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ONEforest

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A Multi-Criteria Decision Support System For
A Common Forest Management to Strengthen Forest
Resilience, Harmonise Stakeholder Interests and
Ensure Sustainable Wood Flows



D6.1 Policy analysis in CSRs



A Multi-Criteria Decision Support System for a Common Forest Management to Strengthen Forest Resilience, Harmonise Stakeholder Interests and Ensure Sustainable Wood Flows

Deliverable 6.1

Title: Policy analysis in four European countries – the cases of Catalonia (Spain), Estonia, Grisons (Switzerland), and Hesse/Thuringia (Germany)

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Executive summary

This document is the Deliverable 6.1

This deliverable aims to provide an overview of the policy contexts for forest ecosystem services across Europe including the transnational level (EU) and national/regional levels, across different geographic types, to understand similarities and differences on how forest ecosystem services are integrated in policy. By displaying and comparing policy in the case study regions of Catalonia (Spain), Estonia, Grisons (Switzerland) and Hesse/ Thuringia (Germany), the aim is to evaluate how FES are prioritized (via policy integration and environmental policy integration) and how forest ecosystem services-related policy is implemented (via policy coherence). The results are derived using the framework of policy integration and environmental policy integration, analysing horizontal and vertical integration. The levels of policy integration and environmental policy integration together with policy coherence states the relationship between different policy areas, how synergies are realized and how conflicts or trade-offs are being decided upon are vital to policy making, to be able to shape future integrations, priorities, and policy implementation, ensuring that policy goals are on target avoiding policy failures. The policy integration analysis does not provide explanations of how well policy succeed, or if it fails, but illustrates how well policy is recognizing the same objectives, identify similar synergies and conflicts. The results of this study can be utilized to a) understand policy and how well it is integrated in each case, and b) to potentially increase the integration of policies related to forest ecosystem services – especially those of the policies that are not well integrated targeting forest ecosystem services, thus bioeconomy-, energy-, and forest and their relationship with biodiversity-, and climate policies.



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Glossary

BES	Biodiversity and forest ecosystem services
BIO	Biodiversity
BEC	Bioeconomy
CC	Climate change
CH	Switzerland
CSR	Case study region
DE	Germany
EN	Energy
EPI	Environmental policy integration
EU	European Union
EUTR	EU timber regulation
ES	Spain
FAO	Food and Agriculture Organization of the United Nations
FES	Forest ecosystem services
FLEGT	Forest Law Enforcement, Governance and Trade
FO	Forest
LULUCF	Land Use, Land-Use Change and Forestry
PI	Policy integration
REED+	Reduction Emissions from Deforestation and forest Degradation
SFM	Sustainable forest management

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1 Introduction

The EU has committed to a “zero-pollution ambition” and to climate neutrality by 2050. Additionally, industrial strategies (e.g., SME strategy, Circular Economy Action plan, and Bioeconomy strategy) together with material flow policy (e.g., Farm to fork strategy and Forest strategy) supported by EU Green Deal, further supports European development towards sustainability. Forests, although diverse across Europe, are recognized as valuable in climate change mitigation through carbon storage, but also as a substitution of non-renewable resources and sustainable use of wood-based materials. Further, forests are valuable in the green transition, replacing fossil-based materials with sustainable bio-based, thus important drivers of bioeconomy transformation and realizing e.g., the EU Green Deal (EC, 2019; Hetemäki et al., 2017; Winkel, 2017). Apart from being important for environmental and economic sustainability, forests also play an important role for recreational use or culture identity, hence social sustainability summarized in the concept of ecosystem services (EC 2013). These goods and services are typically defined as forest ecosystem services (FES). Biodiversity provides the basis for FES, and thus the report will denote biodiversity and forest ecosystem services as BES. FES are divided into services in the categories of providing- (e.g., timber, and non-timber goods), regulating- (e.g., climate change mitigation), supporting- (e.g., pollination, habitat provision) and cultural services (e.g., recreation, aesthetics) (Millennium Ecosystem Assessment, 2005). However, forests are challenged by natural disturbances (e.g., heavy rainfall, drought, storms and fire, pests, and diseases), which directly affect productivity of each of the FES. This multiple use of forests, illustrated by these multi-level interdependencies, entails that increasing use of one aspect of the forest may affect other BES.

Policies related to BES are found in several policy sectors, connecting to the multiple use of the forest resource. In practice it entails that increasing demands of multi-uses of forests, contributing to increasing importance of acknowledging synergies, and resolve conflicts between different BES. However, realizing synergies and mitigating conflicts over BES places demands on strong policy integrations across policy sectors, with the goal of coordinating policy toward the same end goal (De Besi and McCormick, 2015; Johansson, 2018). In forest-related policies, the concept of sustainable forest management (SFM) is often referred to as a main objective of forest management. SFM, with a solid base in the principles of sustainable development, aims at using “*forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their full potential to fulfil, now and in the future, relevant ecological, economic and social functions*” (Siry et al., 2018, p. 138), thus to withhold BES and to promote bioeconomy and sustainability (Schweier et al., 2019).

To coordinate FES-related policies, policy integration frameworks are helpful to illustrate how policies “talk” to one another (Lafferty and Hovden, 2003; Underdal, 1980), specifically to understand how forest related policies are interrelated to other policies relevant for FES, e.g., bioeconomy, biodiversity, conservation, land use policy and energy. There is an abundance of policy integration studies, related to land use and/or environmental policies (e.g., Tosun and Lang, 2017; Trein et al., 2019), together with policy integration analysis targeting conflicts and synergies between FES specifically comparing EU-member countries (Kleinschmit et al. 2017; Sotirov and Storch 2018; Winkel and Sotirov 2016). However, few studies compare EU and non-EU member countries (e.g., Beland-Lindahl et al, forthcoming), particularly in comparisons between nations or regions with variance in biogeography as well as regional differences in cultural settings, economic circumstances, and ecological safety. Such analysis provides dissimilar starting points of policy measures, to ensure future forest management for resilient

forests and sustainable wood flows to forest industry, an advantageous starting point is an overview of current institutional settings in place. The aim of this paper is thus to fill that gap, and to develop knowledge of policy integration to understand the functions of FES in policies.

1.1 Case study regions

The study is based upon four CSR within three EU member countries and one non-EU member country ranging from northern forests, across central Europe, including Alpine regions to Mediterranean forests. The case study contains of the nation Estonia, the region of Catalonia in Spain (ES), the Grisons canton in Switzerland (CH), and the federal states of Hesse and Thuringia in Germany (DE) (see table 1). The areas are characterized by differences in forested area, geographic typology, and governance structure. All regions but one (Estonia) are federal, hence regions are self-governed implementing national regulation in combination with regional policy. Of the case study regions (here on country level), Estonia has the highest share of forestland followed by Spain. Germany and Switzerland have approximately the same share of forestland.

Table 1. Overview of characteristics of case study regions.

	Catalonia (ES)	Estonia	Grisons (CH)	Hesse/Thuringia (DE)
Geography and forest type	Southern Europe Mediterranean forests	Northern Europe Boreal/Hemi-boreal forests	Central Europe Alpine forests	Central Europe Continental forests
Forests area (%) (country level)	41.2*	58.3*	31.0**	32.4*
Forest ownership	Private and state	Private and state	Public and private	Private, corporate, and state
Forest management system	Multiple management	Multiple management	Multiple management	Multiple management
Population in region	Mixed (sparsely populated rural areas)	Mixed (sparsely populated rural areas)	Mixed (sparsely populated rural areas)	Mixed (sparsely populated rural areas)
Government	Federal monarchy	Republic	Federal (canton) republic	Federal republic
EU membership (EC, 2022)	EU member since 1986	EU member since 2004	Non-EU member	Eu member since 1958

* Share of forest land according to definition of Eurostat (Eurostat, 2022)

** Share of forest land according to definition of FAO (FAO, 2020)

All four CSR are characterized by a multiple management system including FES objectives, entailing that FES are provided in sustainable forest management decisions, simultaneously providing different ecosystem services together with biodiversity.

1.2 Purpose

The purpose of this analysis is to provide an overview of the policy contexts for BES in the four CSRs, including the transnational level (EU) and national/regional levels, across different



geographic types, to understand similarities and differences on how FES are integrated in policy. By displaying and comparing policy in the CSRs of Catalonia (ES), Estonia, Grisons (CH) and Hesse/ Thuringia (DE), the aim is to evaluate how FES are prioritized (via policy integration (PI) and environmental policy integration (EPI)) and how FES-related policy is implemented (via policy coherence).

1.3 Report outline

The report first introduces the theoretical framework, followed by the method and material section. The results are then presented first outlining EU FES related policy, followed by main objectives of analysed policies, and finally presenting results from policy integration, in the frameworks of policy integration (PI), environmental policy integration (EPI) and policy coherence. The report is finalized by a concluding discussion.

2 Theoretical framework

To understand how different policy objectives in the four CSRs account for FES, the frameworks of policy integration (PI) and environmental policy integration (EPI) were utilized. The goal PI and EPI is to explore how policy objectives are integrated between different policy sectors – horizontal integration, and how these are implemented – vertical integration. The analysis is limited to the policies specifically related to FES – thus documents that directly mention FES, within the following sectors: biodiversity, bioeconomy, climate, energy, and forest which is the main policy affecting FES in the chosen case-study regions.

Underdal (1980) developed the PI framework to enable analysis of evaluating policy objectives and how they are implemented. The purpose of the PI analysis is to understand how policy meets the requirements of comprehensiveness and consistency in different stages of the policy process. Comprehensiveness identifies four dimensions: time, space, actors, and issues. Time and space refer to how well policy considers long-term consequences and geographical areas, while actors and issue refer to inclusiveness of policy in terms of perspectives, and how interactions between policy are recognized (Underdal, 1980). This means that even if there are identified conflicting objectives, or interdependences between objectives, policy can be integrated. High PI is reflecting different perspectives are considered in the policy documents as well as a wide range of interdependencies. This is identified by analysing the number of objectives and if they are reflecting synergies, conflicts, or neutral together with perspectives address, e.g., challenges, risks, and justifications of policy. The PI framework is well recognized and developed, however not specifically considering environmental contexts in policy, dealing with the need for making trade-offs particularly relevant in policy targeting FES (e.g., Kleinschmit et al., 2017; Lafferty and Hovden, 2003; Lenschow, 2002; Söderberg, 2011). The EPI framework recognises the necessary trade-offs needed between e.g., environmental, and economic objectives in sectors dealing with natural resource management, targeting sustainability (Lafferty and Hovden, 2003; Lenschow, 2002). The aim is to understand the priorities and impacts on sustainability and how multifunctionality is addressed in policy (Sotirov and Storch, 2018; Winkel and Sotirov, 2016). EPI may be divided into strong or weak EPI, measuring how well environmental issues are integrated in policy objectives in comparison with economic issues. In a weak EPI, environmental issues are subordinate, while strong EPI refers to situations where environmental objectives are prioritized over economic (Jordan and Schout, 2006; Söderberg, 2011). To measure EPI, the prioritization of objectives and its justification of priority are analysed, across policy sectors and with forest policy.



To analyse PI and EPI of FES integration, each of the policy sectors in which a connection to FES was found (biodiversity, bioeconomy, climate, energy, and forest) are evaluated and compared to understand integrations of objectives and how well environmental objectives are justified and prioritized. The analysis includes integrations between each of the policy sector, however, specifically targeting the integration between the policy sectors and the forest policy.

The vertical integration analysis focus on understanding how well policy is coherent, hence supporting objectives within and across policies implementing policy, and how well conflicts are eliminated, and synergies are promoted (Nilsson et al., 2012; Nilsson and Eckerberg, 2007; Nordbeck and Steurer, 2016). Policy coherence analysis may be performed in three stages, understanding how policy objectives, instruments and implementation interact (Nilsson et al., 2012). In this study, the focus is on the interaction between objectives and policy instruments implementing policies, to understand the mechanism pushing for fulfilling the policy targets. The analysis does not include the actual outcome or the responsible actors. Coherence is measured, as Steurer (2013) outlined, into hard or soft regulations, thus, with or without explicit sanctions. Additionally, interactions within and across levels are analysed to understand how well instruments are assisting others to achieve the same goal (synergy), or if instruments are compete causing conflicts (Nilsson et al., 2012). High levels of coherence point at synergetic policy objective – policy instrument interactions within and across policy sectors, while low levels of coherence point at conflicting policy implementation.

3 Method and Material

The policy analysis study is based on a comparative approach to understand the similarities and the differences of FES related policies in four CSRs within three EU member and one non-EU member countries as described in the introduction chapter. The analysis of FES-related policies, following the theoretical framework of policy integration, include biodiversity, bioeconomy, climate change, energy, and forest policies. As outlined in the theoretical framework, the current policies within the mentioned areas were analysed, specifically targeting policies that are relevant for FES. The analysis explores horizontal integration by studying how biodiversity, bioeconomy, climate change and energy policies are integrated into each other and how these policies are integrated into forest policy. Finally, vertical integration shows how the objectives of each policy are implemented.

Policy documents were collected by locally knowledgeable researchers in the regions. The policy documents, two to five per policy sector, were chosen meeting all the variables: 1) important policy area for delivering FES; 2) are the most recent; and 3) having a level of authority (e.g., law, bill, strategy adopted by government). In total 34 policy documents were included in the analysis. EU FES related documents was collected with the same characteristics. The policy documents collected is applicable either on national level, or on regional level (in the case of Catalonia (ES), Grisons (CH) and Hesse/Thuringia (DE)). Throughout the report, no distinction is made between national or regional policy, as the purpose of the study is to understand policy in the CSRs, hence a distinction between national and regional level lacks relevance. Table 2 summarizes the number of national and regional policy documents included in the analysis. The full references are given in appendix B. The number of strategies is higher than the number of laws in most parts of the CSRs, and the number of policy documents directly targeting forests are highest, followed by biodiversity and climate change/bioeconomy. For the regions of Catalonia (ES), Grisons (CH) and Hesse/Thuringia (DE), there is a mix of policy documents applicable on national level, and

regional policy in the specific region. Table 2 further illustrates that the analysed documents are mainly national (provided in parenthesis in table 2).

The policy in each CSR has been gathered in national languages, with translation to English. Quotes in the report are given in English with national language in footnotes. Main results from the CSRs are summarized in Appendix A, table I and II, and contains information for the comparative analysis discussing policy integration.

Table 2. Number of documents analysed and division between CSRs and subject areas.

Regions	Laws	Strategy/ other	Total
Catalonia (ES)	- (4)	- (4)	- (8)
Estonia	1 (-)	3 (-)	4 (-)
Grisons (CH)	3 (1)	6 (1)	9 (2)
Hesse/ Thuringia (DE)	4 (2)	5 (-)	9 (2)

Policy sectors	Laws	Strategy/ other	Total
Biodiversity	2 (3)	5 (2)	7 (5)
Bioeconomy	2 (-)	4 (2)	6 (2)
Climate Change	4 (1)	6 (-)	10 (1)
Energy	1 (-)	3 (1)	4 (1)
Forest	2 (1)	9 (1)	13

Note: same policy document may belong to multiple policy sectors.

4 Results

4.1 EU forest ecosystem service-related policies

The European Union has a long history of both indirect and direct forest policies. The current active legislation affecting FES are summarized below, excluding the recently not yet implemented policies such as the new EU forest strategy of 2021 and the biodiversity strategy for 2030.

Policies in place at present are:

- European green deal
- Bioeconomy strategy
- Forest strategy
- Common Agricultural Policy
- EUTR (EU timber regulation) and FLEGT (Forest Law Enforcement, Governance and Trade)
- LULUCF (Land Use, Land-Use Change and Forestry)
- 7th Environment Action Programme, Natura 2000, and phytosanitary regulations
- Trade defence and tariffs
- Regulation of sulphur content of marine fuels and trans-boundary shipments.

The European Green Deal is one of the most extensive policy-packages that is affecting forestry on EU level. It includes a target for the union to be climate neutral, which means no net emissions, in 2050 for which it uses a number of instruments and works to decouple economic growth from resource use (EC, 2019). It is closely connected to the bioeconomy strategy which focuses on sustainable use of natural resources while harmonizing social,

ecological, and economic values. The biodiversity strategy also affects FES directly with objectives especially targeting forests (EC, 2011).

The policy most focused on FES on a European level is the forest strategy (2013 version still active) that sets out targets for bioenergy, climate change mitigation and adaptation, as well as sustainable forest management in other perspectives. The Forest strategy is trying to integrate several objectives and international trade agreements (such as REDD+) to make a coherent forest policy framework (EC, 2021).

Policies that affect forests and forestry on a semi-indirect level are the common agricultural policy, regulation of trade with logged wood (e.g., EUTR and FLEGT), regulations on production, protection of human health, packaging, and construction. All policies concerning climate are in some way referring to FES, including energy and emission trading packages and LULUCF (Aggestam and Pülzl, 2018; Elomina and Pülzl, 2021).

Policies concerning the environment are affecting forests in both direct and indirect ways. EU regulations like 7th Environment Action Programme, Natura 2000 and phytosanitary regulations (e.g., disease control) influences forest and forestry directly. It can be expected that regulating sulphur content of marine fuels and trans-boundary shipments will influence the industry through affecting transportation of forest products (Aggestam and Pülzl, 2018).

4.2 Comparison of case study regions

The main goals of the policy areas of bioeconomy, biodiversity, climate, energy, and forest in the analysed CSRs all target sustainable forest management and FES-related policies are included in all policy sectors however to a different degree, as illustrated in table 3. Creating strategies for sustainable forest management while acknowledging that there may be conflicts between different FES seems important in all regions analysed. One of the most mentioned conflicts is between the need to increase volume of biomass produced and supplied, as well as the need to set aside a higher share of forests for biodiversity and other environmental reasons (e.g., ground water protection).

The main goals of FES biodiversity related policies in the CSR of Estonia are to protect forests to promote biodiversity. For Grisons (CH), the main goals are to promote biodiversity via fostering well-structured forests, light forests, forest reserves, old-growth forests and increasing the deadwood amount. In the CSRs of Catalonia (ES) and Hesse/Thuringia (DE), the focus of the main goals is targeting the management practices more directly to become sustainable with regards to biodiversity.

The main objective in the strategies in FES energy related policy is ensuring the productivity in the biomass production while at the same time prioritizing sustainability. The link between using biomass for energy and mitigating climate change is clear in all regions.

The FES policies relating to bioeconomy are the most heterogeneous in its main goal definitions throughout the regions, as table 3 shows. The underlying theme is creating growth while respecting the environment. Forest related policies main goals focus on creating sustainable forest management.

Lastly, in climate change related FES policies, the main target is to adapt both society and forests to changing climatic circumstances and at the same time try to mitigate to these

changes. In the Hessian (DE) policies, reaching the targets set by the EU are explicitly mentioned, but has indirectly influenced the other EU member regions' policies.

Table 3. The main goals related to from the regions in each subject.

Main goals/region	Catalonia (ES)	Estonia	Grisons (CH)	Hesse/Thuringia (DE)
Biodiversity	Regulate forest management to be more sustainable	Protection, productivity and adapting to climate change	Promotion of biodiversity	Sustainable management
Bioeconomy	Connect growth with preserving environment	Adapting to climate change and preserve environment	Safeguard multiple interests in the forests	Connect growth with preserving environment
Climate change	Decrease greenhouse gas emissions	Decreasing greenhouse gas emissions and adapting to climate change	Decrease greenhouse gas emissions	Use forests for climate change mitigation and adaptation to climate change
Energy	Promote use of bio-energy	Adapting to climate change	Increase use of biomass and mitigate climate change	Sustainable production of biomass and mitigation of climate change
Forest	Regulate forest management balancing economic values and preservation	Regulate forest management balancing economic values and preservation	Safeguard multiple interests in forests	Enforce silvicultural management balancing FES

The policy documents highlight conflicts between different FES, as illustrated in table 4. The most mentioned conflicts timber/biomass production and other FES, e.g., recreation or biodiversity.

Table 4. The main conflicts related to in the regions for each subject.

Main FES conflict/region	Catalonia (ES)	Estonia	Grisons (CH)	Hesse/Thuringia (DE)
Biodiversity	Forest protection and economic values			
Bioeconomy	Biodiversity and biomass production	Nature protection and economic values	Biodiversity and timber production	No conflicts mentioned in analysed documents
Climate change	No conflicts mentioned in analysed documents		Timber production and forest protection	No conflicts mentioned in analysed documents
Energy	Biodiversity and biomass production	Nature protection and economic values	Biodiversity and biomass production	Biodiversity and biomass production
Forest	Socioeconomic values and forest preservation	Timber production and recreational activities	Protection function, timber production, biodiversity	Forest protection, biodiversity, and timber provisioning



4.3 Similarities and difference between the regions in different subject areas

4.3.1 Biodiversity policy

The value of biodiversity is well incorporated in regulations concerning forest management in all CSRs and frequently stated in other areas.

In the policy documents relating to biodiversity, protection and conservation is in focus in the laws, while sustainable forest management is more of a focus in the strategy documents.

In the subgoals of the documents, there is attention devoted to the multifunctional value of forests where several FES are referred to. In the German national conservation act, it is explained that "*[d]ue to their intrinsic value and as the basis for human life and health, nature and the landscape must be protected in such a way, also in responsibility for future generations [...], that 1. biological diversity, 2. the performance and functional capacity of the ecosystems, including the regenerative capacity and sustainable usability of the natural assets, as well as, 3. the diversity, character and beauty as well as the recreational value of nature and the landscape are safeguarded in the long term*"¹ (DE_policy_FO_national, 1975, § 1).

However, there is a large variety in the kind of challenges that the biodiversity related documents are trying to solve. Some examples are harmonizing the different dimensions of sustainability (economic, ecological, and social) in Grisons (CH), exceeding renewal capability of the forests in Estonia and a facing a decrease in biodiversity in Catalonia (ES). It may be a sign of the dissimilar starting points of both biogeography and politics in the regions studied.

Though, policymakers from all regions mention a synergy between biodiversity and climate change mitigation. In Grisons (CH) for example, policy states that "*[t]he adaptation strategy aims to integrate adaptation to climate change into the various sectoral policies and to coordinate activities. [...] In forestry, adaptation to climate change is integrated into the Forest Law. In addition, it is part of the implementation work on the Forest and Climate Change Research Program*"² (CH_Strategy_FO_CC_national, 2020, p. 12). The main conflict between FES that is mentioned is combining economic values with protecting more forest area. The policies have in general made measures mandatory; however few sanctions are in place if the measures are not met.

4.3.2 Bioeconomy

For Hesse/Thuringia (DE) a national bioeconomy strategy is in place, and Catalonia (ES) have specific strategies addressing bioeconomy. These are focused on connecting the values of nature with the overall economy, promoting economic growth in a way that does not deprive the environment on general and forests in particular. In Catalonia (ES) the strategy aims to "*[p]romote the technological transformation of biomass resources of forestry, agricultural, livestock and fisheries origin into bioproducts, biomaterials and bioenergy through the use of*

¹ Natur und Landschaft sind auf Grund ihres eigenen Wertes und als Grundlage für Leben und Gesundheit des Menschen auch in Verantwortung für die künftigen Generationen (...) so zu schützen, dass 1. die biologische Vielfalt, 2. die Leistungs- und Funktionsfähigkeit des Naturhaushaltes einschließlich der Regenerationsfähigkeit und nachhaltigen Nutzungsfähigkeit der Naturgüter sowie, 3. die Vielfalt, Eigenart, und Schönheit sowie der Erholungswert von Natur und Landschaft auf Dauer gesichert sind." (§ 1 BNatSchG)

² Die Anpassungsstrategie hat zum Ziel, die Anpassung an den Klimawandel in die verschiedenen Sektorpolitiken zu integrieren und die Aktivitäten zu koordinieren. [...] In der Waldwirtschaft ist die Anpassung an den Klimawandel integriert in das Waldgesetz. Zudem ist sie Teil der Umsetzungsarbeiten zum Forschungsprogramm Wald und Klimawandel.



*renewable and local biomass, the reduction of waste generation in the supply chain and of the change in consumption patterns (demand and use of bioproducts)*³ (ES_strategy_BEC_regional, 2020, p. 2). A secondary focus in Hesse/Thuringia (DE) as well as in Catalonia (ES) bioeconomy policies, innovation, and research value how to achieve these goals. More knowledge and innovation are also the measures suggested to further the bioeconomy goals. Estonia and Grisons (CH) have policies that address bioeconomy indirectly (Switzerland has a Bioeconomy-strategy not yet implemented when this analysis is conducted), mainly focusing on either forestry, climate change or timber production. In these documents, bioeconomy is referred to as increasing productivity in forests while preserving the natural forest ecosystems. The Estonian Climate change adaption development plan states that “[...] in order to ensure the preservation of use of timber and the quality of timber and to thereby increase carbon sequestration”⁴ (Estonia_strategy_BEC_CC_EN_FO_national, 2017, p. 20). Productivity in the forests is defined in this document in terms of timber production. Climate change is being targeted as the biggest challenge in these policies. Again, the synergy between climate change mitigation and biodiversity is referred to in policies in most regions. At the same time, Catalonia (ES) describes in their bioeconomy strategy biomass production and conservation of biodiversity as an example of a potential conflict between FES.

4.3.3 Climate change policy

The overall challenge identified by climate change-related policy documents is its negative impact on society and the environment. In the Catalan (ES) Law of Climate Change it is clearly stated that “[g]lobal warming is not only an environmental problem; it affects to biodiversity, economy model, mobility, trade, food security, access to water and to natural resources, infrastructures and health”⁵ (ES_policy_CC_regional, 2017, p. 12). These policies are clear on being mandatory to fulfil, with sanctions for those that does not. In all regions analysed, there seems to be a priority on collaboration between different stakeholders to get the best results and impacts from the policy aims.

Climate change related policies are well integrated with biodiversity in all regions, e.g., synergies between biodiversity and both climate change mitigation as well as climate change adaptation are mentioned. One of the objectives in the Catalan (ES) climate law makes clear to prioritize “[t]he conservation of biodiversity and the improvement of the vitality of forest ecosystems, their ability to adapt to available water resources and their regulatory function of the hydrological cycle and protection against erosion and other adverse effects of heavy rains”⁶ (ES_policy_CC_regional, 2017 art. 2, p 5).

Grisons (CH) which is governed by the highest number of climate related policies compared to the other regions, is explicit on the synergy between timber production and carbon sequestration. A federal climate law from 2011 states that “[t]he effect of the sinks in construction wood can be credited”⁷ (CH_policy_CC_national, 2011, Chapter 3, Art.14). This is

³ Promoure la transformació tecnològica de recursos de biomassa d'origen forestal, agrícola, ramader i pesquer en bioproductes, biomaterials i bioenergia a través de l'aprofitament de biomassa renovable i local, de la reducció de la generació de residus en la cadena de subministrament i del canvi en els patrons de consum (demanda i ús de bioproductes).

⁴ [...], et tagada puidukasutuse säilimine ja puidu kvaliteet ning suurendada sel teel süsiniku sidumist.

⁵ L'escalfament global no és només un problema ambiental; afecta la biodiversitat, el model econòmic, la mobilitat, el comerç, la seguretat alimentària, l'accés a l'aigua i als recursos naturals, les infraestructures i la salut.

⁶ La conservació de la biodiversitat i el millorament de la vitalitat dels ecosistemes forestals, llur capacitat d'adaptació als recursos hídrics disponibles i llur funció reguladora del cicle hidrològic i de protecció contra l'erosió i altres efectes adversos de les pluges intenses.

⁷ Die Leistung der Senken von verbautem Holz ist anrechenbar



mentioned in documents from the other regions as well. A prioritized FES for mountain regions in Switzerland is the forests protective function against avalanches and other gravitational hazards. This seems to be a unique feature from Grisons (CH) in the compared regions, although Catalonia (ES) mentions a similar local FES in terms of forests helping with erosion control and being a hydro-regulator. Water system vitality is an important subgoal for Grisons (CH), Estonia and Catalonia (ES) in the policy documents relating to climate change.

The analysed documents for Estonia and Hesse/Thuringia (DE) mention no conflicts.

4.3.4 Energy

In the area of energy related policies, there are more strategy-documents rather than laws referring to FES from the regions. FES in the focus of energy is biomass production. One of the main goals of the Estonian Forestry development plan concludes that *“the use of wood as a renewable raw material and a renewable energy resource is favoured instead of products and non-renewable energy sources with larger CO2 emissions”*⁸ (Estonia_Strategy_BIO_CC_EN_FO_national, 2011, p. 21). Hesse/Thuringia (DE) policies state that biomass is the preferred source of fuel for electricity production, however there are conflicts between biodiversity and biomass production is acknowledge in energy related policies. Furthermore, in the case of energy related policies, the regions address different challenges regarding trade-offs. Catalonia (ES) concludes that a big challenge is that current powerplants fuelled with biomass are not economically feasible, while for Grisons (CH) addressing the challenges of climate change is identified as one of the main challenges.

4.3.5 Forest

The policy area with the largest number of policies relating to FES is forest policy. Out of 34 documents analysed, 13 belong to this category whose main focuses are on forest management. Catalonia (ES) mentions hydro-regulation as the overall challenge to which the policies are responding, Grisons (CH) puts emphasis on maintaining multifunctionality (protective, economic, and social functions), while Hesse/Thuringia (DE) and Estonia mention climate change as the top challenge.

In the subgoals, some of the current challenges of forestry are crystallized. There are trade-offs between different societal demands of forests that these documents aim to acknowledge and, in some cases, tries to solve. The economic performance of forestry is to improve in parallel with ensuring high quality of soil, drinking water and vitality of trees together with wildlife. Additionally, recreational use should be safeguarded. The policy documents initiate by setting the scene, defining used vocabulary, and clarifying e.g., what sustainable management means. From here, the policy documents form a support system for forest owners in terms of economic subsidies and help with making management plans that balance the different desirable FES. An example is a Swiss enforcement aid: *“[the document] concretizes undefined legal terms of laws and regulations and is intended to promote uniform enforcement practice”*⁹(CH_strategy_FO_national, 2005, p. 2). Most of the objectives from all regions somehow relate to FES.

⁸ Puidu kui taastuva tooraine ja taastuenergia allika kasutamine on eelistatud suurema CO2 emissiooniga toodete ning taastumatute energiaallikate asemel.

⁹ [Diese Publikation] konkretisiert unbestimmte Rechtsbegriffe von Gesetzen und Verordnungen und soll eine einheitliche Vollzugspraxis fördern.



4.4 Policy integration of BES related policies

In analysing policy integration (for references see Appendix B), thus how well the policy documents are acknowledging each other's objectives, i.e., horizontal policy integration, and specifically how well FES are integrated in the different policy sectors, the results show that there is a high level of policy integration in each of the analysed CSR. However, the synergies and conflicts brought forward by each CSR are different, as table 5 illustrates. Common synergies in policy are found between forest policy and climate change mitigation focusing on climate change mitigation measures, but also on how to increase the resilience of forests connected to forest damages (e.g., fire, storm, pests, insect damages), and to supportive and regulative ecosystem services.

In Estonia policy focus on the growing forests for climate change mitigation, genetic variations, and protection against damages, targeting the provision of timber production. The Estonian climate policy for instance state that “[t]he goal of the Environmental strategy 2030 is to establish long-term development directions in order to maintain the good condition of the environment. Meanwhile taking the connections of environment to economy and social sector into consideration and their influence on environment and people¹⁰ (*Estonia_strategy_BIO_BEC_CC_EN_FO_national*, 2030, p. 3). The focus in Hesse/Thuringia (DE) policy are targeting synergies between biodiversity and climate change adaption and climate change mitigation. In policy applicable in Hesse/Thuringia (DE) the goal is to develop “a natural climate protection action program to create synergies between nature conservation and climate protection and strengthen with nature restoration measures the resilience of our ecosystems, especially peatlands, forests [...]”¹¹ (*DE_strategy_BEC_FO_national*, 2021, p. 38). However, this policy is not mandatory on federal levels. The perspectives of Catalonia (ES) and Grisons (CH) are similar, identifying synergies between forests and climate change mitigation, identifying functions of forests for hazard protection (e.g., erosion, avalanches, landslides as well as fire prevention). Federal forest law in Grisons (CH) states that “[p]rotection from natural hazards. Where the protection of people or significant property requires it, the cantons secure the avalanche, landslide, erosion and rockfall areas and ensure the protection of streams via forestry”¹² (*Bundesgesetz über den Wald (Waldgesetz WaG)*, 1991, Chapter 3, art.19).

Conflicting policy sectors are found in each of the CSRs and a common conflict are found between timber production and biodiversity, identified by all four CSRs. However, conflicts are not only between forest policy and biodiversity related policies, but also between socio-economic functions, i.e., cultural FES and forest-, biodiversity-, energy- and bioeconomy related policies. Estonia particularly mentions conflicts between clear cut as a felling method and sensitive areas for hazard protection (e.g., erosion and ground water regulation), while Catalonia (ES) identify the same conflicts, however for different reasons. In Catalonia (ES), there are tensions between private land and public land use, protecting forest land from urban exploitation. Grisons (CH) mentions tourism as a problematic conflict area.

In connection with how well the policies in the CSRs are prioritizing environmental aspect, environmental policy integration (EPI) helps reveal policy integration. The PI analysis shows

¹⁰ Eesti keskkonnastrateegia aastani 2030” eesmärgiks on määratleda pikaajalised arengusuunad looduskeskkonna hea seisundi hoidmiseks, lähtudes samas keskkonna valdkonna seostest majandus- ja sotsiaalvaldkonnaga ning nende mõjudest ümbritsevale looduskeskkonnale ja inimesele.

¹¹ natürlicher Klimaschutz, mit dem wir Synergien zwischen Natur- und Klimaschutz schaffen und stärken mit Renaturierungsmaßnahmen die Resilienz unserer Ökosysteme, insbesondere Moore, Wälder [...]

¹² Schutz vor Naturereignissen. Wo es der Schutz von Menschen oder erheblichen Sachwerten erfordert, sichern die Kantone die Lawinen-, Rutsch-, Erosions- und Steinschlaggebiete und sorgen für den forstlichen Bachverbau.



that even though biodiversity and climate change are common challenges for each of the CSRs, environmental priorities are not necessarily high. For each of the CSR biodiversity is showing high EPI together with climate change policies Grisons being the exception (only showing strong EPI in biodiversity policy). However, forest-, energy-, and bioeconomy-related policies show weak EPI. Common for the CSRs are that environmental targets are typically mentioned as a subordinate goal, or sub-goal. In Catalonia (ES), for instance, *“the elements of multifunctionality of forest lands in their aspects of production of environmental and socio-cultural goods and services [...], guarantee the production of raw materials and make adequate use of renewable natural resources”*¹³ (ES_policy_BIO_regional, 2013, p. 3, art. 4).

Concluding the horizontal policy integration analysis, a high level of policy integrations is found in general in the four CSRs, however it is only biodiversity- and climate-related policies that show a relatively strong or strong environmental policy integration. All CSRs recognizes the benefit of forests in climate change mitigation, and Catalonia (ES), Hesse/Thuringia (DE) and Grisons (CH) policies reveal competing objectives, where multiple use of forests are recognized and synergies and trade-offs between forest FES are realized in sustainable forest management, however not prioritizing environmental policy objectives. Estonian policies are characterized of a sectoral objective, where timber production is brought forward forth most, given less priority to other FES, climate change mitigation as an exemption.

To understand policy implementation and policy coherences, the vertical policy integration includes comparing policy instruments as well as policy coherence. In the comparisons of the policy sectors, the analysis must consider the historical development of the policy areas. Biodiversity related and forest policies have been in place for a long period, while bioeconomy, energy (particularly bioenergy) and climate related policies are more recent, affecting the policy instruments' development and implementation.

As the latter part of table 5 illustrates, all CSRs are using a combination of policy instruments, hard and soft policy. The CSRs have in common that compliance to forest law is followed by sanctions or a fine, thus hard policy instruments, combined with soft policy of strategies. Catalonia (ES) and Grisons (CH) both show examples of hard policy instruments in relation to climate policy, where Catalonia (ES) has set up a financial fund for climate change mitigation measures, and Grisons (CH) has sanctions for those who exceed individual emission targets.

To summarize policy integration analysis on the vertical level, policy coherence (measured in high or low), display conflicts and synergies across policy objectives (as analysed in PI and EPI), together with policy implementation. The results indicate that there is, in general, high level of policy coherence across forest and climate policies in all CSRs, illustrated by the synergies of sustainable forest management and climate change mitigation, but also the acknowledged conflicts between biodiversity and forest as well as climate related policies, thus high PI in combination with hard policy instruments. Consequently, low policy coherence is found between bioeconomy, energy, and biodiversity related policies, where a low degree of EPI and goals are for example not harmonized or unclear. Few hard policy instruments are also found within these policy sectors.

¹³ [...] els elements de multifuncionalitat dels terrenys forestals en les seves vessants de producció de béns i serveis ambientals i socioculturals, [...], garantir la producció de matèries primeres i aprofitar adequadament els recursos naturals renovables.

Table 5. Policy integration (PI), environmental policy integration (EPI) and policy coherence in CSR.

	Catalonia (ES)*	Estonia*	Grisons (CH)*	Hesse/Thuringia (DE)*
Policy objective	FES address in all policies			
Policy integration (PI)	<p>High level of PI Synergies: Hydrological planning and forest planning, Fire management and climate change mitigation Recreational use of forest land and land use policy, Growing forests as carbon sink, Forests provider for bioenergy, Sustainable forest management for biodiversity. Climate change reinforce conservation policy, as well as forestry and bioeconomy.</p> <p>Conflicts: Socio-economic function of forestry vs. protection for biodiversity and protection of forest land for exploitation. Private land use vs. public land use (cultural services), Biodiversity protection vs. utilization of wood for bioenergy.</p>	<p>High level of PI Synergies: Growing forests as carbon sink, growing forests as provider of genetic variations, growing forests as provider of protection for forest damages.</p> <p>Conflicts: Clear cut vs. sensitive areas (erosion, deflation, infiltration, ground water regulation). Timber production vs. biodiversity</p>	<p>High level of PI Synergies: Growing forests protective function against several types of hazards (erosion, avalanches and landslides control, pest regulation, noise protection, air pollution protection), forests as biodiversity guarantee and recreation, timber provision and climate change mitigation.</p> <p>Conflicts: Biodiversity vs. timber production Nature conservation vs. tourism</p>	<p>High level of PI Synergies: Biodiversity as guarantee for climate change adaptation, natural growing forests and recreational value, biomass production and climate change mitigation.</p> <p>Conflicts: Biodiversity vs. biomass production (economic sustainability and biodiversity)</p>
Environmental policy integration (EPI)	<p><i>Relatively strong</i> in biodiversity and climate policy.</p> <p><i>Weak</i> in forest and energy, bioeconomy policies.</p> <p>Competing objectives</p>	<p><i>Relatively strong</i> in biodiversity and climate policy.</p> <p><i>Weak</i> in forest and energy and bioeconomy policies.</p> <p>Sectoral objectives</p>	<p><i>Relatively strong</i> in biodiversity policy and climate policy.</p> <p><i>Weak</i> in forest and bioeconomy policies.</p> <p>Competing objectives</p>	<p><i>Strong</i> in biodiversity and climate policy.</p> <p><i>Weak</i> in energy policy</p> <p>Competing objectives</p>

Note: BIO=biodiversity; BEC=bioeconomy; CC=climate; EN=energy; FO=forest * Sources: see appendix B.

	Catalonia (ES)*	Estonia*	Grisons (CH)*	Hesse/Thuringia (DE)*
Policy instruments Hard/Soft	Combination of hard and soft instruments. Hard (in FO, CC, BIO): Sanctions if not comply to policy Financial mechanism for CC fund Soft (in EN, BEC): Strategies	Combination of hard and soft instruments. Hard (in FO, EN, BIO): Fine if failed re-generation Cutting rights for harvest and delivery of timber Prohibit/restriction harvest in key habitats Soft (BEC, CC): license obligation for forest activities Protection for biodiversity	Combination of hard and soft instruments. Hard (in FO): Sanction if forest law is violated Soft (in EN, BEC, BIO & CC) Obligations but no mentioned sanctions.	Combination of hard and soft instruments Hard (in FO) Sanctions if forest law is violated. Mandatory compensation for disturbing intervention for biodiversity Monitoring and enforcement systems in EN Soft (in CC, EN & BIO) Obligations in emission target with follow up from ministry
Policy coherence High/low	High within forest policy and climate policy, as well as biodiversity – in forest-related issues. Low across levels in energy and bioeconomy.	High across levels in forest policy and climate policy. Low across levels in energy, bioeconomy, and biodiversity policies.	High across levels in climate policy and forest policy. Also high between biodiversity and forest policy. Low across levels in biodiversity and energy.	Relatively high across levels in forest and climate policy. Low across levels in biodiversity and energy policy.

Note: BIO=biodiversity; BEC=bioeconomy; CC=climate; EN=energy; FO=forest * Sources: see appendix B.



5 Concluding discussion

The aim of this report is to understand how policies across regions (Catalonia (ES), Estonia, Grisons (CH) and Hesse/Thuringia (DE)) and across geographic types considers forest ecosystem services (FES), in biodiversity-, bioeconomy-, climate-, energy-, and forest policies. The results are derived using the framework of policy integration and environmental policy integration, analysing horizontal and vertical integration. The levels of PI and EPI together with policy coherence states the relationship between different policy areas, how synergies are realized and how conflicts or trade-offs are being decided upon are vital to policy making, to be able to shape future integrations, priorities, and policy implementation, ensuring that policy goals are on target avoiding policy failures.

On a transnational level, EU policies related to forests and FES are in place within all the chosen policy sectors. The policies are of overarching and frame characteristic, leaving detailed regulations for national policy. The intention of the EU policy framework is thus to provide direction for e.g., climate change mitigation, bioeconomy development, and sustainable use of natural resources (including biodiversity) within the union. As three out of the four analysed regions are members, EU policies related to FES are explicitly referred to within their national policies, or indirectly affecting influencing policy.

Based on the 34 policy documents included in the analysis, results indicate that even though the analysed regions have different forest types typically characterized by different challenges and prerequisites, priorities are rather similar. All regions are characterized by integrated forest management; thus, all four groups of forest ecosystem services are integrated and included in policy formulation. Furthermore, the regions regardless of being a member of EU or not, acknowledge climate change and climate change mitigation as a major challenge. All regions bring forward strong synergies between forest and climate change mitigation, however with differences of effects for FES. Catalonia (ES) and Grisons (CH) emphasise the importance of forests to mitigate hazards for society (e.g., erosion, fire), while Hesse/Thuringia (DE) identify biodiversity and recreational benefits in combination with climate change mitigation. Estonia focusses on growing forests, providing for e.g., carbon storage, but also for genetic variations and protection against forest damages (e.g., fire, storm, pests, and insect outbreaks). The analysis of objectives and the synergies/conflicts mentioned shows a high level of policy integration which entails that policy recognizes synergies and conflicts between different FES and that policy documents to a large degree “talk” to each other (Underdal, 1980). Further analysing environmental policy integration (EPI), where integrations of environmental issues into policy are evaluated, biodiversity policy, as expected, has high EPI. Additionally, climate change policies show relatively high to high EPI for all regions. Environmental questions have low priority in most regions within the policy areas of bioeconomy- and energy related policies, while in forest related policies most regions mention that economic, environmental, and social goals of FES are equally important. Following high levels of policy integration is the coherence of policy, illustrating how well synergies are promoted and conflicts solved, both biodiversity- and climate policy show high levels of coherence in all regions, while bioeconomy, biodiversity, energy, and forest are not well integrated, potentially neglecting potential synergies or increasing conflicts over FES.

The policy integration analysis does not provide explanations of how well policy succeed, or if it fails, but illustrates how well policy is recognizing the same objectives, identify similar synergies and conflicts. The results of this study can be utilized to a) understand policy and how well it is integrated, and b) to potentially increase the integration of policies related to FES



– especially the policies that are not well integrated at present, thus bioeconomy-, energy-, and forest related policies and their relationship with biodiversity-, and climate related policies.

This study has not included analysis of coherence on the actors and analysed how institutions and governance structures contribute to policy integration on the vertical level. To develop the analysis further, this perspective together with stakeholder analysis may complete the understanding of how policy connected to FES recognize the needs of supportive, regulative, providing, and cultural FES.

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Appendix A: Table I. Comparative analysis of horizontal policy analysis

	Catalonia (ES)	Estonia	Grisons (CH)	Hesse/Thuringia (DE)
Challenges justifying objectives	<p>Increasing demand on forests to provide renewable goods (energy) (BEC; EN)</p> <p>Public awareness of supporting and regulating services (CC; BIO)</p> <p>Biodiversity loss (BIO) because of climate change (CC).</p> <p>Global warming affects society and its use of FES (CC; BEC; vs. BIO)</p>	<p>Insufficient use of forests cause decline in forest renewable and in long term forestry development (BIO; FO)</p> <p>Climate change increase scale of forest damages (economic, forest health and fatalities) (CC).</p> <p>Over-use of natural resources and exceed of renewable capacity (providing services) (BEC)</p> <p>Recognizes challenges of biodiversity (supporting services) (BIO).</p> <p>Energy (fossil) replacement (EN).</p> <p>Health and quality of life (BEC).</p> <p>Increased environmental risks of increased transportation (BEC)</p> <p>Energy transformation and energy consumption (EN).</p> <p>Ozon-depleting substances. Consumer habits and effect on health (BEC).</p> <p>Land use considering natural aspects (FO, BIO)</p>	<p>Ensure protective, welfare and utility functions of forest (FO)</p> <p>Protect people and material assets against avalanches, landslides, erosion and rockfall (natural hazards) (BEC)</p> <p>Risks of disturbances in forests due to storms, insects, pathogens, and climate change (CC, FO)</p> <p>Fund public services (BEC)</p> <p>The poor state of the environment and biodiversity are insufficiently anchored in Swiss economy and society (BIO, BEC)</p> <p>Limit climate warming (CC)</p> <p>Soil conservation (BIO)</p> <p>Health and recreation (BEC)</p> <p>Need for sawn wood and wood-based materials to replace fossil material (BEC, CC, EN)</p> <p>Water management (BIO)</p> <p>Risk of damage of infrastructure and settlements by gravitational hazards (BEC)</p>	<p>Climate change calls for resilient forests (BIO, CC)</p> <p>The efficiency of the ecosystems services depends on forests preservation (and increase) (FO, BEC, CC)</p> <p>Biodiversity is necessary to provide vital services from environment (BIO, FO)</p> <p>Climate change must be mitigated with help of forests (CC)</p> <p>Climate change effects worsening with declining biodiversity (BIO)</p> <p>Ecologic and economic values are colliding (BEC)</p> <p>Too much biomass harvest can compromise future of forests (EN)</p> <p>Health and quality of life (BEC)</p>

Note: BIO=biodiversity; BEC=bioeconomy; CC=climate; EN=energy; FO=forest



	Catalonia (ES)	Estonia	Grisons (CH)	Hesse/Thuringia (DE)
<p>Comprehensiveness (degree of PI)</p> <p>Interdependence (weak/strong; many/few; synergetic/conflicting; neutral)</p> <p>Weak/Strong PI</p>	<p>High level of integration:</p> <p>Climate – energy – forest: acknowledging multifunctionality of forests, providing for energy, climate change mitigation and biodiversity protection. Indirect synergies: weak to medium.</p> <p>Climate-biodiversity-forestry: sustainable forest management for biomass production, supporting biodiversity to reduce risk for forest damage (e.g., fire), protect water regulation. Many and strong</p> <p>Climate-biodiversity: reducing biodiversity loss and provide carbon sink contribute to climate change mitigation. Strong</p> <p>Forest-biodiversity-bioeconomy: conflict between protecting forest land against urban development (protect land). Strong</p>	<p>High level of integration:</p> <p>Climate – forest – biodiversity: growing forests as carbon sink, growing forest supporting biodiversity: many and strong</p> <p>Forest – biodiversity: timber production vs. biodiversity and genetic resources: conflicts: few but strong</p> <p>Forest – biodiversity: forest growth vs. game access, and game vs. protection of species: conflict: few but strong</p> <p>Low integration with energy and bioeconomy policies.</p>	<p>High level of integration:</p> <p>Biodiversity – bioeconomy – climate:</p> <p>Biodiversity is attributed with economic, social and ecological value and supports climate change mitigation: many, strong.</p> <p>Forest – biodiversity:</p> <p>Protection against natural hazards: many, strong</p>	<p>High level of integration:</p> <p>Biodiversity – forest – climate:</p> <p>Biodiversity promoting forests protective functions against natural hazards and climate change: strong</p> <p>Climate – energy – bioeconomy:</p> <p>Timber use and climate change mitigation: many and strong.</p> <p>Biodiversity – bioeconomy:</p> <p>Preserving forests and extracting biomass conflict: few</p> <p>Loss of biodiversity poses risks to human well-being and the functioning of the economy: strong</p>

Note: BIO=biodiversity; BEC=bioeconomy; CC=climate; EN=energy; FO=forest

	Catalonia (ES)	Estonia	Grisons (CH)	Hesse/Thuringia (DE)
Prioritization Prio/subordinate/neutral Dominating rational Weak/Strong EPI	<p>Climate change mitigation policy is integrated in most policies. Protection measures, i.e., supportive services (e.g., fire, pests, erosion, hydrological basins) are prioritized. (CC, FO)</p> <p>Sustainability is the dominating paradigm in policy, however not coordinated thus leading to fragmented policy, thus weak EPI.</p> <p>Weak EPI: BEC, EN, FO</p> <p>Strong EPI: CC</p> <p>Strong EPI when BEC, EN, BIO and CC are integrated in FO.</p>	<p>Wood production for timber and bioenergy production are in focus in most policy documents, to ensure primary provision of forest-based goods and economic growth of Estonian forest industry (FO, EN).</p> <p>The forest function in climate change mitigation is acknowledged (CC).</p> <p>Synergies between biodiversity conservation and climate change (CC, BIO)</p> <p>On general weak EPI as EN, and BIO are integrated with FO.</p> <p>Strong EPI between BIO and CC.</p>	<p>Protection measures, i.e., supportive services (e.g., erosion, avalanches and landslides control, pest regulation, noise protection, air pollution protection) are mentioned across all documents from Switzerland, this is linked to biodiversity as a synergy (CC, FO, BIO)</p> <p>Multifunctionality of forests are prioritized and mentioned as both conflict and synergy. (BEC)</p> <p>EN integrated into FO policies</p> <p>Strong EPI in FO, BIO, CC</p> <p>Weak EPI in EN</p>	<p>Acknowledge the role forests play in climate change mitigation (CC)</p> <p>The economic value of both increasing forest area and intensify recreational use is mentioned (BEC).</p> <p>Strong EPI in FO, BEC</p> <p>Weak EPI in CC</p>

Note: BIO=biodiversity; BEC=bioeconomy; CC=climate; EN=energy; FO=forest

Appendix A: Table II. Comparative analysis vertical integration

	Catalonia (ES)	Estonia	Grisons (CH)	Hesse/Thuringia (DE)
Policy instruments Specific tools (legal, economic, informational, hard/soft)	<p>Forest policy laws and regulations, planning including advisory services for forest owners (soft). Promote forest management to increase forest resilience (soft). In urban planning instruments seek compensations to withhold forest land (soft).</p> <p>Climate policy is regulated in climate law (soft), combined with economic tools (e.g., taxes and carbon budget) providing for funds to transform into low-carbon society (hard).</p> <p>Biodiversity policy regulating management plan (soft), technical and financial benefits provided for protected areas (soft). Protected areas on mature forests and high natural value forests (hard).</p>	<p>Forest policy law and regulations. Regulations of harvest, regeneration, and environmental consideration (key habitat). Obligation to own harvest and delivery of timber rights (hard policy). Forest development plan as well as protection of biodiversity in forest development plan (soft policy).</p> <p>Climate policy is regulated in development plan. Soft policy increase awareness of climatic challenges and monitor climate risks.</p> <p>Biodiversity (environmental) policy is regulated in development plan. Soft policy to fulfill environmental goals.</p>	<p>Forest policy Control measures and fines. Hard policy to ensure compliance with mandatory silviculture objectives (restrictions on clear-cuts, access to forest infrastructure, use of toxic substances)</p> <p>Climate policy Increasing collaboration and knowledge exchange between different policy actors and sectors</p> <p>Biodiversity policy Control measures to safeguard multiple interests in forests, assuring long-term sustainable use. No sanctions. Soft steering.</p> <p>Energy policy Collaboration and knowledge exchange to harmonize different dimensions of sustainability.</p> <p>Bioeconomy policy Use of wood as CO₂ sink, creation of jobs in peripheral areas, contribution to regional economic cycles, important contribution to circular economy and bioeconomy.</p>	<p>Forest policy Economic support from state level, payments for provision of ecosystem services, sanctions</p> <p>Climate policy Soft policy making sure compliance with national and international targets. No mentioned sanctions.</p> <p>Biodiversity policy Law and strategy document Soft policy with compensation instrument for losses impaired by policy intervention.</p> <p>Energy policy Subsidies and certification schemes for forest owners to fulfil targets while ensuring sustainability.</p> <p>Bioeconomy policy Soft policies focusing on information, dialogue with stakeholders and research</p>

	Catalonia (ES)	Estonia	Grisons (CH)	Hesse/Thuringia (DE)
Type of document Soft/hard	<p>Forest: laws and regulations (soft) describing forest law, and forest management plans. Sanctions and obligations (hard)</p> <p>Biodiversity: policy strategy, reference to all laws concerning biodiversity.</p> <p>Climate: laws and regulations, taxes, carbon budget (hard). Funds provide for low-carbon transition.</p> <p>Energy: is described in a strategy document (soft)</p> <p>Bioeconomy: consists of strategic document (soft).</p>	<p>Forest: Narrow spectrum of instruments (legal, economic, informative) hard policy and soft strategic policy</p> <p>Biodiversity: less broad, hard policy when included in forest policy, otherwise soft policy.</p> <p>Climate: hard policy when included in forest policy, otherwise soft strategic policy.</p>	<p>Forest: Laws/development plan/guidelines and manual: hard</p> <p>Biodiversity: Strategy document: soft</p> <p>Climate: Law/action plan: hard</p> <p>Energy: Strategy document/policy: soft</p> <p>Bioeconomy: Policy document/development plan: soft</p>	<p>Forest: Laws/strategy: hard and soft policy, supportive with few sanctions</p> <p>Biodiversity: Strategy/law: soft instruments</p> <p>Climate: Law: soft</p> <p>Energy: Soft regulation</p> <p>Bioeconomy: Strategy document, informative measures.</p>
Coherence High/low Synergy/Conflict/Neutral	<p>High level of coherence within forest policy as structures and resources promotes forest management. Forest policy weak with other policy areas.</p>	<p>High level of coherence between forest and climate, with synergy between goals (carbon and forest growth)</p> <p>Biodiversity (environment): low (unclear how biodiversity is included in forest policy).</p>	<p>High level of coherence between biodiversity and forest policy. Preserved biodiversity is prioritized in all forest policy, and biodiversity policy is implemented through sustainable forest management.</p> <p>High between climate policy, bioeconomy, and energy policy, with shared objectives.</p> <p>Low level of coherence between biodiversity policy and energy.</p>	<p>Relatively high level of coherence between bioeconomy and climate policy, with synergy between objectives.</p> <p>Neutral: Acknowledged synergy in biodiversity and adaptation to climate change, but not with climate change mitigation.</p> <p>Low level of coherence between biodiversity and energy policy. Biodiversity policy mention high value of biomass but does not suggest coordination with energy policy. Not harmonized with goals of energy policy.</p>

Appendix B: Sources policy analysis

Catalonia (ES)

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- ES_policy_BIO_regional, 1992., Decret 328/1992, de 14 de desembre, pel qual s'aprova el Pla d'interès natural [Decree 328/1992, of 14 December, approving the Natural Interest Plan].
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- ES_strategy_BEC_regional, 2020., Acord de Govern GOV/23/2020, es van aprovar els objectius i el contingut de l'Estratègia de la Bioeconomia de Catalunya 2021-2030 [Bioeconomy strategy of Catalonia (2021-2030)].
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- ES_strategy_BIO_regional, 2018., Estratègia del patrimoni natural i biodiversitat catalana [Strategy of natural heritage and biodiversity in Catalonia].
- ES_strategy_EN_regional, 2021., Estratègia per promoure l'aprofitament energètic de la biomassa forestal i agrícola (2021-2017) [Catalan Strategy to promote forest and agrarian biomass energy use].

Estonia (EE)

- Estonia_Policy_FO_BIO_national, 2006., Metsaseadus [Forest Act].
- Estonia_strategy_BEC_CC_EN_FO_national, 2017., Kliimamuutustega kohanemise arengukava aastani 2030 [Climate Change Adaption Development Plan until 2030].
- Estonia_strategy_BIO_BEC_CC_EN_FO_national, 2030., Eesti Keskkonnastrateegia aastani 2030 [Estonian Environmental Strategy].
- Estonia_Strategy_BIO_CC_EN_FO_national, 2011., Metsanduse Arengukava 2011-2020 [Forestry Development Plan 2011-2020].

Grisons (CH)

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- CH_policy_BEC_CC_EN_national, 2021., Ressourcenpolitik Holz 2030 (BAFU 2021) [Resource policy timber 2030].
- CH_policy_BIO_BEC_CC_FO_national, 1991., Bundesgesetz über den Wald (Waldgesetz WaG) [Federal Forest law (from 1991, status 2007)].
- CH_policy_CC_national, 2011., Bundesgesetz über die Reduktion der CO2-Emissionen [Federal law on the reduction of CO2 emissions (CO2 Act) from Dec. 2011, last status 2021].
- CH_policy_FO_regional, 2021., Kantonales Waldgesetz (KWaG) Graubünden [Cantonal Forest law of Grisons].
- CH_strategy_BIO_BEC_CC_EN_FO_national, 2021., Waldpolitik: Ziele und Massnahmen 2021-2024 (BAFU 2021) [Forest policy: Goal and measures 2021-2024].
- CH_strategy_BIO_FO_regional, 2018., Waldentwicklungsplan 2018 + Graubünden [Forest development plan 2018+ for Grisons].
- CH_strategy_BIO_national, 2017., Strategie Biodiversität Schweiz (Bundesamt für Umwelt, BAFU 2017) [Strategy Biodiversity Switzerland].
- CH_Strategy_FO_CC_national, 2020., Anpassung an den Klimawandel in der Schweiz - Aktionsplan 2020 - 2025 (BAFU 2020) [Adaptation to Climate Change in Switzerland - Action Plan 2020 - 2025].

- CH_strategy_FO_national, 2018., Strategie Freizeit und Erholung im Wald (BAFU, 2018) [Strategy for leisure and recreation in the forest].
- CH_strategy_FO_national, 2005., Nachhaltigkeit und Erfolgskontrolle im Schutzwald (NaIS) - Wegleitung für Pflegemaßnahmen in Wäldern mit Schutzfunktion (BUWAL, 2005) [Sustainability and success control in protection forests (NaIS) - Guidelines for maintenance measures in forests with a protective function].

Hesse/Thuringia (DE)

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- DE_policy_BIO_national, 2009., Gesetz über Naturschutz und Landschaftspflege (Bundesnaturschutzgesetz) [National Nature Conservation Act].
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- DE_strategy_BEC_FO_national, 2021., Mehr Fortschritt wagen. Bündnis für Freiheit, Gerechtigkeit und Nachhaltigkeit. Koalitionsvertrag 2021 - 2025 zwischen SPD, Bündnis 90/Die Grünen und FDP [Daring to make more progress - coalition treaty 2021 - 2025 between Social Democrats (SPD), Green Party (Bündnis 90/Die Grünen) and Free Democratic Party (FDP)].
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