ROSE WOOD 4.0 Sustainable Wood for Europe

SOUTH-EASTERN HUB ROADMAP

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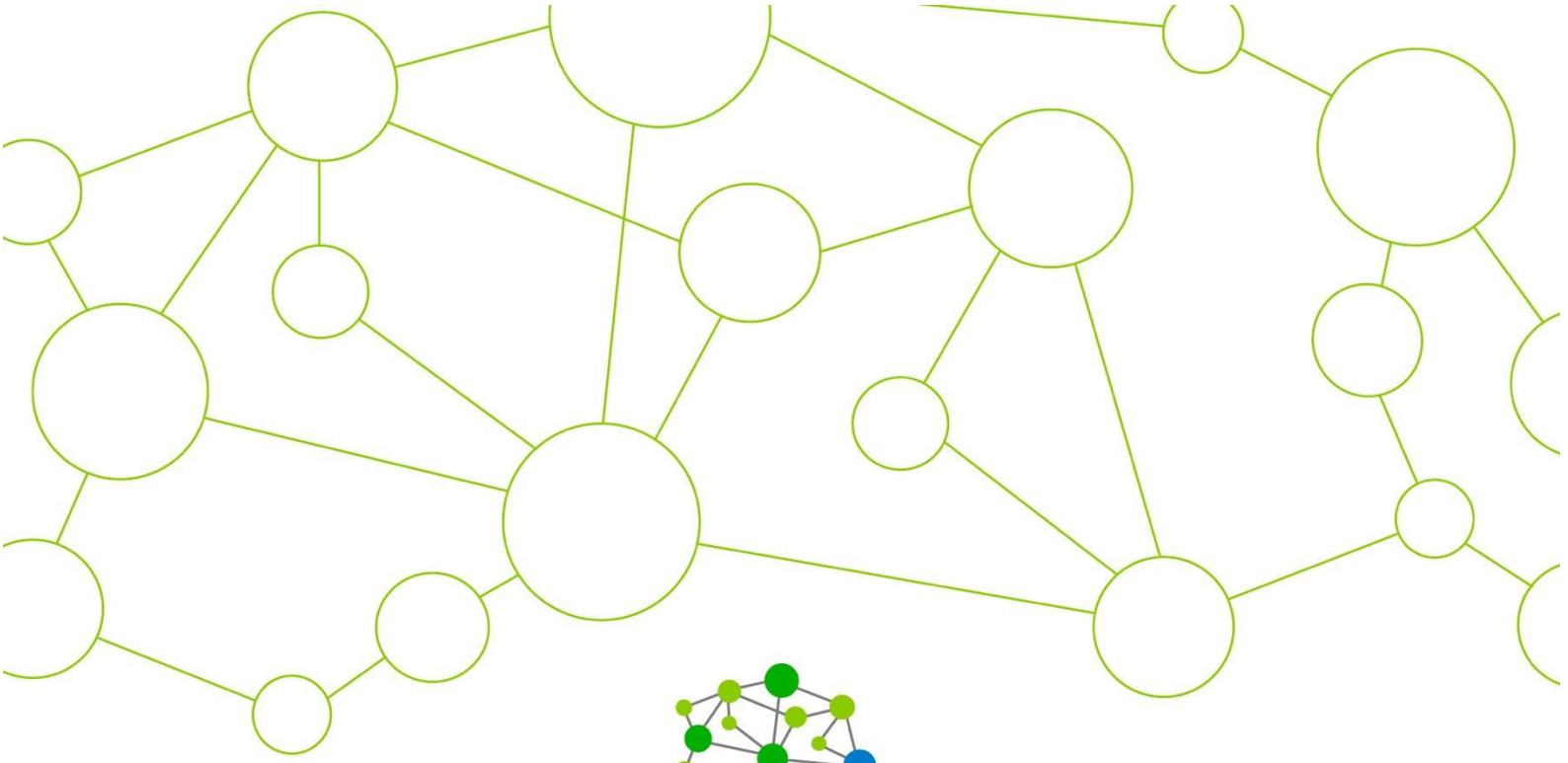

ROSE WOOD 4.0 Sustainable Wood for Europe

South-Eastern Hub Roadmap

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1. Introduction

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

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

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

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

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

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

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

2. Interregional Roadmap for the South-Eastern Hub

2.1 Description of the South-Eastern Hub region

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

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

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

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

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

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

[1] Poročilo Zavoda za gozdove Slovenije, 2019.

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

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

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

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

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

2.1.1 Political Targets for Wood Mobilisation and Forestry

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

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

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

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

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

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

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

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

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

The Strategy has six goals:

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

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

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

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

5. establishing a partnership in terms of social challenges;

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2.1.2 Structures of Decision Making

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

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

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

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

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

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

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

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

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

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

2.1.3 Main actors in forestry in the South-Eastern Hub

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

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

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

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

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

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

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

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

The Biotechnical Faculty is a research and educational institution that provides higher professional and postgraduate education, scientific research, professional and consulting work in the field of wildlife

sciences (biology, microbiology) and agriculture, forestry and fisheries (forestry, zootechnics, agronomy) and related production technologies (woodworking, food, biotechnology). In the Forestry study program, graduates acquire knowledge of forest ecosystems, social aspects of forest management, various techniques and technologies that can be used in forest management and knowledge of modern methodological tools. The study of Wood engineering enables the deepening of knowledge about wood and wood composites and modern technologies for wood processing, as well as the enrichment of knowledge about the construction and design and management of wood and wood products.

The Slovenia Forest Service (ZGS/SFS) is one of the main actors and as a legal entity with the status of a public institution established by the Forest Act, performs the public forestry service in all Slovenian forests, regardless of on ownership. The Slovenian Forest Service is organized at the national level with its headquarters at the Central Unit in Ljubljana, at the regional level in 14 regional units, and at the local level in local units. The public forestry service is almost entirely financed from the budget of the Republic of Slovenia, while special purpose hunting grounds are almost entirely self-financed. The founding rights and obligations are exercised by the Government of the Republic of Slovenia.

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

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

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

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

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

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

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

2.2 Main findings

2.2.1 SWOT analysis

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

Figure 1. Summary of South-Eastern Hub SWOT.

The South-Eastern Hub partners have identified strengths, weaknesses, opportunities and threats of listed domains on country level: forest/land tenure, wood harvesting/storage, wood transport and logistic, wood

processing, recycling, cross cutting issues. One of the main strengths of South-Eastern Hub is a long tradition of forest management and wood industry with an increasing number of small sawmills, pellets and wood chips producers. Also, the existence of high-quality raw wood material and unique tree species. Accordingly, the South-Eastern Hub countries have a high level of production material which meets international market demand.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

- is prepared and reviewed every ten years,
- inventories and maps natural resources during drafting,
- minimizes the risks of degradation,
- ensures the health and vitality of forests through natural forestry measures,
- regulates forest protection.

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

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

2.2.2 Hub's Best Practices and innovations identification

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

Country	BPI Title	BPI Description
Croatia	Digitalized Groundwater Measuring Station System	Digitalized Groundwater Measuring Station System was developed within the project „Protecting the English Oak in the Hungary-Croatia cross-border region". Project coordinator was forest company Mecsekerdő Zrt. from Hungary, project partner was Croatian Forest Ltd., Forest administration Našice (Croatia). System contains information about the movement of water which is very important for oak and other native species in forests. Forest managers can use this information for facing the trend of decrease or increment of groundwater and timely respond to changes.
Croatia	Cooperation for innovative approach in sustainable forest management training (CIA2SFM)	The educational program includes knowledge and concrete information in the field of sustainable forest management and organization of forestry work.
Croatia	Online database of wood processing and furniture producers in Croatia	Government of the Republic of Croatia in collaboration with Ministry of Agriculture developed online database of wood processing and furniture production of the Croatia. Development of online database was first priority area of programming period 2017-2019 for Development Strategy of Wood Processing and Furniture Production Industry of the Republic of Croatia. Purpose of the Base is to connect producers along the value chain as well as other key interdependent actors: economic and public sector, scientific community, end consumers as well as the general public.

Croatia	Green City cadastre – application	Application Green City cadastre presents a list of trees on a specific area i.e. towns. Application contains information about the species and dimensions of trees, the condition of the timber, treetop and roots, and documentation about tree control intervals. Green City cadastre has developed and applied online in two cities in Croatia, Zagreb and Osijek.
Croatia	WAVE ŠŠ Web application for managing data about forests and forest owners	WAVE ŠŠ is developed for the employees of forestry sector and licensed contractors. Application contains 5 modules: timber farming operation module, module of accompanying documents, Christmas-trees module, forest damage module.
Croatia	Detectit - save our forests	DetectIT is forest fire detection device which detects fire by using different sensors. After the detection of fire in the area where device is installed, device sends message to the application. Application contains information of the current situation in the area (level of temperature, humidity, carbon monoxide).
Croatia	Public data of forests	Croatian Forests Ltd is company which manages public forests and forest land in Croatia. The company developed application which contains overview of public data about forests they manage. Application in cartographic form present information in textual and tabular view, as well spatial illustration of type of tree species in specific forest or area. Also, application shows two parameters for every tree species: the total volume of timber and annual growth.
Slovenia	MyForester - Quality assessment of forestry contractors (MojGozdar)	The main objective of the project was to improve the competitiveness of forest-based sector regarding quality of operators' evaluation. The benefits of the web platform are connecting all actors through wood chain and transparent collection of all forestry service providers.
Slovenia	National Forest Inventory (NFI)	Within National Forest Inventory (NFI) forests of Slovenia are monitored and measured. NFI provides extensive and in-depth survey of all Slovenia forests, including information about composition, condition, distribution and size of our forests. It is of great importance for monitoring changes of forests through time, for developing suitable policy measures and for further support of sustainable management of forests. The basis for the inventory is a systematic sample of plots on a 4km x 4km grid. The selection of inventory plots is based on the use of lidar and aerial images. With their help, plots that are not located in the forest are eliminated, and they are also helpful in assessment of forests at inaccessible plots. A special data acquisition application was developed for the purpose of field inventory. This guides the enumerator through the inventory process, and at the same time the data is already digitized and ready for further processing. The application is also connected to a GPE device, which allows the precise determination of the sampling point.
Slovenia	Mobile application for collection of used wood - RecAPPture	The project is dedicated to the development of a mobile and web application that will connect users who want to get rid of the waste wood and M SORA, which will use the wood for the production of wooden windows.
Slovenia	Forest data viewer	Pregledovalnik podatkov o gozdovih is the most comprehensive tool of the Slovenian Forest Service, which enables the acquisition of detailed data on forests up to an individual plot, including data from forest management and silvicultural plans.

Slovenia	Awareness raising, training and action for invasive alien species in the forest (Invazivke)	The Invazivke web application is part of the public electronic information system for collecting data on invasive alien species (IAS), which includes a desktop, web and mobile application and connects several existing information systems that already collect data on IAS in Slovenia.
Slovenia	Slovenian forests protection	Varstvo gozdov Slovenije is information portal. It includes a following content: manual to determine causes of tree injuries, forest protection news, study material, prognosis.
Slovenia	WoodChainManager (WCM)	Web portal WoodChainManager offers different interactive tools (Calculate norms, Cost calculations, Unit converter) suitable for the organization and optimization of forestry works. WCM application enables a simple selection of technological model for the production of roundwood as well as green chips. It includes data on wood flows and prices, wood fuel prices, wood supply chain stakeholders map, wood supply chains.
Slovenia	Digitalisation of fieldwork data collection (MIGHTYFIELDS)	With the MightyFields drag and drop form-builder, you can create mobile forms and dispatch them to your field teams to capture field information. Existing data can be integrated with your existing forms, allowing MightyFields to capture data from mobile devices and to validate their reliability.
Slovenia	Timber log volume calculator (Timberlog)	Calculate timber volume in cubic metre, cubic foot volume (CFT), board feet (CBF) from a diameter or circumferences (girth) and length, create a wood log and share it over email, Dropbox, Google Drive and other sharing apps for free. Create an Excel file report that can easily be imported into Excel and other spreadsheet applications.
Slovenia	Marteloscope demonstration plot Pahernik	Pahernik forests in Slovenia became a part of the European network demonstration plots (Marteloscope) in 2015. They are based on the principle: "If you see, you understand better." The purpose is to show that it is possible, considering social requirements and timber extraction in forest management including the conservation of biodiversity.
Slovenia	Boletus informaticus information system	Boletus informaticus is an information system for recording and mapping fungal species in Slovenia.
Slovenia	Environmental Atlas	The Environmental Atlas of Slovenia is WEB GIS environmental information system with spatial data from the areas of nature, environment, water, ground cover, climate, infrastructure and other data in the entire area of Slovenia. The database is an example of high quality and useful content, which is supported with comprehensive metadata descriptions. It provides basic information on position, content of environmental data and environmental phenomena to general public and expert services.
Slovenia	Website of the special purpose state hunting grounds (LPN)	LPNs have been established for the protection of rare, endangered species of game and wildlife species, and their habitats, for the purpose of implementation of a number of public functions and scientific research in the field of management of game and certain of the protected wildlife species, and their habitats. Our mission is being realized with a natural and sustainable management of game and their habitats. An important part of our vision is the development and expansion of knowledge about the game

		and other wildlife. New knowledge is obtained within a number of research projects and by monitoring of wildlife. Knowledge about the management of game and wildlife is expanding through cooperation with domestic and foreign educational institutions.
Slovenia	Protection of forest against bark beetle	The website publishes / provides information on outbreaks of bark beetles (map), the structure of sanitary felling due to beetles / insects by areas. At the same time, it informs and educates about the handling of an attack, signs of an attack, setting traps, gradations of beetles, and an interactive map of control sample traps.
Slovenia	Digitization of professional works in the field of forestry and ensuring their accessibility through the most institutional repository SciVie	SciVie contains SFI e-publications (monographs, leaflets, brochures, audio and video recordings, databases (). Works by other publishers (articles, parts of monographs, patents,), articles in the scientific journal Acta Silvae et Ligni and digitized studies and SFI reports have been deposited in the repository.
Slovenia	Information support for game management in Slovenia	The web application provides various ways of access for the public and experts to a common database of game collection and serves as a synthetic data source and tool in the preparation of long-term and annual game management plans.
Greece	Small and medium enterprises securing future-proof bioenergy chains (SecureChain)	SecureChain was a Horizon 2020 project focused on promoting market uptake of bioenergy in small and medium-sized enterprises (SMEs) using innovation voucher scheme. The main objective was to promote a Sustainable Supply Chain Management practice that meets highest environmental quality and financial viability standards and targets local biomass suppliers, energy producers and financial sector players. Unique features of the project were that the entire bioenergy chain was considered, and sustainability and financing were an integral part of the project set-up. The specific objectives included a) integration and optimization of local supply chains, b) high efficiency and low impact gain, c) supply sustainability, d) leveraging investments in bioenergy, e) implementation of future-proof bioenergy chains.
Greece	Promotion of residual forestry biomass in the Mediterranean basin (PROFORBIOMED)	PROFORBIOMED (Promotion of residual forestry biomass in the Mediterranean basin) aimed at the promotion of renewable energy as an economic and social opportunity for rural areas, through energy use of forest residues and agricultural biomass. At the same time, it envisaged the creation of new employment opportunities and the development of related industries in this area. The main outputs were: - Assessment of the forest biomass available for energy production. - Transfer and adoption of know-how on sustainable forest management including forest biomass production chains and its use as an energy source. - Improvement of the rural areas' governance, development of clusters and agreements between public and private actors. - Development of a model of public support to sustainable forest management and biomass production. - Identification of financing mechanisms for public and private investments. - Creation of new economic opportunities.

Greece	Supply chain for green wastes (aGROWchain)	Agricultural residues such as straw, bank canes and trees pruning constitute a significant load of green waste in rural areas from both sides of the borders. Those wastes are poorly managed causing severe environmental impacts. At the same time local authorities use expensive fossil fuel for space heating of public buildings, and due to the current economic recession, very often the amount of heat generated cannot satisfy the real needs of the building users. The sustainable management of the green waste can offer a real solution in both of the above problems. There is available technology that can utilize agro-wastes as fuel for space heating under the only condition that a reliable supply chain is established. Scope of this project is to establish a supply chain for green wastes, combined with the relevant business model, which will secure its sustainability. The supply chain will be customized according to the wastes that are available from both sides of the border and the business model will be adapted to the specific local conditions. The supply chain will serve selected end users in each country; therefore, its operability will be tested and possible problems and barriers will be resolved.
Greece	Market Uptake Support for Intermediate Bioenergy Carriers (MUSIC)	The overall aim is to facilitate the further introduction of intermediate bioenergy carriers by developing feedstock mobilisation strategies, improved logistics and IBC trade centres. More specifically, the objectives of the MUSIC project are: - To increase the uptake of intermediate bioenergy carriers through development of advanced and strategic case studies with economic actors (industries) committed to implement the results. - To develop and/or expand existing and future trade centres, either virtual or physical. To assess the technical and non-technical aspects of biomass feedstock mobilisation with the purpose to develop dedicated feedstock mobilisation strategies. - To determine the best, cost-effective solutions for logistics along the entire IBC value chain, from raw unprocessed biomass to IBC end-users. - To involve, engage and support regional stakeholders and market actors, from the primary production sector, industry and beyond. - To evaluate framework conditions (legal, institutional and political) to identify key barriers and enablers. - To provide advice to policy makers at national and regional level to serve as input for more informed policy, market support and financial frameworks. The overall aim of the MUSIC project is to facilitate the further introduction of intermediate bioenergy carriers by developing feedstock mobilisation strategies, improved logistics and IBC trade centres.
Greece	Building cooperation, developing skills and sharing knowledge for Natura 2000 forests in Greece (ForestLife)	The project aims: - To facilitate dissemination of knowledge, best practice and strengthen cooperation between the forest authorities and other stakeholders in forests within Natura 2000 sites, by developing and operating an online “Collaboration Platform for Forests” (CPF). - To foster the development of skills of forest related target groups through training on the fields of forest management for the conservation of biodiversity, adaptation of forest management to climate change, innovative funding etc. - To increase the ability of forest users to access information and be motivated to reduce the disturbance they cause, by providing tools such as an app for smartphones and tablets. - To demonstrate that in Greek forests, and especially those within Natura 2000 sites, amenity and conservation can be compatible, through integrated media and communication work.

Greece	Structured Approaches for Forest Fire Emergencies in Resilient Societies (SAFERS)	The project is going to create an open and integrated platform featuring a forest fire Decision Support System. The platform will use information from different sources: earth observations from Copernicus and GEOSS, fire sensors in forests, topographic data, weather forecasts and even crowdsourced data from social media and other apps that can be used by citizens and first responders to provide situational in-field information.
Greece	GREEce: modeliNg of the FOREst SEctor EcoNomy (GREEN FORESEEN)	Design and carry out a survey of the fuelwood market in Greece, as well as by analysing national statistics on energy consumption. This will give insights on all aspects of fuelwood demand and supply and will allow for the characterisation of the illegal logging problem. It will also assist in the development of the GFSM, as fuelwood constitutes over 65% of total timber production in the country. The ultimate goal of the GFSM will be to enhance forest management by simulating impacts of policy and market changes on the sector. An intentional by product of the GFSM will be the generation of knowledge that can be utilised by other models, such as the EC's European Forest Information Scenario Model (EFISCEN).
Greece	Forest Roads for Civil Protection (FORCIP+)	Through transnational cooperation a wide range of inventories of existing road infrastructure will be accessible, different requirements will be met and a homogeneous model will be established. ICT applications will be developed to improve the efficiency of use and propose improvements on the maintenance of forest roads. Forest fire fighting vehicles will be equipped with GNSS receivers in order to improve time response and increase fuel savings. Fire specialists will be able to use network analysis for resources planning, locating most suitable places for ground means waiting areas or identifying forest surfaces where takes longer to access. Other actors involved in emergencies will be able to use web management applications and public information.

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

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

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

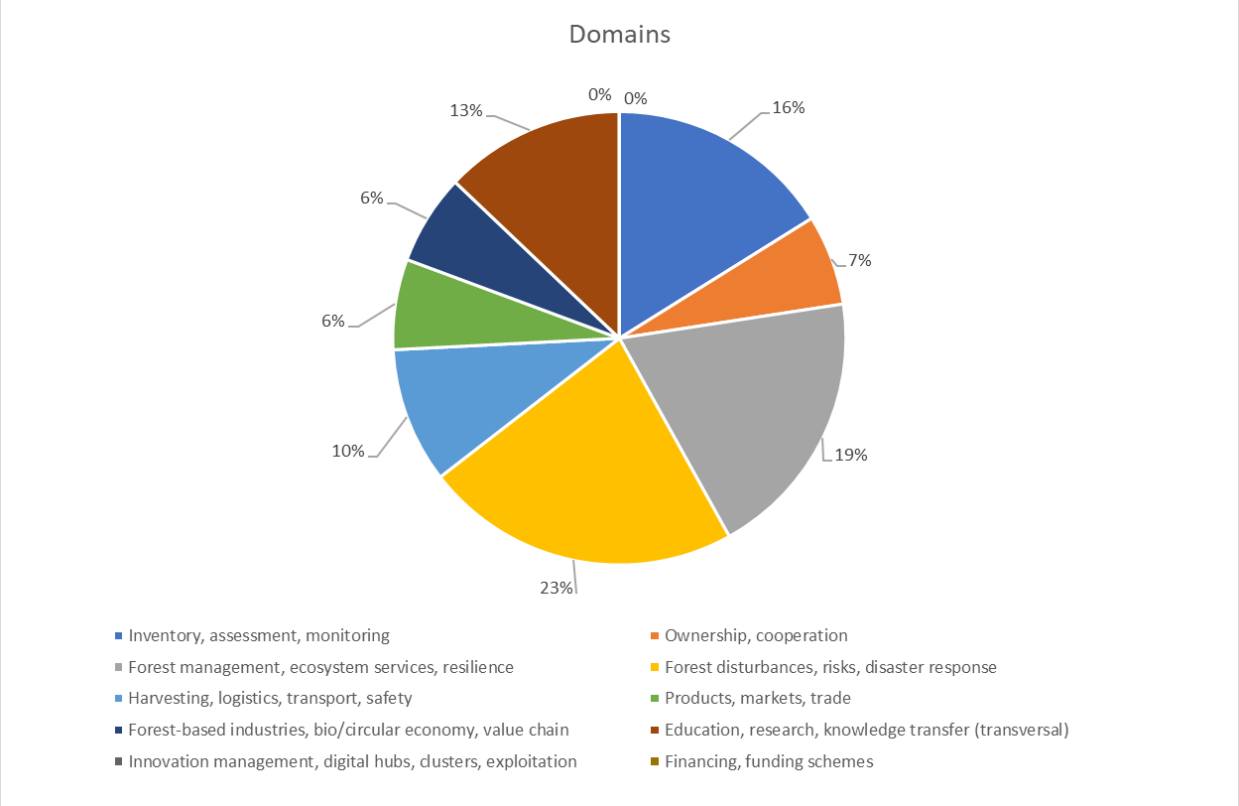

Figure 2: Classification of SEE Hub BPI per domains

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

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

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

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

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

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

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

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

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

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

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

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

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

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

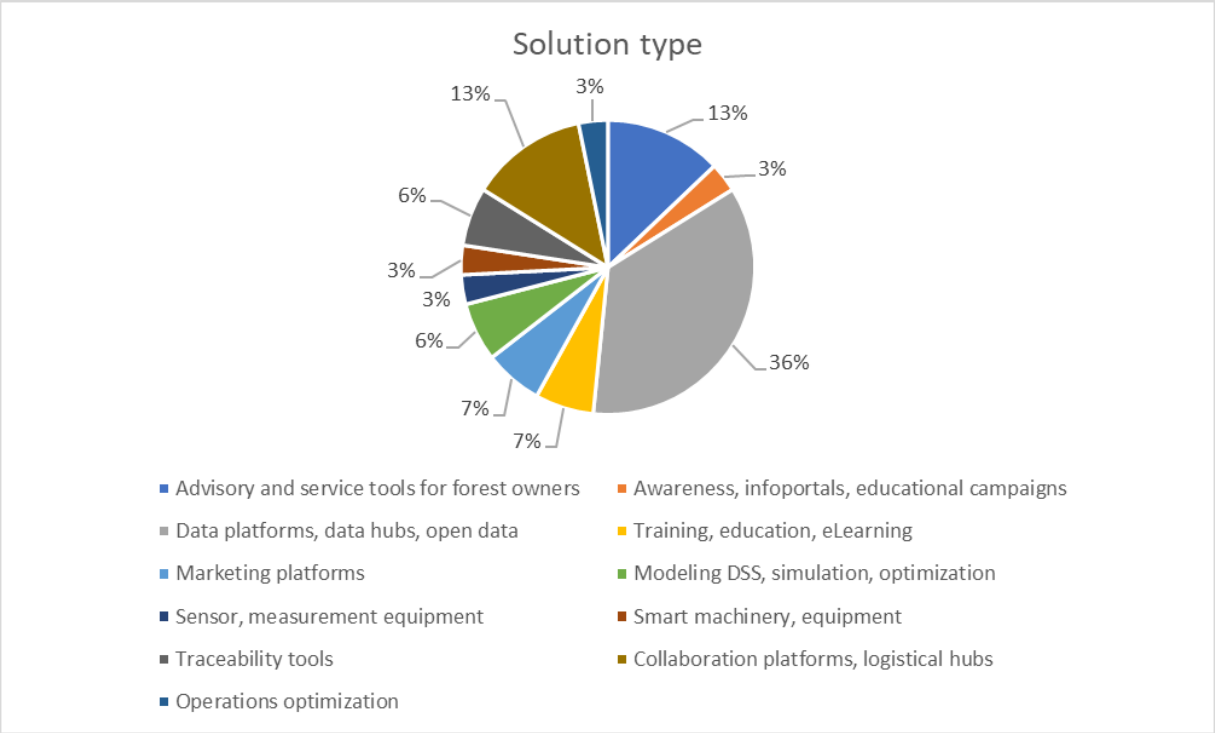

Figure 3. SEE Hub BPI according to solution type

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

2.2.3 Needs analysis

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

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

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

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

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

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

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

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

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

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

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

Education, research and knowledge transfer

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

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

Innovation management

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

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

Apply new digital solutions

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

Build advisory services and tools for stakeholders

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

2.3 Development targets for sustainable wood mobilisation

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

Analysis resulted in the following development targets for:

Croatia

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

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

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

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

Slovenia:

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

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

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

Greece:

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

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

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

2.4 Presentation of the interregional Roadmap

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2.5 Implementation of the roadmap

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

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

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

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

2.6 Conclusions and Outlook

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

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

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

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

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

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

ROSE WOOD 4.0 Sustainable Wood for Europe

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