More fodder for the oven?
Dealing with forest-related conflicts arising from the production and use of energy wood in Europe

Results from the COOL project

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Contents

Tables

Figures

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1 Introduction

1.1 Project background and objectives

Forest biomass[1] is an important source of renewable energy in Europe in terms of fulfilling the EU 2020 targets on climate and energy. As a substitute for fossil fuels, biomass is meant to decrease the emission of greenhouse gases and thereby mitigate global warming (Stupak et al., 2007). In addition to its characteristics as a renewable and storable energy source, biomass rates well regarding questions of security and the cost of energy sources, especially compared to fossil energy sources (European Commission, 2013a; Stupak et al., 2007). Therefore, the European targets and measures relating to energy and climate demand an increasing use of forest biomass (Directive 2009/28/EC, 2009). This political objective to increase the production and use of forest biomass is supported by a variety of policy instruments in different countries (European Commission, 2013a; Lindstad et al., 2015). Hence, the demand for energy wood in Europe has increased in the last decade and a further increase is expected in the future (AEBIOM Europe, 2013; European Commission, 2013a).

However, the political targets and incentives have only marginally taken into account the production side of the forest biomass sector, and the expectations of, and acceptance amongst, stakeholders. While views may differ on the intended extent of future energy wood utilization, increased use is expected to further intensify the competition 1) for wood among different wood-based industries, and 2) between wood production and other forest ecosystem services such as carbon sequestration and biodiversity. In addition, the amount of forest resources available for energy wood utilization as well as national political conditions and forest management practices differ across European countries (Kärkkäinen et al., submitted; Lindstad et al., 2015). Thus, the expected importance of forest-based energy wood calls for an investigation of similarities and differences in policies and management across European countries with regard to trade-offs and synergies between energy wood production and utilisation and other forest-related policy objectives.

In light of this, scientific studies were carried out in 2012-2014 by researchers within the European research project "COmpeting uses of fOrest Land" (COOL;

[1] In this report we use the terms "forest biomass", "forest-based bioenergy" and "energy wood" for biomass from forests that is or can be produced and used for energy purposes. Based on the preferences of the authors of different publications and thus also of different chapters of this report, the terms are not standardised.

http://www.cool-project.uni-freiburg.de), a project within the two ERA-Nets WoodWisdom-Net2 and Bioenergy.

The project COOL addressed the question of in how far the demand for energy wood can be met without compromising other policy objectives and fuelling existing stakeholder conflicts. The core objective of the COOL project was to analyse, compare and evaluate different forest management approaches and political strategies related to the issue of energy wood production in five European countries (Finland, Germany, Norway, Slovenia, and Spain). Emphasis was put on the participation of stakeholders and the inclusion of their perspectives through interviews, questionnaires and workshops.

1.2 Contributing institutions

The COOL-project brought together the following seven research institutions from the five European countries Finland, Germany, Norway, Slovenia and Spain. The seven partners were sponsored by the national WoodWisdom-NET-programmes of the participating countries.

- Chair of Forest and Environmental Policy (IFP), University Freiburg, Germany
- Forest Research Institute (FVA) Baden-Württemberg, Germany
- European Forest Institute - Central European Regional Office (EFICENT), Germany
- Finnish Forest Research Institute (METLA), Finland
- Department of Forestry and Renewable Forest Resources, Biotechnical faculty, University of Ljubljana (ULJ), Slovenia
- Forest Sciences Centre of Catalonia (CTFC), Spain
- Department of Ecology and Natural Resource Management, Norwegian University of Life Sciences (NMBU), Norway

The project consortium was coordinated by the Institute of Forest and Environmental Policy (IFP), University of Freiburg, Germany. All partner institutions contributed to the outcomes and publications of the overall COOL project, which are presented in this final report. Additionally, all partner institutions undertook individual tasks, which in some cases resulted in further publications in native languages, e.g. in magazines for practitioners. These are not included in the present report.

1.3 Report structure

The report provides an overview of the research activities of the overall COOL project. The research project was divided into three work packages. The goals and methodologies of the particular work packages are described in chapter 2.

Chapter 3 summarises European policies for forest-based bioenergy and is based on a Technical Report (Ferranti, 2014) that is one of the outputs of the COOL project. Chapter 4 is based on one of the scientific COOL publications (Lindstad et al., 2015) and focuses on policies relating to forest-based bioenergy in the five partner countries. Chapter 5 is based on a manuscript submitted for the COOL project (Kärkkäinen et al., submitted) that investigates current management practices for bioenergy in the five partner countries. Chapter 5 is based on a COOL publication about stakeholder perceptions on the issues (Peters et al., 2015).

A synthesis of the overall results of the COOL project is presented in chapter 6. Chapter 7 presents the results of a SMART-SWOT analysis. The report finally concludes by outlining major future challenges relating to forest biomass in chapter 8.

2 Work packages and methodology

The comparative analyses of energy wood production and use across the five selected countries was organised into three scientific work packages (WP, see *Figure 1*): WP1 on national policies and management approaches (lead NMBU); WP2 on stakeholder perceptions and conflicts (lead FVA); and WP3, where the country strategies were compared and evaluated (lead IFP). The research was coordinated in WP0 (lead IFP). In the following, the main research questions and the applied methodology of three scientific WPs are described.

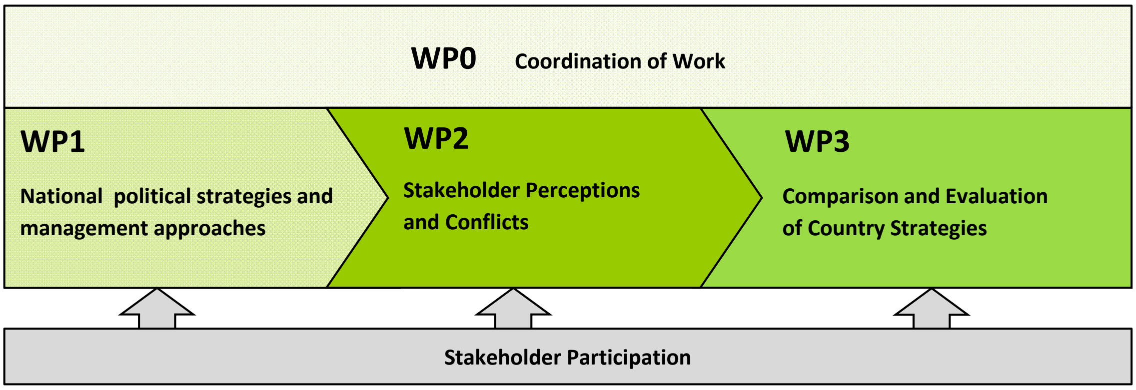

Figure 1: Overview of the work package topics

2.1 National political strategies and forest-related management approaches

WP1; lead: NMBU

Author: Berit H. Lindstad

The objective of WP1 was to compare and analyse different forest management and policy approaches related to the issue of bioenergy production in sustainably managed forests of five heterogeneous European countries (Finland, Germany, Norway, Slovenia and Spain), with a particular focus on the demands and constraints facing bioenergy production and related policy objectives at national and European levels.

The specific objectives were:

1. To carry out an analysis of the forest management and corresponding approaches in the respective partner countries
2. To analyse national policies and how these are linked to an increased focus on the use of bioenergy from woody biomass – both on the supply side (forests and land owners) and the demand side (households and industry sectors).

A template was developed to collect national information on forest management and policy elements relevant to wood energy production and use. The template ensured that consistent information was collected across COOL countries, and thus facilitated analysis and comparison of management and policy differences and similarities across the five countries.

The output of WP1 is two scientific publications, one focusing on management of forests for energy-wood production (Kärkkäinen et al., submitted) and one focusing on policies for forest-based bioenergy across the five countries (Lindstad et al., 2015).

2.2 Stakeholder perceptions and conflicts

WP2; lead: FVA

Authors: Kristina Wirth, Dörte Marie Peters

The objectives of WP2 were to analyse perceptions of different energy-wood related stakeholders in the participating countries with regard to energy wood production and use as well as interrelationships with forest ecosystem services. The research questions focused on stakeholders' perceptions of energy wood production, how they perceive legal frameworks, whether and which interrelationships they perceive between energy wood production and use with forest ecosystem services (e.g. regulating, supporting, habitat or supporting and cultural services), as well as how they expect these issues to develop in the future. Furthermore, differences and similarities between perceptions were analysed across and within countries in order to gain insights into possible current and future trade-offs and synergies relating to energy wood production.

Using a qualitative approach, the research focused on gaining an in-depth understanding of the meaning of actions, situations, concepts etc. used by the different stakeholders. Using a qualitative approach made it possible to address questions like *why* and *how*, instead of concentrating on *what*, *where*, *when* and *how many*. This is why qualitative methods produce information that is specific to the particular cases studied, meaning that more general conclusions can only be propositions (informed assertions). As the main aim of WP2 was to obtain as much structural variation as possible within the sample, an exploratory approach was used for data collection. Specifically, qualitative problem-focused and semi-structured interviews were conducted and analysed with a qualitative content analysis method based on Mayring (2010). Problem-focused interviews focus on a specific socially relevant phenomenon. They are conducted in the form of interviews that are more or less structured by a previously prepared guideline. The interview itself is then recorded to enable a thorough and reflexive analysis.

We focused on six groups of stakeholders: conservation, economic, practitioner, policy, science and social group (see also Table 1). Since qualitative interviews generally focus on small samples (not representative), interviewees need to be chosen carefully. We applied a mixture of selective sampling (choosing the suitable interviewees prior to the interviews) and theoretical sampling (choosing the interviewees in the process of the data assessment according to the results obtained). First, the respective country partners identified and contacted suitable stakeholders in order to secure their participation. Second, if necessary the set of samples (interviewees) was extended during data sampling. Qualitative data sampling aims to achieve information saturation, i.e. numbers of interviewees per group can differ among groups if additional interviews do not generate additional information. In addition, the number of interviewees per stakeholder group and country varied according to the available resources of the research partners and willingness of those persons contacted to participate in an interview.

In order to obtain comparable results in all participating countries in terms of structure and content, the elaboration of a standardised semi-structured guideline was a central part of WP2. The guideline was structured into a narrative-generating introduction, i.e. an exploration of the interviewee's relation to forests and energy wood was a central part of the interview. This involved the use of explorative questions, open questions and those focussed on key topics (e.g. forest management approaches, ecosystem services, policy framework). This was followed by 1-2 questions on aspects not addressed by the interviewee but relevant for the research (e.g. recreation) and a closing question to give the interviewee the possibility to offer any additional insights (i.e. if there was something left that the interviewee wanted to emphasize or address). This guideline was agreed on between all participating partners and applied in all interviews.

Interviews were conducted in native languages, either face to face, by telephone or by Skype between November 2012 and September 2013 and were recorded for later analyses (see Table 1). Each interview was fully transcribed in the respective language and anonymized.

Table 1: Number of interviews per stakeholder group and country (adapted from Peters et al., 2015). 1) Nature conservation associations; 2) Wood industries and associations, timber users, energy wood users; 3) Ministries (including forest administration); 4) Forest owners associations, forest enterprises, foresters; 5) Scientific institutions, researchers and experts; 6) Tourism enterprises/associations

	Finland	Germany	Norway	Slovenia	Spain	TOTAL
Conservation(1	1	3	5	4	2	15
Economic(2	3	13	2	4	2	24
Policy(3	1	4	0	4	1	10
Practitioners(4	5	12	2	7	3	29
Science(5	4	4	3	5	2	18
Social(6	2	1	2	2	0	7
Interview methods	Face-to-face 2 Phone 14	Face-to-face 35 Phone 2	Face-to-face 13 Skype 1	Face-to-face 26	Phone 10	
TOTAL	16	37	14	26	10	103

For the analysis of transcribed interviews, partners agreed upon a common method (i.e. qualitative content analysis based on Mayring (2010)) and applied the software MAXQDA (v.10, Verbi Software) which enables the use of common as well as individual categories as well as the exchange of data sets among partners. Each interview was coded and the text sections assigned to each code were further analysed for each stakeholder group in each country. This process resulted in 28 summaries (translated into English) which were used for further analyses focusing on specific issues (for more details see Kärkkäinen et al., submitted; Peters et al., 2015).

The outputs of WP2 include: one article published in a peer-reviewed journal on synergies and trade-offs perceived by stakeholders regarding forest biomass (Peters et al., 2015); one article focusing on forest management related to forest biomass (Kärkkäinen et al., submitted); and one article soon to be submitted on recreational aspects of forest biomass production and use. In addition, some country-specific articles were published in some of the participating countries in the relevant native language addressing national stakeholders.

2.3 Comparison and evaluation of country strategies

WP3; lead: IFP

Authors: Regina Rhodius, Špela Pezdevšek Malovrh, Mikko Kurttila

Based on the findings of the two previous work packages, in WP3 we compared and evaluated the identified political strategies and forest-related management approaches (in the following named "country strategies") of the studied countries to derive options for relevant policy and management approaches which aim at increasing the use of forest-based bioenergy. The mixed-methods analysis contained the following steps, which due to varying levels of financial resources differed slightly across the five countries:

1) Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis: Identification and selection of the most relevant SWOT factors for analysing the operational environments of each partner country (applied in all five countries)
2) Selection of future scenarios: Precondition for further weighting of the importance of the identified SWOT factors against different future scenarios
3) Multiple Criteria Decision Analysis (MCDA): Weighting of the SWOT factors, categories and groups with Simple Multi-Attribute Rating Technique (SMART) (applied in Finland, Germany, Norway, and Slovenia).

2.3.1 Identification and selection of the most relevant SWOT factors

In all five countries, the conducted stakeholder interviews served as a fundament for the identification of major strengths, weaknesses, opportunities and threats affecting the country strategies. First, in Finland, Germany, and Norway, we derived preliminary SWOT categories (Germany) and factors (Finland, Norway) from the results of the expert and stakeholder interviews (see WP2), and assigned them to pre-determined categories. We used the preliminary categories and factors as starting points for further discussion in stakeholder workshops, which took place between November 2013 and April 2014 (see Table 2).

Table 2: The number of stakeholders

Country	Number of participants in stakeholder workshop	Number of participants in SMART evaluation
Germany	13	9
Finland	11	10
Norway	10	8
Slovenia	0	9

In these workshops, invited stakeholders from different stakeholder groups elaborated the SWOT factors that influence the potential use of forest biomass for energy, using the following four categories: a) forest characteristics and management, b) policy framework, c) science and technology, and d) consumer and society. The first three of these categories were determined as described above by the COOL team; the last one was suggested by stakeholders in the German stakeholder workshop. We incorporated this fourth category in the subsequent workshops in Finland and Norway and in the further analyses in Slovenia. In all workshops, the discussion resulted in a broad list of SWOT factors, which stakeholders prioritised in further analyses. In Finland, stakeholders voted on a maximum of the four most important SWOT factors in each category; in Germany and Norway, the researchers selected these factors based on the workshop discussions.

In Slovenia and Spain, the researchers identified the SWOT factors based on an in-depth analysis of the stakeholder interviews by using the same four categories as for the other countries. In Slovenia, the participating researchers discussed the elaborated list supported by an external forest biomass expert in order to select a maximum of the four most relevant factors per category. Due to financial limitations, the Spanish team did not conduct a special SWOT survey meaning that the weighting of factor importance in different scenarios as described below did not take place. However, it was possible to include the SWOT factors derived from the Spanish interview results into the comparison across countries of the importance of SWOT factors in the different categories.

2.3.2 Selection of scenarios

The objective of WP3 was to weight the importance of the identified SWOT factors for three future scenarios in order to derive options for relevant policy and management approaches. As such, these relevant future scenarios are described below. In recent forest- or energy-related scenario studies, the utilisation of forest-based energy wood is treated as one aspect among a variety of forest utilisation priorities or as one energy resource among others (see UN, 2011). In contrast, in the three COOL scenarios we use the use of forest biomass for energy as the driving variable. In 1) the "BUSINESS AS USUAL" or reference scenario, the use of energy wood is expected to be continued in line with the set national goals or, if national goals do not exist, in the same way as it has been applied during the last decade. In 2) the "INCREASE scenario", the utilisation of forest-based energy wood increases more significantly than in the reference scenario, whereas in 3) the "DECREASE scenario", it decreases significantly.

1) The **"BUSINESS AS USUAL" scenario (BAU)** is a reference and it provides a picture of the future without major changes in current trends and policies and corresponds with the EFSOS II reference scenario (UN, 2011: 30ff). That scenario is based on the B2 storyline of the IPCC describing a world in 2030 that is shaped by a "continuously increasing global population, intermediate levels of economic development, and not so rapid and diverse technological change" (UN, 2011: 30). Although there are assumed differences across the various regions, the development of European forestry is in general characterised by a slightly increasing forest area, increased removals and an

increasing ratio of felling to net annual increment. Nevertheless, the removal would still be “well below the potential sustainable supply” (ibid: 31).

2) The **INCREASE scenario (INC)** is congruent with the second EFSOS II policy scenario called “promoting wood energy”. It assumes continuous high fossil fuel prices and a strong political will for meeting the renewable energy targets by using woody biomass. “Europe in this scenario is characterised by strong demand for wood, emerging scarcities, and concern about sustainability of wood supply, inside and outside Europe” (ibid: 50).” The scenario estimates “the highest possible sustainable supply of wood from Europe’s forests” and the “highest realistic potential supply of wood from outside the forest” (ibid: 50). Policy measures are instigated to mobilise woody biomass. Application of fertilizer is permitted to substitute the effects of removing harvest residues. For this scenario, efforts to provide the right framework and mobilisation strategies are seen as necessary. Negative effects on the nutrient balance as well as on carbon emissions are expected. (ibid: 51).

3) In the **DECREASE scenario (DEC),** possible future developments involve a decrease in the utilization of energy wood. These are summarised here in a new “decrease scenario”. Such a decrease could, on the one hand, be caused by factors leading to a situation in which the use of energy wood is no longer attractive: e.g. decreasing fossil energy prices, low prices of imported pellets and wood chips, as well as emerging new energy resources or high transaction costs for providing and using energy wood. On the other hand, there are societal or political factors, which could lead to a decrease in energy wood use: e.g. a societal attitude, which is against removing harvest residues from the forest or the issue of biodiversity gaining greater political currency.

2.3.3 Weighting of the SWOT factors, categories and groups

The three scenarios and the identified SWOT factors formed the fundament of a common SWOT questionnaire through which we acquired the preference information for the weighting of SWOT factors, categories and groups. By weighting these items in the three scenarios we aimed to reveal which factors in the operational environment are emphasised in different futures and thus, how well the country strategies are responding to these according to the opinions of the stakeholders.

As a whole, the weighting of factors followed the principles of the A’WOT method developed by Kurttila et al. (2000), see also Kajanus et al. (2012). The multi-criteria weighting method SMART was chosen for weighting the factors, categories and groups due to its simple and practical applicability (Edwards and Barron, 1994; Kangas et al., 2008). In the SMART method, stakeholders assess the importance of an item relative to other provided items by giving numerical values based on their subjective preferences or perceptions (Kangas et al., 2008). The weighting of SWOT factors, categories and groups was performed with a questionnaire that was formatted into an excel sheet.

In all four participating countries (FI, GE, NO, SI), the same structure and similar questionnaire format was used to ensure data comparability. Therefore, the SWOT categories and groups were the same, but the list of SWOT factors within the categories differed based on the results of the national SWOT factor analysis. In Finland, Germany and Norway, the questionnaire was sent to the participants of the stakeholder workshops. In Slovenia, where no workshop took place and therefore more background information had to be given to the stakeholders, the questionnaire was used in face-to-face interviews. The number of questionnaire respondents is reported in Table 2 above. Based on the completed and returned questionnaires, the relative local priorities for all SWOT factors, categories and groups were calculated by using SMART (see Kangas et al., 2008)

The results of WP3 are published in a paper focusing on differences in the perception of the BAU and INC scenarios (Pezdevšek Malovrh et al., submitted). Building on the SWOT and SMART results, we derived main challenges for future energy wood utilization and policy recommendations (see COOL brochure p.6-7, download on: www.cool-project.uni-freiburg.de).

3 European Policies for forest-based bioenergy

Author: Francesca Ferranti

The production and use of energy wood from forests are at the intersection between different interests. To give a few examples, forest energy wood is interesting from an economic perspective because it allows for a diversification of forestry production, for the creation of a market for low value wood, and for an increase in forest owners' income. From a social perspective, it enhances the development of rural areas and allows increasing employment rates. When considering the environment, substituting fossil energy with forest energy wood is considered to contribute to climate change mitigation. Though it is characterized by these positive features, energy wood from forests may also conflict with forest biodiversity conservation and nature protection goals because of the intensified forest management approaches needed for its production. Also, it may limit the presence of tourism and recreational activities in forested areas because of intensive disturbance to forest aesthetics. This description shows the complexity and intricacy of forest energy wood as a topic, which is mirrored in the features of the policy and legislative framework that affects the forest energy wood context.

At the European level, resource efficiency, renewable energy, forest, agricultural, biodiversity and climate policies influence the production and use of energy wood. In policy terms, wood is for example a natural resource and is consequently influenced by recent European policy developments relating to matters of resource efficiency (ECN, 2013). It is a forest product and, as such, is affected by discussions in the forest management arena and related economic, social and environmental concerns.; It is an energy source which substitutes fossil fuels and diversifies the energy mix (Directive 2009/28/EC, 2009) and, in this sense, it is influenced by debates in the energy and climate change policy fields. Finally, wood is a construction material and is thus addressed by construction-related policies. In other words, wood is a highly contested resource and forests (as well as the production and use of energy wood from forests) are affected by the policies of numerous sectors.

Next to the competing demands on wood, another factor contributing to the intricate policy framework underpinning the production and use of energy wood in Europe is the fact that the Treaty on the Functioning of the European Union does not make reference to specific provisions for a communitarian forest policy. This means that the European Union has no common and legally binding legislation specifically made for the forest context (Winkel et al., 2009; Pülzl et al., 2013). However, it does have a long tradition of influencing the decisions of the Member States on forest-related matters through non-legally binding policy efforts. In addition to these non-legally binding forest policies, the forest energy wood context is influenced by a whole set of legally binding policies addressing sectors other than “forestry” that nevertheless affect the forest sector (Ragonnaud, 2013). The picture resulting from the above description is of a fragmented European Union forest policy context and the partial subjugation of forest issues to other policy matters such as agriculture and rural development, energy and climate change, industry, biodiversity conservation, resource efficiency, urbanization and construction. Moreover, compared to other renewable energy sources, wood is utilized in the three energy sectors of electricity, heating and transportation, which means that it is impacted on by an even broader range of policies and legislation.

Table 3 includes a list and short description of European Union legislation and instruments affecting the context of forest energy wood, with an explanation of how these affect energy wood production and use.

More details can be found in Ferranti (2014), which is the output of the individual contribution of EFICENT to the COOL project. Ferranti (2014) wrote a Technical Report published by the European Forest Institute and titled “Energy wood: A challenge for European forests. Potentials, environmental implications, policy integration and related conflicts”. The report includes background information which introduces the renewable energy theme and it locates the use of woody biomass for bioenergy in the context of renewable energies. It further describes and discusses several studies on forest energy wood potentials, and analyses trade-offs and synergies associated with the production and use of forest energy wood. The report also illustrates the legislative and policy framework that affects the forest energy wood context, and it finally discusses the integration of forest energy wood and biodiversity conservation policy goals in the context of the European Union. The conclusions address the challenges presented by the production and use of forest energy wood.

Table 3: Overview of policies related to forest biomass (Sources: Ferranti, 2014; Pülzl et al., 2013).

Policy	General objective and how the policy affects energy wood
Forest Strategy and Forest Action Plan (FAP) http://ec.europa.eu/agriculture/forest/strategy/index_en.htm and http://ec.europa.eu/agriculture/fore/action_plan/index_en.htm	These non-legally binding instruments aim to foster forestry activity in the EU by elaborating a common approach to dealing with increasing societal demands towards forests (European Commission, 2006). They address an increased supply of energy wood as one of the challenges for EU forests. Albeit not providing compulsory requirements or funds for forestry and energy wood, they foster competitiveness of the sector, protection of the forest environment, enhancement of the quality of life in forest areas, coordination amongst MS strategies and exchange of good practices (European Commission, 2013b).
Common Agricultural Policy (CAP), including **Rural Development Policy (RDP)** http://ec.europa.eu/agriculture/cap-post-2013/ and http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:EN:PDF	The objective is to increase competitiveness of the European primary sector and promote rural development (European Commission, 2013c). The RDP is the "main instrument at Community level for the implementation of the EU Forestry Strategy" (European Commission, 2009: 16), since measures eligible for funds under the European Agricultural Fund for Rural Development (EAFRD) include forestry measures and forestry-related activities. The CAP, including the RDP, provides financial support for forestry and forest-related activities such as the production of wood for energy, e.g. establishment of short rotation coppice plantations, production of energy wood as a side-product of harvesting activities, and investments in equipment for wood chipping. These policies determine the availability, types and costs of forest woody biomass for the energy sector.
Directive 2002/91/EC on energy performance of buildings http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32002L0091	This Directive promotes the use of renewable energies in buildings by fostering the use of CHP and district heating which are often based on wood. It regulates efficiency of boilers and other installations, indirectly promoting efficient use of wood as a resource.
Directive 2003/30/EC on the promotion of the use of biofuels and other renewable fuels for transport http://ec.europa.eu/energy/renewables/biofuels/biofuels_en.htm	This Directive promotes an increased use of renewable energy sources for the transport sector, by requiring MSs to ensure that a minimum proportion of biofuels and other renewable fuels is placed on their markets, through the establishment of national indicative targets which contribute to the achievement of the overall EU 2010 biofuels target of a 5.75% share of renewable energy in the transport sector. The 2010 target has been revised by Directive 2009/28/EC and upgraded to a new target of 10% for the year 2020 (see below).
Directive 2003/87/EC	The EU-ETS is the cornerstone of EU climate policy. It applies a market system to cost-effectively reduce greenhouse gas emissions.

establishing a scheme for greenhouse gas emission allowance trading within the Community. Also known as EU-ETS http://europa.eu/legislation_summar-ies/energy/european_energy_policy/l28012_en.htm	It also applies a "cap and trade" system which imposes a limit to the total emissions of industries, and allows trading of the assigned "emission allowances" which can be used to emit or can be sold on the market. By putting a price on greenhouse gas emissions and treating wood as a carbon-neutral energy source, its aim is to strengthen the economic competitiveness of woody biomass and other renewable energy sources and ultimately provides an incentive for their use.
Directive 2003/96/EC on the taxation of energy products and electricity http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:283:0051:0070:EN:PDF	This Directive aims at reducing market distortions in the EU generated by divergent taxation systems in the MSs. It promotes the use of renewable energies by allowing lower taxation for renewable energy products and by offering tax incentives for efficient energy generation such as CHP.
Directive 2004/8/EC on the promotion of cogeneration of heat and electricity file:///C:/Users/frferran/Downloads/l_05220040221en00500060.pdf	This Directive aims at increasing the use of respective high efficiency technologies. Member States are required to support and monitor the cogeneration of heat and electricity and demonstrate progress. It promotes CHP and other energy efficient technologies which are often fuelled with wood (e.g. district heating systems).
Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Also known as EU-RED http://www.buildup.eu/publications/31450	This Directive promotes the use of energy from renewable sources. It requires the development of national Renewable Energy Action Plans and sets mandatory national targets for renewable energy to be reached by 2020 and thus stimulates increased use of wood as an energy source.
EU Biodiversity Strategy http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm	With this policy, the EU aims at halting the loss of biodiversity and ecosystem services in its territories by 2020, and to protect, value and appropriately restore ecosystem services and their natural capital by the year 2050 (European Commission, 2011). This is done through the legally binding implementation of the Natura 2000 ecological network of protected areas – Directive 92/43/EC – and of the Green Infrastructure, a network of natural and semi-natural areas which is present in rural and urban settings and which provides ecological, economic and social benefits through natural solutions (European Commission, 2013b). Some of the actions required to achieve these targets involve the implementation of more sustainable forestry which takes better account of environmental issues related to wood extraction. These issues could represent a limitation for an increased extraction of energy wood.
EU Resource Efficiency Roadmap	This non-legally binding instrument aims at developing a fully sustainable economic system in Europe by 2050 by increasing re-

http://ec.europa.eu/environment/re-source_efficiency/pdf/com2011_571.pdf	source productivity and decoupling economic growth from resource use and its environmental impact (European Commission, 2011). Housing and mobility are two of the sectors responsible for most environmental impacts and actions in these areas are proposed to integrate the measures already imposed by EU energy, climate and biodiversity policies. Resources like wood are analyzed from a life-cycle and value-chain perspective to increase efficiency of both production and utilization. Maximizing the amount of wood that can be produced sustainably and reducing energy losses in energy wood use are amongst the actions which might influence the energy wood context.
EC Communication on Innovative and Sustainable Forest-based Industries in the EU http://ec.europa.eu/enterprise/sectors/wood-paper-print-ing/documents/communication/index_en.htm	The goal of the Communication is to propose policy guidelines which ensure a coherent approach towards integrating climate change objectives into the industrial strategy of forest-based industries. The EC points at the need to reduce energy consumption by the addressed industries and increase energy use efficiency, but also at the opportunities offered to forest-based industries by the production of energy wood from forests.
EU Action Plan for Forest Law Enforcement, Governance and Trade (FLEGT) and EU-Timber Regulation http://ec.europa.eu/environment/forests/flegt.htm and http://ec.europa.eu/environment/forests/timber_regulation.htm	These set a licensing scheme for imports of timber in the EU which sets out legally binding measures for EU and MSs aimed at tackling illegal logging in the world's forests by ensuring that no illegal timber or timber products are sold in the EU (Council Regulation EC No 2173/2005; Regulation EU No 995/2010). They potentially reduce the amount of energy wood importable in the EU to those assortments which are assured to come from legal and sustainable sources.

4 Policies on forest-based bioenergy in five European countries

Author: Berit H. Lindstad

Political objectives at both EU and national levels aim at increasing the share of renewable energies. Forest has been and is an important source of bioenergy, which is predicted to continue playing an important role in the future. There is a gap in knowledge regarding what policies are implemented at national levels to increase the production and use of forest-based bioenergy. We investigated these policies across five diverse European countries, classifying the policies as primarily targeting either the supply side (i.e. production) or the demand side (i.e. consumer-directed policies/policy instruments).

The status of use and the potential for renewable energies, including bioenergy, differ considerably across the five countries under study. Moreover, the national targets set by the EU Renewable Energy Directive 2009/28/EC vary. For a brief presentation of variation in situation for renewable energies and forest-based bioenergy, see Table 4.

We investigated the link between current national policies on forest-based bioenergy and other, broader national forest policies as well as the link to the EU 2020 targets on renewable energies. As this is an area undergoing substantial changes in policies and with emerging demands – and thus also changing prices - there are dynamic, complex relationships and driving forces. Our results should therefore be seen as a snap-shot of the situation, and we are aware that broader developments, e.g. in markets, may influence future developments. The issue areas are also characterised by many different opinions on possibilities and challenges, possibly contributing to rapid changes in policies and/or markets.

All five investigated countries have policy documents stating that there is potential to increase the production of forest-based bioenergy, but these documents are generally vague when it comes to suggesting how these resources may be made available. These documents represent the forest sector policy arena whereas from the environmental policy arena there are more concerns raised about i.a. the increasing pressure on forest resources and potential conflicts with protection of biodiversity.

The current production of forest-based bioenergy is highest in Finland and Germany. The share of biomass in total energy consumption is much higher in Finland, where industrial use is more developed than in the other countries where household consumption constitutes the dominant use of bioenergy.

Table 4: Key figures on national importance of renewable energy and forest-based bioenergy (adapted from Lindstad et al., 2015)

	Finland	Germany	Norway	Slovenia	Spain
Renewable energy target 2020/share in 2005,% (Directive 2009/28/EC, 2009; European Economic Area, 2011)	38/28.5	18/5.8	67.5/60.1	25/16.2	20/8.7
Share of woody biomass in renewable energies 2011, % (UNECE/FAO, 2013)	79.5	37.7	6.9	43.8	-
Share of woody biomass in total energy supply 2011, % (UNECE/FAO, 2013)	21.9	4.3	4.2	7.8	-
Roundwood production (traditional fuelwood/industrial roundwood), 2012, in mill cubic metre (Eurostat, 2013)	5.4/ 44.6	9.5/ 42.9	1.8/ 8.9	1.1/ 2.2	3.9/ 13.0

For details on the national policies and policy instruments targeting bioenergy production and consumption in the five European countries, we refer to “Forest-based bioenergy policies in five European countries: an explorative study of interactions with national and EU policies” (Lindstad et al., 2015). Lindstad et al. (2015) employed an analytical framework clarifying horizontal and vertical interlinkages across three policy layers (see Figure 2) in order to compare bioenergy policies across the five countries. In the following, we summarise the main results for (i) national policies on bioenergy, (ii) the relationship to broader forest policy objectives, and (iii) the link between the national policies and EU policies.

4.1 National policies

Policies on production and use of forest-based bioenergy vary in form and intensity across the five countries. Finland has a long history of policies targeting bioenergy production and use, and is the only country among those investigated that has specific recommendations for energy wood harvesting. The other countries have fewer policies targeting forest-based bioenergy, and the policies are partly less direct when addressing bioenergy. Germany stands out with no economic support for production of bioenergy from forests, while the importance (or “strength”) of the supply side policies is also questionable in other countries.

Generally, the national bioenergy policies make references to national objectives of reduced energy imports, reduced dependency on fossil fuels, the potential to enhance rural development/employment, etc. Additionally, the countries make references to European Union renewable energy policies, especially the EU Renewable Energy Directive 2009/28/EC, as well as international and EU obligations related to climate and greenhouse gas mitigation, in their policies for production and use of bioenergy, and other renewable energy policies.

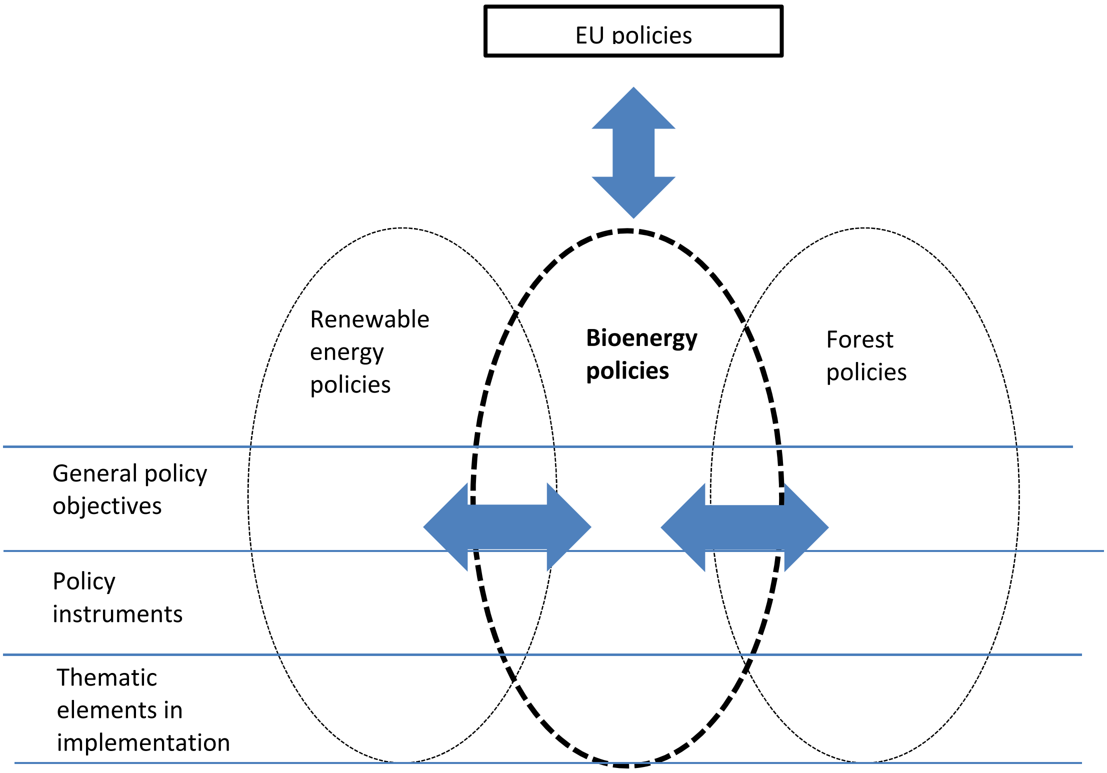

Figure 2: Analytical framework: Horizontal and vertical interlinkages across three policy layers.
Source: Lindstad et al., 2015; based on Oberthür and Gehring, 2006; Nilsson et al., 2012

4.2 Relationship with broader national forest objectives

Concerning the relationship between policies on bioenergy and broader national forest objectives, many of the concerns raised are shared across all five countries. First, the forests are seen as a main source of renewable energy in all the countries, with a potential for further increasing production. Policy documents stress that any forest activity, including the production of energy wood, should follow established requirements for sustainable forest management, national legislation, etc.

Policy documents across the five countries refer to increased use of bioenergy as a potential way to improve the economic situation in the forest sector, while some also highlight that there is a potential for increased competition with forest industry for low quality wood. The potential for more employment and rural development is highlighted as a positive side effect of increased use of forest-based bioenergy. On the other hand, potential conflicts between bioenergy production and environmental concerns are mentioned in national policy documents. The increased pressure on forest resources, challenges related to soil and nutrient supply and in particular the potential trade-offs with conservation of biodiversity are reported repeatedly.

Given the great variability in energetic utilisation of forest resources, the concerns and described synergies and conflicts are remarkably similar across the countries. This may be because many of the documents are describing the potential for increased use of biomass for bioenergy, rather than evaluating the concrete effects on the forest situation in the different countries.

Regarding differences across countries, the potential synergy between bioenergy production in forests and improved wild fire prevention is stressed in Spain. This is an example of different national situations resulting in specific elements, such as fire-fighting, being relevant in one country but not in others.

In general, it may be stated that forest policy documents make references to the forests' potential contributions to climate mitigation and as a source of renewable energy, whereas the renewable energy policies are less explicit about which sources are available/preferable. This may also be a result of the broader scope of the renewable energy policies – which focus more on the demand side, and less on where resources are actually used.

4.3 Links between the national policies and EU policies

Concerning links between the national bioenergy policies and EU policies, all five countries have developed National Renewable Energy Action Plans (NREAPs), as required by the EU Renewable Energy Directive 2009/28/EC. While the targets for renewable energy are binding on national levels, the focus in the NREAPs on forest-based bioenergy varies considerably across the countries. Finland points to forest-based bioenergy as a main source of renewable energy, whereas the NREAPs of Norway and Slovenia anticipate lower contributions from forest resources than what is foreseen in other national policy documents. Here it should be noted that the lack of a common forest policy in a way makes the EU climate and energy policies options for the forest sector to present their potential contribution to broader EU policy objectives.

National forest-based policies also show a high variation in how linkages to other EU policies and directives are presented. This may result from different political cultures in referencing EU policies or providing rationales for policies, as well as different understandings of what the real influence of EU policies versus national policies is. There is obviously the possibility that some countries see their policy development as influencing EU policies, rather than the other way around, in which case they are more likely to stress their national policies. And along the same line, other policies, including international climate change and greenhouse gas policies also influence policy developments at both EU and national levels.

In general, the national and EU policies on renewable energies have been developed in parallel, intensifying around 2007-2009, when political agreement was reached on the EU renewable energy directive. The full effect of these policies may not yet be detectable. Still, it can be concluded that EU policies such as the EU Renewable Energy Directive have a considerable influence on national energy wood policies in all five countries, whereas linkages with other sectors vary across countries: National policies tend to enact elements from different EU policies and tailor them to various domestic circumstances thereby resulting in particular national policy solutions (e.g. synergies between the fire prevention and energy wood policies in Spain). Across the countries, national energy wood strategies underline potential synergies between energy wood production and use and employment and economic prosperity in the forest sector. National strategies also envisage potential trade-offs with biodiversity conservation. All five countries support renewable energy sources with policies that indirectly target energy wood demand. Except for Germany, all countries additionally apply supply-side measures to create incentives for production of energy wood. It is worth noting that Germany has a substantial supply of energy wood despite the absence of supply-side measures. This underlines the fact that there is no one-size-fits-all policy solution to promote the production and use of energy wood.

5 Current Practices for Managing Forests for Bioenergy

Author: Elena Górriz

The EU targets on energy and climate foresee an increase in the utilisation of wood for energy purposes. Finland leads the forest harvest for bioenergy production, accounting for over 22% of the total energetic consumption, far above the other countries. According to NREAPs, Germany and Spain have the most ambitious targets for biomass energy development. These demand-oriented targets do not necessarily take into account the feasibility of its provision, that is the production side (forest sector characteristics, stakeholders expectations), which is crucial as EU RED targets involve a likely increase in forest harvest.

We therefore analysed the preconditions for forest bioenergy production in the five COOL countries (see Kärkkäinen et al., submitted). Specifically, we aimed at identifying (i) current practices for bioenergy production from forests, and (ii) national stakeholders' perceptions regarding forest management options to increase the production of bioenergy from forests. With this objective, over one hundred in-depth interviews were conducted between 2012 and 2013 with key stakeholders in the five countries, including experts from forestry, energy, environmental and civil organisations, scientists and policy-makers. Findings were supplemented with literature review.

5.1 Current energy wood practices

The results reveal that in all studied countries the production of energy wood is currently a by-product of round wood production. Only in Spain does biomass for energy also constitute a main objective. The fact that many interviewees across the studied countries express the view that this current situation will not change in the near future conveys discrepancies between renewable energy demand and its policies on the one side and the production and supply policies on the other side.

The use of whole trees for bioenergy takes place in all studied countries. It is actually the most typical practice in Finland when thinning in rich soils, in Slovenia for thinning in general and in Spain for pre-commercial thinning. In Norway, whole tree extraction is the only practice, mainly occurring in final fellings of broadleaved and low-quality softwood forests. In Germany, it is used for thinning, and PEFC certification standards restrict its use to zones with rich soils.

Use of logging residues is the other most common practice, which is the standard assortment for Germany and Slovenia from final fellings, and also from thinning operations in Germany. Logging residues are also used in Finland in rich soils, in accordance with energy wood recommendations to avoid the depletion of soil nutrients. In Spain, final fellings and thinning are also sources of biomass. The stem is used for bioenergy only in Finland when deploying thinning works. In Slovenia, stem from final felling is used for bioenergy given the low demand for logs from the traditional forest industry. Harvesting stumps is a practice found only in Finland, where the recommendation is to implement this only in rich soils, whereas stump lifting is explicitly forbidden in Slovenia and whole tree utilization is forbidden in Germany. Finally, the complete tree, which also includes extraction of the stump, is prohibited in Germany by PEFC standards. In Spain and Germany, complete tree harvest mostly takes place in short rotation plantations.

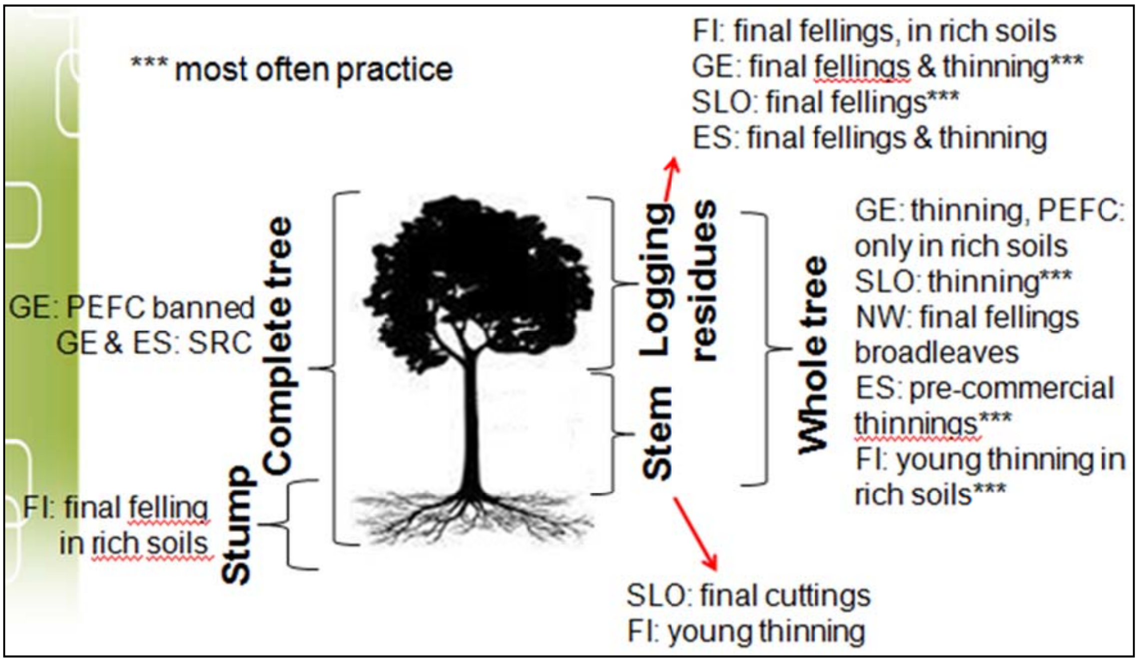

Figure 3: Perceptions regarding potentials to increase bioenergy production from forests

Interviewees identified three options for increase, namely: 1) Changing the energy wood harvesting area; 2) Changing forest management practices; and 3) Changing the wood assortments production. Changing management practices was found to be the least feasible or accepted option, whereas the first and third options are perceived most positively. The decline of pulpwood in Finland and Germany, and the likely continuation of the small size of the forest sectors in Norway, Slovenia and Spain were foreseen by interviewees as being likely to affect forest biomass provision. These dynamics facilitate the use of small-sized trees for the traditional industrial purpose rather than for energy, likely establishing a competition which raises concerns among some stakeholders.

5.2 Changes in energy wood harvesting area

This option received a greater level of support from the interviewed stakeholders. It involves four different means of expanding harvesting for bioenergy: increasing the thinning area, implementing harvest in low profitability forests, afforesting agricultural lands, and short rotation plantations with woody species.

There was consensus amongst interviewees in Finland, Slovenia and Spain regarding increasing the forest surface thinned for biomass supply in young and middle-aged forests. In contrast, there were diverse positions in this respect amongst German stakeholder groups. The use of low profitability forests was perceived positively in Spain and was also supported in Slovenia. However, there was disagreement among German stakeholders and Norwegians were clearly opposed. Similarly, Norwegians were opposed to afforesting agricultural fields; there were divergent positions across stakeholder groups in Spain and Germany regarding this option.

A debate exists among stakeholders in Germany and Spain regarding short rotation crops, based on the potential effects of intensification and high water consumption, respectively. However, this option presents a promising alternative because of expected growth rates and ease of access, i.a. and was viewed very positively by Slovenian interviewees.

5.3 Changes in forest management practices

Interviewed stakeholders expressed more doubts about, than positive attitudes towards, modifying current forestry practices, which would include the incorporation of fast-growth species, increasing forest density, and reducing rotation periods. Shifting forest composition towards fast-growing tree species was seen negatively in Norway, had both supporters and detractors in Germany, and was viewed neutrally in Finland. Only Slovenians expressed support for this alternative. Leaving denser forests for bioenergy was viewed neutrally in Germany, but had detractors in Finland and Norway. Finally, reducing the rotation period met with neutral to negative views in Finland and Germany.

5.4 Changes in wood assortments production

There are five options for the future provision of biomass material for energy, namely: using industrial wood, that is wood previously managed for paper or timber purposes; using logging residues; using low quality trees and deadwood; whole trees; and expanding stump harvesting. These options are generally viewed positively, however, there are still varying views..

Increased use of industrial wood for energy purposes is viewed positively in Finland and Slovenia, in relation to industry dynamics. This option is mostly seen positively in Spain, however, there are some fears of competition with the declining particleboard industry, and some preference towards cascade utilisation. Discrepancies existed among respondent groups in Germany. Increased logging of residues was viewed very positively by all Spanish interviewees on the basis that it reduced fire risk. However, a reduction of logging residues in the forest was questioned in Germany, and viewed negatively by some stakeholders in Slovenia. Slovenian interviewees and most Spanish interviewees consider the use of low quality trees positively. In Spain, the use of deadwood was questioned by conservationists as was also the case in Germany where there was a greater level of opposition. Extending the practice of stump harvesting was viewed mostly negatively in Spain and Norway. There were varying views regarding whole tree harvesting across groups in Germany and Spain.

Although a general shift from material to energetic use of wood is taking place across the countries, energy wood has been mainly produced as a by-product of round wood in all countries studied with the exception of Spain. Logging residues (and also stumps in Finland) are harvested for bioenergy in all countries. With the exception of Norway, thinning as whole trees is also a shared practice across the studied countries. To date, short rotation plantations of forest species do not represent an important source of biomass. Concerning a future increase in harvesting pressure for bioenergy purposes, Norwegian stakeholders are predominantly sceptical, whereas stakeholders in Germany and Spain identified the most varied portfolio of options, likely due to the larger energy consumption in these countries.

Potential changes in management options include increasing the energy wood harvesting area and energy wood assortments. Short rotation crops are seen as a potential relevant source of biomass in Germany and Spain only. On the basis of environmental concerns, stakeholders do not foresee an expansion of stump harvesting. The most accepted options involve the simultaneous promotion of timber production, that is, finding synergies with the material use of wood. This reveals a discrepancy between current energy policies and demand patterns on the one side, and biomass production and energy supply on the other side. In parallel, changes in forest industry (i.e. relating to paper mills in Finland and particleboard in Spain) and declining forest industries (i.e. in Norway, Spain and Slovenia) foster a progressive substitution of timber from forest harvest with biomass for energy.

6 Stakeholder perceptions of trade-offs and synergies

Authors: Dörte Marie Peters, Kristina Wirth

The stakeholders discussed several issues, which we assigned to ***provisioning***, ***regulating***, ***habitat and supporting*** and to ***cultural ecosystem services*** (ES), based on classifications by de Groot et al. (2002), Layke et al. (2012) and TEEB (2014). Our results are summarized in Table 5 and explained in more detail below. The summary is based on the open access publication of Peters et al. (2015).

Table 5: Perceived trade-offs and synergies between energy wood production and use and other ES (Peters et al., 2015): n.a. = not mentioned; 0 = not viewed as synergetic or trade-off; + = mentioned as synergetic; - = mentioned as trade-off; -/+ = mentioned as trade-off and synergy; (mentioned: by at least one interviewee)

	Finland	**Germany**	**Norway**	**Slovenia**	**Spain**
TRADE-OFFS AND SYNERGIES REGARDING PROVISIONING ES					
Roundwood production, forest management practices	+/-	+/-	+/-	+/-	+/0
Competition between material and energetic use	+/-	+/-	+/0	-	+/-
Cascade utilization[2]	0	+/-	n.a.	+	+
Marketability of wood, employment, rural development	+	+	+	+	+
TRADE-OFFS AND SYNERGIES REGARDING REGULATING ES					
Greenhouse gas emissions / Climate change mitigation / CO_2-fixation	+/-	+/-	+/-	+/-	+/-
Hydrology (water quantity and quality) & soil	+/-	+/-	-	-	+/-
Fire prevention	n.a.	n.a.	n.a.	n.a.	+

[2] Haberl & Geissler (2000) describe cascade utilization as "a strategy of integrated optimization of material and energy uses of biomass" and note that "the rationale behind this strategy is that if biomass is used that had been previously used for some other purpose, then this biomass use will not contribute to an increase of NPP [net primary production] appropriation."

Air quality	-	-	-	-	-
TRADE-OFFS AND SYNERGIES REGARDING HABITAT OR SUPPORTING ES					
Biodiversity and nature conservation	-	+/-	-	-	+/-
TRADE-OFFS AND SYNERGIES REGARDING CULTURAL ES					
Recreation	+/-	+/-	+/-	+/-	+/-

6.1 Trade-offs and synergies regarding provisioning ES

Several trade-offs and synergies regarding ***provisioning ES*** were addressed by stakeholders in all countries. They relate to: trade-offs and synergies between the production and use of energy wood and roundwood production and forest management practices such as forest structure and health; the competition between energetic and material wood production and use; cascade utilization; the marketability of currently unprofitable wood assortments; and job opportunities.

Trade-offs mentioned in relation to roundwood production and forest management practices include: a potential shortening of rotation periods (Finland, Germany); damage caused by energy wood harvesting (Finland); changes in forest structure due to an increasing intensity of forest management (Germany, Norway); whole-tree utilization (Germany); stump lifting (Norway); and management changes directed at energy wood production as an inferior alternative to high quality wood production (Finland, Germany, Norway, Slovenia). Synergies between energy wood production and roundwood production pertain to: the utilization of logging residues from final fellings as by-product (Finland); the higher merchantability of management actions that increase forest tending and result in better forest hygiene and health (Germany); the harvesting from young stands which improves the growth of remaining trees (Finland); and the economic opportunities that generally enable forest management (Spain).

Regarding the competition between energetic and material wood production, stakeholders referred to the competition for small trees (Finland), to a potential “biomass bubble” (Spain), or even to a “fight” challenging the means of existence of the wood material industry (Germany). The competition between energy wood production and pulp and paper production was perceived as an economic opportunity by some stakeholders in a situation with declining pulp and paper production (Finland, Norway, Spain), but also perceived as an inferior alternative by others given that energy wood fetches a lower price than pulp and paper (Norway). Stakeholders perceive cascade utilization positively if wood is preferably used materially and burned at the end of the value chain (Germany, Slovenia, Spain), especially as cascade utilization allows for a higher added value of wood (Spain).

A synergy between energy wood production and use and the marketability of currently unprofitable wood assortments was addressed by various stakeholders (Finland, Germany, Norway, Spain). They consider positively the fact that products that otherwise would not be mobilized gain entrance into the market and offer a new source of income for forest owners. This synergy is closely linked to increasing job opportunities, which stakeholders from all countries already see or expect to occur in the future. Especially in Spain, the potential job creation due to an increased production and use of energy wood plays an important role. In Finland, stakeholders noted that the professional workforce is lacking and that no year-round duties are available for employees, which is a negative aspect of this otherwise synergetic issue. Some stakeholders preferred the promotion of wood processing industries rather than energy wood industries, as these have higher added value and employment (Germany, Slovenia). Particularly in Slovenia, traditional wood industries are perceived to be important regarding job opportunities, and the promotion of these is also expected to improve the supply of the by-product energy wood.

6.2 Trade-offs and synergies regarding regulating ES

Looking at trade-offs and synergies between energy wood production and use and ***regulating ES***, stakeholders highlighted: greenhouse gas emissions, climate change mitigation and CO_2-fixation; soil balance and nutrient loss; hydrological issues; fire prevention; and air quality.

Concerning greenhouse gas emissions, climate change mitigation and CO_2-fixation, trade-offs as well as synergies were addressed by stakeholders (Finland, Germany, Norway). Questions regarding net emissions of wood burning, CO_2-fixation in trees vs. material, emissions from transportation etc. were discussed from a great variety of angles, reflecting the complexity of these issues. Negative aspects were discussed mainly by Slovenian stakeholders who in this context hinted at the inefficient use of energy wood in private households. In Spain, stakeholders consider energy wood to have a neutral CO_2 balance; however they prefer short transport chains to ensure this.

Trade-offs mentioned concerning soil balance (Finland, Germany, Norway, Spain) relate to an intensified extraction of wood in the form of residues, crowns, stumps, whole trees, and to a resulting nutrient loss (Germany, Norway). In Finland, energy wood is not harvested from nutrient poor sites; stakeholders thus noted negative effects of energy wood production on soil balance but considered these to remain small. Synergetic effects of energy wood harvesting mentioned by single stakeholders pertained to soil erosion control and wood ash recycling (Germany).

Both trade-offs and synergies between energy wood production and hydrological issues were addressed by stakeholders, however, the statements were very general (Finland, Slovenia, Spain). An issue which only plays an important role in Spain is the synergy between energy wood production and fire prevention. An issue that was communicated by stakeholders from all countries is the trade-off between energy wood use and air quality due to small particle emissions from wood burning, especially in private households.

6.3 Trade-offs and synergies regarding habitat and supporting ES

Trade-offs and synergies regarding ***habitat and supporting ES*** were communicated by stakeholders in all countries; however these were restricted to biodiversity and conservation issues, which are often closely linked to political regulations.

Some stakeholders regard current forest legislation, certification and concepts (such as sustainable forest management) as successful preventers of trade-offs between energy wood production and biodiversity (Germany, Slovenia, Spain). Therefore, as long as existing frame conditions are maintained, stakeholders do not perceive an additional need for regulations or land abandonment (Germany, Slovenia). The potentially increasing importance of energy wood due to the enhancement of forest reserves was identified as a possible trade-off with biodiversity in supplying countries (Germany); furthermore, political regulations fostering forest conservation were mentioned in a negative light as these could lower energy wood production potentials (Finland, Germany, Slovenia).

Other stakeholders noted the necessity of additional regulation to protect biodiversity (Finland, Germany, Spain). As an example, they perceive that an increasing production of energy wood leads to an intensification of forest management and thus to trade-offs with biodiversity. Moreover, they demand limitations on energy wood production including protection of old trees, harvesting prohibitions in breeding season, etc. (Germany). Negative effects of energy wood harvesting on biodiversity in general were also mentioned by stakeholders from Finland and Norway, and some stakeholders also identified the need to research the relevance of different wood assortments (e.g. stumps) for biodiversity (Finland, Norway, Spain).

With regards to habitat and supporting ES, stakeholders from all countries also discussed the importance of harvesting residues, dead wood and old-growth trees for biodiversity. Stakeholders pointed at the importance of protecting dead wood and old-growth trees in order to preserve habitat structures and noted that this could become problematic with an increasing production of energy wood (Germany). Furthermore, stakeholders hinted at the importance of leaving nutrient rich residues (Germany, Slovenia), stumps (Norway) or deadwood and understory (Spain) in the forests in order to protect the habitats of certain species. Other stakeholders questioned the importance of residues for habitat structures (Germany), relied on concepts for old and deadwood (Germany), or argued that there is no trade-off between energy wood harvesting and biodiversity given that the large trees which are relevant for biodiversity do not exist in commercial forests (Finland).

Synergies between energy wood production were also mentioned by interviewees (Germany, Spain). For example, stakeholders stated that residues from nature conservation measures can be used energetically, energy wood can be removed from naturally poor habitats such as juniper heathland, or historical forest management such as coppice or coppice with standards can be promoted (Germany). In Mediterranean forests, some stakeholders perceive forest utilization in general and with this also energy wood production and use as effective tools for biodiversity conservation given that these hinder wildfires by avoiding the abandonment of huge, unused areas.

6.4 Trade-offs and synergies regarding cultural ES

With respect to trade-offs and synergies regarding ***cultural ES***, recreation was addressed by stakeholders from all countries investigated.

Generally, many stakeholders perceive that lay persons do not notice differences in stand structure and views between traditional forest management and energy wood harvesting. As such, they do not consider that there is a trade-off between energy wood production and recreation. They rather highlight the importance of free access to forests, aesthetic values of forests and of the possibility of firewood collection as recreational activity.

In this context, stakeholders identify synergies between energy wood production and use and recreation with regards to access to forests for berry and mushroom picking (Finland), improved access to and inside forests (Norway, Spain), and aesthetic values concerning the outer appearance of landscapes (Finland, Spain) or tidiness of forests (Germany). The collection of firewood is furthermore regarded as a recreational synergy with energy wood production and use by some stakeholders, as it makes local people visit and enjoy forests (Finland, Germany).

Trade-offs perceived by stakeholders relate to the same thematic fields which are access to forests and aesthetic values. As examples, skidding tracks and damage to remaining trees and ground layer (Finland), the use of harvesting machines on former paths (Germany), potential stump utilization (Norway), or general effects of harvesting activities (Spain) caused by energy wood production are perceived to negatively affect the recreational values of forest.

7 Strengths, weaknesses, opportunities and threats of the country strategies

Authors: Regina Rhodius, Špela Pezdevšek Malovrh, Mikko Kurttila

In the following sections, the first two subchapters contain data from Finland, Germany, Norway, and Slovenia, where we applied SMART analysis. In the third subchapter, we describe the most important SWOT factors of the four categories. Here, the SWOT factors identified for Spain have been included.

7.1 Weights of SWOT groups in different scenarios

Figure 3 illustrates the average weights given by stakeholders of the four countries to four SWOT groups in the three scenarios. In Finland, the differences in weights of SWOT groups between the BAU and INC scenarios were rather minor. However, in the DEC scenario, weaknesses were weighted more heavily and opportunities and strengths, in turn, lost their importance. The opposite result was found in both Germany and Norway, where the weight of the opportunities and strengths decreases from INC to BAU and is greatest in the DEC scenario. In these two countries, the stakeholders expect negative developments in the operational environment if the INC scenario were to take place. In Slovenia, the differences in SWOT group weights were also not very dramatic, although the weight of the strengths increased for the BAU and INC scenarios.

The different weights that were assigned by stakeholders of the four countries to the four SWOT groups in the different scenarios may have resulted from different causes. On the one hand, they may indicate that the operational environment of a country is indeed either ill or well prepared for the requirements of the respective scenario. On the other hand, the results may reveal different attitudes amongst stakeholders towards a future scenario based on differing stakeholder values and perceptions independently from the given operational preconditions.

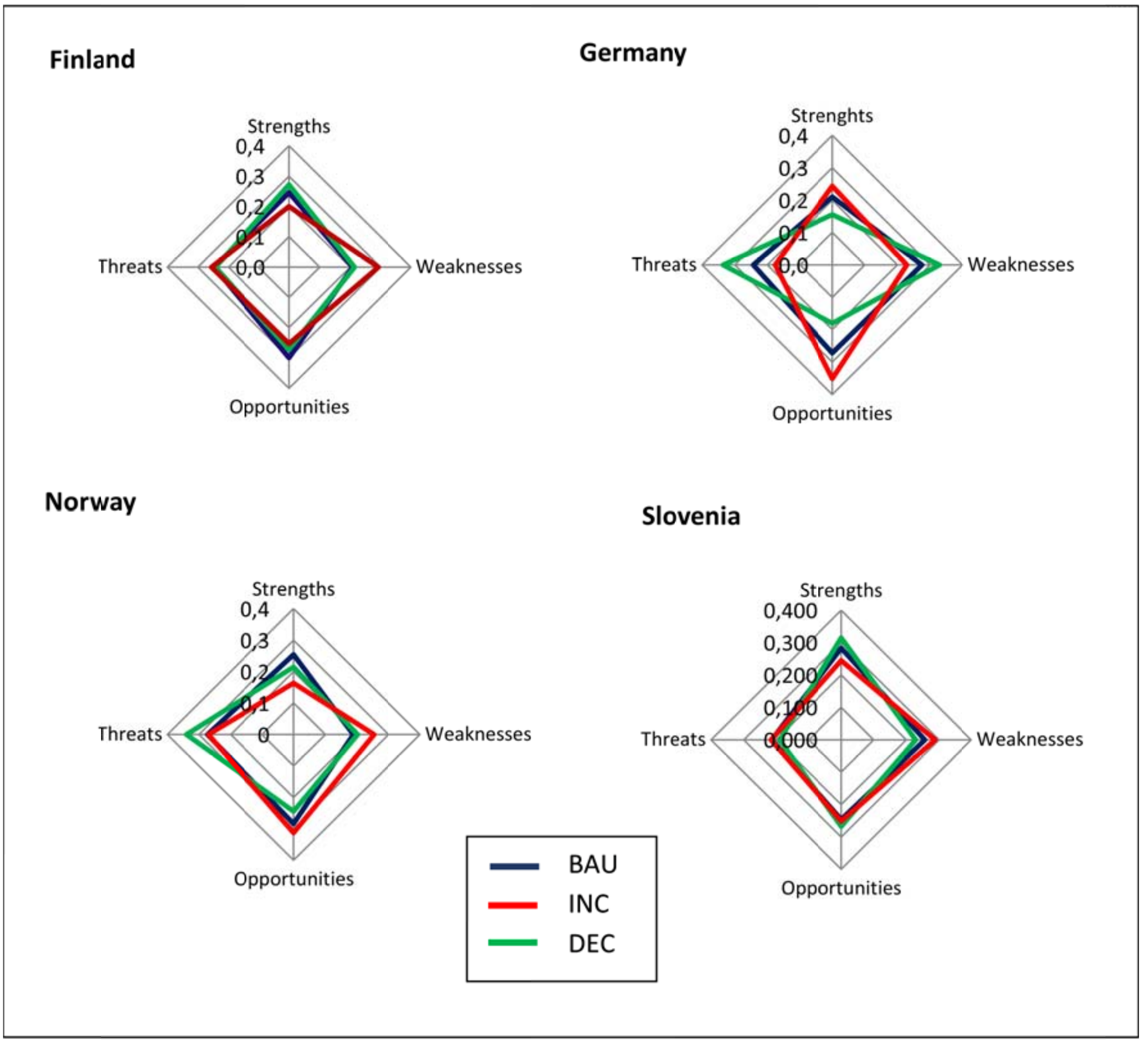

Figure 4: Average weights of the four SWOT groups in the three scenarios in Finland, Germany, Norway, and Slovenia

7.2 Weights of categories in different scenarios

Figures 4-7 present the average weights of the four categories in the scenarios in Finland, Germany, Norway, and Slovenia. In the following, we highlight the most important similarities and differences regarding the importance of the SWOT categories in the four countries.

7.2.1 Forest characteristics and management

In Slovenia and Germany, stakeholders consider this category as the most relevant in terms of strengths (average weight) in contrast to all other categories. Finish stakeholders in the BAU and INC scenarios assigned higher weights to strengths and opportunities than to weaknesses and threats, whereas German stakeholders clearly assigned the highest weight in strengths and opportunities to DEC. In Norway, there was almost no difference between the average weight of the category across SWOT groups and scenarios.

7.2.2 Policy framework

Concerning policy framework, stakeholders across all countries assigned the highest average weight to weaknesses. However, while the high figure in Finland and Norway relates back to DEC, in Germany, weakness is significantly higher in INC and in Slovenia in BAU. As argued in 7.1, this weighting may, on the one hand, indicate that stakeholders see the need to improve political conditions in order to prepare for the respective scenario. On the other hand – as the workshop discussion in Germany revealed – it may relate to a negative attitude of stakeholders towards the scenario in which they assigned the highest weight for weaknesses.

7.2.3 Science and technology

Across all countries and considering the average weight of all scenarios, stakeholders mostly evaluated this category as being less important than the others. In Slovenia, stakeholders assigned the highest figures to strengths and opportunities, in Finland to opportunities, in Germany to strengths, and in Norway to both weaknesses and opportunities. Therefore, from the perspective of stakeholders, this category seemed to be connected with positive aspects.

7.2.4 Consumer and society

This category again reflects the different weights assigned by Scandinavian and German stakeholders to the three scenarios (see a)). In Finland and Norway, stakeholders indicated strong weaknesses in DEC, whereas they assigned strengths to INC (Finland) or INC and BAU (Norway). In contrast, regarding strengths and opportunities, German stakeholders assigned the highest figure to DEC, whereas weaknesses and threats were weighted most strongly in INC. In Slovenia, stakeholders perceived greater strengths and opportunities in BAU and INC than in DEC and clearly identified greater weaknesses in DEC than in BAU and INC.

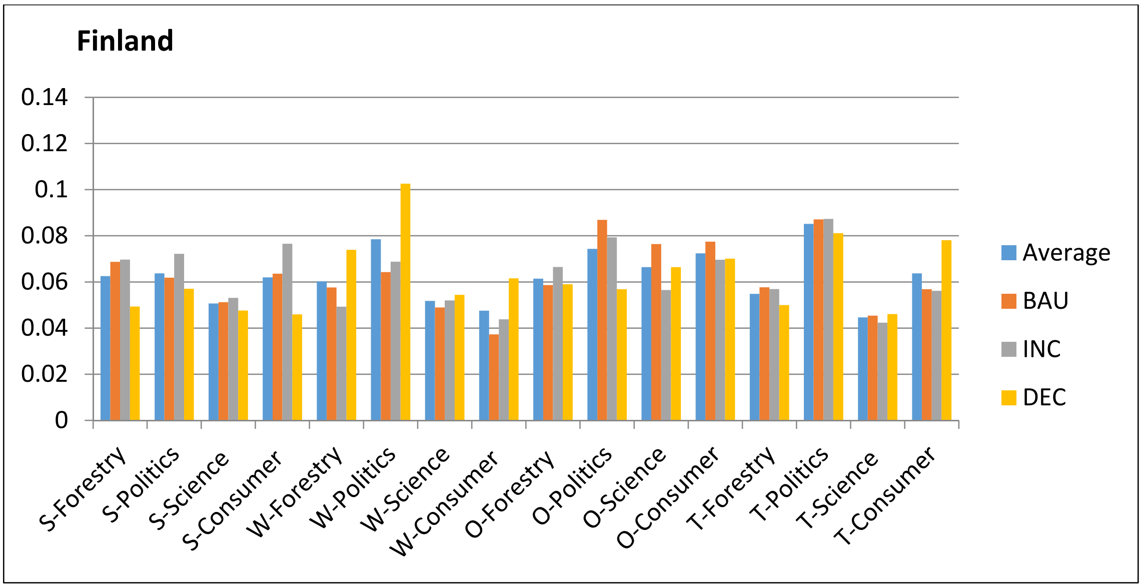

Figure 5: Weights of the four categories in different scenarios in Finland (forestry =forest management & characteristics, politics = political framework, science = science & technology, consumer = consumer & society)

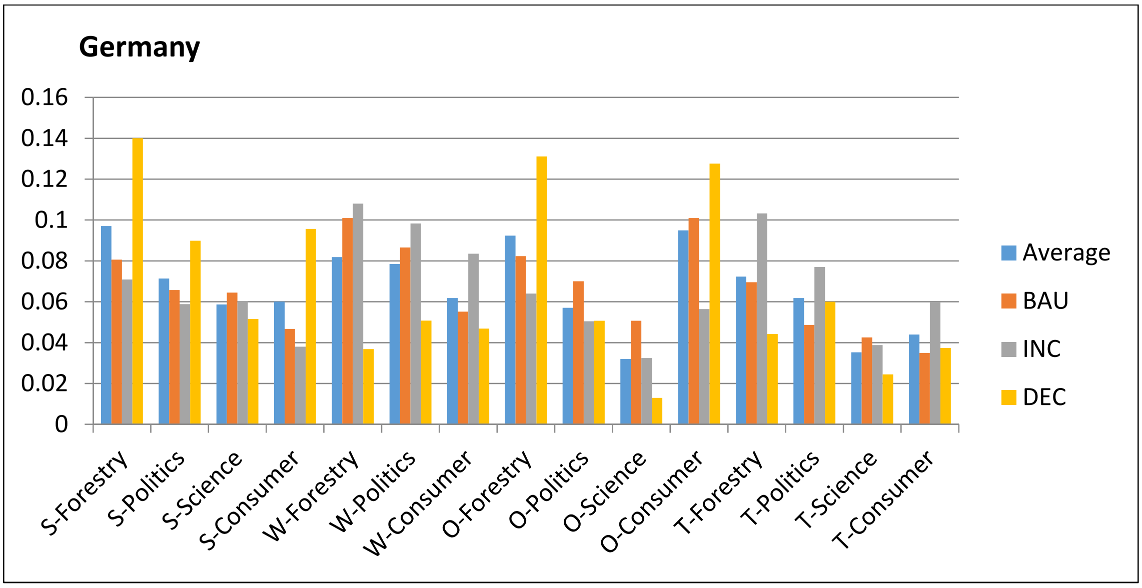

Figure 6: Weights of the four categories in different scenarios in Germany (forestry =forest management & characteristics, politics = political framework, science = science & technology (in this category, no factor was mentioned for weaknesses), consumer = consumer & society)

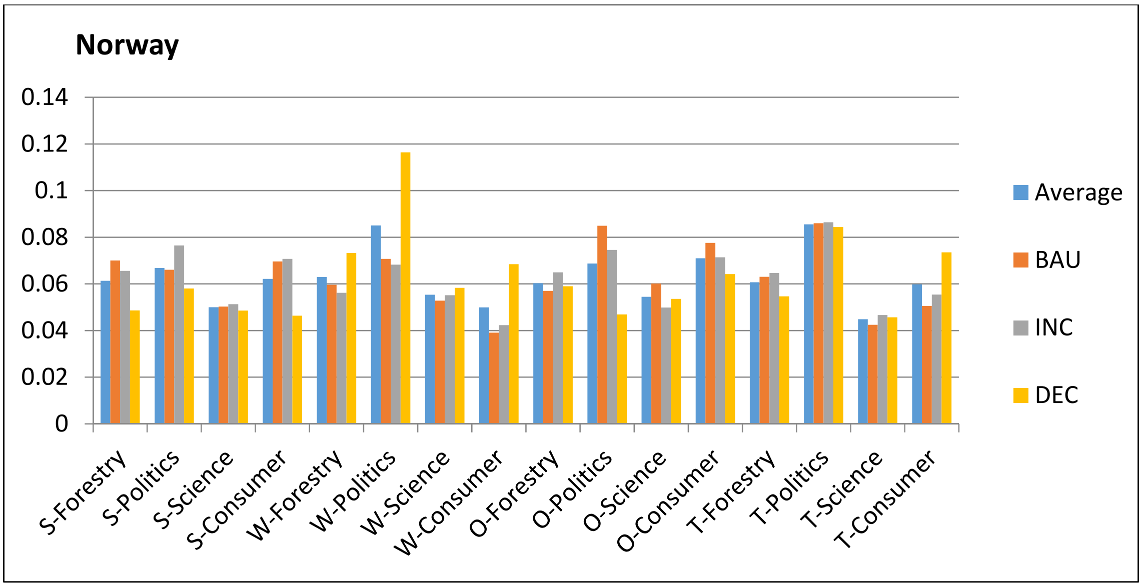

Figure 7: Weights of the four categories in different scenarios in Norway (forestry =forest management & characteristics, politics = political framework, science = science & technology, consumer = consumer & society)

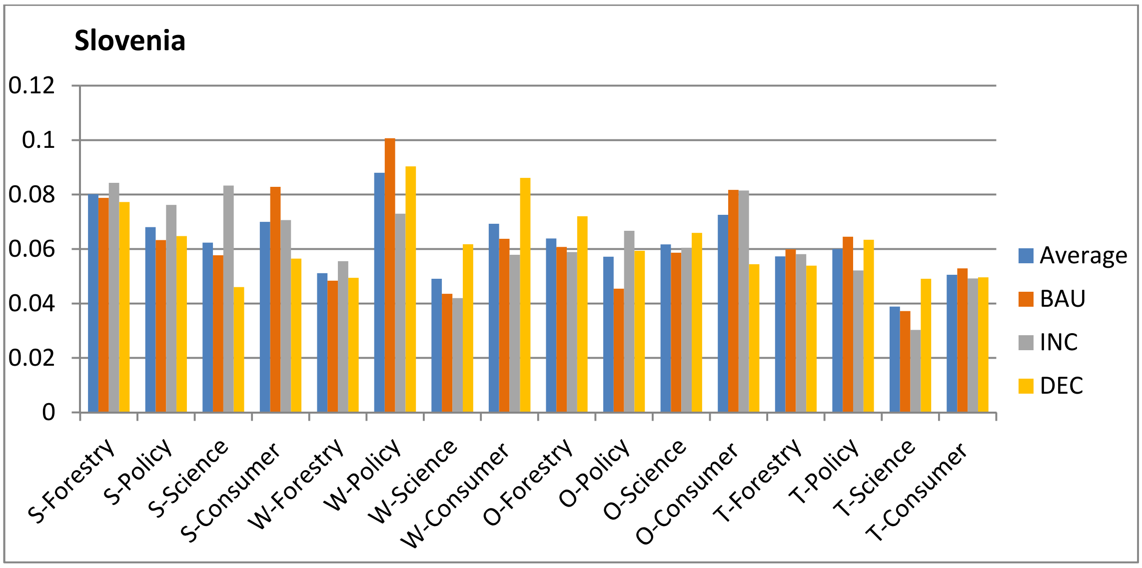

Figure 8: Weights of the four categories in different scenarios in Slovenia (forestry =forest management & characteristics, politics = political framework, science = science & technology, consumer = consumer & society)

7.3 The most important SWOT factors in different categories

Tables 6-9 present the average weights of the most important SWOT factors identified in the four categories in Finland, Germany, Norway, and Slovenia. In the following, we highlight the most important similarities and differences regarding the importance of factors in the SWOT categories. The Spanish research partner contributed to this description with SWOT factors derived from interviews.

7.3.1 Forest characteristics and management

Strengths: Stakeholders in all five countries emphasized the large volume of wood resources available as one of the most important strengths. German stakeholders in particular stressed the modern and sustainable forest management in their country as a major strength, whereas Slovenian actors focused on the potential income generation through energy wood production. In Spain, the greatest strength perceived is the synergy between biomass extractions and wildfire prevention measures.

Weaknesses: Across all countries, interviewees commented on the risk of high pressure on forest ecosystems due to an increased use of energy wood. Norwegian stakeholders are calling for a clarification of the limits for sustainable forest management. Slovenian and Finish stakeholders emphasized the difficult forest ownership structure, whereas in Germany the insufficient database on the amounts of felling was highlighted, and in Spain stakeholders mentioned the restricted accessibility of forests due to topography. Stakeholders in Finland also referred to the poor profitability of energy wood due to the high costs in different phases of the harvesting chain as the main weakness.

Opportunities: Finnish stakeholders emphasised above all the opportunity to harvest larger trees for energy wood in the future as an option for decreasing the costs of harvesting energy wood. In the other four countries, stakeholders emphasised the opportunity to better embed energy wood production into the various ecosystem services of forests. Norwegian stakeholders highlighted opportunities for better differentiating forest management in time and place in order to achieve different societal objectives relating to forests. Spanish stakeholders considered biomass as an opportunity that fills the gap left by the decline of the particleboard industry.

Threats: Mainly Finnish stakeholders, but also Norwegian and Slovenian stakeholders articulated the threat posed by the fact that future harvesting will be decisive for availability of bioenergy because energy wood is a by-product of forestry. In contrast, German and Norwegian stakeholders stated above all else that ecosystem and sustainability limits could be overrun leading to negative impacts on forest biodiversity. In addition, stakeholders mentioned the threat posed by more wood imports brought about by higher competition for wood (Germany) and lower energy wood production (Slovenia).

7.3.2 Policy framework

Strengths: Stakeholders in Norway and Slovenia underlined the role of energy wood in reducing fossil fuels as a key strength, which was supported by the Finnish perspective in which stakeholders considered international agreements related to climate change mitigation as the strongest political driver for increasing energetic wood use. German stakeholders perceived the existing legal framework for forest management as a core strength, whereas Spanish interviewees saw general political support for the new paradigm of biomass extraction as a useful means of fire prevention.

Weaknesses: Across all countries, stakeholders considered inadequate or missing policy measures as an important weakness. Examples include an impatient stop-and-go policy mentioned in Finland, and wrong market incentives identified in Germany and Slovenia. Norwegian actors gave higher priority to the lack of cooperation among different professions and they noted a lack of adequate policy measures for increasing the share of woody biomass in energy supply. In Spain, stakeholders remarked on the low overall political interest in renewable energies within the context of the economic crisis and highlighted the need for stable incentives for large investments and a clearer legal framework for the "energetic crops".

Opportunities: Finnish stakeholders referred to the opportunities for promoting the use of wood for energy provided by market driven policy instruments. In Germany, Norway, and Slovenia, stakeholders mentioned above all the expectation of an increased political focus on renewable energies, especially on aspects of efficiency (Germany) or self-supply (Slovenia). In these three countries, stakeholders expect a future focus on sustainable forest management including the development of sustainability criteria. In Spain, more efficiency criteria in economic incentives was highlighted as an opportunity for increasing the use of wood for energy. Stakeholders also mentioned the role of public bodies in providing an example by starting to use biomass equipment.

Threats: In Finland, stakeholders perceived that competitive disadvantages may arise if the EU and thus EU countries engage in international commitments in the case that other countries do not also commit to these. In line with Slovenian stakeholders, they highlighted the threat of more bureaucracy connected to subsidies and certificates for sustainable forest management. German and Slovenian stakeholders consider that an increasing utilisation of energy wood will have a negative impact on policy measures to mitigate climate change. Norwegian stakeholders referred more to ecological issues and did not consider that environmental costs were included in energy prices. Furthermore, Norwegian, Spanish and Slovenian stakeholders perceived uncertainty in price developments and the future political development as key threats.

7.3.3 Science and technology

Strengths: German and Slovenian stakeholders appreciated the already existing scientific and technological knowledge regarding the utilisation of energy wood, whereas the Norwegian and Spanish stakeholders in particular emphasised the new technology resulting in more energy effective utilization of bioenergy. Finnish stakeholders perceived the networking of researchers in “Finnish science at the top” to be the most important strength in this category.

Weaknesses: Slovenian and Finnish stakeholders identified a gap between existing knowledge and technology for wood production and a lack of implementation in practice. Finnish and Norwegian stakeholders also emphasised the contradictory results concerning the climatic effects of wood energy production and use. In Spain, stakeholders considered that there needs to be consolidation of the value chain.

Opportunities: Stakeholders from all countries see the opportunity to develop new and more energy efficient technologies and products. In Finland, research results are perceived as a major opportunity for facilitating political decision-making. German stakeholders expect energy efficient technologies to become more marketable in the future due to growing demand. In Slovenia, a decrease in GHG emissions through local wood mobilization and therefore less transport was highlighted. In Spain, economic stakeholders saw technical standards as an opportunity for value chain development.

Threats: On the one hand, stakeholders referred to threats posed by research findings and new technologies. Finnish stakeholders explained that research findings related to the carbon neutrality of wood could threaten the additional use of wood. In Germany, stakeholders referred to the so-called rebound effect as a risk, if new technologies are accompanied by higher consumption of resources. In line with that, Slovenian stakeholders perceive that new technologies can have negative impacts on forest ecosystems. On the other hand, Norwegian stakeholders perceived as a threat to science the complexity in energy use and resource management as well as the complexity in carbon balances depending on management practices. Finnish stakeholders also perceived that funding of research and continuity in recruitment of young researchers are threatened.

7.3.4 Consumer and society

Strengths: German and Slovenian stakeholders cited above all the relationship of citizens towards the use of wood, which in Slovenia is based on the traditional use of wood as a primary energy source in private households. German stakeholders considered wood gathering above all as a means for creating a positive relationship between people and the forests. In Norway, actors gave top priority to increased energy security provided by the use of energy wood, whereas in Finland and Spain the substitution of fossil fuels by energy wood was seen as the most important aspect. In Spain, stakeholders identified the greater price competitiveness of biomass in comparison to fossil fuels as the main strength.

Weaknesses: Stakeholders across all countries consistently highlighted the lack of sufficient public awareness regarding environmental effects of bioenergy use and the importance of saving energy. German stakeholders linked this observation with their perception that the public perceives burning of wood as ecologically friendly given that wood is a renewable resource. Slovenian stakeholders mentioned the inefficient use of wood in private households.

Opportunities: Finnish stakeholders expect an increase in energy self-sufficiency and similarly, in Germany and Slovenia, stakeholders referred to the increasing importance of saving energy and a more efficient use of wood. In addition, the opportunity for more employment and hence higher income from that branch is important to Finnish, Spanish and especially Slovenian stakeholders. In Norway, stakeholders referred to the possibility that increased fossil energy prices could make bioenergy more attractive, perhaps meaning that Norway as an oil producing country would become aware of moral obligations to produce renewable energy. In Spain, an increasingly prominent paradigm within the forestry sector, which highlights biomass energy as a means of preventing wildfires, is spreading to policy-makers and final consumers.

Threats: Stakeholders in all countries perceive threats relating to a lack of consciousness in society about bioenergy issues. Further perceived threats relate to land use changes and competition. According to Finnish, German, and Slovenian stakeholders, people lack an understanding of interactions between energy wood and forestry measures. Furthermore, in Germany and Slovenia, stakeholders referred to the increasing competition for forest land. Norwegian and Slovenian stakeholders considered that intensive bioenergy production could threaten recreation and have negative impacts on landscape elements. In Spain, stakeholders reflected on the vulnerability of biomass development to the evolution of substitutive energy prices, their fear of competitor lobbies that could damage the biomass image, and the lower benefit of energetic use of wood in relation to material use.

Table 6: SWOT – most important SWOT factors within each category – FINLAND. Numbers in bold highlight the most important factor of each category in the scenario.

Groups	Categories	Factors	Scenarios (global priorities) BAU	INC	DEC
Strengths	Forest characteristics & management	Large, increasing wood resources	0,0277		0,0168
		Good for forest management: support the production of saw logs and pulpwood		0,0249	
	Policy framework	The contracts concerning climate change mitigation promote the energetic use of wood	**0,0278**	**0,0275**	**0,0236**
	Science & technology	Co-operation between research institutes and companies	0,0139	0,0131	
		Networking of researchers, "Finnish science at the top"			0,0173
	Consumer & society	Substitution of fossil fuels	0,0214	0,0251	
		Environmentally friendly, renewable, self-sufficient energy produced nearby			0,0145
Weaknesses	Forest characteristics & management	Large costs in the different phase of harvesting chain, small income => poor profitability (not crown mass)	0,0194	0,0151	0,0341
	Policy framework	Impatient and stop-go subsidy policy decreases willingness to invest	**0,0258**	**0,0257**	**0,0419**
	Science & technology	Contradictory results about the climatic effects of wood energy production and use	0,0181	0,0172	0,0236
	Consumer & society	Emissions caused by the burning of wood (including small particle emissions)	0,0108	0,0134	
		Most people are not interested in where the energy comes from and what kind of energy is used			0,0269
Opportunities	Forest characteristics & management	Harvesting of larger trees for energy wood (more resources, lower costs)		0,0189	**0,0213**
		Developing source of income for forest owners	0,0175		
	Policy framework	Emission trade promotes the use of wood for energy	0,0264	**0,0263**	
		More taxes for fossil fuels/the prices of alternative energy sources have risen			0,0149
	Science & technology	Development of new, more processed products (e.g. biofuels)	0,0199	0,0144	0,0165
	Consumer & society	The degree of self-sufficiency is increased	**0,0284**	0,0251	
		Decentralized and centralized energy production (development in the direction of decentralized production)			0,0209
Threats	Forest characteristics & management	Harvesting of energy wood decreases forest biodiversity		0,0175	
		The use of domestic wood decreases in forest industry => amount of by-products, logging residues and possibilities to harvest stumps decrease (dependency on forest industry)	0,0170		0,0161
	Policy framework	EU commits itself to the international commitments without the commitment of others	**0,0262**	**0,0251**	**0,0312**
	Science & technology	Funding of academic research, continuity, recruitment of young researchers			0,0137
		Research results about carbon neutrality of wood threatens the additional use of wood	0,0137	0,0173	
	Consumer & society	Not enough skilled employees (image/not paid enough)		0,0211	
		Plants invest in coal	0,0232		0,0272

Table 7: SWOT – most important SWOT factors within each category – GERMANY. Numbers in bold highlight the most important factor of each category in the scenario.

Groups	Categories	Factors	Scenarios (global priorities) BAU	INC	DEC
Strengths	**Forest characteristics & management**	**Modern and sustainable forest management is implemented.**	0,0203	0,0174	0,0248
	Policy framework	**A legal framework for the management of forests exists.**	**0,0571**	**0,0472**	**0,0709**
	Science & technology	**Scientific and technological know-how for utilization possibilities of wood are given.**	0,0215	0,0157	0,0296
	Consumer & society	**Wood gathering ("Selbstwerbung") from forests creates a positive relationship between citizens andforests.**	0,0514	0,0375	0,0429
Weaknesses	**Forest characteristics & management**	**Energy wood utilization has negative impacts on forest biodiversity.**		0,0304	
		The database is not sufficient (fellings, etc.).	**0,0394**		0,0381
	Policy framework	**Political targets in the energy sector are too ambitious.**	0,0393		
		Inadequate market incentives are provided.		0,0381	**0,0390**
	Science & technology	//			
	Consumer & society	**Lack of awareness among citizens regarding the importance of saving energy.**		**0,0469**	0,0319
		Misleading PR suggests that burning wood is ecologically friendly and that wood is an endless resource.	0,0297		
Opportunities	**Forest characteristics & management**	**Energy wood utilization is embedded in multifunctional demands.**	0,0309		0,0442
		The increase in energy wood utilization leads to higher wood prices which is good for the forestry sector.		0,0158	
	Policy framework	**Efficiency becomes more important for decisions in energy sector.**	0,0344	0,0226	**0,0545**
	Science & technology	**Technologies for an efficient use are marketable due to growing demand.**	0,0287	0,0225	0,0460
	Consumer & society	**Saving wood and efficient use of wood are becoming more important.**	**0,0373**	**0,0257**	0,0430
Threats	**Forest characteristics & management**	**Forest ecosystems are overrun by demand; the demand cannot be satisfied within limits of sustainability.**	0,0205	0,0270	0,0129
	Policy framework	**The demand for energy wood has negative impact on political climate mitigation targets.**	0,0299		0,0268
		The implementation of cascade utilization is hindered as wood needs to be burned directly.		0,0526	
	Science & technology	**The development of new technologies leads to pressure to use more wood („Reboundeffekt“)**	**0,0437**	**0,0626**	**0,0298**
	Consumer & society	**Actors are competing for forest area.**		0,0310	
		Changes in increasing wood utilization are not questioned by society.	0,0234		0,0202

Table 8: SWOT – most important SWOT factors within each category – NORWAY. Numbers in bold highlight the most important factor of each category in the scenario.

Groups	Categories	Factors	Scenarios (global priorities) BAU	INC	DEC
Strengths	Forest characteristics & management	Norway has available forest resources		0,0178	0,0134
		Bioenergy is mainly based on forest resources	0,0154		
	Policy framework	Bioenergy can reduce fossil energy consumption, and is one part of the solution in the renewable future	**0,0270**	**0,0248**	**0,0211**
	Science & technology	Knowledge and technology is available, also within other technology sectors, for increasing the use of bioenergy			0,0118
		New technology results in more energy effective utilisation of bioenergy	0,0202	0,0150	
	Consumer & society	Bioenergy increases security of the energy availability		0,0168	0,0142
		Bioenergy is a local renewable energy source, short travelled energy, important in the sustainability perspective and for greenhouse gas emissions	0,0228		
Weaknesses	Forest characteristics & management	The limits for sustainable forest management, and the relationship between public and private regulations, need to be clarified - because the focus on renewable resources will increase the pressure on forest resources (implementation of the sustainability regulation has to be more strict, more forests need to be protected)	**0,0189**	**0,0209**	0,0257
	Policy framework	Lack of cooperation among different professions	0,0167	0,0177	**0,0416**
	Science & technology	There are incompatible results/findings concerning climate effects of forests and forest products, including bioenergy production and use	0,0169	0,0155	0,0169
	Consumer & society	«People in the street» care more about energy prices than environmental effects and the share of renewables	0,0150	0,0166	0,0181
Opportunities	Forest characteristics & management	Better differentiation of forest management in time and place can help to achieve different societal objectives relating to forests	0,0225	0,0247	0,0311
	Policy framework	It is important to make forest management in Norway more sustainable	0,0271	**0,0260**	0,0310
	Science & technology	There are possibilities within new value chains, coordinated technology and infrastructure (effective, environmental use of wood in lasting products with energy utilisations in final stage (cascade use), also for bio-based energy in aviation)		0,0149	
		Energy efficiency can be increased (ensuring full-scale assessments of energy-efficiency (energy in versus energy out), energy loss in production, utilisation of rest heat, etc.)	0,0189		0,0178
	Consumer & society	Increased prices on fossil energy could make bioenergy more attractive in the future	**0,0276**	0,0217	**0,0341**
Threats	Forest characteristics & management	Harvesting of bioenergy on areas that would otherwise be left untouched is negative for biodiversity as well as other ecological values	0,0272	0,0387	0,0157
	Policy framework	Energy pricing does not reflect environmental costs	**0,0372**	**0,0440**	**0,0412**
	Science & technology	Complexity in carbon sequestration and storage, variations within and between nature types, for different management practices (forest soils, albedo) and for different time perspectives, etc.		0,0209	
		Energy use and resource management is complex to start with, and increasing use of bioenergy can be positive or negative depending on where and how it is harvested and used	0,0208		0,0172
	Consumer & society	Saving energy and efficient energy utilisation should come before increased use of renewable energy	0,0311	0,0299	0,0334

Table 9: SWOT – most important SWOT factors within each category – SLOVENIA. Numbers in bold highlight the most important factor of each category in the scenario.

Groups	Categories	Factors	Scenarios (global priorities) BAU	INC	DEC
Strengths	Forest characteristics & management	Slovenia has a potential for wood biomass production	0,0226		
		Use of wood for energy purposes is a source of additional income		0,0254	**0,0254**
	Policy framework	(Favorable) political framework for forest management is available			0,0243
		Energy wood decreases the use of fossil fuels and is considered as one of the future RES	0,0235	0,0307	
	Science & technology	Scientific and technological know-how for utilization possibilities of wood are given			0,0193
		Technological conditions for efficient use of energy wood exists	0,0217	**0,0330**	
	Consumer & society	Wood is a traditional and important primary energy source in households	**0,0344**	0,0283	0,0222
Weaknesses	Forest characteristics & management	Increased use of renewable sources increases pressure on forest ecosystems		0,0178	
		Many private forest owners and fragmentation prevent adequate forest management	0,0211		0,0195
	Policy framework	Implementation of political measures in practice is insufficient	**0,0372**	**0,0259**	0,0330
	Science & technology	Research results and findings are only partially transferred into practice	0,0294	0,0240	**0,0444**
	Consumer & society	Energy wood in households is used inefficiently and in too big amounts		0,0197	
		Inappropriate general public awareness raising about wood burning as a nature-friendly energy source and as an unlimited resource	0,0203		
		The majority of the general public is not interested in knowledge about energy origin and ways of using it			0,0271
Opportunities	Forest characteristics & management	Energy wood production can become a part of multi-purpose forest use			0,0219
		Increased energy wood use means larger income for private forest owners	0,0215	0,0185	
	Policy framework	Policies' orientation towards increasing use of RES and subsidies for self-supply with renewable energy	0,0188	0,0292	0,0242
	Science & technology	Development of new and technically improved products and technologies		**0,0319**	
		Wood mobilization enables transport localization and decrease in negative GHG emissions	**0,0366**		**0,0352**
	Consumer & society	Saving (reduced use) and efficient use of energy wood is gaining importance			0,0175
		Energy wood production and use contribute to new workplaces and provide additional income for rural inhabitants	0,0229	0,0227	
Threats	Forest characteristics & management	Energy wood is mainly a by-product of forest management - its availability depends on allowed cut and implementation of silvicultural works			0,0213
		Lower energy wood production and use in Slovenia may mean increasing importation of energy wood from other countries	0,0217	0,0225	
	Policy framework	Political uncertainty and tenuous future development of the prices of energy sources also means uncertainty in the development of a future policy framework			0,0232
		Acquisition of subsidies and certificates of sustainable forest management is bureaucratised	0,0220	0,0190	
	Science & technology	Development of new technologies influences forest ecosystems and has increased pressure on energy wood use	**0,0372**	**0,0303**	**0,0491**
	Consumer & society	Pressure of different stakeholders on use of forest land is increasing	0,0273	0,0223	
		Increased use of wood is not in the focus of the general public; they do not recognize the connection between the use of energy wood and forest measures			0,0204

8 Conclusions: Challenges and policy recommendations

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The different COOL results and publications have led to some final conclusions, which predominantly show still existing challenges related to the production and use of forest-based bioenergy. The following challenges are outlined as a synthesis of the results and are intended to serve as a basis for policy and management decisions and developments.

8.1 Strengthen the political framework

Stakeholders from all countries cited misguided or absent policy measures as a main factor hindering the promotion of energy wood production and use. Regarding future developments of the political framework, Finnish stakeholders stressed that ad-hoc policy is disincentivising investments in the energy wood sector. In Germany, Norway and Slovenia, stakeholders expect the political focus on renewable energies, especially on efficiency (Germany) or self-supply (Slovenia), to increase. Spanish stakeholders criticised the general lack of political interest in renewable energies and budget cuts as well as the lack of a transparent framework for the "energetic crops" (Spain reduced feed-in tariffs during recent years due to the economic crisis). Thus, stakeholders in all countries are convinced that long-term political will and stable incentives are essential for meeting the EU 2020 targets.

8.2 Mobilise wood resources

Stakeholders in all countries identify mobilising wood resources for energy as a major challenge. They named constraining factors such as low profitability (Finland, Norway), difficult forest ownership structures (Finland, Slovenia), insufficient data on the rates of felling (Germany) and accessibility of forests (Spain). In order to address these constraints, stakeholders support the following forest management options: enhanced thinning in young and middle-aged forest stands (Finland, Slovenia, Spain); increased harvesting of low profitability forests and short-rotation coppice (Germany, Spain); increased use of logging residues (all countries) and of industrial wood for energy due to a possible decrease in its production capacity (Finland, Spain).

8.3 Manage competition for wood

Some stakeholders in all countries are concerned that competition for wood between material and energetic uses as well as competition between different wood-based industries will have significant effects on energy wood production. Although energy wood production could benefit from the decreasing capacity of pulpwood industries, some stakeholders fear that future harvesting levels would be decisive for the availability of the by-product energy wood (Finland, Norway, Slovenia). Therefore, decreasing domestic wood use (Finland, Norway, Slovenia) and insufficient harvest levels in private forests (Slovenia) could lead to a decrease in energy wood production and use. Some German stakeholders point at discrimination against other wood-related industries by subsidies, causing market distortions that favour energy wood production and use.

8.4 Preserve ecosystem services

Stakeholders across countries perceive possible trade-offs between energy wood production and ecological values emerging from forest ecosystem services; synergies play a less important role and mainly relate to biomass extraction in protected areas. In particular, existing and potential trade-offs with biodiversity conservation are highlighted. Increasing future production of energy wood may put strains on the sustainability of ecosystems (Germany), and fuel competition for forest land (Germany, Slovenia), thus placing forest biodiversity at risk.

8.5 Address uncertainties regarding climate change

In all countries, stakeholder perceptions about the implications of energy wood production and use for climate change mitigation vary as much as the scientific findings used to support them. On the one hand, energy wood is ascribed great significance in terms of mitigating climate change and reducing dependency on fossil fuels. International agreements on climate change mitigation are thus perceived as the strongest political drivers of energy wood production and use. On the other hand, many stakeholders stated that different forest management practices, technologies and assortments used make it more complex to evaluate the carbon balance of energy wood. For instance, some German stakeholders claimed that the material use of wood and its associated carbon storage contributes more to reducing greenhouse gas levels than energy wood use and that long transport distances render carbon neutrality unattainable.

8.6 Raise public awareness

Stakeholders across all countries pointed to the lack of sufficient public awareness about environmental effects of energy wood use and the importance of saving energy. German stakeholders linked this observation with the public perception that burning wood is ecologically friendly given that wood is a renewable resource. Slovenian stakeholders referred to the inefficient use of wood in private households. In the case that energy wood use increases in the future, Finnish stakeholders expect an increase in energy self-sufficiency. In Germany and Slovenia, stakeholders predicted that saving energy and more efficient use of wood will become more important. In Spain, an increasingly prominent paradigm within the forestry sector, which highlights using energy wood to prevent wildfires, is taking hold among policy-makers and energy consumers.

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