and implementation of logistic platform and medium/small sawmills
- On regional level:
    - The regions are trying to standardize the educational requirements for forest operators and some of them are improving their forests account's systems highly problematic on several levels.
    - The Veneto Region, being part of the Pianura Padana regions, recently started to deepen the activities in order to increase air quality levels operating on the fuelwood quality together with the high efficiency stove and boilers technologies. Also being one of the regions that suffered the most from the VAIA storm Veneto region is still trying to cope with the high amount of timber windthrown and still left on the ground. The recovery of that material needs to be pursued by the implementation of new forest infrastructures (forest roads, logistic platforms and forest sites) and proper production subsidies.
- On the level of the private sector:
    - The private sector is striving to provide a wide understanding of the market and, also thanks to the VAIA storm, to restructure the internal market of processed timber products.

The revised ***Portuguese*** National Forest Strategy (PNFS) is in line with the Portuguese commitments towards meeting sustainability in forests set under the United Nations Forum on Forests (UNFF) and the Ministerial Conferences on the Protection of Forests in Europe (Forest Europe) as well as the global commitments such as the Paris Agreement.

The main objectives of the PNFS are:

- minimizing the risk for biotic and abiotic disturbances;
- specification of the territory according to forest functions (wood production, multifunctional forestry);
- improving forest management and forest productivity,
- valuing forest products,
- improving the competitiveness of the forest sector and rationalization and simplifications of policy instruments.

Only by improving forest management and establishing a smart resilient landscape, risks can be reduced and forest productivity increased. On the one hand, this can only be achieved through proper cooperative management that aggregates small forest owners providing technical support and funding. On the other hand, the need for developing local markets and assisting owners and industries to optimize harvesting, storage and transporting logistics is essential. Finally, this can only be effectively implemented if the forestry sector transactions are fair and transparent and the bureaucracy is reduced. Overall, the best practices identified for Portugal, complemented and/or improved based on the concepts/tools of other Hubs' best practices and innovations, if implemented at a considerable scale in Portugal and in an integrated and coordinated manner, involving all the actors from different ministries and entities would certainly produce results.

2.4 Presentation of the Interregional Roadmap

The goal of the project ROSEWOOD4.0 is to establish an exchange of knowledge based on best practices and innovations (BPI) from other regions in Europe. Based on the findings, suitable best practices shall be transferred to other regions to turn weaknesses into opportunities or strengths.

The following BPI from other Hubs and countries from SWE were chosen as most useful for South-Western Hub forest sector:

MAIN WEAKNESSES AND NEEDS	South-Western Hub BPI	Other Hubs' BPI
Small holding of forest land dealing to lack of cooperation owners/foresters, and need of support in the legal framework	e-globulus (PT) eMoBois (FR) Areas Florestais Agrupadas (PT) AKIS focus group (ES) Forest Wise (PT)	FVS - Woodland owners community (DE) KomSilva (DE) Wald-wird-mobil.de (DE) MojGozdar (Sl) Metsään.fi (FI)
Few options for financial support	CIFA (FR)	Privatwald.fnr (DE) Forestry Fund (NO)
Markets. Optimization of the wood forest resources and products	NEOSYLVAQ (FR) IT FOR II (IT)	Build in wood (RO) Basajaun (EU) Forest stock market e-drewno.pl (Pl) SecureChain (GR) Online database of wood processing and furniture production (CR) Timber inventory system (PL)
Poor forest management of small-scale forest owners and associations	LaForêtBouge (FR) Safety for Rescue (IT) Melhor eucalipto (PT) STERES (FR)	Bitcomp (DE) HolzmobRegio (AT) Forest becomes mobile initiative (DE)

Sustainability, environment and biodiversity, climate change (pests, forest diseases)	C.A.F.E. (ES) CrossForest (ES) CLIMAFOR (FR) RiLegno (IT) PaperChain Project (PT)	ARBOAIR (SE) DetectIt (CR)
Lack of digitalization, , updated and available data	Harvester simulator (FR) Extrafor (FR) ChainWood (ES) WoodChain (IT) LegnOK (IT) SADfLOR (PT) Rustechworld (PT) FCTools & sIMfLOR platform (PT) Forest LIDARioja (ES) SISREP (ES)	Biomob (EU) WoodChainManager (Sl) Woodlogistic data platform (AT) WaspWoodlogistics (DE) ForOps (FI) TimFlow wood tracking system (RO) Electronic Timber Tracking (UA) Joint wood terminals (FI) Forwarder2020 (CH) Kollegenschutz 4.0 (CH)
Weak infrastructure		FelixForst (AT) Joint wood terminals (FI) Forestry Road Scanner (CH) The Forestry Extension Institute (NO)
Need for educational strategies to explain forest ecosystem services to the public	LaForêtBouge (FR) Je me forme pour mes bois (FR) Together for the Forests (ES)	Waldaktie (Forest Shares) (DE) ThinkTree (NO)

Table 8: BPI matched with Main Weaknesses and Needs for the SWE Hub.

Despite the fact that the Hub seemed to have a local solution for the identified weaknesses and needs, in some cases the results weren't as good as expected or the implementation failed at some point. That is the reason why these points remain weaknesses and need other solutions to be addressed effectively.

At Hub level, the best practices and innovations from other Hubs were analyzed to see if these could help solving the weaknesses detected in SWE. To facilitate the pairing each SWE country analyzed the BPI from other Hubs by domain and selected the ones that seemed most promising to tackle the national weaknesses. Similar best practices can be found in different countries but limited information is available to determine their applicability and the requirements for adaptation in SWE Hub countries, thus a more detailed analysis is required to determine their suitability

In the case of ***Spain***, many of the best practices identified are useful, but those related to communication and those that help to promote management by private owners of small plots of land stand out. Therefore, those with the best implementation in Spain are **LaForêtBouge (FR), Metsään.fi (FI), CLIMAFOR (FR), ThinkTree (NO), Areas Florestais Agrupadas (PT),** among others, since all the best practices identified are of great interest and can boost Spanish forestry development.

The best practices and innovations that would be of interest for ***France*** are mostly concerning cooperation between actors, improvement of communication and also development of new technologies for remote sensing and data analysis. Thus, BPI exposed here could be of interest. From the Central West Hub, **Bitcomp**

(Germany) and HolzmobRegio (Austria) are in keeping with this need to develop tools for owners, and take climate change into account. This gives France new insights on how to improve existing platforms. From the Northern Hub, Arboair (Sweden) could help in tackling the bark beetle problem that was identified in many spruce stands all over the country. Such initiative could also be interesting to develop solutions for other forest pests and diseases affecting France. ThinkTree (Norway) is also a good example of what could be done in the New Aquitaine region to communicate better on the purpose of forest management and help reducing the lack of trust from the general public into foresters and owners. From the South West Hub, initiatives to strengthen the local cooperation would make sense as well for the New Aquitaine region: Together for Forest (Spain) and IT FOR II (Italy) work on developing local markets and value chains, and to increase collaboration between different stakeholders.

To tackle the need for France to invest in bio-economy, promote wood as a construction material and also as a key raw material, and develop alternative forest products, the practice from the Central-East Hub Build-in-Wood (Romania) is relevant. It is also a way to promote carbon storage and sustainability. Initiatives such as ReGaP (Germany and Poland) and Re-Leaf are also worth exploring, to think of recycling wood waste and also creating alternative and ecological production trajectories.

As for ***Italy*** most of the best practices of interest are related to the fragmentation of forest lands and the abandonment of rural areas. For this reason, best practices useful for forest owners on a economic level are of high interest. Best practices such as Forest becomes mobile initiative (DE) and FVS - Woodland owners' community (DE) can support undecisive and unaware forest owners to manage or make them profitable. This might also help the rural area abandonment and the fragmentation of forest plots. Increasing interests and in forest, making them profitable, increase the management levels. Another important issue on the Italian forest sector is related to the low level of forest infrastructure that is a relevant hindering factor. Biomob (EU) and FelixForst (AT)can be of interests and very helpful for forest enterprises and forest workers. In the end Waldaktie (Forest Shares) (DE) would help the end user to have a a better understanding of forest ecosystems and forestry in general.

BPI that could be useful once adapted for the ***Portuguese*** conditions relate to: i) minimizing forest area fragmentation and improving forest management (*domains: ownership, cooperation*); ii) optimizing logging and transport operations (*Domain harvest*); iii) valuing and/or diversifying forest income while supporting the development of new products and markets (*Domain: Products, markets, trade*); and iv) developing funding schemes (and/or reducing operation costs) (*Domain: Financing, funding schemes)*. Despite some BPI have been developed to tackle some of these weaknesses in Portugal and/or within the South-Western Hub by Portugal itself, similar BPI from other Hubs could be useful. Thus, LaForetBouge (FR) and ForetData (FR) platforms from SWE and the Wald-wird-mobil.de (DE) (from CWE under the domain "Ownership, cooperation" could serve as inspiration for developing or improving/completing existing Portuguese BPI (e.g. Forscope, e-globulus). Under the domain "Harvesting, logistics, transport, safety", several digital platforms or tools, similar to Forscope, all aiming to connect actors along the forestry wood chain could serve to improve or further develop the Portuguese tool, namely, Woodlogistic data platform (AT, CWE hub), WaspWoodlogistics (DE, CWE hub), ForOps (FI, NE hub), and MojGozdar (SI, SEE hub). An interaction with the developers and users of these systems could help promote an effective implementation at regional or national scale. Still under this domain, TimFlow wood tracking system (Ro, CEE hub), which aims to monitor wood traceability and improve transparency, could be a useful tool to help valuing wood (similar to Rustechworld). Another interesting initiative that could affect the logistics of burnt wood harvested is the Joint wood terminals (FI, NE hub) that create intermediate storage for wood from several small-scale units.

To promote the development of products, markets and trade in rural areas that could lead to an increase in revenues from forest management, the **Forest stock market e-drewno.pl** system (PL, CEE hub) could be a solution toward the engagement of managers and sawmills in wood sale auctions. Under the same domain, "products, markets and trade" the **SecureChain** (Gr, SEE hub) initiative that gathers small and medium enterprises with the aim of securing future-proof bioenergy chains could serve as an example to energize rural areas and local markets. The major issue is the lack of funding, for which initiatives such as the **privatwald.fnr Webportal** (DE, CWE hub), under the domain "Financing, funding schemes", responsible for assisting forest owners in applying for funding could be extremely useful.

2.5 Implementation of the Interregional Roadmap

During the development of Rosewood 4.0 project, SWE Hub partners have been working closely with expert advisors of the four countries (Spain, France, Italy, Portugal) in different workshops and meetings to identify the strong and the weak points of the respective regional forest sectors. First ideas arose to implement strategies for addressing weaknesses and needs.

As SWE hub manager, Cesefor will host the hybrid implementation workshops, both online and in-person, with the collaboration of the Institute for Business Competitiveness of the regional government of Castilla y León that has already shown interest in the implementation strategy of the South-West-Europe Hub. The same way, the rest of the hub partners will invite and enhance the implementation with the equivalent regional entities.

The objectives of the implementation workshops will be:

- To present the main business ideas with good possibilities of being implemented in different territories and with greater impact, based on the research carried out in the framework of the Rosewood 4.0 project.
- To induce innovation in the wood utilization sector, with the overall objective of improving its sustainable mobilization (e.g. by finding new sources or applying new technologies). The approach of the workshops can be described as a collective brainstorming of a preferably diverse group of stakeholders, with the expected outcome being the collection of grassroots ideas for new businesses. In general, the workshops will initiate an active process of idea creation, collection, follow-up and implementation.
    - To stimulate discussion on the way forward to increase international technology transfer and participation in European R&D programs by the business sector of Castilla y León.

Participants invited to the workshops will be:

- Representatives of private companies operating in the forestry sector in the Southwest Europe region.

The partners of the South-Western Hub: Cesefor (Castilla y León), University of Lisbon (Portugal), CRPF Aquitaine (France), AIEL (Italy), their experts and all the entrepreneurs who, having received the information about the workshops, would like to participate.

- All other Rosewood 4.0 project partners and representatives of the wood value chain. The workshops will also be open to internal or external collaborators of the companies, consultancies, and representatives of the research sector.

The conferences may have different focuses:

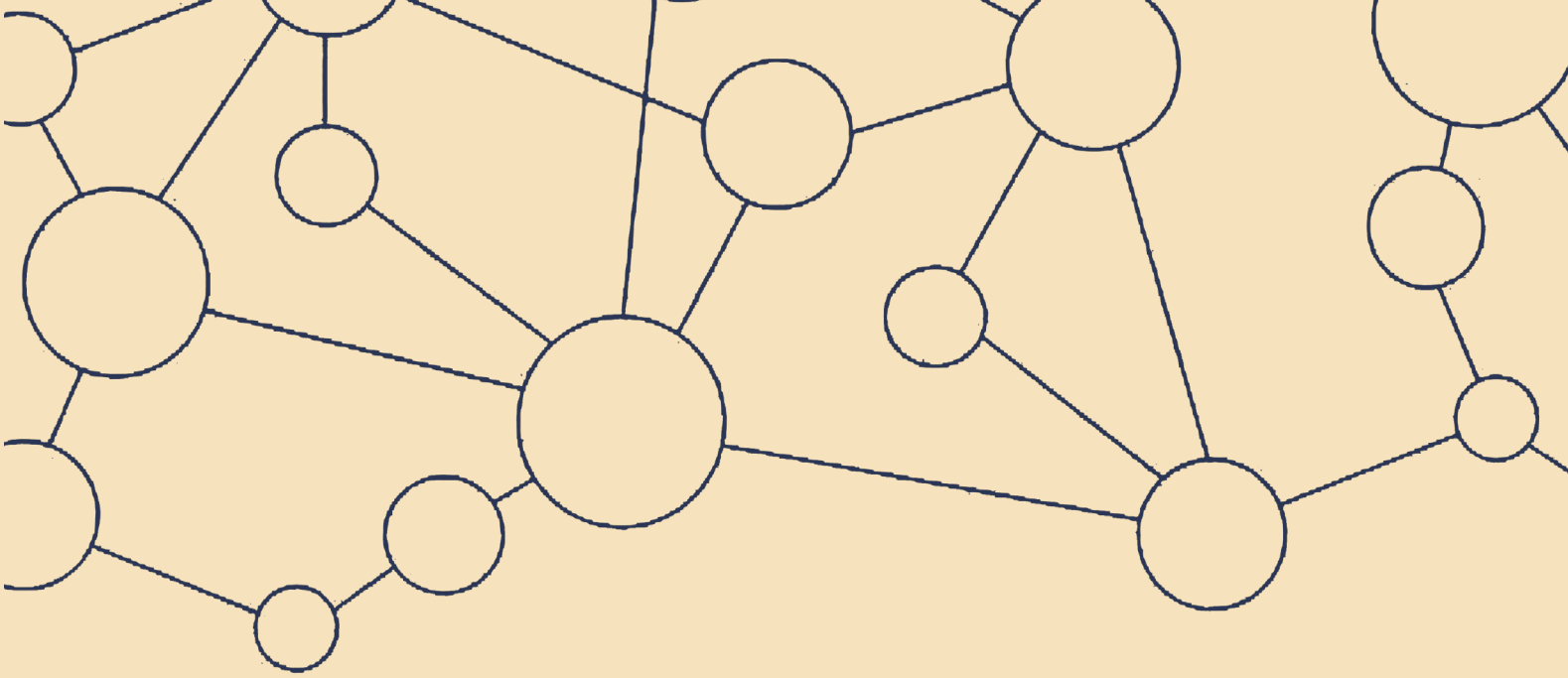
- To promote the knowledge of the most recent technological innovations in the wood handling sector, for the benefit of the companies in the hub.

- To propose collaboration and the possibility of establishing lines of business between different companies and between several countries.
- Information on European R&D&I funding programs. Work programs, rules of participation, search for partners, presentation of the European Enterprise Network (Enterprise Europe Network).
- Elaboration and dissemination of partner search profiles, international technology offers and demands, through the Enterprise Europe Network.

2.6 Conclusions and Outlook

After the research and collaboration work carried out in the Rosewood 4.0 project, expectations are high regarding the result of the implementation of the BPI of different hubs, and the medium-term development of the forestry sector in Southwest Europe. The involvement of Business Competitiveness Entities will result in a higher success rate.

With the work done so far it has been observed that the technological development of the hub is not at a low level but there is a gap between the technologies created by companies, universities and administrations, and the implementation in small companies and private owners, which are very disconnected from the new possibilities and the current market. Different BPI in other countries have obtained better results; with an adequate knowledge transfer, similar results can be achieved in Southwest Europe. The support and collaboration between countries will be essential to succeed in effectively transferring knowledge.



ROSE WOOD 4.0 Sustainable Wood for Europe

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Gozdarski inštitut Slovenije Slovenian Forestry Institute

Centar kompetencija d. za istraživanje i razvoj

CluBE Bioeconomy & Environment Cluster Western Macedonia

PROWOOD

LAPIN AMK Lapland University of Applied Sciences

Paper Province

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SOUTH-EASTERN HUB ROADMAP

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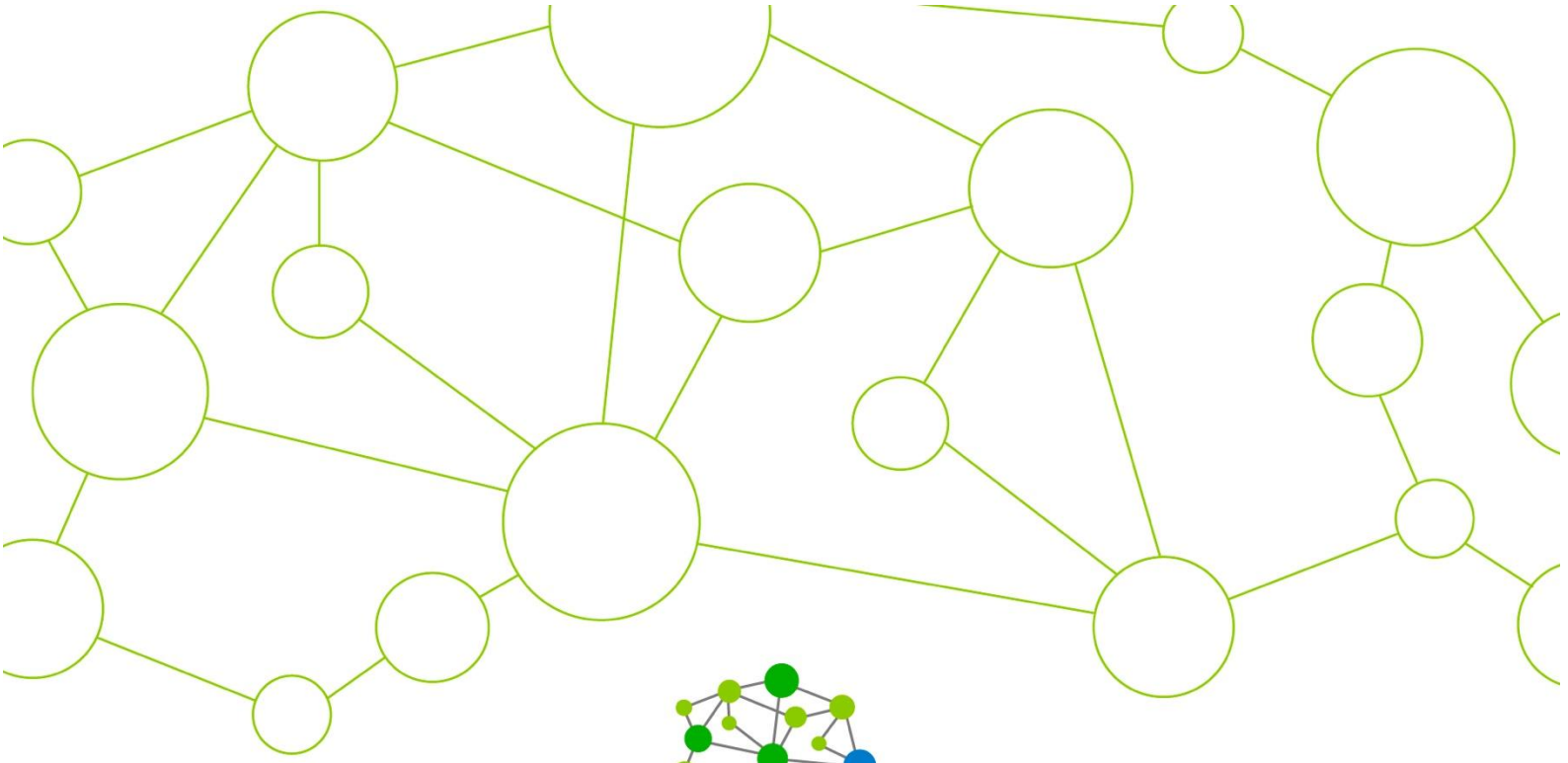

ROSE WOOD 4.0 Sustainable Wood for Europe

South-Eastern Hub Roadmap

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1. Introduction

Modern information and communication technologies (ITC) continue to develop rapidly in all sectors of the economy and society. The forestry sector (compared to agriculture or manufacturing sectors) is however lagging behind in terms of adaptation and spreading of modern ICT solutions. A major challenge is the large variety of ecosystems, forest owner types, supply chain actors and stakeholders, and regional disparities of technological progress. Forest industry 4.0 solutions (including new measurement sensors, high resolution digital maps, forest planning tools, risk monitoring, realtime data exchange and control, logistical optimisation, etc.) are a major field of innovation and future market, which will enable continuous information exchange at all stages in the supply chain, tracking timber flows from forest harvesting to processed wood products and markets. Furthermore, Decision Support Systems (DSS), educational tools and marketing platforms for forest owners are more and more emerging to connect knowledge and practice, and the actors within a region. This will leverage huge benefits for resource efficiency, sustainable use and climate change mitigation. These solutions can however only be exploited to their full potential, if they are more adapted and adopted, disseminated and deployed in the various regional contexts. The need for broader sharing of ITC-driven solutions and best practices is imminent and increasing, to maintain and enhance the competitiveness of Europe's forest industry by transforming it to a forest industry 4.0.

Digitalisation is one of the most powerful drivers of change in all aspects of society. In forestry, it has the potential to enhance the information flows and the relationships between actors (owners, managers, authorities, workers, communities and society) at all steps of the value chain. It has the potential to improve decision-making, empower forest managers and workers to achieve greater sustainability and fulfilment of multi-functionality standards as well as improving efficiency and transparency. However, the adoption of digital solutions is generally slow and very uneven across Europe. Through its Roadmaps, ROSEWOOD4.0 identifies and supports the adoption of close to market solutions and the replication of success cases by stakeholders of the value-chain.

Throughout Europe, the challenges for a sustainable wood mobilisation are diverse and often a lack of specific knowledge leads to non-ideal solutions. However, international and interregional knowledge transfer offers the potential to improve this situation. Against this background, the ROSEWOOD4.0 project has initiated five regional Hubs throughout Europe bringing together 21 partners from 18 countries to steer the interregional knowledge transfer on sustainable wood mobilisation:

- Northern Europe: Finland, Sweden, Norway, Baltic countries, Denmark
- Central-West Europe: Germany, Belgium, France, Switzerland, Austria
- Central-East Europe: Czech Republic, Hungary, Poland, Romania, Slovakia, Ukraine
- Southern-West Europe: Spain, Italy, Portugal and South of France
- Southern-East Europe: Bulgaria, Croatia, Greece, Slovenia

These 5 communities within ROSEWOOD4.0 will facilitate wood mobilisation through mutual learning across European regions. ROSEWOOD4.0 builds on the insights and experience gained in recent research and innovation efforts and will implement specific activities to reinforce digitalisation of the forestry domain with a sharp focus in the most relevant innovation opportunities in the following areas which are highly impacting the sustainable wood mobilisation: (a) Engaging forest owners and overcoming land tenure fragmentation, improved forest planning and risk management, adapted silvicultural measures for increased multifunctionality and biodiversity conservation; (b) Design and maintenance of infrastructures, optimized forest operations and logistics for improved economic and environmental performance; (c) Organisation and transparency of regional wood markets; new business models and market arrangements; (d) Access to finance and business support, including through EAFRD measures and PES (payment for environmental services) type mechanisms; legal and fiscal regimes; (e) Education, training and skills development.

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By creating adapted materials and extensively sharing technological and non-technological innovations, best practice cases and RDI results, **ROSEWOOD4.0 multi-stakeholders approach** closes knowledge gaps and creates new opportunities for economic partnerships within the whole wood mobilisation value-chain. ROSEWOOD4.0 focuses on tailored (user- and region-specific) **transfer of know-how and information** that enables and supports **stakeholders of the wood value-chain to exploit innovations and best-practices** and facilitates the capture of innovative ideas enhancing the development of the field. ROSEWOOD4.0 aims also to provide practitioners with development skills (educational and entrepreneurial) and facilitate organisational innovations leading to **novel exploitation actions** leveraging the uptake of new ideas and Best Practices in daily business.

The roadmaps presented here address stakeholders throughout Europe for facilitating the transfer of knowledge and collaboration between partnership regions. The roadmaps represent the collection, the analysis and strategic direction of the results from the five Hub regions including their validation. The main objective of the roadmaps on Hub level is to strengthen the regions through transfer of the gathered knowledge, experiences and circumstances. With the accurate description and assessment of well-functioning best practices and innovations as inputs, there is an active support in strengthening the local wood value-chain development thanks to newly developed digital tools. Further, the roadmaps enhance cooperations by increasing interactions between stakeholders and regions for creating opportunities to initiate further and new developments. Relying on networks , it supports the self-initiative and empowers the forestry to push new actions. For this purpose, the roadmaps highlight best practices and innovations (BPI) that have the potential to serve as tools for prosperous and sustainable wood mobilisation among European regions. ROSEWOOD4.0 has initiated a web-portal for presenting the best practices and innovations to the wider public and stakeholders. This way, new solutions can be incorporated and the transfer of best practices monitored. The roadmaps give readers insights into regional perspectives of wood mobilization, capitalizing on information and cooperation possibilities between European regions. By steering the knowledge transfer between the regions, the roadmaps aim to provide a European perspective on digitilization issues in the forestry domain. In times of structural changes, a changing climate and new technologies, the ROSEWOOD4.0 Hubs can rely on a broad knowledge base from various countries for identifying suitable approaches for their regions. For this purpose, the roadmaps shall pave the road towards more collaboration between the regions, transfer of best practices and innovations meeting the needs of the regions. All this will further develop the ROSEWOOD4.0 network and strengthen the individual regions onto their path towards a sustainable wood mobilization and the transition to a bio-based economy in Europe.

2. Interregional Roadmap for the South-Eastern Hub

2.1 Description of the South-Eastern Hub region

ROSEWOOD4.0 South-Eastern Hub managed by Competence Centre Ltd covers project the countries Croatia, Greece and Slovenia. All countries of the Hub are rich in natural resources especially forests, with great potential for supplying sustainable wood to Europe's bio economy. The aim of the South-Eastern Hub is to address challenges specific to the regional forestry and wood industry sector through transfer of knowledge and expertise from other ROSEWOOD4.0 regions for strengthening local value chains of forestry and wood industry from the tree in the forest all the way to the final product with high added value.

In *Croatia*, forests cover 2.75 million hectares or approximately 49.3 % of total mainland area in the Republic of Croatia. The state owns 2,097,318 hectares (76 %) of forests and forest land, while 661,721 hectares (24 %) are privately owned.

The basic division of forests and forest land includes the following categories:

- a) Overgrown forest land, area of 2,492,676 hectares which is 90 % of forests and forest land, i.e. 44.5 % of the land area of Croatia;
- b) Unforested production forest land, area of 199,147 hectares which is 7 % of the total area of forests and forest land, i.e. 3.6 % of the land area of Croatia;
- c) Unforested non-productive forest land, area of 24,956 hectares, which is 1 % of the total area of forests and forest land, i.e. 0.4 % of the land area of Croatia;
- d) Infertile forest land, with an area of 42,260 hectares, which is 2 % of the total area of forests and forest land, i.e. 0.8 % of the land area of Croatia.

In terms of the Forest Act, forests are classified according to their purpose as commercial (production of forest products), protective (protection of land, water, settlements, buildings and other property) and special purpose forests (strict reserves, national parks, special reserves, natural monuments, significant landscapes, park-forests); forests and parts of forests registered for the production of forest seeds (seed stands); forests intended for scientific research; forests for the needs of Croatian defence; urban forests and forests for the purposes determined by special regulations.
The current Forest Management Plan determines that the wood stock in Croatia is 418.6 million m^3 of which 315.8 million m^3 are state forests managed by Croatian Forests Ltd; 83.7 million m^3 are in the forests of private forest owners and 19.1 million m^3 are state forests used by other legal entities.
The annual increase in wood stock in Croatia is 10.1 million m^3, of which 7.5 million m^3 is in forests managed by Croatian Forests, and 2.2 million m^3 in privately-owned forests. Annually, in forests managed by Croatian forests, less than increment is used, which ensures the future of sustainable management.
According to tree species, the most significant shares are beech (37.2 %), pedunculate oak (11.6 %), sessile oak (9.4 %), hornbeam (8.4 %), fir (7.9 %), ash (3.2 %), spruce (2.3 %), other hardwood deciduous (11.4 %), other softwood deciduous (5.1 %) and other conifers (3.5 %).

Slovenia is the third most forested country in Europe, after Finland and Sweden. 1,177,244 hectares of forests cover more than half of the country (58.1 %). Most of the forests are located in the beech, fir-beech and beech-oak sites (70 %), all of which have relatively high production capacity. Growing stock and increment have been increasing for more than 50 years. In 1953, according to forest management plans, the average growing stock was 112 m^3/ha, and at the end of 2018 it was 302 m^3/ha. In commercial forests (multi-purpose forests and special purpose forests in which forest management measuring are allowed), the average growing stock is even higher and amounts to 309 m^3/ha. The annual increment is 8.8 mio m^3 or 7.48 m^3 per hectare. In commercial forests, the average increment per hectare is 7.75 m^3. The share of coniferous trees in growing stock is 47 % and 53 % of deciduous trees. A comparison of the proportions of individual tree species indicates a decrease in the proportion of conifers and an increase in the proportion of deciduous trees. The decrease is the largest in the last 5 years for spruce. In 2018, the cut in Slovenian forests was more than 6 million m^3 of trees, 72 % of which have been conifers and 28 % deciduous trees. The cut falls behind the possible one according to forest management plans and it amounts to 89 % of it.[1]
The average private forest estate is small and often further fragmented into several separate parcels. From the beginning to the end of the 20th century, the average size of private forest property in Slovenia decreased by 50 %. In 1990, the average forest property of 2.8 hectares stayed approximately the same until today, despite the return of large state estates to private owners.
Only 14 % of private owners in Slovenia (without cooperatives and church) own a forest larger than 5 hectares. These large forest owners manage half of privately-owned forest land and for them forests represent a substantial source of income. The remaining 86 % of private owners own forest holdings smaller than 5 hectares and due to small size, the economic interest in these forests is poorly expressed.

[1] Poročilo Zavoda za gozdove Slovenije, 2019.

According to the latest data there are some 300,000 forest owners in Slovenia (SFS, 2020).[2] On average, private forest ownership consists of three spatially separated estates, and one third of private forest estates are owned by two or more owners. On average, smaller holdings have more owners than larger ones. The size of forest estates is still decreasing in the process of inheritance. For the great majority of these estates, forests are not of economic interest.

According to the National Forest Inventory of 1992, total forests and other forest areas *in Greece* amount to 6,513 thousand hectares and cover 49.4 % of the total country area. According to the 2010 Global Assessment of Forest Resources, total forests and other forest areas of the country remained almost unchanged at 6,539 thousand hectares (49.6 %), but the area of forests increased from 25.5 % to 29.6 %.

Just over half of this area (51.6 %) is covered by wood-producing species, while the remaining 48.4 % by non-marketable wood products (mainly evergreen broadleaves). In the wood-producing species, 57 % of the area concerns broadleaves (predominantly oak species) and 43 % coniferous species (mainly fir, black pine and warm conifers).

The majority of forests extend in mountainous areas and specifically at an altitude ranging from 600-1200 m (41 %) and at a slope of 26-45 % (42.5 % of forests). 74.1 % of forests and other forest areas belong to the public, 9 % to Local Government Organizations, 6.5 % to individuals and the remaining 10.4 % are monastic and co-owned forests. This percentage of public forests is considered one of the highest in Europe.[3] Apart from public forests, the size of other forest areas such as private forests are considered relatively large as well. Specifically, 99 % of public forests are larger than 100 hectares, while 58.3 % of private forests are larger than 1,500 hectares.

Forest areas are distinguished into those with measurable trees (i.e. trees with a diameter of ≥ 5 cm), and those without measurable trees. The area without measurable trees consists of the area with regenerating seedlings of various main forest species, the area with evergreen broadleaf diameter <5 cm in diameter and the area without regeneration (uncovered area). Considering that the wood is produced mainly from the forest and not from the other forest areas, then the area with measurable trees, which amounts to 1,484,487 hectares, is the forest area intended for wood production and which is 22.8 % of the total forest area (1,484,487 ha / 6,513,068 ha).

2.1.1 Political Targets for Wood Mobilisation and Forestry

The Government of the *Republic of Croatia* adopted a National forest policy and strategy in 2003. The general objective of policies listed in the Strategy is to increase contribution to the national economy through sustainable forest management, use and comprehensive protection of forest resources and biodiversity, applying research results, respecting international norms and resolutions, and respecting local community rights.

The national forest policy and strategy is divided into Management of forest ecosystems; Forestry Administration and Legislation; Non-wood products – tourism, hunting and other products of forests and forest land; Wood industry; Environment and spatial planning; Education, research and international cooperation; Public Relations and Promotion. Each activity defines the organization or institution responsible for implementation. Also, the major partner organizations have been identified where possible which are not directly responsible for implementation but can play an important role in cooperation.

In 2018, the Economic and Social Council of Vukovar-Srijem County adopted the *Declaration of Forest of Vukovar-Srijem County* which represents initiatives and activities towards the Ministry of Agriculture and the Ministry of Regional Development and EU Funds. Proposed activities put in focus existing forest

[2] Poročilo Zavoda za gozdove Slovenije, 2020.
[3] FAO, Global Forest Resources Assessment 2010. Main Report, 2010.

resources in the function of local economic development, i.e. the policy of sale and delivery of logs in Croatian forests Ltd. should be in accordance with logical economic and social criteria.

Declaration emphasized that allocation of the rights should be based on green public procurement, i.e. criteria for selecting customers should be distance of raw material to processing facility, impact on the overall development of space – impact on the local economy, level of processing –finalization, innovation and application of new technologies, environmental responsibility, energy efficiency and success in using EU aids.

Currently, distribution of raw materials in Croatia is based on the Letter of Understanding signed between the *Croatian Chamber of Economy - Association of Wood Processing Industry* and the Croatian Forests Ltd.

In 2016, the Croatian Government accepted Decision on adoption of the *Smart Specialisation Strategy of the Republic of Croatia for the period from 2016 to 2020*. The strategy contains goals and priority activities related to research, development and commercialization of innovations.

The main aim of the Strategy is to direct capacity in the field of knowledge and innovation to areas of greatest potential in order to initiate the development and transformation of the economy based on research, development and innovation activities.

The Strategy has six goals:

1. strengthening the capacity for research, development and innovation in order to achieve excellent research and meet the needs of the economy;

2. overcoming fragmentation of the innovation value chain and the gap between research and business sectors;

3. modernization and diversification of Croatian economy with the growth of private research and development;

4. improvement in global value chains, promotion of the internationalization of the Croatian economy;

5. establishing a partnership in terms of social challenges;

6. creation of smart skills - improving the qualifications of the existing and new workforce for smart specialization.

The Strategy is divided into 5 priority thematic areas: Health and quality of life (pharmaceutical production and production of medical equipment and devices; health services and new methods of preventive medicine and diagnostics; nutrition); Energy and sustainable environment (energy technologies, systems and equipment; technologies and equipment in the function of environmental protection); Transport and mobility (production of road and rail parts and high value-added systems; environmentally friendly transport solutions; intelligent transport systems and logistics); Security cyber security (defence technologies and dual-use products; mine action program) and Food and bio-economy (sustainable food production and processing; sustainable wood production and processing).

The *Innovation promotion Strategy of the Republic of Croatia 2014-2020* is one of the most important cross-sectoral strategies. It aims to strengthen the Croatian national innovation system (NIS) and to provide an efficient framework for strengthening the competitiveness of Croatian R&D and economy in general through innovation and technological development.

The Strategy is based on 4 thematic pillars, each with several related priorities.

- Thematic pillar 1. Development of innovation system, including regulatory and fiscal framework (Priorities: Improving the governance of innovation system; Development and upgrading of

innovation value chain; Establishment of regulatory framework; Establishment of fiscal framework).
- Thematic pillar 2. Strengthening the innovation potential in the Croatian economy (Priorities: Support to establishment and growth of innovative SMEs; Support to R&D and innovation investments in SMEs; Support to R&D and innovation investments in large Enterprises; Facilitating access to finance; Facilitating foreign direct investments in high-technology sectors and emerging industries).
- Thematic pillar 3. Promotion of cooperation and knowledge transfer between business, public and research sectors (Priorities: Support to interaction between industry and science and research organization; Contribution to solving societal challenges through innovation).
- Thematic pillar 4. Human resource development for innovation and creation of attractive environment for world class researchers (Priorities: New skills development for R&D and innovation; Provision of business support to entrepreneurs in R&D and innovation; Promotion of scientific excellence and internationalization).

At the beginning of 2017, the Government of the Republic of Croatia adopted the *Development Strategy of Wood Processing and Furniture Production Industry of the Republic of Croatia for period 2017-2020* with an Action plan for implementation. The strategy is alleging on three key bases, which are:

- partnership of all stakeholders which are interested in development process and future implementation,
- joint participation of public and real sector representatives and responsibility for performance Implementation,
- transparency of drafting process as a result of work by working bodies, expert teams and through public consultation with the interested public.

The Strategy considers the complexities and specifics of wood processing and furniture production and external factors, defines their development models and vertical measures that are feasible in the program period. Also, it defines development guidelines and strategic measures that are feasible only in long period.

The Industrial strategy aims at establishing a coherent industrial policy instead of ad-hoc policy for specific branches/sectors. The main objective for Croatian industry for the period of 2014 - 2020 is the repositioning of identified strategic activities in the global value chain towards developing activities that create added value. The strategic development objectives are:

- Growth of industrial production at an average annual rate of 2.85 %;
- Growth in the number of new employees by 85,619 by the end of the 2020, of which at least 30 % of the highly educated;
- Growth of labour productivity by 68.9 % in the period of 2014 - 2020;
- Increase in exports in the period 2014 - 2020 by 30 % and change in the export structure in favour of export products with high added value.

In accordance with the strategic development objectives, defined four key priority areas of industrial strategy are the creation of a stable investment environment; fostering strategic cooperation between industry and the educational system; restructuring of public management and administration; and the development of capital markets (alternative sources of funding).

The list of sectors which the Industrial strategy has identified as strong is part of an extensive analysis undertaken to define S3 priorities: Basic pharmaceutical products and preparations production; Computer, electronic and optical products production; Fabricated metal products production; Computer programming, consultancy and related activities (ICT); Electrical equipment production; Machinery and equipment production. Additionally, the Industrial Strategy also emphasizes the important role of the following economic activities (Food products production and Production of furniture).

Many Croatian forest ecosystems have lost stability and are deteriorating under today's very difficult ecological conditions due to disturbances in the humidity regime caused by the drop-in groundwater level and lack of floodwater and the years of extreme drought with increased average annual and multiannual temperatures. Other ecological conditions i.e. air pollution, water and soil pollution also have negative impact on forests. For example, drying of Slavonian oak is caused by climate change. Air pollution is one of the stress factors leading to the reduced vitality and drying of forests in Croatia. Correlation between climate changes and the appearance of plant diseases and pests on forest trees in the period 1996-2004 has been observed in Croatia. The occurrence of bark beetles in fir and spruce forests is most indicative after dry periods when physiologically weakened trees become easily accessible to bark beetles as secondary pests.

In Slovenia, the *Slovenian Smart Specialization Strategy (S4) and Strategic Development Innovation Partnerships (SRIP)* identifies national strategic development priorities and niches, which in practice are supported by a targeted, comprehensive and tailored package of measures. Smart specialization is a platform for focusing development investment in areas where Slovenia has a critical mass of knowledge, capacities and competences and where it has the innovative potential to position itself in global markets. S4 is a strategy for enhancing the competitiveness of an economy by enhancing its innovation capacity, diversifying its existing industry and services, and growing new and rapidly growing industries or businesses.

Strategic Development Innovation Partnerships (SRIP) represent a country's development measure under the Smart Specialization Strategy of Slovenia (S4). They are intended for Slovenian companies, research institutions and other stakeholders with the aim of strengthening the innovation potential of the Slovenian economy in individual priority areas.

SRIP Smart Buildings and Home with Wood Chain (PSiDL) brings together Slovenian stakeholders in the areas of forest-wood value chain, advanced non-bio construction products, smart devices and systems and active building management. It operates in a wide area of sustainable buildings and homes. The central focus of the SRIP PSiDL development partnership is an offer of complete solutions for a sustainable, environmentally and user-friendly, healthy, connective and energy-efficient living and working environment of the future. Special emphasis is placed on quality indoor environment, energy efficiency and environmental care.

The National Forest Programme (NFP) is a basic strategic document devoting designation of national policy of sustainable development and forest management. The main postulates of NFP are directed towards conservation of forests and ensuring multifunctional role of forests. It includes long-term vision of forest management, defining also connections between forestry and protection of the environment, nature conservation, forest-based sectors and other interested stakeholders.

The NFP shall set out the national policy on sustainable, close-to-nature and multi-purpose forest management, the guidelines for preservation and development of forests and the requirements for their exploitation or multi-purpose use. It shall also include guidelines for sustainable management of wild animals and the preservation and improvement of their living conditions. For the implementation of the NFP, the ministry responsible for forestry shall prepare five-year operational programmes adopted by the Government of the Republic of Slovenia.

The NFP shall be amended and supplemented in accordance with changes that occur in forests and with changing management conditions. Every five years, the ministry responsible for forestry shall prepare a report on the implementation of the National Forest Programme and its five-year operational programmes. The report shall be adopted by the Government of the Republic of Slovenia.

The expert basis for the NFP shall be drawn up by the Slovenia Forest Service, an NFP proposal shall be drawn up by the ministry responsible for forestry upon preliminary discussion involving the public

concerned and it shall be adopted by the National Assembly on the proposal of the Government of the Republic of Slovenia.

In December 2017, the Government of the Republic of Slovenia adopted the *Strategy for the Development of Slovenia 2030*, the umbrella development framework of the country, putting quality of life for all citizens at the forefront. Within twelve interconnected development goals there are also several important points considering area of wood mobilization:

- Inclusive labour market and quality jobs: promotion of both, men and women, in a gender atypical and deficit profession;
- Low-carbon circular economy: breaking the link between economic growth and resource use growth and GHG emissions, which will be possible by educating and connecting different stakeholders to move to a circular economy; promoting innovation, the use of design and information and communication technologies to develop new business models and products for the efficient use of raw materials, energy and adaptation to climate change; replacement of fossil fuels by promoting energy efficiency and RES in all areas of energy use, while coordinating interests in cross-cutting areas: water - food - energy - ecosystems;
- Sustainable management of natural resources: introducing an ecosystem-based way of managing natural resources and moving beyond sectoral thinking, inter alia by timely reconciling national and transnational interests in cross-cutting areas of water - food - energy - ecosystems that will change and adapt in the future also due to the effects of climate change; ensuring the sustainable development of the forest as an ecosystem in terms of its ecological, economic and social functions;

In Greece, Forest maps have already been completed for 54 % of the country's territory. The rest is under way and expected to cover the whole country by the end of 2020. Forest areas have expanded considerably since 1990 and stand at approximately 30 % of the country's total land area. The main reason for this increase is the adoption and implementation of forestry measures in agriculture.

Wood harvesting, of which 3/4 are wood for heating purposes, has been trending slowly downwards, from around 2.5 million m^3 in 1990 to 1.4 million m^3 in 2016, when 23,000 were employed in the wood value chain, half the figure of 1990. Approximately half of those employees worked in wood processing industries.

The country itself is constantly deficient in wood, since more than 2,000,000 m^3 of round timber are imported each year, either in solid form (round timber, sawn timber, OTE and PPC poles, piles) or in the form of processed products (particle board, fibreboard, the whole amount of pulp that becomes paper of various types for domestic needs, etc.), and more than 1.5 billion euros are spent annually on these imports. Domestic production is limited and covers only 1/3 of the domestic needs.

In Western Macedonia, one of the main problems with the use of wood biomass is related to the chain of its collection and transport to the recovery units. In many cases, the low energy density of biomass is an important parameter with adverse effects on the economy and investments, something which also tends to limit potential applications. Therefore, the transport distance of biomass must be relatively short and for this reason the biomass power plants should be very close to the source of biomass.

Nevertheless, utilization of forest biomass is expected to assist in the production of heating and electricity and the reduction of greenhouse gas emissions, thus contributing to the achievement of national targets for the penetration of RES in energy production and consumption. One of the most important obstacles to the utilization of biomass in energy supply is the cost of the supply chain and biomass energy conversion technology. Therefore, its utilization presupposes the correct organization and operation of all stages of the supply chain. In addition, special attention must be paid to the characteristics that greatly affect the

cost of transporting and processing biomass, such as the seasonality and availability of biomass, the moisture content, the energy content and the apparent density.

The Region of Western Macedonia, through the Regional Operational Plan aims to boost economic development and create job opportunities in West Macedonia. It contributes to achieving European targets for smart, sustainable and inclusive growth, also in line with the Smart Specialization Strategy, in order to create jobs and help SMEs become more competitive and innovation-driven. Within its key EU and national development priorities, there are:

- Strengthening research, technological development and innovation;
- Enhancing access to and use and quality of ICT;
- Enhancing competitiveness of SMEs;
- Supporting the shift towards a low-carbon economy in all sectors;
- Promoting climate change adaptation, risk prevention and management;
- Preserving and protecting the environment and promoting resource efficiency;
- Promoting sustainable transport and removing bottlenecks in key network infrastructures;
- Investing in education, training and vocational training for skills and lifelong learning.

The primary objective of the Greek policy for resource efficiency is to ensure the viable and sustainable development of the related sectors from production to end use, also protecting the environment and contributing towards addressing climate change. Greece takes an active part in the global effort made to reduce greenhouse gas emissions, most of which is generated by the energy sector. An additional key objective is to preserve and manage resources in a way that ensures the smooth, uninterrupted and reliable coverage of domestic energy needs, as well as access for all consumers (people, businesses and public sector bodies).

With regard to climate change adaptation, Greece has already developed and adopted by means of Law 4414/2016 the National Strategy for Adaptation to Climate Change, which sets out the general objectives, guiding principles and means of implementation of a modern, effective and developmental adaptation strategy within the framework set by the United Nations Convention on Climate Change, European Directives and international experience.

2.1.2 Structures of Decision Making

Croatia has two main decision-making institutions in forestry and wood industry. The Ministry of Agriculture is a central public administrative authority for agriculture and forestry, food processing industry, rural development and fishery. The Ministry manages administrative and other tasks related to forestry, forest protection, regulation of legal relations in forests and forest land owned by the state, inspection activities related to forestry and hunting and implements international agreements related to forestry. Furthermore, within the Ministry and its Department for forestry, hunting and wood industry, the Sector for private forests, and the Service for improvement of private forests are functioning as an advisory service. Public service promotes knowledge in agriculture, forestry and fisheries with the aim of preserving biodiversity and landscape diversity in the interest of village, rural areas and islands. Also, it provides professional advice, instructions and practical demonstrations from the field of agriculture, forestry and fisheries for the purpose of presenting new technologies, techniques and management methods.
The Croatian Forest Ltd. is a commercial company owned by the state and organized in 17 Management Units. Company manages state owned forests and forest land in Croatia (2 024 461 ha) on the basis of General and Unit management Plan and allocates wood raw materials to the wood processors. According to the above, decision making system in Croatia is centralistic.

In Slovenia, the Ministry for Agriculture, Forestry and Food of Republic Slovenia, the Directorate of Forestry and Hunting is responsible for area of forests, forestry and hunting. Its main tasks are monitoring of the state-of-the-art situation and preparation of systematic solutions, supervision of the work of the public forestry service and monitoring the market for timber and non-timber forest services and goods. In the field of hunting, the main task is game management and preparation of legislation.

Approximately half of Slovenian forests is part of Natura 2000 network, which is regulated by the Ministry of the Environment and Spatial Planning of Republic Slovenia. All regulations about management in Natura 2000 forests are adopted in forest management plans, which are finally approved by the Ministry for Agriculture, Forestry and Food.

The Regional Government of *Western Macedonia* is a self-governing territorial legal entity which acts as the second level of local government. The Regional Government is responsible for planning and implementing regional policies with regard to their responsibilities according to the principles of sustainable development and social cohesion, and in consideration of both National and European policies.

Municipalities are self-governing territorial entities which form the first level of local authorities. Municipalities are responsible for the administrations of local affairs.

In Western Macedonia in particular, throughout its 4 Prefectures (Grevena, Kastoria, Kozani and Florina), details regarding forest areas are as follows:

In Grevena there are 30 managed forests (in total of 83) which cover about 55 % of the total potentially managed forested area. Every year the 250 active members of the 38 cooperatives operating within the Prefecture of Grevena log about 40,000 cubic meters of timber with an annual gross value of € 1.5 million.

The 15 managed forests of Kastoria also cover about 55 % of the total forested area. Every year, approximately 85,000 m^3 of timber are cut down by the 280 active members of the 35 forest cooperatives, with an annual gross value of € 2.5 million.

In Kozani there are 117,410 acres of managed forest areas out of a total of 232,000 acres employing 70 lumberjacks from 7 forest cooperatives with an annual gross value of approximately € 430,000.

Finally, in Florina almost the entire forested area of 550,000 acres is managed. Approximately 55,000 m^3 of firewood are felled by 250 active loggers belonging to 44 forest cooperatives and have an annual gross value of € 2 million.

2.1.3 Main actors in forestry in the South-Eastern Hub

The main actors in forestry and wood industry value chain in *Croatia* are grouped in different associations, organizations, institutions. Competence Centre Ltd. identified 17 institutions in the value chain of wood mobilization. The stakeholders are grouped according to activity: wood production forestry, first transformation (silviculture, owners, contractors, exploitation support), second transformation (pulping, sawmills, pellets, chips, roundwood), distribution, services, consumers, recycling.

Public actors that cover all activities in value chain are the Croatian chamber of commerce, the Croatian chamber of trade and crafts, the Croatian chamber of forestry and wood technology engineers, the Croatian employer's association, while the Ministry of Agriculture with database of wood and furniture production covers distribution and services in Croatia.

Seven organizations (clusters, associations, national company, institute) are identified that cover certain sectors of activity in the value chain domains and bring together actors specialized in different fields of the same sector of activity. Five organizations are oriented toward wood production forestry. Wood-based

industry in Croatia consists of a large number of small and medium-sized enterprises that face difficulties in reaching a good market position and becoming competitive.

The main representative of research organizations is the Croatian Forestry Research Institute, a public research institution owned by the Republic of Croatia. The Institute's principle objectives are conservation and preservation of stability, productivity, biodiversity and genetic resources of forest ecosystems in Croatia using natural rejuvenation and achieved level of sustainable forest management. Research and services are organized into six Research Divisions, two departments (Department for Nursery Production, Department for Laboratory Analysis), three Regional Research Centres and Common Affairs Service, with a total of 85 employees. One of the Institutes' primary missions is to build the public awareness and participate in education on the importance of sustainable forest management (international and national scientific and expert conferences, seminars, workshops, annual Door-open day, etc.).

One of the important stakeholders which represents education sector in forestry and wood industry in Croatia is the Faculty of Forestry and Wood Technology at the University of Zagreb. The Faculty is an internationally recognized institution which offers a high level of education for careers in forestry, wood processing and furniture manufacture. The undergraduate and graduate studies of Forestry; Wood Technology; Urban Forestry and Nature and Environment Protection are the only studies of this type organized at the institutions for higher education in Croatia, and are designed for the education of professionals in the field of Forest and Wood Technology Sciences. Since its establishment, the Wood Technology Studies at the Faculty of Forestry has been greatly important in education as well as in research activities related to wood as material, to its mechanical processing and chemical treating, to wood products, equipment and machinery required in wood technology, and to the organizational and economic matters. Since it is the only high-level education institution in Croatia, recently the University of Zagreb, Wood Technology Studies are conducted in Virovitica and Vinkovci.

The Croatian Wood Cluster is one of the main national professional association and operational cluster in forestry and wood processing industry with more than 70 members, mainly wood processing companies. The Cluster is a member of a wide European sectoral network, the European confederation of wood working industries, CEI-Bois. The main objectives of the Croatian Wood Cluster are enhancing sustainability and competitiveness of the sector, encouraging innovations, investments, research, knowledge and technology transfer.

In Slovenia, sustainable, close-to-nature and multifunctional forest management, in accordance with the principles of environmental protection and natural values, sustainable and optimal functioning of forests as an ecosystem and the realization of their functions, is taken care of by the public forestry service. A public forest service was set up by the state to ensure the implementation of forestry regulations, to ensure the public interest in management and use of all forests and forest area, regardless of ownership. The activities of the public forestry service are a) monitoring of forest's condition and development, b) forest protection, c) directing the management of forests, forest area, individual forest trees and groups of forest trees outside settlements, d) directing the construction and maintenance of forest roads, e) keeping records and databases for forestry, f) counselling and training of forest owners, g) forest seed production, the storage of forest tree and shrub species seeds, establishment and operation of a seed bank, g) providing seedlings of forest tree and shrub species, h) taking over works performed in the forest, if they were co-financed from the budget of the Republic of Slovenia. Public forest service is performed by Slovenia Forest Service and Slovenian Forestry Institute and supervised by Ministry for Agriculture, Forestry and Food.

The Slovenia Forest Service (ZGS/SFS) is one of the main actors and as a legal entity with the status of a public institution established by the Forest Act, performs the public forestry service in all Slovenian forests, regardless of on ownership. The Slovenian Forest Service is organized at the national level with its

headquarters at the Central Unit in Ljubljana, at the regional level in 14 regional units, and at the local level in local units. The public forestry service is almost entirely financed from the budget of the Republic of Slovenia, while special purpose hunting grounds are almost entirely self-financed. The founding rights and obligations are exercised by the Government of the Republic of Slovenia.

The Slovenian Forestry Institute (GIS/SFI) is a public research institute of national importance in the field of basic and applied research of forests, forest landscape, forest ecosystem, game ecology, hunting, forest management, use of forest goods and services. In order to share knowledge and raise awareness of the importance of forest and its management, GIS aims to transfer and integrate scientific knowledge to all pores of the sustainable development of society. As part of its research program and complementary research, the Institute also performs public services in the interest of the state, forestry and environmental public services.

The Chamber of Agriculture and Forestry of Slovenia is the umbrella interest organization of natural and legal persons in the Republic of Slovenia engaged in agriculture, forestry and fishery. It aims to protect and represent their interests, to consult them and accelerate economical and environment friendly activities. The preferential tasks of the Chamber are acceleration of development and improvement of economic conditions, assurance of specialist services operation, co-formation of legislation, improvement of social conditions in life, keeping settlement of Slovenian rural areas and promotion of Slovenian agriculture at home and abroad. It provides 4 specialist services, such as agricultural advisory service, selection and monitoring production in stockbreeding, forestry advisory service and centres for fruit-growing and nursery.

The Company Slovenian State Forests (SiDG) is responsible for timber harvesting, timber sales, transporting wood assortments, maintaining forest infrastructure (except forest roads), forest protection and silvicultural work, any other work which is necessary for the provision of social and ecological functions, and other activities that are directly or indirectly related to state forest lands.

In Greece, the Ministry of Rural Development and Food is responsible for agricultural policy, interventions in rural development and the rural economy of Greece. The interventions are aimed at producing sufficient, quality and safe products, at ensuring a satisfactory level of agricultural income and reasonable prices for consumers, providing public goods, ensuring the sustainable use of natural resources and protecting the environment.

The Ministry of Environment and Energy is responsible for environmental and energy policy. It is also responsible for energy policy making, as well as for renewable energy and energy efficiency policy making. Additionally, the Ministry of Environment and Energy is also responsible for waste policy and forest policy making, for monitoring / making an inventory of greenhouse gas emissions and for the coordination of all relevant actions and adaptation to climate change. The ministry oversees a total of 48 institutions, including public-sector energy companies.

The Ministry of Infrastructure and Transport is responsible for the strategic planning and implementation of the country's infrastructure projects, the planning and implementation of national policy and the creation of an appropriate institutional framework at European and international level to develop high-quality transport services in conditions of healthy competition.

The Ministry of Economy and Development is responsible for the elaboration of the country's development strategy aimed at ensuring financial stability, implementing reforms for growth and employment, and modernising the public sector through the effective coordination of the implemented policies.

2.2 Main findings

2.2.1 SWOT analysis

The South-Eastern Hub partners have developed a SWOT analysis on the country level, which have been merged into an interregional SWOT. The identified strengths, weaknesses, opportunities and threats were presented to experts in the frame of validation workshops and further developed according to suggestions. Identified weaknesses and threats in regional SWOT analysis has been foundation for the preselection of best practices from other Hubs. The main findings are shown in Figure 1.

Figure 1. Summary of South-Eastern Hub SWOT.

The South-Eastern Hub partners have identified strengths, weaknesses, opportunities and threats of listed domains on country level: forest/land tenure, wood harvesting/storage, wood transport and logistic, wood processing, recycling, cross cutting issues. One of the main strengths of South-Eastern Hub is a long tradition of forest management and wood industry with an increasing number of small sawmills, pellets and wood chips producers. Also, the existence of high-quality raw wood material and unique tree species. Accordingly, the South-Eastern Hub countries have a high level of production material which meets international market demand.

In the field of wood transport and logistics, Croatia and Slovenia have good logistical connection and transport networks while Greece identified a lack of logistic background and an underdeveloped forest road network. The analysis on Wood harvesting/storage has led to the conclusion that Croatia has a high level of modern technology in state owned forest while private forest owners use old machinery due to high investment costs. Also, in Slovenia, forest works are performed by using obsolete machinery. South-Eastern Hub countries have skilled scientific and technical personnel in the wood harvesting/storage domain but a low level of educated workers in the use of forestry machinery.

The analyses show that Slovenia has a higher level of application of digital solutions in forestry and wood industry compared to Croatia and Greece where a low level of applying digital solutions was identified.

Cross-Cutting issues show that Croatia and Greece have similar problems related to a lack of skilled professionals to implement modern technologies and insufficiently developed training programme for the adoption of new technologies. Also, Croatia and Greece highlight obsolete curricula which are not adapted to the current state-of-the-art.

According to the listed weaknesses, collaboration between stakeholders in the value chain (private forest owners, state forest owners, decision makers, sawmills) is crucial. Currently, Croatia has small and fragmented private forest properties – a large number of forest owners with an insufficient level of optimal forest exploitation, while Slovenia identified conflicts between different uses/functions of forest, but also small and fragmented forest property. Greece has understaffed public agencies responsible for preserving and guarding forests.

The main opportunities seen as possibilities for improvement of the situation in forestry and wood industry of South-Eastern Hub countries are consolidation/cooperation of private forest owners, investments in modernisation of technology and mechanisation, implementation of newest digital solutions and improvement of curricula.

Identified threats which have a significant impact on wood industry and forestry value chains are a low interest in education, obsolete techniques and equipment, lack of interest for implementation of new digital methodologies and insufficient and complex subsidy/funding programs for implementation of digital methodologies and long-term projects. The SWOT analysis of the South-Eastern Hub shows that raising awareness on the importance of modernization and implementation of digital solutions in forestry and wood industry is crucial. Also, it is necessary to improve curricula in line with market requirements in order to strengthen employee skills and market competitiveness.

Croatia has a favourable geographic location and a good transport network as well as logistical connection with a generally good condition of forest roads. The country abounds with high quality raw material i.e. Slavonian oak. One of the main identified strengths in Croatia is the long tradition of forest management and wood industry with a long tradition and rich experience in furniture production. Other strengths are a high level of implementation of modern mechanisation and technology in state-owned forests.

Low level of private owner's interest to implement planned silvicultural measures due to high costs and a low level of educated private forest owners in use of forestry machinery are the main weaknesses. Also, use of old machinery by the private forest owners due to high investment costs represents a problem which causes many consequences. Wood processors have an insufficient number of labour forces especially in operating modern technology.

The main identified opportunities are seen in raising awareness of small private owners for sustainable management in their forests, development of silvicultural policies toward creating local value chains for smart and sustainable use of forest resources, investment in modernisation of the mechanisation, introduction of environmentally friendly technologies, increasing the utilization of forest biomass potential, raising awareness on zero-waste concepts, and the availability of recycling material. Furthermore, the improvement of curricula by introducing modern technologies to young, educated people in wood processing and furniture industry who are willing to stay and work in rural areas in Croatia can result in significant improvements in forestry and wood industry.

Depopulation of rural areas, climate changes and natural disasters, lack of interest for implementation of new digital methodologies, lack of available capital for investments in modernisation of technology, lack of funds for implementation of new digital methodologies, poor cooperation between companies and vocational schools and low level of curriculum improvement have been identified as main threats.

Identified strengths *in Slovenia* are a long tradition of sustainable and close-to-nature forest management, Public forest service (Slovenia Forest Service), a relatively high density of forest roads, an increasing number of small sawmill, the fact that the wood industry has the status of a prospective industry in strategic documents of the economic policy of the Republic of Slovenia, several highly innovative companies, also in the field of wood recycling and calls for national research projects in the field of digitalisation of the sector.

Small and fragmented forest property, including a lack of targeted services for small-scale forest owners, represent obstacles for proper forest management. Besides that, unpredictable flow of wood from private forests, obsolete machinery, lack of wood for domestic wood industry, lack of cooperation with designers and knowledge pool organizations, lack of innovativeness, lack of awareness and regulations in the field of wood recycling, and a weak connections between the "forest" and "wood" part of the forest-wood value chain are the main identified weaknesses.

Opportunities are identified in further development and increased performance of PFO associations, political support for regional initiatives followed also with financial support, joint timber sales to get higher log prices, modernization and optimization of technology and business processes, improvement of forest owner's forest-wood related education, establishment of collecting centres for discharged/used wood. Also, a positive public image of wood a material should not be neglected.

The increasing number of non-farm forest owners, a low level of realization of planed silvicultural work, very low competitiveness of sawmills compared to neighbouring countries, production of products with (too) low added value and increase in the frequency of extreme events represent the main threats.

The general feel for sustainable wood mobilization in *Greece*, is that there is considerable space for building on opportunities currently untapped. For instance, up until now there is a scarcity of efficient and most importantly, flexible financial tools. Flexibility refers to the ability to support public and most importantly private entities to invest without distractions from external factors, such as the ups and downs of other markets or value chains, for instance the financial market, or internal inefficiencies, such as lack of stable funding schemes, unaffected by bureaucratic processes or changes in the general socio-economic and political status. These factors have led businesses, mainly, to place new investments very low in their priority list.

Nevertheless, despite difficulties, new developments, like the increasing need for biomass and existing factors like availability of skilled personnel, seem to provide new incentives. This is already apparent in the number of small SMEs that produce biomass, especially for heating purposes. Actually, the use of biomass for heating is expected to increase significantly in the Region of Western Macedonia, mainly due to its expected use in district heating systems, which are in the process of eliminating the use of thermal power from coal. Additionally, the economic forefront seems to be gaining momentum and new initiatives for helping businesses are being under development.

On the other hand, the increased exploitation of agricultural, energy and forest products, as expected in the coming years, creates issues of conflict between different land uses and the use of land in an environmentally sound way. Here, we should be careful because the expected increase in the demand for forest products will increase the pressure on ecologically vulnerable areas. The use of wood in large quantities can have negative environmental, economic and social effects.

Therefore, the management of wood production should be done through approved management plans that not only ensure the sustainability of wood production, but also have positive effects on other forest functions and largely meet the pan-European sustainability guidelines. A Forest management plan:

- is prepared and reviewed every ten years,
- inventories and maps natural resources during drafting,
- minimizes the risks of degradation,

- ensures the health and vitality of forests through natural forestry measures,
- regulates forest protection.

However, there are serious weaknesses in the management practice. The drafting of management studies is often based on guidelines and specifications which are long obsolete. The re-drafting of the management plans every decade has largely stopped or, whenever possible, is carried out only after a great and persistent effort of the few foresters of the Forest Service.

Overall, judging from the outcomes produced by practices already in use, it is obvious that ICT can be a driving force in the process of shaping initiatives in wood mobilization, and in the wood value chain in general.

2.2.2 Hub's Best Practices and innovations identification

Screening of Best Practices and Innovations (BPI) in Croatia, Slovenia and Greece has been carried out through desktop research supported by expert interviews. So far, partners have gathered 31 examples of BPI (Slovenia 16, Croatia 7, Greece 8).

Country	BPI Title	BPI Description
Croatia	Digitalized Groundwater Measuring Station System	Digitalized Groundwater Measuring Station System was developed within the project „Protecting the English Oak in the Hungary-Croatia cross-border region". Project coordinator was forest company Mecsekerdő Zrt. from Hungary, project partner was Croatian Forest Ltd., Forest administration Našice (Croatia). System contains information about the movement of water which is very important for oak and other native species in forests. Forest managers can use this information for facing the trend of decrease or increment of groundwater and timely respond to changes.
Croatia	Cooperation for innovative approach in sustainable forest management training (CIA2SFM)	The educational program includes knowledge and concrete information in the field of sustainable forest management and organization of forestry work.
Croatia	Online database of wood processing and furniture producers in Croatia	Government of the Republic of Croatia in collaboration with Ministry of Agriculture developed online database of wood processing and furniture production of the Croatia. Development of online database was first priority area of programming period 2017-2019 for Development Strategy of Wood Processing and Furniture Production Industry of the Republic of Croatia. Purpose of the Base is to connect producers along the value chain as well as other key interdependent actors: economic and public sector, scientific community, end consumers as well as the general public.
Croatia	Green City cadastre – application	Application Green City cadastre presents a list of trees on a specific area i.e. towns. Application contains information about the species and dimensions of trees, the condition of the timber, treetop and roots, and documentation about tree control intervals. Green City cadastre has developed and applied online in two cities in Croatia, Zagreb and Osijek.
Croatia	WAVE ŠŠ Web application for managing data about forests and forest owners	WAVE ŠŠ is developed for the employees of forestry sector and licensed contractors. Application contains 5 modules: timber farming operation module, module of accompanying documents, Christmas-trees module, forest damage module.
Croatia	Detectit - save our forests	DetectIT is forest fire detection device which detects fire by using different sensors. After the detection of fire in the area where device is installed, device sends message to the application. Application contains information

		of the current situation in the area (level of temperature, humidity, carbon monoxide).
Croatia	Public data of forests	Croatian Forests Ltd is company which manages public forests and forest land in Croatia. The company developed application which contains overview of public data about forests they manage. Application in cartographic form present information in textual and tabular view, as well spatial illustration of type of tree species in specific forest or area. Also, application shows two parameters for every tree species: the total volume of timber and annual growth.
Slovenia	MyForester - Quality assessment of forestry contractors (MojGozdar)	The main objective of the project was to improve the competitiveness of forest-based sector regarding quality of operators' evaluation. The benefits of the web platform are connecting all actors through wood chain and transparent collection of all forestry service providers.
Slovenia	National Forest Inventory (NFI)	Within National Forest Inventory (NFI) forests of Slovenia are monitored and measured. NFI provides extensive and in-depth survey of all Slovenia forests, including information about composition, condition, distribution and size of our forests. It is of great importance for monitoring changes of forests through time, for developing suitable policy measures and for further support of sustainable management of forests. The basis for the inventory is a systematic sample of plots on a 4km x 4km grid. The selection of inventory plots is based on the use of lidar and aerial images. With their help, plots that are not located in the forest are eliminated, and they are also helpful in assessment of forests at inaccessible plots. A special data acquisition application was developed for the purpose of field inventory. This guides the enumerator through the inventory process, and at the same time the data is already digitized and ready for further processing. The application is also connected to a GPE device, which allows the precise determination of the sampling point.
Slovenia	Mobile application for collection of used wood - RecAPPture	The project is dedicated to the development of a mobile and web application that will connect users who want to get rid of the waste wood and M SORA, which will use the wood for the production of wooden windows.
Slovenia	Forest data viewer	Pregledovalnik podatkov o gozdovih is the most comprehensive tool of the Slovenian Forest Service, which enables the acquisition of detailed data on forests up to an individual plot, including data from forest management and silvicultural plans.
Slovenia	Awareness raising, training and action for invasive alien species in the forest (Invazivke)	The Invazivke web application is part of the public electronic information system for collecting data on invasive alien species (IAS), which includes a desktop, web and mobile application and connects several existing information systems that already collect data on IAS in Slovenia.
Slovenia	Slovenian forests protection	Varstvo gozdov Slovenije is information portal. It includes a following content: manual to determine causes of tree injuries, forest protection news, study material, prognosis.

Slovenia	WoodChainManager (WCM)	Web portal WoodChainManager offers different interactive tools (Calculate norms, Cost calculations, Unit converter) suitable for the organization and optimization of forestry works. WCM application enables a simple selection of technological model for the production of roundwood as well as green chips. It includes data on wood flows and prices, wood fuel prices, wood supply chain stakeholders map, wood supply chains.
Slovenia	Digitalisation of fieldwork data collection (MIGHTYFIELDS)	With the MightyFields drag and drop form-builder, you can create mobile forms and dispatch them to your field teams to capture field information. Existing data can be integrated with your existing forms, allowing MightyFields to capture data from mobile devices and to validate their reliability.
Slovenia	Timber log volume calculator (Timberlog)	Calculate timber volume in cubic metre, cubic foot volume (CFT), board feet (CBF) from a diameter or circumferences (girth) and length, create a wood log and share it over email, Dropbox, Google Drive and other sharing apps for free. Create an Excel file report that can easily be imported into Excel and other spreadsheet applications.
Slovenia	Marteloscope demonstration plot Pahernik	Pahernik forests in Slovenia became a part of the European network demonstration plots (Marteloscope) in 2015. They are based on the principle: "If you see, you understand better." The purpose is to show that it is possible, considering social requirements and timber extraction in forest management including the conservation of biodiversity.
Slovenia	Boletus informaticus information system	Boletus informaticus is an information system for recording and mapping fungal species in Slovenia.
Slovenia	Environmental Atlas	The Environmental Atlas of Slovenia is WEB GIS environmental information system with spatial data from the areas of nature, environment, water, ground cover, climate, infrastructure and other data in the entire area of Slovenia. The database is an example of high quality and useful content, which is supported with comprehensive metadata descriptions. It provides basic information on position, content of environmental data and environmental phenomena to general public and expert services.
Slovenia	Website of the special purpose state hunting grounds (LPN)	LPNs have been established for the protection of rare, endangered species of game and wildlife species, and their habitats, for the purpose of implementation of a number of public functions and scientific research in the field of management of game and certain of the protected wildlife species, and their habitats. Our mission is being realized with a natural and sustainable management of game and their habitats. An important part of our vision is the development and expansion of knowledge about the game and other wildlife. New knowledge is obtained within a number of research projects and by monitoring of wildlife. Knowledge about the management of game and wildlife is expanding through cooperation with domestic and foreign educational institutions.
Slovenia	Protection of forest against bark beetle	The website publishes / provides information on outbreaks of bark beetles (map), the structure of sanitary felling due to beetles / insects by areas. At the same time, it informs and educates about the handling of an attack, signs of an attack, setting traps, gradations of beetles, and an interactive map of control sample traps.

Slovenia	Digitization of professional works in the field of forestry and ensuring their accessibility through the most institutional repository SciVie	SciVie contains SFI e-publications (monographs, leaflets, brochures, audio and video recordings, databases (). Works by other publishers (articles, parts of monographs, patents,), articles in the scientific journal Acta Silvae et Ligni and digitized studies and SFI reports have been deposited in the repository.
Slovenia	Information support for game management in Slovenia	The web application provides various ways of access for the public and experts to a common database of game collection and serves as a synthetic data source and tool in the preparation of long-term and annual game management plans.
Greece	Small and medium enterprises securing future-proof bioenergy chains (SecureChain)	SecureChain was a Horizon 2020 project focused on promoting market uptake of bioenergy in small and medium-sized enterprises (SMEs) using innovation voucher scheme. The main objective was to promote a Sustainable Supply Chain Management practice that meets highest environmental quality and financial viability standards and targets local biomass suppliers, energy producers and financial sector players. Unique features of the project were that the entire bioenergy chain was considered, and sustainability and financing were an integral part of the project set-up. The specific objectives included a) integration and optimization of local supply chains, b) high efficiency and low impact gain, c) supply sustainability, d) leveraging investments in bioenergy, e) implementation of future-proof bioenergy chains.
Greece	Promotion of residual forestry biomass in the Mediterranean basin (PROFORBIOMED)	PROFORBIOMED (Promotion of residual forestry biomass in the Mediterranean basin) aimed at the promotion of renewable energy as an economic and social opportunity for rural areas, through energy use of forest residues and agricultural biomass. At the same time, it envisaged the creation of new employment opportunities and the development of related industries in this area. The main outputs were: - Assessment of the forest biomass available for energy production. - Transfer and adoption of know-how on sustainable forest management including forest biomass production chains and its use as an energy source. - Improvement of the rural areas' governance, development of clusters and agreements between public and private actors. - Development of a model of public support to sustainable forest management and biomass production. - Identification of financing mechanisms for public and private investments. - Creation of new economic opportunities.
Greece	Supply chain for green wastes (aGROWchain)	Agricultural residues such as straw, bank canes and trees pruning constitute a significant load of green waste in rural areas from both sides of the borders. Those wastes are poorly managed causing severe environmental impacts. At the same time local authorities use expensive fossil fuel for space heating of public buildings, and due to the current economic recession, very often the amount of heat generated cannot satisfy the real needs of the building users. The sustainable management of the green waste can offer a real solution in both of the above problems. There is available technology that can utilize agro-wastes as fuel for space heating under the only condition that a reliable supply chain is established. Scope of this project is to establish a supply chain for green wastes, combined with the relevant business model, which will secure its sustainability. The supply chain will be customized according to the wastes that are available from both sides of the border and the business model will be adapted to the specific local conditions. The supply chain will serve

		selected end users in each country; therefore, its operability will be tested and possible problems and barriers will be resolved.
Greece	Market Uptake Support for Intermediate Bioenergy Carriers (MUSIC)	The overall aim is to facilitate the further introduction of intermediate bioenergy carriers by developing feedstock mobilisation strategies, improved logistics and IBC trade centres. More specifically, the objectives of the MUSIC project are: - To increase the uptake of intermediate bioenergy carriers through development of advanced and strategic case studies with economic actors (industries) committed to implement the results. - To develop and/or expand existing and future trade centres, either virtual or physical. To assess the technical and non-technical aspects of biomass feedstock mobilisation with the purpose to develop dedicated feedstock mobilisation strategies. - To determine the best, cost-effective solutions for logistics along the entire IBC value chain, from raw unprocessed biomass to IBC end-users. - To involve, engage and support regional stakeholders and market actors, from the primary production sector, industry and beyond. - To evaluate framework conditions (legal, institutional and political) to identify key barriers and enablers. - To provide advice to policy makers at national and regional level to serve as input for more informed policy, market support and financial frameworks. The overall aim of the MUSIC project is to facilitate the further introduction of intermediate bioenergy carriers by developing feedstock mobilisation strategies, improved logistics and IBC trade centres.
Greece	Building cooperation, developing skills and sharing knowledge for Natura 2000 forests in Greece (ForestLife)	The project aims: - To facilitate dissemination of knowledge, best practice and strengthen cooperation between the forest authorities and other stakeholders in forests within Natura 2000 sites, by developing and operating an online "Collaboration Platform for Forests" (CPF). - To foster the development of skills of forest related target groups through training on the fields of forest management for the conservation of biodiversity, adaptation of forest management to climate change, innovative funding etc. - To increase the ability of forest users to access information and be motivated to reduce the disturbance they cause, by providing tools such as an app for smartphones and tablets. - To demonstrate that in Greek forests, and especially those within Natura 2000 sites, amenity and conservation can be compatible, through integrated media and communication work.
Greece	Structured Approaches for Forest Fire Emergencies in Resilient Societies (SAFERS)	The project is going to create an open and integrated platform featuring a forest fire Decision Support System. The platform will use information from different sources: earth observations from Copernicus and GEOSS, fire sensors in forests, topographic data, weather forecasts and even crowdsourced data from social media and other apps that can be used by citizens and first responders to provide situational in-field information.
Greece	GREEce: modeliNg of the FOREst SEctor EcoNomy (GREEN FORESEEN)	Design and carry out a survey of the fuelwood market in Greece, as well as by analysing national statistics on energy consumption. This will give insights on all aspects of fuelwood demand and supply and will allow for the characterisation of the illegal logging problem. It will also assist in the development of the GFSM, as fuelwood constitutes over 65% of total timber production in the country.

		The ultimate goal of the GFSM will be to enhance forest management by simulating impacts of policy and market changes on the sector. An intentional by product of the GFSM will be the generation of knowledge that can be utilised by other models, such as the EC's European Forest Information Scenario Model (EFISCEN).
Greece	Forest Roads for Civil Protection (FORCIP+)	Through transnational cooperation a wide range of inventories of existing road infrastructure will be accessible, different requirements will be met and a homogeneous model will be established. ICT applications will be developed to improve the efficiency of use and propose improvements on the maintenance of forest roads. Forest fire fighting vehicles will be equipped with GNSS receivers in order to improve time response and increase fuel savings. Fire specialists will be able to use network analysis for resources planning, locating most suitable places for ground means waiting areas or identifying forest surfaces where takes longer to access. Other actors involved in emergencies will be able to use web management applications and public information.

Table 1: Most relevant Best Practices and Innovations from the SEE Hub

South-Eastern Hub partners screened BPI covering social / technical innovations, business practices, companies, pilot projects, research and education programs and all other segments of the forestry-wood value chain. Emphasis have been given to the digital domain and digitally supported solutions.

BPI are organised according to domains and solution types. Classification of practice domains is used to organize the collection of BPI and as a structure of future repository. Domains correspond to main activities along the forest-wood industry value chain from forest management to final products and markets. 1/5 of gathered SEE Hub BPI is covering forest management domain. Even though, inventory, assessment and monitoring (4 BPI), forest disturbances, risks and disaster response (4 BPI) and as well as education, research, knowledge transfer (4 BPI) domains are also represented, which are shown in Figure 2. Up to date Hub partners did not identify any BPI within the innovation management nor the financing domain.

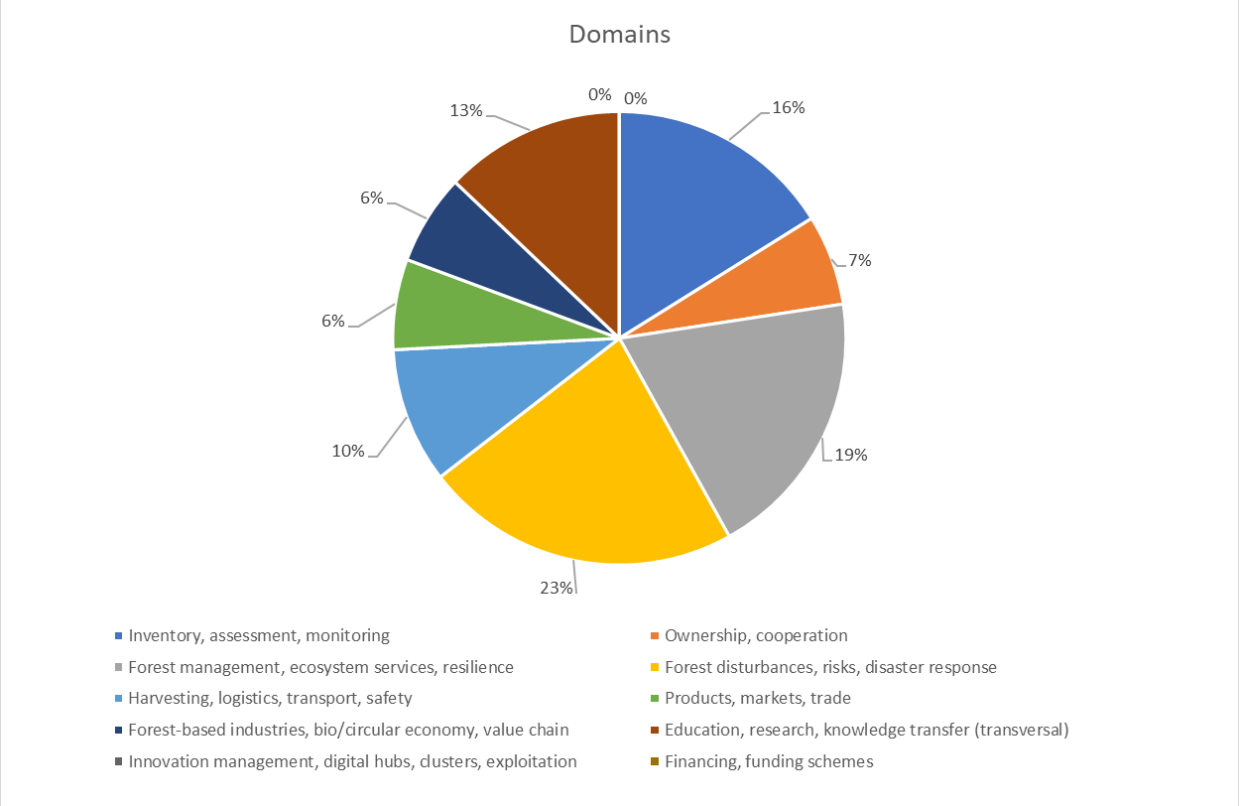

Figure 2: Classification of SEE Hub BPI per domains

BPI types of solutions allow grouping of similar technological concepts and systems. Type of solution is used for characterisation of BPI and among gathered BPI, data platforms and advisory and service tools for forest owners are the most represented solution types. The e-learning and training solution types, and traceability and modelling/simulation are the least represented.

The BPI **Environmental atlas of Slovenia**, **Forest data viewer** and **Public data of forests** are examples of quality digital solutions which provide useful information about forest. **National Forest Inventory** provides extensive and in-depth survey on forests using several digital tools. **Green City Cadastre** is also a digital solution which provides information and overview of type of greenery and tree species in towns.

WoodChainManager (WCM) is a sustainable management and planning, logistics and cooperation system, suitable for organization and optimization of forestry works. WCM is implemented in practice and proved successful in comparison to other systems and approaches. Also, the BPI **GREEce: modeliNg of the FOREst SEctor EcoNomy** are dedicated to forest management based on designed survey of the fuelwood market in Greece and analyses of national statistics on energy consumption. This approach will give insights on all aspects of fuelwood demand and supply, and will allow characterisation of the illegal logging problem.

The BPI **SecureChain** offers sustainable supply chain management that meets highest environmental quality and financial viability standards and targets local biomass suppliers, energy producers and financial sector players. **Market Uptake Support for Intermediate Bioenergy Carriers** supports market uptake of three types of IBCs by developing feedstock mobilisation strategies, improved cost-effective logistics and trade centres. The investigated IBCs include pyrolysis oil, torrefied biomass and microbial oil.

RecAPPture (Mobile application for collection of used wood) is a marketing platform for the collection of waste wood and connection of producers. The South-Eastern Hub identified a low level of awareness on the importance of recycling as well as a lack of appropriate infrastructure. Wood processors could, through

implementation of digital solutions, collect raw materials and create innovative product from waste wood. Promotion of residual forestry biomass in the Mediterranean basin promotes renewable energy and improves energy efficiency, as an economic and social opportunity for rural areas, through energy use of forest residues and agricultural biomass. The BPI Supply chain for green wastes also promotes recycling of green waste with technology that can utilize agrowastes as fuel for space heating.

The BPI Timberlog and Marteloscope are dedicated to forest management and decision-making processes. The application Timberlog is implemented in practice and has over 100,000 downloads with positive reviews from users.

BPI examples addressing the protection of forest ecosystems from parasites and adverse natural conditions are Slovenian forests protection; Protection of forest against bark beetle; Digitalized Groundwater Measuring Station System; Boletus informaticus information system; Awareness raising, training and action for invasive alien species in the forest. The Implementation of listed BPI could mitigate the impact of natural appearance and enable foresters timely reacting and protection of their forests. Also, listed BPI contribute to the protection of unique forest species. The BPI DetectIT-save our forests is oriented towards the protection of forests from fire by using different sensors. The BPI Structured Approaches for Forest Fire Emergencies in Resilient Societies is also dedicated to fire protection of forest with integrated platform featuring a forest fire Decision Support System. The BPI Forest Roads for Civil Protection is dedicated to the development of an application which will contain information about rural road network (infrastructure) which can be useful in cases of emergency, especially forest fires.

The BPI Information support for game management in Slovenia and Website for the special purpose state hunting grounds are oriented towards game management. Listed BPI enable key information for protection of rare, endangered species of game and wildlife species and serve as a background for the development of long-term and annual game management plans.

Online database of wood processing and furniture producers in Croatia and Digitalization of professional works in the field of forestry and ensuring their accessibility through the most institutional repository SciVie are examples of BPI which provide publicly available information. Listed information provides foresters, forests owners and wood processors key information about current situation on market and serves as a platform for decision-making.

The BPI "WAVE ŠŠ" Web application for managing data about forest and forest owners and Digitalisation of fieldwork data collection are examples of BPI which assist in work. "WAVE ŠŠ" Web application for managing data about forest and forest owners enables employees in the forestry sector and licensed contractors' inputs for their work. Digitalisation of fieldwork data collection also provides inputs for quality work and enables digitalisation of the processes within the organisation. The implementation of listed BPI could speed up the work processes and increase the possibility of timely decision-making.

Cooperation for innovative approach in sustainable forest management training provides specific and comprehensive knowledge about sustainable forest management. Implementation of listed training inform forest owners and other stakeholders about sustainable forest management and its impact on forestry and wood industry. The above leads to an increase in awareness on the sustainable forest and increases the probability of application approach in business and forest management. Also, the BPI Building cooperation, developing skills and sharing knowledge for Natura 2000 forests in Greece supports the exchange of BPI and the development of skills of forest managers and other personnel workers in forests within Greek Natura 2000 sites. It is oriented on developing and operating an online "Collaboration Platform for Forests" (CPF), on developing field training program for forest management, conservation of biodiversity, adaptation of forest management to climate change, etc.

Gathered BPI from the SEE Hub were presented to the experts during validation workshops held in June and September 2020. Following experts' recommendations, SEE Hub partners prioritized collected BPI

according to the following criteria: technological impact, economic impact, ecological impact, social impact, mobilisation impact, replicability, priority. The BPI **My Forester** has been given highest priority. It is intended to improve the competitiveness of the forest-based sector regarding the quality of operators' evaluation, connect all actors through wood chain and transparent collection of all forestry service providers.

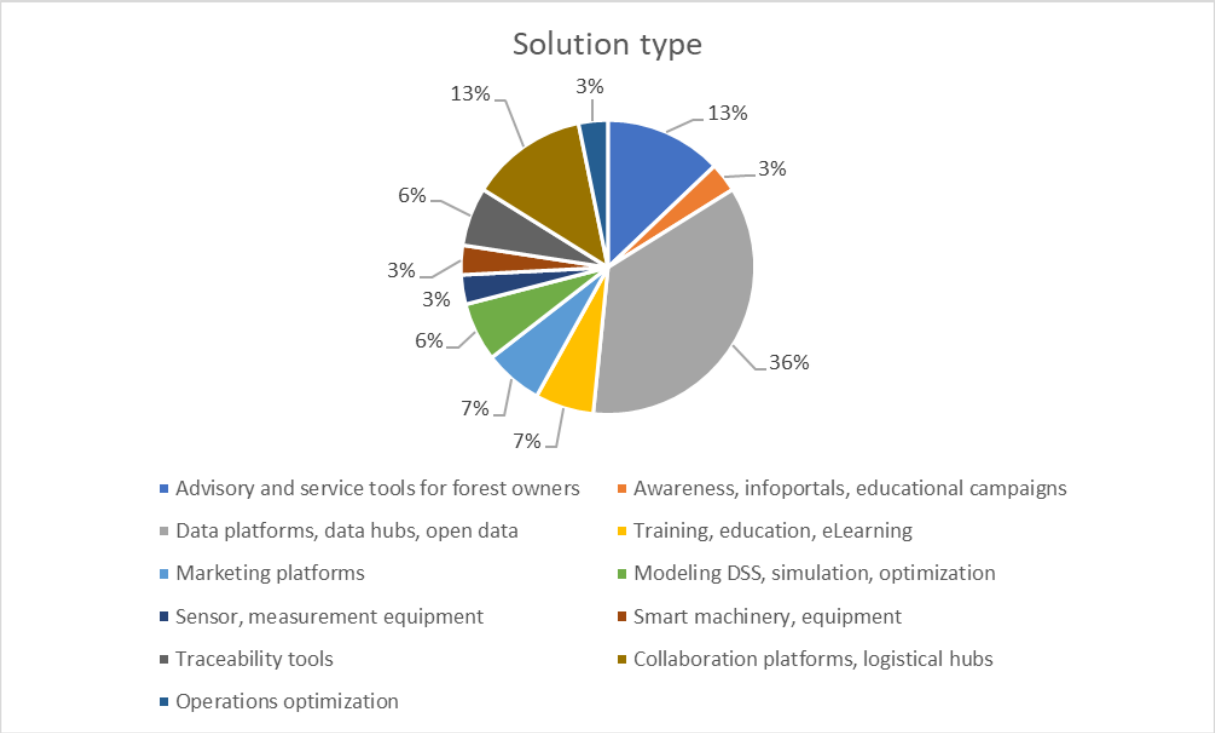

Figure 3. SEE Hub BPI according to solution type

Considering the solution type of BPI, SEE Hub gathered the most practices with solution type data platforms, while a significant share of BPI has the solution type advisory and service tools for forest owners.

2.2.3 Needs analysis

Regarding ***Croatia,*** the Competence Centre Ltd. analysed forestry and wood industry stakeholders' needs through literature studies research, survey on vocational programme and through direct contact with stakeholders.

Competence Centre Ltd. is an active member of Wood Cluster Slavonian Oak which is a member of the ROSEWOOD4.0 Network. The Cluster promotes sustainable development, environmental protection and increased competitiveness of forestry and wood industry. The Cluster gathers 38 of members (local governments, wood processors and producers, education institutions, etc). Members of the Wood Cluster Slavonian Oak emphasized the lack of wood raw materials as a main problem in the wood processing industry. They consider that public institutions which allocate wood raw material should increase the quantity for wood processors from Eastern Croatia. Also, the Cluster supports local wood for local use i.e. to local wood processors. Wood processors emphasized the lack of educated workers for implementing modern technologies.

Within the ROSEWOOD4.0 project, Competence Centre Ltd. collected information on educational measures and teaching media that exists in the Croatian education system. Eight examples of educational and teaching media in forestry and wood sector were identified. Croatia has a considerable number of e-

learning activities with a focus on the woodworking industry but is characterised by insufficient practical work for students. Collected examples of educational measures i.e. programmes are mostly addressing sustainable forest management and the wood processing industry. Vocational programmes are oriented on the wood processing industry including programs for forestry technicians, carpentry technician designers, carpenters, designers, restorers, and CNC operators. Programmes offer insufficient practical work for students which is crucial due to the lack of skilled professionals and interest to implement modern technologies (ICT). Even though the wood industry is generally satisfied with the recruitment of the workforce, they identified the wood processing skills, innovation and technology transfer, scientific knowledge about the wood as material, implementation of digital tools and machinery as priority education areas to be improved for the enhancement of the workforce quality and overall business development.

Regarding the funding program support, wood processors from Croatia are facing a lack of funding programs which support the modernisation of machinery. Also, forestry and wood stakeholders in Croatia are limited in accessing funds due to a low level of knowledge and information about funding opportunities and procedures. Therefore, this represents the main difficulty in accessing financial support. The need for a higher level of consultancy support in obtaining financial resources, the use of information dissemination channels created for a specific stakeholder group and the simplification of the application processes have been identified as main needs. The local, County level calls are usually small-scale due to limited financial resources of local governments. Nevertheless, the calls mostly support innovation projects, activities of SMEs related to strengthening competitive market performance. Even though national and EU funds are rather larger-scale in comparison to local ones, financial opportunities and subsidy programs are insufficient, complex and burdened with a long evaluation period (up to 12 months). SMEs are facing subsidy programs and calls for proposals comprising hard to reach conditions. Based on the above, it is necessary to develop more efficient programs and evaluation systems.

Stakeholders needs analysis identified problems related to insufficient availability of wood raw material, insufficient vocational programme with practical work and insufficient funding programmes for the modernisation of machinery.

In Slovenia, private forest owners (PFO) with small forest parcel are the prevailing group of forest owners. Low interest to work in the forest, small size of average forest property and lack of knowledge on forest management hamper optimal use of wood in these forests. To raise awareness about the importance of forest, possibilities for development and additional income, it is of great importance for PFOs to recognize advantages of owning a forest and managing it in a sustainable way. Therefore, they need to be educated in this regard and to achieve this goal, they need access to information about basic forest management, structure of forestry in Slovenia, market of wood etc. PFOs are a diverse group of people with diverse lifestyles and competences. Therefore, great emphasis should be put on designing a proper knowledge transfer process that would be flexible, available and appropriate for as many as possible of PFOs.

Natural hazards in recent years made all stakeholders of forest-based value chains more aware of climate change and its negative effect on the forests and quality and quantity of wood. Work in the forest after natural hazards is more demanding, dangerous and less cost-effective. PFOs and forest contractors would need more support in addressing environmental challenges in terms of subsides, seedling material, adapted forest management practices and extended services.

For recently passive and un-educated PFOs in terms of forestry, entrance in active forest management process can be stressful. Besides silviculture, also at least basic knowledge about work in forest is needed or how and where to find a proper forest contractor. Additionally, PFOs usually lack information about where to sell their wood, about the prices and other rules at the wood market.

One of the main challenges in the Slovenian forest-wood value chain is the link between forest and wood industry part of the chain. In this regard clear relationships, transparency and broad knowledge about both chain parts is crucial.

In Greece and especially in Western Macedonia, the priorities for improving the sustainability of the wood value chain should be placed on education, research, innovation management, ICT tools and advisory services. Specifically, in each respective category:

Education, research and knowledge transfer

Although skilled workforce exists, a lack of adequately trained workforce in terms of digital skills has been identified. This is linked to the shortage of skilled entrepreneurs, workers in the wood value chain and harvesters, and especially the lack of cutting-edge ICT technologies that come with substantial effort but provide substantial added value. This is probably a major barrier to additional wood mobilization. This also applies to research projects and transferring knowledge from well tested practices.

Therefore, we should seek for strong institutional capacity (from universities and research centres to public authorities and SMEs), with sufficient human resources towards research and innovation in forestry. Well-educated researchers and technical staff have to develop the necessary knowledge, preferably through research projects, and translate it into recommendations for all relevant actors across the value chain.

Innovation management

Additionally, the region seeks for innovative measures like promoting practices that meet high environmental quality and financial viability standards and also target biomass suppliers, energy producers as well as actors from the financial sector.

Research and innovation management should expand to cover thematic fields such as genetics, biodiversity, harvesting technology, socio-economics etc.

Apply new digital solutions

Digital solutions are also needed, from monitoring factors such as weather conditions and accessibility, to effective logistics and new marketing policies. ICT is crucial for the whole wood value chain.

Build advisory services and tools for stakeholders

The transition to using these tools has to be guided toward new practices suitable for each stakeholder. Additionally, advisory services are needed to entail building and using new financial tools or providing information pertaining to finding funds to carry out operations that lack financial resources. Finding and using services as such can be difficult, especially for individual forest owners and businesses whose engagement with the wood value chain is only part-time.

2.3 Development targets for sustainable wood mobilisation

South-Eastern Hub partners in collaboration with stakeholders defined the principle “local wood for local use” as a main target for sustainable wood mobilisation. Local wood for local use is a precondition for a strong local forestry value-chain which ensures a strong local bio-based economy.

Analysis resulted in the following development targets for:

Croatia

- **Improved collaboration between public authorities, wood processors and other stakeholders of forestry and wood industry value chain.** It is crucial that public authorities collaborate with stakeholders in the field of importance of digitalisation for sustainable wood mobilisation. Currently, wood processors use a low level of digitalisation in their companies because of high investments costs and a lack of knowledge in sustainable wood mobilisation. Public authorities

should develop silvicultural policies directed for smart and sustainable use of forests resources and organize education for raise awareness.

- Improved financial support directed for equipping. Public authority on local and national level should develop financial programmes directed at equipping in accordance with the market needs of foresters and wood processors. Private forest owners are facing a lack of investment regarding modern machinery due to the high cost. The financial situation of companies, technical know-how, and machine availability have an impact on the volume and assortments that can be produced in harvesting operations. Forest harvesting is one of the most important and cost-intensive operations in forest management. Foresters and wood processors with better financial support are able to mechanize many harvesting processes and increase productivity and working safety this way.
- Improved educational training and vocational curriculum. Public and private education institution should harmonize curricula in line with market requirements, which will strengthen employee skills and market competitiveness. Currently, it is crucial to implement vocational trainings directed toward implementation of new technologies. The main part of vocational training should be practical work on machinery or in companies. Educational training and vocational curricula should result in students with practical knowledge that they can apply in forests and in the wood processing industry. This would also increase the attractiveness of the forestry and wood industry sector among young people.

  Increased quantities of wood raw material. The Public authority which manages state forests and allocates raw materials should bring new policy and documents which include the allocation of raw materials in line with the market needs. Also, they should ensure that local wood stay on proposition for local processors.

Slovenia:

- Strengthening existing Forest Owners' Associations for joint market presence. Fragmented forest properties, small size of forest properties, a high number of forest owners hamper professional work and an optimal use of wood in private forest. The establishment of PFOs associations and machinery rings are important steps towards strengthening private forest management. However, the willingness for cooperation of PFOs is still insufficient, greatly influenced by forest property size, age, and co-ownership. The main identified issues PFOs are facing are a low timber price, while on the other hand wood industry stakeholders consider prices of wood too high and not in line with its quality. A development target would also be the establishment of machinery rings reducing machinery and labour costs and organizing interesting on-line course encouraging forest owners to participate in wood mobilization.
- Development of local Forestry Value Chains. The current situation on the wood market does not satisfy the needs of the domestic wood industry for year-round and reliable wood supply in terms of quality and quantity. Therefore, more knowledge about prices and timber market organization along with organization of joint wood sale from private forest is needed. On the one hand we have a long tradition of sustainable and close-to nature forest management and high production capacity of high-quality raw wood material, on the the other hand there is a competitiveness of the wood processing industry, low productive small companies (modern technology and equipment are used to a limited extent) which have limited financing possibilities.
- Adjusting the management to climate change. The necessity to implement adaptation strategies because it may affect the availability of economically most important wood (e.g. oak, beech, fir) was recognised. Natural hazards in recent years made all stakeholders of the forest-based value-chain more aware of climate change and its effects on the forests in general and the wood's quality and quantity. Working in forests after natural hazards is more demanding, dangerous, and less cost-effective. Therefore, PFOs and forest contractors would like to receive more support in

addressing environmental challenges in terms of subsidies, seedling material and extended services.

- Raising awareness of cascade use of wood and establishing market for emanating products. Side streams of wood (wood dust, branches) produced during harvesting in private forests and wood processing are mainly used for heating purposes, but also sold to biomass heating plants, paper industry and farmers. In case of PFOs and forest contractors, other use of wood, in terms of cascading use of wood, was not taken into consideration so far and represents an option for improvement. So far, a large amount of side streams and waste wood is lost in Slovenia and its recycling/reuse will need to get more attention. Important aspect of this development target is adjusting mechanization and technology for the purpose of cascade use of wood.
- Improvement of wood processing industry. The main challenges of the SEE hubs' wood processing industry are a non-optimal business environment, lack of innovative and high-tech materials and products with added value, outdated design of products, lack of cooperation with R&D institutions, obsolete tools and technology. Regardless the identified challenges, the business of the wood-processing industry has a positive trend in terms of number of employees, revenues from sales and in the share of exports. In Slovenia, there are several networks, associations and mechanisms that offer support in the field of wood industry. Support of decision making in terms of grants is of high importance and already shows good results. The potential of improvement in the wood processing industry could be found in an increased number of business support centres dedicated to SMEs in the wood sector, participation of SMEs in national and international business cooperation structures, level of RDI, technology transfer and cooperation between research and companies and favourable national policies and incentive schemes and subsidies. The development target is also implementation of modern techniques / practices and knowledge transfer, development of silvicultural policies towards creating local value-chains for smart and sustainable use of forest resources, development and modernization of technology / mechanization and, improved cooperation between industry and R&D. We recognize the importance for improvement of social networks and digital facility for information sharing (study circles).

Greece:

- The Region of Western Macedonia, and Greece in general, would benefit greatly from creating detailed Operational Plans, followed by open calls for actions, driven by public and private funding, on how the wood sector can benefit from digital technologies and how digital technologies act as catalysts for innovation through new business models. The questions that should be tackled are:
    - what digital technologies must local firms use in their business models?
    - how do digital technologies enable firms to improve their business?
    - what are the general trends in research and practice towards Industry 4.0 in the wood supply chain?
    - how can digital technologies boost innovation for creating and capturing value through new business models?
- The role of digital technologies from the Industry 4.0 concept facilitates the creation new business models in wood mobilization. The aforementioned Operational Plans should foster research, development and innovation in wood mobilization applications that identify and track materials within the supply chain, focusing on exploitation techniques on data collection, data integration, and data analysis, the use of cyber-physical systems, cloud computing, the Internet of Things etc. The application of these technologies should be carefully studied in all steps of the wood supply chain, namely:
    - Harvest planning, control and operations – The process of preparing for harvesting operations, as well as all organizational tasks around the time of the actual harvest. Additionally, operations pertaining to felling and processing as well as extraction.

- Timber transport and logistics – Management of transport and logistics processes is the final step in the forest. It comprises timber inventory, transport organization and scheduling, route optimization, truck operations (localization, navigation, loading, transportation of logs) as well as quality control.
- Timber sales – Sales could be planned upfront or after the harvest and involve all local selling endpoints and price variations, for instance industry or domestic customers in wholesale or retail fashion.

- Taking all into consideration, Western Macedonia should invest in **researching and developing business models in fields currently unexplored** by local businesses, such as digital transformation, lifecycle management, resource efficiency, circular business models and smart services.

2.4 Presentation of the interregional Roadmap

Project partners screened an extensive range of available best practices and innovations (BPI) from previous projects and other national and European sources to select the most relevant examples. The aim is to boost cross-regional learning on BPI, latest managerial, social and technological innovations, especially in the digital domain. South-Eastern Hub partners screened BPI implemented in EU regions and pre-selected 30 examples according to weaknesses identified within the SEE Hub SWOT. BPI have been pre-selected according to the needs of South-Eastern Hub with special emphasis on digitally supported solutions.

Prioritisation of BPI was done according to weaknesses identified within the SEE Hub SWOT and following the criteria: technological impact, economic impact, ecological impact, social impact, mobilisation impact, replicability, priority. The SEE Hub pre-selected BPI mainly covering two domains, namely the 1) inventory, assessment and monitoring domain and 2) the education, research, knowledge transfer domain. Harvesting and logistics domain and products, markets and trade domain are also represented strongly in pre-selected BPI. Among pre-selected practices, advisory and service tools for forest owners are the most represented solution type. Collaboration platforms and logistical hubs, as well as open data platforms, are solution types also represented strongly in pre-selected BPI. Preselected BPI from other Hubs are:

Country of Origin	Best practice/ innovation	Subject of the BP/innovation and expected results	Associated weaknesses of SEE Hub
Finland	**Climate Smart Forestry- Innovation**	Climate smart forestry was created for mitigating climate change in forestry. Main objective is to create a carbon-based classification method as a practical tool for planning forest use. The basic principle in the climate-wise classification of forest compartments is to define them as either carbon sinks or storages.	Insufficient level of awareness and lack of knowledge about the importance of recycling. Insufficient knowledge and lack of interest for improvement;
Romania	**TimFlow-WoodTracking**	Application that contains data from all trucks delivering logs to the first company implementing the traceability system; precise routes of the transports, a reference to the documents of origin and photos of the cargo.	Outdated technology, production processes and infrastructure for technology transfer.
Norway	**School of forestry**	E-learning for multiple levels of foresters/forest owners initiated by industry leaders.	Lack of skilled professionals and interest to implement modern technologies (ICT); Insufficient knowledge and lack of interest for improvement; Lack of cooperation between knowledge pools and industry.
Austria	**DeepDigitalForest**	Enhancement and optimisation of multi-phase inventory and survey methods for the digitalization of the forest. From space-born or airborne remote sensing via cost-efficient forest inventory assessment to a wall-to-wall mapping of forest resources and a linked mobile management planning tool	Lack of skilled professionals and interest to implement modern technologies (ICT).

Austria	**Biomass trading centres calculation tool**	Calculation tool for the establishment and operation of biomass trading centres.	Low innovation capacity; Low interest for investments.
Germany	**Smart Wood Supply Chain Management - assessment of industry 4.0 potentials in the wood supply chain**	Operational potentials of Industry 4.0 in the optimization of existing value-added processes, and its strategic potentials for the evolution of existing or the development of new business models.	Digital solutions are not implemented in wood transport and logistic; Low innovation capacity in wood processing.
Austria	**Ingenious material**	Information platform with the aim of attracting young people to take part in education in the forestry and wood processing sector.	Lack of skilled professionals and interest to implement modern technologies (ICT); Insufficient knowledge and lack of interest for improvement; Lack of cooperation between knowledge pools and industry; Low employment opportunities.
Germany	**Forest management software**	Forest management software which contains data on all aspects of the forest and provide a wide range of information for making decisions.	Insufficient level of awareness and lack of knowledge about the importance of recycling.
Norway	**Ydalir district**	Zero Emission Neighbourhood focused on use of local wood for building a house.	Lack of cooperation between knowledge pools and industry; Lack of cooperation between designers and wood industry.
Norway	**Forestry fund**	The Forest Fund consists of funds that forest owners are obliged to dispose of in all sales of timber and biofuel. The purpose of the scheme is to secure financing for sustainable management of forest resources.	Lack of solid logistics background; Poor conditions of forest roads; Low level of educated private forest workers in use of forestry machinery.
Germany	Centre of Excellence Forest and Timber 4.0	Provider of necessary competencies and infrastructures for the development and demonstration of the Forest and Wood 4.0 vision, research of new components, processes and business models as well as for the further education and consulting of the cluster actors.	Insufficient knowledge and lack of interest for improvement; Lack of solid logistics background; Lack of skilled professionals and interest to implement modern technologies (ICT).
Germany	Comparison of silvicultural concepts by simulation of growth processes in forests on the smartphone	System that will provide forest owners with realistic and technically sound options for sustainable management of their forests.	Insufficient level of optimal forest exploitation; Lack of skilled professionals and interest to implement modern technologies (ICT); Insufficient knowledge and lack of interest for improvement; Lack of services in line with needs of small-scale forest owners (i.e. timber sale, economic extension services, Lack of small PFOs' interest in forests and forests management.
Austria	HolzmobRegio	Digital Forest Management documentation tool which support and advice forest owners and provide better overview of the own forest.	Insufficient level of optimal forest exploitation; Insufficient knowledge and lack of interest for improvement; Lack of services in line with needs of small-scale forest owners (i.e. timber sale, economic extension services, Lack of small PFOs' interest in forests and forests management.
Germany	Forest land consolidation of community forests in NRW	Effective land development instrument to overcome fragmentation of small-scale private forests through realignment of land parcels.	Fragmented private forest properties; Insufficient level of optimal forest exploitation; Unresolved ownership and cadastral issues.
Norway	The Forestry Extension Institute	Organizations which provides training for multiple levels of foresters including e-learning and YouTube videos.	Lack of skilled professionals and interest to implement modern technologies (ICT); Insufficient knowledge and lack of interest for improvement.
Austria	FelixForst	System which provides detailed information on dimensions, number of pieces, assortment distribution and, if applicable, forming errors, as well as on costs, revenues, inventories, and much more. Digital mapping ensures greater transparency, accelerates and facilitates process handling in real time.	Outdated technology, production processes and infrastructure for technology transfer; Digital solutions are not implemented in wood transport and logistic; Lack of solid logistics background.
Germany	Forest becomes mobile initiative	Non-profit partnership of public and private forestry and wood industry organisations providing support and	Lack of services in line with needs of small-scale forest owners (i.e. timber sale, economic extension services); Lack of small PFOs' interest in

		innovative solutions for small-scale forest owners and associations.	forests and forests management; Insufficient knowledge and lack of interest for improvement; Weak connections between the "forest" and "wood" part of the forest-wood value chain.
Austria	Woodlogistic Data Plattform	Modular software for optimization of the entire wood procurement process through communication, planning and control measures.	Lack of services in line with needs of small-scale forest owners (i.e. timber sale, economic extension services); The wood flow from private forests is unpredictable; Lack of skilled professionals and interest to implement modern technologies (ICT).
Germany	Information platform on forests in NRW incl. interactive digital maps on forest cover, ecology, geology, types of use and calamities	The internet portal Waldinfo.NRW offers comprehensive public information on the forests in North Rhine-Westphalia, their diverse functions and sustainable management. The information provided is intended in particular to support forest owners in the adaptation of forest management to climate change.	Insufficient exploitation of national forest services; Lack of small PFOs' interest in forests and forests management;
Austria	Evergreen Innovation Camp - Hackathon	Evergreen Innovation Camp Hackathon give unique opportunity to develop a solution for an exciting real-life challenge from the forestry and timber industry in 48 hours together with team of students and young professionals from different fields of study. The winner of Evergreen Innovation Camp Hackathon 2019 team "Tree ID" developed a concept based on matching laser measurement data from the forest and at the mill.	Insufficient knowledge and lack of interest for improvement; Low employment opportunities; Weak connections between the "forest" and "wood" part of the forest-wood value chain.
Austria	dataholz	Online database of wood and wood-based materials, building materials, components and component connections for timber construction.	Insufficient knowledge and lack of interest for improvement.
Spain	Digital Service Infrastructures to integrate models supporting forest management and forest protection	Cross-Forest combine Forest Inventory Datasets, Forestry maps and observational big data to create and integrate models supporting forest management and forest protection.	Lack of small PFOs' interest in forests and forests management; Insufficient knowledge and lack of interest for improvement.
France	Forest insurance investment account	Financial instruments for private forest reinvestment, where the owner maintains control of the money.	Lack of subsidies and compensation mechanism; Insufficient knowledge and lack of interest for improvement.
Finland	Biomass atlas	Service that enables users to calculate the amount of biomass in a given geographical area, as well as examining the opportunities to utilise the biomass and restrictions on its use.	Low innovation capacity; Low interest for investments.
Norway	National Forest Inventory	Provides information on the condition and development of Norway's forest resources, based on a nation-wide survey of permanent sample plots visited every five years. Development and testing of remote sensing applications to provide information about the forest resources is an important field of research within the NFI.	Understaffed public agencies for forest preservation; Insufficient knowledge and lack of interest for improvement.
Canada	Forestry 4.0 Initiative	Initiative that specialized in the creation of solutions of forest sector's global competitiveness.	Use of obsolete machinery by the private forest owners due to high investment costs; Low level of educated private forest workers in use of forestry machinery; Outdated technology, production processes and infrastructure for technology transfer; Digital solutions are not implemented in wood transport and logistic; Lack of solid logistics background.
Austria	Forest mapping management tool	Digital tool for planning and monitoring forest work. Precise record methods provide an accurate account of actual state. Those data can be further used for digital forest economic plans. The main determinant of Forest Mapping Management is the provision of advisory and service tools to forest owners.	Lack of small PFOs' interest in forests and forests management; Insufficient knowledge and lack of interest for improvement.

Germany	Advanced Virtual Aptitude and Training Application in Real Time	Digital coaching, assistance and feedback system is designed to improve the productivity and job satisfaction of forest machine operators with reduced mental stress and to make the training of junior staff more attractive and efficient.	Low level of educated private forest workers in use of forestry machinery; Lack of skilled professionals and interest to implement modern technologies (ICT).
Finland	Finnish education technology going global	Educational platform which support pedagogical work. Platform comprises of the web-application, used for creating the content on the map interface, and the freely downloadable mobile application, needed for navigating on the learning trail outdoors.	Lack of skilled professionals and interest to implement modern technologies (ICT).
Poland	Forest Data Bank	Provider of information of forest management, forest condition and its changes regardless of the form of ownership. This information is interrelated with the database on nature conservation and the state of the natural environment.	Lack of small PFOs' interest in forests and forests management; Insufficient knowledge and lack of interest for improvement.

Table 2: BPI from other Hubs matched with main needs and weaknesses in SEE Hub

Pre-selected BPI could tackle some of weaknesses identified in the South-Eastern Hub SWOT analysis. The **Climate Smart Forestry- Innovation and Forest management software** best practices have potential to resolve insufficient level of awareness and lack of knowledge about the importance of recycling. Carbon-based classification method and forest management software shows the actual situation of forest and could stimulate foresters and forest owners to use applications of sustainable forest management. The Implementation of the best practice **TimFlow-WoodTracking** from the Central-East Hub may improve the logistic background and increase the application of modern technologies in wood transport and logistic. The best practices **School of forestry** and **Ingenious material** could attract young people to the forestry and wood industry sector and increase the number of quality labour in the market. The **DeepDigitalForest** may increase knowledge and improve interest for improvement. Implementing the BPI **Biomass trading centres calculation tool** from the Central West Hub may improve innovation capacity and raise interest for investments in wood processing (wood biomass). The BPI **Smart Wood Supply Chain Management** may raise up implementation of digital solutions in wood transport and logistic and raise innovation capacity in wood processing. **Ydalir district** could improve cooperation between knowledge pools and industry and also between designers and wood industry. The implementation of BPI **Forestry fund** may improve logistic background, conditions of forest roads and increase level of educated private forest workers in use of forestry machinery.

Innovation and innovation management could come through with novel software tools and possibly integrated ICT solutions involving fields like IoT and AI. Forest digitization with interactive maps and GIS tools is a route we would like to further develop.

The flow of research and technological development information and the exchange of knowledge and "good practices" within and between sets of actors and countries should be encouraged.

All suggested approaches should be in line with high standards for energy and resource efficiency and environmental performance. Additionally,

- All relevant actors should be fully committed and involved and their needs should be considered, especially as regards their motivation, training, skills and resources. Targeted and steered participation by specific groups needs to be assured in order to achieve optimal results.
- The sustainability of forests and other wood resources, as well as of operations, rely also on policies and regulatory measures. These need to be considered at all stages of planning and execution of wood mobilization.
- Regional and local conditions, including forest and other wood resources, markets, infrastructures, equipment availability, etc. need to be considered and relevant adaptations made as appropriate.

Mentioned preselected BPI from other Hubs could cover many weaknesses of South-Eastern Hub. Also, with the implementation of preselected BPI, the South-Eastern Europe Hub partners could improve

digitalization in forestry and wood industry and stimulate practitioners to implement modern technologies. Listed benefits lead to skilled professionals and increased levels of competitiveness.

2.5 Implementation of the roadmap

South-Eastern Hub partners in collaboration with experts, identified development targets for sustainable wood mobilisation in their countries. As a main target they emphasized **"local wood for local use".** Public authorities should develop strategies which protect local wood processors and ensure sufficient quantities of raw wood material.

Public authorities should develop silviculture policies for smart and sustainable use of forests resources to stimulate private forest owners, wood processors and other stakeholders towards sustainable wood mobilisation. Also, they should in collaboration with experts organize workshops dedicated to the importance of digitalisation for sustainable wood mobilisation. The SWOT analysis of South-Eastern Hub identified a low level of digitalisation in wood transport, logistic and wood harvesting/storage. Accordingly, it is necessary that foresters and wood processors implement principles of sustainable wood mobilisation in the forest managing and wood processing with emphasized digitalisation.

Stakeholders identified insufficient financial support regarding equipment. Public authorities on the local and national level should ensure financial support in accordance with the market needs i.e. machinery and reconstruction of forest road. Wood processors and foresters are currently facing a lack of competitive work force, especially in managing modern machinery / technologies. To ensure formal and informal education, professionals, wood processors, forest owners and foresters should collaborate with public and private education institutions. It is crucial to improve educational training and vocational curricula in line with the market needs and requirements of the end user.

For the implementation of recommendations listed in the Roadmap, it is necessary to improve collaboration between stakeholders along and across the forestry and wood value chain. Roadmap recommendations and implementation of BPI from other Hubs could strengthen forestry and wood industry value chain of South-Eastern Hub and cover weaknesses.

2.6 Conclusions and Outlook

The overall aim of the South-Eastern Hub is to increase the contribution of forestry and wood processing industry to the national economy, by applying research results and ecologically and economically acceptable technologies and methodologies in sustainable management and comprehensive protection of forest resources and biodiversity. The protection and preservation of biodiversity as well as sustainable management of forest resources and their sustainable utilisation also implies positive impact on their deterioration and focus on potential for satisfying the needs of current and future generations.

Current technology used in the South-Eastern Hub forests relies on traditional methods and machinery and should be aligned with significant advances in the development of environmentally friendly technologies, especially in harvesting, transport and forest establishment.

Despite the fragmented nature and relatively small average private forest properties, they have the potential to contribute more in terms of wood mobilisation and other forest ecosystem services. Contribution of private forests could be increased with remedial actions like example incentives such as government subventions for sustainable management of private forests. Furthermore, adjustment of current format and regulatory requirements for forest management plans, which are based on an ecosystem approach suited for large management units and are therefore ill-suited for small average private owner holdings, could increase the contribution of private forests. Still the most prominent measure

will be the enlargement of the private forest property on which sustainable forest management resulting with valuable products and income for the owners, is easy to implement.

Modern forest management considers research & development & innovation performed by scientists and researchers with project management skills, since the current communication of research results relies on very traditional methods and it does not address the needs for the implementation of results at the operational level. It is of great importance for South-East Europe hub countries to adapt education and research systems, institutions, and organisations to the needs of modern forestry. The needs of the forestry sector are changing constantly, and it is important that education system adapt their programmes to meet these changing needs, and also to answer to growing societal needs towards forests.

Forestry needs to become more transparent and to adequately present its results, achievements and specific qualities. The realisable benefits are many and include creation and stabilisation of employment in rural areas, harmonisation of regulatory framework, development of added value and import substitution, while safeguarding natural resources.

ROSE WOOD 4.0 Sustainable Wood for Europe

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WOOD PROD

NLC Narodne lesnicke centrum National Forest Centre

PAPER PROVINCE

CNPF

LAPIN AMK Lapland University of Applied Sciences

AIEL Associazione Italiana Energie Agroforestali

FORZA

Luke Natural Resources Institute Finland

TRETORGET - for innovasjon og resultater

ROSE WOOD 4.0 Sustainable Wood for Europe

CENTRAL-WEST HUB ROADMAP

https://rosewood-network.eu/

Central-West Hub Roadmap

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1. Introduction

Modern information and communication technologies (ITC) continue to develop rapidly in all sectors of the economy and society. The forestry sector (compared to agriculture or manufacturing sectors) is however lagging behind in terms of adaptation and spreading of modern ICT solutions. A major challenge is the large variety of ecosystems, forest owner types, supply chain actors and stakeholders, and regional disparities of technological progress. Forest industry 4.0 solutions (including new measurement sensors, high resolution digital maps, forest planning tools, risk monitoring, realtime data exchange and control, logistical optimisation, etc.) are a major field of innovation and future market, which will enable continuous information exchange at all stages in the supply chain, tracking timber flows from forest harvesting to processed wood products and markets. Furthermore, Decision Support Systems (DSS), educational tools and marketing platforms for forest owners are more and more emerging to connect knowledge and practice, and the actors within a region. This will leverage huge benefits for resource efficiency, sustainable use and climate change mitigation. These solutions can however only be exploited to their full potential, if they are more adapted and adopted, disseminated and deployed in the various regional contexts. The need for broader sharing of ITC-driven solutions and best practices is imminent and increasing, to maintain and enhance the competitiveness of Europe's forest industry by transforming it to a forest industry 4.0.

Digitalisation is one of the most powerful drivers of change in all aspects of society. In forestry, it has the potential to enhance the information flows and the relationships between actors (owners, managers, authorities, workers, communities and society) at all steps of the value chain. It has the potential to improve decision-making, empower forest managers and workers to achieve greater sustainability and fulfilment of multi-functionality standards as well as improving efficiency and transparency. However, the adoption of digital solutions is generally slow and very uneven across Europe. Through its Roadmaps, ROSEWOOD4.0 identifies and supports the adoption of close to market solutions and the replication of success cases by stakeholders of the value-chain.

Throughout Europe, the challenges for a sustainable wood mobilisation are diverse and often a lack of specific knowledge leads to non-ideal solutions. However, international and interregional knowledge transfer offers the potential to improve this situation. Against this background, the ROSEWOOD4.0 project has initiated five regional Hubs throughout Europe bringing together 21 partners from 18 countries to steer the interregional knowledge transfer on sustainable wood mobilisation:

- Northern Europe: Finland, Sweden, Norway, Baltic countries, Denmark
- Central-West Europe: Germany, Belgium, France, Switzerland, Austria
- Central-East Europe: Czech Republic, Hungary, Poland, Romania, Slovakia, Ukraine
- Southern-West Europe: Spain, Italy, Portugal and South of France
- Southern-East Europe: Bulgaria, Croatia, Greece, Slovenia

These 5 communities within ROSEWOOD4.0 will facilitate wood mobilisation through mutual learning across European regions. ROSEWOOD4.0 builds on the insights and experience gained in recent research and innovation efforts and will implement specific activities to reinforce digitalisation of the forestry domain with a sharp focus in the most relevant innovation opportunities in the following areas which are highly impacting the sustainable wood mobilisation: (a) Engaging forest owners and overcoming land tenure fragmentation, improved forest planning and risk management, adapted silvicultural measures for increased multifunctionality and biodiversity conservation; (b) Design and maintenance of infrastructures, optimized forest operations and logistics for improved economic and environmental performance; (c) Organisation and transparency of regional wood markets; new business models and market arrangements; (d) Access to finance and business support, including through EAFRD measures and PES (payment for environmental services) type mechanisms; legal and fiscal regimes; (e) Education, training and skills development.

By creating adapted materials and extensively sharing technological and non-technological innovations, best practice cases and RDI results, **ROSEWOOD4.0 multi-stakeholders approach** closes knowledge gaps and creates new opportunities for economic partnerships within the whole wood mobilisation value-chain. ROSEWOOD4.0 focuses on tailored (user- and region-specific) **transfer of know-how and information** that enables and supports **stakeholders of the wood value-chain to exploit innovations and best-practices** and facilitates the capture of innovative ideas enhancing the development of the field. ROSEWOOD4.0 aims also to provide practitioners with development skills (educational and entrepreneurial) and facilitate organisational innovations leading to **novel exploitation actions** leveraging the uptake of new ideas and Best Practices in daily business.

The roadmaps presented here address stakeholders throughout Europe for facilitating the transfer of knowledge and collaboration between partnership regions. The roadmaps represent the collection, the analysis and strategic direction of the results from the five Hub regions including their validation. The main objective of the roadmaps on Hub level is to strengthen the regions through transfer of the gathered knowledge, experiences and circumstances. With the accurate description and assessment of well-functioning best practices and innovations as inputs, there is an active support in strengthening the local wood value-chain development thanks to newly developed digital tools. Further, the roadmaps enhance cooperations by increasing interactions between stakeholders and regions for creating opportunities to initiate further and new developments. Relying on networks, it supports the self-initiative and empowers the forestry to push new actions. For this purpose, the roadmaps highlight best practices and innovations (BPI) that have the potential to serve as tools for prosperous and sustainable wood mobilisation among European regions. ROSEWOOD4.0 has initiated a web-portal for presenting the best practices and innovations to the wider public and stakeholders. This way, new solutions can be incorporated and the transfer of best practices monitored. The roadmaps give readers insights into regional perspectives of wood mobilization, capitalizing on information and cooperation possibilities between European regions. By steering the knowledge transfer between the regions, the roadmaps aim to provide a European perspective on digitalization issues in the forestry domain. In times of structural changes, a changing climate and new technologies, the ROSEWOOD4.0 Hubs can rely on a broad knowledge base from various countries for identifying suitable approaches for their regions. For this purpose, the roadmaps shall pave the road towards more collaboration between the regions, transfer of best practices and innovations meeting the needs of the regions. All this will further develop the ROSEWOOD4.0 network and strengthen the individual regions onto their path towards a sustainable wood mobilization and the transition to a bio-based economy in Europe.

2. Interregional Roadmap for the Central-West Hub

2.1 Description of the Central-West Hub region

The Central-West Hub (CWE Hub) is one of five ROSEWOOD4.0 Regional Wood Mobilization Hubs, which covers countries in Central West Europe, namely Austria, Belgium, France, Germany (North Rhine-Westphalia) and Switzerland.

The CWE Hub project partners are:

1. Holzcluster Steiermark GmbH (HCS), Austria,
2. InnovaWood (IW), Belgium,
3. Centre National de la Propriété Forestière (CNPF), France,
4. State Enterprise for Forestry and Timber North Rhine-Westphalia - Forest education and training center (FBZ), Germany

5. School of Agricultural, Forest and Food Sciences (HAFL), Bern University of Applied Science (BFH), Switzerland

The CWE Hub countries have a long tradition in sustainable forest management and forest regulations. Forestry has an important role in terms of socio-cultural and socio-economic developments in this region. There is a strong link between forestry and historical and cultural developments, as well as a strong dependence on living standards and ecological stability. This connection is still very prominent, which greatly influences public and political decision-making. Nevertheless, each region has different geological, geographical, and political circumstances, which are the basis for obtaining a clear picture of the current situation in the forest sector in the Central-West-Europe Hub.

Almost 48 % of ***Austria's*** national territory is covered with forest. The Provinces of Styria and Carinthia have the highest share of forest, with more than 60 % of the province area being forested in each case.

Over the past 10 years, the forest share has grown by an average of 3,400 hectares per year, which corresponds to an annual increase by 4,762 soccer fields. As a result, the total forest area has for the first time exceeded 4 million hectares.

The production value of forests along the entire value chain amounts to 12 billion euros. The average export surplus is 3.5 billion euros. A total of around 172,000 holdings are involved in this value creation, and 300,000 people earn an income from it.

82 % of Austrian Forests are privately owned by about 145,000 forest owners. This area covers a total of three million hectares of woodland. Private ownership in Austrian forests can be broken down as such: 50 % own less than 200 hectares (small scale forests), and 22 % own more than 200 hectares (big forest holders). 10 % of Austrian forests are owned by communities, for example agricultural co-ops. 18 % are state-owned. The Austrian federal forests (ÖBf) manage 15 % of the national forest area. [1]

Domestic forests constitute an essential pillar of climate protection: Forests and their soils sequester about 3.6 billion tons of CO_2 equivalents, which is about 40 times the annual emissions in Austria.

Climate change poses great challenges for domestic forests. For example, the year 2018 was marked by a strong bark beetle infestation. According to estimates, about 4 million cbm of wood were damaged, which is the highest damage ever recorded. The high pest pressure is mainly due to long periods of drought. Spruce stands are particularly affected. If possible, these must be felled quickly and removed from the forest.

Domestic forests play an important role in protecting against natural hazards, especially in the alpine region. 800,000 hectares of forest stands are considered protective forest and thus contribute to the protection of settlement areas. Within the framework of torrent and avalanche control, the Federal Ministry of Agriculture, Regions and Tourism (BMLRT) provides funds to ensure these functions of the forest, which are important for life and limb, in the best possible way.

Women play an important role in forestry: 30 % of the owners of small forests are female and 25 % of the forest area is owned by women. However, only 11 % of the forestry workers are women. [2]

One third of the ***French*** territory is forest, representing 16.5 million hectares of forested lands. Most of this forest is used for wood production, whereas 0.7 million hectares are protected and recreational forest. Historically, French forests have been dominated by broadleaved trees such as beech and oak, but nowadays coniferous trees (maritime pine, spruce, and Douglas fir) are more and more present, especially in plantations.

[1] Federal Forestry Agency, Facts and Figures - BFW-Waldzahlen | V9.12 (06/2021).
[2] Federal Forestry Agency, Facts and Figures - Waldinventur des BFW - Daten und Fakten (bmlrt.gv.at) (06/2021).

One feature of the forest in France is the important part of private forest (75 %) over public forest. In the region New Aquitaine, the proportion of privately owned forest reached 93 % in 2019, representing 21 % of the national private forest.

The New Aquitaine region, resulting from the fusion of Aquitaine, Limousin and Poitou-Charentes in 2016, is one of the first forest regions in France and hosts the largest man-made woodland of western Europe, the Landes of Gascony. The forest was planted to fight erosion of the land and plays a big part in the regional economy thanks to wood and paper industry. The standing volume of the New Aquitaine production forest amounts to 383 million m^3 (excluding poplar plantations). From forestry and logging to finished products and retail, the wood-forest sector plays an essential role in the local economy and job market: 28,300 establishments employ 56,300 people; 31,000 of whom work in the four main segments: forestry and logging, sawmill and wood processing, paper and board industry and carpentry work. The main threats for the forest of New Aquitaine are fire hazards, storms, and pests such as bark beetle and pine processionary.

The forest is very fragmented, firstly because of the urbanization of the landscape and the development of road networks, and secondly because of the small properties: on a national scale, 3 million private forest owners do have less than 4 hectares of forest, most of which comes from family heritage.

Forest income comes mostly from wood production, sawmills, and paper industry, but other activities and products linked to the forest are important such as hunting, mushroom and truffles, honey production and cork.

For North Rhine-Westphalia (NRW)in ***Germany,*** the NRW State Forest Report 2019 states that the forested area of 27 % is just below the national average. In absolute terms, NRW ranks fourth with 909,511 hectares, behind Bavaria (2.6 million hectares), Lower Saxony (1.2 million hectares), and Berlin/Brandenburg (1.13 million), meaning that approximately 8 % of Germany's forest area is in NRW. Forest ownership in Germany is basically rather small-structured. 55.8 % of forest owners manage an area of less than two hectares with a total area of 48,000 hectares. The proportion of privately-owned forest in NRW is the highest in Germany – here, almost two-thirds of the forests are privately owned, with around 40 % of these private forest areas being smaller than 20 hectares. Private forest owners with small areas can hardly manage their forests efficiently and therefore often join forces to form forest management associations.

The condition of forests in North Rhine-Westphalia continued to deteriorate in 2020. Although the proportion of trees without damage has increased from 19 % in 2019 to 23 % as of now, the proportion of trees with significant crown defoliation has increased from 42 to 44 %. This is the highest figure since the surveys began in 1984. This increase in severe crown damage is a clear indication of the worrying condition of the forest. The mean needle/leaf loss across all tree species shows a slight increase to 29 % in 2020 (28 % in the previous year) after strong increases in the previous two years. The third drought summer in a row and the massive infestation of bark beetles are hitting spruce particularly hard. By 2020, over 10 % of the spruce stand has died. According to a recent survey by the North Rhine-Westphalia State Forestry and Timber Agency, the amount of damaged spruce timber since 2018 is around 31.5 million m^3 (as of November 2020). The average long-term mortality rate for all tree species has risen from 0.21 % (2018) to 2.4 % (2019) and has nearly doubled in 2020 to 3.98 %.

Measures for resilient reforestation are financially supported by the state. The NRW "reforestation concept" envisions planting trees in groups, as a mixed forest with at least four different tree species that are more drought resistant. Digital location maps for forest owners provide information which tree is particularly suitable in which location.[3]

[3] Landesbetrieb Wald und Holz NRW (2019/2020): Landeswaldbericht NRW 2019; Waldzustandsbericht 2020, accessible online: https://www.wald-und-holz.nrw.de/wald-in-nrw/waldzustand (15.06.2021).

In North Rhine-Westphalia, the forestry and timber industry employ around 160,000 employees subject to social insurance contributions and 31,000 marginally employed persons. The forestry and wood industry cluster achieved a turnover of 39.49 billion euros (2014). With around 7 % of sales and 9 % of employees in the manufacturing sector, the forestry and wood industry cluster are a considerable economic factor in NRW.[4] But, according to the IAB research report "Skilled workers and unfilled jobs in an aging society" (13/2012) 34 % of farms in agriculture and forestry tend to have an older workforce. Many enterprises in the forestry sector anticipate problems in filling skilled labor positions that they cannot counteract with their own operational strategies.[5]

In Germany, women have worked in forestry for around 40 years, but they present only 9 % of the workforce in state forest administration – with significant local differences. In Eastern German states, the share tends to be higher. The share of women owning forests is increasing and expected to rise further in the next years.[6]

One third of ***Switzerland*** is covered with forest. This results in a total of around 1,28 million hectares. It is enclosed by about 11,000km of forest edge which are particularly biodiverse habitats and assume many important functions in connections with stand structures and its stability. Per inhabitant there are around 1,520m^2 of forest.

The area of forests is increasing annually by about 5,400 hectares in Switzerland, especially in mountain regions. The total stock of wood in Switzerland's forests is about 427 million m^3, deadwood is included in this number. Switzerland has by far the highest stocks per hectare Europe-wide which are around 375 m^3. Annually, 10 million m^3 of wood grows. In other words, 1 m^3 every 3 seconds. By this process around 2.5 million tons of carbon are sequestered, which corresponds to around 10 million tons of CO_2. In Switzerland 1 ton of CO_2 is traded at a price of 100 francs per ton. This means that the worth of CO_2 sequestration of Switzerland's forests is 1 billion swiss francs (910 million €, on the 24.03.2021).

Together with the shrub species, there are over 130 different native woody plants in Switzerland's forests. The most important tree species, especially in terms of economic importance, as in most European countries, with a share of about 77 % of the wood supply is Norway spruce. Conifers make up a good two-third of the total wood supply resulting in one third for the deciduous tree species.

There are around 250,000 forest owners throughout Switzerland. Of these, more than 244,000 are private and almost 3,500 are public forest owners. Around 30 % of the forest area belongs to private owners (natural persons or legal entities), 35 % to public-law organizations without fiscal sovereignty (civic communities, corporations), 30 % to municipalities and 5 % is owned by the Confederation and the cantons. Public forest owners own an average of 300 hectares and the private forest holders own an average of 1.3 hectares.

Switzerland's annual wood consumption, including imported wood, is around 11 million m^3. Without overexploiting the forest (sustainable wood production), Switzerland could harvest 7-8 million m^3 domestically. Currently, only about 4.5 million m^3 of wood worth approx. 380 million Swiss francs (344 million €) are harvested annually, about two-thirds is coniferous and one-third hardwood. About half of the harvested wood is sold as "trunk wood", about one third is "energy wood". The gross value added of the Swiss forestry and timber industry is 4.5 billion Swiss francs (4.07 billion €) per year. Switzerland has a well-developed

[4] Umwelt.nrw (2021): Die Holzwirtschaft im Branchen-Cluster Forst und Holz, accessible online: https://www.umwelt.nrw.de/naturschutz/wald/die-holzwirtschaft-im-branchen-cluster-forst-und-holz (15.06.2021).
[5] Bechmann, Sebastian et al. (2012): Fachkräfte und unbesetzte Stellen in einer alternden Gesellschaft. Problemlagen und betriebliche Reaktionen, in: IAB Forschungsbericht 13/2012, accessible online: http://doku.iab.de/forschungsbericht/2012/fb1312.pdf (15.06.2021).
[6] PRO Forstverein Wald (2018): Frauen im Forst: Nach wie vor die Ausnahme, in: proWald August 2018, accessible online: https://www.forstwirtschaft-in deutschland.de/fileadmin/content/pdf/Frauen-Beitraege.pdf (15.06.2021).

network of forest roads with about 30,500 km of forest roads. This simplifies the management and timber harvesting but is also a big cost factor in the Swiss forestry sector.

More than 700 forest enterprises manage certain forest districts: approx. 850 mobile/flexible forestry contractors support them in their work. In addition, thousands of private individuals (e.g. farmers) use and maintain their forest themselves. The forestry sector employs 6,200 people; around 7,500 are involved in raw wood processing (sawmills, etc.). The forestry sector and the entire timber industry, including carpenters, joineries, woodworkers, pulp, and paper industry provide almost 100,000 jobs. Despite many advances in the past decade with the aid of an increasing mechanization, working in the forest is still dangerous and indeed one of the most dangerous professions. Unfortunately, more than 1,500 occupational accidents (302 / 1,000 full-time positions) occur each year.

A good 40 % of the forest has a protective effect (e.g. against rockfall, avalanches, debris flows). That is about 6,000 km^2 of forest. Forest protects around 130,000 buildings and several thousand km of traffic routes. The protective effect of the forest has an economic value of approx. 4 billion Swiss francs (3.6 billion €) per year. Around 40 % of drinking water comes from the forest. More than half of all groundwater protection zones in Switzerland are in the forest. The natural water filtering effect of the forest saves about 80 million Swiss francs (72.4 million €) in treatment costs. The value of the forest as a recreational resource is estimated at 2-4 billion Swiss francs. More than 6 % of the Swiss forest area are reserves. About 25,000 plants, animals and fungi are dependent on the forest, i.e. around 40 % of the total biodiversity.

In our forest, around 150 million tons of carbon are stored (approx. 550 million tons CO_2).

A total of around 130 million Swiss francs (118 million €) is paid annually in federal contributions to forestry. Of this amount, 100 million Swiss francs (91 million €) is spent on protection services (protective forest management and protective structures). Forest biodiversity is currently being promoted with around 10 million Swiss francs (9.1 million €). Young forest maintenance is supported with about 12 million Swiss francs (10.8 million €). Another 11 million Swiss francs (10 million €) are used for areas such as research, climate change, etc.

By way of comparison: agriculture receives annual federal funding amounting to a good 3.5 billion Swiss francs (3.17 billion €). [7]

2.1.1 Political targets for Wood mobilization and Forestry

In ***Austria,*** The „Austrian forest strategy 2020“ is prepared in the framework of the Austrian forest dialogue — in cooperation with all stakeholders. The Forest Strategy is intended as an instrument to harmonize the multiple interests and demands made on Austrian forests and to find solutions to utilization conflicts. The Forest Strategy 2020 is to provide forest-political cornerstones to ensure and continuously optimize the sustainable management and maintenance of Austrian forests. The overall objective of the Strategy is to ensure and optimize the ecological, economic, and social dimensions of sustainable forest management in a well-balanced way. Special attention is paid to the added value and the potential of the Austrian forestry and timber sectors for a „livable Austria“. The Forest Strategy 2020 is to help ensure the multifunctional services rendered by forests for present and future generations.

For consistency with the Austrian Forest Report, the Austrian Forest Programme as well as national and international reporting obligations, the Strategy is structured along the following seven forest-political fields of action (in the present Forest Report referred to as „criteria“):

[7] WaldSchweiz (2021): Zahlen und Fakten, accessible online: https://www.waldschweiz.ch/schweizer-wald/wissen/schweizer-wald/zahlen-fakten/ (24.03.2021).

1. Contribution of Austrian forests to climate protection
2. Health and vitality of Austrian forests
3. Productivity and economic aspects of Austrian forests
4. Biodiversity in Austrian forests
5. Protective functions of Austrian forests
6. Social and economic aspects of Austrian forests
7. Austria's international responsibility for sustainable forest management.

The forest-based sector is very important in *France* as well as in the region New Aquitaine. Softwood lumber accounts for 50 % of the harvest, pulpwood, and energy wood for 39 % and 11 % respectively. New Aquitaine is France's leading surplus region in terms of external trade, with nearly 250 million € released in 2016. Primary transformation (sawmill industries, wood-based boards, and pulp) produced 11 million tons of goods in 2014. Secondary transformation produced more than 20 million tons of wood and paperboard products in 2014, 70 % of which goes to the paper industry.

The two main political axes for wood mobilization are 1) strengthening the competitiveness of the sector and 2) stimulating silviculture and sustainable forest management. Indeed, strengthening the competitiveness of the forestry sector is essential to enhance the value of local wood resources and create jobs in rural areas. This involves supporting companies in their positioning on new markets, stepping up research and innovation, and finally encouraging partnerships between stakeholders. Concerning sustainable forest management, the diversity of forest areas and species implies a diversity of silvicultural practices. Hardwood forests generally have little wood mobilization, while softwood forests are managed more intensively. The stimulation of silviculture in New Aquitaine's forests must include sustainable practices to tackle the challenges due to the multiple functions of the forest. Boosting sustainable management requires complementary actions, such as reinforcing present efforts and certification of sustainability, grouping forests, and updating the silvicultural techniques and education for forest owners.

These political targets of sustainability together with competitiveness are encouraged by the 2020 recovery plan ("France Relance") presented by the French ministry for agriculture and food. Thanks to this plan, financial support will be given to forest owners and operators who wish to invest and adapt their forest to climate change in the years 2021 and 2022. This concerns poor, unmanaged or vulnerable forest lands, and the requirements include for example that 20 % of the forest should be diversified for surfaces above 10 hectares. This shall help to reconnect private owners to their forest and empower themselves in the decision-making process. Initiatives have already started, such as the creation of a free service platform for private owners (LaForêtBouge).

Moreover, New Aquitaine contributes to mitigating climate change in additional ways. Plantation forests offer a resource and substitute for other more carbon-producing materials. and mixed hardwood forests are more likely to store carbon in the forest ecosystem. The adaptation of the forests of New Aquitaine to a new climate is a major concern, and another priority in forest policies is limiting the emissions of greenhouse gases, increasing carbon capture and storage.

Forestry policy in *Germany*, NRW, aims at striking a balance between the interests of owners, the recreational needs of almost 18 million inhabitants and the diverse functions of the forest.

The state forestry law guarantees free access to forests and thus ensures all citizens the important function of quiet recreation in near-natural ecosystems. Conflicts of use and objectives resulting from the multifunctionality of the forest must be addressed appropriately.

Forest policy to sustainably guarantee these multifunctional services and to develop recommendations for action that can be applied regionally and locally. In North Rhine-Westphalia with the highest proportion of private forests in Germany, this means taking into account the diverse ownership interests and the participation of the approximately 152,000 owners, and very different silvicultural conditions.

Conflicting goals between economic expectations, societal demands, and nature conservation requirements must be minimized or resolved e.g. by providing appropriate advice from experts, granting subsidies and/or compensation funds, but also by providing a clear legal framework. Expert management of the forest, whether by knowledgeable forest owners or by qualified foresters, ensures the proper and sustainable management of forests in the interests of property and society. Forest policy must also increasingly coordinate with other policy areas such as nature conservation policy, species, and soil protection law, or planning law.

Protecting the diverse functions of the forest is a legal mandate. Based on a nationwide guideline, the protective and recreational functions of the North-Rhine-Westphalian forest were updated and made digitally available in 2019.[8]

With the Forest Policy 2020, the **Swiss Confederation** creates favorable framework conditions so that the forest can fulfil its diverse functions for society, the economy, ecology, and climate. It thus lays the foundations for sustainable, efficient, and innovative forest management.

The Forest Policy 2020 sets out eleven goals:

1. The potential of sustainably usable wood is exploited.
2. The forest and wood use contributes to climate change mitigation and the impact of climate change on forest service's remains minimal.
3. The protective forest service is ensured.
4. Biodiversity is maintained and specifically improved.
5. The forest area is maintained.
6. The economic performance of forestry is improved.
7. Forest soils, drinking water and tree vitality are not endangered.
8. The forest is protected from harmful organisms.
9. The balance between forest and game is guaranteed.
10. Leisure and recreational use are spared.
11. Education, research and knowledge transfer are ensured.

To achieve these goals, the Confederation, together with the cantons and other actors, drew up a plan of measures in 2012. While the implementation of most of the measures could begin immediately, legal adjustments were required for some points.

The action plan provides for two implementation stages. While the second stage will last until 2019, the first stage ended in 2015. A report by ETH Zurich and **the Swiss Federal Institute of Agricultural, Forest and Food Sciences (HAFL)** shows the interim status of the implementation of measures by the Confederation, cantons and other central actors and measures the achievement of objectives.

The interim report finds that the implementation of the Forest Policy 2020 is on track for most of the goals. The study identifies a need to catch up in the exploitation of wood utilization potential, in the economic efficiency of forest management, in forest health (forest soil, groundwater and tree vitality), in the balance

[8] Umwelt.nrw (2021): Forstpolitik, accessible online: https://www.umwelt.nrw.de/naturschutz/wald/forstpolitik inisterium NRW: Forstpolitik (15.06.2021).

between forest and game, and in recreational and leisure use. In contrast, the most significant progress has been made in the protection forest and in biodiversity.

The FOEN sees the interim report as confirmation of the direction it has taken, and in the second implementation stage up to 2019 it will focus on the objectives with a backlog. The cantons, forest owners, managers, forest experts and associations also can take stock and adjust their commitment.

The implementation of the Forest Policy 2020 made it necessary to amend the Forest Act in individual points. The amendments entered into force on 1.1.2017 together with the corresponding amendments to the Forest Ordinance. This will make it easier in the future to protect the forest from harmful organisms, to adapt it to climate change and to promote the use of wood.

The experience with the implementation of the Forest Policy 2020 is good and the interim report on the first stage, which lasted until 2015, gives the process a good report card. Based on the overarching strategic foundations, there are no indications for a fundamental change of course after 2020. From a technical point of view, too, there is only a need for selective adjustments (particularly regarding the indicators and individual measures). The Federal Department of the Environment, Transport, Energy and Communications (DETEC) has therefore decided to continue the objectives and thrusts of the current forest policy beyond 2020. The adjustments to the action plan for the period from 2021 onwards will be closely coordinated primarily with the cantons as central partners of the Confederation.[9]

The vision of the Forest Policy 2020 gets concretized with the vision of the Wood Resource Policy 2017-2020 and its four political goals. An efficient Swiss forestry sector sustainably exploits the wood utilization potential of the Swiss forest. The demand for material wood products is increasing in Switzerland, especially for wood from Swiss forests. Energy wood is harvested sustainably and utilized efficiently and in an environmentally friendly manner. The innovative strength of the forest and wood value chain is increasing.[10]

The Wood Action Plan is the most important instrument for the targeted implementation of the Wood Resource Policy. It has three main topics. The FOEN can support projects on these focal points. One example is WOODVETIA – the campaign which encourages consumers to choose Swiss wood. The Wood Action Plan was launched in 2009 and supports projects that deal with the raw material wood and its utilization. The fourth phase of the Wood Action Plan is currently running from 2021 to 2026, with around 4 million Swiss francs (3.6 million €) available annually for projects.

The Wood Action Plan promotes innovative projects that strengthen and develop the use of Swiss wood (Art 34a and 34b Forest Act). On the one hand by means of applied research and development, on the other hand by means of communication. It responds to current challenges such as the increased occurrence of damaged wood due to storms, drought, and beetle infestation by focusing on new utilization and application areas such as wood-based bioproduct plants.

A monitoring committee of the FOEN steers and manages the Wood Action Plan. A monitoring committee with representatives from the forestry, timber and wood energy industries, other federal agencies, the cantons,

[9] Bundesamt für Umwelt (2018): Waldpolitik 2020, accessible online: https://www.bafu.admin.ch/bafu/de/home/themen/wald/fachinformationen/strategien-und-massnahmen-des-bundes/waldpolitik-2020.html (15.06.2021).
[10] Ibid.: Ressourcenpolitik Holz, accessible online: https://www.bafu.admin.ch/bafu/de/home/themen/wald/fachinformationen/strategien-und-massnahmen-des-bundes/ressourcenpolitik-holz.html (25.03.2021).

nature conservation and environmental protection, the real estate sector and communications advises on strategic issues. A technical expert committee provides support in the assessment of project applications.[11]

Forest programme agreements: With the "restructuring of financial equalization and the division of tasks between the Confederation and the cantons (NFA)", subsidies are generally handled on a performance-oriented basis within the framework of four-year programme agreements.

As of 1.1.2008, the FOEN concluded programme agreements with the cantons for the first time with the corresponding performance and quality indicators. In the forest sector, the Protection Forest, Biodiversity in Forests and Forest Management programmes will be combined into a "Forest" programme agreement from 2020. The period of the agreements from 2020 will exceptionally last five years, from 2020 to 2024.[12]

Since 2008, programme agreements have been the central instrument for the partnership-based implementation of environmental policy between the Confederation and the cantons. For this purpose, the Confederation and the cantons agree every four years on which services a canton will provide to contribute to the Confederation's strategic objectives. At the same time, the Confederation undertakes actions to support the cantons financially. The actual programme agreements define the services to be provided by the canton, the financial contribution, and the modalities for annual reporting, among other things. The "Manual on Programme Agreements in the Environmental Sector" is based on the subsidy and environmental laws and ordinances and brings together in one document the legal, procedural, and technical bases of the programme agreements. It explains the Federal Office for the Environment's (FOEN) guidelines regarding the application, negotiation, conclusion, and implementation of programme agreements. It is divided into a procedural part (Part 1) and a technical part (Parts 2-8).[13]

The previous programmes "Protection Forest", "Forest Biodiversity" and "Forest Management" are now combined in a new "Forest" programme agreement. This programme agreement corresponds with the canton's desire for more flexibility in the use of funds and an optimization of the interfaces between the cantons and the Confederation. At the technical level, the previous programmes will not undergo any significant changes. The annual reporting by the cantons is to remain the same in terms of content but will be carried out per canton in a joint document for all three programmes.[14]

2.1.2 Structures of Decision Making

To steer, promote, develop, and verify sustainable forest management, several institutions and organizations with specific goals and tasks are active in ***Austria***. Basically, they must fulfil three functions: Creating laws and shaping policy; Supporting and supervising compliance with law; Generating and passing on knowledge (research, development, training and further training, advisory services, information).

Legislation and policy development are the responsibility of the Federal Government and the Provincial Governments, the National Assembly and the Provincial Parliaments, the representations of interest and NGOs. The federal and provincial forest authorities are responsible for the execution of the laws.

[11] Bundesamt für Umwelt (2021): Aktionsplan Holz, accessible online: https://www.bafu.admin.ch/bafu/de/home/themen/wald/fachinformationen/strategien-und-massnahmen-des-bundes/aktionsplan-holz.html (25.03.2021).
[12] Bundesamt für Umwelt (2019): Programmvereinbarungen Wald, accessible online: https://www.bafu.admin.ch/bafu/de/home/themen/wald/fachinformationen/strategien-und-massnahmen-des-bundes/programmvereinbarungen-wald.html (24.03.2021).
[13] Bundesamt für Umwelt (2018): Handbuch Programmvereinbarungen im Umweltbereich 2020-2024.
[14] Ibid.

Research and education institutions from university to the skilled-workers level, Statistics Austria and many more complete the picture. Their effectiveness depends on well-defined objectives as well as on the availability of sufficient technical equipment, funds, and staff. [15]

Decisions concerning forest in *France* are made both at national and regional levels. On a national level, the Ministry for agriculture and food issues laws and regulations to govern forest policy, both in public and private sectors. The four main goals are:

- Create value in France by mobilizing the resource in a sustainable way
- Meet citizens' expectations and integrate them into territorial projects
- Combine forest mitigation and adaptation to climate change
- Develop synergies between forest and industry

Examples of these directions can be found in the 2014 National Forest and Wood Programme, or more recently in the 2020 Recovery Plan.
A significant proportion of national measures are divided into regional strategies to adapt to specific territorial characteristics, but also to resonate with the competences of local authorities, and regional councils. Each region must develop a Regional Forest and Wood Programme, which serves as a framework for ensuring consistency between all other regional documents. Decisions at regional scales are made together between forest institutions (such as CRPF) and local authorities.

In the federal system present in *Germany*, laws are made on a central level (Bundeswaldgesetz), while administration, regulation, law enforcement and funding policies are within the responsibility of the states.

Switzerland is a federalist state: the power is divided between the Confederation, the cantons, and the communes. The cantons and municipalities have great leeway to fulfil their tasks. Federalism makes it possible for Switzerland to exist as a single entity – despite unity – despite four linguistic cultures and different regional peculiarities.

The Confederation, the 26 cantons and around 2212 municipalities share the power. Cantons and municipalities have extensive competences and a high degree of autonomy. The Confederation only takes on tasks that the cantons and municipalities cannot perform themselves. Each canton has its own constitution, parliament, government, and courts. Of the municipalities, about one fifth have their own parliament, especially the cities.[16]

In the context of Swiss forestry, this means that the Confederation is creating favorable framework conditions with the Forest Policy 2020. With suitable concepts for the implementation, the cantons ensure that the goals set are achieved and can set the accents that are important in their point of view. This ensures that, on the one hand, the cantons can also pursue their own interests and that local conditions are considered during the implementation process. Finally, the communes support the cantons in the concrete implementation on the ground with their knowledge and competences.

[15] Republic of Austria, Federal Ministry of Agriculture, Forestry, Environment and Water Management (2015): Sustainable Forest Management in Austria, Austrian Forest Report 2015.
[16] Bundeskanzlei (2021): Der Bund kurz erklärt, accessible online: file:///C:/Users/jf01/Downloads/DE_BUKU_2021_Einzelseiten.pdf (25.03.2021).

2.1.3 Main actors in forestry in the Central-West Hub

The main actors in the forestry sector in partnership countries of the CWE Hub are the following:

Forestry companies

Austria	Austrian State Forest (ÖBF), Municipality of Vienna, monasteries, former aristocratic families, and families of industrials
France	Forestry contractors, cooperatives, and experts
Germany	Forst-Info Andreas Gohrbandt Waldkontor GmbH Rupert Pichler Forst Service Zitterbart Forstbetrieb B. Beyer GmbH Forstunternehmen Hubert Rüttgers
Switzerland	Forestry contractors Switzerland, Swiss Forestry Contractors, cooperatives, Domat-EMS, Schilliger, Tschopp

Forestry Associations: services for forest owners

Austria	Austrian Forest Owners' Cooperative and eight regional associations
France	CNPF (National Forest Ownership Center), CRPF (local branch of CNPF) French Ministry for agriculture and food
Germany	Waldbauernverband NRW
Switzerland	Association of Forest Owners in Switzerland (Waldschweiz), Bernese Forest Owners Association (BWB), 22 cantonal forestry associations Forestry Associations of Eastern Switzerland, Swiss Forestry Contractors Association (FUS), Association of Swiss Forestry Personnel (VSF), Association of Bernese Foresters and Forest Workers

State Forest Enterprise

Austria	Österreichische Bundesforste AG
France	ONF (National Forestry Office) DRAAF (Regional Directorate of Food, Agriculture and Forestry) DDT (Departmental Directorates of the Territories)
Germany	Landesbetrieb Wald und Holz NRW
Switzerland	State forestry enterprise (canton Berne, canton Zug, canton Lucerne, canton Aargau, Sense (canton Freiburg))

Supervisor of the Forest Act, education of forestry professionals, forestry development

Austria	Forest Chapter of the Chamber of Agriculture (one per province, one on national level)
France	IGN (National Institute for Geographical and forest information) FNB (National Wood Federation)

	FIBOIS (Interprofessional Association for Forest, Wood, Paper)
Germany	Landesbetrieb Wald und Holz NRW
Switzerland	Federal office for the environment (FOEN)

Forest Research Centre	
Austria	Bundesforschungszentrum für Wald (BFW) University of Natural Resources and Life Sciences in Vienna
France	INRAE (National Research Institute for Agriculture, Food and Environment)
Germany	Forstliches Bildungszentrum NRW Universities in Göttingen (Lower Saxony), Weihenstephan, Munich (Bavaria) and Erfurt (Thuringia)
Switzerland	Swiss Federal Institute of Agricultural, Forest and Food Sciences (HAFL), Swiss Federal Institute of Technology Zurich (ETHZ), Swiss Federal Institute for Forest, Snow and Landscape (WSL)

Educational Institutes	
Austria	University of Natural Resources and Life Sciences in Vienna Forestry school Bruck an der Mur Forest training centers in Gmunden, Ossiach, Rotholz, Pichl
France	AgroParisTech, Lorraine university
Germany	Forstliches Bildungszentrum NRW Universities with a BA in forest-related subjects in Göttingen (Lower Saxony), Weihenstephan, Munich (Bavaria) and Erfurt (Thuringia)
Switzerland	Swiss Federal Institute of Agricultural, Forest and Food Sciences (HAFL), Swiss Federal Institute of Technology Zurich (ETHZ), Swiss Federal Institute for Forest, Snow and Landscape (WSL), Forest Education Centre Lyss, Forest Education Centre Maienfeld

Table 1: Main actors in the forestry sector in the Central-West Hub countries.

2.2 Main findings

2.2.1 SWOT Analysis

The Central-West Hub regions were first analyzed by SWOT analyses on national respectively province level. The project partners and experts have then discussed the findings and merged it into one common SWOT for the Central-West Hub (Table 2).

Strengths	Weaknesses
• Sufficient forest resources are available and sustainably managed • High degree of forest utilization • Professional forest owner associations play an important role in supporting small-scale forest owners by providing a broad range of services and up-to-date information e.g. advisory and extension services, access to forest service providers, contracting services, access to timber market, market information, increased market power, etc.) • Forest certification schemes are in place • High safety standards in forestry • Skilled and experienced forest staff, forest service providers and forest machine operators • Dense forest road network with digitally available forest road maps Various digital logistic platforms are available and in use • Highly mechanized and partially automatized softwood sawmilling industry • Consolidated (softwood) sawmilling sector: production is split either into large units or small specialized sawmills. This consolidation process is mirrored by a sharp decrease in the number of sawmills. Switzerland: partially agree • Excellent production know-how with focus on high quality Switzerland: leading in technical and innovative know-how on timber construction (engineering) • High awareness of resource and energy efficiency on company level • Access to R&D units, cluster organization and innovation support agencies dedicated to forestry and wood working industry • Professional vocational and education system for forestry and wood working industry exists	• Low interest in collective forest management / joint forest operations • High share of elderly forest owners • Conflict between forest owners and the general public regarding the extent of forest management (timber production) Non-wood benefits e.g. environmental and recreational services, biodiversity, protection function, etc. gain higher significance in the general public • Lack of advanced digital solutions for real time forest monitoring lack of use cases for artificial intelligence (AI) lack of comprehensive decision support systems (DSS) for forest owners / FOAs • Forest service providers face an aging workforce and do not attract young employees Switzerland: new recruitments are possible, main problem is to keep forest workers in their jobs in the long term (high fluctuation of workforce) • Digitalization / automatic data exchange across companies and actors in the supply chain still not common • Level of digitalization within enterprises lower than in other industrial sectors • High-cost pressure and competition between transport companies leads to opportunistic behaviour • Industry 4.0 only partly applied • Working conditions are not very attractive Switzerland: disagree • Competitiveness of the sawmilling sector lags behind foreign companies (except AT): Switzerland: Yes, due to high wages, small processing volumes, little storage quantities, high prices, and very strong competition from AT and GER Germany: Regionally diversified sector lacking a joint representation of interests, tendency towards overcapacity. Austria: is among the top sawmilling countries (softwood only) • Timber construction still not legally equal to other construction material • Lack of concepts for product lifecycles • Social mistrust against wood harvesting, conflict between nature protection and managed forests

Opportunities	Threats
• Comprehensive digital decision support systems and tools for forest owners / forest owner associations • Attracting skilled workers / young employees through modernisation of job profiles and digitalisation • Forest owner association (FOA) gain importance and significance in terms of digital transformation, forest owner management and wood mobilization e.g.: -) FOAs as a major facilitator for the digitalization of the wood value chain -) FOAs providing comprehensive information and advisory services to small-scale forest owners. -) FOAs as middlemen in the timber trading business • FOAs as a tool for small-scale forest owners to avoid price disadvantages on the timber market / to guarantee a stable raw material supply to downstream industries • Public and political support of regional value chains and value-added products with a low environmental footprint • Further development of data exchange standards and data interfaces covering all aspects of the wood supply chain • Efficiency gains within enterprises and in the supply chain through the use of digital solutions and cooperative platforms • Further product diversification and new value-added products • New business models and applications in the context of Bioeconomy/Circular economy • Wood hybrid products (softwood + hardwood) e.g. for the construction sector • Implementation of industry 4.0 to increase efficiency and reduce costs • Emerging/growing markets for timber constructions: -) Urban construction market -) Public building sector -) Multistory buildings -) international markets • Increasing demand for CO_2-neutral products /production systems • Eco design concepts for wood buildings enabling the reuse of timber elements after the end-of life of buildings	• Climate change: -) increasing abiotic and biotic risks and damages -) higher economic risk due to calamities and dieback of forest stands -) higher forest management costs / decreasing profitability • Ongoing trend for urbanization: -) increasing public pressure in favor of forest protection / preservation -) higher share of new types of forest owners -) decreasing interest in forest management • Low willingness / capability to invest in new technologies or major digital innovations due to high-cost pressure • Shortage of skilled workers which is further severed by an aging work force • Poor to no broadband network availability in forests hinders consistent digitalisation resp. near real-time communication • Competition instead of cooperation between freight carriers have a negative impact on the overall transaction cost • Very high dependency of the softwood sawmilling sector on a single tree species Austria: Norway spruce (Picea abies) • Highly competitive international players • Lack of strong lobbying on European level may lead to unrealistic / detrimental regulations on the reuse/recycling of wood waste • Preference for/Persistence on the energetic use of wood residues in the forest-based industries may conflict with upcoming European and national environmental and climate protection policies • Persistant lack of public understanding on the economic significance of forests • Phase out of the woodworking sector from the regional/national innovation strategy due to its low (reported) R&D share • Sector cannot attract young talents and potentials

Table 2: Central-West Hub Joint SWOT.

Regarding the strengths, the CWE Hub regions have sufficient available certified resources which are operated under sustainable management systems. The high-quality infrastructure of the forest sector is a powerful

strength of the region with its highly functional supply chain. Moreover, the Central-West Hub holds excellent knowledge of forest management and a well-developed round-wood market, which is an opportunity for the future development of the forestry sector. Well-trained professionals manage forests of any type of ownership professionally and sustainably. In terms of weaknesses, the fragmented ownership with many private, small-scale forestry owners, leaves some of the potentials of the forests unused. Implementation of collective forest management is still not recognized as an opportunity. This can further be detected by the lack of communication between the different sectors of the chain of custody. Except for Switzerland the working conditions are considered not to be very attractive in comparison to other industries.

The CWE Hub is a region with high prices and high wages. To keep this in balance, it is necessary to maintain high productivity and excellent product quality by exploiting state-of-the-art technologies and production concepts. The high concentration in the sawmill and pulp industry results in diminishing profit margins for small forest owner, which leads to an increasing demotivation to participate in the round wood market.
The declining interest in an active forest management is further reinforced by an increasing share of urbanized forest owners disconnected from their forests, on-going public debates on forest conservation, the social demand for close-to-nature forestry, mistrust in established forest advisory and extension services, and a decreasing knowledge on forest practices and management. Therefore, the Central-West Hub faces weaknesses in societal matters like communication outside the sector, lack of public interest, and knowledge transfer.

In the CWE Hub digitalization of harvesting and management services was identified as an opportunity to raise productivity. Education and communication to sensitize the wider public and urbanized forest owners is another opportunity. Especially urbanized forest owners without direct spatial or vocational affiliation to their forests might be reached to raise a sustainable mobilization of roundwood by managing their stands. Development of new value-added product offers opportunities to forest industry by developing new business models in the context of circular economy.

Climate change and the ongoing trend for urbanization are the main threats for the forest sector in the CWE Hub regions. Unmanaged forest stands with a high stock are increasingly vulnerable to calamities e.g. storms, snow break, bark beetles etc. The consequences of climate change and thus the threats are difficult to estimate for the forest vitality and stability. Forecasts of climate change impacts show major impairments for forests, which might lead to losses in forest productivity and biodiversity. This threat is severed due to the focus on spruce as the main tree species for the wood processing industry in Central Europe.

2.2.2 Hub's Best Practices and Innovations Identification

Screening of best practices and innovations (BPI) in the CWE Hub has been carried out through desktop research supported by expert interviews and stakeholder workshops. The total number of selected BPI in the CWE Hub is 96, of which 27 were selected in Austria, 41 in Germany, 17 in Switzerland and 11 in France. Thanks to these figures, it can be concluded that the CWE Hub is rich in best practices, innovations and research projects related to the topic of wood mobilization in forests.

Innovative projects like **iWald, Komsilva** or **HolzMobRegio** are designed to activate and to support new type of forest owners – and are especially targeting urbanized forest owners without deep background knowledge in forestry and forest management. One of the main goals of these BPI is also to improve the direct communication and exchange of information between forest owners, forest owner associations, forest advisory services and forest service providers.

In the CWE Hub, a wide range of ready-to-use forest management Apps like **LogBuch, Moti, Festmeter** are of high relevance. They are programmed to easily collect single tree and forest stand data, make forecasts, or run management simulations as well as giving management advice. Moreover, these apps are designed to

edit, evaluate and share gathered data with other users (e.g. potential service companies, public authorities, forest owner associations) as well as to ease up forest procedures.

Awareness raising and information portals are also areas with good examples. BPI like **Woodpassage, Infoholz** or **Holzbaucharta** are representative BPI of regional and international actions to raise the awareness of the public for wooden buildings, to promote the regional wood value chain and make its economic, social and environmental impact visible to the public.

Communication campaigns addressing the importance of silvicultural care along with practical trainings for passive, small-scale forest owners e.g. **wald-wird-mobil.de**, were identified as one of the major pulls in the region to boost the rate of sustainably harvested wood.

Selection of the most promising BPI from CWE Hub		
Country	*BPI Title*	*Description*
Germany		
DE	KWH4.0	Center of Excellence Forest and Timber 4.0
AT		Application of drones for seedling transport in steep terrains
CH	SiWaWA 2.0	Forest growth simulation model
CH	Moti.ch	Mobile Timber Cruise - Smartphone tool for forest inventory
FR		The forest moves
AT		HolzmobRegio
Switzerland		
DE	GEODAT	Geographic data standard for wood logistics
DE	Virtueller Wald	Virtual Forest
DE	Wald-wird-	Forest becomes mobile initiative
CH	Wegemesslanze	Innovation on forest road quality assessment
CH	Kollegenschutz	Innovation for increased work safety in forest operations
France		
DE	Wald-wird-	Forest becomes mobile initiative
CH	HeProMo	Productivity models for harvesting processes
AT	-	HolzmobRegio
DE	TREEO	Free app for smallholder farmers in developing countries
DE	ForestManager	Forest administration app
AT	-	Forest-IMate
DE	Forstify	App for timber trading
DE	iWald	Comparison of silvicultural concepts by simulation of growth
AT	-	Biomass trading centres calculation tool
CH	Moti.ch	Mobile Timber Cruise - Smartphone tool for forest inventory

Austria		
FR	NEOSYLVAQ	Project NEOSYLVAQ
DE	KWH4.0	Center of Excellence Forest and Timber 4.0
DE	iWald	Comparison of silvicultural concepts by simulation of growth
DE	WASP	WaspWoodlogistics

Table 3: Selection of the most promising BPI from CWE Hub.

Selection of the most promising BPI from other Hubs		
Germany		
Country	*BPI Title*	*Description*
FI	Virtuaalimetsä	Virtual Forest 2.0 Innovation
FI	LogForce	LogForce
FI	Biomassa-atlas	Biomass atlas
EU	Forwarder2020	Smart Forwarder for sustainable and efficient forest operation and
SI	MojGozdar	MyForester - Quality assessment of forestry contractors
Switzerland		
ES	E-MONTE	Timber trade platform
SE	HiVision	Digitalized truck crane
ES	ChainWood	Blockchain for Immutable Timber
IR	Forest HQ	Central platform to help improve operational performance and
FI		Open Source Wood Initiative
Austria		
IE	Forest HQ	Central platform to help improve operational performance and
FI	-	Online network for machinery transfer
FI	-	Metsäverkko
FI	Industry4.0	Open Source Wood Initiative
SE	-	What Wood You Do?
EU	-	Biobord.eu
NO		School of forestry
NO		The Forestry Extension Institute
NO		Use of drones in vocational education
SE	Industry4.0	Digital sawmill
NO		Ydalir district

SE		Lindbäcks Bygg
DE	KWH4.0	Center of Excellence Forest and Timber 4.0

Table 4: Selection of the most promising BPI from other Hubs.

2.2.3 Needs analysis

Finding **responses to climate changes** and their negative impact on the forestry sector is one of the challenges facing the forestry sector in the CWE Hub. Forest management, products and productivity are closely linked with and dependent on climatic conditions. Climate change calls for adaptive forest management. The uncertainty of the extent of climate change and the responses of local forest stands, and the limits of interpretations of climate-change experiments leave forest managers with a wide range of practical options, but few clear-cut recommendations for management decisions. Whereas forestry professionals are familiar and comfortable with decision-making within wide margins of evidence, lay-persons may be overwhelmed by the lack of guidance. The increasing number of non-expert forest owners of small forest properties finds itself in an unexpectedly difficult situation when making decisions on forest management with long-term implications.

Urbanization and globalization are one of the biggest challenges facing the CWE Hub region. The significant number of **private forest owners** live in urban areas, sometimes at a considerable distance from their property. The move of owners from rural to urban areas continues or is even speeding up.

The knowledge held by new urban small-scale forest owners about forestry and its benefits is often at a low level. Informing them about the multiple benefits of sustainable forest management and increased wood mobilization is crucial. These groups of forest owners can often not be reached by forest administrations with their traditional programs for counselling or encouragement. In addition, the forest management goals of these type of forest owners are diverse, and many owners do not act in a market-driven way. Therefore, the cooperation of authorities, associations, and forest owners should be intensified relying on modern communication and digitalization. Customized approaches are needed to motivate each owner.

In almost all CWE Hub countries, except in Switzerland, there is an evident **need for skilled workforce**. Forest contractors find it difficult to reach the workforce and to retain the existing workforce. The trained workforce often leaves the job in the forest sector due to better conditions in other sectors. In most countries, forest-related jobs need to be modernized and digitized to attract young labor, but also to prevent the outflow of existing labor. By using new technologies and more progressive marketing, it would be possible to make such jobs more attractive to women as a new target group.

2.3 Development targets for sustainable wood mobilization

Based on the SWOT analysis and selected BPI at the local and Hub level, the following main conclusions can be reached:

- In the CWE Hub, softwood products are dominating in construction and chemical use. A large share of softwood stands is owned by small-scale private forest holders. To develop and support sustainable wood mobilization in these forests, it is necessary to utilize digital tools and platforms to reach out to private forest owners (communication), to provide them with near-real time information on their forests, to provide instant and customer-tailored advisory and extension services, and to link them to the round wood market.
- Another important aspect is to strengthen intermediary organizations like forest owner associations to enable small scale forest owners to adapt their forest to climate change effects, to maintain the

multi-faceted societal functions of the eco-system forest in Europe, and to strengthen their position on the round wood market.

2.4 Presentation of the interregional roadmap

Selected examples of best practices and innovations from other Hubs but also from the CWE Hub were presented to the local stakeholders and experts within two validation workshops. Prioritization of BPI was done according to the selection of main threats and main weaknesses identified within the CWE SWOT and following these criteria: technological impact, economic impact, ecological impact, social impact, mobilization impact, replicability, and priority.

Main Threats CWE Hub			
Threats	*BPI Country*	*BPI Title*	*Selected by*
Climate change • increasing abiotic and biotic risks and damages • higher economic risk due to calamities and dieback of forest stands • higher forest management costs / decreasing profitability	GER GER FI FI GER GER NO SE	DroneMapper Virtual Forest Climate Smart Forestry Ground laser measurement -innovation Waldinfo NRW iWald Afforestation as a climate mitigation action Bark beetle risk map	AT AT AT/GER AT CH AT GER AT
Low willingness / capability to invest in new technologies or major digital innovations due to high-cost pressure	GER FI FI AT GER GER NO	Wood logistics company co-owned by forest owner associations WoodForce LogForce FelixForst Smart Forest Worker KWH4.0 WASP Forestry value creation fund	AT AT AT AT CH AT GER
Shortage of skilled workers which is further severed by an aging work force	DE FR NO SE	AVATAR Harvester simulator Choose Forest HiVision	CH FR GER AT
Competition instead of cooperation between freight carriers have a negative impact on the overall transaction costs	FI FR FR	Digitally Connected Forest Operation Value Chain- Innovation FORLOG Foretdata	GER CH FR/GER
Persistent lack of public understanding on the economic significance of forests	FR CH AT AT	La forêt bouge Woodvetia Woodpassage wooddays	AT CH GER GER

	FR NO NO NO	Je me forme pour mes bois Choose Forest Women in Forestry Think Tree	FR AT AT AT

Table 5: BPIs matched with main threats.

Main Weaknesses CWE Hub			
Weaknesses	*BPI Country*	*BPI Title*	*Selected by*
Conflict between forest owners and the general public regarding the extent of forest management (timber production)	GER AT FR NO FR FR	TREEO APP ins Holz FORETDATA ALLMA Je me forme pour mes bois Climafor	AT GER AT CH FR FR
Lack of advanced digital solutions for real time forest monitoring lack of use cases for artificial intelligence (AI) lack of comprehensive decision support systems (DSS) for forest owners / FOAs	CH CH DE FI FI FI FR AT NO SE FI SE DE DE CH DE DE SE FR IR	SiWaWA 2.0 Moti.ch Virtueller Wald Virtuaalimetsä 2.0 Kuutio.fi Wuudis The forest moves Festmeter ALLMA Arboair Trestima HiVision iWald ForestManager Road condition monitoring LogBuch AJA KATAM™ Forest STERES Forest HQ	AT AT/GER AT GER AT AT AT AT AT AT AT AT AT AT AT AT GER CH AT FR AT
Digitalization / automatic data exchange across companies and actors in the supply chain still not common	EU FI FR FR AT CH PT	Flexwood LogForce Forlog Foretdata FHPDat F2020 Forscope	CH AT/GER FR FR GER AT CH

Timber construction still not legally equal to other construction materials	FI NO AT AT CH	Open Source Wood Initiative Ydalir district dataholz wooddays Lignum	GER AT/GER GER/CH GER GER
Social mistrust against wood harvesting, conflict between nature protection and managed forests	FR CH AT AT FR NO	La forêt bouge Woodvetia KLAR Woodpassage Je me forme pour mes bois Think Tree	FR CH GER CH FR AT

Table 6: BPIs matched with main weaknesses.

1. One of main threats in all CWE Hub regions is **climate change**. Forests and forest management systems need to adapt to these changes and must be able to meet a multitude of challenges. Although the CWE region has a very developed forestry sector and has managed forests in a sustainable way for centuries, it is evident that **advanced digital real-time forest monitoring solutions are not being used at full capacity**. One of the main reasons for this low willingness to invest in new technologies or large digital innovations is a lack of knowledge on digital solutions, the challenging integration of new solutions into the existing company infrastructure, lack of digital competence at all company levels, fear of too much transparency, and uncertainty on the total benefit of digitalization. Related to this topic numerous best practices from CWE hub but also from other hubs are available:

   - Virtuaalimetsä 2.0 – FI
     Virtual Forest 2.0 Innovation is a research and development project, which develops an innovation tool that enables efficient visualization of forest resource and spatial data in 3D. Virtual forest is an application, which can be used in the participatory planning of land use, guidance of forest owners and for combining interests of different stakeholder groups concerning the utilization of natural resources and areas. Virtual forest 2.0 project also aims to enhance the quality of visualization by developing new data to enable more precise visualization. The project aims to enhance the use of visualization e.g. in the forest bioeconomy sector.

   - Drones in the service of forestry – CH
     With their prompt, cost-effective and yet very precise terrain and inventory data, drones offer the possibility of digitally recording the dynamic processes in the forest and thus enable the precise planning of timber harvesting, rejuvenation, or other interventions. Single tree detection software uses drone data as the basis for estimating important tree parameters (tree position, height, and diameter). This research project investigates how the workflow with drone data can be optimized and how single tree detection software can be used to increase the efficiency of forest management. The innovative and creative aspect of this project is to create a digital twin of the forest. This twin provides all important tree parameters for the researchers to model the forest, make estimations of interventions, plan and make predictions.

   - Virtual Forest – DE
     In order to support the competitiveness on the worldwide market – but also to overcome efficiency problems related to the forest owner structure in North Rhine-Westphalia (NRW), Germany – the "Virtual Forest" is being developed as an intelligent planning and decision support

tool for forest growth as well as for wood mobilization. In practice, the heart of the Virtual Forest consists of a database of approx. 240 million single trees in NRW, its major wood resource. To identify the trees, latest aerial survey and satellite technology is used and combined with virtual reality and robotics know-how to efficiently gather and visualize the data. Thus, the Virtual Forest serves as a reliable and very up-to-date base and framework for new efficient forest planning, wood mobilization and machine logistics methods.

2. One of the weaknesses of the CWE region is that **digital data exchange between companies and actors in the supply chain is still not common**, which of course affects the productivity and competitiveness of the sector. Examples of good practices, both within and outside the region, have also been identified in this segment:

   - **Forest HQ – IR**
     A central platform to help improve operational performance and optimize log production.
   - **LogForce – FI**
     LogForce is used by both the forest companies and contractors. With CFLogistics LogForce the planner can ensure that requested amounts of wood are transported to the delivery destinations. Also, the driver has a real-time information on what is supposed to be delivered from where and to where. LogForce makes updating the plans easy since the information is delivered digitally to trucks.
   - **Forest Supply Chain Optimization System (Forscope) – PT**
     The Forscope is a prototype of an advanced planning system whose main functionalities include:
     (i) a digital marketplace for non-used forest-based biomass;
     (ii) support supply chains design;
     (iii) support the optimization of logistics processes;
     (iv) planning and control of operations from forest-to-mill.

3. **The shortage of skilled workers which is further fueled by an aging workforce** is one of the selected major weaknesses in the CWE regions. To attract a new workforce, it is necessary to develop and implement new modern ways of communication and job promotion. In addition, the existing workforce needs to be kept motivated by offering them attractive jobs and opportunities for continuous development.

   - A good example is the **EU project AVATAR** which has developed a digital coaching, assistance, and feedback system for improving productivity and job satisfaction for forest machine operators.
   - **Choose forest – NO** works with recruitment, expertise and reputation building for the forest industry. Choose Forest is funded by members of the industry, the Ministry of Agriculture and Food, the Norwegian Forestry Association, and the Confederation of Norwegian Enterprise – FoodDrinkNorway, as well as funds from the forestry's various project funds.
   - Forestry crane work is often an isolated and rugged business carried out in challenging temperatures and harsh environments. Hiab's **HiVision™** is transforming the working conditions and productivity using virtual reality technology, goggles, external cameras. Precision and efficient log lifting every time - all from the safety and comfort of the crane cabin.

4. **The current legal framework is adapted to conventional construction products and technologies.** Not only the building regulations, but also the standards have been established for conventional building. The building laws need to be adapted to allow the development and experiments regarding more sustainable building materials like timber. None of the selected best practices offers a solution to the actual problem. Several best practices like **Open Source Wood Initiative – FI, Ydalir district – NO, dataholz – AT, wooddays – AT or Lignum – CH** have been selected as most promising initiatives to support and encourage changes in building codes.

5. To foster communication and cooperation between forest owners and the public regarding the extent of forest management (timber production) some of relevant BPIs like **APP ins Holz, FORETDATA, ALLMA, Je me forme pour mes bois, Climafor** have been identified. Some of them also target and cover consultation and teaching programmes on forest products and management matters.

6. The forest industries in CWE Hub use the latest technology to grow, manage, harvest, and process its renewable resources. Nevertheless, **negative perceptions regarding forestry, forest products and the forest product industry persist**. Regional and local marketing actions to raise the awareness of and inform the public are considered as the most important instruments to address prevailing negative perceptions:

   - **Think Tree – NO**
     Think Tree is a joint initiative from the forest and wood industry in Norway, aiming to show how forest and wood can contribute to fight the climate change.
   - **Swiss national wood promotion programme (Woodvetia) – CH**
     The awareness campaign aims to positively influence and consolidate people's attitude to Swiss wood on a long-term basis. The forestry and timber industry are combining forces to promote the use of native timber. Consumers are being encouraged to consciously choose Swiss wood when building new houses, carrying out conversion projects and buying furniture. Woodvetia is not using conventional advertising methods such as TV commercials and posters, but instead wants to get people actively involved.
   - **Woodbox and Wooddays – AT**
     Road show on forward-thinking timber architecture on tour through Europe. Dialogues, lectures, and presentations of best practices focus on wood as a topic for the future when it comes to building and living in urban areas.

2.5 Implementation of the interregional roadmap

Each partner country in the CWE Hub has a very long history in sustainable forest management. As such, detailed national and regional forest policies and strategies exist along with well-established administration and implementation structures.
The roadmap of the CWE Hub ROSEWOOD4.0 and the underlying joint SWOT analysis must be understood as a complementary bottom-up approach, where practitioners provided a state-of-the-art picture of the current wood value chain in the CWE Hub. The roadmap focuses on the weaknesses and threats perceived by the involved stakeholders ranging from forest authorities, research and education representatives, forest entrepreneurs and private forest owners. In response to those needs and threats, existing solutions, and promising innovations from within the CWE Hub and from the four other hubs were identified, presented, discussed, and matched by the project partners and their partner networks. The successful transfer or degree of exploitation depends on the partner domain and available resources. Especially BPI from other hubs usually require adaptions to fit to the prevailing forest practices and structures in the CWE Hub and the respective

partner country. Even though some of the available and accessible BPI cannot immediately be implemented by the stakeholders, it must be noted, that these BPI are still utilized through learning from them and providing an inspiration and motivation to actively progress in the digitalization of the forest value chain.

Within the remaining ROSEWOOD4.0 project run-time the focus will be on knowledge transfer of the identified BPI (as outlined in the previous sections) according to the stakeholders needs of the respective hub country, on creating cooperation opportunities by matching stakeholders of different hub partner countries and between the hubs. The project partners will facilitate and moderate this process through regional operational groups and tailor-made transfer and dissemination activities according to the specific needs of the locally rooted forest community. Bi- and multilateral workshops, round tables, tech-talks, moderated match-making events, agenda-setting actions, and the formation of consortia for research and innovation projects will foster the uptake of and cooperation between BPI owners and receiving entities. The stakeholder involvement in the SWOT analysis and the roadmap development has already resulted in several first moderated bilateral meetings and talks on potential cooperation and knowledge transfer in the CWE Hub. For dissemination of the roadmap and the underlying BPIs, a wide range of formats will be used like videos, online study tours, BPI presentations and pitches.

2.6 Conclusions and Outlook

The CWE Hub countries have a long and successful tradition in sustainable forest management and a well-established forest innovation system shaped by the needs of mostly locally rooted actors.
The ROSEWOOD4.0 hub approach enables and boosts the exchange of BPI between forest regions in Europe. Within the first 12 month, the CWE partner countries and their local stakeholders have received a tremendous amount of new ideas for overcoming shortcomings and risks in the wood value chain especially when it comes to the digital transformation of the highly fragmented forest supply chain.

Call for actions is required on the topics of climate change and new forest management regimes, lack of qualified labor, new types of forest owners, and the future role of forest owner associations and similar intermediaries to overcome the high fragmentation of private forests. The CWE roadmap matches successful best practices and upcoming innovations from around Europe with the identified weaknesses and threats in the partner countries. This interregional roadmap provides our locally rooted actors with a unique overview of state-of-the-art solutions and novel technologies to overcome their own weaknesses and to respond to perceived threats to strengthen and progress the whole wood supply chain.

Concerning the weaknesses identified in CWE Hub there is a need for deeper development of co-operation between horizontal and vertical actors by exploiting existing digital solutions and frameworks, getting near-real time information on forest status and changes, data sharing, making use of remote-sensing technologies and mobile applications in the field work, and radically innovating the prevailing communication channels between all actors in the wood value chain. ROSEWOOD4.0 hub network fosters the transfer of knowledge and best practices between locally rooted actors to respond to their current and future needs to maintain a sustainable and responsible forest management in Central Europe.

ROSE WOOD 4.0 Sustainable Wood for Europe

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ROSE WOOD 4.0 Sustainable Wood for Europe

CENTRAL-EAST HUB ROADMAP

https://rosewood-network.eu/

Central-East Hub Roadmap

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1. Introduction

Modern information and communication technologies (ITC) continue to develop rapidly in all sectors of the economy and society. The forestry sector (compared to agriculture or manufacturing sectors) is however lagging behind in terms of adaptation and spreading of modern ICT solutions. A major challenge is the large variety of ecosystems, forest owner types, supply chain actors and stakeholders, and regional disparities of technological progress. Forest industry 4.0 solutions (including new measurement sensors, high resolution digital maps, forest planning tools, risk monitoring, realtime data exchange and control, logistical optimisation, etc.) are a major field of innovation and future market, which will enable continuous information exchange at all stages in the supply chain, tracking timber flows from forest harvesting to processed wood products and markets. Furthermore, Decision Support Systems (DSS), educational tools and marketing platforms for forest owners are more and more emerging to connect knowledge and practice, and the actors within a region. This will leverage huge benefits for resource efficiency, sustainable use and climate change mitigation. These solutions can however only be exploited to their full potential, if they are more adapted and adopted, disseminated and deployed in the various regional contexts. The need for broader sharing of ITC-driven solutions and best practices is imminent and increasing, to maintain and enhance the competitiveness of Europe's forest industry by transforming it to a forest industry 4.0.

Digitalisation is one of the most powerful drivers of change in all aspects of society. In forestry, it has the potential to enhance the information flows and the relationships between actors (owners, managers, authorities, workers, communities and society) at all steps of the value chain. It has the potential to improve decision-making, empower forest managers and workers to achieve greater sustainability and fulfilment of multi-functionality standards as well as improving efficiency and transparency. However, the adoption of digital solutions is generally slow and very uneven across Europe. Through its Roadmaps, ROSEWOOD4.0 identifies and supports the adoption of close to market solutions and the replication of success cases by stakeholders of the value-chain.

Throughout Europe, the challenges for a sustainable wood mobilisation are diverse and often a lack of specific knowledge leads to non-ideal solutions. However, international and interregional knowledge transfer offers the potential to improve this situation. Against this background, the ROSEWOOD4.0 project has initiated five regional Hubs throughout Europe bringing together 21 partners from 18 countries to steer the interregional knowledge transfer on sustainable wood mobilisation:

- Northern Europe: Finland, Sweden, Norway, Baltic countries, Denmark
- Central-West Europe: Germany, Belgium, France, Switzerland, Austria
- Central-East Europe: Czech Republic, Hungary, Poland, Romania, Slovakia, Ukraine
- Southern-West Europe: Spain, Italy, Portugal and South of France
- Southern-East Europe: Bulgaria, Croatia, Greece, Slovenia

These 5 communities within ROSEWOOD4.0 will facilitate wood mobilisation through mutual learning across European regions. ROSEWOOD4.0 builds on the insights and experience gained in recent research and innovation efforts and will implement specific activities to reinforce digitalisation of the forestry domain with a sharp focus in the most relevant innovation opportunities in the following areas which are highly impacting the sustainable wood mobilisation: (a) Engaging forest owners and overcoming land tenure fragmentation, improved forest planning and risk management, adapted silvicultural measures for increased multifunctionality and biodiversity conservation; (b) Design and maintenance of infrastructures, optimized forest operations and logistics for improved economic and environmental performance; (c) Organisation and transparency of regional wood markets; new business models and market arrangements; (d) Access to finance and business support, including through EAFRD measures and PES (payment for environmental services) type mechanisms; legal and fiscal regimes; (e) Education, training and skills development.

By creating adapted materials and extensively sharing technological and non-technological innovations, best practice cases and RDI results, **ROSEWOOD4.0 multi-stakeholders approach** closes knowledge gaps and creates new opportunities for economic partnerships within the whole wood mobilisation value-chain. ROSEWOOD4.0 focuses on tailored (user- and region-specific) **transfer of know-how and information** that enables and supports **stakeholders of the wood value-chain to exploit innovations and best-practices** and facilitates the capture of innovative ideas enhancing the development of the field. ROSEWOOD4.0 aims also to provide practitioners with development skills (educational and entrepreneurial) and facilitate organisational innovations leading to **novel exploitation actions** leveraging the uptake of new ideas and Best Practices in daily business.

The roadmaps presented here address stakeholders throughout Europe for facilitating the transfer of knowledge and collaboration between partnership regions. The roadmaps represent the collection, the analysis and strategic direction of the results from the five Hub regions including their validation. The main objective of the roadmaps on Hub level is to strengthen the regions through transfer of the gathered knowledge, experiences and circumstances. With the accurate description and assessment of well-functioning best practices and innovations as inputs, there is an active support in strengthening the local wood value-chain development thanks to newly developed digital tools. Further, the roadmaps enhance cooperations by increasing interactions between stakeholders and regions for creating opportunities to initiate further and new developments. Relying on networks , it supports the self-initiative and empowers the forestry to push new actions. For this purpose, the roadmaps highlight best practices and innovations (BPI) that have the potential to serve as tools for prosperous and sustainable wood mobilisation among European regions. ROSEWOOD4.0 has initiated a web-portal for presenting the best practices and innovations to the wider public and stakeholders. This way, new solutions can be incorporated and the transfer of best practices monitored. The roadmaps give readers insights into regional perspectives of wood mobilization, capitalizing on information and cooperation possibilities between European regions. By steering the knowledge transfer between the regions, the roadmaps aim to provide a European perspective on digitilization issues in the forestry domain. In times of structural changes, a changing climate and new technologies, the ROSEWOOD4.0 Hubs can rely on a broad knowledge base from various countries for identifying suitable approaches for their regions. For this purpose, the roadmaps shall pave the road towards more collaboration between the regions, transfer of best practices and innovations meeting the needs of the regions. All this will further develop the ROSEWOOD4.0 network and strengthen the individual regions onto their path towards a sustainable wood mobilization and the transition to a bio-based economy in Europe.

2. Interregional Roadmap for the Central-East Hub

2.1 Description of the CEE Hub regions

The Rosewood 4.0. Central-East Hub covers the countries of Poland, Slovakia, Ukraine and Romania, represented by the member organizations National Forest Center (Slovakia), PRO WOOD Regional Wood Cluster (Romania), NGO FORZA (Ukraine) and Łukasiewicz Research Network – Wood Technology Institute ITD (Poland). The following pages give a brief overview of the respective regions' forest sectors.

Overall the CEE HUB represents forest sectors that account as a whole for 28,05 million ha of forests and over 262.000 employment in forestry.

Figure 1: Map showing European Countries by Forest Area.[1]

For all four countries considered, climate change and sustainable forest management practices are priority issues in both scientific and operational aspects. Common areas of interest of the CEE Hub include capacity building, risk management, digital solutions along the entire value chain, and the transfer between science and industry.

The forest land in ***Poland*** covers the area of 9.5 million hectares, that is 30.9 % of the country's land area (2019), including forests – 9.3 million hectares. Almost 81 % of forests are public, whereas 77 % of forests area are managed by the State Forests. Private forests have a 19 % share in total forest area, where natural persons are the main group of forest owners[2]. The dominant species in Polish forests is pine (58 % of forest area),

[1] Maps of World (2017): European Countries by Forest Area, https://www.mapsofworld.com/europe/thematic/countries-by-forest-area.html (13.07.21).

[2] Zajączkowski G., Jabłoński M., Jabłoński T., Szmidla H., Kowalska A., Małachowska J., Piwnicki J., Raport o stanie lasów w Polsce 2019, CILP, Warsaw 2020, Statistical Yearbook of Forestry 2020, Statistics Poland, Warsaw 2020.

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which is growing on the land with poorest soils. In the mountain areas a higher share of spruce, fir and beech can also observed. Coniferous species are dominating in the 68.2 % of Polish forests, but the area of broadleaf stands is growing (from 13 % in 1945 to 24.1 % in 2019). The common non-coniferous tree species are oak, ash, maple, sycamore, elm but also birch, beech, alder, poplar, hornbeam, aspen, linden and willow. The medium age of forest stand in Poland is 60 years, with the majority aged between 40 and 80 years[3].

Growing stock of wood (gross grand timber) is estimated at 2600 million m^3, where 78 % is managed by State Forests and 17 % by private forests. In 2019, 43.5 million m^3 of wood was harvested, including 40.9 million m^3 of wood from forests managed by State Forests (94 %) and 1.9 million m^3 of private forests. 76 % of harvested roundwood were coniferous species (33.3 million m^3) and more than 88 % of harvested wood was intended for material processing [4].

Main abiotic threats for Polish forests are drought and strong winds. In 2019, 113.4 thousand hectares of forest stands waere affected by abiotic factors. In terms of pests, the main species causing forest damage are Melolontha spp., Ips acuminatus, Phaenops cyanea and Tomicus sp.[5]

The forestry-wood sector is an important part of the Polish economy, accounting for 2.2 % of GDP (2019). The wood sector has an 8.8 % share in the sold production and 12 % in employment in the total industry[6]. Poland is among European and world leaders in wood-based panels and furniture production and export.

<table>
<tr><td colspan="2">Poland forests in facts</td></tr>
<tr><td>Forests
Forest land: 9.5 million ha, 30.9 % of land area
Forests: 9.3 million ha
Total volume (gross grand timber): 2 645 million m^3
Annual cuttings: 42.4 million m^3
Annual increment (timber, State Forests): 66.7 million m^3</td><td>Economic significance and employment, 2019
Average paid employment: forestry – 43.8 thousand jobs, wood sector – 353 thousand jobs
Employed persons: forestry – 54.3 thousand, wood sector – 406.2 thousand
Gross output: forestry – 4 300 million EUR, wood sector -– 37 577 million EUR
Export: roundwood – 315 million EUR, wood products (except paper) – 10 004 million EUR, paper and paper products – 4 771 million EUR</td></tr>
<tr><td colspan="2">Production volumes, 2019
Timber: 40.6 million m^3
Slash: 1.7 million m^3</td></tr>
<tr><td colspan="2">Sustainability
almost 7 million ha of forests hold the FSC FM certificate (75 % of forest area)
7.2 million ha of forests own PEFC FM certificate (77 %)</td></tr>
</table>

Table 1: Poland forests in facts.

The area of forest stands in ***Slovakia*** is 1,949,980 hectares (Green Report 2019)[7]. Between 1990 and2020, the average annual increase in forest area was 943 hectares. Besides the forests on forest land, also a part of

[3] Ibidem.

[4] Ministry of the Environment, Poland. Statement on the wood market review and prospects, UNECE Committee on Forests and the Forest Industry, 2020.

[5] Zajączkowski G., et al., Raport o stanie lasów… op.cit.

[6] Bidzińska G., Leszczyszyn E., Augustyniak D., Ratajczak E., Monitorowanie zmian w polskim sektorze leśno-drzewnym według standardów Komitetu leśnictwa i przemysłu drzewnego EKG ONZ w latach 2019-2021, Poznań 2020; Statistical Yearbook of the Republic of Poland 2020, Statistics Poland, Warsaw 2020.

[7] Report on the forest sector of the Slovak Republic 2019, GREEN REPORT (abridged version), Responsible organisation: National forest centre, Lead author: Martin Moravčík, Bratislava 2020

agricultural land is overgrown by forest (so-called „white plots“) in Slovakia. The total area of these plots is estimated at 288,000 hectares.

The forest cover, calculated as the percentage of forest land out of the total area of the Slovak Republic, reached 41.3 % in 2019 (based on the cadastre). If the area of „white plots“ was included, the cover would be 45.6 % ± 0.9 % (based on NFI results).The majority of Slovak forests are semi-natural.

Production forests are primarily managed for timber production whilst still providing other important ecological and social functions. High percentage of incidental felling (felling after natrural disturbances) results in lower volumes of high-quality log grades as timber is damaged. Protective forest are mostly available for wood supply, however, soil and water protection, as well as protection of other natural resources and infrasructure, represent their main fuction, which is reflected in the intensity of their managment. Special-purpose forests are the third, quite variable, category of forests, with main functions ranging from recreation to nature conservation. Part of them is also available for wood supply, though with many restrictions to felling.

<table>
<tr><td colspan="2">Slovak forests in facts</td></tr>
<tr><td>Forests
Slovak forests cover 1.95 million hectares – 41 % of the land area, 48 % of which is owned by state
Total growing stock is 483 million m³
Annual felling 9.2 million m³, 5.5 million of which is coniferous, 3.7 million broadleaved
Annual increment 11.9 million m³
Annually, 17 000 hectares of forest is regenerated, of which 59 % through planting</td><td>Economic significance and employment
Contribution of forestry to GDP was 0.65% in 2019, if hunting and other services are calculated, even over 1%.
Export value timber and paper, 2015; € 1.1 billion
Average annual income from forestry for forest owners, 2019: € 4.200
Total production value of timber and wood products through the value chain is approx. € 1.9 billion, or 2.6 % of Slovak total value creation</td></tr>
<tr><td>Production volumes, 2018
2.3 million m³ timber for pulp industry
4.7 million m³ sawn timber
1.2 wood-based pannels</td><td>Employment
53.000 employees in the forest-based value chain of which:
almost 20,000 employees in forestry
about 33,000 employees in forestry and wood-based industry</td></tr>
<tr><td colspan="2">Sustainability
1.2 million ha – 61.5 % of the total forest area - is PEFC-certified
0.1 million ha – 4.9 % - is certified by FSC
63 % of the forest land is included in protected areas, of which 3.6 % in strictly protected areas</td></tr>
</table>

Table 2: Slovakia Forests in facts

Ukraine is an agricultural-industrial country with relatively low forest cover (16 % of the country's surface, rank 34 in Europe). However, the country's total forested area of 105,000 km² is substantial when compared to other European countries (rank 9 in Europe).

Ukraine's forests contain mainly commercially important tree species that are useful sources of timber. The main species are Pine (Pinus sylvestris, 35 %), Oak (Quercus ssp., 26 %), Spruce, (Picea abies, 10 %), Beech (Fagus sylvatica, 9 %), and Birch (Betula ssp., 5 %). The largest continuous forest areas are to be found in Western Ukraine (incl. Carpathians) and the Polissya region (north-west, Figure 1). Ukraine's total stock is

estimated at 2.1 billion m^3 with an average annual increase of 35 million m^3, which largely exceeds the annual harvest of about 22 million m^3.[8]

The forests of Ukraine are distributed very irregularly over the country, the largest continuous forest area is concentrated in the Ukrainian Carpathians. Here the forest cover is 39 %, and average annual growth per hectare of forest land is 4.4 m^3/ha/y, thus the Carpathian forests produce about 9 million m^3 of wood annually. Current harvest in the Carpathian region forests accounts for 5 million m^3, or up to 60 % of annual increment. That means that about 25 % of Ukrainian wood resources are harvested in the Carpathian region of Ukraine.

Forest cover in different natural zones significantly varies and is considered as insufficient from the point of view of the optimal impact of forests on climate, soils, water resources, protection from erosion and provision of timber resources. More than half of the forests of the country are men-made (secondary stands) and need more intense care.

The forest cover is relatively stable and slightly growing due to afforestation measures. However, there are several factors that may have a large impact on wood quantity and quality in the future. These include the Ukrainian silviculture and timber harvest practices that continue to switch from mainly clear-cut harvesting to gradual and selective harvesting of the close-to-nature silviculture[9]. This, if applied, in the long-term future, may result in a better stability and quality of timber and continuous forest cover.

Another issue is the spruce and pine dieback that has a negative effect for some Ukrainian regions where spruce/pine are prevailing. Anticipative long-term silvicultural measures are needed and will prove decisive here, too.

Connected to these issues is the loss of about 190 km^2 per year of standing forest area (0.2 % of the total forest area) due to forest pests, diseases, fires, adverse weather conditions and other reasons. Also, as of early 2019, 4,000 km^2 (5 % of the total forest area) are affected from forest dieback. For the whole of Ukraine, 69 % of timber comes from sanitary cuts which impacts the quality of timber.

These three issues gain additional importance under the different climate change scenarios contemplated and are considered in the public reports of the SFRAU 2018[10] and SFRAU 2019[11].

The above mentioned close-to-nature silvicultural approaches are based on selective harvesting where the forest cover does exist continuously, the biotic diversity is preserved, the structure of natural different-age forests is recovered, the forest stand durability is maintained, and the timber is harvested in the amount equal to the annual increment. Based on the expert opinion, for the Carpathian region, an annual growth of 2.0-2.5 million m^3 of wood may be achieved by means of close-to-nature silviculture methods. Nowadays, one of the bottlenecks for wider application of close-to-nature silviculture is the low density of mountain forest roads and the limited use of the low impact harvesting machinery.

[8] SFRAU (2019):Public report of the State Agency of Forest Resources of Ukraine for 2019. State Forest Agency of Ukraine (SFRAU), https://drive.google.com/file/d/1UApjLM9DPt0MugIiiTWMbg4IXN8PAvWZ/view?usp=sharing.

[9] FORZA (2009): Cluster analysis of the forest sector of the Carpthian region of Ukraine. FORZA, http://www.forza.org.ua/sites/default/files/klasterniy_analiz_korotkiy.pdf.

[10] SFRAU (2018): Public report of the State Agency of Forest Resources of Ukraine for 2018. State Forest Agency of Ukraine (SFRAU), https://drive.google.com/file/d/194P-skQpV9fI1BOdYBGSKix_u1yHlfhQ/view.

[11] SFRAU (2019): Public report of the State Agency of Forest Resources of Ukraine for 2019. State Forest Agency of Ukraine (SFRAU), https://drive.google.com/file/d/1UApjLM9DPt0MugIiiTWMbg4IXN8PAvWZ/view?usp=sharing.

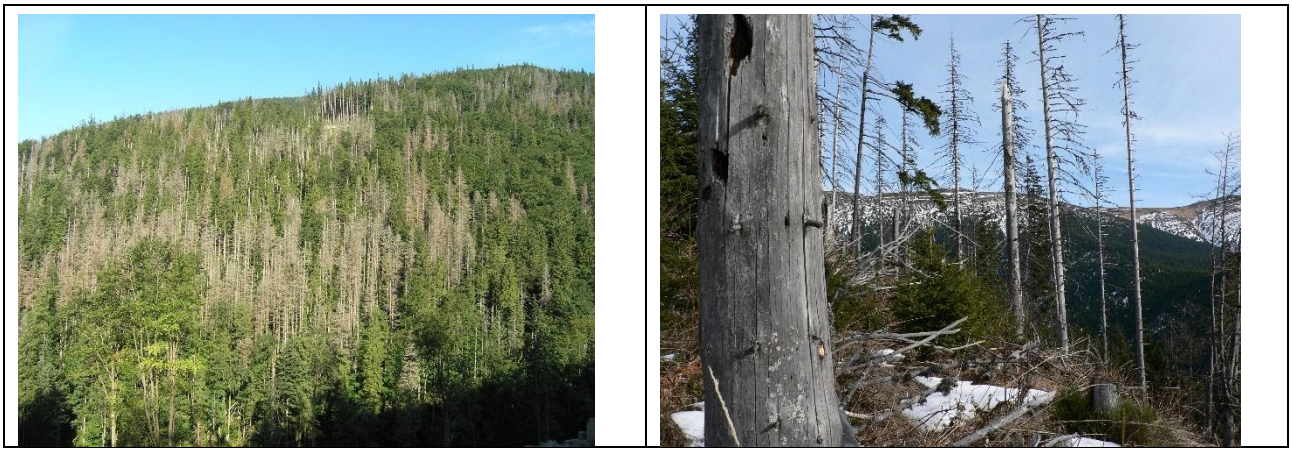

Image 1: Spruce dieback and windfall damage in Rakhiv region, Zakarpttiya, Ukraine. Photo source: FORZA.

Ukraine forests in facts	
Forests • Forest area of 9.7 mio. ha • Forest cover of 17 % (some regions up to 54 %) • Public forests (99 %), 73 % managed by the State Forests	**Economic significance and employment** • 60 000 employees in forestry • 112 000 employees in wood processing, furniture and pulp and paper • Total sales value of timber and wood products through the value chain is approx. € 4 029.2 Mio EUR billion, or 1.38 % of Ukraine's total sales
Production volumes, 2018 • 173 000 employed in forestry and wood based industries (2018)	**Employment** • 173 000 employed in forestry and wood based industries (2018)
Sustainability 4.49 Mio. ha or 43 % of the forest area of the country is FSC-certified (2020)	

Table 3: Ukraine forests in facts

Starting from the reality that the forest area in ***Romania*** covers 6,559 thousand hectares of the country's territory, in the context of climate change, forests play an important role, not only for capturing carbon dioxide, but also for biomass production and the potential they have for renewable energy.

Forests are important from a social and cultural point of view: they are attractive for the rural and urban population, they allow the development of recreational activities, are beneficial for health and represent an important cultural heritage. The forest industry has an important role in the national economy, both through the financial contribution at local and central level, but also through the provision of vital wood resources and wood products, absolutely necessary for the proper functioning of society and the state.

Romania has secular forests. The existence of secular forests in Romania and their lack in other states, especially in Europe, derives strictly from the way forests are managed, unchanged in our country in the last 100 years.

The forest area has not decreased in Romania, on the contrary, it is much larger than the area officially included in the forest arrangements in the national forest fund.

The average volume of wood mass / ha is 340 m3 / ha which is much higher than the volume estimated in the National Forest Inventory is 321.9 cubic meters / ha and much higher than the volume assessed according to the previous forest inventory in 1986, which figure average volume / ha at 217 cubic meters.

The annual legal volume exploited in Romania is 17-18 million cubic meters, firewood being considered an inferior assortment in terms of timber capitalization, only 5 million cubic meters of firewood resulting from the sorting of wood according to the laying acts worth. The direct contribution of the wood industry to the formation of GDP in Romania has been relatively constant in the last decade (ranging between 1.1% and 1.5%).

The forestry and wood processing sector contributes 1.7 billion euros to the state budget, when the direct and indirect effects on the economy are taken into account. Also, 128,000 people are directly employed in the sector, and another 186,000 people in related sectors. The wood processing industry contributes to employment in less developed areas, by creating production units

In Romania, rural development is a priority, and the contribution of the forest in the sense of this development is extremely important by providing jobs. The Romanian Government recognizes the forestry sector as an area of strategic interest. Therefore, the perspective for the future is to ensure a competitive development of the Romanian forest sector.

Forest management development is recently increasingly influenced by private forest owners, forestry faculties, forestry institutes as well as forest associations.

Romanian forests in facts	
Forests • Forest area: 6.9 million hectares • Forest cover: 30.12 % in 2018 • Public forests: 45 %	**Economic significance and employment** • Contribution to the Romanian GDP is 3.5 % • 18 million hectares extracted wood sold • 128 000 employed in forestry, 186 000 in sectors connected to forestry
Production volumes, 2018 • 1.94 thousand m^2	
Sustainability • 27,043 hectares forest regeneration out of which 17,972 hectares natural regeneration, 9,071 artificial regeneration	

Table 4: Romanian Forests in facts

2.1.1 Political targets for wood mobilisation and forestry

In *Poland*, the main document regarding forestry and setting the goals for its development, is the National Forest Policy (NFP, 1997), which includes priorities such as: conservation, protection, restoring and proper support of biological diversity, enhancing forest immunity to abiotic and biotic factors, maintaining and improving forest ecosystem services, promoting production and the use of wood, supporting private forest owners, forest education of society, and conducting forest research[12]. This document, however, has not been updated, and does not reflect current international trends and goals in policy[13]. This gap may be addressed by the National Forest Programme (under development) and the Regional Operational Programmes of National Forest Policy. Some of the priorities not included in NFP (e.g. forest adaptation to climate change, enhancing the role of forests and forests management in in mitigating climate change, increasing the role of forests and forests management in developing rural areas) may also be found in other policies in areas such as environment, biodiversity, climate change and energy, agriculture and rural development[14]. The Forest Act

[12] Polityka Leśna Państwa, Ministerstwo Ochrony Środowiska Zasobów Naturalnych i Leśnictwa, Warsaw 1997.

[13] Kaliszewski A., Forest policy goals in Poland in light of the current forestry aims in Europe. Part 3. European priorities for the forest policy in Polish programmes and strategies, Forest Research Papers, 2018, vol. 79 (3): 211-227.

[14] Ibidem.

(1991) specifies rules for maintenance, protection and increasing forest resources as well as forest management priorities in relation to other environmental issues and economy[15].

In 2007, *Slovakia* developed its National Forestry Programme (NFP) as the main strategic document for forests and forestry. There were two action plans to the NFP so far, the first one for the period of 2009-2013, the second for 2014-2020. At present, an updated NFP is being developed. The NFP is fully compatible with contemporary global and pan-European documents related to the development of national strategies for forests. It consists of five strategic objectives elaborated to 18 priorities, covering the whole spectrum of sustainable forest management. However, implementation of the action plans was quite formal, lacking resources and capacities for their promotion.
The Forest Act. Enacted in 2005, was regularly amended since then, the most recently in 2021, many amendments enforced by nature conservation development.
All the Slovak forests are managed based on forest management plans the, elaboration of which is coordinated and guided by the NFC. Their implementation is supported through certified forest managers (who are obligatory) and monitored by state authorities.

Ukraine needs to articulate its national forest policy and strategy[16]. The Concept for Reform and Development of Forest Management72, adopted in 2006, has become outdated and, aside from the Forest Code 2006, Ukraine lacks a written forest policy that lays out a vision for how the country's forests should be managed. The goals of forest management designed to meet economic, ecological and social objectives, and of diverse stakeholders, are not explicitly articulated and available in the public domain, nor are any specific metrics and indicators given that could be used to measure progress. There is a tendency to use short-term measures and blunt instruments, such as moratoriums, bans and decrees. Between 2015 and 2017, several attempts were made to agree on a forest policy, but they failed to materialize due to lack of consensus between all interested stakeholders. Another attempt to develop a Forest Strategy has started in 2021.
The core act, the Forest Code of Ukraine, was adopted in 1994 and revised in 2006. The Forest Code 2006 professes the economic role of forests as secondary to their protective and recreational functions.

Ukraine is highly vulnerable to the impacts of climate change and has identified agriculture, water resources, energy, transportation, health, the urban environment and forests, and coastal zone management as the key adaptation priorities. Ukraine's climate change legislation and regulatory provisions are scattered amongst several laws, resolutions and governmental decrees. The Government of Ukraine adopted the Concept on State Climate Policy Implementation until 2030 in December 2016 and the Action Plan to Implement the Concept on State Climate Policy in December 2017. The Low Emission Development Strategy (LEDS) of Ukraine until 2050 was adopted and submitted to UNFCCC in accordance with Paris Agreement requirements in 2018.The Law (adopted in 2019) on the Main Principles (strategy) of the State Environmental Policy of Ukraine until 2030 envisages, among others, climate change adaptation policies. Ukraine adopted a 2020 National Renewable Energy Action Plan in 2014, which sets a target to increase Ukraine's share of renewables to 11 % of total final energy consumption by 2020. The Law "On the Principles of Monitoring, Reporting and Verification of Greenhouse Gas Emissions" adopted in 2019 entered into force on 1st January 2021. The National Focal Point under UNFCCC is the Ministry of Environmental Protection and Natural Resources of Ukraine.

In *Romania*, the lack of a coherent and transparent strategy regarding the wood industry, the regulation of the industry by ministerial decisions, and the non-existence of a political agreement has brought the wood industry in Romania to a level where it is over-regulated but neither coherent with regard to a medium-term strategy nor based on a long-term strategy. There are some regional strategies, such as the one developed by the PRO

[15] The Forest Act, Journal of Laws 1991, No 101, Item 444 (as amended).

[16] Ukraine Country Forest Note: Growing Green And Sustainable Opportunities. The World Bank, 2020.

WOOD Cluster, for the Center region, but they only fulfil an advisory role for industry actors. By involving the profile faculties such as industry players in 2017, an attempt was made to develop a national strategy but failed due to frequent political changes.

From the point of view of climate change, the forest fund in some regions of the country is changing completely, new species appear instead of the old ones, which no longer have yield due to global warming. These changes are not addressed at all in the political representatives, they are regulated somewhat by the forest owners. The concept of sustainability is an unknown concept, not addressed by politics. A commission has been set up to address the effects of climate change, which must make proposals to reduce the effects of climate change.
The National Commission on Climate Change promotes the measures and actions necessary for the unitary application on the Romanian territory of the objectives and provisions of the United Nations Framework Convention on Climate Change, signed in Rio de Janeiro on June 5, 1992, ratified by Law no. 24/1994, with subsequent amendments, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change, adopted on December 11, 1997, ratified by Law no. 3/2001, as well as the provisions adopted at the level of the European Union and at national level.

2.1.2 Main actors in Forestry in the Central-East Hub

The main actors in the forestry sector in partnership countries of the CEE Hub are the following:

- Supervisor of the Forest Law
  - Poland: Ministry of Climate and Environment
  - Slovakia: Ministry of Agriculture nad Rural Development of the Slovac Republic
  - Ukraine: State Forest Resource Agency
  - Romania: Ministry of Environment, Water and Forests

- State Forest Enterprises:
  - Poland: State Forests, consisting of Directorate General, 17 regional directorates, 430 forest districts and 22 other organizational units, Bureau for Forest Management and Geodesy
  - Slovakia: Forest of the SR (895 thousand hectares, 32 branch enterprises + DG + Semenoles (reproductive material enterprise)), State Forest of Tatra National Park (38 thousand hectares), Ulič State Enterprise (25 thousand hectares), Military Forests (63 thousand hectares), forestry schools' forests (12 thousand hectares)
  - Ukraine: 310 state forest enterprises across Ukraine organized into 24 regional units (with administrative reform about to start in 2021)
  - Romania: Romsilva – Regia Națională a Pădurilor

- Forestry companies:
  - Poland: 2002 companies and 15839 natural persons conducting economic activity
  - Slovakia: the list of the most important private companies in forestry (mainly in timber felling) includes Prima Group Ltd. Trenčín, Lesinvest Púchov, Lesservis Ltd. Kráľova Lehota, Slovenská lesnícka spoločnosť Ltd. Banská Bystrica (activities include forest management planning), Euroforest Ltd. Zvolen (activities include forest management planning), Hard Forest Ltd. Lopušné Pažite, Data forest Ltd. Teplička nad Váhom, Lespro Ltd. Prešov, Lesprodukt Ltd. Hunkovce, Wood Working Ltd. Ružomberok, DR Drevo, Ltd. Banská Bystrica, Bio Timber Ltd. Lietavská Lúčka, L.S.O. Ltd. Bardejov, Forest Energy Ltd. Trenčín, etc.

- Ukraine: Ukrainian state forest inventory and planning production union "Ukrderzhlisproject", Ukrainian state planning and surveying institute of forest management "Ukrdiprolis", Kharkiv state planning and surveying institute of agro melioration and forest management "Kharkivdiproagrolis", State company "Forest management innovation-analytic center", State organization "Ukrainian forest breeding center"
- Romania: Frasinul Srl, Construct Muntenia, Prunus Forest, Aldona Forest, Marena Silva, Limsilva Forest, Est-Vest Forest, Austroforest International, etc.

- Forestry Associations, forest-focused interest groups:
  - Poland: Polish Union of Private Forest Owners, Association of Forest Entrepreneurs, Polski Związek Pracodawców Leśnych (Polish Union of Forestry Employers), Polish Forest Society, Stowarzyszenie Leśników i Właścicieli Lasów Prywatnych (Association of Foresters and Private Forest Owners), Association of Foresters and Wood Technologists, Stowarzyszenie Kobiet Lasu (Women of Forests Association), Towarzystwo Przyjaciół Lasu (Friends of Forests Society), Polish Hunting Association
  - Slovakia: Forestry Chamber, Union of the Non-state Forest Owner's Associations
  - Ukraine: All-Ukrainian Public organization Ukrainian Foresters Society, Forest Workers Trade Union, Hunters and Fishermen Society, Civil Society "All-Ukrainian Association of hunters and users of hunting lands", Agency for Sustainable Development of the Carpathian Region FORZA, Ukrainian Bioenergy Association, Association of protected areas of Ukraine
  - Romania: Romanian Federation of Forest and Pasture Owners – Nostra Silva, Romanian Foresters Association - ASFOR, Forest Managers Association - AAP, Professional Association of Forestry Service Providers - APPSS and Forestry & Fordaq

- Science, research and development:
  - Poland: Forest Research Institute, Łukasiewicz Research Network – Wood Technology Institute and universities
  - Slovakia: National Forest Centre, Slovak Academy of Sciences – Forest Ecology Insitute
  - Ukraine: Ukrainian Research Institute for Mountain Forestry (UkrRIMF), Ukrainian Research Institute of Forestry and Forest Melioration (URIF&FM)
  - Romania: National Institute for Research and Development in Forestry "Marin Drăcea", Faculty of Forestry and Forest, University of Transylvania from Brașov, Faculty of Forestry, University of Stefan cel Mare, Suceava

- Educational Institutes:
  - Poland: universities e.g. Poznań University of Life Sciences, Warsaw University of Life Sciences, Kraków University of Life Sciences, University of Warmia and Mazury in Olsztyn; 11 forestry technical secondary schools and a wide range of companies offering vocational courses
  - Slovakia: Faculty of Forestry of the Technical University in Zvolen, forestry apprenticeship schools and colleges, and specialised forestry colleges
  - Ukraine: 27 higher educational institutions including the leading Ukrainian National Forestry University (UNFU), National University of Life and Environmental Sciences of Ukraine (NUBIP), State Ecological Academy of Postgraduate Education and Management (DEA), Ukrainian Center for training, retraining and upgrade training of forest management staff (UkrCentrkadrylis)

- Romania: Faculty of Forestry and Forest, University of Transylvania from Brașov, Faculty of Forestry, University of Stefan cel Mare, Suceava

- Clusters and promotion organizations in forest-based industry:
  - Poland: The Polish Chamber of Commerce of Furniture Manufacturers, Polish Economic Chamber of Wood Industry, Wood Based Panels Producers Association of Poland, Association of Machine Manufacturers, Woodworking Equipment and Tools DROMA, The Polish Chamber of Biomass, Szczecinek Furniture Cluster, Polish Parquet Layers Association
  - Slovakia: Association of Wood Processors of the Slovak Republic, Pulp and Paper Industry Federation
  - Ukraine: Ukrainian Association Of Furniture Manufacturers, Ukrainian Association of Wood Processing Equipment, Wood Processing and Furniture Cluster Lviv, Ukrainian Association Of Window Systems
  - Romania: Pro Wood Regional Wood Cluster; Transylvanian Furniture Cluster; Carpathian Furniture Cluster, Association of Forest Administrators, Society for Forestry and the Environment

2.1.3 Structures of decision making

In *Poland*, the structure of decision making is centralistic. The majority of forests is managed by the State Forests, a self-financing organizational unit without legal personality, which consists of Directorate General, 17 regional directorates, and 430 forest districts. Additionally, there are 22 other organizational units, which perform auxiliary fincions, including[17]:

- State Forests Information Centre – promotion, publishing, website management;
- Coordination Centre for Environmental Projects – coordination of the environmental projects of the State Forests, implementing programmes for the Operational Programme "Infrastructure and Environment", analysing th eopportinities for financial aid for the forestry and wood sector;
- Forest Gene Bank 'Kostrzyca' – collecing and storing the gene resources of trees and shrubs, research on resource conservation, producing bioprobes;
- Forest Culture Centre in Gołuchów – operating the Museum of Forestry, education;
- Forest Technology Centre in Jarocin – producing forestry machinery and equipment.

In *Slovakia*, the Ministry of Agriculture and Rural Development of the Slovak Republic is the supreme national authority on forests. The largest state enterprise, the Forests of the Slovak Republic, manages 868,200 hectares of forests. The Union of the Non-state Forest Owner's Associations is the official body representing the interests of non-state forest owners including owners of private, municipal and church forests. The Slovak Forestry Chamber is a non-govermental association of individual foresters, forest owners and forestry legal entities that enforces and protects professional, social and economic interests of its members. In addition to the National Forest Centre (NFC), there are a number of other important organisations involved in forestry in Slovakia.

Most of the forests of *Ukraine* are publicly owned (99 %), with 73 % managed by the State Forest Resources Agency and the rest by a variety of other state agencies.
The State Forest Resources Agency of Ukraine (SFRAU) is the central executive body that implements state policy in the forest sector. 310 state forest companies across Ukraine organized into 24 regional units are in charge of managing these forests. The variety of roles (control, administration, legislation and management and commercial activities) carried out by SFRAU, its subordinate institutions and enterprises is noted to contain

[17] https://www.lasy.gov.pl/en/our-work/sf-national-forest-holding/organization [12.07.2021].

inherent conflicts of interest and is extensively prone to corruption. Calls for separating regulatory functions from the operational ones have increased within the government but also from the side of the private and NGO sector.

The political and decision-making system in *Romania*, regarding the wood industry is a very centralized one. The thawed ministry for forest management is the Ministry of Environment, Waters and Forests, which directly or indirectly manages 6.9 million hectares of forest of which 45 % is state, managed by Romsilva, which is the state institution and the rest of the private sector that manages based laws developed by the Ministry of Environment, Waters and Forests. They are organized in composesorates because there are many individuals who have come together to have a better representation at regional and national level. At the same time, in 2020, associations of composesorates were established, which ensure an even greater representation of private owners before the state. The control of the application of the forestry legislation is ensured by the Forest Guard, which has 10 subordinate regional offices.

2.2 Main Findings

2.2.1 SWOT Analysis

All four countries were first analyzed by the experts in national SWOT analyses and then merged into one joint SWOT analysis for the Central-Eastern Hub.

In *Poland*, the forestry and wood sector has a long tradition and a strong position in the national economy. Large and expanding forest area and growing stock volume result in a situation where wood demand is satisfied mainly by domestic resources. Polish forests are multifunctional and have widely implemented certification of forest management (FSC, PEFC). The majority of Polish forests is managed by State Forests, which employs highly qualified staff and implements modern information systems for forest management and planning. The market of forest services is well developed, as well as wood processing industries, which have a high production capacity and offer a diverse range of high quality wood materials and products. Some of the industries, such as pulp industry and wood-based panels industry, have a high level of production process automation. Cascading wood principles are widely implemented in the sector. Strong linkages with foreign markets provide high competitiveness of Polish wood processing industries.

In terms of weaknessess, a high fragmentation of private forestry as well as some industries (sawmilling, final wood products) can be observed which is coupled with a lack of trust and very few bottom up initiatives. In forestry, traditional silviculture is dominating and diminishing area of young forest stands is a growing concern. There are also significant regional differences in technological development, both in forestry and wood industry. The dominance of one wood supplier is resulting in insufficient competition on the wood market. Many enterprises in the sector lack innovation capabilities and readiness to implement 4.0 industry technologies (mainly SMEs) accompanied by insufficient investment in staff. As a consequence, they are competing on a basis of low cost and imitative solutions. Lack of value chain optimisation further restricts the opportunities for more efficient and environmentally sound production. Additionally, lack of data on wood recycling is impeding the development of post-consumer wood market.

The main opportunities lie in the growing social awareness of the importance of the green, sustainable economy and the development of digital technologies in the forestry and wood sector. A growing machine fleet and the development of forest infrastructure will make forest management easier. In the primary and secondary wood product industries the main drivers are new material-efficient technologies and new types of high value addedd wood materials and products as well as new applications of wood. It is expected that the stable development trend of industries upstream (wood materials) and downstream (costruction) of the value chain will continue in upcoming years.

There are also many threats to the sustainable wood mobilisation in Poland. One of the most serious threats is the adverse impact of climate change on forest coupled with slower than expected implementation of climate mitigation and adaptation policies. An important barrier for the forest services and industry are labour shortages and growing costs (of transport, storage, energy etc.). Other threats are enhanced competition for wood resources and the lack of an effective system of collecting, processing and managing wood waste (mainly post-consumer wood). Overexploitation of production function of forest may, in turn, lead to imbalance in forest ecosystems and decrease in the sustained provision of ecosystem services. Ineffective transfer of knowledge and poor industry-science cooperation will impede the innovation ability of forestry and wood enterprises in Poland. In the context of digitalisation, the inadequate security measures of information systems may be a concern. Finally, adverse economic conditions (related to e.g. the slowdown caused by the coronavirus pandemic) and an unfavourable business environment (e.g. complex and unstable legislation) may further hinder the development of the sector.

Slovakia has a long tradition in forestry, however, some trends of the 19th and early 20th century influenced the forests to a lesser extent than in western countries (e.g. the establishing of spruce monocultures). Thanks to this, Slovak forestry has been close-to-nature, in a way, before it became an international trend. Tree species composition is rather diverse, mostly suited to the site conditions. Scientific knowledge and professional skills in forestry are at good level. Forest area and growing stock are quite high and both have been slowly increasing during the last decades. Forest road network is quite dense (except mountain areas). Despite climate change, climate is still favourable for forestry.

Though forestry machinery is broadly used, opportunities include its modernisation and increasing its numbers, especially of cable systems. Further development of forest road network will be necessary for a broader implemantation of close-to-nature forestry practices. Optimisation of legislation (buerocracy reduction) and improvement of cooperation within forest-based sector can be also helpful.

Though 40% of forests is owned by the state, the ownership of the rest is quite scattered, with a number of small owners, which can be considered one of the weaknesses. Almost 51 % of forests is managed by the state companies, however, one fifth of this are forests of unknown owners management of which is restricted. Cooperation of non-state forest owners and their associations is insufficient, as well as their cooperation with related industries. Much of the forests are located in protected areas, the protection of which is steadilly becoming more restrictive, forming thus an unpredictable economic environment. The legislative system of nature conservation is overcomplicated. Average annual area damaged by natural disasters (mainly wind and snow) and, subsequently, by pests, has been quite high in the last decades, resulting in a high proportion of salvage cuts (with negative impact on wood quality). Terrain conditions of many forest stands are quite demandig, requiring proper technologies. Valorisation of harvested wood is insufficient. Valuable log grades are often not identified, at least not by foresters (80 % of wood is bought by trading companies). Rather obsolete machinery in forest felling further limits possibilities for the improvement of this situation. This reduces the possibilities for growth of revenues from wood as well as for overall improvement of forestry economics.

The list of threats include climate change with its negative influence on the frequency and severity of natural disasters and the proportion of salvage cuts to planned cuts. Proportion of spruce and other conifers is declining that may result in discrepancy beween wood supply (both quality and species structure) and demands of domestic wood-processing industries. Insufficient maintenance of forest roads represent another threat. Competitiveness of wood sector is rather low, except multinational companies such as MONDI, KRONOSPAN, due to fragmented capacities and lack of financial resources. Implementation of research results and guidelines into practice is many times slow and insufficient.

Ukraine has various high production forests with stable or expanding forest area and growing stock volume. At the same time, climate change and illnesses affect the stand stability and productivity. To add to this, dominating state forest compnies have outdated and worn-out logging equipment and missing forest

infrastructure. The mentioned factors have a significant negative effect on the quality of the felled timber, with pulpwood and fuelwood accounting for some 50 %.
The analysis shows that accessing forests (in terms of transport, technology) is regarded as a key opportunity that cannot, however, be solved without major infrastructural investments. Public finance of the forest sector is extremely low and state forest enterprises largely do not make sufficient profit and pay very high taxes, struggle to fulfill the expectations of delivering on both, economic and environmental goods and services to the country.

Improving the capacity to adapt to climate change is on the agenda of the European Union and Ukraine is beginning to understand the necessity of the climate adaptive silviculture, which is seen as an opportunity.

The wood industry is shaped by many smaller companies which is regarded as a disadvantage and results in high competition for timber as raw resource and thus limited processing efficiency. At the same time, a number of companies in Ukraine offer quality wood products from certified forests (44 % of Ukraine's forests are FSC certified as of 2020) and have good potential to expand their range of exports from lower to higher value added products (technical wood products like particleboard, flooring, laminated products, veneer, cross-laminated timber, pellets, construction timber etc. as well as furniture).

Gaps in the value chain particularly concern manufacturers of state-of-the-art timber construction elements and recognition of wood as a modern building material. The booming wood construction sector in the EU and globally has the potential to further increase the demand for respective products. Sensibilisation campaigns / state programs like "Building with Wood" or "Circular economy" can be indirect ways of supporting growth.

Identified strengths of ***Romania*** are a long tradition of sustainable and close-to nature forest management and wood production. Furthermore, high quality raw wood material represents a high production potential for meeting the demands for high-quality products. At the same time, challenges arise from fragmented forest properties and lack of private forest owner's management knowledge. This situation results in low productivity and low competitiveness of SMEs due to lack of modern technology and equipment use which represents the challenge for the CEE Hub. The region's analysis detected a low level of wood sector support along with a low level of participation in business cooperation structures and research, development and innovation (RDI) which limits the options for technology transfer and cooperation.
Opportunities were identified in the development of regional business models for creation of local forestry value chains along with the development of silvicultural policies supporting local value chains for smart and sustainable use of forest resource. More potential and knowledge could be generated by strengthening forest owners' associations and cooperation activities. They might be further empowered by improved cooperation between industry and research and development (R&D). Moreover, development and modernisation of the technology and use of modern techniques/practices will improve the knowledge transfer and social networks/digital facilities for information sharing (study circles) aiming at the development of the sector.
Finally, the threats are seen in the low level of exploitation of forests and increase of non-farm forest owners. Foreseen insufficient cooperation between forest stakeholders and cross-sectoral cooperation, will not enable the region to face the international competition with producers from low labour costs countries. Moreover, it is anticipated that lack of ecosystem understanding will additionally burden the sector.

Below the consolidated SWOT of the CEE HUB as prepared and validated by the Rosewood4.0 experts from four countries is presented:

STRENGTHS	WEAKNESSES
• Various high production forests with stable or expanding forest area and growing stock volume	• High fragmentation of private forests, which makes sustainable forest management more difficult.

• Transition to 'close-to-nature' forestry is being rolled out in some countries/regions, though not entirely in a strategic manner • Good levelof scientific and professional knowledge in the filed of forest management (mostly in State forests) and wood industry • High share (except UA) of mechanised wood harvesting, with the use of modern and highly efficient forest equipment in state forests and big companies • Relatively well developed R&D base focusing on wood harvesting innovations (except UA) • Creation of renewable energy market • Good to high levell of digitalization in forestry (mainly State forests) with the use of advanced IT systems and detailed data regarding wood flows • Online wood sales or online auctions in State Forests • Digital solutions n forestry applied mostly in inventory, public data on forests and trade • Wood sector is well diversified and includes a plethora of products • Exports of low value-added forest-based products very strongly exceed imports, export of pellets strongly exceeds imports • Increasing awareness of wood producers related to the concept of circular economy, implementation cascading wood use principles	Incomplete (based on estimation) data about wood harvesting in private forests • Insufficient use of modern mechanisation and technologies • High calamity share • Conservative approach to forest management. Slow implementation of new knowledge • Poor "climate adaptive thinking" and "going digital" thinking of forest authorities and decision makers • Unfavourable changes in forest age-class structure – diminishing area of young forest stands as a result of the reduction in forest regeneration and afforestation intensity, and decrease of final felling (PL) • Outdated and worn-out logging equipment and technologies • Low level of cooperation among actors along the value chain • Lack of digital skills among private forestry owners • Dominance of traditional (non-digital) logistic solutions in sawmill industry (main recipient of wood); low level of digitalisation of business processes, especially in SMEs • Lack of value chain optimisation (from the forest to the sawmill); rich data and well-developed information system in State Forests used only for the internal purposes of this enterprise • The sector has received widespread negative media attention in the last couple of years, mainly regarding allegations of illegal timber exports (UA) • Under-utilisation of wood waste from harvesting and fuel wood. High logistical costs of woody biomass / residues collection, handling and transportation • Wood Processing, 1ST: Low-tech, mature industries with lower technological innovation capabilities • Limited resource and energy efficiency at 1st stage wood processing • High focus on export of wood in the rough or sawn wood vs processed goods • Wood industry: limited strategic orientation and planning • Missing to average quality infrastructure (standards, certification, testing) impacting competitiveness on the EU and global level, except Poland • Lack of essential infrastructure such as the forest road network and harvesting machinery (UA) • Deficit of skilled workers and qualified middle management staff (also because of job migration) • Lack of readiness of the majority of the enterprises to implement Industry 4.0 technologies, low efficiency of Industry 4.0 supporting programmes and limited financing of digitalization • Ineffective knowledge transfer between science and industry

	• Lack of long-term promotional strategy of forest and wood products, strengthening their competitive position against non-wood substitutes • Low focus of value added production for many wood products • Low demand for innovative products and technologies on domestic markets • Low interest of young people in forestry careers • VET and higher education lagging behind requirements of time
OPPORTUNITIES • Improving capacity to adapt to climate change is on the agenda. Climate adapted silvicultural solutions are starting to be discussed • Development of digital technologies facilitating forest management in all types of forests (remote sensing and teledetection, mobile apps for localisation, land plot identification, collection and transport of wood etc.) • Growing social awareness on the importance of green economy • VET and open courses to enhance harvesting skills, incl. for machine operation • Improvement of curriculum by introducing modern technologies (e.g. e-learning) • EU-financed projects improving forest infrastructure are starting • Increasing demand for wood materials, incl. demand from construction sector • Development of new types of wood materials and their applications (e.g. glued timber) • Development of networks and digital tools for information exchange • New circular economy policies, Green Deal, and policies promoting low-carbon technologies	THREATS • In the short and mid-term period, the climate change is expected to negatively affect the tree growth, tree regeneration and tree mortality and will require anticipative long-term climate-adaptive silvicultural measures • State forest enterprises largely do not make sufficient profit to buy sophisticated machines. They also tend to adhere to traditional harvesting approaches • Labour outflow from the forest services, lack of or insufficient interest in working in forestry (especially among young people) • Lack of or inadequate safety of information systems (cybersecurity) • Lack of adequate and predictable financing for afforestation and modernization of the sector • Lack of fiscal measures, incentives for digitalized and eco-friendly transports • Economic downturn (as a result of, inter alia, coronavirus pandemic), resulting in slowdown in the construction and furniture industry growth, which are main buyers of wood materials • Strong substitution of wood materials by non-wood alternatives, such as plastic, glass or concrete • Enhanced competition on the high processed wood products market from EU and other countries, such as China • Insufficient financing of innovative research, poor science - industry cooperation in innovative solutions implementation • Slower than expected implementation of the climate policy; lack of support of key economies for the international climate policy targets (USA, China)

Table 5: Consolidated SWOT of the CEE HUB

The main points for the Central-East Hub SWOT are summarized below:

The CEE Hub countries are rich in forest resources, and the forest cover is generally increasing. All four countries have a long history of forest management and strong state institutions following scientific methods with detailed forward planning directed toward the maintenance and expansion of forests. The underlying principles of forest management in most countries are multifunctional and sustainable forest management, combining protective, productive and social functions (mainly in State Forests). The Forest Code 2006 in UA,

however, professes the economic role of forests as secondary to their protective and recreational functions. The transition to 'close-to-nature' forestry is being rolled out in some countries/regions, though not entirely in a strategic manner. Forests in all the countries are largely certified and operated under certified environmental management systems.

The region has various high production forests with stable or expanding forest area and growing stock volume. At the same time, climate change and disastrous weather turbulences decisively alter the forests' structure, stability and productivity. Other weaknesses are seen in unfavorable changes in forest age-class structure – diminishing area of young forest stands as a result of the reduction in forest regeneration and afforestation intensity, and a decrease of final felling. The combination of planned felling and felling in response to pest, disease and general dieback is significant and rising. Climate-adapted silvicultural solutions that are starting to be discussed and are gradually embedded into the national strategies, forest subsidies, funds and accurate forest inventory data as well for the private forests offer some of the tools to tackle those problems.

Public sector financing of forests is very low. The exception is Poland where the State Forest is a self-financing entity of a good financial situation, however, the private forests remain underfunded. There is potential for raising private financing for conservation and afforestation programmes which needs to be carefully explored.

Woodworking has a long-established tradition and is an important pillar of the economy of the four countries. Wood based companies (mostly small and medium-sized) produce a plethora of products, among others various categories of furniture, construction elements such as glued laminated timber and windows, semi-finished products such as furniture parts, wood-based panels, as well as pulp and paper. Very strong wood industry with value added production can be found especially in Poland.

CEE Hub countries are exporters of primary and secondary forest products. One of the key challenges for the industry is to increase the production of high value-added wood products, including furniture. Development of new wood-based products and their applications (such as glued timber, chemically- and thermally-modified wood) offer huge opportunities to the industry and for the circular economy. Concerning the development of new products, there is a need for a stronger cooperation between research and industry.

Some challenges vary from country to country. Whereas in PL, SK and RO there is a relatively good network of forest roads and a high share of mechanized wood harvesting, with the use of modern and highly efficient forest equipment in state forests and big companies, mountainous UA regions often lack essential infrastructure such as the forest road network and harvesting machinery, leading to higher logistical costs than elsewhere.

In the conditions of scarce financing of forest infrastructure, opportunities have been identified in broader application of modern software facilitating navigating and working in the forest. The sector could take advantage of modern remote sensing and planning software for quantitative techniques to improve accuracy and efficiency of survey and management planning, reporting data for all forests irrespective of ownership. Interdisciplinary co-operation is required to gain all the possible benefits of digitalization in the future.

It has to be seen though to what extent the private forest owners and sawmill industry can uptake the digital solutions and whether exchange of information between State Forest as wood producers and sawmills through electronic communication means would be implemented rather soon.

Forestry in all four countries each has a specific feature: the share of forests or forest industry in the state economy may not be high, but the forestry sector plays an important role for rural development and rural employment. All four countries strongly agree that there is a need for a long-term promotional strategy of wood and wood products, strengthening their competitive position against non-wood substitutes. Some

enabling factors and exploitable opportunities concern the new circular economy policies, Green Deal, and policies promoting low-carbon technologies. Development of wood construction sector in EU and globally is also expected to increase in eco-awareness of consumers and producers and to further increase demand for respective wood products.

These trends are also seen as the ways to spruce up the forest education. The forest education in the four countries is of relatively high quality and has strong scientific traditions. However, all four countries agree that VET and higher education are lagging behind the requirements of time and young people are generally not interested to pursue forestry careers. With new kinds of solutions utilizing digital technologies, education is nowadays more accessible to everyone regardless of the place of living or the life situation. Improvement of curriculum by introducing modern technologies (e.g. E-learning) and developing new targeted short training programs for forestry professionals could be ways to get young people interested in forestry, improve labour market conditions and contribute to the steady growth of qualifications and competences.

2.2.2 Best Practices and innovations identification

Screening of Best Practices and Innovations (BPI) in Poland, Romania, Ukraine and Slovakia has been carried out through desktop research supported by expert interviews. The result is a list of 51 best practices and innovations (BPI) of the CEE Hub that has been scrutinized internally by each hub member agains the criteria of effiency and potential for region. Thus, a **shortlist of 14 resulting BPI** has been compiled. BPI are quite evenly distributed between countries.

- Forest stock market e-drewno.pl, Forest Data Bank, REMBIOFOR, SAT4EST, Timber Inventory System (PL),
- TimFlow, Forest Radar (Radarul Padurilor), Build in Wood (RO),
- LignoSilva INFRA, e-LOS, ATBIOMAP, reFlex (SK),
- Electronic Timber Tracking, RE-leaf paper (UA).

Country	*BPI Title*	*Description*
Poland	Forest Data Bank (BDL)	Forest Data Bank (Bank Danych o Lasach) is a data warehouse collecting, processing and sharing information concerning forests of all ownership forms in Poland. Data Bank provides both descriptive and geo-referenced spatial data, through web portal and mobile app. Available data cover forest stand and statistical unit description, forecasting and additional information such as: forest protection, fire protection, nature conservation, environment monitoring, hydrology, climatology, geology, nature and forest regionalisation, forest functional areas, seed regionalisation and National Register of Boundaries.
Poland	Earth observation based service supporting local administration in non-state forest management (SAT4EST)	SAT4EST is a R&D project funded by ESA (European Space Agency), aimed at the development of the non-state forest focused service dedicated to the local government administration (on NUTS-4 level). The aim of the project is to deliver a simple, intuitive and low-cost tool in a form of web-based application, integrating satellite and other data and allowing for calculating statistics over a given area and generating simple reports.
Poland	Timber Inventory System (TIS)	Timber Inventory System is a wood tracking system which supports the elimination of illegal logging. It is based on a range of products and solutions already available on the market, which are further developed and seamlessly integrated into one system. The purpose is registration of activities related to the

		wood (including harvesting and transport), providing reliable information about the harvesting, seller, buyers and institutions responsible certification and control of chain of custody.
Poland	Forest stock market e-drewno.pl (e-drewno.pl)	e-drewno.pl is a sales platform, enabling customers to take part in a wood sale auction in a forest district online. The system has been operating since 2005 and it has been implemented in all forest districts in Poland. Currently 20% of timber harvested by the State Forests is offered on auctions on e-drewno.pl.
Poland	Remote sensing based assessment of woody biomass and carbon storage in forests (REMBIOFOR)	REMBIOFOR is a R&D project, which aim is to work out the complex method of defining selected forest stand descriptions as well as aboveground biomass and carbon sequestration, based on the use of remote sensing for the purposes of forest management planning. The project activities included i.e. determining the amount of biomass and carbon in the forest based on radar data, development of methods for the inventory of selected stand descriptions, growing stock and biomass with the use of active remote sensing techniques, local correction of dendrometric volume equations based on terrestrial laser scanning data (TLS) and development of the merchantable volume conversion factors into biomass and carbon.
Ukraine	Electronic Timber-Tracking https://open.ukrforest.com/	Electronic timber tracking is a single electronic register of Ukrainian timber. Permanent forest users are obliged to electronically tag each log (or in case of firewood each batch) enabling to establish the legality of its harvesting, namely: description of the log, place and time, name of the team that carried out the procurement, transport document. Thus the system digitally represents the supply chain from forest to the buyer at the first processing facility. Electronic timber accounting has been implemented in Ukraine in phases since 2009, and is still running. At first the system was used only by permanent users under the State Agency of Forest Resources of Ukraine (SFRA) and since 2020 it becomes obligatory to all permanent forest users in Ukraine. Technology, equipment and software come from Latchbacher (AT) and are adapted to the Ukrainian conditions. For foresters, as key users, the system decreases the time to register, process and report on sales of unprocessed timber. At the same time, it is also freely accessible for the general public on the website. Anyone can track the legality of timber origin knowing the number of the tag, or invoice number, or truck license plate. As of December 2019 electronic timber tracking is carried out by 504 enterprises (incl. 297 enterprises of the SFRA). Ministries and agencies are also connected to the system for control and information exchange purposes. In total, more than 3,700 mobile users are connected.
Ukraine	Re-Leaf paper https://www.re-leaf-paper.com/	Production of paper from fallen leaves. Has been tested for production of packaging paper, is still at its pilot phase. RE-leaf scales the process of pulp production, which is based on the use of fibre from fallen leaves and in the future other types of fibre from agricultural waste. RE-leaf significantly reduced energy consumption due to a simplified method of fibre extraction, water consumption was reduced by 15 (!) times and all processes are based on the use of chemical reagents free of

		sulfates, sulfites and chlorine, compared to conventional pulp production processes. The product created brings what was once considered waste back into the economic cycle and is itself recyclable. This provides RE-leaf customers with a guarantee that the company is not sourcing from controversial sources. RE-leaf PAPER is made of fallen leaves coming to the enterprise from cities. This makes it possible to solve the problem of the utilization of plant waste in the urban ecosystem and preserve the integrity of forest ecosystems.
Romania	Timflow Woodtracking	Timflow is a traceability system based on GPS tracking of saw log deliveries. At present, you can check all saw log deliveries to HS Timber Productions's mills in Romania. Timflow is: • a wood traceability monitoring system, which can be accessed online or on a mobile device by anyone; • each truck is equipped with a GPS device, to register log transportation routes; • after setting up an account, a calendar date and an unloading location can be selected; • the application offers access to photos of the loads and the option to request copies of the transport documents.
Romania	Radarul Padurilor Romania	InspectorulPadurii.ro is a measure of the Ministry of Environment, Waters and Forests together with the Romanian Government to make transparent the activity of exploitation - transport of wood from Romania. At the same time, this portal is an automatic method for identifying illegally cut timber transports from Romania. Users are able to observe alerts from satellites indicating information and once every few days (between 2 and 7 days depending on the satellite) any change in the aerial image associated with the forest vegetation in Romania. The portal also accesses the SUMAL database of the Ministry of Environment, Waters and Forests in real time. From this database, information is extracted to be processed in the internal system, about the enhancement documents, the locations where the timber transports are loaded and the information related to these points.
Romania	Build-in-Wood Horizon 2020 project	The construction industry has a significant environmental footprint. It is a substantial contributor of greenhouse gas emissions. These harmful emissions can be minimised by optimising the use of environmentally-conscious construction resources. The EU-funded Build-in-Wood project will develop a sustainable and innovative wood value chain for the construction of multi-storey wood buildings. It will develop the materials and components as well as structural systems and façade elements for multi-storey wood buildings for both new construction and retrofitting applications. The project will deliver a Design Guide – a dynamic co-created online toolbox of documented materials and components. At the end of the project in 2023, it will have demonstrated full-scale digital case projects and a test system for prototypes.

		Main project objectives: • To make wood a natural choice of building material for the construction of multi-storey buildings • To decrease GHG-emissions of the European building sector • To establish an innovative and sustainable European value chain for multi-storey wood buildings • To improve the connection between rural and urban areas and to contribute to sustainable urbanisation • To increase productivity of the building sector
Slovakia	3D CT scanner for wood fault detection	Implementation of 3D data collection system for the needs of forest management management decision-making in the production-production process. LignoSilva focuses on implementation of the **3D scanner** into the chain of production and processing of wood in sawmills. The scanner digitally reconstructs the internal features of the log allowing the assessment of the optimum cutting solution in real time. **Laser cutting technology** allows optimized cutting solutions based on the highest resale value of final products. These unique technologies will be interconnected in a fully automated production line. Full use of innovative initiatives also entails the establishment of a long-term link between forest management and processing capacities of the region. Domestic sawmilling in recent years processed an average of 4.5 million m3 industrial roundwood. Waste generated in sawmilling in the amount of around 1.3 million m3 (29 %). Applying the pilot line (3D scanner, 2D scanner, laser cutting) for hardwood production, it is expected that the yield of 1 m3 would increase from 71% at present to 90% for lumber, and from 45% to 60% for final products. **Objectives** • Demonstrate an establishment of pilot line of innovation technologies (3D scanner - 2 D scanner - Laser cutting) as a model case for sawmill companies. • Demonstrate assortments innovative practices and handling of wood as a necessary basis for an increase yield of wood logs to maximize revenues from the sale of wood. • Improve and deepen the knowledge of producers and processors of wood in optimizing the yield of raw wood assortments.
Slovakia	Interactive atlas of biotic agents affecting forest tree health	Advisory and expert services in forest protection against biotic pests, pest mapping and forecasting of their population development, monitoring of invasive biotic pests, sanitary measures development Sustainable wood production is more and more influenced by various pests and dramatically affected by large scale calamities connected with climate change. New, invasive insects, diseases and more frequent extreme weather events (windstorms, drought and snow) cause large economic losses and often irreversible changes to local and regional biodiversity.

		FPS will offer an expert knowledge base for innovations in pest risk management. There is lack of general knowledge about harmful pests, and lack of detailed information about its spatial distribution and about control methods against them. Sustainable wood production is more and more influenced by various pests and dramatically affected by large scale calamities connected with climate change. New, invasive insects, diseases and more frequent extreme weather events (windstorms, drought and snow) cause large economic losses and often irreversible changes to local and regional biodiversity. FPS will offer an expert knowledge base for innovations in pest risk management. There is lack of general knowledge about harmful pests, and lack of detailed information about its spatial distribution and about control methods against them.
Slovakia	Advanced Techniques for Biomass mapping in Abandoned Agriculture Land using Novel Combination of Optical and Radar Remote Sensing Sensors	Identification of long-term unused agricultural land, quantification of growing wood biomass for management of this land (AAL) The necessity to address and to handle the proposed themes is given by the fact that after years of disinterest in the AAL, the biomass growing there became the topic of a wide discussion. The reason is first of all harvesting of timber for combustion in biomass facilities. Timber harvesting has been spurred by broader strategic decisions. The EU has set in its strategy Europe 2020 the aim to increase the share of energy produced from renewable resources to 20% and the Slovak Republic committed itself to produce 14% of energy from renewable energy resources. The necessity to know the status of forest biomass on AAL also ensues from the commitment of precise inventorying of greenhouse gasses in the sector of land use and forest economy. The Framework Convention of the UNO also imposes to countries the duty to prepare and maintain accounts of a sector of the Kyoto Protocol LULUCF (Land use, Land Use Change and Forestry) according to Article 3 of the European Parliament and the Council of the European Union No. 529/2013/EU and the Annex to the Kyoto Protocol. Users – Decision making sphere: • Ministry of Agriculture and Rural Development of the Slovak Republic • Ministry of Environment of the Slovak republic Other potential customers: • Producers of energy from wood biomass • Land owners and managers • Nongovernmental organisations Products and services with potential of commercialisation • Derivations of the stock and biomass increment on AAL • Derivations of harvesting amounts/rates on AAL • Inputs for projects of construction of new capacities producing the renewable energy.

Slovakia	Remote Forest Land explorer	Contactless survey of forest and non-forest ecosystems. Determination of dendrometric parameters of trees, state of forest transport network.

Table 6: Selected Best Practices & Innovations identified within the CEE HUB

2.2.3 Needs analysis

The following needs and problems have been identified in the four countries of the CEE Hub:

One of the main needs identified in ***Poland*** is strengthening social capital, encouraging and supporting the creation of sustained and effective cooperation networks, including bottom-up network initiatives. Networks would help to overcome, at least partially, weaknesses connected to high fragmentation of wood industries, which results in low innovation and financing capabilities. Ensuring additional sources of financing, the implementation of digital solutions (including Industry 4.0) and developing digital skills is equally important. More effective transfer of knowledge between science and industry and changes in competitive strategies of the companies would contribute to the creation of more innovative solutions, rather than imitative ones. In forestry, the predominance of traditional silviculture, based on substantial human intervention in the process of forest growth is observed, modernisation in terms of technologies and methods of wood harvesting would be also beneficial. Last, but not least, post-consumer wood market in Poland is underdeveloped and an effective system for collecting, processing and utilisation of wood waste (both for material and energy purposes) is needed.

In **Slovakia**, digitalisation of information systems of forestry non-state forest owners and contractors needs to be promoted and broader implemented. Furthermore, the possibilities to improve the readiness of forestry practice to absorb and implement new developments and technologies should be investigated and addressed.

Cross-sectoral cooperation, especially this between forest (agriculture) and environment sectors, has to be improved, conflicting issues need to be identified and solved.

There is a need to search for financial resources to increase investnents into forestry machinery and new technologies, especially in felling and skidding operations.

In addition, valorisation of harvested wood should be increased via the use of new technologies and improvement of forest stand management.

In ***Ukraine,*** both forest companies and industry are in need of a predictable forest policy, with support and clear messages from the state demonstrating support rather than excessive bureaucratic restrictions. Both forestry and wood-based insutries feel the deficit of skilled workers and qualified middle management staff (also because of job migration) especially when it comes to implementing modern technologies. Addressing the gap between education, training and industry uptake, improved curriculum in wood and forest professions is regarded as a big current need. Construction of new and maintenance of existing forest road networks leading to a higher road network in Ukraine is mentioned as a top enabling factor to secure access to timber and transportation possibilities. In addition, the wood-based industry needs a stable, year-round access to timber with stable timber prices from forest companies.

In **Romania**, the fragmented forest properties have to be channelled into associations in order to increase the capacity for optimized management and innovations. The low competitiveness of the wood processing industry can be improved by investment in innovative SMEs. Based on the needs identified, it would be apropiate to create centres dedicated to technology transfers for the SMEs in the wood sector, in order to increase their competitiveness. Encouraging the participation of SMEs in national and international business cooperation structures is also needid, given the fact, that the sector is mostly characterized by tradition.

A significant problem is on policy level in Romania. To make the sector even more attractive and good working, there would be an urgent need to refresh and improve the national policies and lack of incentive schemes and subsidies. In order to solve issues related to the need of increasing competitiveness of the sector, there is need to provide specific trainings and professional knowledge for private forest owners in forest management. Last, but not least, there is need to increase the productivity at small enterprises by investments in modern technology and equipment. Increase the access to finance for these companies.

2.3 Development targets for sustainable wood mobilisation

The main development targets for the forestry-wood sector in *Poland* are:

- More cooperation in forestry and in wood sector, both between private companies, as well as public entities and research organisations, including development of new networks and clusters;
- More innovations in forestry and in wood sector, increased use of digital technologies, increasing the value added in manufacturing wood materials and products and contributing to more sustaiable forest management;
- Building the effective market for recycled and post-consumer wood

For *Slovakia,* the development targets include:

- Exploit the forest-based sector's great potential regarding the cascading use of renewable raw materials to produce a wide range of innovative value-added products, managing natural resources sustainably, mitigating climate change
- Reflect the global trends and structural changes within the European forest industry - SK National Support Group of Forest-based sector Technology Platform, to become more complex sector, cross sectoral, interlinked
- Improve support for innovation by strong encouragement for public and private sector cooperation focusing on knowledge transfer between companies and industries
- Provide clear policy support, capacity building for continued progress by structuring research, innovation, education, market contitions
- Explore the full potential offered by resources and the ways in which their utilization as primary raw materials can be embedded in policy-making, industry´s ways of working and society expectations
- Seek environmental sustainability and resource-efficiency as necessities

In *Romania,* the development target encompass:

- improved use of local wood and establishment of the local value chains from the tree in the forest all the way to the final products with high added value. The local wood for local use is a precondition for a strong local forestry value chain which ensures a strong local bio-economy, contributing to a strong regional, national and European economy.
- improved cooperation between forest owners/stakeholders followed by stronger national (political/ financial/ policy) support to forest associations are essentials. Development of silvicultural policies towards creating local value chains for smart and sustainable use of forest resources, along with digitalisation and modernisation of the forestry and wood industry mechanisation will ensure improvement of sustainable wood mobilisation.
- digitalisation and modernisation of mechanisation followed by enhanced forestry stakeholders' skills through social networks and knowledge transfer. Development of alternative sources of wood is seen as a potential wood mobilisation measure by expert stakeholders but still not recognised by the governments and ministries. Therefore, actual supporting programmes are still required.

Main development targets in *Ukraine* include:

- The separation of policy, enforcement and commercial functions in Ukraine's forest sector between institutions to avoind conflict of interests;
- Adaptation of forests to climate change;
- Reducing the total area of clear cuts;
- Increasing the productivity and resilience of forests;
- Conservation and monitoring of biodiversity;
- Increase of forest cover;
- Fire prevention;
- Digital transformation of the forest industry;
- Implementation of a transparent timber trade market.

These are written in the Strategy of ecological safety and adaptation to climate change till 2030 and the State strategy of forests management till 2035.

- In 2021 the National inventory of forests of Ukraine began. It should provide reliable information about forest area, total wood reserves, total volume (quantity) of trees, average taxonomic indicators of plantations, increment, deposition and felling, sanitary condition of plantations, the amount of dead wood, forest renewal status, etc. This information for the needs of state management, strategic planning of forest management, state forest inventory, and monitoring of forests, National and international reporting on forests will be the basis for making informed decisions on forest resource management and environmental issues.
- The State Agency and the Ministry of Foreign Affairs of Ukraine are working on the reform of the forestry sector to introduce modern solutions, create a transparent and comfortable digital environment, save time and reduce bureaucratic paperwork. The reform will take place in several stages, one of which is the digitalization stage, which includes:
- App "Diya" with access to logging receipts, timber origin certificates
- Creation of a single Internet portal with information about monitoring of domestic consumption of wood, digital timber tracking, consolidated data on the electronic taxation of wood, register of permanent foresters, hunters, certificates of origin; electronic auctions for timber sales, maps of logging sites, interactive public map of the state forest inventory, thematic geospacial data, general data of the national forest inventory
- The forestry reform will also focus on reorganization of state forestry enterprises through consolidation, review of old licensing procedures and changes in the tax burden on enterprises.
- Afforestation is another critical task for the country to focus on (Decree of President of Ukraine on afforestation 2021, State Program under preparation).
- Transition to close-to-nature forest management, reduction of clear cut harvesting methods and transition to gradual, selective and combined methods is in the spotlight and supported by the State Forestry Agency of Ukraine in 2021.

It is important that as a result of the digitalization, all information flows are planned to be combined into a single digital "Forest Portal".

2.4 Presentation of the interregional Roadmap

The methodology to shortlist the final BPI from other Hubs was based on a two-step approach, combining the rating by the CEE Hub partners and online polling by the CEE Hub experts, resulting in the **final list of 27 BPI from other Hubs**.

The overall combined results of the prioritization and voting suggest that– according to the experts - the following 27 BPI from other Hubs but also 9 BPI from our own CEE Hub can be most useful to overcome identified weaknessess of the CEE region:

Main weaknesses matched by the most relevant best practices and innovations

WEAKNESS	*PL*	*SK*	*RO*	*UA*	*NE (NO, FI, SE))*	*CWE (DE, BE, FR, AU, CH)*	*SWE (ES, IT, PT)*	*SEE (CR, GR, SL)*	*EU*
Climate change: unfavorable changes in forest age-class structure; Poor "climate adaptive thinking" of forest authorities and decision makers; Pest and disease management		**e-LOS**			**Mellevä** **Arboair**			**Green City cadastre** **Invazivke** **DetectIT**	
Lack of cooperation, slow adaptability of the sector; Conservative approach to forest management; low uptake of research results in management/ production/ policy							**FORETDATA**		**TECH4EFFECT**
Lack of efficient forest management practices / information platforms					**Metsään.fi**	**iWald**	**C.A.F.E**		
Lack of long term promotional strategy of forest and wood products			**Build-in-Wood**			**Waldinfo NRW** **Hilfe im Wald App** **Woodvetia**			
Lack of qualified labor and gaps in education					**Skogkurs** **Pilke Science Centre**	**KWH4.0** **AVATAR**			
Low level of digitalization in forestry and wood based industries		**LignoSilva Infra**				**WH40** **Wood Supply 4.0**			
Low public finance and subsidies in the sector					**KEMERA**				
Low transparency and law enforcement effectiveness in forest sector	**TIS**		**TimFlow** **WoodTrack**	**Electronic Timber Tracking**			**ChainWood**		
Slow development of digitalization of forestry suppliers and non-state forest owners, inventory. High fragmentation of private forests	**REMBIOFOR** **Forests Data Bank** **SAT4EST**				**Drones in forestry planning**	**Drones for seedling** **LogBuch** **TREEO**		**MojGozdar – MyForester**	
Under-utilization of wood waste		**Atbiomap**			**Biomassa-atlas**				
Lack of marketing platforms	**e-drewno.pl**								

Table 7: Main weaknesses of the CEE Hub matched by the most relevant best practices and innovations

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862681.

Emphasis was given to best practices and initiatives of other Hubs that address the domain of inventory, assessment, but also to the domain of forest education and subsidies in forestry – that match the needs and weaknesses of the CEE region as identified in the SWOT.

The identified BPI have a good potential to tackle some of weaknesses identified in the Central-East Hub SWOT analysis. Although each country's context is quite particular, by matching strengths and weaknesses, common objectives and possible solutions of the BPI, this Roadmap identified the following strategic fields of interest:

CLIMATE CHANGE is expected to effect in yet unforeseen impacts for forest management, including in Eastern Europe.

In view of that, current silvicultural systems and strategies have to be reexamined with view to more flexibility and risk prevention of forest management. The ROSEWOOD4.0 complementarities across the CEE Hub countries revealed the following major opportunities for future RTD in climate change adaptation and mitigation, fire and pest control:

- Matching countries: PL, SK, RO, UA

Collaboration should therefore focus on the control, monitoring mechanisms (*e-Los, Detect-it, Melleva) and* adaptation of current silvicultural systems and practices to mitigate the impact of climate change-induced calamities on forest ecosystems *(Invazivke, Green City Cadastre).* Public authorities, with their key roles, are in a strong position to launch and test new silvicultural practices on a larger scale.

Close-to-nature silviculture has been identified a suitable concept to promote sustainable forest management and mitigate pronounced impacts of climatic disasters as well in less-developed forest regions, notably Carpathia. Linking these regional efforts with future cross-border RTD undertakings presents an opportunity to strengthen alternatives to predominant clear-cut harvesting systems in Eastern European countries.

A need for better utilizing the *WOOD FUEL FROM FORESTS AND RECYCLING PRACTICES* in industry has been commonly pronounced by the partners.

- Matching countries: PL, SK, RO, UA

Several targets and needs have been identified, including the identification of accessible sources, the quantification of potential harvests and study logistical constraints. Projects like *Atbiomap* and *Biomassa Atlas* can provide a good starting point to address those.

New business models involving participation and integration of different players in the value added chain and hence an increased profitability should be explored, evaluated and tested.

Biomassa Atlas

Tackling the weakness of insufficient qualitative valorization of harvested wood, the Biomassa Atlas is a good example for Slovakia how increasing the complex utilization of wood produced on forest and non-forest land and residues after wood processing for energy and other purposes. It can stregthen and increase the raw material self-sufficiency of regions and wood utilization efficiency

SILVICULTURAL PRACTICES ARE A KEY COMPONENT OF FORESTRY. The CEE Hub countries are concerned by the unfavourable changes in forest age-class structure – diminishing area of young forest stands as a result of the reduction in forest regeneration and afforestation intensity, and decrease of final felling (PL). Some countries (UA) mention low quality of wood harvested (50% firewood). The high rate of sanitary logging, especially in UA and SK, may be perceived as another risk factor in terms of illegal logging.

- Matching countries: PL, SK, RO, UA

The ROSEWOOD4.0. analysis revealed that advancing the regional state of technology and know-how in timber harvesting through exchange of knowledge and best practices as well as experimental case studies (*Metsään.fi, iWald*) can be a major opportunity and enabling factor.

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As in other sectors, the range of fast developing *MODERN COMMUNICATION TECHNOLOGIES AND PLATFORMS* has seen a rapid expansion in the forest sector during the past years. Information systems in the forest sector see a continuous growth also in the CEE countries.

- Matching countries: PL, SK, RO, UA

With the amount of information available, CEE partners perceive that the challenge however is a stronger link with the users, assurance of the accuracy and quality of data, linking data from forests with the forest-based industry trade / markets. Some efficient tools supporting the knowledge-based networks are offered by *FORETDATA, TECH4EFFECT, Metsään.fi, iWald, C.A.F.E.* In particular, *LignoSilva Infra, WH40 and Wood Supply 4.0* make a good connection to the wood-based industry.

Here the target is to initiate a trans-regional knowledge exchange process among the ROSEWOOD4.0. consortium and its wider network of partners.

Wood Supply 4.0

Because of low level of digitalisation and poor performance in terms of technological and intangible innovations (mainly in the sawmill industry but also in some companies of 2nd stage wood processing), the comprehensive strategy of implementing Industry 4.0 solutions and technologies in forestry-wood sector is needed. Wood Supply 4.0 project is delivering knowledge on the potential of industry 4.0 in the forest-wood-supply chain, both at operational and strategic level. Through this kind of project it would be possible to create understanding of most beneficial ways of development of the industry 4.0 in forestry-wood sector in Poland, aiming both at optimisation of processess (and lowering costs) as well as creating new business models. A significant step forward would be proposing and implementing innovative technological solutions.

FORETDATA

Innovative, easy-to-use tools for collaboration are needed to allow effective and safe information exchange and encourage the enterprises from forestry-wood sector in Poland to engage in joint projects. One example of collaborative platform is FORETDATA, which facilitates the exchange of data related to logging sites, in order to monitor forest area in Aquitaine, France. The next step could be extending the system to further steps in the value chain, monitoring the processing of harvested raw material into wood materials and wood products. This may improve cooperation and transparency between forest owners (mainly State forests) and their subcontractors and customers, as well as between wood processing companies, and enhance the adaptability of the sector to changing climate conditions and events such as extreme storms and pest outbreaks

SMALL-SCALE FORESTRY AND FOREST OWNERSHIP are important issues to be considered in the region. High fragmentation of private forests makes sustainable forest management more difficult.

National level forest inventories give a general overview on exiting forests and their use potentials, yet their results on the private forests are incomplete. Therefore, practices need to address this target group and propose adapted solutions.

- Matching countries: PL, SK, RO

Practices and tools for localized forest resource assessment, optimization of data tools on inventory, amounts of harvested and used timber, are important targets (*MojGozdar – MyForester, TREEO*).

Motivation of private forest owners to employ sustainable forest management practices (versus potential deforestation risk) and willingness versus un-willingness to utilize their forest / harvest trees need to be addressed, in particular by strengthening the forest ownership cooperation and access to industry value chains. Examples of such networks, associations and various business cooperation models are presented in the BPI *Metsään.fi and FORETDATA*.

2.5 Implementation of the roadmap

For the implementation process there is a strong need of good partners along the entire forest and wood value chain. Successful knowledge transfer activities should be initiated to foster transmission, absorption and use of the new knowledge.

The CEE Hub partners therefore agree that education events with networking opportunities are a good way to start an exchange between professionals.

The CEE Hub plans to organize a set of idea implementation workshops that could provide a forum for the experts, industry and research from four countries to set forth ways to adapt the knowledge from the other Rosewood4.0. Hubs.

The objectives of the implementation workshops will be to present the main business ideas with good possibilities of being implemented in different territories and with greater impact, based on the research carried out in the framework of the Rosewood 4.0 project. The approach of the workshops can be described as a collective brainstorming of a preferably diverse group of stakeholders, with the expected outcome being the collection of grassroots ideas for new businesses. In general, the workshops will initiate an active process of idea creation, collection, follow-up and implementation.

The most important strategic task is to stimulate the sector's activities in terms of climate change, silviculatural practices, and digital transformation. The primary assumption is to improve intersectoral cooperation, which has a direct effect on the economic efficiency of the entire value chain.

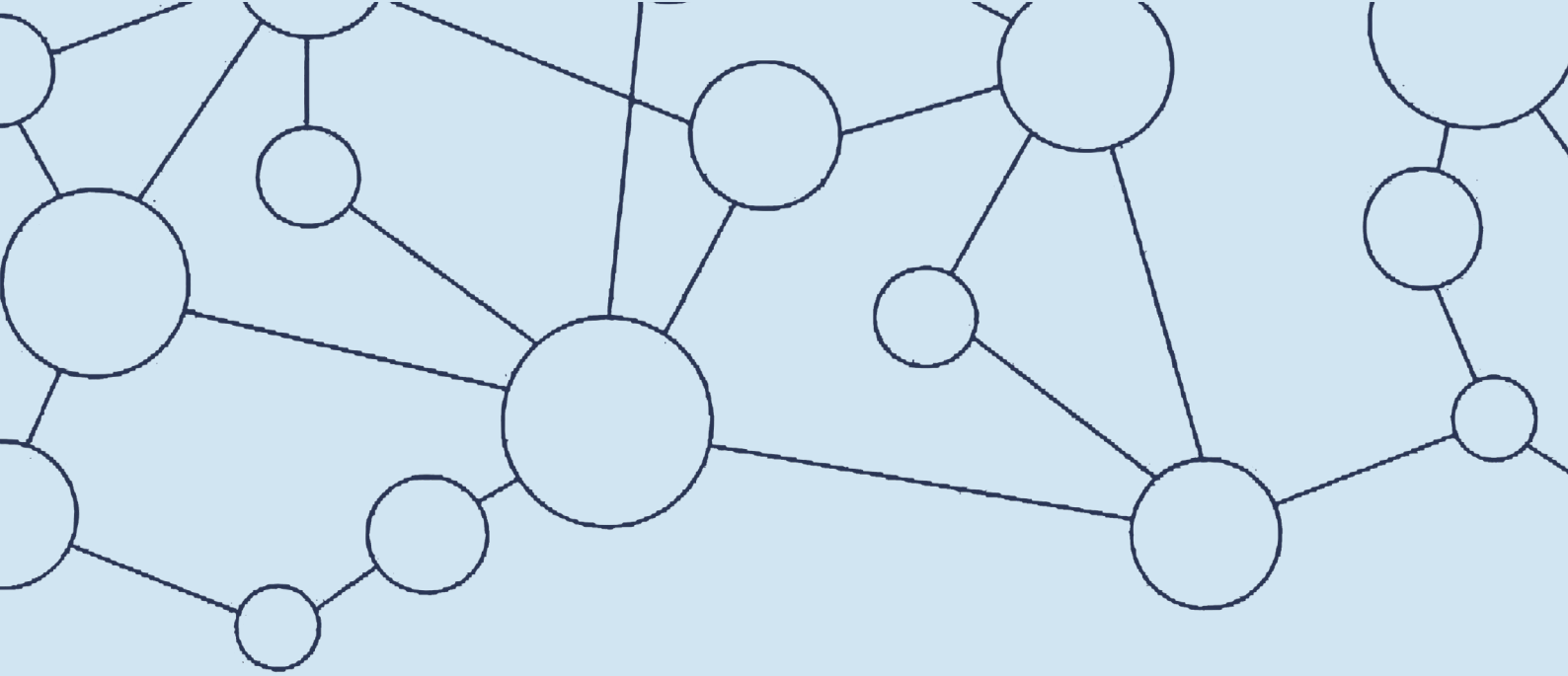
Project partners and representatives of the wood value chain from all Rosewood4.0. Hubs are welcome to join. The workshops will also be open to internal or external collaborators of the companies, consultancies, and representatives of the research sector.
In Poland, Łukasiewicz Research Network – Wood Technology Institute is cooperating closely with the authorities (Ministry of Climate and Environment), State Forests and other actors from the forestry-wood chain (both individual enterprises and networks, such as wood industry associations and clusters). Established contacts and new joint projects will form a basis for the ROSEWOOD4.0 Roadmap implementation. An additional dissemination event in Autumn 2021 will ease the transfer of knowledge and promote the Roadmap conclusions among the stakeholders in the sector.

2.6 Conclusions and Outlook

The regional and interregional analysis of the needs and challenges of the four countires that shape the Central-East Hub (Slovakia, Ukraine, Romania and Poland) was made with a special focus on wood mobilization and digitalization. The analysis shows the big potential for transferring the Best Practices and Innovations from other countries of the Hub and the interregional knowledge transfer between Hubs. Based on that, development targets for the regions were identified.

The implementation of selected targets depends on many factors, among the most important are: creating and implementing a long-term promotional strategy of wood and wood products, identifying sustainable financing models for cooperation initiatives and improving the cooperation and knowledge transfer between science and industry. It is necessary to engage all the stakeholders in the implementation of the strategies, including national and local administration, business associations, enterprises, public and private forest owners, forest service providers, universities and research organisations, NGOs. Changing social perceptions

and needs require not only to implement new solutions but also to ensure the balance between different forest ecosystem services and to build social dialogue. Meanwhile, transparent law and rules are of utmost importance to ensure trust and diminish uncertainty among stakeholders. There are still some gaps, hindering the sustainable wood mobilisation in the CEE Hub, such as missing data (e.g. on recycled/post-consumer wood and wood by-products), imprecise regulations (e.g. on wood waste, wood for energy purposes) and missing knowledge (e.g. on Industry 4.0 potential in forestry-wood sector, climate change mitigation and adaptation in forestry, innovative, sustainable forest management methods, tools and strategies, engaging local communities in forestry-wood sector strategy development).



ROSE WOOD 4.0 Sustainable Wood for Europe

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CROSS-REGIONAL ROADMAP

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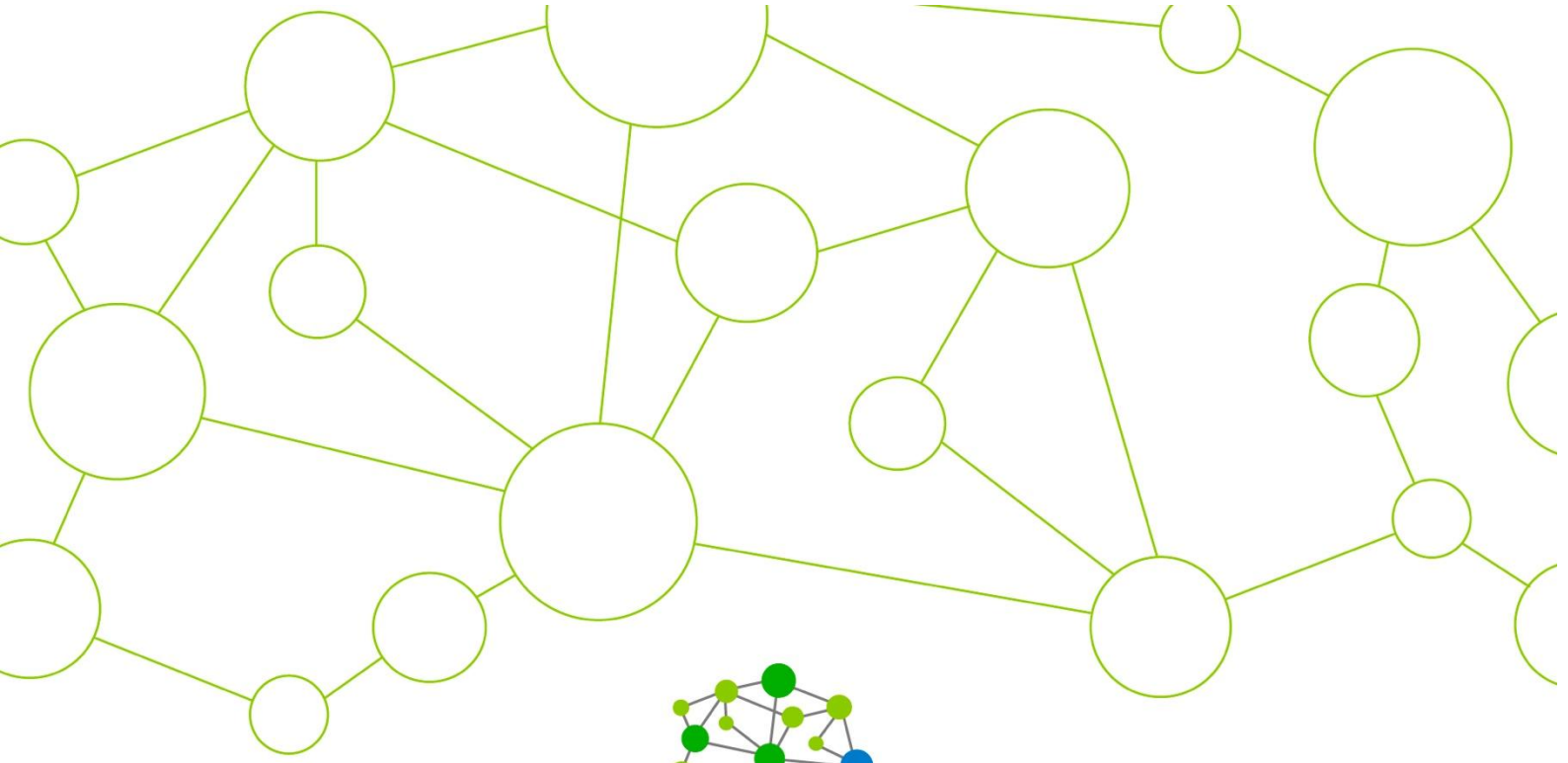

ROSE WOOD 4.0 Sustainable Wood for Europe

Cross-regional Roadmap

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The study is based on the BPI database and the 5 regional Hub Roadmaps written in the frame of the ROSEWOOD4.0 project.

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1. Introduction

Digitalization in forestry

Digitalization is a worldwide trend cutting across all industries, which requires fundamental change not only in processes and technologies, but also in mindsets of stakeholders. Organizations have generally acknowledged the need to dedicate resources towards digital transformation, and thus exploit the potential for more efficient processes with increased flexibility, productivity and customer accommodation in order to achieve a competitive advantage. However, while digitalization holds great potential for process improvement, companies face significant challenges to implement this transformation, because it requires both technical expertise, and specific industry expertise (Holmström 2020: 2; Makkonen 2018: 76).

Forestry has usually been associated with little use of advanced technology, and the use of conventional machinery in harvesting, processing and transportation of timber. Digitalization in this rather conservative context has thus seen a reluctant uptake and stakeholder investment. While initiatives applying digital technologies to work or communication processes exist, and some countries are more advanced than others, the wood value chain in general has so far remained a late technology follower, with most stakeholders lacking the necessary knowledge regarding the selection and implementation of digital tools for information and communication purposes or machinery automation (Feng/Audy 2020: 3; Holmström 2020: 3).

Reasons for this slow uptake of digitalization are multifold, and indeed also related to the infrastructure of forests and forest ownership. Predominant public ownership of forests and fragmented private ownership contributes to the conservative character of the sector. Besides commercial aspects, social and environmental aspects of forest ecosystems also play a major role and have to be taken into account in transformative processes. In addition, forest operations are usually carried out by small companies (contractors) with little resources to implement changes. Another characteristic is the remote location of forests in rural areas, which makes it less likely to attract the necessary expertise. Makkonen (2018: 73) states that while there exists already a lot of data, stakeholders tend to remain traditional in their attitudes and are hesitant to engage in change.

Despite these challenges, digitalization offers many potential benefits to forestry stakeholders. A “digital ecosystem” for forestry would link “all physical assets of the forest supply chain” and integrating “suppliers, customers, and partners” on the operational level (Feng/Audy 2020: 9). Different kinds of digital data can support processes from harvest planning to transport and sales (Müller et al. 2019). Forest management is based on information regarding the “distribution, composition, structure, and disturbance of forests over time” (Weitao et al. 2019. 1), i.e. monitoring of ecosystem data. Forest inventory can thus use remote-sensing and location technology to obtain a broad range of data on the status quo of forest resources. Not only do these technologies replace the costly use of surveying crews, they also improve the quality of data collected, e.g. mapping of individual trees regarding species, estimations on tree height and yield, detection of areas with low growth rates or dead trees (Müller et al. 2019: 210; Holmström 2020: 7, Weitao et al. 2019: 1).

Monitoring data allows for deeper analysis and simulations regarding forest stocks, harvestable volume and costs, which are important for sales negotiations and planning activities with other market actors, including quality assessment and control. Furthermore, digital systems can enhance the navigation and operation of forest machines, both regarding the harvesting process and transportation. Today, forest machines equipped with many sensors optimise their own performance as well as the result of the harvested wood. In timber transport, data services improve timing, routing and safety (Müller et al. 2019: 211-212).

In terms of general work processes, forestry practicioners can benefit from digital information on current and future forest resources to make more informed management decisions and better accommodate customer demands (Holmström 2020: 7). More exchange of information between stakeholders of the wood value chain through digital tools is not only an opportunity for improvement but also an increasing need. Typically forestry stakeholders operate rather individually and independently from each other, resulting in inefficient, uncoordinated processes. Increased interaction and communication are likely to lead to a higher flexibility regarding customer demands, cost savings and reduced raw material loss. For this communication to be effective, trust between the diverse actors of the value chain has to be built, especially considering the traditional, trust-based character of forestry (Makkonen 2018: 73-77).

Purpose and objectives of ROSEWOOD4.0's roadmapping process

ROSEWOOD4.0 carries out a broad, Europe-wide collection of Best Practices and Innovations (BPI) that have been tried and tested by practitioners in their regional context. These BPI have a dedicated focus on digitalization and are being validated with the involvement of regional stakeholders as to their suitability and relevance for targeted knowledge exchange and transfer between the five Regional Hubs. This focused cross-regional exchange of BPI has the potential to strengthen two levels of trust: first, the trust of stakeholders towards solutions to current challenges facilitated by digital tools (i.e. a validated solution has worked already in another country, so it could be interesting for my region), and the trust between different stakeholders of the value chain (i.e. these solutions worked because people shared data and collaborated).

The strategic roadmaps developed by Hub partners and stakeholders in the frame of the project firstly provide a plausible direction and guidance for addressing region-specific challenges through exploitation of learnings from other European regions. Secondly, they can also serve as a stimulus for forestry stakeholders to approach and adopt digitalization more seriously, and to start exploring new ways of cooperation and communication between all actors in the value chain.

The following cross-regional roadmap proposes a meta-perspective on the knowledge flows between the five ROSEWOOD4.0 Regional Hubs, highlighting the opportunities for cooperation in forestry across European regions. The insights presented in this report are the result of the overarching analysis of regional gaps and BPI collected, leading to proposed directions for practical uptake by the five Regional Hubs and their affiliated stakeholders.

2. Regional strengths and gaps in wood mobilization

The Rosewood 4.0 Hubs each completed an analysis of the internal and external factors influencing the development and reach of the Forestry sector in each of the regions through the completion of a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis. The respective, in-detail SWOT analysis for each of the Hubs can be found in the individual Hub Roadmaps. In this Cross-regional Roadmap, we analyse the input of the regional Roadmaps as a whole in order to: identify categories, or groups, of strengths and gaps (a combination of weaknesses and threats) that were identified across the regions; establish which are the most recurrent types of gaps in each region; and identify possible knowledge flows and opportunities for collaboration and knowledge-sharing across the different Hubs and regions.

2.1 Analysis of regional strengths based on Hubs' SWOTs

The following main categories of strengths have been identified based on the SWOT analysis of the individual Hub Roadmaps. Strengths individually identified by each Hub have been grouped based on similarity of topic or focus. In many occasions, the separate Hubs identified similar characteristics or elements to other regions but with slightly different wording or descriptions accounting for the nuances of each region. The below analysis seeks to harmonise these into identifiying the general categories where Hubs are particularly strong and may have identifiable knowledge or experience to share between each other.

Across the five Hub Roadmaps, strengths individually identified by each Hub in the frame of its respective SWOT analysis, have been grouped here in eight main strength categories for better overview. The following table illustrates the number of individually identified strengths of each Hub within the main strength categories developed. The full table of individually identified Hub strengths and which Hub identified them, is included in Annex 1.

Main Strength Categories	Number of individual strengths identified per Hub in each main strength category					
	NE	CWE	SWE	CEE	SEE	**Total**
1. Strong and competitive forest industry, processes and supply chains	3	3	4	4	1	**15**
2. Incorporation of digitalisation and data management solutions	3	2		3		**8**
3. Increasing focus on renewable energies, sustainability and circular economy	1	2	1	3		**7**
4. Educational and knowledge transfer resources available	1	2		1		**4**
5. R&D and Innovation support available		2	1	1		**4**
6. Skilled and experienced staff across disciplines		2	1		1	**4**
7. High safety standards, certifications and controls in place	1	1	1			**3**
8. High availability and access to quality raw materials			2		2	**4**
Total	9	14	10	12	4	

Table 1: Main strength categories and the identified strengths from each individual Hub, organised into main categories.

This grouping identifies the category 1 "Strong and competitive forest industry, processes and supply chains" as the clearly strongest one across all regional Hubs (15), followed by "Incorporation of digitalisation and data management solutions" (8).

In terms of the data distribution per Hub, the following observations can be made:

- NE Hub has most strengths across the categories 1 "Strong and competitive forest industry, processes and supply chains" and 2 "Incorporation of digitalisation and data management solutions".

- CWE Hub has the broadest range of strengths of all five hubs, with identified strengths across seven out of eight categories. In particular, the main focus is on the available industry and processes (strength category 1.) with a similar number of strengths identified across categories 2-6.
- SWE Hub shares one of the strongest strength contributions to category 1, and is one of the only two Hubs which has identified strengths in the availability and access to raw materials. Across all categories, except for 2 and 4, SWE Hub has a similar strength representation.
- CEE Hub has also one of the highest contributions to strengths within category 1 (4), followed by categories 2 and 3 (3).
- SEE Hub is one of the only two Hubs contributing to the strength category 8 related to the availability of raw materials, with strengths also identified fitting to categories 1 and 3.

2.2 Analysis of regional gaps based on Hubs' SWOTs

This section focuses on the Weaknesses and Threats identified by each Hub in the SWOTs within each individual roadmap, which for the purpose of this cross-regional analysis have been grouped together in the term 'Gaps'. The sub-gaps, those specific weaknesses and threats identified by each Hub within their SWOTs have been grouped into seven main categories which are common in terms of topic and focus.

A table including all sub-gaps per the main seven gap categories and which Hub identified them can be found in Annex 1 of this document.

The table below shows, for each Hub, how many of the identified sub-gaps were grouped into each of the seven main gap categories for this roadmap analysis. The purpose of this data is to identify where each Hub may be lacking developments, resources, technology or opportunities, in order to better understand where input from other Hubs, further resources or other types of support may be most needed.

Main Gap Categories	Number of gaps identified per Hub in each gap category					
	NE	CWE	SWE	CEE	SEE	Total
1. Improve forest resilience and adaptation to climate change	1	1	1	3		6
2. Improve infrastructure and capacity of public actors	2		2	1	5	10
3. Activate private owners and cooperative forest management	3	3	2	2	6	16
4. Ensure a well-trained workforce through attractive skills development and education	2	1		1	3	7
5. Enhance economic and environmental performance of forest supply chains		3	1	4	9	17
6. Grow the forest-based bioeconomy through circular use and value-added products	1	1	1	3	1	7
7. Raise public awareness, social acceptance and political support for forestry.	2	3	1			6
Total	11	12	8	14	24	

Table 2: Main gap categories and number of gaps identified from each Hub for each category (source: individual Hub Roadmaps).

From the above table we can extract the following information:

- The Gap categories 3 " Activate private owners and cooperative forest management" and 5 " Enhance economic and environmental performance of forest supply chains" cover the most gaps identified by all Hubs, with 17 and 16 sub-gaps in total, respectively.
- Gap category 3, "Activate private owners and cooperative forest management" has the most even distribution across all Hubs, meaning there is a general lack of resources or solutions across all regions when it comes to this topic. In particular SEE Hub has an especially high amount of sub-gaps relevant to this category (6).
- Gap category 6 "Grow the forest-based bioeconomiy through circular use and value added products", while also having an even distribution across Hubs, has overall lower identified sub-gaps for all Hubs with respect to category 3.
- Gap category 5 "Enhance economic and environmental performance of forest supply chains", while having a significant total amount of identified sub-gaps, has a very mixed range of importance for each Hub, being the highest by far for the SEE Hub (9), the highest of all categories for CEE Hub (4), but having no identified gaps in this category for NE Hub.

At the Hub-level, we can gather the following points:

- NE Hub has an overall balanced distribution of sub-gaps across categories, ranging between zero and three (0-3) for all seven gap categories. From the seven main gap categories, the NE Hub only has no identified gaps for Gap 5 "Enhance economic and environmental performance of forest supply chains", and the highest sub-gaps are identified in Gap 3 "Activate private owners and cooperative forest management" (3).

- CWE Hub is balanced across categories, with identified gaps ranging between zero and three (0-3). CWE Hub identified no gaps under the category 2 “Improve infrastructure and capacity of public actors”, while having the highest sub-gaps for categories 3 “Activate private owners and cooperative forest management” (3) and 5 “Enhance economic and environmental performance of forest supply chains” (3).
- SWE Hub has identified the lowest number of gaps overall (8), with sub-gaps ranging between zero to two (0-2) for each category, having no gaps under category 4 “Ensure a well-trained workforce through attractive skills development and education” and two (2) sub-gaps for categories 2 and 3.
- CEE Hub has a slightly wider distribution ranging from zero to four (0-4) sub-gaps per main category, with no gaps identified under 7 “Raise public awareness, social acceptance and political support for forestry” and the highest number of sub-gaps found for category 5 “Enhance economic and environmental performance of forest supply chains” (4).
- SEE Hub identified the highest number of sub-gaps overall (24). This Hub has a very varied gap distribution ranging between zero and nine (0-9), with no identified gaps for categories 1 and 7 “Improve forest resilience and adaptation to climate change” and “Raise public awareness, social acceptance and political support for forestry” but 9 gaps under category 5.
- Overall, Northern and Western Hubs (NE, CWE, SWE) have a relatively more balanced distribution of gaps across all areas, compared to the Eastern Hubs which show larger differences between categories.

2.3 Main Knowledge Flows: Which strengths from hubs may compensate gaps from other hubs

This section aims to identify any links or knowledge flows which may initially be aparent through comparing the identified strengths from the five Hubs against the identified Gaps in the regions. This preliminary analysis is made as part of this cross-regional roadmap, without providing the specific solutions, transfer mechanisms or innovations which may make the knowledge flow happen: the selection of specific means of transfer, represented in this and the individual roadmaps by the Best Practices and innovations (BPI) is explained in the next two sections.

- All Hubs, except SEE Hub have the largest number of strengths in the first category “Strong and competitive forest industry, processes and supply chains”. The gaps relevant to this category are 2 “Improve infrastructure and capacity of public actors”, 3 “Activate private owners and cooperative forest management” and 5 “Enhance economic and environmental performance of forest supply chains”, for which the largest number of gaps is found, by a large difference, from SEE Hub. This suggests that there is opportunity for knowledge flow and the learning and incorporation of methods and ideas from all other Hubs towards this Hub in particular, but also across all other Hubs and as part of internal (within the same Hub) knowledge sharing.
- “Increasing focus on renewable energies, sustainability and circular economy” is a relatively strong strength category, particularly for CEE Hub. This can be related to Gap categories 1 “Improve forest resilience and adaptation to climate change” and 6 “Grow the forest-based bioeconomy through circular use and value-added products”. These categories are relevant for all Hubs in terms of gaps identified in at least one of them. We can note that for both gap categories, CEE is also the Hub to have identified the largest set of sub-gaps. This may indicate two things:
    - There is opportunity for knowledge flow internally within the CEE Hub.
    - The focus on climate change, renewable energies and circular economy is a particularly important one for CEE Hub, and therefore the region is especially aware in identifying both the strengths and gaps that are present in the Hub in these areas.

Altogether, the balanced number of strengths and gaps across other Hubs leaves a possibility open for knowledge transfer and flow of ideas and solutions across all Hubs.

- Activities related to digitalisation, data management and enhancing cooperation and logistics across actors in the industry can be found within the Strength 2 “Incorporation of digitalisation and data management solutions”, and Gap 5 “Enhance economic and environmental performance of forest supply chains”. Particularly strong are NE, CEE and CWE Hub and largest number of sub-gaps have been identified by SEE Hub, but also additional related gaps from CEE and CWE Hub. This suggests a flow of information from the Northern and Central Hubs towards the Southern Hubs in particular, with also strong possibility for internal (within the same Hub) knowledge sharing in particular for CWE and CEE Hub.
- Regarding having a skilled workforce and the opportunity for education and knowledge sharing, strength category 6 “Skilled and experienced staff across disciplines” and gap 4 “Ensure a well-trained workforce through attractive skills development and education” can be related. Within the strength category 6, CWE Hub in particular as well as SWE and SEE Hub make the contributions in terms of specific strengths. In terms of gaps, all Hubs except for SWE identified gaps in this main category, which was particularly important for SEE Hub. Considering these gap and strength distributions among hubs, a main knowledge flow from CWE and SWE Hub to SEE Hub as well as an internal knowledge sharing between SEE Hub members can be expected.
- Finally, the topic regarding access to public funding and resources to increase innovation is encompassed by Strength 5 “R&D and Innovation support available”, for which a link with Gap 2 “Improve infrastructure and capacity of public actors” and gap 7 “Raise public awareness, social acceptance and political support for forestry” is found. In terms of strengths, the Central and Western Hubs (CWE, SWE and CEE) contribute with identified individual strengths. Gaps 2 and 7 are both important in particular for NE Hub, as well as for SWE Hub. Gap 2 is in addition especially important for SEE. In this case, therefore, it can be understood that knowledge sharing from the central and western Hubs towards both Northern and Eastern regions could be beneficial.

The knowledge flows identified here may differ from the selection of BPI both within a same Hub and from other Hubs, selected as interesting or relevant by the Hubs in their Roadmaps. This information is provided in the following Sections 3 and 4, where the Section 4.3 identifies specifically which BPI were chosen in response to individual gaps of each Hub.

3. BPI assessment from ROSEWOOD4.0

The identified Best Practices and innovations (BPI), representing the means of transfer of each regional Hub within ROSEWOOD4.0, are analysed in detail below. For this purpose, the following aspects are highlighted:

- Number of Best Practices identified per Hub
- Number of Best Practices identified per country
- Number of Best Practices identified per domain per Hub
- Number of Best Practices identified per solution type per Hub

It can thus be determined where the means of transfer in Europe are located, in which domain and in which solution type approaches.

3.1 Number of BPI identified per Hub

In ROSEWOOD4.0 there are five regional Hubs where Best Practices and innovations (BPI) have been gathered. Additionally, Best Practices identified having their origins outside of the five Hubs, have been classified generally as “EU” (European) or “INT” (International).

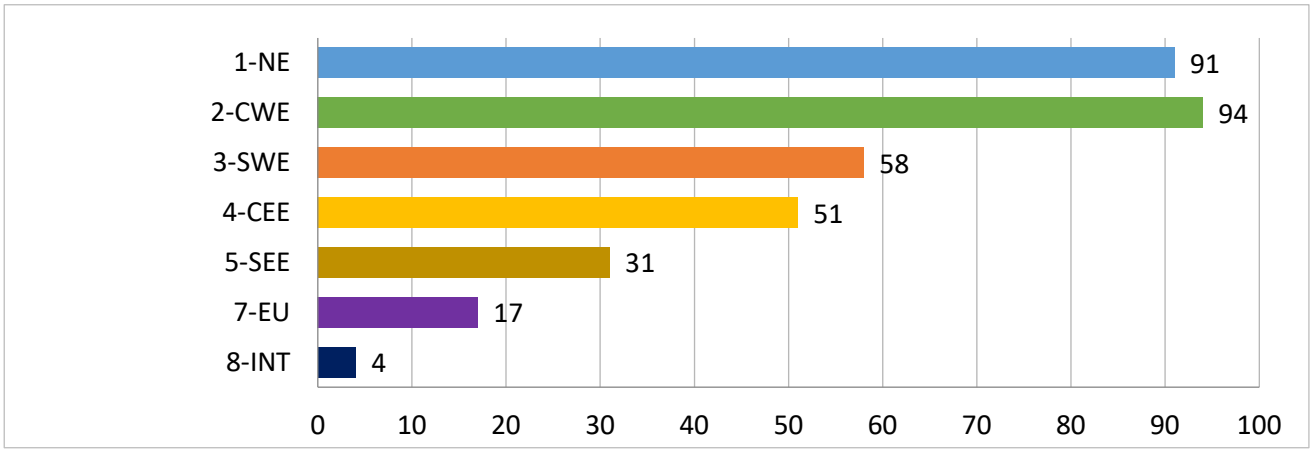

Figure 1: Total number of best practices identified per Hub.

In total 346 Best Practices and Innovations (BPI) have been identified in the project. Regarding the distribution of the identified BPI across the different regions, i.e. their origin, the analysis shows that the majority of them originate from CWE (94) and NE (91) Hub. We can see that the number of identified BPI decreases in terms of geographical distribution from North to South.

3.2 Number of BPI identified per country

To further deepen the analysis within each regional Hub, the identified BPI were also classified according to their country of origin.

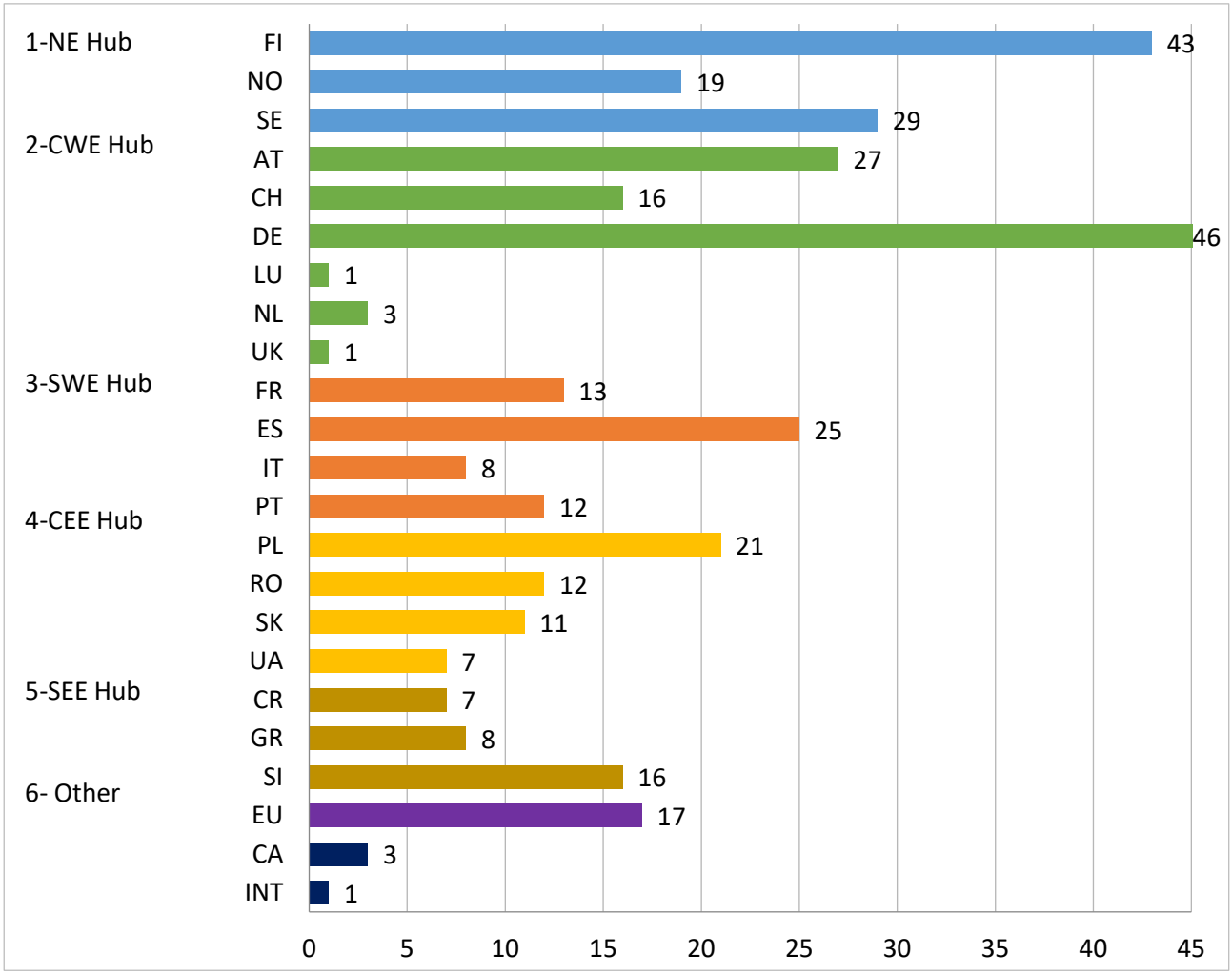

Figure 2: Total number of best practices identified per country.

The analysis shows that most of the identified BPI are identified in Germany/CWE Hub (46) and Finland/NE Hub (43). In SWE Hub, most identified BPI originate from Spain (25), in CEE Hub the majority comes from Poland (21) and in SEE Hub from Slovenia (16).

3.3 Number of BPI identified per domain per Hub

In order to gain additional insights, the identified BPI are now listed below by domain per Hub. This allows a more accurate assessment of the distribution of means of transfer in Europe by area of activity.

	Hubs							
Domains	**1-NE**	**2-CWE**	**3-SWE**	**4-CEE**	**5-SEE**	**7-EU**	**8-INT**	**Total result**
Inventory, assessment, monitoring	14	22	12	18	5	2	1	74
Harvesting, logistics, transport, safety	17	18	8	3	3	7	1	57
Education, research, knowledge transfer (transversal)	15	14	5	8	4	3		49
Products, markets, trade	10	14	5	7	2			38
Forest management, ecosystem services, resilience	8	7	7	7	6	1		36
Ownership, cooperation	4	8	13	2	2	1		30
Forest-based industries, bio/circular economy, value chain	11	3	3	3	2	1	1	24
Forest disturbances, risks, disaster response	5	1	1	2	7	1		17
Innovation management, digital hubs, clusters, exploitation	4	5	2	1		1	1	14
Financing, funding schemes	3	2	2					7
Total result	**91**	**94**	**58**	**51**	**31**	**17**	**4**	**346**

Table 3: Total number of best practices identified per domain per Hub.

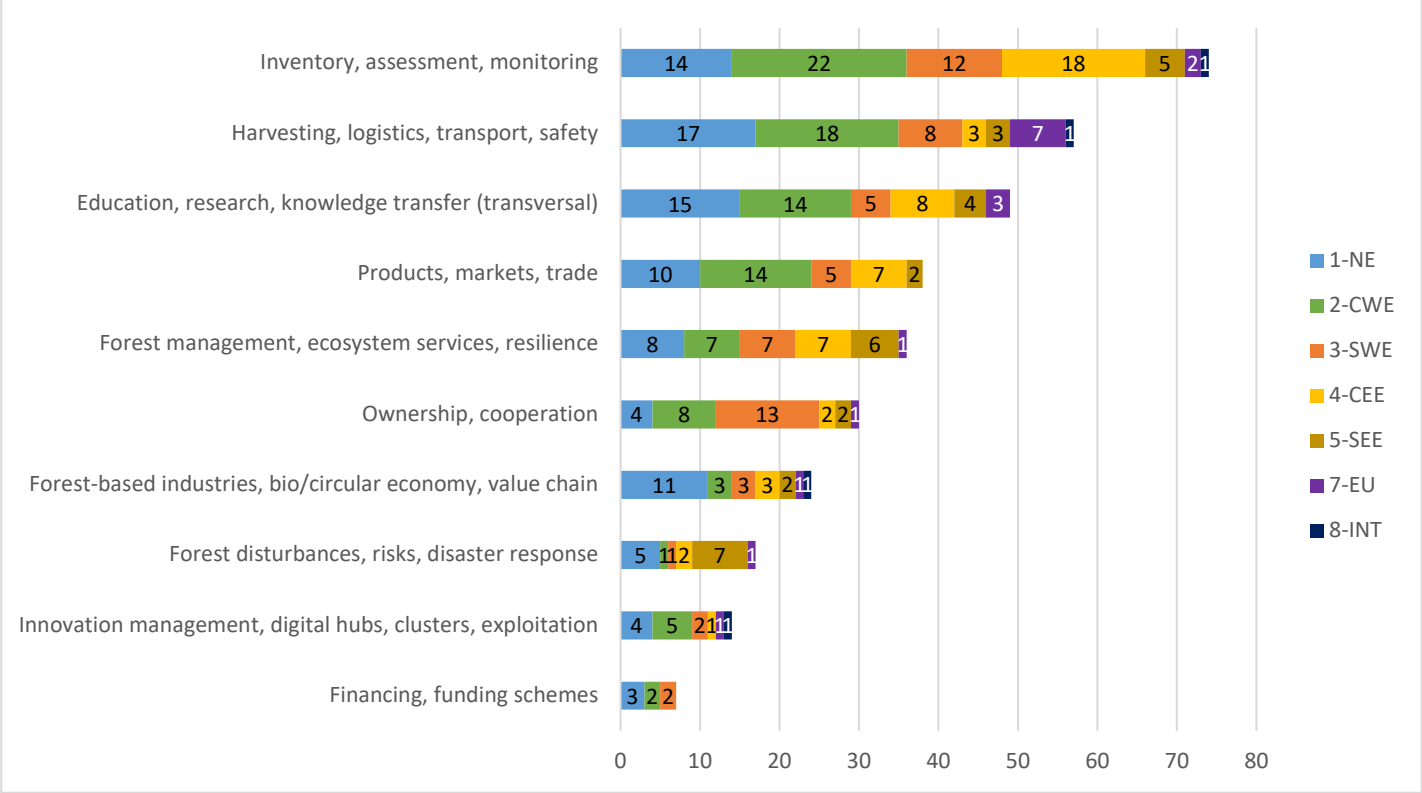

Figure: 3: Total number of best practices identified per domain per Hub.

Here we can see that most of the BPI have been identified in the three domains “Inventory, assessment, monitoring” (74), “Harvesting, logistics, transport, safety” (57) and “Education, research, knowledge transfer (transversal)” (49).

In all three domains, at least one BPI from each regional Hub can be found. Again, CWE and NE Hub, but also CEE Hub lead in the number of corresponding BPI.

The weakest domains in terms of BPI number are “Financing, funding schemes” (7), “Innovation management, digital Hubs, clusters, exploitation” (14) and “Forest disturbances, risks, disaster reponse” (17). The domain “Financing, funding schemes” has low BPI contributions while two Hubs, CEE and SEE Hub are not represented here.

Following an analysis per Hub we can state that:

- NE Hub has identified BPI in every domain, especially “Harvesting, logistics, transport, safety” (17). However, the categories “Finance, funding schemes” (3), “Innovation management, digital Hubs, clusters, exploitation” (4) and “Ownership, cooperation” (4) are lower-pitched in NE Hub.

- CWE Hub has identified BPI in every domain, especially “Inventory, assessment, monitoring” (22). However, the categories “Forest disturbances, risks, disaster reponse” (1), “Financing, funding schemes” (2) and “Forest-based industries, bio/circular economy, value chain” (3) might need additional input from outside CWE Hub.

- SWE Hub has identified BPI in every domain, especially “Ownership, cooperation” (13). However, the categories “Forest disturbances, risks, disaster reponse” (1), “Financing, funding schemes” (2) and “Innovation management, digital Hubs, clusters, exploitation” (2) are lower-pitched in SWE Hub.

- CEE Hub has identified BPI in nearly every domain, only “Financing, funding schemes” lacks a corresponding input from CEE and also “Innovation management, digital Hubs, clusters, exploitation” (1), “Forest disturbances, risks, disaster reponse” (2) and “Ownership, cooperation” (2) do not count many BPI from CEE Hub. In contrast, the domain “Inventory, assessment, monitoring” (18) seems to be especially pronounced in CEE Hub.

- SEE Hub has not identified any BPI in the domain “Finance, funding schemes” and “Innovation management, digital Hubs, clusters, exploitation”. Also, they might need additional input in the domains “Forest-based industries, bio/circular economy, value chain” (2), “Ownership, cooperation” (2) and “Products, markets, trade” (2). However, the strengths of SEE Hub seem to lie in the categories “Forest disturbances, risks, disaster response” (7) and “Forest management, ecosystem services, resilience” (6).

This leads to the following conclusions:

All regional Hubs seem to lack some BPI input in the domain “Financing, funding schemes”. That can either mean that:

- There is no need for a BPI in this domain since everything works fine for all the Hubs
- Every Hub needs support/BPI input in this domain.

Chapter 2 focused on the strengths and gaps identified by the Hubs. In Annex 1 we can see that a number of gaps under Gap category 2 “Improve infrastructure and capacity of public actors”, namely “Lack of funding for R&D and efforts to find new opportunities” has been identified by the NE Hub, “Low public finance, subsidies

and compensation mechanisms in the sector" by CEE and SEE Hub and "Few options for financial support" by the SWE Hub. This leads to the assumption that the lack of BPI in the domain "Financing, funding schemes" represents indeed a need which has been identified and could use a BPI input.

Furthermore, both CWE and CEE Hub account for most BPI in the domain "Inventory, assessment, monitoring". Here the question arises if other Hubs selected the according BPI in this domain from these two Hubs, which will be more closely analyzed in Chapter 4.3 (Number of BPI selected per Hub per domain).

3.4 Number of BPI identified per solution type per Hub

Having examined the identified BPI per domain and Hub, we now turn to the analysis of the identified BPI per solution type and Hub. This will allow a deeper and more concrete insight into the strengths and solution approaches inside the regional Hubs in Europe.

	Hubs							
Solution type	**1-NE**	**2-CWE**	**3-SWE**	**4-CEE**	**5-SEE**	**7-EU**	**8-INT**	**Total result**
Sensors, measurement equipment	13	16	1	10	1	2		43
Advisory and services tools for forest owners	10	14	4	6	4	1		39
Modelling, DSS, simulation, optimization	6	10	12	3	2	2		35
Data platforms, data hubs, open data	5	4	1	8	11	1		30
Awareness, infoportals, educational campaigns	5	11	2	6	1	2		27
Smart machinery, equipment	12	7	2	1	1	3		26
Traceability tools		3	7	4	2		2	18
Marketing platforms	1	7	3	5	2			18
Collaboration platforms, logistical hubs	6	4	4		4			18
Training, education, eLearning	8	4	1	2	2			17
Joint forest management		6	10					16
Sustainable, bio-based, circular products, smart materials	10		2	3				15
R&D platforms, testbeds, co-creation initiatives	4	3	2	1		4	1	15
Operations optimization	3	2	1		1	1		8
Funding schemes, grants	4	1	2					7
Cooperative initiatives, networks, clusters			4	1				5
Smart biotechnologies	2			1		1		4
Innovation contests	2						1	3
Data standards		2						2
Total result	**91**	**94**	**58**	**51**	**31**	**17**	**4**	**346**

Table 4: Total number of best practices identified per solution type per Hub.

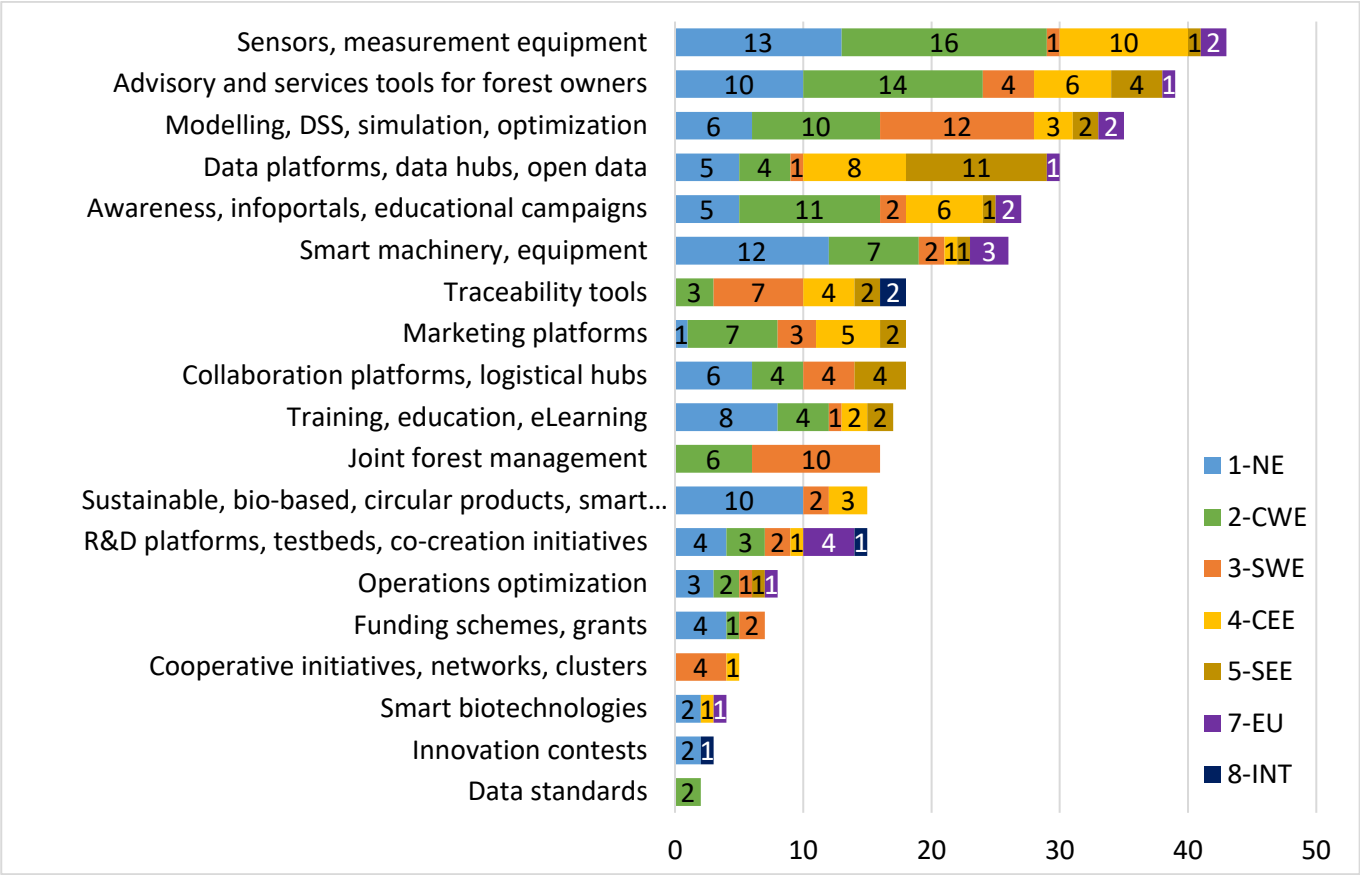

Figure: 4: Total number of best practices identified per solution type per Hub.

The majority of identified BPI can be categorized in the three solution types "Sensors, measurement, equipment" (43), "Advisory and service tools for forest owners" (39) and "Modelling, DSS, simulation, optimization" (35). In all three categories at least one BPI from each regional Hub can be found. CWE and NE Hub provide most of the BPI identified, CEE and SWE Hub follow.

"Data standards" (2) and "Innovation contests" (3) are in contrast solution types which count only very few BPI

Following an analysis per Hub we can state that:

- NE Hub has identified BPI corresponding to nearly every solution type. It is the leading Hub having identified solutions in "Smart machinery, equipment" (12) and also adds a lot of BPI in the categories "Sensors, measurement equipment" (13), "Advisory and services tools for forest owners" (10) and "Sustainable, bio-based, circular products, smart materials" (10). There are no BPI from NE Hub corresponding to the solution type "Data standards", "Cooperative initiatives, networks, clusters", "Joint forest management" and "Traceability tools".

- CWE Hub has identified BPI corresponding to nearly every solution type. It is leading Hub having identified solutions in "Sensors, measurement equipment" (16) and also adds a lot of BPI in the categories "Advisory and services tools for forest owners" (14) and "Modelling, DSS, simulation, optimization" (10). It is the only Hub having identified BPI in the solution type "Data standards". There are no BPI from CWE Hub corresponding to the solution type "Innovation contests", "Smart

biotechnologies", "Cooperative initiatives, networks, clusters" and "Sustainable, bio-based, circular products, smart materials".

- SWE Hub has identified BPI corresponding to nearly every solution type. It is a leading Hub having identified solutions in "Modelling, DSS, simulation, optimization" (12) and also adds a lot of BPI in the categories "Joint forest management" (10) and "Traceability tools" (7). There are no BPI from SWE Hub corresponding to the solution type "Data standards", "Innovation contests" and "Smart biotechnologies".

- CEE Hub has identified BPI corresponding to a lot of solution types. It identified most of their BPI in the categories "Sensors, measurement equipment" (10), "Data platforms, data Hubs, open data" (8) and "Advisory and service tools for forest owners" (6). There are no BPI from CEE Hub corresponding to the solution types "Data standards", "Innovation contests", "Funding schemes, grants", "Operations optimization", "Joint forest management" and "Collaboration platforms, logistical Hubs".

- SEE Hub has identified BPI corresponding to more than the half of the listed solution types. It is the leading Hub having identified solutions in "Data platforms, data Hubs, open data" (11). It can further add some BPI in the categories "Advisory and services tools for forest owners" (4) and "Collaboration platforms, logistical Hubs" (4). There are no BPI from SEE Hub corresponding to the solution type "Data standards", "Innovation contests", "Smart biotechnologies", "Cooperative initiatives, networks, clusters", "Funding schemes, grants", "R&D platforms, testbeds, co-creation initiatives", "Sustainable, bio-based, circular products, smart materials" and "Joint forest management".

3.5 Interim Conclusion

Having gone through the individual steps of analysis above, we can now come to the following first conclusions:

- The main means of transfer in Europe seem to be located mainly in the northern regions, i.e. CWE and NE Hub. These regions count the highest number of identified BPI (see figure 1 and 2).
- The main means of transfer in Europe can be found in the domains "Inventory, assessment, monitoring", "Harvesting, logistics, transport, safety" and "Education, research, knowledge transfer (transversal)". These domain categories count the highest number of identified BPI (see figure 3).
- The main means of transfer in Europe can be categorized in the solution types "Sensors, measurement equipment", "Advisory and services tools for forest owners" and "Modelling, DSS, simulation, optimization". These solution type categories count the highest number of identified BPI (see figure 4).

4. Knowledge transfer between regions: Transfer of BPI among Hubs to cover gaps

Chapter 3 has focused on the identified BPI in Europe taking several analytical steps regarding their origin of the identified BPI, domain and solution type offered.

Chapter 4 now turns the focus to those BPI, which have been actively selected by the Hubs based on their identified gaps and needs. The selection of BPI by the Hubs has been done both from the own Hub (internally) and from other Hubs (externally) and will be analysed in detail below. For this purpose, the following aspects are highlighted:

- Number of BPI selected among Hubs
- Repartition of the selections per Hub
    - Number of BPI selected per Hub internally (from own Hub)
    - Number of BPI selected per Hub externally (from other Hubs)
    - Number of BPI selected per Hub per domain (internally and externally)
    - Number of BPI selected per Hub per solution type (internally and externally)
- Most relevant BPI for transfer: selected BPI by 2 Hubs or more

4.1 Presentation of the BPI selected among Hubs (Statistics)

After the SWOT analysis done within the Hubs, the 346 identified BPI have been screened to respond to the Hub's respective weaknesses and threats. This led to a selection of BPI which is presented below (y representing "yes" = selected, - representing "no" = not selected).

Hubs	Nb. of BPI (not) selected
1-NE	**91**
selected	43
2-CWE	**94**
selected	46
3-SWE	**58**
selected	31
4-CEE	**51**
selected	13
5-SEE	**31**
selected	7
7-EU	**17**
selected	4
8-INT	**4**
selected	1
Total BPI identified	**346**
Total BPI selected	**145**

Table 5: Number of selected best practices by their origin.

Focusing only on the selected BPI, the following table emerges from the above:

In total, 145 out of 346 Best Practices have been selected as relevant to support local innovation and cover the gaps of the respective Hubs. The table shows how many BPI were selected per Hub from the overall amount of identified BPI. In the table and bar chart they are arranged by their origin (from which Hub they come).

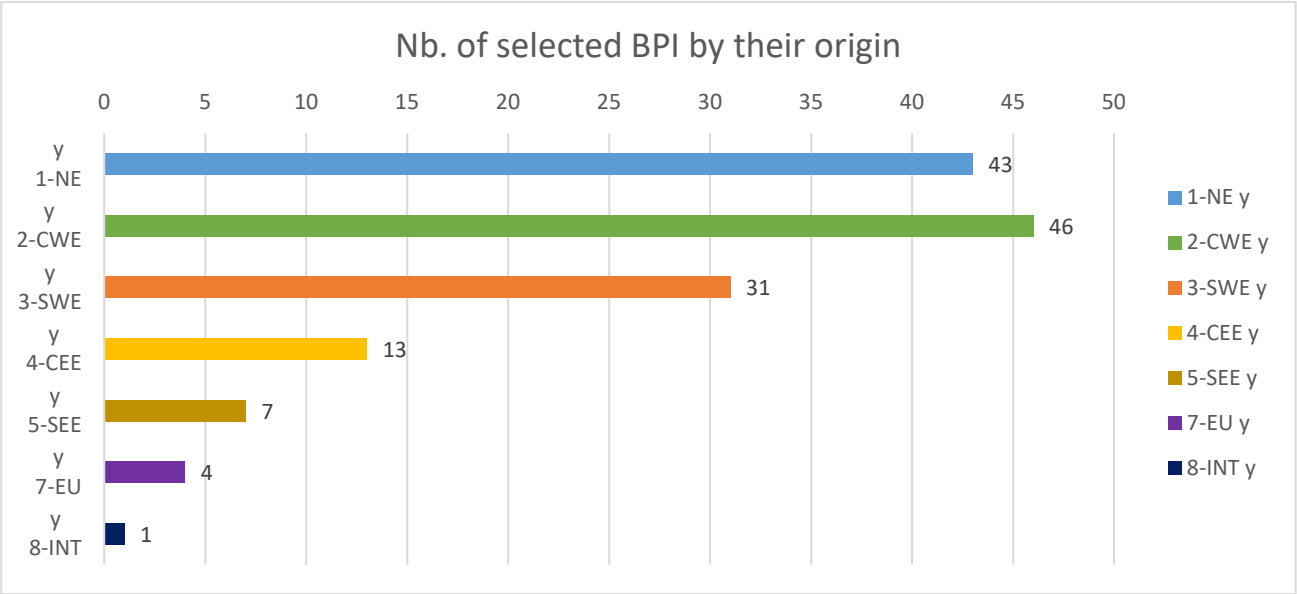

Figure 5: Number of selected best practices by their origin.

The analysis shows that most of the selected BPIcome from CWE (46) and NE Hub (43), which corresponds to the geographical distribution of all identified BPI (see figure 1). This means that the main interest in the regions concerned in on BPI coming from these Hubs, then a main knowledge transfer from the North to the South and East of Europe.

4.2 Repartition of the selections

The following analysis show the number of selected BPI arranged by each Hub's selection (from where the selected BPI come). This allows an analysis to determine the number of selected BPI coming from the Hub internally (own Hub's BPI) and externally (other Hubs' BPI). The selection of BPI within an own Hub represents a transfer possibility of the BPI between countries within the Hub.

NE Hub

NE Hub	Hub of origin				
Selection	1-NE	2-CWE	3-SWE	4-CEE	Total result
	18	6	2	2	28
Total result	**18**	**6**	**2**	**2**	**28**

Table 6: Repartition of selected BPI by NE Hub.

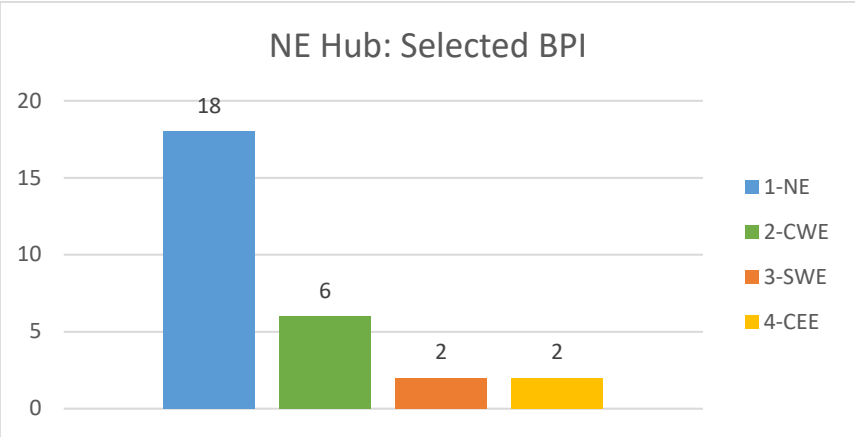

Figure 6: Repartition of selected BPI by NE Hub.

The NE Hub selected 28 BPI in total.

Of the 28 selected BPI, 18 come from NE Hub internally and 10 come from other Hubs: 6 from CWE Hub, 2 from SWE Hub and 2 from CEE Hub.

NE Hub selected no BPI from SEE Hub.

CWE Hub

CWE Hub	Hub of origin				
Selection	1-NE	2-CWE	3-SWE	7-EU	Total result
y	21	26	9	1	57
Total result	**21**	**26**	**9**	**1**	**57**

Table 7: Repartition of selected BPI by CWE Hub.

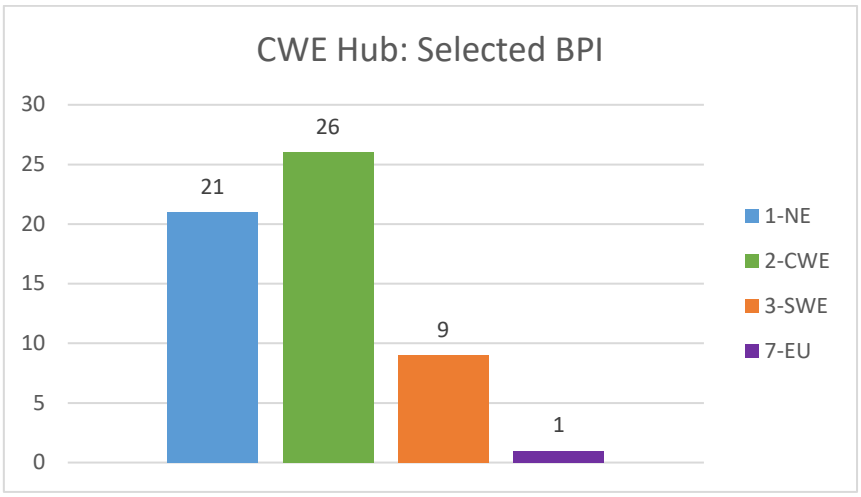

Figure: 7: Repartition of selected BPI by CWE Hub.

The CWE Hub selected 57 BPI in total.

Of the 57 selected BPI, 26 come from CWE Hub internally and 31 come from other Hubs: 21 from NE Hub, 9 from SWE Hub and 1 from EU.

CWE Hub selected no BPI from CEE and SEE Hub.

SWE Hub

SWE Hub	Hub of origin						
Selection	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
y	8	12	26	5	5	2	58
Total result	**8**	**12**	**26**	**5**	**5**	**2**	**58**

Table 8: Repartition of selected BPI by SWE Hub.

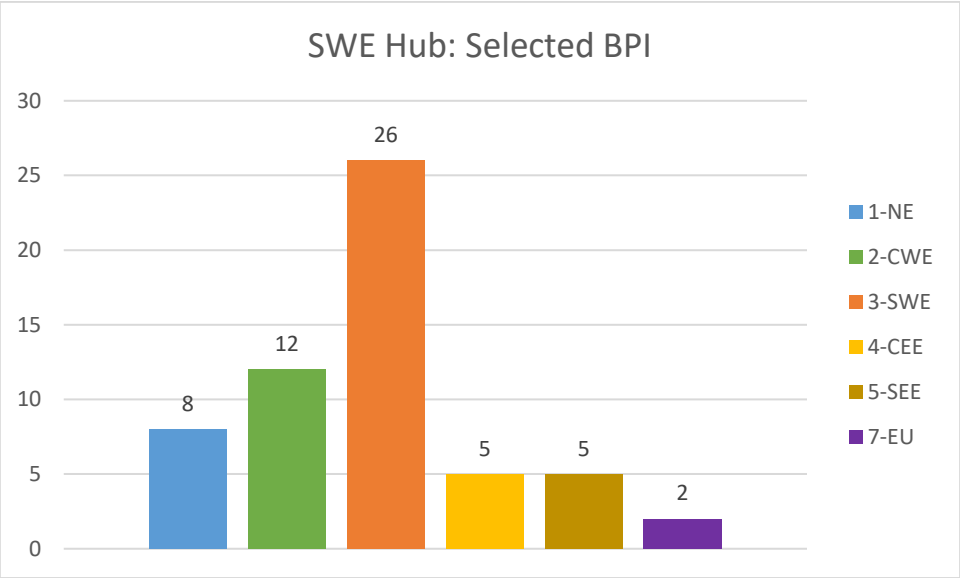

Figure 8: Repartition of selected BPI by SWE Hub.

The SWE Hub selected 58 BPI in total.

Of the 58 selected BPI, 26 come from SWE Hub internally and 32 come from other Hubs: 8 from NE Hub, 12 from CWE Hub, 5 from CEE Hub, 5 from SEE Hub and 2 from EU.

CEE Hub

CEE Hub	Hub of origin						
Selection	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
y	8	11	3	10	4	1	37
Total result	**8**	**11**	**3**	**10**	**4**	**1**	**37**

Table 9: Repartition of selected BPI by CEE Hub.

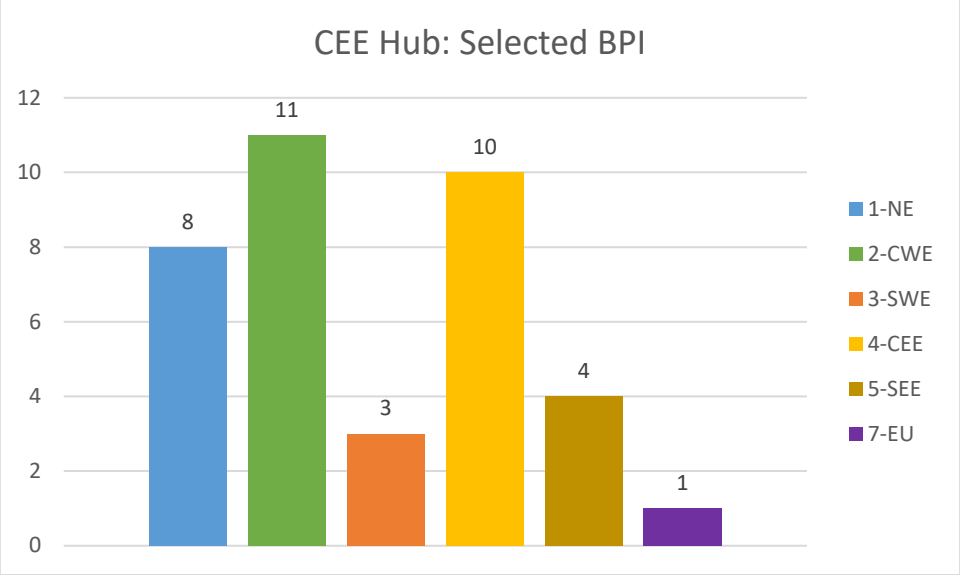

Figure 9: Repartition of selected BPI by CEE Hub.

The CEE Hub selected 37 BPI in total.

Of the 37 selected BPI, 10 come from CEE Hub internally and 27 come from other Hubs: 8 from NE Hub, 11 from CWE Hub, 3 from SWE Hub, 4 from SEE Hub and 1 from EU.

SEE Hub

SEE Hub	Hub of origin					
Selection	1-NE	2-CWE	3-SWE	4-CEE	8-INT	Total result
y	8	17	2	2	1	30
Total result	**8**	**17**	**2**	**2**	**1**	**30**

Table 10: Repartition of selected BPI by SEE Hub.

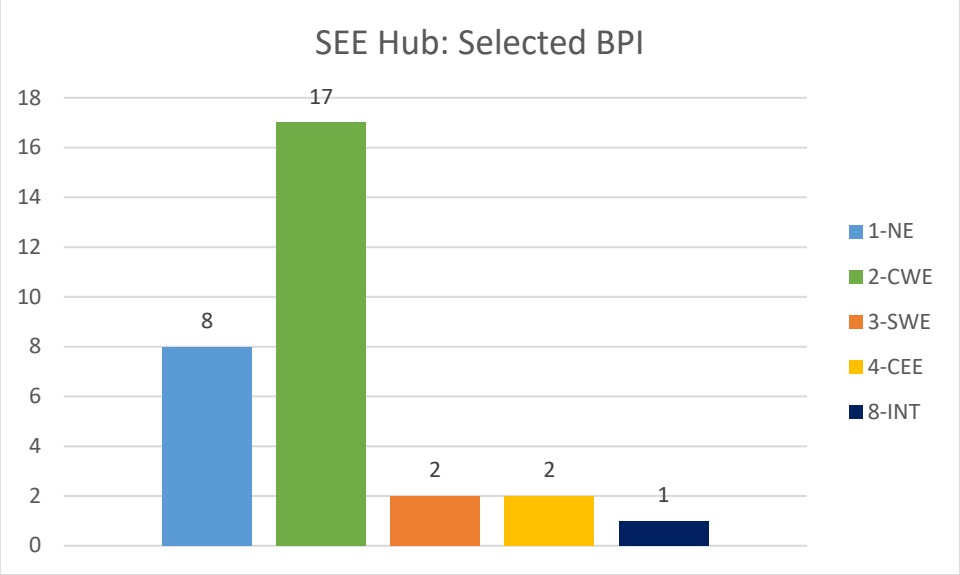

Figure 10: Repartition of selected BPI by SEE Hub.

The SEE Hub selected 30 BPI in total.

Of the 30 selected BPI, 0 come from SEE Hub internally and 30 come from other Hubs: 8 from NE Hub, 17 from CWE Hub, 2 from SWE Hub, 2 from CEE Hub and 1 from International.

4.3 Number of BPI selected per hub per domain (internal and external)

The following tables and charts show the number of selected BPI per domain arranged by each Hub's selection (from where the selected BPI come). This allows an analysis to determine the number of selected BPI per domain coming from the Hub internally (own Hub's BPI) and externally (other Hubs' BPI).

NE Hub

Selection by NE Hub	Hubs of origin				
Domains	1-NE	2-CWE	3-SWE	4-CEE	Total result
Education, research, knowledge transfer (transversal)	6	1			7
Financing, funding schemes	2				2
Forest disturbances, risks, disaster response	3				3
Forest management, ecosystem services, resilience			1		1
Forest-based industries, bio/circular economy, value chain	2			1	3
Harvesting, logistics, transport, safety	3	2			5
Innovation management, digital hubs, clusters, exploitation		1	1		2
Inventory, assessment, monitoring	1	2		1	4
Ownership, cooperation	1				1
Total result	**18**	**6**	**2**	**2**	**28**

Table 11: Repartition of selected BPI by NE Hub per domain.

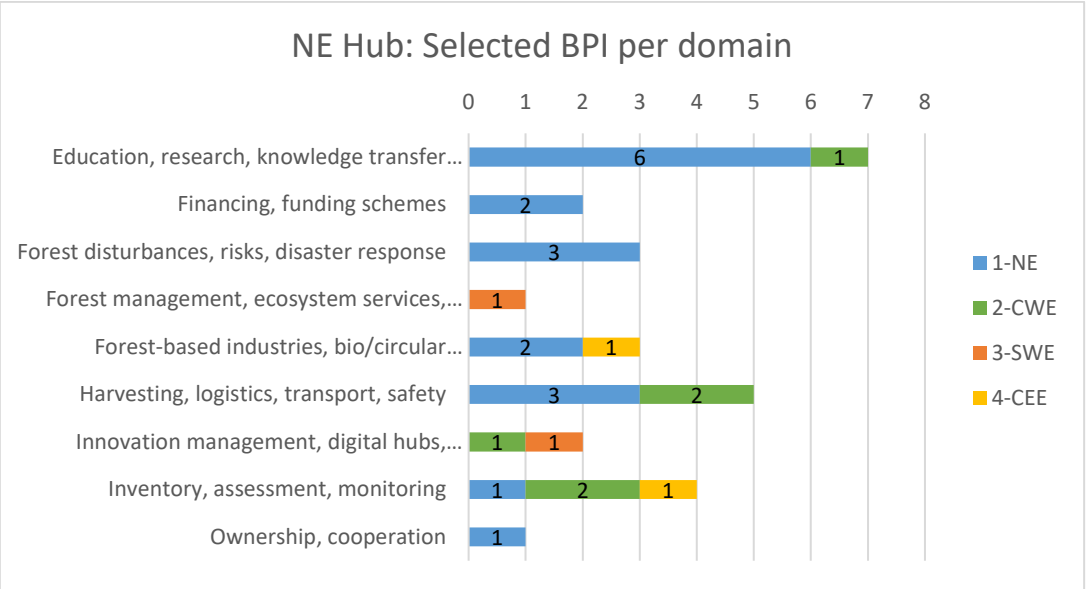

Figure 11: Repartition of selected BPI by NE Hub per domain.

The NE Hub selected most of the BPI in the domain "Education, research, knowledge transfer (transversal)" (7). Nearly all BPI from this domain have been selected from NE Hub internally (6).

In the domain categories "Forest management, ecosystem services, resilience" (1) and "Innovation management, digital Hubs, clusters, exploitation" (2) exclusively BPI coming from other Hubs (SWE and CWE) have been selected by NE Hub.

CWE Hub

Selection by CWE Hub	Hubs				
Domains	1-NE	2-CWE	3-SWE	7-EU	Total result
Education, research, knowledge transfer (transversal)	3	6	2		11
Financing, funding schemes	1				1
Forest disturbances, risks, disaster response	2				2
Forest management, ecosystem services, resilience	2	2			4
Forest-based industries, bio/circular economy, value chain	1				1
Harvesting, logistics, transport, safety	5	6	2	1	14
Innovation management, digital Hubs, clusters, exploitation		1			1
Inventory, assessment, monitoring	4	9	3		16
Ownership, cooperation	2	1	2		5
Products, markets, trade	1	1			2
Total result	**21**	**26**	**9**	**1**	**57**

Table 12: Repartition of selected BPI by CWE Hub per domain.

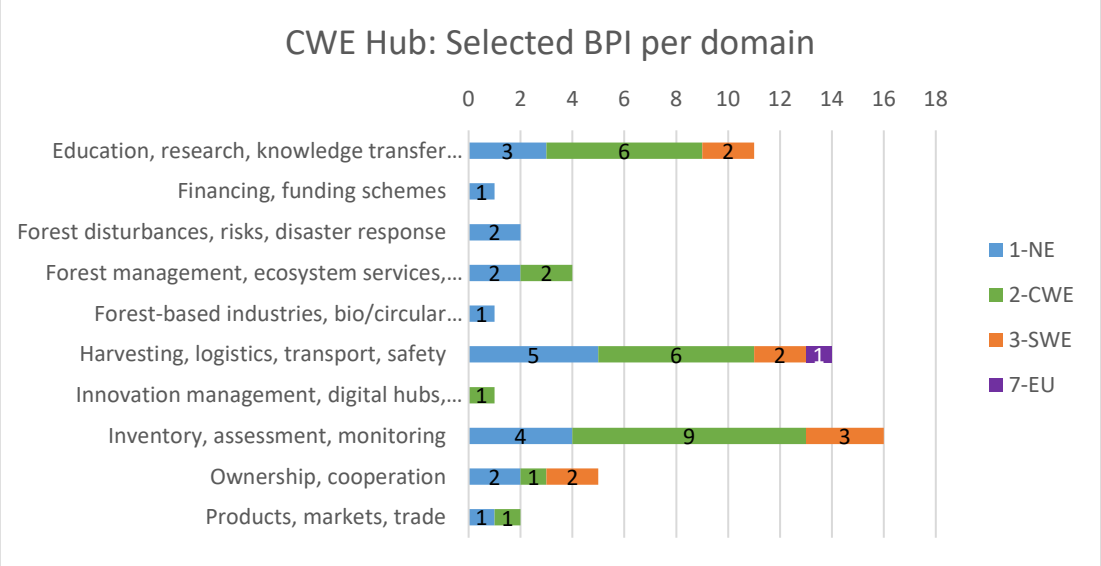

Figure 12: Repartition of selected BPI by CWE Hub per domain.

The CWE Hub selected most of the BPI in the domain "Inventory, assessment, monitoring" (16). Most of the BPI from this domain have been selected from CWE Hub internally (9).

In the domain categories "Financing, funding schemes" (1), "Forest disturbances, risks, disaster response" (2) and "Forest-based industries, bio/circular economy, value chain" (1) exclusively BPI coming from NE Hub have been selected by CWE Hub.

SWE Hub

Selection by SWE Hub	Hubs						
Domains	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
Education, research, knowledge transfer (transversal)	2	2	4				8
Financing, funding schemes	1	1	1				3
Forest disturbances, risks, disaster response	1		1				2
Forest management, ecosystem services, resilience		1	2		1		4
Forest-based industries, bio/circular economy, value chain			2	1		1	4
Harvesting, logistics, transport, safety	2	6	4	1	2	1	16
Innovation management, digital Hubs, clusters, exploitation			2				2
Inventory, assessment, monitoring	1		5	2			8
Ownership, cooperation	1	2	2		1		6
Products, markets, trade			3	1	1		5
Total result	**8**	**12**	**26**	**5**	**5**	**2**	**58**

Table 13: Repartition of selected BPI by SWE Hub per domain.

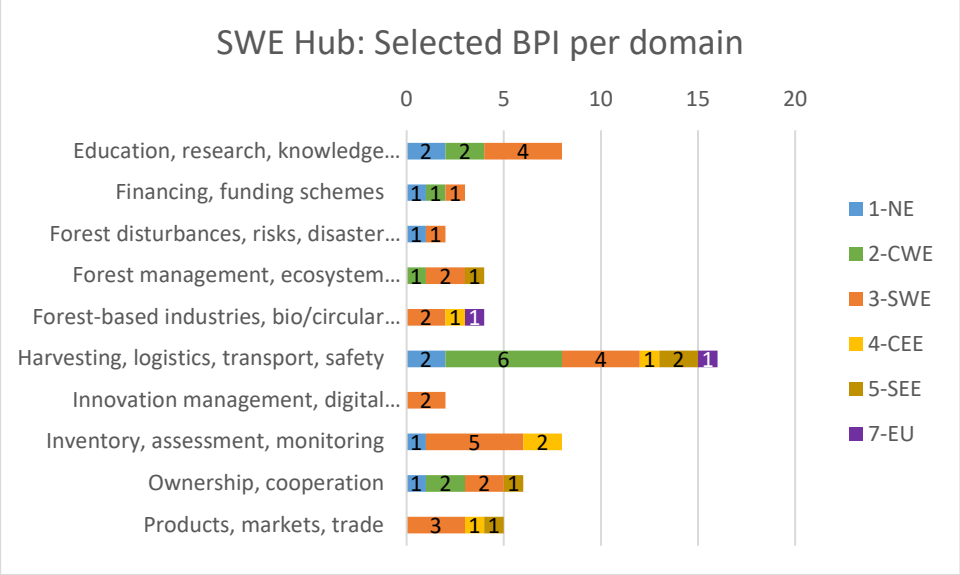

Figure 13: Repartition of selected BPI by SWE Hub per domain.

The SWE Hub selected most of the BPI in the domain "Harvesting, logistics, transport, safety" (16). Most of the selected BPI from this domain are coming from CWE Hub (6).

In the domain "Inventory, assessment, monitoring" 8 BPI have been selected by SWE Hub, including 5 coming from SWE Hub internally.

All domains include selected BPI coming from SWE Hub internally.

CEE Hub

Selection by CEE Hub	Hubs						
Domains	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
Education, research, knowledge transfer (transversal)	2	2					4
Financing, funding schemes	1						1
Forest disturbances, risks, disaster response	2			1	1		4
Forest management, ecosystem services, resilience			1	1	2		4
Forest-based industries, bio/circular economy, value chain				1			1
Harvesting, logistics, transport, safety		1	1	1	1	1	5
Innovation management, digital hubs, clusters, exploitation		2					2
Inventory, assessment, monitoring	2	3		5			10
Ownership, cooperation	1	1	1				3
Products, markets, trade		2		1			3
Total result	**8**	**11**	**3**	**10**	**4**	**1**	**37**

Table 14: Repartition of selected BPI by CEE Hub per domain.

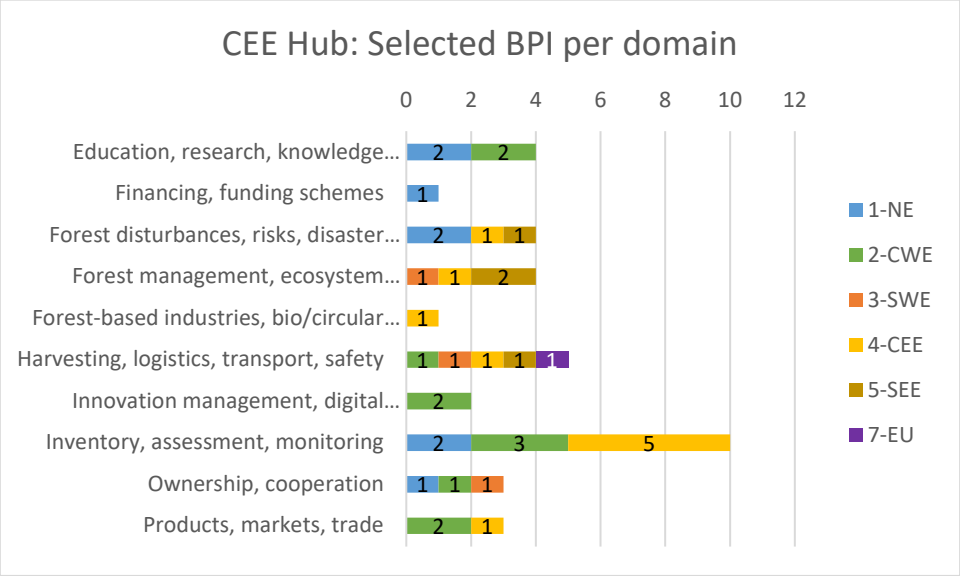

Figure 14: Repartition of selected BPI by CEE Hub per domain.

The CEE Hub selected most of the BPI in the domain "Inventory, assessment, monitoring" (10). Half of the selected BPI from this domain have been selected from CEE Hub internally (5).

In the domain categories "Education, research, knowledge transfer (transversal) (4)", "Financing, funding schemes" (1), "Innovation management, digital Hubs, clusters, exploitation" (2) and "Ownership, cooperation" (3) exclusively BPI coming from other Hubs (NE, CWE, SWE) have been selected by CEE Hub.

SEE Hub

Selection by SEE Hub	Hubs					
Domains	1-NE	2-CWE	3-SWE	4-CEE	8-INT	Total result
Education, research, knowledge transfer (transversal)	3	3				6
Financing, funding schemes	1		1			2
Forest management, ecosystem services, resilience	1	2				3
Harvesting, logistics, transport, safety		2		1	1	4
Innovation management, digital Hubs, clusters, exploitation		2	1			3
Inventory, assessment, monitoring	2	3		1		6
Ownership, cooperation		2				2
Products, markets, trade	1	3				4
Total result	**8**	**17**	**2**	**2**	**1**	**30**

Table 15: Repartition of selected BPI by SEE Hub per domain.

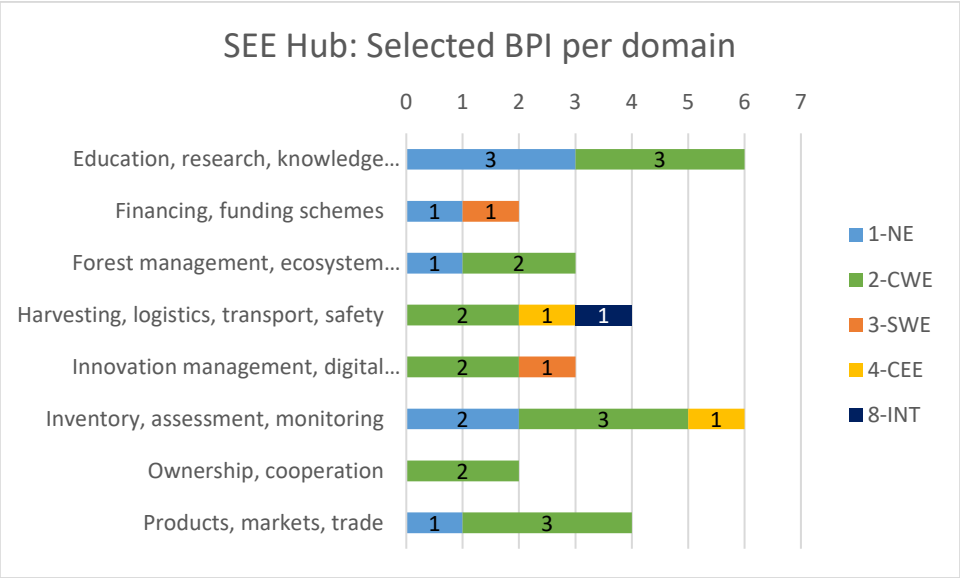

Figure 15: Repartition of selected BPI by SEE Hub per domain.

The SEE Hub selected most of the BPI in the domain "Education, research, knowledge transfer (transversal)" (6) and "Inventory, assessment, monitoring" (6). Most of the selected BPI from these domains come from NE and CWE Hub.

SEE Hub selected exclusively BPI coming from other Hubs, therefore no BPI from SEE Hub are included in the selection.

4.4 Number of BPI selected per hub per solution type (internal and external)

The following tables and charts show the number of selected BPI per solution type arranged by each Hub's selection (from where the selected BPI come). This allows an analysis to determine the number of selected BPI per solution type coming from the Hub internally (own Hub's BPI) and externally (other Hubs' BPI).

NE Hub

Selection by NE Hub	Hubs Hub of origin				
Solution type	1-NE	2-CWE	3-SWE	4-CEE	Total result
Advisory and services tools for forest owners	1				1
Awareness, infoportals, educational campaigns	3				3
Collaboration platforms, logistical hubs	1				1
Funding schemes, grants	2				2
Modelling, DSS, simulation, optimization	1	1	1		3
Operations optimization	2				2
R&D platforms, testbeds, co-creation initiatives			1		1
Sensors, measurement equipment	2	2		2	6
Smart machinery, equipment	3	2			5
Sustainable, bio-based, circular products, smart materials	1				1
Traceability tools		1			1
Training, education, eLearning	2				2
Total result	**18**	**6**	**2**	**2**	**28**

Table 16: Repartition of selected BPI by NE Hub per solution type.

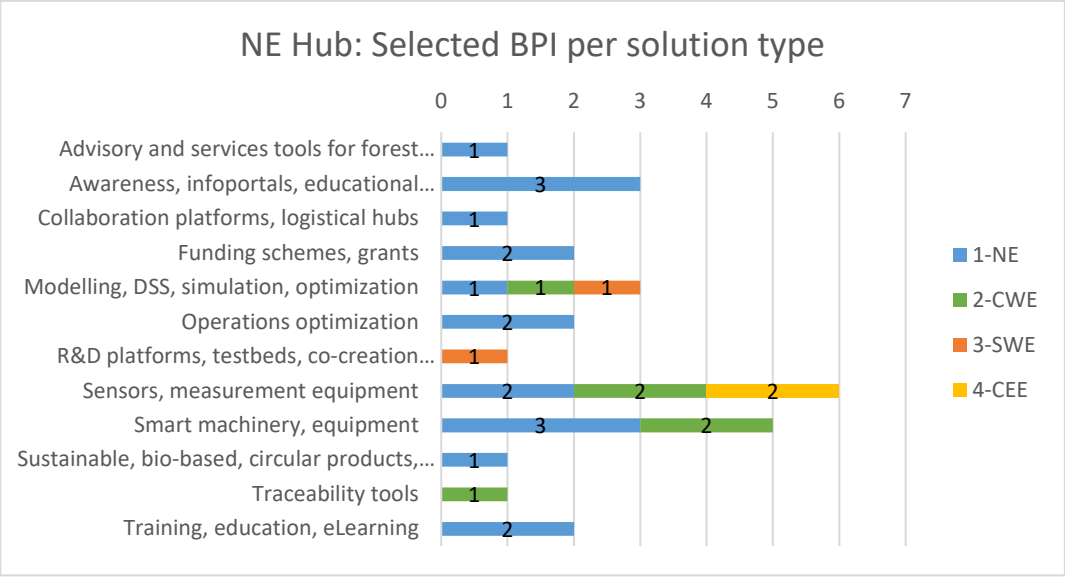

Figure 16: Repartition of selected BPI by NE Hub per solution type.

The NE Hub selected most of the BPI providing a solution in the category "Sensors, measurement, equipment" (6). Here 2 of the BPI have been selected from NE Hub internally.

In the solution categories "R&D platforms, testbeds, co-creation initiatives" (1) and "Traceability tools" (1) exclusively BPI coming from other Hubs (SWE, CWE) have been selected by NE Hub.

CWE Hub

Selection by CWE Hub	Hubs Hub of origin				
Solution type	1-NE	2-CWE	3-SWE	7-EU	Total result
Advisory and services tools for forest owners	2	3			5
Awareness, infoportals, educational campaigns	3	6	1		10
Collaboration platforms, logistical Hubs	4	3	2		9
Data standards		1			1
Funding schemes, grants	2				2
Joint forest management		1			1
Marketing platforms		1			1
Modelling, DSS, simulation, optimization	2	3	3		8
Operations optimization			1		1
R&D platforms, testbeds, co-creation initiatives	1				1
Sensors, measurement equipment	5	5		1	11
Smart machinery, equipment	1	3	1		5
Sustainable, bio-based, circular products, smart materials	1				1
Training, education, eLearning			1		1
Total result	**21**	**26**	**9**	**1**	**57**

Table 17: Repartition of selected BPI by CWE Hub per solution type.

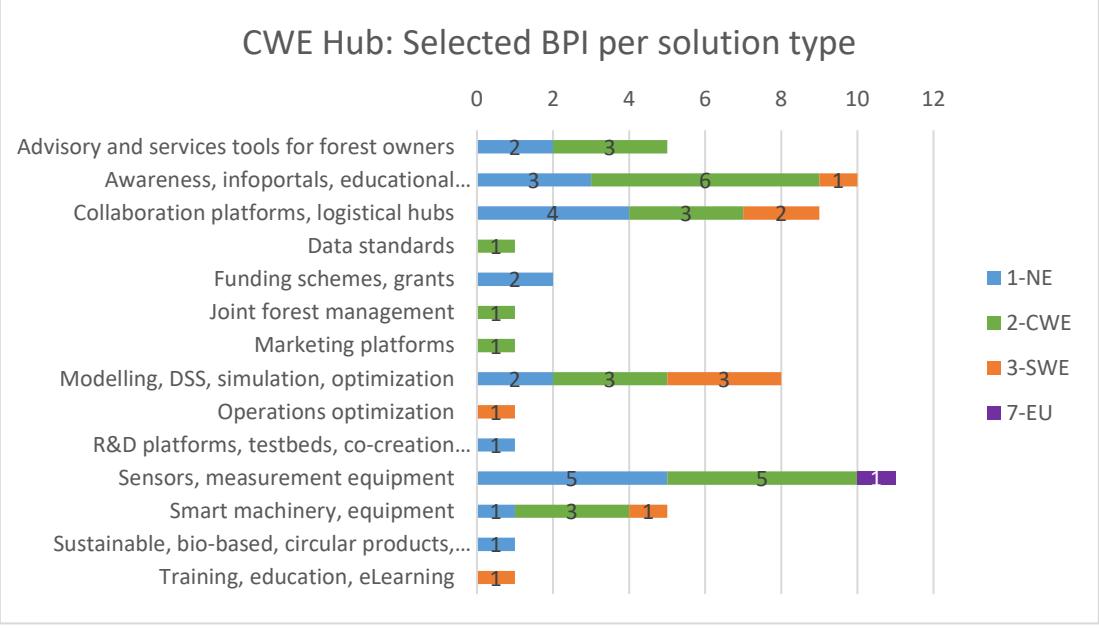

Figure 17: Repartition of selected BPI by CWE Hub per solution type.

The CWE Hub selected most of the BPI providing a solution in the category "Sensors, measurement, equipment" (11). Here most of the BPI have been selected from CWE Hub internally (5) and NE Hub (5).

In the solution type categories “Funding schemes, grants” (2), “Operations optimization” (1), “R&D platforms, testbeds, co-creation initiatives” (1), “Sustainable, bio-based, circular products, smart materials” (1) and “Training, education, eLearning” (1) exclusively BPI coming from other Hubs have been selected by CWE Hub (NE, SWE). However, in the three solution type categories “Data Standards”, “Joint forest management” and “Marketing platforms” only BPI stemming from the CWE Hub have been selected.

SWE Hub

Selection by SWE Hub	Hubs Hub of origin						
Solution types	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
Advisory and services tools for forest owners	1	3	2				6
Awareness, infoportals, educational campaigns	1		1	1			3
Collaboration platforms, logistical Hubs	3	3	1				7
Cooperative initiatives, networks, clusters			1				1
Data platforms, data Hubs, open data					1		1
Funding schemes, grants	1		1				2
Joint forest management		1	2				3
Marketing platforms			2	1	1		4
Modelling, DSS, simulation, optimization			7		1		8
Operations optimization					1		1
R&D platforms, testbeds, co-creation initiatives			1			2	3
Sensors, measurement equipment	1	2					3
Smart machinery, equipment		1	2				3
Sustainable, bio-based, circular products, smart materials			1				1
Traceability tools			5	3	1		9
Training, education, eLearning	1	2					3
Total result	**8**	**12**	**26**	**5**	**5**	**2**	**58**

Table 18: Repartition of selected BPI by SWE Hub per solution type.

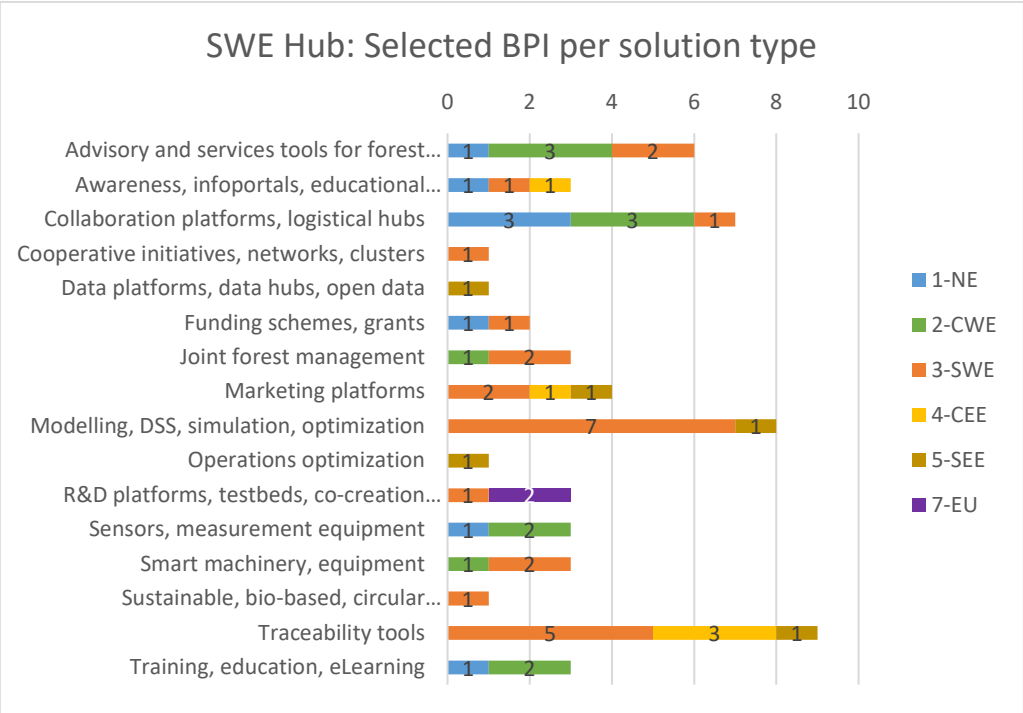

Figure 18: Repartition of selected BPI by SWE Hub per solution type.

The SWE Hub selected most of the BPI providing a solution in the category "Modelling,DSS, simulation, optimization" (8). Here nearly all of the BPI have been selected from SWE Hub internally.

In the solution categories "Data platforms, data Hubs, open data" (1), "Operations optimization" (1), "Sensors, measurement equipment" (3) and "Training, education, eLearning" (3) exclusively BPI coming from other Hubs (SEE, NE, CWE) have been selected by SWE Hub.

CEE Hub

Selection by CEE Hub	Hubs Hub of origin						
Solution types	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
Advisory and services tools for forest owners		3		1			4
Awareness, infoportals, educational campaigns		2		1	1		4
Collaboration platforms, logistical Hubs	1		1				2
Data platforms, data Hubs, open data	1			2	1		4
Funding schemes, grants	1						1
Marketing platforms				1	1		2
Modelling, DSS, simulation, optimization	1	1	1				3
R&D platforms, testbeds, co-creation initiatives		2					2
Sensors, measurement equipment	2			3			5
Smart machinery, equipment		3				1	4
Traceability tools			1	2	1		4
Training, education, eLearning	2						2
Total result	**8**	**11**	**3**	**10**	**4**	**1**	**37**

Table 19: Repartition of selected BPI by CEE Hub per solution type.

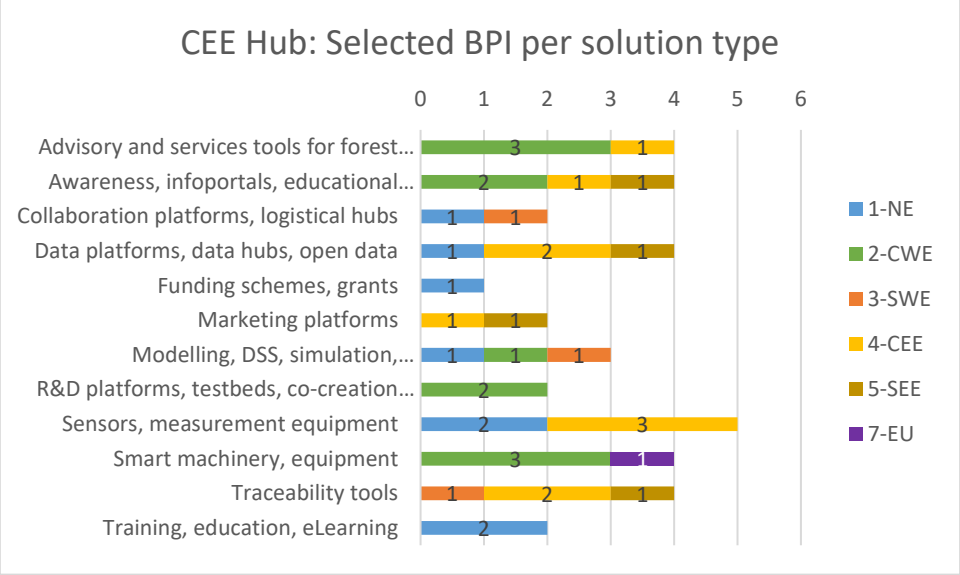

Figure 19: Repartition of selected BPI by CEE Hub per solution type.

The CEE Hub selected most of the BPI providing a solution in the category “Sensors, measurement equipment” (5). Here most of the BPI have been selected from CEE Hub internally (3).

In the solution type categories “Collaboration platforms, logistical Hubs” (2), “Funding schemes, grants” (1), “Modelling, DSS, simulation, optimization” (3), “R&D platforms, testbeds, co-creation initiatives” (2), “Smart machinery, equipment” (4) and “Training, education, eLearning” (2) exclusively BPI coming from other Hubs (NE, SWE, CWE, EU) have been selected by CEE Hub.

SEE Hub

Selection by SEE Hub	Hubs Hub of origin					
Solution types	1-NE	2-CWE	3-SWE	4-CEE	8-INT	Total result
Advisory and services tools for forest owners		6				6
Awareness, infoportals, educational campaigns		2				2
Collaboration platforms, logistical Hubs		2				2
Data platforms, data Hubs, open data	1			1		2
Funding schemes, grants	1		1			2
Joint forest management		1				1
Modelling, DSS, simulation, optimization	1	1				2
Operations optimization		1				1
R&D platforms, testbeds, co-creation initiatives		1	1		1	3
Sensors, measurement equipment	1	1				2
Smart machinery, equipment		1				1
Sustainable, bio-based, circular products, smart materials	1					1
Traceability tools		1		1		2
Training, education, eLearning	3					3
Total result	**8**	**17**	**2**	**2**	**1**	**30**

Table 20: Repartition of selected BPI by SEE Hub per solution type.

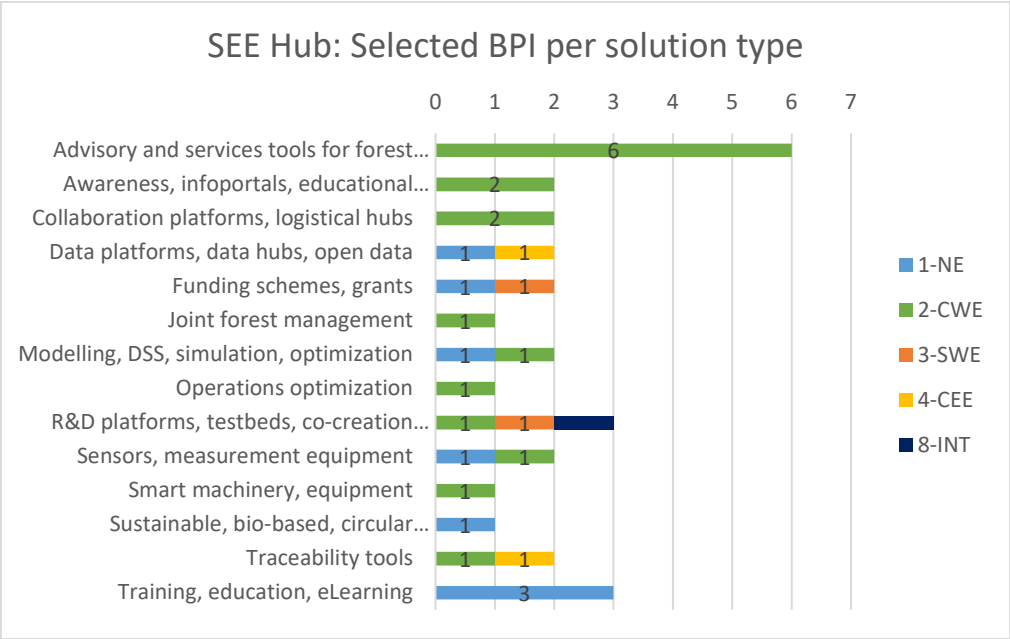

Figure 20: Repartition of selected BPI by SEE Hub per solution type.

The SEE Hub selected most of the BPI providing a solution in the category "Advisory and services tools for forest owners" (6). Here all BPI come from CWE Hub.

SEE Hub selected exclusively BPI coming from other Hubs, therefore no BPI from SEE Hub are included in the selection.

4.5 Most relevant BPI for transfer: BPI selected by 2 Hubs or more (List and domains) and from where they are coming

The following table and chart show the number of BPI which have been selected by at least two Hubs, arranged by domain and Hub of origin. This allows an analysis to determine in general the most relevant BPI for transfer.

BPI Selection by 2 Hubs or more	Hubs					
Domains	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	Total result
Education, research, knowledge transfer (transversal)	3	2	1			6
Financing, funding schemes	2		1			3
Forest disturbances, risks, disaster response	2					2
Forest management, ecosystem services, resilience	1	1	1		1	4
Forest-based industries, bio/circular economy, value chain				1		1
Harvesting, logistics, transport, safety	2	6	1	1	1	11
Innovation management, digital Hubs, clusters, exploitation		2	1			3

Inventory, assessment, monitoring	2	5	2	2		11
Ownership, cooperation	1	2	2			5
Products, markets, trade	1	2		1		4
Total result	**14**	**20**	**9**	**5**	**2**	**50**

Table 21: Repartition of most relevant BPI for transfer by domain and Hub of origin.

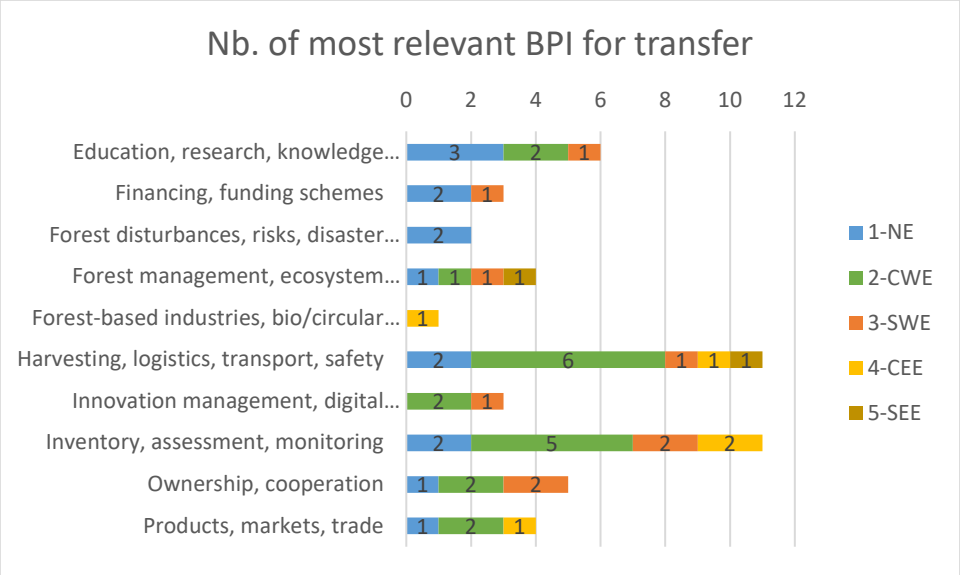

Figure 21: Repartition of most relevant BPI for transfer by domain and Hub of origin.

In total 50 BPI have been selected at least two times and can therefore be considered as the 50 most relevant BPI for transfer. They are listed in Annex 2.

Most of the BPI which have been selected at least two times can be categorized in the domains "Harvesting, logistics, transport, safety" (11) and "Inventory, assessment, monitoring" (11). These seem to be the most demanded and popular fields for BPI across all Hubs. However, this observation relates to the fact that these two domains represent in general those where most of the BPI have been identified (see figure 3) Therefore the high number of selected BPI in these two domains is also partially given due to the total high number of BPI gathered, i.e. the probability of selection/transfer rises the higher these BPI domains are represented in the overall collection.

Regarding the origin of BPI we can state that:

- In the two most popular domains "Harvesting, logisitcs, transport, safety" and "Inventory, assessment, monitoring" most of the repeatedly selected BPI come from CWE Hub. In the domain "Forest disturbances, risks, disaster response" (2) only 2 BPI from the NE Hub have been selected at least two times. In the domain "Forest-based industries, bio/circular economy, value chain" (1) only CEE Hub could identify 1 BPI that has been selected at least two times.

Most of the BPI selected at least two times come from the NE, CWE and SWE Hub, which mirrors the overall distribution of identified BPI among Hubs (see figure 1).

4.6 Interim Conclusion

Having gone through the individual steps of analysis above, we can now come to the following conclusions:

- The majority of selected BPI originate from the Hub internally. SEE Hub is the only one not having selected a BPI from its own Hub members.
- Most of the BPI selected externally by NE and CWE Hub come from one another.
- Most of the BPI selected externally by the other Hubs come from NE or CWE Hub.

In line with the majority of identified BPI in NE and CWE Hub (see figure 1), we can see that the selection of BPI is also largely concentrated on these two Hubs. Conversely, only a comparatively small number of BPI have been selected from the southern and eastern Hubs.

4.7 BPI from external or internal Hubs selected to solve specific gaps (knowledge flows between hubs)

As part of the individual Hub Roadmaps, each Hub identified BPI, both from all over Europe, which would solve the specific gaps they had identified (see section 2.2).

The following tables gather this information with the aim of summarising the knowledge flows between Hubs i.e. which Hubs have available solutions that could be helpful to support or solve the gaps of other (or their own) Hubs.

An important note for the below data is that the number of BPI originating from each Hub (columns) may not be added in order to establish a total number of BPI offered by one same Hub for a particular gap. Within the selection made by each Hub (row), care has been taken to not double-count any same BPI for the same gap category (as, for example, the same BPI could have been chosen in response to two or more different sub-gaps for the same Hub). However, it is still the case that different Hubs may choose the same BPI to deal with different gaps within the same category. Therefore, the sum of the columns does not represent a total number of BPI offered by each Hub. Instead, we refer to the number of times BPI from that Hub have been chosen in response to a particular gap. This still provides an indication of which Hub has identified BPI which are relevant to other Hubs in response to an existing gap.

GAP 1. Improve forest resilience and adaptation to climate change					
Hub making selection of BPI	**Hub from which BPI selected comes from**				
	NE	**CWE**	**SWE**	**CEE**	**SEE**
NE	2	1	2		
CWE	4	4			
SWE	1		5		1
CEE	2			1	3
SEE					

Table 22: Gap 1 – Hubs' BPI selection.

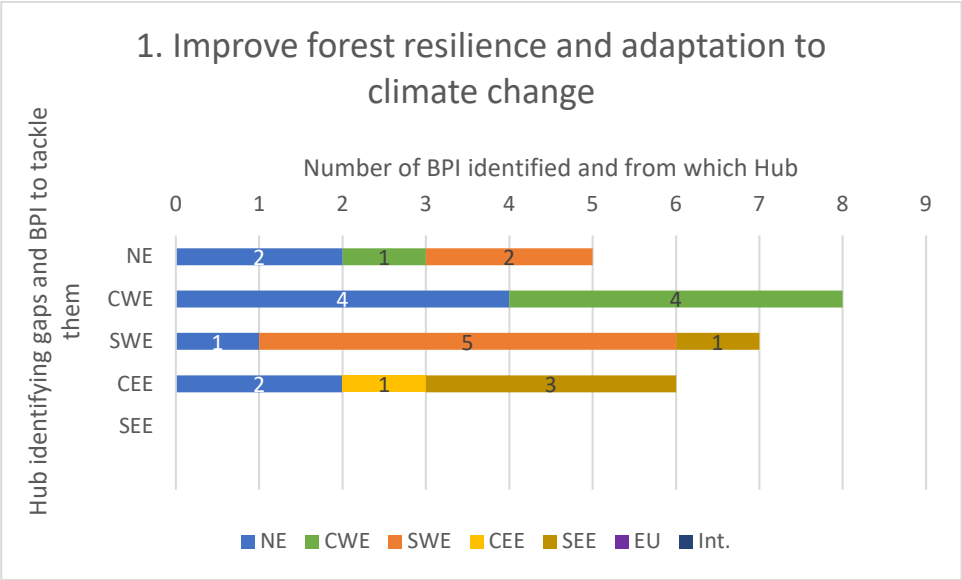

Figure 22: Gap 1 - Hubs' BPI selection.

From the above data we can gather the following understanding:

- NE Hub: Most BPI were chosen from either own Hub or SWE, followed by CWE Hub.
- CWE Hub: there is a clear balance between the selection of BPI from own Hub and from NE Hub, with no chosen BPI for this particular gap from the other Hubs.
- SWE Hub: there is a clear preference for BPI from own Hub, with slight input from NE and SEE regions.
- CEE Hub: Largest selection of BPI comes from SEE Hub, followed by NE Hub and one BPI from own Hub.
- SEE HUb: none of the identified weaknesses or threats for this Hub fit this particular category.

The Hub for which BPI were chosen the most number of times in response to this gap was NE Hub (8), closely followed by CWE Hub (7 times).

GAP 2. Improve infrastructure and capacity of public actors					
Hub making selection of BPs	**Hub from which BP selected comes from**				
	NE	**CWE**	**SWE**	**CEE**	**SEE**
NE	2	2			
CWE					
SWE	3	3	1		
CEE	1				
SEE	2	4	1		

Table 23: Gap 2- Hubs' BPI selection.

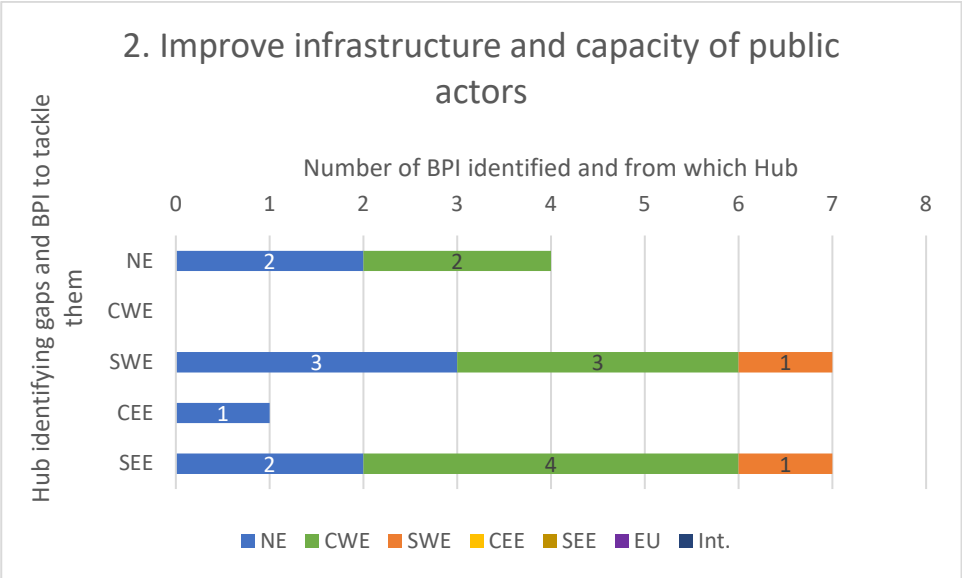

Figure 23: Gap 2 - Hubs' BPI selection.

For this gap category, the following results are summarised for each Hub:

- NE Hub: balanced number of BPI from own Hub and from CWE Hub regions.
- CWE Hub: none of the identified weaknesses or threats for this Hub fit this particular category.
- SWE Hub: balanced selection between BPI from NE and CWE Hub, with one BPI from own Hub.
- CEE Hub: only one BPI chosen, from NE Hub.
- SEE Hub: preference for BPI from CWE Hub, followed by NE Hub and one input from SWE Hub.

In response to this second Gap category "Improve infrastructure and capacity of public actors", there is a clear distinction on the selection of BPI from NE and CWE Hub. This suggests that these Hubs are particularly strong in having solutions which are relevant, both internally and externally, to support this specific gap.

GAP 3. Activate private owners and cooperative forest management							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE	9	5					
CWE	8	9	3				
SWE	1	5	8		1		
CEE	2	4	1	3	1		
SEE	4	11	2	1			

Table 24: Gap 3 - Hubs' BPI selection.

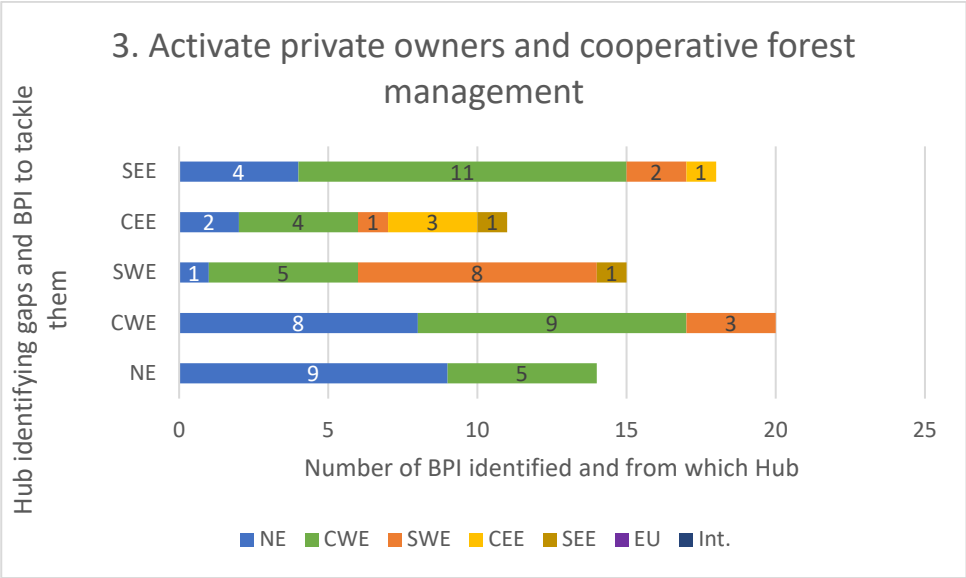

Figure 24: Gap 2 - Hubs' BPI selection.

The above data can be summarised as follows:

- NE Hub: strong preference for BPI from own Hub, followed by a significant input from CWE Hub but no other Hubs.
- CWE Hub: balanced input between selection of BPI from own Hub and from NE, with additional selection from SWE.
- SWE Hub: Strong preference for BPI from own Hub, followed by selection from CWE Hub and slight input from NE and SEE Hub:
- CEE Hub: relatively balanced input, having selected BPI from all five Hubs, especially from CWE Hub.
- SEE Hub: a strong focus on selection of BPI from CWE Hub, followed by NE, SWE and CEE Hub, with none selected from own Hub.

For the Gap category "Activate private owners and cooperative forest management", the Hub for which BPI were selected a highest number of times was CWE Hub. Overall, the strongest contributions in terms of selected BPI are from CWE and NE Hub.

GAP 4. Ensure a well-trained workforce through attractive skills development and education							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE	8	10					
CWE	2	1	1				
SWE							
CEE	2	2					
SEE	3	6					1

Table 25: Gap 4 - Hubs' BPI selection.

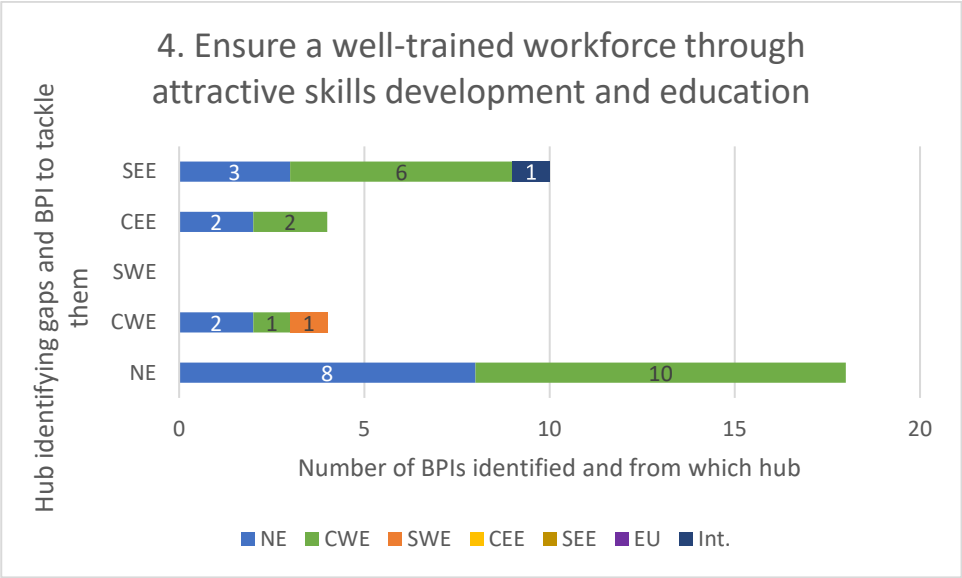

Figure 25: Gap 4 - Hubs' BPI selection.

The data above can be summarised as follows:

- NE Hub: The selected BPI are primarily from CWE Hub and from the own Hub.
- CWE Hub: relatively balanced selection of BPI coming from NE, SWE Hubs and own Hub.
- SWE Hub: the weaknesses and threats identified by SWE Hub did not fit this particular gap category.
- CEE Hub: a balanced selection between solutions identified by NE and by CWE Hub.
- SEE Hub: a strong selection of BPI from CWE Hub, followed by BPI from NE Hub and one international selection (BPI from Canada).

Overall, there is a strong preference for BPI from CWE and NE Hub selected in response to the gap category "Ensure well trained workforce through attractive skills development and education".

GAP 5. Enhance economic and environmental performance of forest supply chains							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE							
CWE	4	6	3				
SWE	2	4	10	2	1	1	
CEE		6	1	7	1		
SEE	4	7		1			1

Table 26: Gap 5 - Hubs' BPI selection.

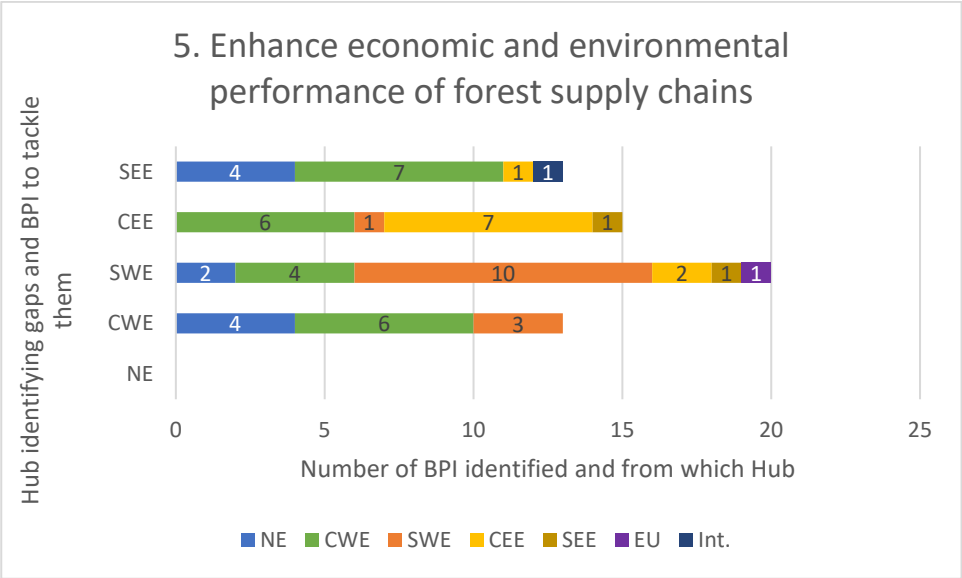

Figure 26: Gap 5 - Hubs' BPI selection.

The above data can be summarised as follows:

- NE Hub: the gaps (weaknesses and threats) identified by NE did not fit this main gap category.
- CWE Hub: Strong preference for selection of BPI from within the own Hub, followed by a balanced input of BPI from NE and SWE Hub.
- SWE Hub: a broad selection of BPI, with a strong focus on BPI identified within the Hub itself, followed by a range of BPI from all other Hubs and one European solution.
- CEE Hub: Wide range of BPI selected, from four out of five Hubs. The largest selection is from within the same Hub itself, followed closely by BPI from CWE Hub.
- SEE Hub: Relatively broad selection, including three Hubs and one International solution (BPI from Canada). The largest selection was of BPI from CWE Hub.

For the gap "Enhance economic and environmental performance of forest supply chains" it may be highlighted that three out of four Hubs which identified gaps that meet this category selected the largest number of BPI from their own Hub.

Overall, while CWE Hub shows the highest number of times for which its BPI were chosen, there is a strong contribution in terms of selected BPI from all five Hubs, and both European and International levels.

GAP 6. Grow the forest-based bioeconomy through circular use and value-added products							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE				1			
CWE	2	3					
SWE			2	3	2	1	
CEE	1	3		3			
SEE	1	1					

Table 27: Gap 6 - Hubs' BPI selection.

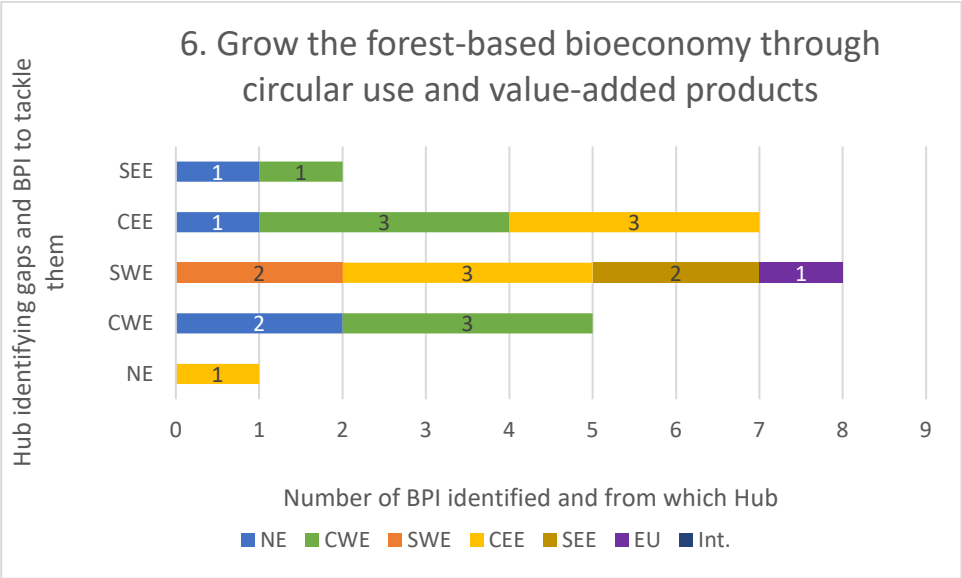

Figure 27: Gap 6 - Hubs' BPI selection.

The above data can be summarised as follows:

- NE Hub: This particular gap category is the only one for which the selection from NE Hub does not strongly prioritise BPI from the own NE Hub or from CWE Hub.
- CWE Hub: There is a preference for BPI selected from the Hub itself, followed by NE Hub.
- SWE Hub: A varied selection of BPI from CEE, SWE and SEE Hub, as well as one European contribution.
- CEE Hub: The main selection is made from own Hub BPI and from CWE Hub.
- SEE Hub: A balanced selection of BPI from only NE and CWE Hub.

For the gap "Grow the forest-based bioeconomy through circular use and value-added products" the selection of BPI is quite broadly distributed across all five Hubs.

GAP 7. Raise public awareness, social acceptance and political support for forestry.							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE	5	1					
CWE	2	5	4				
SWE	1	1	3				
CEE							
SEE							

Figure 28: Gap 7 - Hubs' BPI selection.

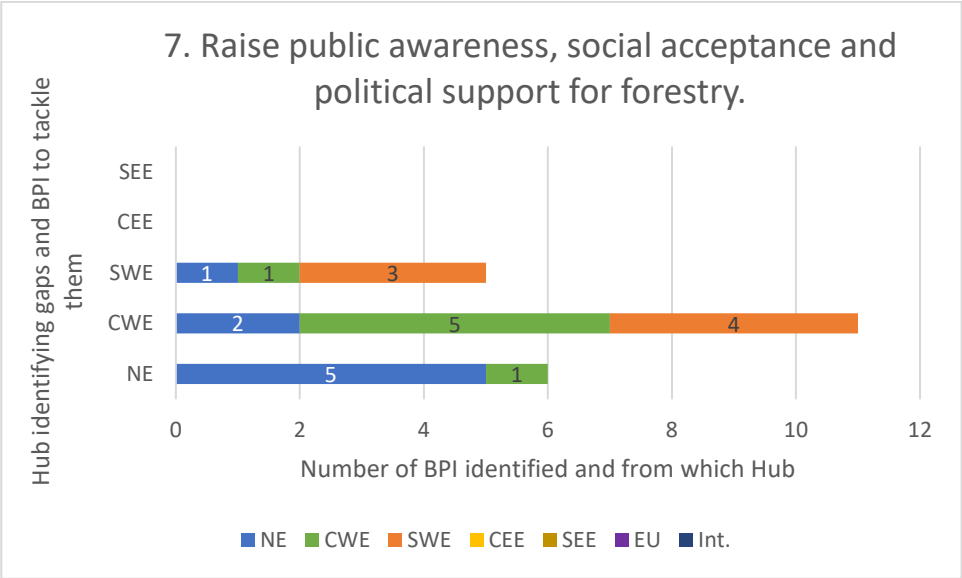

Figure 28: Gap 7 - Hubs' BPI selection.

Finally, for the last gap category, the following may summarise the above data:

- NE Hub: there is a strong focus from own BPI selection, with a slight contribution from CWE Hub.
- CWE Hub: while the highest number of BPI is selected from the own Hub, there is a significant contribution from SWE Hub.
- SWE Hub: a strong selection from own Hub, followed by equal input from NE and CWE Hub.

The Gap category "Raise public awareness, social acceptance and political support of forestry" may be characterised by Hubs having selected largely the BPI from their own Hubs. Overall, there is a clear focus on the selection of BPI from NE, CWE and SWE Hub, which are at the same time, the only three Hubs for which weaknesses and threats that fit this category were identified.

Overall:

- NE Hub: mostly selected internal and CWE Hub.
- CWE Hub: mostly internal, NE and SWE Hub.
- SWE Hub: Very varied selection across all Hubs while maintaining a strong selection of internal BPI
- CEE Hub: Overall relatively varied selection across all Hubs but the focus on selection of BPI from CWE, NE and internally from CEE Hub prevails.
- SEE Hub: A strong preference for selection of NE and CWE Hub BPI. Additional selection from CEE and SWE Hub is also in place.

5. Conclusion

The in-detail analysis of the Best Practices and Innovations (BPI) collected and their transfer between the five Hubs as well as within Hubs performed in the frame of this Cross-Regional Roadmap allows to draw conclusions regarding the interregional knowledge flows and the potential for increased collaboration between major regios of the European wood sector.

BPI collected by Hubs

In the collection of BPI, there is a notable **decrease in the number of BPI provided by Hubs from North to South**, resulting in a clear **prevalence of BPI from the Central-Western (CWE) and Northern Hub (NE)**, more specifically of BPI from Finland and Germany. A more detailed analysis of the topics covered by collected BPI reveals that the three domains most strongly represented in the Rosewood4.0 BPI collection are *"Inventory, assessment, monitoring"*, *"Harvesting, logistics, transport, safety"* and *"Education, research, knowledge transfer (transversal)"* (in that order), while *"Financing, funding schemes"* is the domain least covered. The overall prevalence of BPI from CWE and NE Hub is also mirrorred in the three domains most strongly represented, however, each Hub has provided at least one BPI in these domains, and in specific domains, other Hubs than CWE and NE Hub might lead in terms of BPI numbers.

On a similar note, not all of the three aforementioned domains are necessarily the strongest represented in individual Hub's BPI collection: The only domain being among the three BPI-strongest in each Hub is *"Inventory, assessment, monitoring"* with a major BPI contribution from the Central-Eastern Hub (CEE). The high BPI contribution of both CWE and NE Hub in the overall BPI collection has thus been considered as a relativizing factor throughout the analysis when drawing (interim) conclusions.

With respect to BPI solution types, "*Sensors, measurement, equipment*", *"Advisory and service tools for forest owners"*, and *"Modelling, DSS, simulation, optimization"* (in that order) accounted for the highest number of BPI, and *"Data Standards"* for the lowest. Here, same as with regard to BPI domains, every Hub has at least provided one BPI to each of the three highest BPI solution types with NE and CWE Hub taking the lead. On a Hub level, different BPI solution types than the three mentioned prevail in terms of BPI numbers. For instance, while "*Sensors, measurement, equipment*" is BPI-strongest, this solution type is not among the highest three BPI contributions for neither the South-Western Hub (SWE) nor the South-Eastern Hub (SEE). Another interesting aspect is that the Eastern Hubs (CEE and SEE) lead in the number of provided BPI in the fourth highest solution type, *"Data platforms, data hubs, open data"*. Overall, the distribution of BPI within different solution types shows a varied picture with a number of individual BPI prevalences.

BPI selection by Hubs – Knowledge Flows

The knowledge flows identified following the BPI selection of each Hub are mostly **internal** (within a Hub) and, if external, characterized by **knowledge flowing from NE and CWE Hub**. Regarding the overall focus in the selection of BPI from NE and CWE Hub, it is important to underline that the majority of BPI provided is likewise focused on these two Hubs, which makes a BPI selection from NE and CWE Hub more probable. In comparison, only a small number of BPI have been selected from the Southern and Eastern Hubs.

More specifically, CWE and NE Hub have a vivid knowledge exchange between each other as well as each a strong internal knowledge flow. These two Hubs also had a similar distribution of gaps as a starting point while CWE Hub also accounts for the broadest distribution of strengths across identified categories. SWE and CEE Hub have a comparatively broad selection of BPI with knowledge input from various Hubs including a notable internal knowledge flow between own Hub members. SEE Hub is a special case in having chosen only external BPI for knowledge transfer; of these, most stem from CWE and NE Hub. This Hub has also identified the highest number of gaps.

A closer look at the **BPI domains most frequently selected for transfer** underlines *"Harvesting, logistics, transport, safety"*, *"Inventory, assessment, monitoring"*, and *"Education, research, knowledge transfer (transversal)"* as the most relevant. This corresponds to the BPI domains with the highest number of available BPI. Apart from these domains, one other domain, namely *"Forest management, ecosystem services, resilience"*, has been among the most selected in the Eastern Hubs (CEE and SEE). This underlines the above mentioned three domains as a focus of overall knowledge transfer, however, it should be noted, that the Eastern Hubs show a more varied knowledge input regarding the range of BPI selected in their respective most relevant BPI domains.

For the three BPI domains most frequently represented in BPI selection, external knowledge flow prevails for the Southern and Eastern Hubs (SWE, CEE, SEE), in contrast to the Northern and Central-Western Hub characterized by a predominantly internal knowledge flow. The knowledge flow in these most preferred domains is not always evident from the strengths and gaps identified for the respective Hub which suggests individual preferences for specific BPI. Furthermore, there has been little to no evidence of Hubs preferably transferring BPI in domains for which they had a lower number of own BPI, only the Eastern Hubs have a higher number of selected BPI in domains in which they were less represented themselves. This might mean that regional priorities continue from BPI collection to BPI selection.

With respect to **BPI Solution Types**, *"Sensors, measurement equipment"* and *"Awareness, infoportals, educational campaigns" (of equally high number)*, followed by *"Traceability tools", Collaboration platforms, logistical hubs",* and *"Modelling, DSS, simulation, optimization"* (of equally high number) have been **most frequently selected for transfer.** These BPI solution types only partially mirror the distribution of collected BPI. Another difference with regard to the analysis of BPI domains, is that the analysis of solution types shows a more diverse and especially more individual BPI choice with Hub-specific prioritization. For instance, the South-Western Hub has not even prioritized one of the overall most frequently selected BPI solution types, *"Sensors, measurement equipment",* among its three highest. Since the BPI solution types offer a more nuanced categorization of BPI than the broader categorization of BPI domains, the detailed tables and analysis in this Cross-regional Roadmap allow for the consideration and emphasis of specific Hub BPI choices.

The knowledge flow in the mentioned BPI solution types is mostly external (CWE, CEE, SEE) with the exception of SWE and NE Hub which both have a predominantly internal knowledge flow. The knowledge flow assumed from the distribution of strengths and weaknesses can mostly be confirmed by actual selections. Similar to the analysis of BPI domains, Hubs do not seem to have a priority for balancing out BPI solution types for which they had a lower number of BPI themselves. The notable exception is SEE Hub which has an explicity external focus in BPI selection.

Overall, this Cross-regional Roadmap offers an in-depth analysis and findings on interregional knowledge flows between key regions of wood mobilisation in Europe, the domains and solution types considered most relevant for transfer by specific regions and across Europe, and delivers insights on what regions could offer a solution for diverse challenges identified for European forestry.

List of Authors

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Annex 1

List of strengths identified within the five Hub Roadmaps. The grouping in the five categories was done for the purpose of this cross-regional roadmap, after the individual strengths had been separately identified.

Strong and competitive forest industry, processes and supply chains	
Strong forest industry	NE
Highly mechanized supply chain	NE
Very competitive pulp and sawmill industry using new technology	NE
Various high production forests with stable or expanding forest area and growing stock volume	CEE
High share (except UA) of mechanised wood harvesting, with the use of modern and highly efficient forest equipment in state forests and big companies	CEE
Wood sector is well diversified and includes a plethora of products	CEE
Exports of low value-added forest-based products very strongly exceed imports, export of pellets strongly exceeds imports	CEE
Forest certification schemes are in place	CWE
Highly mechanized and partially automatized softwood sawmilling industry	CWE
Consolidated (softwood) sawmilling sector: production is split either into large units or small specialized sawmills. This consolidation process is mirrored by a sharp decrease in the number of sawmills.	CWE
long tradition of forest management and wood industry with increasing number of small sawmills, pellets and wood chips producers	SEE
Large forest areas including potentially productive ones in the future	SWE
High mechanization for harvesting wood in softwood stands	SWE
Strong network of forest roads	SWE
Strong industrial network in certain areas	SWE

Incorporation of digitalisation and data management solutions	
Developed Digitalization systems in forestry	NE
Open and accurate forest inventory data	NE
Developed enterprises for harvesting and logistics	NE
Good to high levell of digitalization in forestry (mainly State forests) with the use of advanced IT systems and detailed data regarding wood flows	CEE
Online wood sales or online auctions in State Forests	CEE
Digital solutions in forestry applied mostly in inventory, public data on forests and trade	CEE
Dense forest road network with digitally available forest road maps	CWE
Various digital logistic platforms are available and in use	CWE

Increasing focus on renewable energies, sustainability and circular economy	
Multiple and sustainable use of forests	NE
Transition to ‘close-to-nature’ forestry is being rolled out in some countries/regions, though not entirely in a strategic manner	CEE
Creation of renewable energy market	CEE

Increasing awareness of wood producers related to the concept of circular economy, implementation cascading wood use principles	CEE
Sufficient forest resources are available and sustainably managed	CWE
High awareness of resource and energy efficiency on company level	CWE
Great value of biodiversity in the Mediterranean environment	SWE

Educational and knowledge transfer resources available	
Well organized education system for the value chain (vocational schools, technical school, university of applied sciences) and training for all workforce	NE
Good levelof scientific and professional knowledge in the filed of forest management (mostly in State forests) and wood industry	CEE
Excellent production know-how with focus on high quality	CWE
Professional vocational and education system for forestry and wood working industry exists	CWE

R&D and Innovation support available	
Relatively well developed R&D base focusing on wood harvesting innovations (except UA)	CEE
High degree of forest utilization	CWE
Access to R&D units, cluster organization and innovation support agencies dedicated to forestry and wood working industry	CWE
Tax incentive and forest investment	SWE

Skilled and experienced staff across disciplines	
Professional forest owner associations play an important role in supporting small-scale forest owners by providing a broad range of services and up-to-date information e.g. advisory and extension services, access to forest service providers, contracting services, access to timber market, market information, increased market power, etc.)	CWE
Skilled and experienced forest staff, forest service providers and forest machine operators	CWE
skilled scientific and technical personnel	SEE
Different forms of grouping of owners	SWE

High safety standards, certifications and controls in place	
High degree of work safety	NE
High safety standards in forestry	CWE
Certificated forest	SWE

High availability and access to quality raw materials	
existence of high-quality raw wood material and unique tree species	SEE
high level of production material which meets international markets demand	SEE
Abundance of raw materials and large extension of forests (availability and diversity)	SWE
Multifunctional raw material	SWE

List of weaknesses and threats as identified by the five Hub Roadmaps. The grouping into categories of main Gaps was done for the purpose of this cross-regional roadmap, after the individual weaknesses and threats had been separately identified.

1. Improve forest resilience and adaptation to climate change	
Climate change (e.g. forest damanges, pests)	NE
Climate change (	CWE
Climate change + Poor "climate adaptive thinking" of forest authorities and decision makers; Pest and disease management	CEE
Sustainability, environment and biodiversity, climate change (pests, forest disseases)	SWE
2. Improve infrastructure and capacity of public actors	
Poor condition of forest road network	NE
Lack of funding for R&D and efforts to find new opportunities.	NE
Low public finance, subsidies and compensation mechanisms in the sector	CEE, SEE
Few options for financial support	SWE
Understaffed public agencies for forest preservation	SEE
Poor conditions of forest roads	SEE
Weak infrastructure	SWE
Insufficient exploitation of national forest services	SEE
Insufficient level of optimal forest exploitation	SEE
3. Activate private owners and cooperative forest management	
High amount of small forest owners and decreased interest/ competence in forestry for owners	NE
Aging of forest owners	NE
High fragmentation of private forests	CEE
Lack of efficient forest management practices/platforms	CEE
Insufficient knowledge and lack of interest for improvement	SEE
Lack of small PFOs' interest in forests and forests management	SEE
Lack of services in line with needs of small-scale forest owners (i.e. timber sale, economic extension services)	SEE
Unresolved ownership and cadastral issues	SEE
The wood flow from private forests is unpredictable	SEE
Small holding of forest land dealing to lack of cooperation owners/foresters, and need of support in the legal framework	SWE
Poor forest management of small-scale forest owners and associations	SWE
Lack of comprehensive decision support systems (DSS) for forest owners / FAOs	CWE
Lack of advanced digital solutions for real time forest monitoring	CWE
Lack of use cases for artificial intelligence	CWE
4. Ensure a well-trained workforce through attractive skills development and education	
Shortage of skilled workers which is further severed by an aging work force	CWE

Lack of qualified labor and gaps in education	CEE
Lack of skilled professionals and interest to implement modern technologies (ICT)	SEE
Lack of qualified and local forestry labor especially for harvesting operations, planting and silviculture	NE
Urbanizing and lack of attractivity for jobs in the value chain and for jobs in rural areas	NE
Low employment opportunities	SEE

5. Enhance economic and environmental performance of forest supply chains	
Low level of digitalization in forestry and wood based industries	CEE
Low transparency and law enforcement effectiveness in forest sector	CEE
Slow development of digitalization of forestry suppliers and non-state forest owners.	CEE
Lack of cooperation and slow adaptability of the sector	CEE
Low willingness / capability to invest in new technologies or major digital innovations due to high-cost pressure	CWE
Competition instead of cooperation between freight carriers have a negative impact on the overall transaction costs	CWE
Digitalization / automatic data exchange across companies and actors in the supply chain still not common	CWE
Outdated technology, production processes and infrastructure for technology transfer	SEE
Low innovation capacity	SEE
Weak connections between the “forest” and “wood” part of the forest-wood value chain	SEE
Use of obsolete machinery by private owners due to high investment costs	SEE
Lack of solid logistics background	SEE
Low interest for investments.	SEE
Digital solutions are not implemented in wood transport and logistic	SEE
Lack of cooperation between knowledge pools and industry	SEE
Lack of cooperation between designers and wood industry	SEE
Lack of digitalization, poor harvesting and logistics	SWE

6. Grow the forest-based bioeconomy through circular use and value-added products	
Lack of long-term promotional strategy of forest and wood products	CEE
Lack of marketing platforms	CWE, CEE
Timber construction still not legally equal to other construction materials	CWE
Markets. Optimization of the wood forest resources and products	SWE
Lack of knowledge on recycling and circular business models	NE
Under-utilization of wood waste	CEE
Insufficient level of awareness and lack of knowledge about the importance of recycling	SEE

7. Raise public awareness, social acceptance and political support for forestry.	
Social acceptance of forestry	NE
Increased national/EU restrictions on harvesting and other use of forests	NE
Persistent lack of public understanding on the economic significance of forests (forestry perceived as of low economic significance)	CWE

Conflict between forest owners and the general public regarding the extent of forest management (timber production)	CWE
Social mistrust in forest management and wood harvesting	CWE
Conflict between nature protection and managed forests	CWE
Need for educational strategies to explain forest ecosystem services to the public	SWE

Annex 2: List of most relevant Best Practices

The table below lists the BPI which have been selected by two Hubs or more. The BPI are clustered by domains. For each BPI the country of origin and the number of times it has been selected are indicated in brackets.

BPI Selection by 2 Hubs or more	
Domains and BPI title	Total result
Education, research, knowledge transfer (transversal)	6
Forestry Extension Institute (NO, 4)	
Advanced Virtual Aptitude and Training Application in Real Time (DE, 4)	
Think Tree (NO, 2)	
Women in Forestry (NO, 2)	
Dataholz (AT, 2)	
Harvester simulator (FR, 2)	
Financing, funding schemes	3
Forestry fund (NO, 3)	
Financing of Sustainable Forestry (FI, 2)	
Forest insurance investment account (FR, 2)	
Forest disturbances, risks, disaster response	2
Detecting bark beetles with AI (SE, 4)	
Bark beetle risk map (SE, 2)	
Forest management, ecosystem services, resilience	4
Carbon, Aqua, Fire & Eco-resilience DSS (ES, 3)	
Climate Smart Forestry-Innovation (FI, 2)	
HolzmobRegio (AT, 2)	
Detectit - save our forests (CR, 2)	
Forest-based industries, bio/circular economy, value chain	1
Build-In-Wood (RO, 2)	
Harvesting, logistics, transport, safety	11
FelixForst (AT, 3)	
Road condition monitoring (CH, 3)	
TimFlow – WoodTracking (RO, 3)	

Digitally Connected Forest Operation Value Chain- Innovation (FI, 2)	
Digitalized truck crane (SE, 2)	
Application of drones for seedling transport in steep terrains /mountainous areas (AT, 2)	
Woodlogistic Data Plattform (AT, 2)	
Forwarder2020 prototypes (CH, 2)	
WaspWoodlogistics (DE, 2)	
Blockchain for Inmutable Timber (ES, 2)	
MyForester - Quality assessment of forestry contractors (Sl, 2)	
Innovation management, digital hubs, clusters, exploitation	**3**
Digital Service Infrastructures to integrate models supporting forest management and forest protection (ES, 3)	
Evergreen Innovation Camp – Hackathon (AT, 2)	
Center of Excellence Forest and Timber 4.0 (DE, 2)	
Inventory, assessment, monitoring	**11**
Comparison of silvicultural concepts by simulation of growth processes in forests on the smartphone (DE, 3)	
Information platform on forests in NRW (DE, 3)	
LogBuch (DE, 3)	
Virtual Forest (DE, 3)	
Biomass atlas (FI, 2)	
Virtual Forest 2.0 Innovation (FI, 2)	
Festmeter (AT, 2)	
Carbon accounting tool (FR, 2)	
Simulations of technical-economic feasbility of forest stands (FR, 2)	
Forest Data Bank (PL, 2)	
Timber Inventory System (PL, 2)	
Ownership, cooperation	**5**
eServices for Forest Owners and Service providers (FI, 3)	
Forest becomes mobile initiative (DE, 2)	
Free app for smallholder farmers in developing countries (DE, 2)	
FORETDATA (FR, 2)	
The forest moves (FR, 2)	
Products, markets, trade	**4**
Ydalir district (NO, 2)	
Swiss national wood promotion programme (CH, 2)	
Smart Wood Supply Chain Management (DE, 2)	
Forest stock market e-drewno.pl (PL, 2)	
Total result	**50**

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