

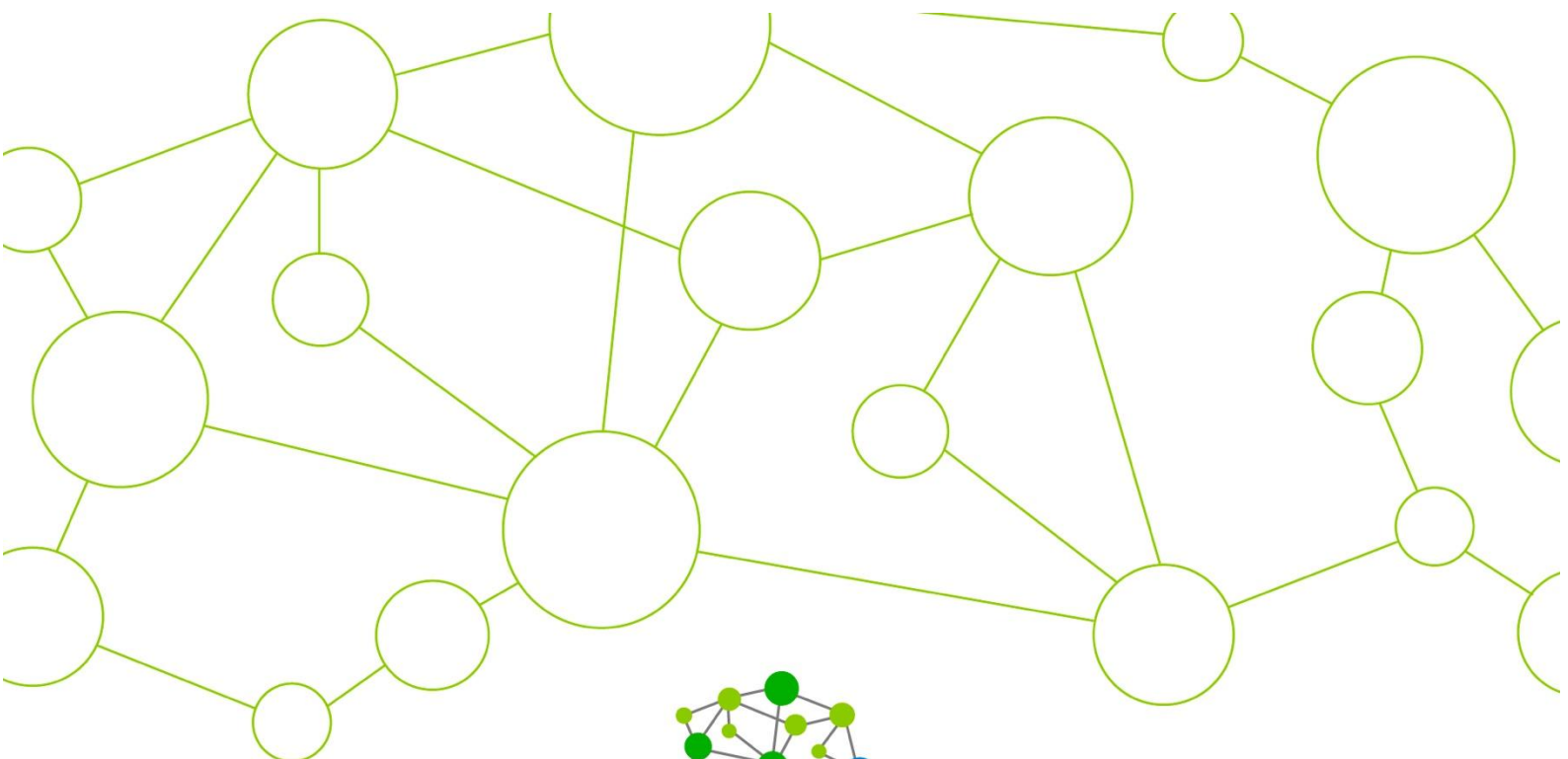


ROSE WOOD
4.0 Sustainable Wood
for Europe

CENTRAL-EAST HUB ROADMAP

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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 digitization 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 owners². 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.

which is growing on the land with poorest soils. In the mountain areas a higher share of spruce, fir and beech can also be 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 years³.

Growing stock of wood (gross grand timber) is estimated at 2600 million m³, where 78 % is managed by State Forests and 17 % by private forests. In 2019, 43.5 million m³ of wood was harvested, including 40.9 million m³ of wood from forests managed by State Forests (94 %) and 1.9 million m³ of private forests. 76 % of harvested roundwood were coniferous species (33.3 million m³) and more than 88 % of harvested wood was intended for material processing⁴.

Main abiotic threats for Polish forests are drought and strong winds. In 2019, 113.4 thousand hectares of forest stands were 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 industry⁶. Poland is among European and world leaders in wood-based panels and furniture production and export.

Poland forests in facts	
Forests <ul style="list-style-type: none"> Forest land: 9.5 million ha, 30.9 % of land area Forests: 9.3 million ha Total volume (gross grand timber): 2 645 million m³ Annual cuttings: 42.4 million m³ Annual increment (timber, State Forests): 66.7 million m³ 	Economic significance and employment, 2019 <ul style="list-style-type: none"> 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
Production volumes, 2019 <ul style="list-style-type: none"> Timber: 40.6 million m³ Slash: 1.7 million m³ 	
Sustainability <ul style="list-style-type: none"> 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 %) 	

Table 1: Poland forests in facts.

The area of forest stands in *Slovakia* is 1,949,980 hectares (Green Report 2019)⁷. Between 1990 and 2020, 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 % \pm 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 natural 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 infrastructure, represent their main function, which is reflected in the intensity of their management. 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.

Slovak forests in facts	
Forests <ul style="list-style-type: none"> 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 	Economic significance and employment <ul style="list-style-type: none"> 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
Production volumes, 2018 <ul style="list-style-type: none"> 2.3 million m³ timber for pulp industry 4.7 million m³ sawn timber 1.2 wood-based panels 	Employment <ul style="list-style-type: none"> 53.000 employees in the forest-based value chain of which: <ul style="list-style-type: none"> almost 20,000 employees in forestry about 33,000 employees in forestry and wood-based industry
Sustainability <ul style="list-style-type: none"> 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 	

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 m³ with an average annual increase of 35 million m³, which largely exceeds the annual harvest of about 22 million m³.⁸

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 m³/ha/y, thus the Carpathian forests produce about 9 million m³ of wood annually. Current harvest in the Carpathian region forests accounts for 5 million m³, 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 silviculture⁹. 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 km² 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 km² (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 2018¹⁰ and SFRAU 2019¹¹.

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 m³ 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/1UApjLM9DPT0MugliiTWMBg4IXN8PAvWZ/view?usp=sharing>.

⁹ FORZA (2009): Cluster analysis of the forest sector of the Carpathian 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-skQpV9f11BOdYBGSKix_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/1UApjLM9DPT0MugliiTWMBg4IXN8PAvWZ/view?usp=sharing>.

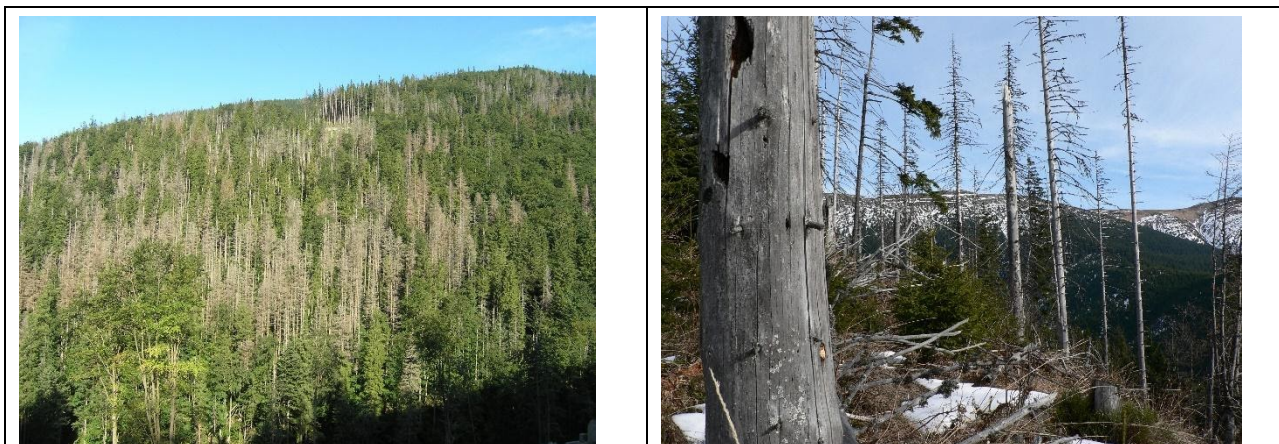


Image 1: Spruce dieback and windfall damage in Rakhiv region, Zakarpattia, Ukraine. Photo source: FORZA.

Ukraine forests in facts	
Forests <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 173 000 employed in forestry and wood based industries (2018) 	Employment <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Forest area: 6.9 million hectares Forest cover: 30.12 % in 2018 Public forests: 45 % 	Economic significance and employment <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 1.94 thousand m² 	
Sustainability <ul style="list-style-type: none"> 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 research¹². This document, however, has not been updated, and does not reflect current international trends and goals in policy¹³. 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 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 development¹⁴. 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 economy¹⁵.

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 strategy¹⁶. 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 Slovak 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. Lopošné 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 Braşov, 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 Braşov, 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 functions, including¹⁷:

- 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 the opportunities for financial aid for the forestry and wood sector;
- Forest Gene Bank 'Kostrzyca' – collecting 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-governmental 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 weaknesses, 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 added 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 (construction) 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 implementation of close-to-nature forestry practices. Optimisation of legislation (bureaucracy 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 steadily 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 demanding, 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 between 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 companies 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
<ul style="list-style-type: none"> Various high production forests with stable or expanding forest area and growing stock volume 	<ul style="list-style-type: none"> High fragmentation of private forests, which makes sustainable forest management more difficult.

<ul style="list-style-type: none"> • Transition to ‘close-to-nature’ forestry is being rolled out in some countries/regions, though not entirely in a strategic manner • Good level of scientific and professional knowledge in the field 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 level 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 in 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 	<p>Incomplete (based on estimation) data about wood harvesting in private forests</p> <ul style="list-style-type: none"> • 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
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	<ul style="list-style-type: none"> • 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
<p>OPPORTUNITIES</p> <ul style="list-style-type: none"> • 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 	<p>THREATS</p> <ul style="list-style-type: none"> • 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 against the criteria of efficiency 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

		<p>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.</p> <p>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.</p>
Romania	Timflow Woodtracking	<p>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.</p> <p>Timflow is:</p> <ul style="list-style-type: none"> • 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	<p>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.</p>
Romania	Build-in-Wood Horizon 2020 project	<p>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.</p>

		<p>Main project objectives:</p> <ul style="list-style-type: none"> • 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	<p>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.</p> <p>Objectives</p> <ul style="list-style-type: none"> • 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	<p>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.</p>

		<p>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.</p> <p>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.</p> <p>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.</p>
Slovakia	Advanced Techniques for Biomass mapping in Abandoned Agriculture Land using Novel Combination of Optical and Radar Remote Sensing Sensors	<p>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.</p> <p>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:</p> <ul style="list-style-type: none"> • 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 <p>Products and services with potential of commercialisation</p> <ul style="list-style-type: none"> • 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.
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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 investments 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 industries 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 appropriate 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 needed, 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 sustainable 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 conditions
- 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 avoid 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 geospatial 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 weaknesses 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			Mellvä 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							FORETD ATA		TECH4EFF ECT
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			ChainW ood		
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



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 strengthen 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.



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 processes (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 existing 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, silvicultural 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.

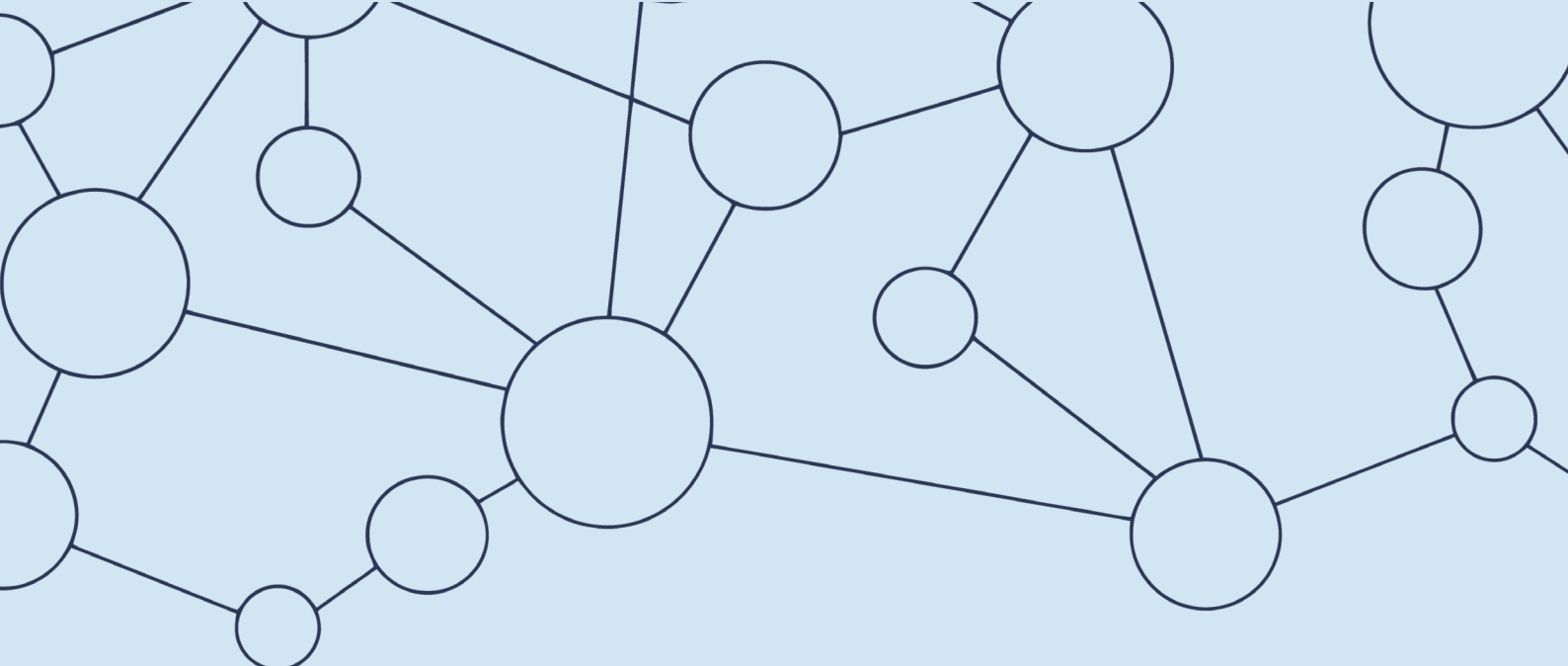
In Poland, Łukasiewicz Research Network – Wood Technology Institute is cooperating closely with the authorities (Ministry of Climate and Environment), State Forests and other actors from the forestry-wood chain (both individual enterprises and networks, such as wood industry associations and clusters). 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 countries 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).



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 862681

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