ROSE WOOD 4.0 Sustainable Wood for Europe

CROSS-REGIONAL ROADMAP

rosewood-network.eu

Cross-regional Roadmap

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1. Introduction

Digitalization in forestry

Digitalization is a worldwide trend cutting across all industries, which requires fundamental change not only in processes and technologies, but also in mindsets of stakeholders. Organizations have generally acknowledged the need to dedicate resources towards digital transformation, and thus exploit the potential for more efficient processes with increased flexibility, productivity and customer accommodation in order to achieve a competitive advantage. However, while digitalization holds great potential for process improvement, companies face significant challenges to implement this transformation, because it requires both technical expertise, and specific industry expertise (Holmström 2020: 2; Makkonen 2018: 76).

Forestry has usually been associated with little use of advanced technology, and the use of conventional machinery in harvesting, processing and transportation of timber. Digitalization in this rather conservative context has thus seen a reluctant uptake and stakeholder investment. While initiatives applying digital technologies to work or communication processes exist, and some countries are more advanced than others, the wood value chain in general has so far remained a late technology follower, with most stakeholders lacking the necessary knowledge regarding the selection and implementation of digital tools for information and communication purposes or machinery automation (Feng/Audy 2020: 3; Holmström 2020: 3).

Reasons for this slow uptake of digitalization are multifold, and indeed also related to the infrastructure of forests and forest ownership. Predominant public ownership of forests and fragmented private ownership contributes to the conservative character of the sector. Besides commercial aspects, social and environmental aspects of forest ecosystems also play a major role and have to be taken into account in transformative processes. In addition, forest operations are usually carried out by small companies (contractors) with little resources to implement changes. Another characteristic is the remote location of forests in rural areas, which makes it less likely to attract the necessary expertise. Makkonen (2018: 73) states that while there exists already a lot of data, stakeholders tend to remain traditional in their attitudes and are hesitant to engage in change.

Despite these challenges, digitalization offers many potential benefits to forestry stakeholders. A “digital ecosystem” for forestry would link “all physical assets of the forest supply chain” and integrating “suppliers, customers, and partners” on the operational level (Feng/Audy 2020: 9). Different kinds of digital data can support processes from harvest planning to transport and sales (Müller et al. 2019). Forest management is based on information regarding the “distribution, composition, structure, and disturbance of forests over time” (Weitao et al. 2019. 1), i.e. monitoring of ecosystem data. Forest inventory can thus use remote-sensing and location technology to obtain a broad range of data on the status quo of forest resources. Not only do these technologies replace the costly use of surveying crews, they also improve the quality of data collected, e.g. mapping of individual trees regarding species, estimations on tree height and yield, detection of areas with low growth rates or dead trees (Müller et al. 2019: 210; Holmström 2020: 7, Weitao et al. 2019: 1).

Monitoring data allows for deeper analysis and simulations regarding forest stocks, harvestable volume and costs, which are important for sales negotiations and planning activities with other market actors, including quality assessment and control. Furthermore, digital systems can enhance the navigation and operation of forest machines, both regarding the harvesting process and transportation. Today, forest machines equipped with many sensors optimise their own performance as well as the result of the harvested wood. In timber transport, data services improve timing, routing and safety (Müller et al. 2019: 211-212).

In terms of general work processes, forestry practicioners can benefit from digital information on current and future forest resources to make more informed management decisions and better accommodate customer demands (Holmström 2020: 7). More exchange of information between stakeholders of the wood value chain through digital tools is not only an opportunity for improvement but also an increasing need. Typically forestry stakeholders operate rather individually and independently from each other, resulting in inefficient, uncoordinated processes. Increased interaction and communication are likely to lead to a higher flexibility regarding customer demands, cost savings and reduced raw material loss. For this communication to be effective, trust between the diverse actors of the value chain has to be built, especially considering the traditional, trust-based character of forestry (Makkonen 2018: 73-77).

Purpose and objectives of ROSEWOOD4.0's roadmapping process

ROSEWOOD4.0 carries out a broad, Europe-wide collection of Best Practices and Innovations (BPI) that have been tried and tested by practitioners in their regional context. These BPI have a dedicated focus on digitalization and are being validated with the involvement of regional stakeholders as to their suitability and relevance for targeted knowledge exchange and transfer between the five Regional Hubs. This focused cross-regional exchange of BPI has the potential to strengthen two levels of trust: first, the trust of stakeholders towards solutions to current challenges facilitated by digital tools (i.e. a validated solution has worked already in another country, so it could be interesting for my region), and the trust between different stakeholders of the value chain (i.e. these solutions worked because people shared data and collaborated).

The strategic roadmaps developed by Hub partners and stakeholders in the frame of the project firstly provide a plausible direction and guidance for addressing region-specific challenges through exploitation of learnings from other European regions. Secondly, they can also serve as a stimulus for forestry stakeholders to approach and adopt digitalization more seriously, and to start exploring new ways of cooperation and communication between all actors in the value chain.

The following cross-regional roadmap proposes a meta-perspective on the knowledge flows between the five ROSEWOOD4.0 Regional Hubs, highlighting the opportunities for cooperation in forestry across European regions. The insights presented in this report are the result of the overarching analysis of regional gaps and BPI collected, leading to proposed directions for practical uptake by the five Regional Hubs and their affiliated stakeholders.

2. Regional strengths and gaps in wood mobilization

The Rosewood 4.0 Hubs each completed an analysis of the internal and external factors influencing the development and reach of the Forestry sector in each of the regions through the completion of a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis. The respective, in-detail SWOT analysis for each of the Hubs can be found in the individual Hub Roadmaps. In this Cross-regional Roadmap, we analyse the input of the regional Roadmaps as a whole in order to: identify categories, or groups, of strengths and gaps (a combination of weaknesses and threats) that were identified across the regions; establish which are the most recurrent types of gaps in each region; and identify possible knowledge flows and opportunities for collaboration and knowledge-sharing across the different Hubs and regions.

2.1 Analysis of regional strengths based on Hubs' SWOTs

The following main categories of strengths have been identified based on the SWOT analysis of the individual Hub Roadmaps. Strengths individually identified by each Hub have been grouped based on similarity of topic or focus. In many occasions, the separate Hubs identified similar characteristics or elements to other regions but with slightly different wording or descriptions accounting for the nuances of each region. The below analysis seeks to harmonise these into identifiying the general categories where Hubs are particularly strong and may have identifiable knowledge or experience to share between each other.

Across the five Hub Roadmaps, strengths individually identified by each Hub in the frame of its respective SWOT analysis, have been grouped here in eight main strength categories for better overview. The following table illustrates the number of individually identified strengths of each Hub within the main strength categories developed. The full table of individually identified Hub strengths and which Hub identified them, is included in Annex 1.

Main Strength Categories	Number of individual strengths identified per Hub in each main strength category					
	NE	CWE	SWE	CEE	SEE	**Total**
1. Strong and competitive forest industry, processes and supply chains	3	3	4	4	1	**15**
2. Incorporation of digitalisation and data management solutions	3	2		3		**8**
3. Increasing focus on renewable energies, sustainability and circular economy	1	2	1	3		**7**
4. Educational and knowledge transfer resources available	1	2		1		**4**
5. R&D and Innovation support available		2	1	1		**4**
6. Skilled and experienced staff across disciplines		2	1		1	**4**
7. High safety standards, certifications and controls in place	1	1	1			**3**
8. High availability and access to quality raw materials			2		2	**4**
Total	9	14	10	12	4	

Table 1: Main strength categories and the identified strengths from each individual Hub, organised into main categories.

This grouping identifies the category 1 "Strong and competitive forest industry, processes and supply chains" as the clearly strongest one across all regional Hubs (15), followed by "Incorporation of digitalisation and data management solutions" (8).

In terms of the data distribution per Hub, the following observations can be made:

- NE Hub has most strengths across the categories 1 "Strong and competitive forest industry, processes and supply chains" and 2 "Incorporation of digitalisation and data management solutions".

- CWE Hub has the broadest range of strengths of all five hubs, with identified strengths across seven out of eight categories. In particular, the main focus is on the available industry and processes (strength category 1.) with a similar number of strengths identified across categories 2-6.
- SWE Hub shares one of the strongest strength contributions to category 1, and is one of the only two Hubs which has identified strengths in the availability and access to raw materials. Across all categories, except for 2 and 4, SWE Hub has a similar strength representation.
- CEE Hub has also one of the highest contributions to strengths within category 1 (4), followed by categories 2 and 3 (3).
- SEE Hub is one of the only two Hubs contributing to the strength category 8 related to the availability of raw materials, with strengths also identified fitting to categories 1 and 3.

2.2 Analysis of regional gaps based on Hubs' SWOTs

This section focuses on the Weaknesses and Threats identified by each Hub in the SWOTs within each individual roadmap, which for the purpose of this cross-regional analysis have been grouped together in the term 'Gaps'. The sub-gaps, those specific weaknesses and threats identified by each Hub within their SWOTs have been grouped into seven main categories which are common in terms of topic and focus.

A table including all sub-gaps per the main seven gap categories and which Hub identified them can be found in Annex 1 of this document.

The table below shows, for each Hub, how many of the identified sub-gaps were grouped into each of the seven main gap categories for this roadmap analysis. The purpose of this data is to identify where each Hub may be lacking developments, resources, technology or opportunities, in order to better understand where input from other Hubs, further resources or other types of support may be most needed.

Main Gap Categories	Number of gaps identified per Hub in each gap category					
	NE	CWE	SWE	CEE	SEE	Total
1. Improve forest resilience and adaptation to climate change	1	1	1	3		6
2. Improve infrastructure and capacity of public actors	2		2	1	5	10
3. Activate private owners and cooperative forest management	3	3	2	2	6	16
4. Ensure a well-trained workforce through attractive skills development and education	2	1		1	3	7
5. Enhance economic and environmental performance of forest supply chains		3	1	4	9	17
6. Grow the forest-based bioeconomy through circular use and value-added products	1	1	1	3	1	7
7. Raise public awareness, social acceptance and political support for forestry.	2	3	1			6
Total	11	12	8	14	24	

Table 2: Main gap categories and number of gaps identified from each Hub for each category (source: individual Hub Roadmaps).

From the above table we can extract the following information:

- The Gap categories 3 " Activate private owners and cooperative forest management" and 5 " Enhance economic and environmental performance of forest supply chains" cover the most gaps identified by all Hubs, with 17 and 16 sub-gaps in total, respectively.
- Gap category 3, "Activate private owners and cooperative forest management" has the most even distribution across all Hubs, meaning there is a general lack of resources or solutions across all regions when it comes to this topic. In particular SEE Hub has an especially high amount of sub-gaps relevant to this category (6).
- Gap category 6 "Grow the forest-based bioeconomiy through circular use and value added products", while also having an even distribution across Hubs, has overall lower identified sub-gaps for all Hubs with respect to category 3.
- Gap category 5 "Enhance economic and environmental performance of forest supply chains", while having a significant total amount of identified sub-gaps, has a very mixed range of importance for each Hub, being the highest by far for the SEE Hub (9), the highest of all categories for CEE Hub (4), but having no identified gaps in this category for NE Hub.

At the Hub-level, we can gather the following points:

- NE Hub has an overall balanced distribution of sub-gaps across categories, ranging between zero and three (0-3) for all seven gap categories. From the seven main gap categories, the NE Hub only has no identified gaps for Gap 5 "Enhance economic and environmental performance of forest supply chains", and the highest sub-gaps are identified in Gap 3 "Activate private owners and cooperative forest management" (3).

- CWE Hub is balanced across categories, with identified gaps ranging between zero and three (0-3). CWE Hub identified no gaps under the category 2 “Improve infrastructure and capacity of public actors”, while having the highest sub-gaps for categories 3 “Activate private owners and cooperative forest management” (3) and 5 “Enhance economic and environmental performance of forest supply chains” (3).
- SWE Hub has identified the lowest number of gaps overall (8), with sub-gaps ranging between zero to two (0-2) for each category, having no gaps under category 4 “Ensure a well-trained workforce through attractive skills development and education” and two (2) sub-gaps for categories 2 and 3.
- CEE Hub has a slightly wider distribution ranging from zero to four (0-4) sub-gaps per main category, with no gaps identified under 7 “Raise public awareness, social acceptance and political support for forestry” and the highest number of sub-gaps found for category 5 “Enhance economic and environmental performance of forest supply chains” (4).
- SEE Hub identified the highest number of sub-gaps overall (24). This Hub has a very varied gap distribution ranging between zero and nine (0-9), with no identified gaps for categories 1 and 7 “Improve forest resilience and adaptation to climate change” and “Raise public awareness, social acceptance and political support for forestry” but 9 gaps under category 5.
- Overall, Northern and Western Hubs (NE, CWE, SWE) have a relatively more balanced distribution of gaps across all areas, compared to the Eastern Hubs which show larger differences between categories.

2.3 Main Knowledge Flows: Which strengths from hubs may compensate gaps from other hubs

This section aims to identify any links or knowledge flows which may initially be aparent through comparing the identified strengths from the five Hubs against the identified Gaps in the regions. This preliminary analysis is made as part of this cross-regional roadmap, without providing the specific solutions, transfer mechanisms or innovations which may make the knowledge flow happen: the selection of specific means of transfer, represented in this and the individual roadmaps by the Best Practices and innovations (BPI) is explained in the next two sections.

- All Hubs, except SEE Hub have the largest number of strengths in the first category “Strong and competitive forest industry, processes and supply chains”. The gaps relevant to this category are 2 “Improve infrastructure and capacity of public actors”, 3 “Activate private owners and cooperative forest management” and 5 “Enhance economic and environmental performance of forest supply chains”, for which the largest number of gaps is found, by a large difference, from SEE Hub. This suggests that there is opportunity for knowledge flow and the learning and incorporation of methods and ideas from all other Hubs towards this Hub in particular, but also across all other Hubs and as part of internal (within the same Hub) knowledge sharing.
- “Increasing focus on renewable energies, sustainability and circular economy” is a relatively strong strength category, particularly for CEE Hub. This can be related to Gap categories 1 “Improve forest resilience and adaptation to climate change” and 6 “Grow the forest-based bioeconomy through circular use and value-added products”. These categories are relevant for all Hubs in terms of gaps identified in at least one of them. We can note that for both gap categories, CEE is also the Hub to have identified the largest set of sub-gaps. This may indicate two things:
    - There is opportunity for knowledge flow internally within the CEE Hub.
    - The focus on climate change, renewable energies and circular economy is a particularly important one for CEE Hub, and therefore the region is especially aware in identifying both the strengths and gaps that are present in the Hub in these areas.

Altogether, the balanced number of strengths and gaps across other Hubs leaves a possibility open for knowledge transfer and flow of ideas and solutions across all Hubs.

- Activities related to digitalisation, data management and enhancing cooperation and logistics across actors in the industry can be found within the Strength 2 “Incorporation of digitalisation and data management solutions”, and Gap 5 “Enhance economic and environmental performance of forest supply chains”. Particularly strong are NE, CEE and CWE Hub and largest number of sub-gaps have been identified by SEE Hub, but also additional related gaps from CEE and CWE Hub. This suggests a flow of information from the Northern and Central Hubs towards the Southern Hubs in particular, with also strong possibility for internal (within the same Hub) knowledge sharing in particular for CWE and CEE Hub.
- Regarding having a skilled workforce and the opportunity for education and knowledge sharing, strength category 6 “Skilled and experienced staff across disciplines” and gap 4 “Ensure a well-trained workforce through attractive skills development and education” can be related. Within the strength category 6, CWE Hub in particular as well as SWE and SEE Hub make the contributions in terms of specific strengths. In terms of gaps, all Hubs except for SWE identified gaps in this main category, which was particularly important for SEE Hub. Considering these gap and strength distributions among hubs, a main knowledge flow from CWE and SWE Hub to SEE Hub as well as an internal knowledge sharing between SEE Hub members can be expected.
- Finally, the topic regarding access to public funding and resources to increase innovation is encompassed by Strength 5 “R&D and Innovation support available”, for which a link with Gap 2 “Improve infrastructure and capacity of public actors” and gap 7 “Raise public awareness, social acceptance and political support for forestry” is found. In terms of strengths, the Central and Western Hubs (CWE, SWE and CEE) contribute with identified individual strengths. Gaps 2 and 7 are both important in particular for NE Hub, as well as for SWE Hub. Gap 2 is in addition especially important for SEE. In this case, therefore, it can be understood that knowledge sharing from the central and western Hubs towards both Northern and Eastern regions could be beneficial.

The knowledge flows identified here may differ from the selection of BPI both within a same Hub and from other Hubs, selected as interesting or relevant by the Hubs in their Roadmaps. This information is provided in the following Sections 3 and 4, where the Section 4.3 identifies specifically which BPI were chosen in response to individual gaps of each Hub.

3. BPI assessment from ROSEWOOD4.0

The identified Best Practices and innovations (BPI), representing the means of transfer of each regional Hub within ROSEWOOD4.0, are analysed in detail below. For this purpose, the following aspects are highlighted:

- Number of Best Practices identified per Hub
- Number of Best Practices identified per country
- Number of Best Practices identified per domain per Hub
- Number of Best Practices identified per solution type per Hub

It can thus be determined where the means of transfer in Europe are located, in which domain and in which solution type approaches.

3.1 Number of BPI identified per Hub

In ROSEWOOD4.0 there are five regional Hubs where Best Practices and innovations (BPI) have been gathered. Additionally, Best Practices identified having their origins outside of the five Hubs, have been classified generally as “EU” (European) or “INT” (International).

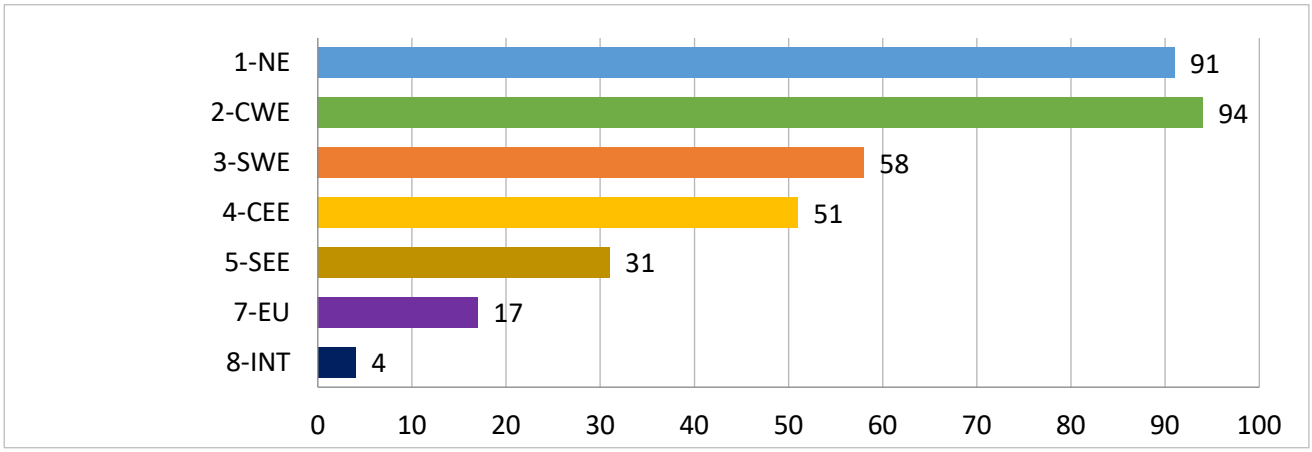

Figure 1: Total number of best practices identified per Hub.

In total 346 Best Practices and Innovations (BPI) have been identified in the project. Regarding the distribution of the identified BPI across the different regions, i.e. their origin, the analysis shows that the majority of them originate from CWE (94) and NE (91) Hub. We can see that the number of identified BPI decreases in terms of geographical distribution from North to South.

3.2 Number of BPI identified per country

To further deepen the analysis within each regional Hub, the identified BPI were also classified according to their country of origin.

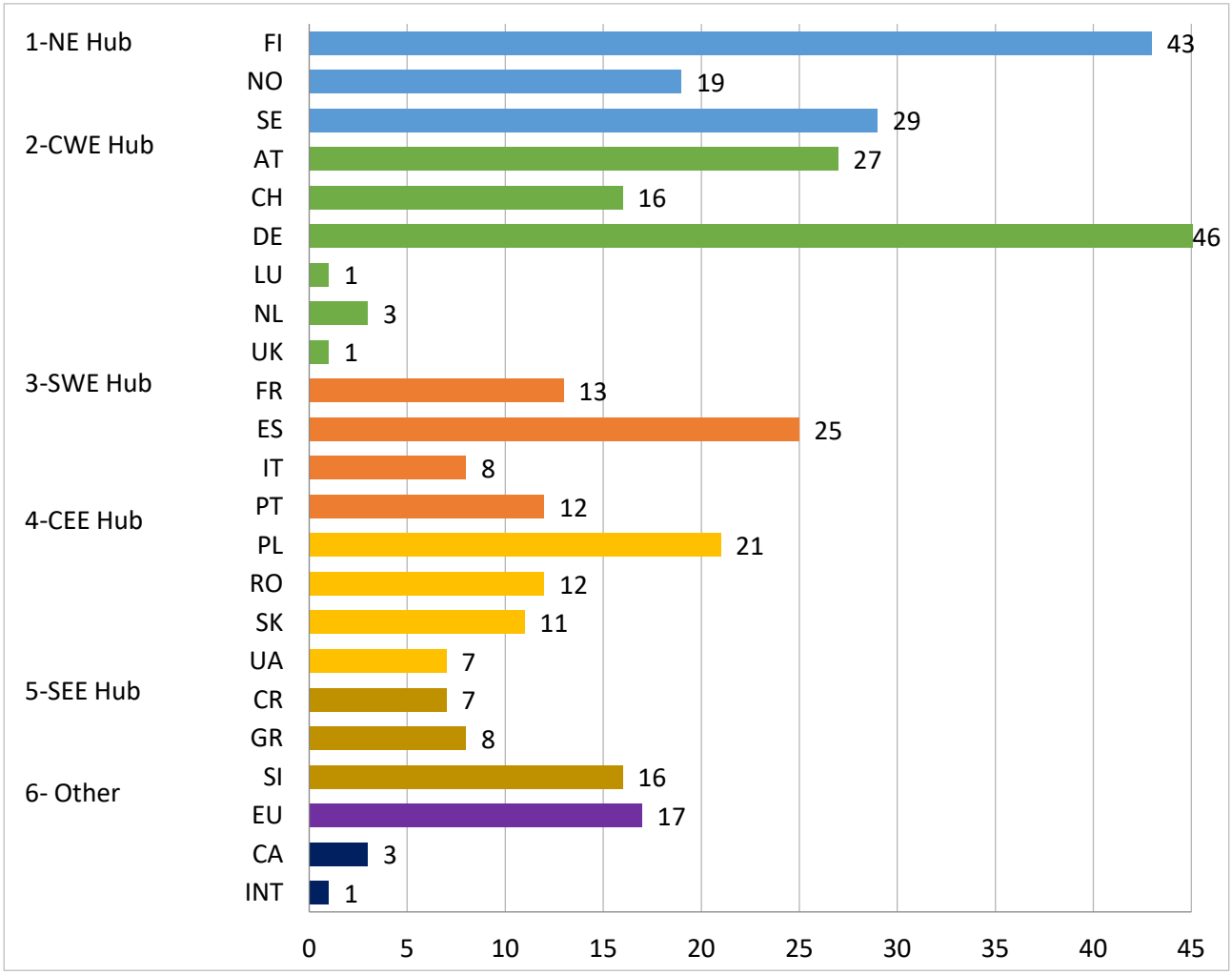

Figure 2: Total number of best practices identified per country.

The analysis shows that most of the identified BPI are identified in Germany/CWE Hub (46) and Finland/NE Hub (43). In SWE Hub, most identified BPI originate from Spain (25), in CEE Hub the majority comes from Poland (21) and in SEE Hub from Slovenia (16).

3.3 Number of BPI identified per domain per Hub

In order to gain additional insights, the identified BPI are now listed below by domain per Hub. This allows a more accurate assessment of the distribution of means of transfer in Europe by area of activity.

	Hubs							
Domains	**1-NE**	**2-CWE**	**3-SWE**	**4-CEE**	**5-SEE**	**7-EU**	**8-INT**	**Total result**
Inventory, assessment, monitoring	14	22	12	18	5	2	1	74
Harvesting, logistics, transport, safety	17	18	8	3	3	7	1	57
Education, research, knowledge transfer (transversal)	15	14	5	8	4	3		49
Products, markets, trade	10	14	5	7	2			38
Forest management, ecosystem services, resilience	8	7	7	7	6	1		36
Ownership, cooperation	4	8	13	2	2	1		30
Forest-based industries, bio/circular economy, value chain	11	3	3	3	2	1	1	24
Forest disturbances, risks, disaster response	5	1	1	2	7	1		17
Innovation management, digital hubs, clusters, exploitation	4	5	2	1		1	1	14
Financing, funding schemes	3	2	2					7
Total result	**91**	**94**	**58**	**51**	**31**	**17**	**4**	**346**

Table 3: Total number of best practices identified per domain per Hub.

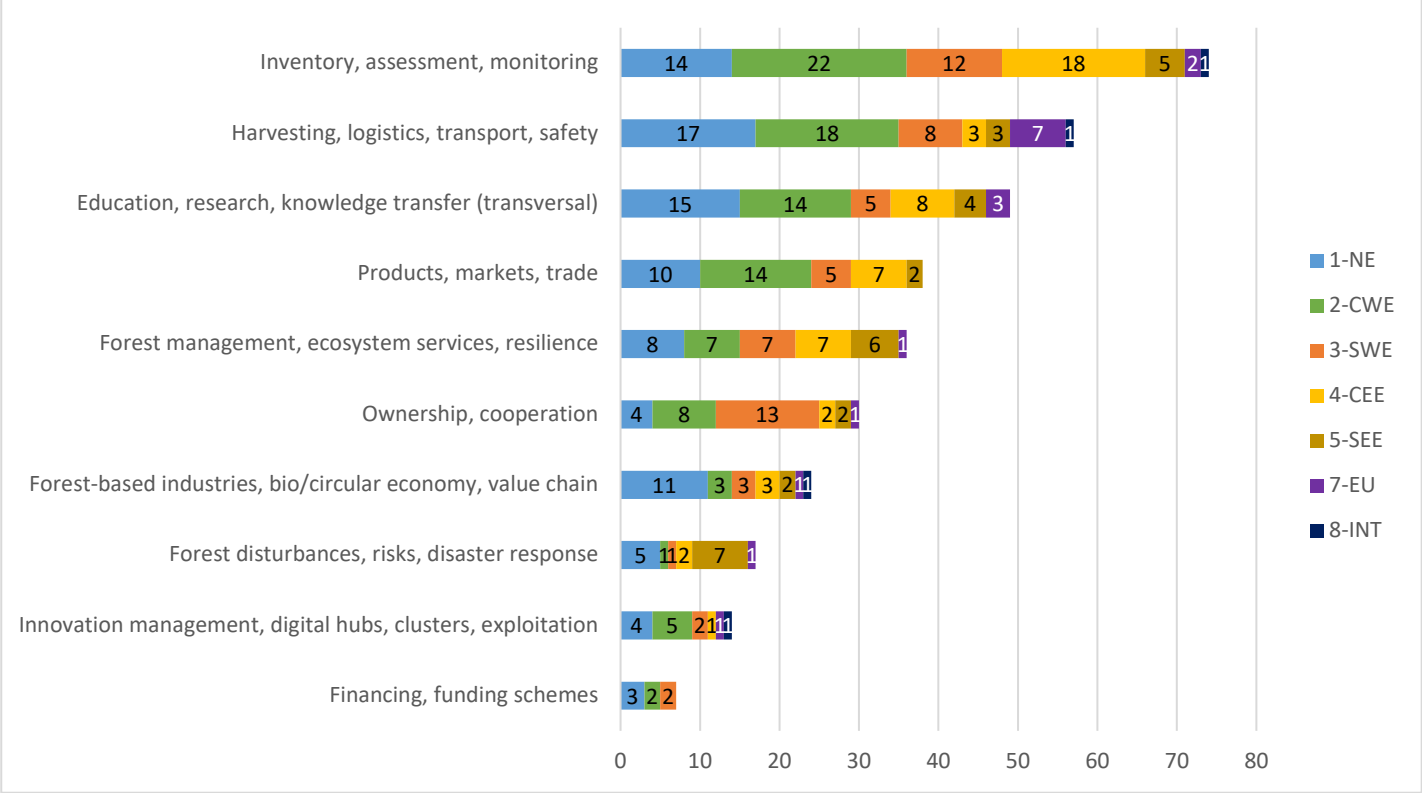

Figure: 3: Total number of best practices identified per domain per Hub.

Here we can see that most of the BPI have been identified in the three domains “Inventory, assessment, monitoring” (74), “Harvesting, logistics, transport, safety” (57) and “Education, research, knowledge transfer (transversal)” (49).

In all three domains, at least one BPI from each regional Hub can be found. Again, CWE and NE Hub, but also CEE Hub lead in the number of corresponding BPI.

The weakest domains in terms of BPI number are “Financing, funding schemes” (7), “Innovation management, digital Hubs, clusters, exploitation” (14) and “Forest disturbances, risks, disaster reponse” (17). The domain “Financing, funding schemes” has low BPI contributions while two Hubs, CEE and SEE Hub are not represented here.

Following an analysis per Hub we can state that:

- NE Hub has identified BPI in every domain, especially “Harvesting, logistics, transport, safety” (17). However, the categories “Finance, funding schemes” (3), “Innovation management, digital Hubs, clusters, exploitation” (4) and “Ownership, cooperation” (4) are lower-pitched in NE Hub.

- CWE Hub has identified BPI in every domain, especially “Inventory, assessment, monitoring” (22). However, the categories “Forest disturbances, risks, disaster reponse” (1), “Financing, funding schemes” (2) and “Forest-based industries, bio/circular economy, value chain” (3) might need additional input from outside CWE Hub.

- SWE Hub has identified BPI in every domain, especially “Ownership, cooperation” (13). However, the categories “Forest disturbances, risks, disaster reponse” (1), “Financing, funding schemes” (2) and “Innovation management, digital Hubs, clusters, exploitation” (2) are lower-pitched in SWE Hub.

- CEE Hub has identified BPI in nearly every domain, only “Financing, funding schemes” lacks a corresponding input from CEE and also “Innovation management, digital Hubs, clusters, exploitation” (1), “Forest disturbances, risks, disaster reponse” (2) and “Ownership, cooperation” (2) do not count many BPI from CEE Hub. In contrast, the domain “Inventory, assessment, monitoring” (18) seems to be especially pronounced in CEE Hub.

- SEE Hub has not identified any BPI in the domain “Finance, funding schemes” and “Innovation management, digital Hubs, clusters, exploitation”. Also, they might need additional input in the domains “Forest-based industries, bio/circular economy, value chain” (2), “Ownership, cooperation” (2) and “Products, markets, trade” (2). However, the strengths of SEE Hub seem to lie in the categories “Forest disturbances, risks, disaster response” (7) and “Forest management, ecosystem services, resilience” (6).

This leads to the following conclusions:

All regional Hubs seem to lack some BPI input in the domain “Financing, funding schemes”. That can either mean that:

- There is no need for a BPI in this domain since everything works fine for all the Hubs
- Every Hub needs support/BPI input in this domain.

Chapter 2 focused on the strengths and gaps identified by the Hubs. In Annex 1 we can see that a number of gaps under Gap category 2 “Improve infrastructure and capacity of public actors”, namely “Lack of funding for R&D and efforts to find new opportunities” has been identified by the NE Hub, “Low public finance, subsidies

and compensation mechanisms in the sector" by CEE and SEE Hub and "Few options for financial support" by the SWE Hub. This leads to the assumption that the lack of BPI in the domain "Financing, funding schemes" represents indeed a need which has been identified and could use a BPI input.

Furthermore, both CWE and CEE Hub account for most BPI in the domain "Inventory, assessment, monitoring". Here the question arises if other Hubs selected the according BPI in this domain from these two Hubs, which will be more closely analyzed in Chapter 4.3 (Number of BPI selected per Hub per domain).

3.4 Number of BPI identified per solution type per Hub

Having examined the identified BPI per domain and Hub, we now turn to the analysis of the identified BPI per solution type and Hub. This will allow a deeper and more concrete insight into the strengths and solution approaches inside the regional Hubs in Europe.

	Hubs							
Solution type	**1-NE**	**2-CWE**	**3-SWE**	**4-CEE**	**5-SEE**	**7-EU**	**8-INT**	**Total result**
Sensors, measurement equipment	13	16	1	10	1	2		43
Advisory and services tools for forest owners	10	14	4	6	4	1		39
Modelling, DSS, simulation, optimization	6	10	12	3	2	2		35
Data platforms, data hubs, open data	5	4	1	8	11	1		30
Awareness, infoportals, educational campaigns	5	11	2	6	1	2		27
Smart machinery, equipment	12	7	2	1	1	3		26
Traceability tools		3	7	4	2		2	18
Marketing platforms	1	7	3	5	2			18
Collaboration platforms, logistical hubs	6	4	4		4			18
Training, education, eLearning	8	4	1	2	2			17
Joint forest management		6	10					16
Sustainable, bio-based, circular products, smart materials	10		2	3				15
R&D platforms, testbeds, co-creation initiatives	4	3	2	1		4	1	15
Operations optimization	3	2	1		1	1		8
Funding schemes, grants	4	1	2					7
Cooperative initiatives, networks, clusters			4	1				5
Smart biotechnologies	2			1		1		4
Innovation contests	2						1	3
Data standards		2						2
Total result	**91**	**94**	**58**	**51**	**31**	**17**	**4**	**346**

Table 4: Total number of best practices identified per solution type per Hub.

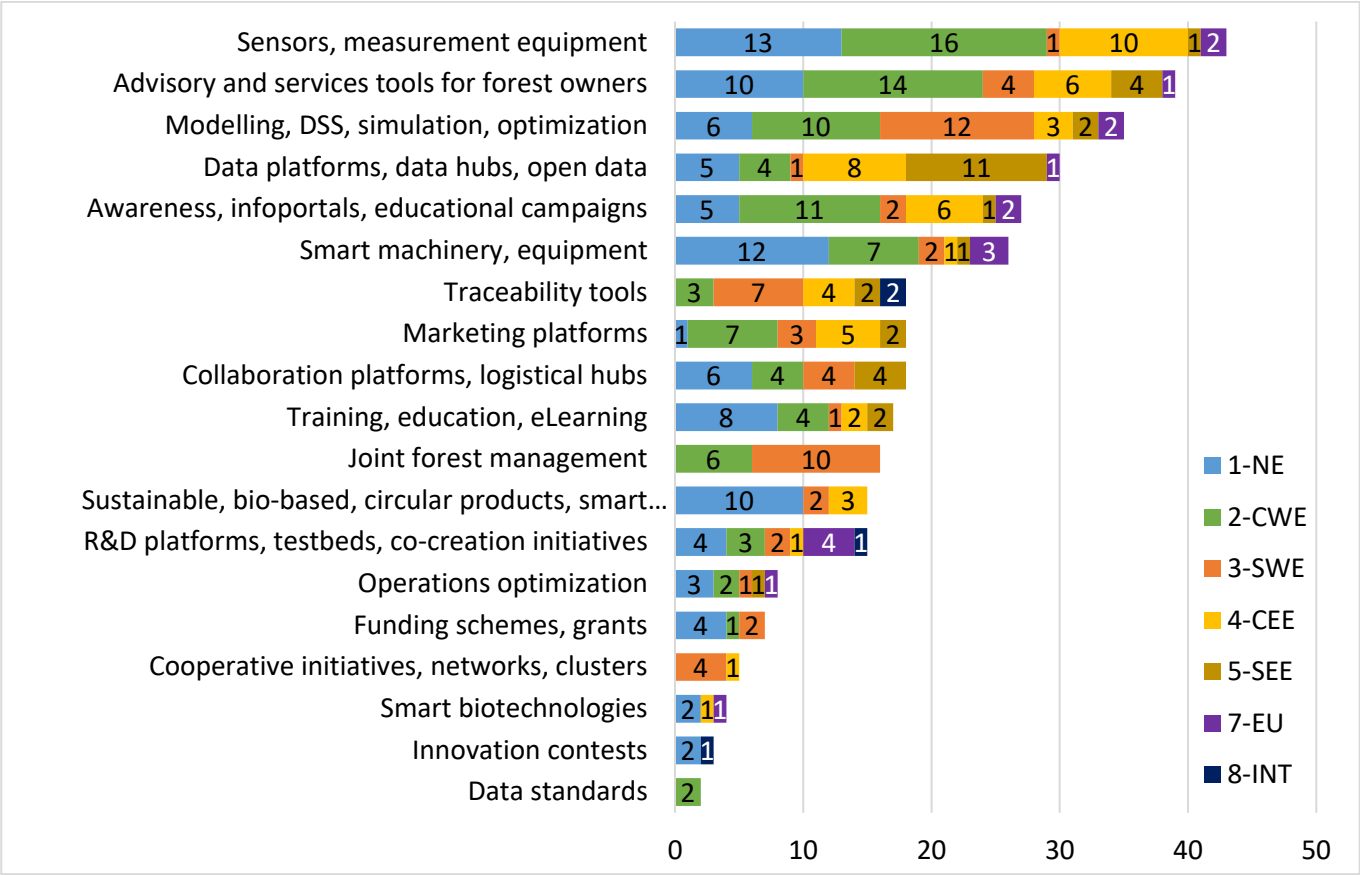

Figure: 4: Total number of best practices identified per solution type per Hub.

The majority of identified BPI can be categorized in the three solution types "Sensors, measurement, equipment" (43), "Advisory and service tools for forest owners" (39) and "Modelling, DSS, simulation, optimization" (35). In all three categories at least one BPI from each regional Hub can be found. CWE and NE Hub provide most of the BPI identified, CEE and SWE Hub follow.

"Data standards" (2) and "Innovation contests" (3) are in contrast solution types which count only very few BPI

Following an analysis per Hub we can state that:

- NE Hub has identified BPI corresponding to nearly every solution type. It is the leading Hub having identified solutions in "Smart machinery, equipment" (12) and also adds a lot of BPI in the categories "Sensors, measurement equipment" (13), "Advisory and services tools for forest owners" (10) and "Sustainable, bio-based, circular products, smart materials" (10). There are no BPI from NE Hub corresponding to the solution type "Data standards", "Cooperative initiatives, networks, clusters", "Joint forest management" and "Traceability tools".

- CWE Hub has identified BPI corresponding to nearly every solution type. It is leading Hub having identified solutions in "Sensors, measurement equipment" (16) and also adds a lot of BPI in the categories "Advisory and services tools for forest owners" (14) and "Modelling, DSS, simulation, optimization" (10). It is the only Hub having identified BPI in the solution type "Data standards". There are no BPI from CWE Hub corresponding to the solution type "Innovation contests", "Smart

biotechnologies", "Cooperative initiatives, networks, clusters" and "Sustainable, bio-based, circular products, smart materials".

- SWE Hub has identified BPI corresponding to nearly every solution type. It is a leading Hub having identified solutions in "Modelling, DSS, simulation, optimization" (12) and also adds a lot of BPI in the categories "Joint forest management" (10) and "Traceability tools" (7). There are no BPI from SWE Hub corresponding to the solution type "Data standards", "Innovation contests" and "Smart biotechnologies".

- CEE Hub has identified BPI corresponding to a lot of solution types. It identified most of their BPI in the categories "Sensors, measurement equipment" (10), "Data platforms, data Hubs, open data" (8) and "Advisory and service tools for forest owners" (6). There are no BPI from CEE Hub corresponding to the solution types "Data standards", "Innovation contests", "Funding schemes, grants", "Operations optimization", "Joint forest management" and "Collaboration platforms, logistical Hubs".

- SEE Hub has identified BPI corresponding to more than the half of the listed solution types. It is the leading Hub having identified solutions in "Data platforms, data Hubs, open data" (11). It can further add some BPI in the categories "Advisory and services tools for forest owners" (4) and "Collaboration platforms, logistical Hubs" (4). There are no BPI from SEE Hub corresponding to the solution type "Data standards", "Innovation contests", "Smart biotechnologies", "Cooperative initiatives, networks, clusters", "Funding schemes, grants", "R&D platforms, testbeds, co-creation initiatives", "Sustainable, bio-based, circular products, smart materials" and "Joint forest management".

3.5 Interim Conclusion

Having gone through the individual steps of analysis above, we can now come to the following first conclusions:

- The main means of transfer in Europe seem to be located mainly in the northern regions, i.e. CWE and NE Hub. These regions count the highest number of identified BPI (see figure 1 and 2).
- The main means of transfer in Europe can be found in the domains "Inventory, assessment, monitoring", "Harvesting, logistics, transport, safety" and "Education, research, knowledge transfer (transversal)". These domain categories count the highest number of identified BPI (see figure 3).
- The main means of transfer in Europe can be categorized in the solution types "Sensors, measurement equipment", "Advisory and services tools for forest owners" and "Modelling, DSS, simulation, optimization". These solution type categories count the highest number of identified BPI (see figure 4).

4. Knowledge transfer between regions: Transfer of BPI among Hubs to cover gaps

Chapter 3 has focused on the identified BPI in Europe taking several analytical steps regarding their origin of the identified BPI, domain and solution type offered.

Chapter 4 now turns the focus to those BPI, which have been actively selected by the Hubs based on their identified gaps and needs. The selection of BPI by the Hubs has been done both from the own Hub (internally) and from other Hubs (externally) and will be analysed in detail below. For this purpose, the following aspects are highlighted:

- Number of BPI selected among Hubs
- Repartition of the selections per Hub
    - Number of BPI selected per Hub internally (from own Hub)
    - Number of BPI selected per Hub externally (from other Hubs)
    - Number of BPI selected per Hub per domain (internally and externally)
    - Number of BPI selected per Hub per solution type (internally and externally)
- Most relevant BPI for transfer: selected BPI by 2 Hubs or more

4.1 Presentation of the BPI selected among Hubs (Statistics)

After the SWOT analysis done within the Hubs, the 346 identified BPI have been screened to respond to the Hub's respective weaknesses and threats. This led to a selection of BPI which is presented below (y representing "yes" = selected, - representing "no" = not selected).

Hubs	Nb. of BPI (not) selected
1-NE	**91**
selected	43
2-CWE	**94**
selected	46
3-SWE	**58**
selected	31
4-CEE	**51**
selected	13
5-SEE	**31**
selected	7
7-EU	**17**
selected	4
8-INT	**4**
selected	1
Total BPI identified	**346**
Total BPI selected	**145**

Table 5: Number of selected best practices by their origin.

Focusing only on the selected BPI, the following table emerges from the above:

In total, 145 out of 346 Best Practices have been selected as relevant to support local innovation and cover the gaps of the respective Hubs. The table shows how many BPI were selected per Hub from the overall amount of identified BPI. In the table and bar chart they are arranged by their origin (from which Hub they come).

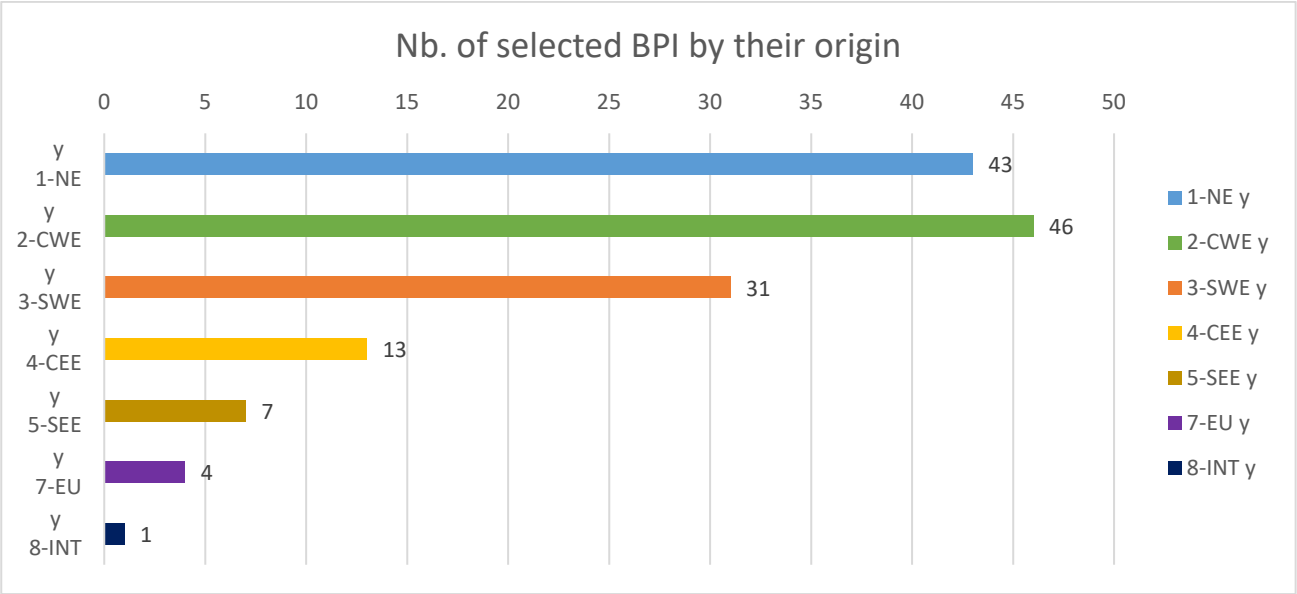

Figure 5: Number of selected best practices by their origin.

The analysis shows that most of the selected BPIcome from CWE (46) and NE Hub (43), which corresponds to the geographical distribution of all identified BPI (see figure 1). This means that the main interest in the regions concerned in on BPI coming from these Hubs, then a main knowledge transfer from the North to the South and East of Europe.

4.2 Repartition of the selections

The following analysis show the number of selected BPI arranged by each Hub's selection (from where the selected BPI come). This allows an analysis to determine the number of selected BPI coming from the Hub internally (own Hub's BPI) and externally (other Hubs' BPI). The selection of BPI within an own Hub represents a transfer possibility of the BPI between countries within the Hub.

NE Hub

NE Hub	Hub of origin				
Selection	1-NE	2-CWE	3-SWE	4-CEE	Total result
	18	6	2	2	28
Total result	**18**	**6**	**2**	**2**	**28**

Table 6: Repartition of selected BPI by NE Hub.

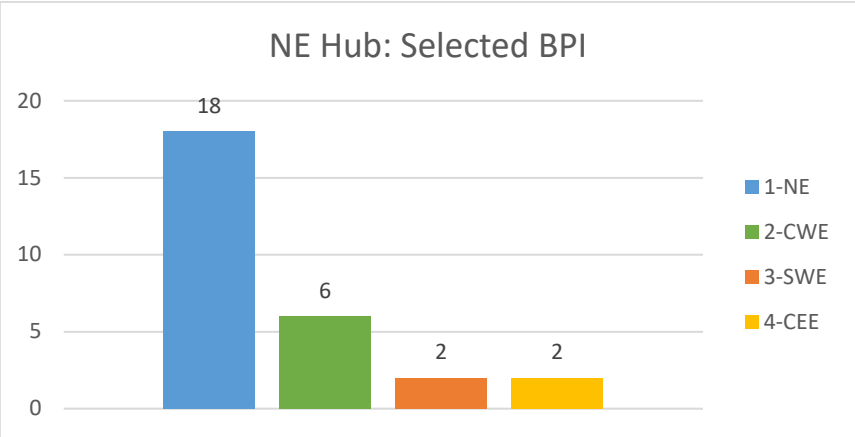

Figure 6: Repartition of selected BPI by NE Hub.

The NE Hub selected 28 BPI in total.

Of the 28 selected BPI, 18 come from NE Hub internally and 10 come from other Hubs: 6 from CWE Hub, 2 from SWE Hub and 2 from CEE Hub.

NE Hub selected no BPI from SEE Hub.

CWE Hub

CWE Hub	Hub of origin				
Selection	1-NE	2-CWE	3-SWE	7-EU	Total result
y	21	26	9	1	57
Total result	**21**	**26**	**9**	**1**	**57**

Table 7: Repartition of selected BPI by CWE Hub.

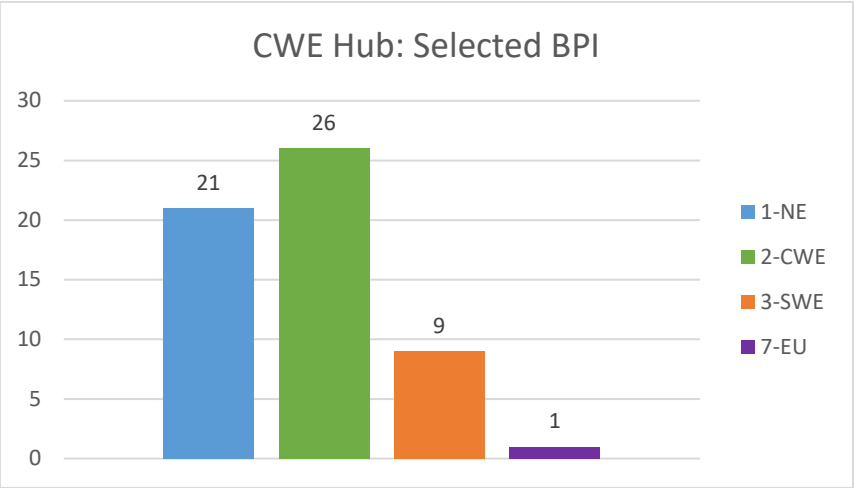

Figure: 7: Repartition of selected BPI by CWE Hub.

The CWE Hub selected 57 BPI in total.

Of the 57 selected BPI, 26 come from CWE Hub internally and 31 come from other Hubs: 21 from NE Hub, 9 from SWE Hub and 1 from EU.

CWE Hub selected no BPI from CEE and SEE Hub.

SWE Hub

SWE Hub	Hub of origin						
Selection	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
y	8	12	26	5	5	2	58
Total result	**8**	**12**	**26**	**5**	**5**	**2**	**58**

Table 8: Repartition of selected BPI by SWE Hub.

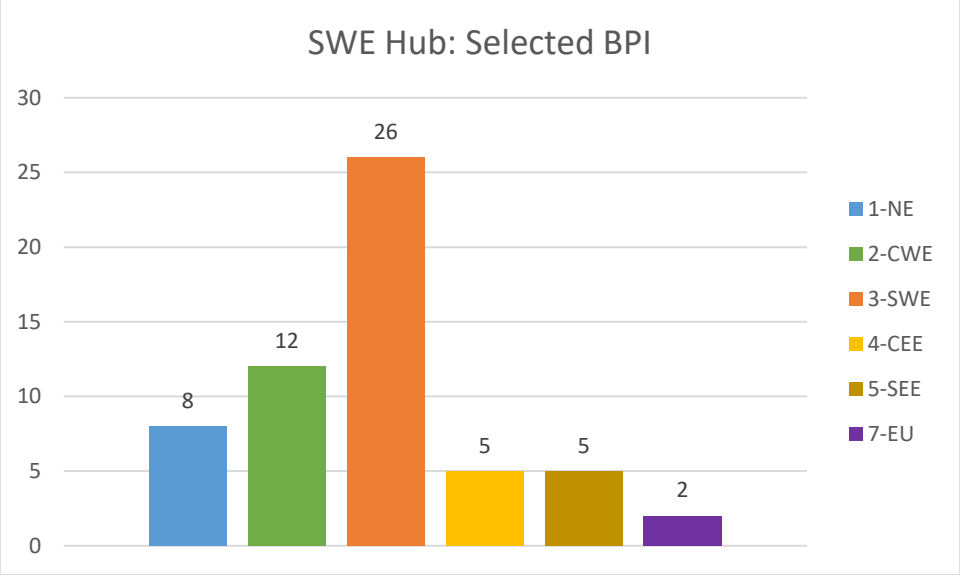

Figure 8: Repartition of selected BPI by SWE Hub.

The SWE Hub selected 58 BPI in total.

Of the 58 selected BPI, 26 come from SWE Hub internally and 32 come from other Hubs: 8 from NE Hub, 12 from CWE Hub, 5 from CEE Hub, 5 from SEE Hub and 2 from EU.

CEE Hub

CEE Hub	Hub of origin						
Selection	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
y	8	11	3	10	4	1	37
Total result	**8**	**11**	**3**	**10**	**4**	**1**	**37**

Table 9: Repartition of selected BPI by CEE Hub.

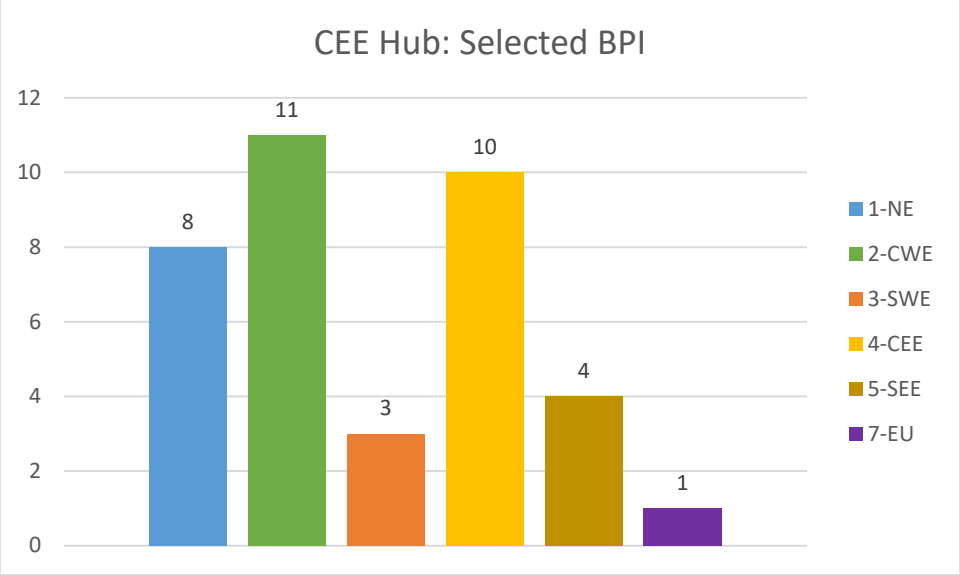

Figure 9: Repartition of selected BPI by CEE Hub.

The CEE Hub selected 37 BPI in total.

Of the 37 selected BPI, 10 come from CEE Hub internally and 27 come from other Hubs: 8 from NE Hub, 11 from CWE Hub, 3 from SWE Hub, 4 from SEE Hub and 1 from EU.

SEE Hub

SEE Hub	Hub of origin					
Selection	1-NE	2-CWE	3-SWE	4-CEE	8-INT	Total result
y	8	17	2	2	1	30
Total result	**8**	**17**	**2**	**2**	**1**	**30**

Table 10: Repartition of selected BPI by SEE Hub.

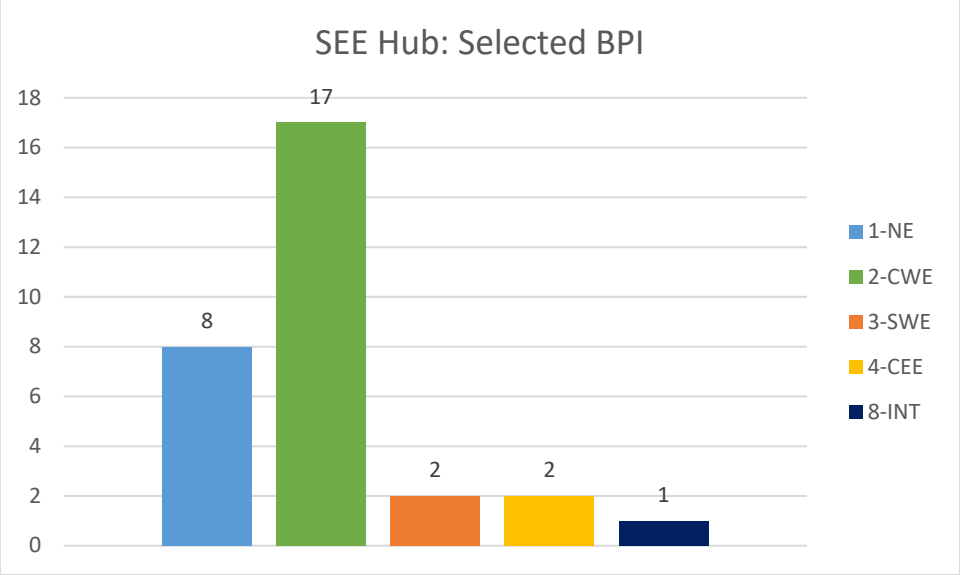

Figure 10: Repartition of selected BPI by SEE Hub.

The SEE Hub selected 30 BPI in total.

Of the 30 selected BPI, 0 come from SEE Hub internally and 30 come from other Hubs: 8 from NE Hub, 17 from CWE Hub, 2 from SWE Hub, 2 from CEE Hub and 1 from International.

4.3 Number of BPI selected per hub per domain (internal and external)

The following tables and charts show the number of selected BPI per domain arranged by each Hub's selection (from where the selected BPI come). This allows an analysis to determine the number of selected BPI per domain coming from the Hub internally (own Hub's BPI) and externally (other Hubs' BPI).

NE Hub

Selection by NE Hub	Hubs of origin				
Domains	1-NE	2-CWE	3-SWE	4-CEE	Total result
Education, research, knowledge transfer (transversal)	6	1			7
Financing, funding schemes	2				2
Forest disturbances, risks, disaster response	3				3
Forest management, ecosystem services, resilience			1		1
Forest-based industries, bio/circular economy, value chain	2			1	3
Harvesting, logistics, transport, safety	3	2			5
Innovation management, digital hubs, clusters, exploitation		1	1		2
Inventory, assessment, monitoring	1	2		1	4
Ownership, cooperation	1				1
Total result	**18**	**6**	**2**	**2**	**28**

Table 11: Repartition of selected BPI by NE Hub per domain.

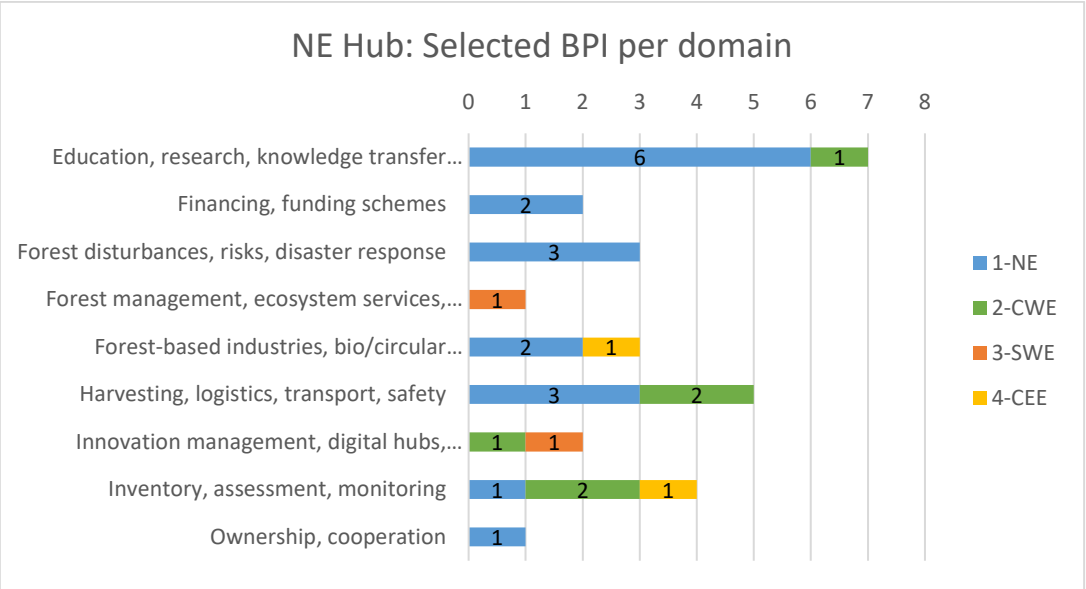

Figure 11: Repartition of selected BPI by NE Hub per domain.

The NE Hub selected most of the BPI in the domain "Education, research, knowledge transfer (transversal)" (7). Nearly all BPI from this domain have been selected from NE Hub internally (6).

In the domain categories "Forest management, ecosystem services, resilience" (1) and "Innovation management, digital Hubs, clusters, exploitation" (2) exclusively BPI coming from other Hubs (SWE and CWE) have been selected by NE Hub.

CWE Hub

Selection by CWE Hub	Hubs				
Domains	1-NE	2-CWE	3-SWE	7-EU	Total result
Education, research, knowledge transfer (transversal)	3	6	2		11
Financing, funding schemes	1				1
Forest disturbances, risks, disaster response	2				2
Forest management, ecosystem services, resilience	2	2			4
Forest-based industries, bio/circular economy, value chain	1				1
Harvesting, logistics, transport, safety	5	6	2	1	14
Innovation management, digital Hubs, clusters, exploitation		1			1
Inventory, assessment, monitoring	4	9	3		16
Ownership, cooperation	2	1	2		5
Products, markets, trade	1	1			2
Total result	**21**	**26**	**9**	**1**	**57**

Table 12: Repartition of selected BPI by CWE Hub per domain.

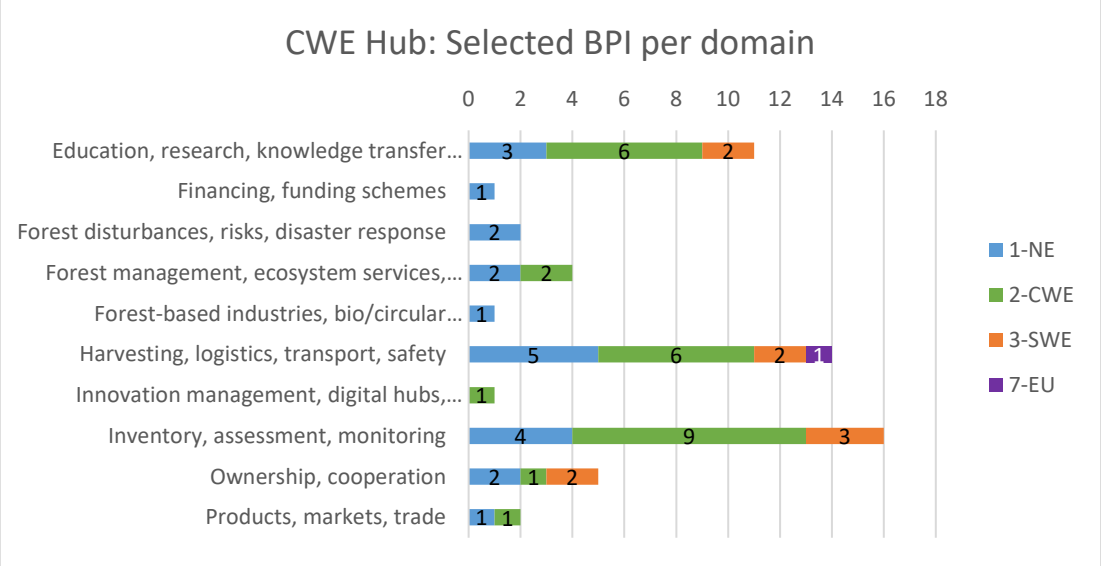

Figure 12: Repartition of selected BPI by CWE Hub per domain.

The CWE Hub selected most of the BPI in the domain "Inventory, assessment, monitoring" (16). Most of the BPI from this domain have been selected from CWE Hub internally (9).

In the domain categories "Financing, funding schemes" (1), "Forest disturbances, risks, disaster response" (2) and "Forest-based industries, bio/circular economy, value chain" (1) exclusively BPI coming from NE Hub have been selected by CWE Hub.

SWE Hub

Selection by SWE Hub	Hubs						
Domains	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
Education, research, knowledge transfer (transversal)	2	2	4				8
Financing, funding schemes	1	1	1				3
Forest disturbances, risks, disaster response	1		1				2
Forest management, ecosystem services, resilience		1	2		1		4
Forest-based industries, bio/circular economy, value chain			2	1		1	4
Harvesting, logistics, transport, safety	2	6	4	1	2	1	16
Innovation management, digital Hubs, clusters, exploitation			2				2
Inventory, assessment, monitoring	1		5	2			8
Ownership, cooperation	1	2	2		1		6
Products, markets, trade			3	1	1		5
Total result	**8**	**12**	**26**	**5**	**5**	**2**	**58**

Table 13: Repartition of selected BPI by SWE Hub per domain.

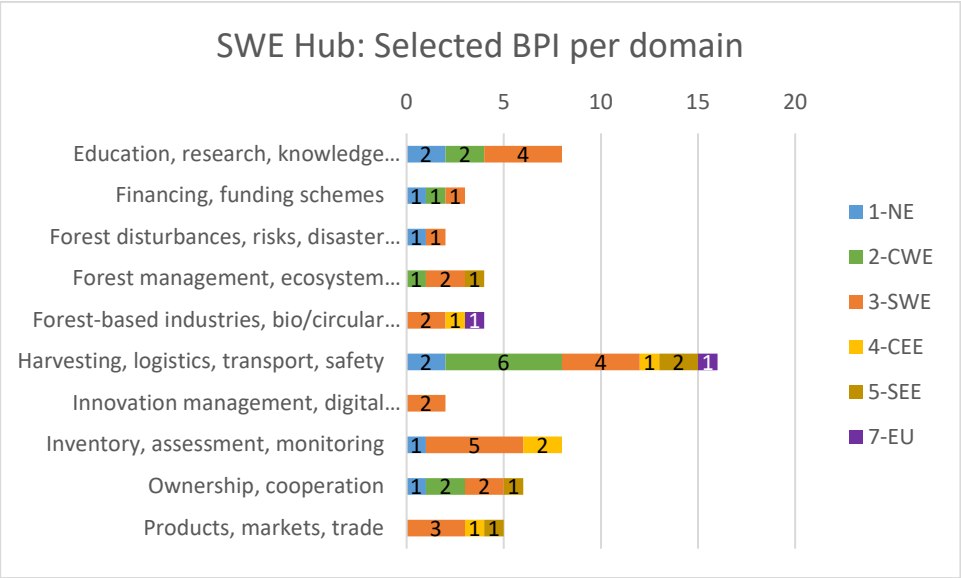

Figure 13: Repartition of selected BPI by SWE Hub per domain.

The SWE Hub selected most of the BPI in the domain "Harvesting, logistics, transport, safety" (16). Most of the selected BPI from this domain are coming from CWE Hub (6).

In the domain "Inventory, assessment, monitoring" 8 BPI have been selected by SWE Hub, including 5 coming from SWE Hub internally.

All domains include selected BPI coming from SWE Hub internally.

CEE Hub

Selection by CEE Hub	Hubs						
Domains	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
Education, research, knowledge transfer (transversal)	2	2					4
Financing, funding schemes	1						1
Forest disturbances, risks, disaster response	2			1	1		4
Forest management, ecosystem services, resilience			1	1	2		4
Forest-based industries, bio/circular economy, value chain				1			1
Harvesting, logistics, transport, safety		1	1	1	1	1	5
Innovation management, digital hubs, clusters, exploitation		2					2
Inventory, assessment, monitoring	2	3		5			10
Ownership, cooperation	1	1	1				3
Products, markets, trade		2		1			3
Total result	**8**	**11**	**3**	**10**	**4**	**1**	**37**

Table 14: Repartition of selected BPI by CEE Hub per domain.

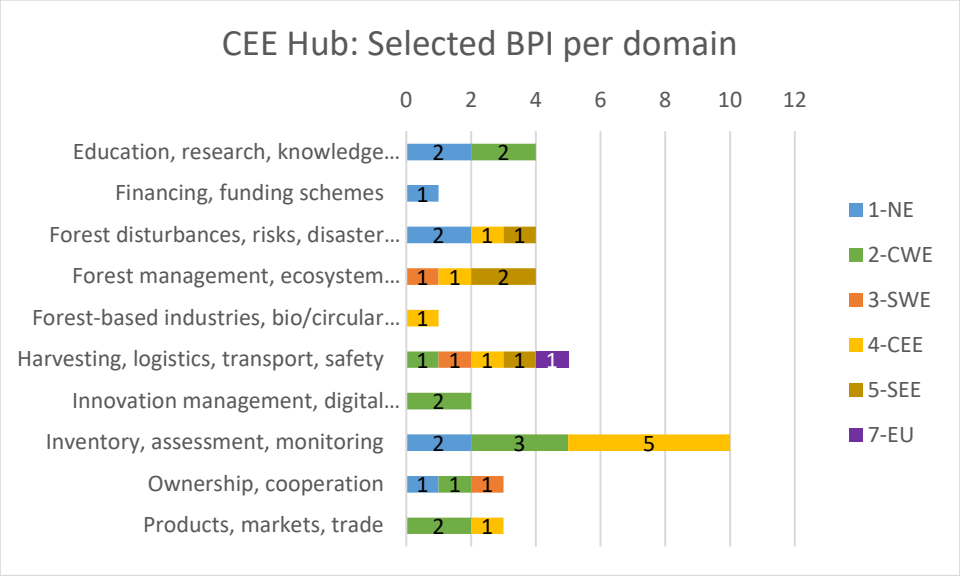

Figure 14: Repartition of selected BPI by CEE Hub per domain.

The CEE Hub selected most of the BPI in the domain "Inventory, assessment, monitoring" (10). Half of the selected BPI from this domain have been selected from CEE Hub internally (5).

In the domain categories "Education, research, knowledge transfer (transversal) (4)", "Financing, funding schemes" (1), "Innovation management, digital Hubs, clusters, exploitation" (2) and "Ownership, cooperation" (3) exclusively BPI coming from other Hubs (NE, CWE, SWE) have been selected by CEE Hub.

SEE Hub

Selection by SEE Hub	Hubs					
Domains	1-NE	2-CWE	3-SWE	4-CEE	8-INT	Total result
Education, research, knowledge transfer (transversal)	3	3				6
Financing, funding schemes	1		1			2
Forest management, ecosystem services, resilience	1	2				3
Harvesting, logistics, transport, safety		2		1	1	4
Innovation management, digital Hubs, clusters, exploitation		2	1			3
Inventory, assessment, monitoring	2	3		1		6
Ownership, cooperation		2				2
Products, markets, trade	1	3				4
Total result	**8**	**17**	**2**	**2**	**1**	**30**

Table 15: Repartition of selected BPI by SEE Hub per domain.

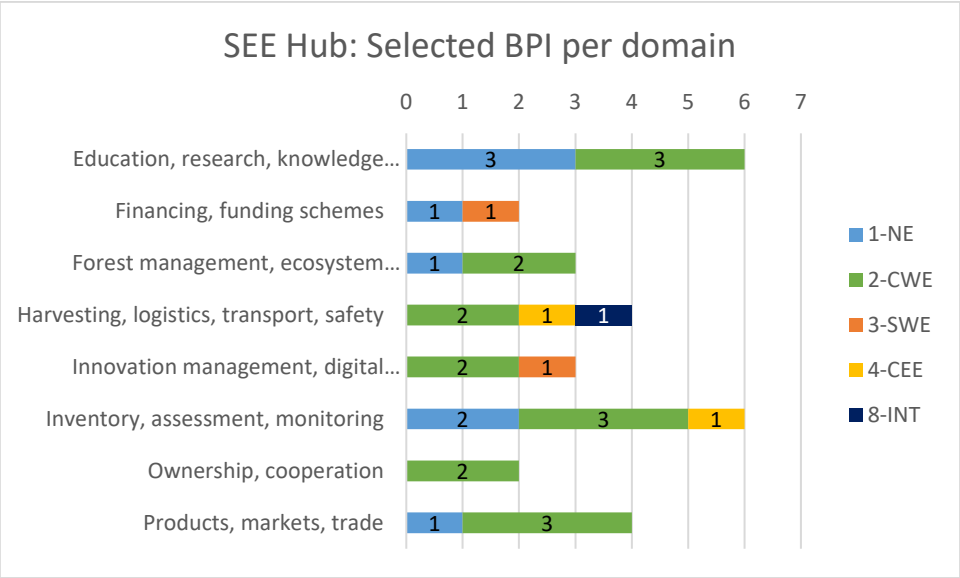

Figure 15: Repartition of selected BPI by SEE Hub per domain.

The SEE Hub selected most of the BPI in the domain "Education, research, knowledge transfer (transversal)" (6) and "Inventory, assessment, monitoring" (6). Most of the selected BPI from these domains come from NE and CWE Hub.

SEE Hub selected exclusively BPI coming from other Hubs, therefore no BPI from SEE Hub are included in the selection.

4.4 Number of BPI selected per hub per solution type (internal and external)

The following tables and charts show the number of selected BPI per solution type arranged by each Hub's selection (from where the selected BPI come). This allows an analysis to determine the number of selected BPI per solution type coming from the Hub internally (own Hub's BPI) and externally (other Hubs' BPI).

NE Hub

Selection by NE Hub	Hubs Hub of origin				
Solution type	1-NE	2-CWE	3-SWE	4-CEE	Total result
Advisory and services tools for forest owners	1				1
Awareness, infoportals, educational campaigns	3				3
Collaboration platforms, logistical hubs	1				1
Funding schemes, grants	2				2
Modelling, DSS, simulation, optimization	1	1	1		3
Operations optimization	2				2
R&D platforms, testbeds, co-creation initiatives			1		1
Sensors, measurement equipment	2	2		2	6
Smart machinery, equipment	3	2			5
Sustainable, bio-based, circular products, smart materials	1				1
Traceability tools		1			1
Training, education, eLearning	2				2
Total result	**18**	**6**	**2**	**2**	**28**

Table 16: Repartition of selected BPI by NE Hub per solution type.

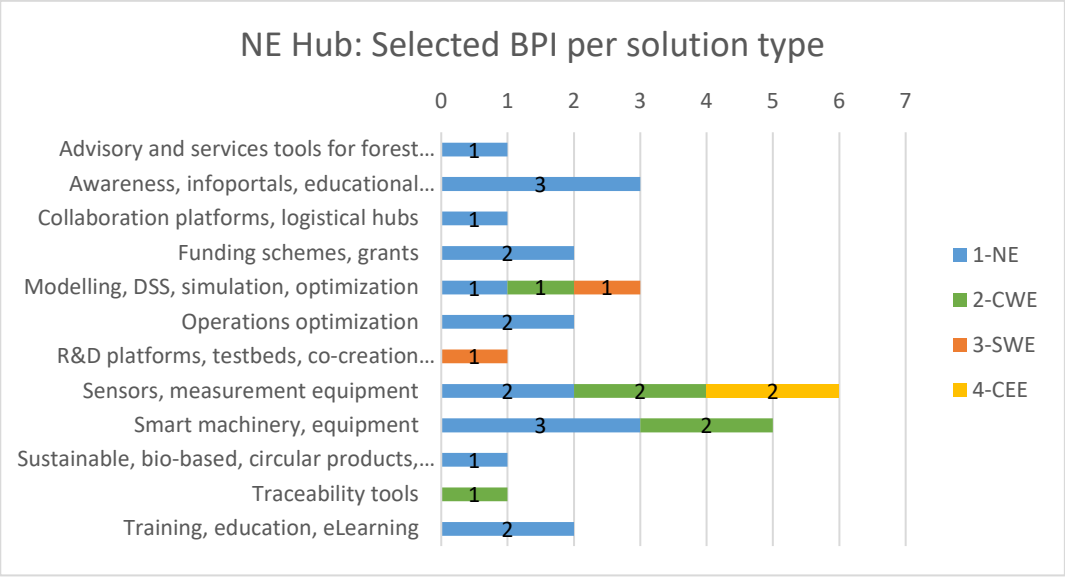

Figure 16: Repartition of selected BPI by NE Hub per solution type.

The NE Hub selected most of the BPI providing a solution in the category "Sensors, measurement, equipment" (6). Here 2 of the BPI have been selected from NE Hub internally.

In the solution categories "R&D platforms, testbeds, co-creation initiatives" (1) and "Traceability tools" (1) exclusively BPI coming from other Hubs (SWE, CWE) have been selected by NE Hub.

CWE Hub

Selection by CWE Hub	Hubs Hub of origin				
Solution type	1-NE	2-CWE	3-SWE	7-EU	Total result
Advisory and services tools for forest owners	2	3			5
Awareness, infoportals, educational campaigns	3	6	1		10
Collaboration platforms, logistical Hubs	4	3	2		9
Data standards		1			1
Funding schemes, grants	2				2
Joint forest management		1			1
Marketing platforms		1			1
Modelling, DSS, simulation, optimization	2	3	3		8
Operations optimization			1		1
R&D platforms, testbeds, co-creation initiatives	1				1
Sensors, measurement equipment	5	5		1	11
Smart machinery, equipment	1	3	1		5
Sustainable, bio-based, circular products, smart materials	1				1
Training, education, eLearning			1		1
Total result	**21**	**26**	**9**	**1**	**57**

Table 17: Repartition of selected BPI by CWE Hub per solution type.

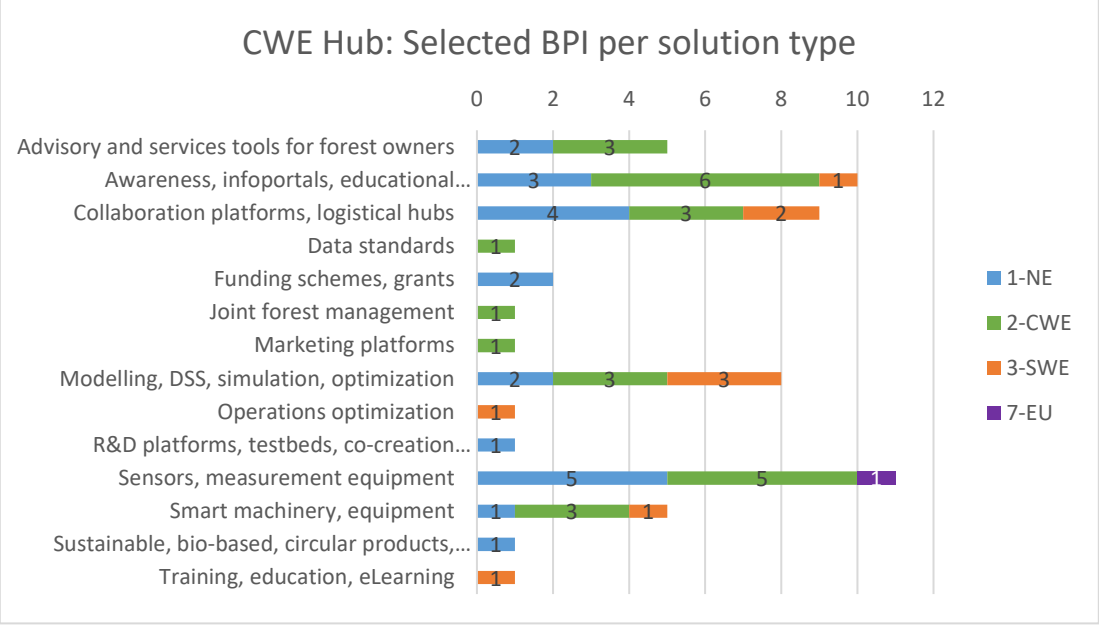

Figure 17: Repartition of selected BPI by CWE Hub per solution type.

The CWE Hub selected most of the BPI providing a solution in the category "Sensors, measurement, equipment" (11). Here most of the BPI have been selected from CWE Hub internally (5) and NE Hub (5).

In the solution type categories “Funding schemes, grants” (2), “Operations optimization” (1), “R&D platforms, testbeds, co-creation initiatives” (1), “Sustainable, bio-based, circular products, smart materials” (1) and “Training, education, eLearning” (1) exclusively BPI coming from other Hubs have been selected by CWE Hub (NE, SWE). However, in the three solution type categories “Data Standards”, “Joint forest management” and “Marketing platforms” only BPI stemming from the CWE Hub have been selected.

SWE Hub

Selection by SWE Hub	Hubs Hub of origin						
Solution types	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
Advisory and services tools for forest owners	1	3	2				6
Awareness, infoportals, educational campaigns	1		1	1			3
Collaboration platforms, logistical Hubs	3	3	1				7
Cooperative initiatives, networks, clusters			1				1
Data platforms, data Hubs, open data					1		1
Funding schemes, grants	1		1				2
Joint forest management		1	2				3
Marketing platforms			2	1	1		4
Modelling, DSS, simulation, optimization			7		1		8
Operations optimization					1		1
R&D platforms, testbeds, co-creation initiatives			1			2	3
Sensors, measurement equipment	1	2					3
Smart machinery, equipment		1	2				3
Sustainable, bio-based, circular products, smart materials			1				1
Traceability tools			5	3	1		9
Training, education, eLearning	1	2					3
Total result	**8**	**12**	**26**	**5**	**5**	**2**	**58**

Table 18: Repartition of selected BPI by SWE Hub per solution type.

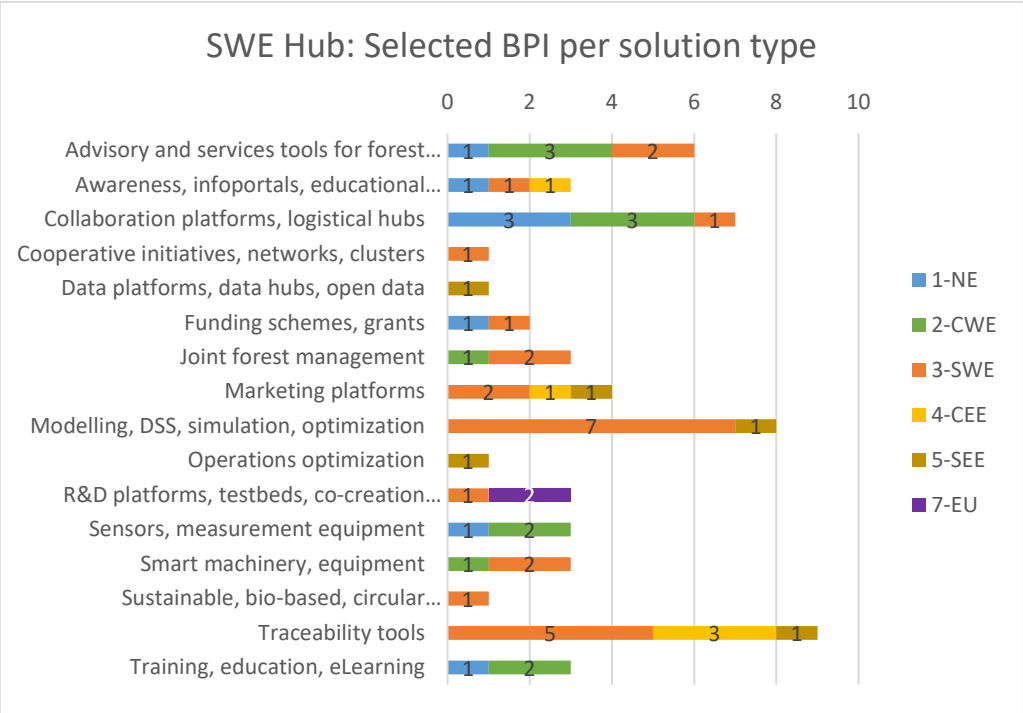

Figure 18: Repartition of selected BPI by SWE Hub per solution type.

The SWE Hub selected most of the BPI providing a solution in the category "Modelling,DSS, simulation, optimization" (8). Here nearly all of the BPI have been selected from SWE Hub internally.

In the solution categories "Data platforms, data Hubs, open data" (1), "Operations optimization" (1), "Sensors, measurement equipment" (3) and "Training, education, eLearning" (3) exclusively BPI coming from other Hubs (SEE, NE, CWE) have been selected by SWE Hub.

CEE Hub

Selection by CEE Hub	Hubs Hub of origin						
Solution types	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	7-EU	Total result
Advisory and services tools for forest owners		3		1			4
Awareness, infoportals, educational campaigns		2		1	1		4
Collaboration platforms, logistical Hubs	1		1				2
Data platforms, data Hubs, open data	1			2	1		4
Funding schemes, grants	1						1
Marketing platforms				1	1		2
Modelling, DSS, simulation, optimization	1	1	1				3
R&D platforms, testbeds, co-creation initiatives		2					2
Sensors, measurement equipment	2			3			5
Smart machinery, equipment		3				1	4
Traceability tools			1	2	1		4
Training, education, eLearning	2						2
Total result	**8**	**11**	**3**	**10**	**4**	**1**	**37**

Table 19: Repartition of selected BPI by CEE Hub per solution type.

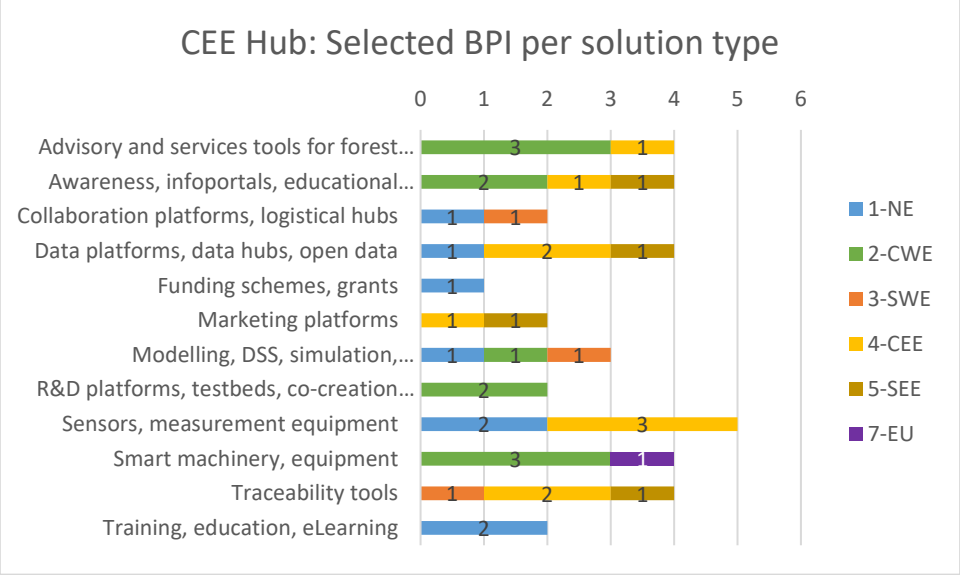

Figure 19: Repartition of selected BPI by CEE Hub per solution type.

The CEE Hub selected most of the BPI providing a solution in the category “Sensors, measurement equipment” (5). Here most of the BPI have been selected from CEE Hub internally (3).

In the solution type categories “Collaboration platforms, logistical Hubs” (2), “Funding schemes, grants” (1), “Modelling, DSS, simulation, optimization” (3), “R&D platforms, testbeds, co-creation initiatives” (2), “Smart machinery, equipment” (4) and “Training, education, eLearning” (2) exclusively BPI coming from other Hubs (NE, SWE, CWE, EU) have been selected by CEE Hub.

SEE Hub

Selection by SEE Hub	Hubs Hub of origin					
Solution types	1-NE	2-CWE	3-SWE	4-CEE	8-INT	Total result
Advisory and services tools for forest owners		6				6
Awareness, infoportals, educational campaigns		2				2
Collaboration platforms, logistical Hubs		2				2
Data platforms, data Hubs, open data	1			1		2
Funding schemes, grants	1		1			2
Joint forest management		1				1
Modelling, DSS, simulation, optimization	1	1				2
Operations optimization		1				1
R&D platforms, testbeds, co-creation initiatives		1	1		1	3
Sensors, measurement equipment	1	1				2
Smart machinery, equipment		1				1
Sustainable, bio-based, circular products, smart materials	1					1
Traceability tools		1		1		2
Training, education, eLearning	3					3
Total result	**8**	**17**	**2**	**2**	**1**	**30**

Table 20: Repartition of selected BPI by SEE Hub per solution type.

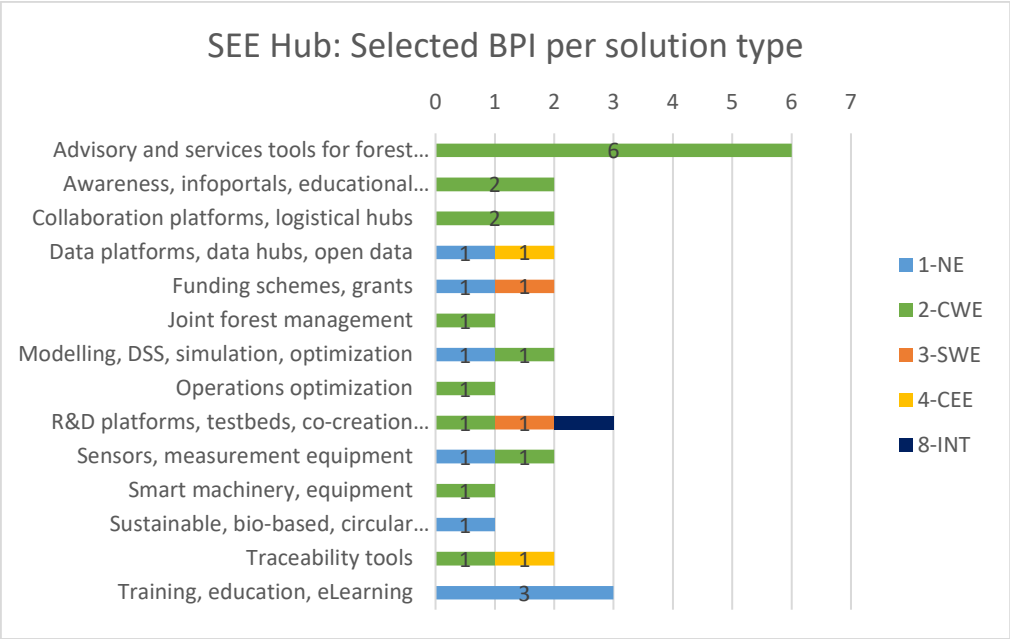

Figure 20: Repartition of selected BPI by SEE Hub per solution type.

The SEE Hub selected most of the BPI providing a solution in the category "Advisory and services tools for forest owners" (6). Here all BPI come from CWE Hub.

SEE Hub selected exclusively BPI coming from other Hubs, therefore no BPI from SEE Hub are included in the selection.

4.5 Most relevant BPI for transfer: BPI selected by 2 Hubs or more (List and domains) and from where they are coming

The following table and chart show the number of BPI which have been selected by at least two Hubs, arranged by domain and Hub of origin. This allows an analysis to determine in general the most relevant BPI for transfer.

BPI Selection by 2 Hubs or more	Hubs					
Domains	1-NE	2-CWE	3-SWE	4-CEE	5-SEE	Total result
Education, research, knowledge transfer (transversal)	3	2	1			6
Financing, funding schemes	2		1			3
Forest disturbances, risks, disaster response	2					2
Forest management, ecosystem services, resilience	1	1	1		1	4
Forest-based industries, bio/circular economy, value chain				1		1
Harvesting, logistics, transport, safety	2	6	1	1	1	11
Innovation management, digital Hubs, clusters, exploitation		2	1			3

Inventory, assessment, monitoring	2	5	2	2		11
Ownership, cooperation	1	2	2			5
Products, markets, trade	1	2		1		4
Total result	**14**	**20**	**9**	**5**	**2**	**50**

Table 21: Repartition of most relevant BPI for transfer by domain and Hub of origin.

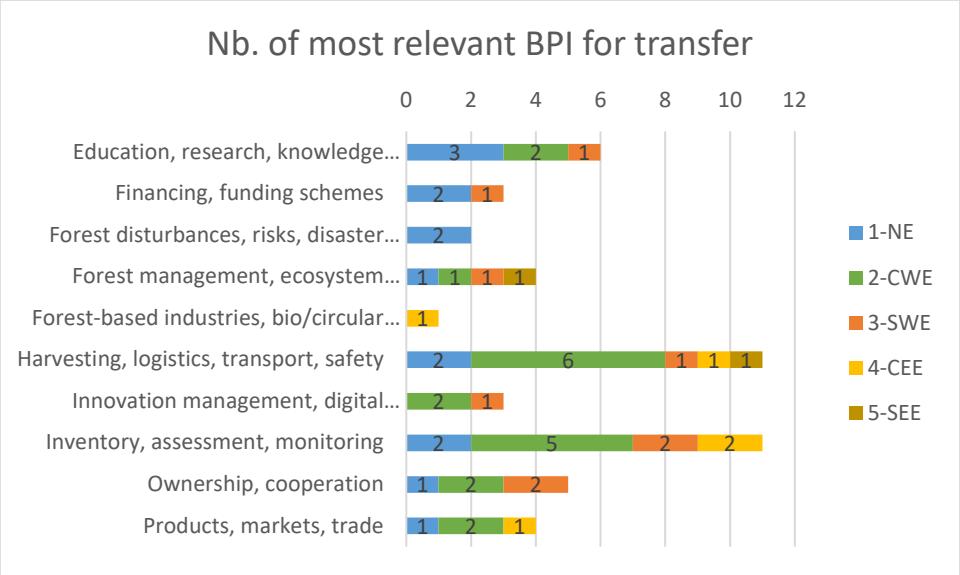

Figure 21: Repartition of most relevant BPI for transfer by domain and Hub of origin.

In total 50 BPI have been selected at least two times and can therefore be considered as the 50 most relevant BPI for transfer. They are listed in Annex 2.

Most of the BPI which have been selected at least two times can be categorized in the domains "Harvesting, logistics, transport, safety" (11) and "Inventory, assessment, monitoring" (11). These seem to be the most demanded and popular fields for BPI across all Hubs. However, this observation relates to the fact that these two domains represent in general those where most of the BPI have been identified (see figure 3) Therefore the high number of selected BPI in these two domains is also partially given due to the total high number of BPI gathered, i.e. the probability of selection/transfer rises the higher these BPI domains are represented in the overall collection.

Regarding the origin of BPI we can state that:

- In the two most popular domains "Harvesting, logisitcs, transport, safety" and "Inventory, assessment, monitoring" most of the repeatedly selected BPI come from CWE Hub. In the domain "Forest disturbances, risks, disaster response" (2) only 2 BPI from the NE Hub have been selected at least two times. In the domain "Forest-based industries, bio/circular economy, value chain" (1) only CEE Hub could identify 1 BPI that has been selected at least two times.

Most of the BPI selected at least two times come from the NE, CWE and SWE Hub, which mirrors the overall distribution of identified BPI among Hubs (see figure 1).

4.6 Interim Conclusion

Having gone through the individual steps of analysis above, we can now come to the following conclusions:

- The majority of selected BPI originate from the Hub internally. SEE Hub is the only one not having selected a BPI from its own Hub members.
- Most of the BPI selected externally by NE and CWE Hub come from one another.
- Most of the BPI selected externally by the other Hubs come from NE or CWE Hub.

In line with the majority of identified BPI in NE and CWE Hub (see figure 1), we can see that the selection of BPI is also largely concentrated on these two Hubs. Conversely, only a comparatively small number of BPI have been selected from the southern and eastern Hubs.

4.7 BPI from external or internal Hubs selected to solve specific gaps (knowledge flows between hubs)

As part of the individual Hub Roadmaps, each Hub identified BPI, both from all over Europe, which would solve the specific gaps they had identified (see section 2.2).

The following tables gather this information with the aim of summarising the knowledge flows between Hubs i.e. which Hubs have available solutions that could be helpful to support or solve the gaps of other (or their own) Hubs.

An important note for the below data is that the number of BPI originating from each Hub (columns) may not be added in order to establish a total number of BPI offered by one same Hub for a particular gap. Within the selection made by each Hub (row), care has been taken to not double-count any same BPI for the same gap category (as, for example, the same BPI could have been chosen in response to two or more different sub-gaps for the same Hub). However, it is still the case that different Hubs may choose the same BPI to deal with different gaps within the same category. Therefore, the sum of the columns does not represent a total number of BPI offered by each Hub. Instead, we refer to the number of times BPI from that Hub have been chosen in response to a particular gap. This still provides an indication of which Hub has identified BPI which are relevant to other Hubs in response to an existing gap.

GAP 1. Improve forest resilience and adaptation to climate change					
Hub making selection of BPI	**Hub from which BPI selected comes from**				
	NE	**CWE**	**SWE**	**CEE**	**SEE**
NE	2	1	2		
CWE	4	4			
SWE	1		5		1
CEE	2			1	3
SEE					

Table 22: Gap 1 – Hubs' BPI selection.

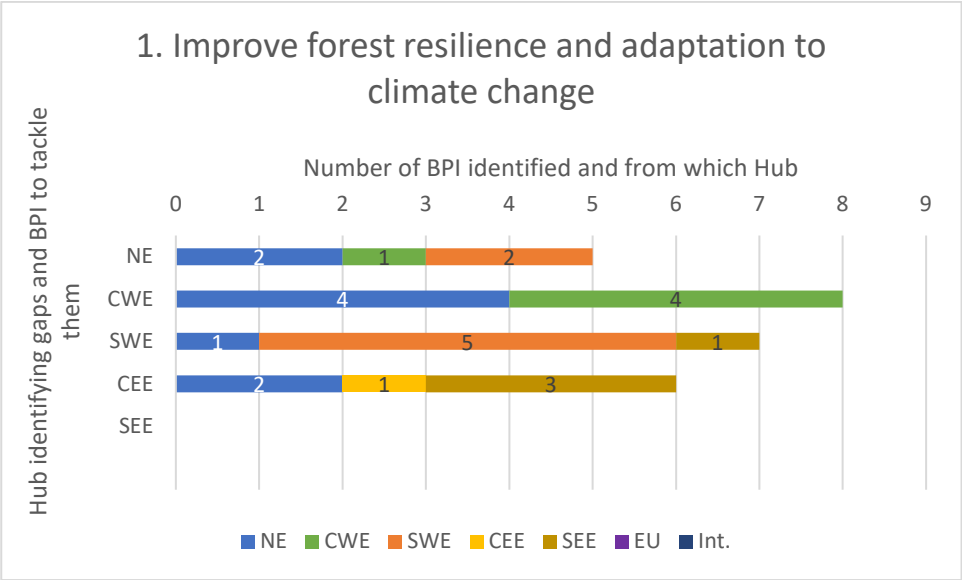

Figure 22: Gap 1 - Hubs' BPI selection.

From the above data we can gather the following understanding:

- NE Hub: Most BPI were chosen from either own Hub or SWE, followed by CWE Hub.
- CWE Hub: there is a clear balance between the selection of BPI from own Hub and from NE Hub, with no chosen BPI for this particular gap from the other Hubs.
- SWE Hub: there is a clear preference for BPI from own Hub, with slight input from NE and SEE regions.
- CEE Hub: Largest selection of BPI comes from SEE Hub, followed by NE Hub and one BPI from own Hub.
- SEE HUb: none of the identified weaknesses or threats for this Hub fit this particular category.

The Hub for which BPI were chosen the most number of times in response to this gap was NE Hub (8), closely followed by CWE Hub (7 times).

GAP 2. Improve infrastructure and capacity of public actors					
Hub making selection of BPs	**Hub from which BP selected comes from**				
	NE	**CWE**	**SWE**	**CEE**	**SEE**
NE	2	2			
CWE					
SWE	3	3	1		
CEE	1				
SEE	2	4	1		

Table 23: Gap 2- Hubs' BPI selection.

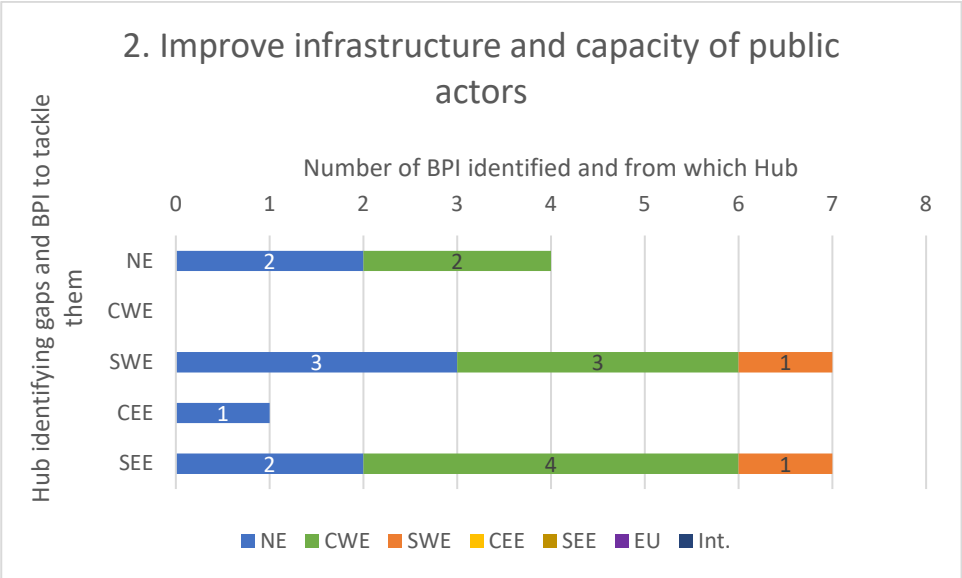

Figure 23: Gap 2 - Hubs' BPI selection.

For this gap category, the following results are summarised for each Hub:

- NE Hub: balanced number of BPI from own Hub and from CWE Hub regions.
- CWE Hub: none of the identified weaknesses or threats for this Hub fit this particular category.
- SWE Hub: balanced selection between BPI from NE and CWE Hub, with one BPI from own Hub.
- CEE Hub: only one BPI chosen, from NE Hub.
- SEE Hub: preference for BPI from CWE Hub, followed by NE Hub and one input from SWE Hub.

In response to this second Gap category "Improve infrastructure and capacity of public actors", there is a clear distinction on the selection of BPI from NE and CWE Hub. This suggests that these Hubs are particularly strong in having solutions which are relevant, both internally and externally, to support this specific gap.

GAP 3. Activate private owners and cooperative forest management							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE	9	5					
CWE	8	9	3				
SWE	1	5	8		1		
CEE	2	4	1	3	1		
SEE	4	11	2	1			

Table 24: Gap 3 - Hubs' BPI selection.

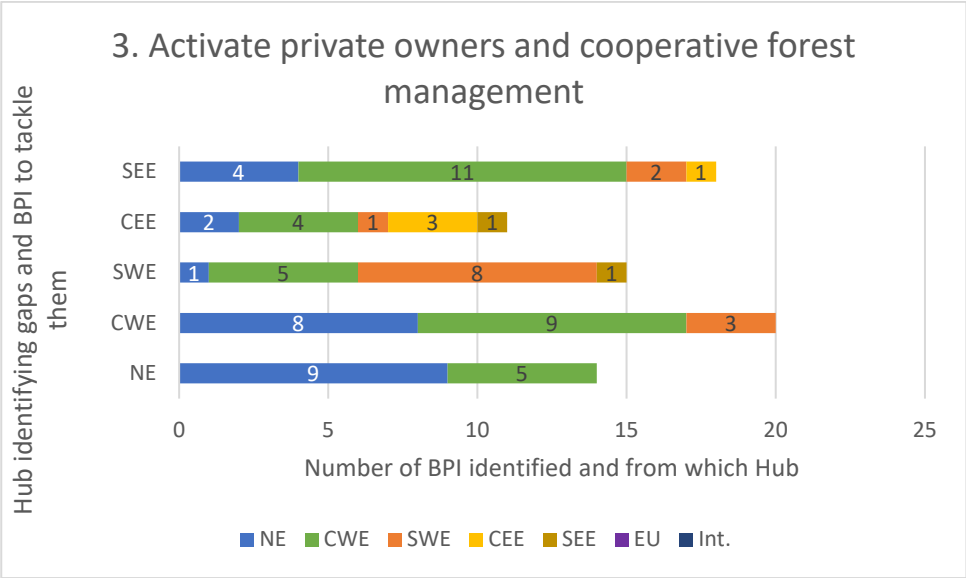

Figure 24: Gap 2 - Hubs' BPI selection.

The above data can be summarised as follows:

- NE Hub: strong preference for BPI from own Hub, followed by a significant input from CWE Hub but no other Hubs.
- CWE Hub: balanced input between selection of BPI from own Hub and from NE, with additional selection from SWE.
- SWE Hub: Strong preference for BPI from own Hub, followed by selection from CWE Hub and slight input from NE and SEE Hub:
- CEE Hub: relatively balanced input, having selected BPI from all five Hubs, especially from CWE Hub.
- SEE Hub: a strong focus on selection of BPI from CWE Hub, followed by NE, SWE and CEE Hub, with none selected from own Hub.

For the Gap category "Activate private owners and cooperative forest management", the Hub for which BPI were selected a highest number of times was CWE Hub. Overall, the strongest contributions in terms of selected BPI are from CWE and NE Hub.

GAP 4. Ensure a well-trained workforce through attractive skills development and education							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE	8	10					
CWE	2	1	1				
SWE							
CEE	2	2					
SEE	3	6					1

Table 25: Gap 4 - Hubs' BPI selection.

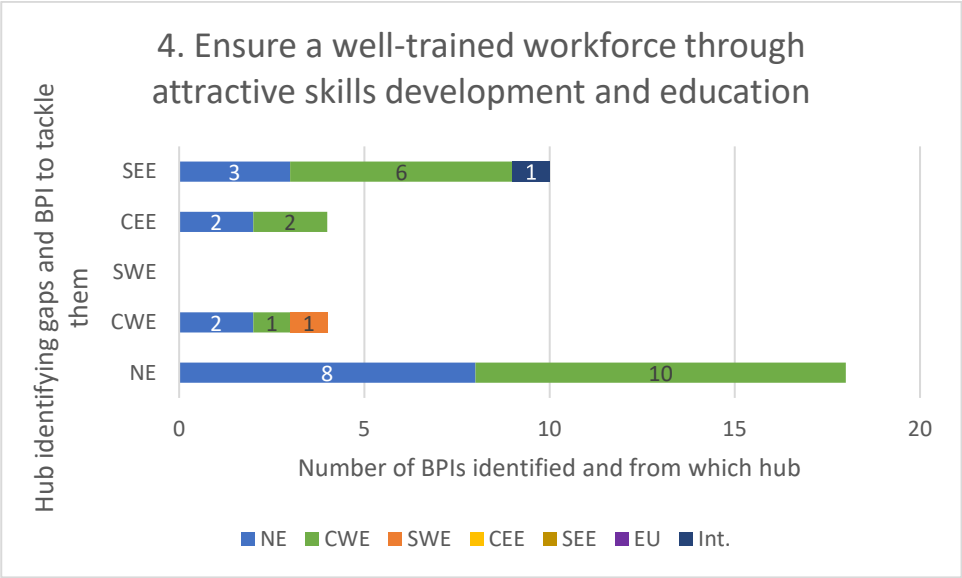

Figure 25: Gap 4 - Hubs' BPI selection.

The data above can be summarised as follows:

- NE Hub: The selected BPI are primarily from CWE Hub and from the own Hub.
- CWE Hub: relatively balanced selection of BPI coming from NE, SWE Hubs and own Hub.
- SWE Hub: the weaknesses and threats identified by SWE Hub did not fit this particular gap category.
- CEE Hub: a balanced selection between solutions identified by NE and by CWE Hub.
- SEE Hub: a strong selection of BPI from CWE Hub, followed by BPI from NE Hub and one international selection (BPI from Canada).

Overall, there is a strong preference for BPI from CWE and NE Hub selected in response to the gap category "Ensure well trained workforce through attractive skills development and education".

GAP 5. Enhance economic and environmental performance of forest supply chains							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE							
CWE	4	6	3				
SWE	2	4	10	2	1	1	
CEE		6	1	7	1		
SEE	4	7		1			1

Table 26: Gap 5 - Hubs' BPI selection.

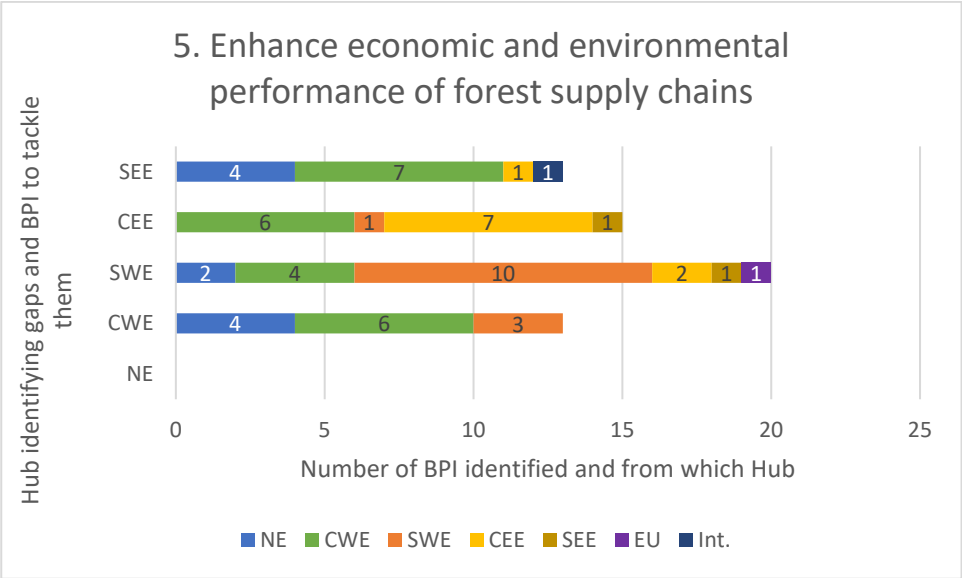

Figure 26: Gap 5 - Hubs' BPI selection.

The above data can be summarised as follows:

- NE Hub: the gaps (weaknesses and threats) identified by NE did not fit this main gap category.
- CWE Hub: Strong preference for selection of BPI from within the own Hub, followed by a balanced input of BPI from NE and SWE Hub.
- SWE Hub: a broad selection of BPI, with a strong focus on BPI identified within the Hub itself, followed by a range of BPI from all other Hubs and one European solution.
- CEE Hub: Wide range of BPI selected, from four out of five Hubs. The largest selection is from within the same Hub itself, followed closely by BPI from CWE Hub.
- SEE Hub: Relatively broad selection, including three Hubs and one International solution (BPI from Canada). The largest selection was of BPI from CWE Hub.

For the gap "Enhance economic and environmental performance of forest supply chains" it may be highlighted that three out of four Hubs which identified gaps that meet this category selected the largest number of BPI from their own Hub.

Overall, while CWE Hub shows the highest number of times for which its BPI were chosen, there is a strong contribution in terms of selected BPI from all five Hubs, and both European and International levels.

GAP 6. Grow the forest-based bioeconomy through circular use and value-added products							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE				1			
CWE	2	3					
SWE			2	3	2	1	
CEE	1	3		3			
SEE	1	1					

Table 27: Gap 6 - Hubs' BPI selection.

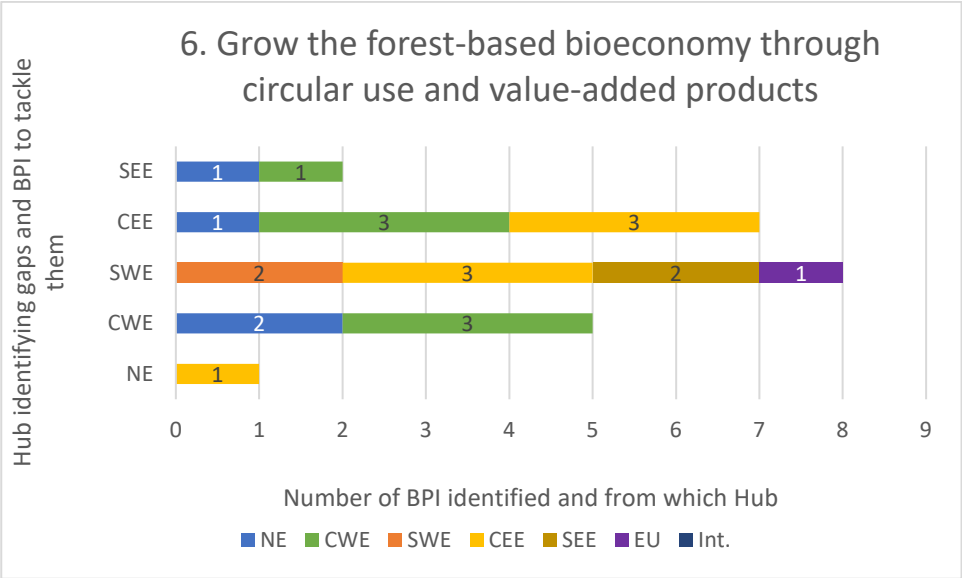

Figure 27: Gap 6 - Hubs' BPI selection.

The above data can be summarised as follows:

- NE Hub: This particular gap category is the only one for which the selection from NE Hub does not strongly prioritise BPI from the own NE Hub or from CWE Hub.
- CWE Hub: There is a preference for BPI selected from the Hub itself, followed by NE Hub.
- SWE Hub: A varied selection of BPI from CEE, SWE and SEE Hub, as well as one European contribution.
- CEE Hub: The main selection is made from own Hub BPI and from CWE Hub.
- SEE Hub: A balanced selection of BPI from only NE and CWE Hub.

For the gap "Grow the forest-based bioeconomy through circular use and value-added products" the selection of BPI is quite broadly distributed across all five Hubs.

GAP 7. Raise public awareness, social acceptance and political support for forestry.							
Hub making selection of BPs	**Hub from which BP selected comes from**						
	NE	**CWE**	**SWE**	**CEE**	**SEE**	**EU**	**Int.**
NE	5	1					
CWE	2	5	4				
SWE	1	1	3				
CEE							
SEE							

Figure 28: Gap 7 - Hubs' BPI selection.

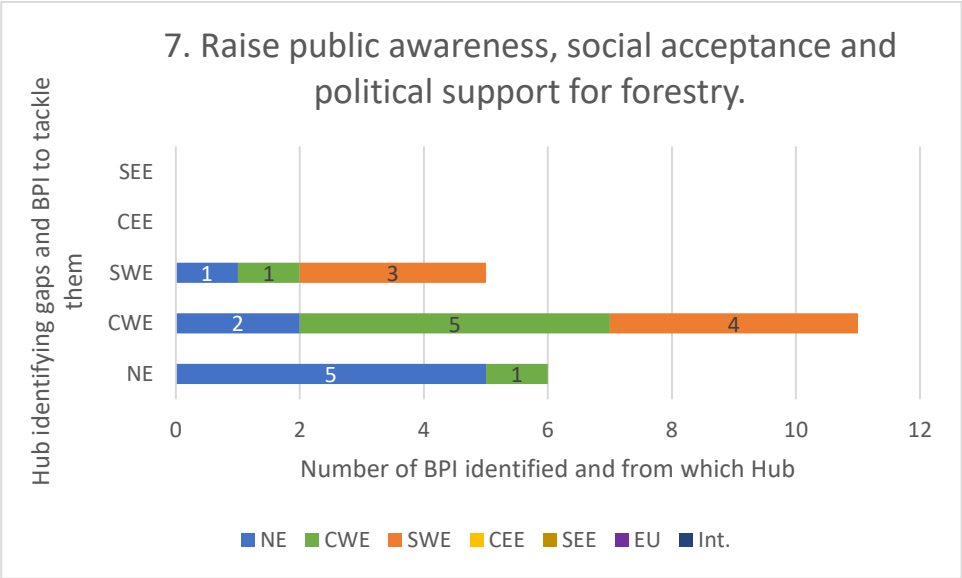

Figure 28: Gap 7 - Hubs' BPI selection.

Finally, for the last gap category, the following may summarise the above data:

- NE Hub: there is a strong focus from own BPI selection, with a slight contribution from CWE Hub.
- CWE Hub: while the highest number of BPI is selected from the own Hub, there is a significant contribution from SWE Hub.
- SWE Hub: a strong selection from own Hub, followed by equal input from NE and CWE Hub.

The Gap category "Raise public awareness, social acceptance and political support of forestry" may be characterised by Hubs having selected largely the BPI from their own Hubs. Overall, there is a clear focus on the selection of BPI from NE, CWE and SWE Hub, which are at the same time, the only three Hubs for which weaknesses and threats that fit this category were identified.

Overall:

- NE Hub: mostly selected internal and CWE Hub.
- CWE Hub: mostly internal, NE and SWE Hub.
- SWE Hub: Very varied selection across all Hubs while maintaining a strong selection of internal BPI
- CEE Hub: Overall relatively varied selection across all Hubs but the focus on selection of BPI from CWE, NE and internally from CEE Hub prevails.
- SEE Hub: A strong preference for selection of NE and CWE Hub BPI. Additional selection from CEE and SWE Hub is also in place.

5. Conclusion

The in-detail analysis of the Best Practices and Innovations (BPI) collected and their transfer between the five Hubs as well as within Hubs performed in the frame of this Cross-Regional Roadmap allows to draw conclusions regarding the interregional knowledge flows and the potential for increased collaboration between major regios of the European wood sector.

BPI collected by Hubs

In the collection of BPI, there is a notable **decrease in the number of BPI provided by Hubs from North to South**, resulting in a clear **prevalence of BPI from the Central-Western (CWE) and Northern Hub (NE)**, more specifically of BPI from Finland and Germany. A more detailed analysis of the topics covered by collected BPI reveals that the three domains most strongly represented in the Rosewood4.0 BPI collection are *"Inventory, assessment, monitoring"*, *"Harvesting, logistics, transport, safety"* and *"Education, research, knowledge transfer (transversal)"* (in that order), while *"Financing, funding schemes"* is the domain least covered. The overall prevalence of BPI from CWE and NE Hub is also mirrorred in the three domains most strongly represented, however, each Hub has provided at least one BPI in these domains, and in specific domains, other Hubs than CWE and NE Hub might lead in terms of BPI numbers.

On a similar note, not all of the three aforementioned domains are necessarily the strongest represented in individual Hub's BPI collection: The only domain being among the three BPI-strongest in each Hub is *"Inventory, assessment, monitoring"* with a major BPI contribution from the Central-Eastern Hub (CEE). The high BPI contribution of both CWE and NE Hub in the overall BPI collection has thus been considered as a relativizing factor throughout the analysis when drawing (interim) conclusions.

With respect to BPI solution types, "*Sensors, measurement, equipment*", *"Advisory and service tools for forest owners"*, and *"Modelling, DSS, simulation, optimization"* (in that order) accounted for the highest number of BPI, and *"Data Standards"* for the lowest. Here, same as with regard to BPI domains, every Hub has at least provided one BPI to each of the three highest BPI solution types with NE and CWE Hub taking the lead. On a Hub level, different BPI solution types than the three mentioned prevail in terms of BPI numbers. For instance, while "*Sensors, measurement, equipment*" is BPI-strongest, this solution type is not among the highest three BPI contributions for neither the South-Western Hub (SWE) nor the South-Eastern Hub (SEE). Another interesting aspect is that the Eastern Hubs (CEE and SEE) lead in the number of provided BPI in the fourth highest solution type, *"Data platforms, data hubs, open data"*. Overall, the distribution of BPI within different solution types shows a varied picture with a number of individual BPI prevalences.

BPI selection by Hubs – Knowledge Flows

The knowledge flows identified following the BPI selection of each Hub are mostly **internal** (within a Hub) and, if external, characterized by **knowledge flowing from NE and CWE Hub**. Regarding the overall focus in the selection of BPI from NE and CWE Hub, it is important to underline that the majority of BPI provided is likewise focused on these two Hubs, which makes a BPI selection from NE and CWE Hub more probable. In comparison, only a small number of BPI have been selected from the Southern and Eastern Hubs.

More specifically, CWE and NE Hub have a vivid knowledge exchange between each other as well as each a strong internal knowledge flow. These two Hubs also had a similar distribution of gaps as a starting point while CWE Hub also accounts for the broadest distribution of strengths across identified categories. SWE and CEE Hub have a comparatively broad selection of BPI with knowledge input from various Hubs including a notable internal knowledge flow between own Hub members. SEE Hub is a special case in having chosen only external BPI for knowledge transfer; of these, most stem from CWE and NE Hub. This Hub has also identified the highest number of gaps.

A closer look at the **BPI domains most frequently selected for transfer** underlines *"Harvesting, logistics, transport, safety"*, *"Inventory, assessment, monitoring"*, and *"Education, research, knowledge transfer (transversal)"* as the most relevant. This corresponds to the BPI domains with the highest number of available BPI. Apart from these domains, one other domain, namely *"Forest management, ecosystem services, resilience"*, has been among the most selected in the Eastern Hubs (CEE and SEE). This underlines the above mentioned three domains as a focus of overall knowledge transfer, however, it should be noted, that the Eastern Hubs show a more varied knowledge input regarding the range of BPI selected in their respective most relevant BPI domains.

For the three BPI domains most frequently represented in BPI selection, external knowledge flow prevails for the Southern and Eastern Hubs (SWE, CEE, SEE), in contrast to the Northern and Central-Western Hub characterized by a predominantly internal knowledge flow. The knowledge flow in these most preferred domains is not always evident from the strengths and gaps identified for the respective Hub which suggests individual preferences for specific BPI. Furthermore, there has been little to no evidence of Hubs preferably transferring BPI in domains for which they had a lower number of own BPI, only the Eastern Hubs have a higher number of selected BPI in domains in which they were less represented themselves. This might mean that regional priorities continue from BPI collection to BPI selection.

With respect to **BPI Solution Types**, *"Sensors, measurement equipment"* and *"Awareness, infoportals, educational campaigns" (of equally high number)*, followed by *"Traceability tools", Collaboration platforms, logistical hubs",* and *"Modelling, DSS, simulation, optimization"* (of equally high number) have been **most frequently selected for transfer.** These BPI solution types only partially mirror the distribution of collected BPI. Another difference with regard to the analysis of BPI domains, is that the analysis of solution types shows a more diverse and especially more individual BPI choice with Hub-specific prioritization. For instance, the South-Western Hub has not even prioritized one of the overall most frequently selected BPI solution types, *"Sensors, measurement equipment",* among its three highest. Since the BPI solution types offer a more nuanced categorization of BPI than the broader categorization of BPI domains, the detailed tables and analysis in this Cross-regional Roadmap allow for the consideration and emphasis of specific Hub BPI choices.

The knowledge flow in the mentioned BPI solution types is mostly external (CWE, CEE, SEE) with the exception of SWE and NE Hub which both have a predominantly internal knowledge flow. The knowledge flow assumed from the distribution of strengths and weaknesses can mostly be confirmed by actual selections. Similar to the analysis of BPI domains, Hubs do not seem to have a priority for balancing out BPI solution types for which they had a lower number of BPI themselves. The notable exception is SEE Hub which has an explicity external focus in BPI selection.

Overall, this Cross-regional Roadmap offers an in-depth analysis and findings on interregional knowledge flows between key regions of wood mobilisation in Europe, the domains and solution types considered most relevant for transfer by specific regions and across Europe, and delivers insights on what regions could offer a solution for diverse challenges identified for European forestry.

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Annex 1

List of strengths identified within the five Hub Roadmaps. The grouping in the five categories was done for the purpose of this cross-regional roadmap, after the individual strengths had been separately identified.

Strong and competitive forest industry, processes and supply chains	
Strong forest industry	NE
Highly mechanized supply chain	NE
Very competitive pulp and sawmill industry using new technology	NE
Various high production forests with stable or expanding forest area and growing stock volume	CEE
High share (except UA) of mechanised wood harvesting, with the use of modern and highly efficient forest equipment in state forests and big companies	CEE
Wood sector is well diversified and includes a plethora of products	CEE
Exports of low value-added forest-based products very strongly exceed imports, export of pellets strongly exceeds imports	CEE
Forest certification schemes are in place	CWE
Highly mechanized and partially automatized softwood sawmilling industry	CWE
Consolidated (softwood) sawmilling sector: production is split either into large units or small specialized sawmills. This consolidation process is mirrored by a sharp decrease in the number of sawmills.	CWE
long tradition of forest management and wood industry with increasing number of small sawmills, pellets and wood chips producers	SEE
Large forest areas including potentially productive ones in the future	SWE
High mechanization for harvesting wood in softwood stands	SWE
Strong network of forest roads	SWE
Strong industrial network in certain areas	SWE

Incorporation of digitalisation and data management solutions	
Developed Digitalization systems in forestry	NE
Open and accurate forest inventory data	NE
Developed enterprises for harvesting and logistics	NE
Good to high levell of digitalization in forestry (mainly State forests) with the use of advanced IT systems and detailed data regarding wood flows	CEE
Online wood sales or online auctions in State Forests	CEE
Digital solutions in forestry applied mostly in inventory, public data on forests and trade	CEE
Dense forest road network with digitally available forest road maps	CWE
Various digital logistic platforms are available and in use	CWE

Increasing focus on renewable energies, sustainability and circular economy	
Multiple and sustainable use of forests	NE
Transition to ‘close-to-nature’ forestry is being rolled out in some countries/regions, though not entirely in a strategic manner	CEE
Creation of renewable energy market	CEE

Increasing awareness of wood producers related to the concept of circular economy, implementation cascading wood use principles	CEE
Sufficient forest resources are available and sustainably managed	CWE
High awareness of resource and energy efficiency on company level	CWE
Great value of biodiversity in the Mediterranean environment	SWE

Educational and knowledge transfer resources available	
Well organized education system for the value chain (vocational schools, technical school, university of applied sciences) and training for all workforce	NE
Good levelof scientific and professional knowledge in the filed of forest management (mostly in State forests) and wood industry	CEE
Excellent production know-how with focus on high quality	CWE
Professional vocational and education system for forestry and wood working industry exists	CWE

R&D and Innovation support available	
Relatively well developed R&D base focusing on wood harvesting innovations (except UA)	CEE
High degree of forest utilization	CWE
Access to R&D units, cluster organization and innovation support agencies dedicated to forestry and wood working industry	CWE
Tax incentive and forest investment	SWE

Skilled and experienced staff across disciplines	
Professional forest owner associations play an important role in supporting small-scale forest owners by providing a broad range of services and up-to-date information e.g. advisory and extension services, access to forest service providers, contracting services, access to timber market, market information, increased market power, etc.)	CWE
Skilled and experienced forest staff, forest service providers and forest machine operators	CWE
skilled scientific and technical personnel	SEE
Different forms of grouping of owners	SWE

High safety standards, certifications and controls in place	
High degree of work safety	NE
High safety standards in forestry	CWE
Certificated forest	SWE

High availability and access to quality raw materials	
existence of high-quality raw wood material and unique tree species	SEE
high level of production material which meets international markets demand	SEE
Abundance of raw materials and large extension of forests (availability and diversity)	SWE
Multifunctional raw material	SWE

List of weaknesses and threats as identified by the five Hub Roadmaps. The grouping into categories of main Gaps was done for the purpose of this cross-regional roadmap, after the individual weaknesses and threats had been separately identified.

1. Improve forest resilience and adaptation to climate change	
Climate change (e.g. forest damanges, pests)	NE
Climate change (	CWE
Climate change + Poor "climate adaptive thinking" of forest authorities and decision makers; Pest and disease management	CEE
Sustainability, environment and biodiversity, climate change (pests, forest disseases)	SWE
2. Improve infrastructure and capacity of public actors	
Poor condition of forest road network	NE
Lack of funding for R&D and efforts to find new opportunities.	NE
Low public finance, subsidies and compensation mechanisms in the sector	CEE, SEE
Few options for financial support	SWE
Understaffed public agencies for forest preservation	SEE
Poor conditions of forest roads	SEE
Weak infrastructure	SWE
Insufficient exploitation of national forest services	SEE
Insufficient level of optimal forest exploitation	SEE
3. Activate private owners and cooperative forest management	
High amount of small forest owners and decreased interest/ competence in forestry for owners	NE
Aging of forest owners	NE
High fragmentation of private forests	CEE
Lack of efficient forest management practices/platforms	CEE
Insufficient knowledge and lack of interest for improvement	SEE
Lack of small PFOs' interest in forests and forests management	SEE
Lack of services in line with needs of small-scale forest owners (i.e. timber sale, economic extension services)	SEE
Unresolved ownership and cadastral issues	SEE
The wood flow from private forests is unpredictable	SEE
Small holding of forest land dealing to lack of cooperation owners/foresters, and need of support in the legal framework	SWE
Poor forest management of small-scale forest owners and associations	SWE
Lack of comprehensive decision support systems (DSS) for forest owners / FAOs	CWE
Lack of advanced digital solutions for real time forest monitoring	CWE
Lack of use cases for artificial intelligence	CWE
4. Ensure a well-trained workforce through attractive skills development and education	
Shortage of skilled workers which is further severed by an aging work force	CWE

Lack of qualified labor and gaps in education	CEE
Lack of skilled professionals and interest to implement modern technologies (ICT)	SEE
Lack of qualified and local forestry labor especially for harvesting operations, planting and silviculture	NE
Urbanizing and lack of attractivity for jobs in the value chain and for jobs in rural areas	NE
Low employment opportunities	SEE

5. Enhance economic and environmental performance of forest supply chains	
Low level of digitalization in forestry and wood based industries	CEE
Low transparency and law enforcement effectiveness in forest sector	CEE
Slow development of digitalization of forestry suppliers and non-state forest owners.	CEE
Lack of cooperation and slow adaptability of the sector	CEE
Low willingness / capability to invest in new technologies or major digital innovations due to high-cost pressure	CWE
Competition instead of cooperation between freight carriers have a negative impact on the overall transaction costs	CWE
Digitalization / automatic data exchange across companies and actors in the supply chain still not common	CWE
Outdated technology, production processes and infrastructure for technology transfer	SEE
Low innovation capacity	SEE
Weak connections between the “forest” and “wood” part of the forest-wood value chain	SEE
Use of obsolete machinery by private owners due to high investment costs	SEE
Lack of solid logistics background	SEE
Low interest for investments.	SEE
Digital solutions are not implemented in wood transport and logistic	SEE
Lack of cooperation between knowledge pools and industry	SEE
Lack of cooperation between designers and wood industry	SEE
Lack of digitalization, poor harvesting and logistics	SWE

6. Grow the forest-based bioeconomy through circular use and value-added products	
Lack of long-term promotional strategy of forest and wood products	CEE
Lack of marketing platforms	CWE, CEE
Timber construction still not legally equal to other construction materials	CWE
Markets. Optimization of the wood forest resources and products	SWE
Lack of knowledge on recycling and circular business models	NE
Under-utilization of wood waste	CEE
Insufficient level of awareness and lack of knowledge about the importance of recycling	SEE

7. Raise public awareness, social acceptance and political support for forestry.	
Social acceptance of forestry	NE
Increased national/EU restrictions on harvesting and other use of forests	NE
Persistent lack of public understanding on the economic significance of forests (forestry perceived as of low economic significance)	CWE

Conflict between forest owners and the general public regarding the extent of forest management (timber production)	CWE
Social mistrust in forest management and wood harvesting	CWE
Conflict between nature protection and managed forests	CWE
Need for educational strategies to explain forest ecosystem services to the public	SWE

Annex 2: List of most relevant Best Practices

The table below lists the BPI which have been selected by two Hubs or more. The BPI are clustered by domains. For each BPI the country of origin and the number of times it has been selected are indicated in brackets.

BPI Selection by 2 Hubs or more	
Domains and BPI title	Total result
Education, research, knowledge transfer (transversal)	6
Forestry Extension Institute (NO, 4)	
Advanced Virtual Aptitude and Training Application in Real Time (DE, 4)	
Think Tree (NO, 2)	
Women in Forestry (NO, 2)	
Dataholz (AT, 2)	
Harvester simulator (FR, 2)	
Financing, funding schemes	3
Forestry fund (NO, 3)	
Financing of Sustainable Forestry (FI, 2)	
Forest insurance investment account (FR, 2)	
Forest disturbances, risks, disaster response	2
Detecting bark beetles with AI (SE, 4)	
Bark beetle risk map (SE, 2)	
Forest management, ecosystem services, resilience	4
Carbon, Aqua, Fire & Eco-resilience DSS (ES, 3)	
Climate Smart Forestry-Innovation (FI, 2)	
HolzmobRegio (AT, 2)	
Detectit - save our forests (CR, 2)	
Forest-based industries, bio/circular economy, value chain	1
Build-In-Wood (RO, 2)	
Harvesting, logistics, transport, safety	11
FelixForst (AT, 3)	
Road condition monitoring (CH, 3)	
TimFlow – WoodTracking (RO, 3)	

Digitally Connected Forest Operation Value Chain- Innovation (FI, 2)	
Digitalized truck crane (SE, 2)	
Application of drones for seedling transport in steep terrains /mountainous areas (AT, 2)	
Woodlogistic Data Plattform (AT, 2)	
Forwarder2020 prototypes (CH, 2)	
WaspWoodlogistics (DE, 2)	
Blockchain for Inmutable Timber (ES, 2)	
MyForester - Quality assessment of forestry contractors (Sl, 2)	
Innovation management, digital hubs, clusters, exploitation	**3**
Digital Service Infrastructures to integrate models supporting forest management and forest protection (ES, 3)	
Evergreen Innovation Camp – Hackathon (AT, 2)	
Center of Excellence Forest and Timber 4.0 (DE, 2)	
Inventory, assessment, monitoring	**11**
Comparison of silvicultural concepts by simulation of growth processes in forests on the smartphone (DE, 3)	
Information platform on forests in NRW (DE, 3)	
LogBuch (DE, 3)	
Virtual Forest (DE, 3)	
Biomass atlas (FI, 2)	
Virtual Forest 2.0 Innovation (FI, 2)	
Festmeter (AT, 2)	
Carbon accounting tool (FR, 2)	
Simulations of technical-economic feasbility of forest stands (FR, 2)	
Forest Data Bank (PL, 2)	
Timber Inventory System (PL, 2)	
Ownership, cooperation	**5**
eServices for Forest Owners and Service providers (FI, 3)	
Forest becomes mobile initiative (DE, 2)	
Free app for smallholder farmers in developing countries (DE, 2)	
FORETDATA (FR, 2)	
The forest moves (FR, 2)	
Products, markets, trade	**4**
Ydalir district (NO, 2)	
Swiss national wood promotion programme (CH, 2)	
Smart Wood Supply Chain Management (DE, 2)	
Forest stock market e-drewno.pl (PL, 2)	
Total result	**50**

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