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How national bioeconomy strategies address governance challenges arising from forest-related trade-offs

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ABSTRACT

The term 'bioeconomy' stands for an economy that primarily relies on renewable biotic resources and thus supports the vision of a low carbon society. The respective 'bioeconomy strategies' bear high conflict potential as they, sometimes unintentionally, rely on forest-land or wood as a resource, which are already appropriated also in other policies. We first outline the resulting governance challenges in terms of coherence of policy goals, consistency of instruments and the congruence between the two and identify trade-offs between forest ecosystem services that exhibit a high conflict potential regarding the bioeconomy. We then provide a comparative analysis of the extent to which bioeconomy strategies tackle the related governance challenges for two pairs of countries from the temperate (Germany and Switzerland) and the boreal (Sweden and Norway) forest zone. We find that the strategies do not mention conflicts related to wood mobilization. Coherence and consistency tend to be addressed for non-extractive forest utilizations that are perceived as a market opportunity rather than solely a restriction on wood mobilization. The latter seems more common in countries with a multi-functional forestry paradigm. Consequences for the prevailing forest management paradigm, however, are not explored in the strategies and thus policy congruence is neglected.

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1. Introduction

As the need for more sustainable lifestyles and methods of production increases, there is remarkable political momentum to introduce new or reform existing environmental and resource regimes. In December 2019, the European Commission (EC) presented the European Green Deal which lays out a roadmap for making the EU's economy sustainable. As a part of it, the EU Biodiversity Strategy to 2030 and a new European Climate Law are underway. The EC also recently elaborated an updated Bioeconomy Strategy (EC, 2018). For the EU, the bioeconomy is predicted to be of major importance for a low carbon society (Scarlat et al., 2015). One promise of a bioeconomy is to derive efficient high-tech renewable resources, e.g. biomass from forests, as substitutes for non-renewable resources (Ingrao et al., 2018).

However, forests are often already addressed in many other policy fields with an interest in strengthening sustainability. Novel bioeconomy strategies thus add another layer to the existing fabric of interwoven policies. This addition can give rise to new or aggravate existing trade-offs between forest ecosystem services, i.e. situations in which prioritizing and hence intensifying certain forest utilizations comes at the expense of forest uses for other purposes (Juerges et al., 2021). Such trade-offs can manifest in conflicts between actors, as deciding on them will create winners and losers. These conflicts occur at the policy goal level when actors have

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different preferences for forest utilizations and expect that these cannot be satisfied by providing the respective ecosystem services in sufficient amount, quality and in a timely manner at the relevant locations and scales, based on the prevailing forest management paradigm. According to Winkel et al. (2011), different forest management paradigms exist, among which 'sustained yield' and 'multipurpose forestry' are the two most relevant for our cases. 'Sustained yield' focusses on sustainable timber production in terms of the 'maximum possible periodic timber yields (in terms of quantity and quality)' without strongly integrating other forest utilizations. These, such as e.g. recreation, thus tend to take place in special zones, i.e. protected areas. This rather segregative forest management approach is the prevailing forestry paradigm of the Northern European countries, i.e. the boreal forest zone. In contrast, 'multipurpose forestry' emphasizes the 'maximum possible periodic yields from sales of (1) timber and (2) other forest services' (Winkel et al., 2011) and thus aims at providing multiple functions within one and the same forest stand (Blattert et al., 2018). Multipurpose forestry is common in the temperate forest zone, particularly in Western and Central Europe.

In this paper, we focus on trade-offs between forest ecosystem services and hence conflicts that are induced at the policy goal level due to the aim of establishing a bioeconomy. We deliberately go beyond the more obvious potential trade-offs between different utilizations of wood or between timber mobilizations and nature conservation. Proceeding from a recent list of relevant trade-offs between forest ecosystem services provided by Juerges et al. (2021), we also emphasize less obvious conflicts that are likely to occur under the premise of a bioeconomy. A progressive notion of the bioeconomy implies that also non-timber-based forest ecosystem services, such as recreation or carbon sequestration, will be marketized more systematically, as non-extractive forest utilization holds the promise of decoupling economic growth from resource utilization (Boecher et al., 2020). Finally, conflicts can also arise between interests for forest utilization and for alternative uses of the forested land. If wind energy is permissible in forested areas, this may conflict with the goal of forest protection (Höfer et al., 2016). In that case, the trade-off prevails between all forest ecosystem services that could possibly be provided on that spot and the benefit derived from the alternative utilization (Juerges et al., 2021).

These conflicts are potentially the cause but also the result of policy incoherence, either within and between forest and wood policy or across a broader set of related policy sectors. Mastering such conflicts thus calls for coherent cross-sectoral approaches not only to coordinate the supply and use of forest and wood resources but also to enhance innovation and value creation across sectors (Guerrero & Hansen, 2021; Schütte, 2018; Wolfslehner et al., 2016). As Howlett and Rayner (2013) point out, this implies a threefold governance challenge, as it is not only the coherence of goals that has to be considered but also the consistency of instruments as well as the congruence between goals and instruments.

This governance challenge is not easily solved, though. Several scholarly appraisals of the forest and wood related bioeconomy discourse have pointed out how incoherence persists (Ladu et al., 2020; Singh et al., 2021), also within existing domestic narratives of Sustainable Forest Management (SFM) (Pülzl et al., 2014) and that strategy documents thus evade conflicts and more tangible suggestions at the level of policy instruments (Kleinschmit et al., 2017).

With this article, we offer two contributions to this literature. First, we examine whether governmental bioeconomy strategies address conflicts that can be expected to arise as a result of the political will to move toward a bioeconomy and a low carbon society more generally. Second, we examine whether the bioeconomy strategies actually also address the coherence, consistency and congruence of the policies involved.

In what follows, we derive from the policy analysis literature how policy strategies can be expected to address governance challenges that arise from potentially conflicting policies (namely by pointing to or offering solutions for incoherence, inconsistencies and lacking congruence) and suggest forest ecosystem trade-offs and potential conflicts that seem most likely and most relevant with respect to a bioeconomy and low carbon society. We then compare bioeconomy strategies and related policy documents of two pairs of countries from the temperate (Germany and Switzerland) and the boreal (Sweden and Norway) forest zone with varying approaches towards sustainable forest management.

We find that in countries with a multi-purpose forestry paradigm, conflicts between the forest sector and other land-use sectors are more prominently addressed. Similar to other studies on bioeconomy strategies, we also find that trade-offs between different utilizations of wood tend to be ignored and, more fundamentally,

that these policy documents challenge the prevailing forestry paradigm only marginally, if at all. Hence, the bioeconomy strategies do not (yet) tackle the governance challenges posed by the shift towards a bioeconomy.

2. Policy strategies for tackling governance challenges

To assess to what extent trade-offs between forest ecosystem services can be expected to be addressed by bioeconomy strategies of different countries, we need to understand the possible role of policy strategies. A bioeconomy governance framework, according to Gawel et al. (2018), will aim at enabling the economic expansion of the bioeconomy while limiting its negative consequences by finding regulatory and other means to manage the inherent conflicts (compare also Ladu et al., 2020). For many potential conflicts this requires the integration of sectoral policies (Wolfslehner et al., 2016).

Howlett and Rayner (2013) have formulated the resulting governance challenges in terms of coherence of goals, consistency of instruments and congruence between goals and instruments. One function of policy strategies should be to tackle these challenges by suggesting how coherence, consistency and congruence could be upheld. As policy reform is path-dependent and usually a result of incremental changes, however, policy strategies are not necessarily based on consistent and coherent policy designs (Howlett & Rayner, 2007) and this can all the more be expected for cross-sectoral bioeconomy policy strategies.

2.1. Coherence

Policy coherence refers to the harmonization of goals – these should not contradict each other (Howlett & Rayner, 2013). However, even if a policy includes goals from different sectors, there is a danger that their interactions and potential conflicts are not addressed or even purposely concealed (Nordbeck & Steurer, 2016). Hence, we do not expect bioeconomy strategies to address incoherence between goals. We expect it to be more likely, though, for the countries of the temperate zone, where goals other than wood production might be more easily accepted in a system with a multifunctional forest management paradigm.

2.2. Consistency

Consistency means that policy instruments should reinforce rather than undermine each other (Howlett & Rayner, 2013). Inconsistency between policy instruments can occur if rules are simply added on top of the existing regulations (Mahoney & Thelen, 2010). Kleinschmit et al. (2017, p. 50) observe, that policy integration in political bioeconomy discourses remains superficial and is 'mainly addressed in rhetorical terms within policy goals […] but not in policy practice, meaning strategies and instruments that aim to foster the implementation of environmental goals aspects'. Recent research indicates that to address potential conflicts and achieve policy goals, particularly procedural instruments (planning and participative involvement of stakeholders) play an important complementary role alongside substantive instruments (Howlett, 2019; Pakizer et al., 2020). Our second expectation is thus that bioeconomy strategies mainly suggest procedural instruments as a means to increase consistency of future policy reforms rather than outlining consistent combinations of policy instruments for reconciling trade-offs in detail.

2.3. Congruence

Congruence is defined as the mutually supportive interplay between goals and instruments. Lacking congruence may result from the 'conversion' of a policy (Mahoney & Thelen, 2010), i.e. the introduction of new goals without adapting the instrument mix accordingly (Howlett & Rayner, 2013). The actors from the forest sector strongly identify with the vision of a bioeconomy (Stein et al., 2018) and see the concept merely as a reframing of the existing role of the forest and thus also of the existing forest management paradigm (Pülzl et al., 2014).

As we will argue below (Section 3), some trade-offs between forest ecosystem services prevent an integrated provision of these services on the same forest stand. Expanding both services on the same plot would thus at

some point challenge the multifunctional forest management paradigm. Conversely, the segregative 'sustained yield' paradigm might also become challenged in the context of a bioeconomy. A more integrated forest management approach could help to reconcile some trade-offs that primarily occur within different forms of wood use (e.g. fuelwood and wood for industrial uses) rather than forest management, as it might allow satisfying the demand for both purposes from the same forest stand. Also, a rather segregative provision might be impaired by the spatial distribution of an increasing demand (e.g. recreation).

If the bioeconomy strategies would mention such implications for the existing forest management paradigms, this could help detecting a potential incongruence between goals (of a bioeconomy) and instruments. Of course, the prevailing forest management paradigm is an ideal type and thus subject to interpretation and contingent on choosing the relevant scale for implementation. Ultimately, this is the result of forest planning, which inherently involves calibrating goals and instruments. Although we do not expect the bioeconomy strategies to openly question the prevailing forestry paradigm, our third expectation is that the strategies at least refer to forest planning as a means to maintain congruence.

3. Forest-related conflicts potentially induced by a bioeconomy

Which forest ecosystem services trade-offs are most likely to provoke conflict if a bioeconomy would become reality? We build on a recent list of trade-offs among forest ecosystem services (developed from a European context) and the potential conflicts arising thereof (Juerges et al., 2021). Juerges et al. (2021) suggest a classification of these conflicts: first, 'overarching conflicts' are very general notions of conflicts while the conflicts due to 'silvicultural practices' are relevant to judge possible consequences of intensified timber production, but as such do not directly capture the different interests for such intensified management. Conflicts arising due to the shift toward a bioeconomy are rather included in the categories 'energy', 'climate change' and 'recreation'.

One implication of a bioeconomy is an increased utilization of wood, not only for construction, pulp and paper and new chemical treatment but also for the substitution of fossil energy sources. Hence, the *material vs. energetic utilization of wood* is a particularly relevant category of forest ecosystem services trade-offs also in the typology of Juerges et al. (2021). If used as material, wood can substitute energy-intensive materials whereas if it is used directly for energy production, it can substitute fossil energy sources (Werner et al., 2010). The underlying trade-off can result in conflicts if competition for wood is fueled by policies promoting on the one hand its use as material and on the other hand its use for energy production (Guo & Gong, 2019).

Another relevant promise of a bioeconomy is that it will provide natural carbon storage capacities. Managing the forest to optimize carbon sequestration within the forest is an interesting new potential source of income for forest owners, however, it implies increasing the biomass stock in the forest through active management and beyond what is possibly provided by non-managed surfaces already. *Timber provision vs. carbon sequestration* is thus a forest ecosystem services trade-off to consider. It results in conflict between policies that promote harvesting wood (either for material or energy purposes) and policies that rather promote carbon sequestration and storage in standing forests (Ellison et al., 2014; Geijer et al., 2011).

A further potential forest-based bioeconomy sector is recreation. For some new forms of outdoor recreation that heavily depend also on the forest, in particular bike trails, a sharp increase in demand can be observed over the last decade. At the same time, this kind of forest utilization is often not sufficiently regulated (Pröbstl-Haider et al., 2018). Hence we consider *timber provision vs. cultural ecosystem services in particular recreation*, as a further relevant class of bioeconomy related forest ecosystem services trade-offs.

Finally, it is particularly interesting that Juerges et al. (2018) have included 'wind energy projects in forests vs. other uses' as a relevant conflict that arises from the fact that forests sometimes provide ideal conditions for the location of certain types of infrastructure. Forests often provide interesting locations for renewable energy infrastructure, such as hydro – and wind – energy facilities, as several factors favor the construction of these facilities close to or in the forest: comparatively low land prices, the prevalence of forests on hilltops exposed to wind and in steep terrain for hydropower, as well as a tendency to find sufficiently remote sites to keep the disturbances for the settlement area low (Höfer et al., 2016). However, there also exist other similar uses of forested land: disposal sites for construction material or quarries, that might be attributed to a 'circular

economy' that aims at closed resource cycles. Hence, we find a trade-off between *maintaining forest cover vs. removing forest to provide space for other sustainable economy infrastructure*, which relates to the issue that there can also be competition for the very land a forest grows on (Troxler & Zabel, 2021).

Of the conflict categories provided by Juerges et al. (2021), we do not consider 'hunting', 'cultural heritage' and 'nature conservation'. These ecosystem services can of course be affected by increased harvesting and thus are relevant as possible restrictions. Biodiversity conservation is potentially in conflict with increasing harvest levels or other forms of forest utilization. As an example, full tree and stump extraction for fuelwood purposes minimizes deadwood availability for saproxylic beetles and finally also further ecosystem services (Eyvindson et al., 2018). However, nature conservation, hunting and cultural heritage are not services we expect to be exploited by a bioeconomy so much and as such, they are not in the foreground of our analysis.

4. Methods

We compare how bioeconomy strategies address the trade-offs, their ensuing conflicts and the related governance challenges for two countries from two distinct biogeographical regions: Switzerland and Germany from the temperate zone and Sweden and Norway from the boreal zone. These pairs of countries represent differing forestry paradigms and approaches to sustainable forest management, with the temperate zone countries reflecting the 'multipurpose forestry' paradigm and the boreal zone the 'sustained yield' paradigm. The two countries of each forest management paradigm can be differentiated with respect to the relative strength of the forestry sector, which is somewhat stronger according to various indicators (such as e.g. the contribution of the forest sector to gross value added or the volume of marketed roundwood) for Sweden and Germany, respectively (Forest Europe, 2020, p. 95 and 236).

Our aim is to compare the official 'national bioeconomy strategies' across these cases. Sweden issued an official bioeconomy strategy in 2012 (SEA et al., 2012). Norway's bioeconomy strategy was published in 2018 (Norwegian Ministries, 2018) and is a very comprehensive document in terms of length and topics covered, similar to the German bioeconomy strategy (BMEL, 2014) which is already a follow-up of an earlier bioeconomy research strategy. With respect to forest, the German strategy paper mainly references the German forest strategy (BMELV, 2011). Switzerland lacks a dedicated bioeconomy strategy but is currently evaluating the need for such an explicit policy paper. We will thus primarily make references to the Swiss forest strategy (BAFU, 2013) and related strategy documents, such as the 'Energy-Strategy 2050' (Schweizerischer Bundesrat, 2013) and 'Resource Policy Wood' (BAFU et al., 2017).

In these strategy documents, we identified text that explicitly refers to the forest and to forest management implications of a bioeconomy and addresses governance challenges (coherence, consistency and congruence) with respect to the above-mentioned trade-offs and ensuing conflicts. To do so, we developed a corresponding coding scheme that is listed in Table 1: the strategy documents may more generally refer to the trade-offs in the first column or they may even acknowledge that there are conflicts arising from these trade-offs. They further may address instruments that should tackle these trade-off classes or even more explicitly refer to the conflicts identified. Finally, they may even mention 'multifunctionality' (or a similar term) as something that is either challenged (Switzerland, Germany) or that should be considered more (Norway, Sweden). The content analysis as such was conducted simply by reading the documents and marking content that corresponds to the nine categories listed in Table 1. As the documents are all not very long and do not refer to our categories very often, this turned out to be a feasible and sufficient coding strategy.

5. Empirical review of bioeconomy strategies

Table 2 summarizes the findings from the content analysis, which shows that the bioeconomy strategies address (some) trade-offs between forest ecosystem services. However, they add virtually nothing with respect to how resulting conflicts could be addressed (coherence), they are also rather silent about a consistent coordination of policy instruments and they do not actively challenge the prevailing forest management paradigm and thus are not addressing congruence.

Table 1. Coding scheme for the examination of trade-offs and resulting conflicts in the biodiversity strategies.

Trade-offs	Coherence (concerning potential conflicts)	Consistency (concerning instruments)	Congruence (concerning forest management paradigm and planning)
Industrial vs. energetic utilization of wood	• Are industrial utilizations of wood and pulp and the energetic utilization of wood (fuel wood) mentioned as bioeconomy strategies? • Is a potential goal conflict between these two options mentioned?	• Are any implications for forest management mentioned arising from the increasing utilization of fuel wood or new industrial exploitations of wood? • Are any instruments mentioned to explicitly deal with the goal conflicts (agreements, subsidies) • Is the need for coordinating instruments mentioned (industrial wood / fuel wood)?	If challenges or more specific implications for forest management are mentioned, do these imply a partly renunciation from the prevailing forest management paradigm, i.e. from either 'multiple service forestry' (the multifunctional provision of most / the most important forest ecosystem services within the same forest area/stand as far as possible; Switzerland and Germany) or 'sustainable timber production' (allowing but also requiring a stronger spatial segregation of forest functions; Norway, Sweden)?
Timber provision vs. carbon-sequestration (in the forest)	• Are carbon sequestration in wood and in the forest mentioned as a possible bioeconomy strategies? • Is a potential goal conflict between these two options mentioned?	• Are any implications for forest management mentioned arising from carbon sequestration in wood or forests? • Are any instruments mentioned to explicitly deal with these goal conflicts (e.g. certificates, climate fund, cascading wood use, carbon tax, subsidies for wood mobilization)? • Is the need for coordinating instruments mentioned (wood processing and forest management)?	
Timber provision vs. cultural ecosystem services (in particular recreation)	• Is a goal conflict with respect to forest recreation framed as a conflict between bioeconomy options or as a conflict between the bioeconomy and recreation as a limiting factor?	• Are any implications for forest management mentioned arising from the increasing need to provide recreation forests? • Are any instruments mentioned to explicitly deal with these goal conflicts (e.g. planning, capacity building, payments for ecosystem services)? • Is the need for coordinating instruments mentioned (spatial planning and forest management)?	
Maintaining forest cover vs. removing forest to provide space for other sustainable economy infrastructure	• Are land use conflicts mentioned between the forest and energy infrastructure or quarries, disposal sites etc.? • Are land use conflicts mentioned between agriculture and forest (e.g. forest clearance compensation)?	• Are any implications for forest management mentioned arising from the increasing need to provide space for infrastructure in the forest? • Are any instruments mentioned to explicitly deal with these goal conflicts (e.g. planning, regulation)? • Is the need for coordinating instruments mentioned (spatial planning / forest area preservation)?	

5.1. Material vs. energetic utilization of wood

Material and energetic utilization of wood are core elements of all bioeconomy documents. The German bioeconomy strategy refers to both. It emphasizes innovative material uses but also mentions the importance of fuelwood particularly for heating energy (BMEL, 2014, p. 35). However, no dedicated instruments are suggested and serious trade-offs are not anticipated. The same holds more or less true for the Swiss forest strategy that

Table 2. Trade-offs, the resulting goal conflicts and how they are addressed the bioeconomy strategies.

Trade-offs	Coherence (concerning potential conflicts)	Consistency (concerning instruments)	Congruence (concerning forest management paradigm and planning)
Industrial vs. energetic utilization of wood	DE: No goal conflict mentioned CH: No goal conflict mentioned SE: mentioned implicitly NO: No goal conflict mentioned	DE: No instruments mentioned CH: No instruments mentioned SE: Forest management implications, information instruments NO: No instruments mentioned	DE/CH: Multifunctional forest management approach potentially challenged by promotion of forest sink. SE: 'Multifunctional cultivation system' can be interpreted as challenging the rather segregative SFM approach, explicitly mentioned NO: Forest planning to better disentangle biodiversity preservation and timber production is not challenging SFM approach.
Timber provision vs. carbon-sequestration (in the forest)	DE: Wooden and forest sink mentioned without goal conflict CH: Wooden and forest sink mentioned without goal conflict. Goal conflict with fuel wood SE: No goal conflict mentioned NO: Wood sink and substitution potential emphasized, forest sink barely mentioned and goal conflicts not at all	DE: Sustainability certification, forest climate fund CH: CO2 certificates and cascading of fuel wood SE: No instruments mentioned NO: Extensive references to support for research, carbon tax, emission trading, government support for wood mobilization	
Timber provision vs. cultural ecosystem services (in particular recreation)	DE: Restriction for timber production but market opportunity in forest strategy CH: Restriction for timber production but also market opportunity SE: Restriction for timber production NO: Restriction for timber production	DE: Procedural instruments (capacity building) CH: Forest planning and (private) compensation schemes SE: No instruments mentioned NO: No instruments mentioned	
Maintaining forest cover vs. removing forest to provide space for other sustainable economy infrastructure	DE: Goal conflict between agricultural and forest land CH: No goal conflict mentioned SE: No goal conflict mentioned NO: Goal conflict between agricultural and forest land (biodiversity action plan)	DE: Procedural instruments CH: No instruments mentioned SE: No instruments mentioned NO: Land use planning	

mentions fuelwood and material uses of wood as the two dimensions of wood mobilization that should be accomplished (BAFU, 2015, p. 18f). Even the Swiss Energy Strategy places material and energetic uses of biomass at the same level but also mentions this only once (Schweizerischer Bundesrat, 2013, p. 7659). According to the resource policy paper (BAFU et al., 2017, p. 24), it should be possible to increase the amount of fuelwood by about half of the currently utilized amount without impairing other functions and goals. This adds to the impression that the Swiss actors perceive either no or no serious trade-off situation here.

Also, the Swedish biodiversity strategy does not discuss the potential trade-off between material and energetic use of timber explicitly (SEA et al., 2012, p. 24). In contrast to the German and Swiss strategy papers, though, it does differentiate between energy crop and energy assortment (using the wood that cannot be otherwise processed) and emphasizes the knowledge and logistics requirements of more 'multifunctional production systems'. It thus acknowledges such a trade-off implicitly.

The Norwegian Bioeconomy strategy mentions fuelwood extensively (Norwegian Ministries, 2018, p. 18 and 65) but never makes an explicit reference to trade-offs with other uses of wood. Rather different programs for wood mobilization for energetic and material utilizations are mentioned in parallel and it is emphasized that the different wood utilizations are aligned along a value chain in a harmonized way. It is also pointed out at different occasions that Norway has abundant forest resources and that the Government is determined to support mobilizing these in the future (Norwegian Ministries, 2018, p. 53).

Most of the bioeconomy strategies estimate that forest resources are sufficient and that the related trade-offs are mostly negligible. The exception is Sweden that identifies a need for an integrated provision of fuelwood and timber on the same surfaces.

Accordingly, the need for specific instruments seems to be unnecessary as far as wood mobilization is concerned, apart from Sweden which is the only country that mentions forest management implications.

In Sweden, the prevailing forest management approach is addressed by acknowledging 'multifunctional cultivation systems' to reconcile material and energetic utilization of wood (SEA et al., 2012, p. 24). It is expected that increasing wood mobilization for both purposes will require developing respective knowledge.

5.2. Timber provision vs. carbon sequestration

Carbon sequestration in wooden products is mentioned rather prominently in the German bio-economy strategy. There are various references to long-living wooden products (p. 35) and product cascades, explicitly also mentioning wood and pulp and particularly also scrap wood. Also 'sustainability certification' is mentioned as one instrument. With respect to carbon sequestration more generally, however, the strategy makes rather general references to the German forest strategy paper. In the latter, forest as a carbon sink is explicitly mentioned, as is a particular instrument, the 'Forest Climate Fund' that should tackle trade-offs between fuelwood and carbon sequestration in wood and forest. The German forest strategy mentions the carbon sink in forests (BMELV, 2011, p. 11) and promotes measures to maintain this sink and to include wooden products in the calculation. More detailed information with respect to instruments and particularly CO_2 certificates for the forest are not given.

For the Swiss context, it is noticeable that carbon sequestration in forests and wood is not explicitly mentioned by the Swiss energy strategy, which is very much focusing on climate policy by emphasizing strategies and instruments to mitigate CO_2 emissions. Carbon sinks are discussed at length by the forest and resource policy strategy papers, though. The management and optimization of the carbon sink in forests and wood is an important part of the forest strategy (BAFU, 2013, p. 60f). It is directly also linked to the CO_2 emission reduction commitment at the international level (Kyoto Protocol) and also mentions CO_2 certificates as a possible future instrument to be implemented. The resource policy paper further contains a reference to fuelwood as it supports cascading wood products and emphasizes the improved carbon balance of employing scrap wood as fuelwood (BAFU et al., 2017, p. 22).

Carbon sequestration in wooden products or the forest is not mentioned at all in the Swedish bioeconomy strategy. New products derived from timber are the primary perspective of the Swedish bioeconomy strategy but even this perspective does not argue with the carbon sequestration potential. However, the strategy does mention other ecosystem services for which it might be hard to derive a price tag and gives water regulation as an example (SEA et al., 2012, p. 28). Although this could be interpreted as an invitation to also commodify non-timber products, it is rather formulated in a way that emphasizes the more general need to protect such alternative ecosystem services.

Achieving a reduction in climate gas emissions is an overarching objective of Norway's strategy (Norwegian Ministries, 2018, p. 18f) and both, the potential to substitute carbon-intensive products and to store carbon in durable wooden products shall be achieved by producing, extracting and efficiently using biomass. Keeping trees in the forest for the mere sake of carbon sequestration is not in line with this approach, although it is also mentioned, rather as a side note (Norwegian Ministries, 2018, p. 56). The document contains extensive references to procedural instruments such as networking programs (pp. 29 and 32), information instruments (p. 38) financial instruments such as investment aids (p. 46), and regulation to reduce waste (p. 49). Most relevant for the forest sector, however, is the announcement of government support (most probably subsidies) for intensified logging (p. 55f) combined with stricter environmental standards. The vision of a bioeconomy is further embedded in climate policy and thus synergetic to planned and already implemented emission taxes and emission trading schemes (p. 39f).

Carbon sequestration is mentioned by most strategies. We find, however, that Norway and Sweden are reluctant to mention the forest sink at all while no trade-off with industrial utilization of wood is identified

for the carbon sink in durable wooden products or fuelwood. This is quite different for Switzerland and Germany. It is particularly striking that the forest sink is not only mentioned but also promoted to some extent in both cases. Although the inherent trade-off is not mentioned explicitly, this can still be taken as a potentially supporting coherence.

The most comprehensive treatment of policy instruments concerns carbon sequestration. This goes beyond procedural instruments in Germany and Switzerland and seems rather consistent, combining different economic and informational instruments or combining the sink in wood and forests. Apparently, although ignoring the forest sink, also the Norwegian strategy paper suggests a rather consistent list of instruments in this realm.

Although mentioning the carbon sink in the forest can be seen as a consequence of the prevailing multifunctional sustainable forest management approach in Germany and Switzerland, it potentially also challenges multifunctional forest management. As it implies increasing the forest biomass on large areas over long time-horizons, it eventually would also be competing with wood production on productive surfaces. Reconciling this trade-off would then require a spatial delineation of these production systems. These consequences are not mentioned which leaves some potential for incongruence.

5.3. Timber provision vs. cultural ecosystem services

The recreational function of forests is mentioned in the German bioeconomy strategy (BMEL, 2014, p. 50 and 52) but only among other forest functions that have to be considered (and again a reference is made to the forest strategy) and to be protected from negative impacts of increased logging. The German forest strategy deals with the topic extensively (BMEL, 2014, p. 35), and mentions the compensation of special, professionally organized, recreational offers and the need to explore these market opportunities with the concerned sport associations.

The Swiss forest strategy also contains its own section on forest recreation (BAFU, 2013, p. 45ff) and similar to the German case, recreation is either depicted as a weak forest function that has to be protected or as a threat to the forest. Moreover, compensation strategies for 'recreational forests' are strongly supported.

The Swedish and the Norwegian bioeconomy strategies don't identify forest recreation as serious alternative markets that could be worth exploring by the forest sector. In the Swedish case, it is only mentioned among other uses of the forests that could come into conflict with increased harvesting to meet the needs of the energy sector and the timber processing industry (SEA et al., 2012, p. 28). In the Norwegian bioeconomy strategy, it is also merely identified as a restriction for forest management, although it receives more attention (Norwegian Ministries, 2018, p. 56 and 63).

Forest recreation is merely mentioned as a restriction for wood mobilization in Sweden and Norway, while in Switzerland and Germany it is also presented as a potential market opportunity, which gives it more weight relative to wood mobilization.

Germany and Switzerland mention planning and compensation schemes relative to forest recreation, as do Germany and Norway with respect to conflicts between different land-use sectors.

5.4. Maintaining forest cover vs. removing forest

The German bioeconomy strategy makes an explicit reference to land-use competition and biodiversity offsetting in its section on the 'competition over surfaces' (BMEL, 2014, p. 66). It emphasizes that too much agricultural (and forested) land is lost in favor of settlement and traffic and that the quality of biodiversity offsetting should be increased and regulation should be harmonized. However, the strategy also stipulates that compensation on agricultural land must decrease. Although it is not mentioned explicitly, this can have the consequence that biodiversity offsetting will sidestep into the forest, to some extent. The government has started a 'dialog-forum' on that matter although it does not seem to be very active at the moment of writing.

In Switzerland, land-use competition between different sectors is not mentioned by any of the strategy papers examined so far. This is notable, as Switzerland is very densely populated. Land-use competition is also not mentioned in the Swedish case. The Norwegian bioeconomy strategy makes references to the Norwegian biodiversity strategy (Norwegian Ministry of Climate and Environment, 2016) concerning land-use conversion. Although this strategy paper extensively deals with the impact of land-use conversion on biodiversity, it mentions the trade-offs outlined above only very indirectly: it contains a section on ecological compensation, which, however, does not mention forests directly (p. 23ff) and a section on 'mountains' also refers to infrastructure for wind power but without mentioning potential locations in the forest (p. 37). As far as Norway is concerned, its bioeconomy strategy strongly emphasizes an extensive list of instruments to implement environmental restrictions for the announced rather aggressive wood mobilization strategy (Norwegian Ministries, 2018, pp. 57–59). However, it is also mentioned that forest planning should help to differentiate high production areas from old and other forests suitable for nature protection, which reassures the prevailing rather segregative forest management approach.

6. Discussion

Our first expectation is largely confirmed: the examined bioeconomy strategies avoid addressing incoherence between goals and thus also tend to neglect coordinating policy sectors by explicitly pointing out trade-offs between different ecosystem services. Our findings are also in line with our second expectation and the literature (Aggestam & Pülzl, 2018; Kleinschmit et al., 2017), which indicate that the bioeconomy strategies seem to avoid emphasizing complementary policy instruments between sectors. Finally, our analysis also establishes that the prevailing forestry paradigm is not openly questioned and thus congruence is not addressed by the bioeconomy strategies examined, except for Sweden. In line with this latter finding, Bennich et al. (2018) found that experts interviewed about a potential shift to a bioeconomy in Sweden emphasized the need for a 'shift to diversified forestry' as the primary requirement and hence away from the current 'sustained yield' paradigm.

We expected that indicating incoherence would be avoided less by the countries with a multifunctional forest management paradigm. This can be confirmed for forest recreation to some extent, although none of the strategies spells out incoherence clearly. A similar differentiation between the countries from the temperate and the boreal forest zone can be made out for carbon sequestration, particularly the forest sink.

The above differentiation is not so straightforward anymore for land-use conflicts between different bioeconomy or low carbon land-use sectors. Only Germany and Norway address related land-use conflicts. While suppressing environmental and land-use concerns seems to be symptomatic for the Swedish case (Fischer et al., 2020), the strong legal protection of the forest surface in Switzerland might be the reason for the lack of emphasis of this topic there.

We expected the bioeconomy strategies to avoid the identification of (combinations of) substantive instruments and rather to suggest procedural instruments. While the bioeconomy strategies mention procedural instruments often in relation to recreation and land-use conflicts, it is also striking that Germany and Switzerland but also Norway did not shy away from outlining quite comprehensive instrument mixes particularly with respect to carbon sequestration. Although limited to carbon sequestration in wooden products and thus promoting it as an extractive utilization, particular care is given to mentioning mutually supportive instruments for carbon sequestration in timber in the German, Swiss and Norwegian policy strategies. This somewhat contradicts the finding of Kleinschmit et al. (2017) that policy integration attempts tend to avoid explicitly outline implications at the more concrete policy instruments level.

One important observation from these findings is that coherence and consistency appear to be higher if the bioeconomy strategies conceive alternative forest utilizations not solely as restrictions on extractive forest utilization but as viable market opportunities. This seems to be the case more for non-extractive forest utilizations (carbon sequestration in forests and recreation) in countries with a multifunctional forestry paradigm.

However, as expected the bioeconomy strategies are not seriously challenging the forestry paradigms and they do refer to planning approaches rather only with respect to recreation and land-use conflicts but not with

respect to carbon sequestration or conflicts related to the utilization of wood. In Switzerland and Germany, incongruence can be expected to be particularly relevant with respect to carbon sequestration in the forest, as this, if implemented on a grand scale, would challenge conventional forest management and multifunctionality (compare the topical dispute regarding the respective claims made by Schulze et al., 2020). In contrast, although the Swedish strategy does not consider less conventional products or the need to integrate goals from other sectors as something relevant for the bioeconomy aspiration, it nonetheless mentions the need to contain potential negative consequences of the prevailing, rather segregative forestry paradigm. In that respect, the Norwegian bioeconomy strategy differs: it is strongly embedded in a broader climate policy discourse and does make extensive references to other forest uses – albeit merely as restrictions to wood mobilization rather than as alternative sources of income. Still, the prevailing forestry paradigm remains.

All in all, while the bioeconomy strategies examined all strongly refer to the forest and wood sectors as a central pillar of the bioeconomy, they do not extensively address the inherent contradictions and potential trade-offs, as it is postulated by Ahlqvist and Sirvio (2019). This may have negative consequences: Kröger and Raitio (2017), for instance, demonstrate for the Finish case how ignoring conflicts in the policy discourse hinders a more comprehensive governance framework, which would be needed to avoid the apparent deficiencies in the regulation of forest utilization (Borgstrom, 2018) in order to mitigate the negative consequences of a growing forest-based bioeconomy.

While bioeconomy strategies cannot be expected to give strong impulses for an 'ecological perspective on economics' (Boecher et al., 2020), it would also be short-sighted to expect them to simply reference and reproduce the existing forestry paradigm. As Hafner et al. (2020) establish for Germany, professionals in wood-based sectors of the bioeconomy typically do not reflect the concept and tend to give it a rather narrow interpretation in their own interest. Even scholarly research on the bioeconomy tends to be guided by these documents and thus 'reproduces a weak approach to sustainability' (Holmgren et al., 2020, p. 1860). According to Hafner et al. (2020), for a more comprehensive understanding to become prevalent, actors expect politics to provide them with coherent guidelines and framework conditions.

7. Conclusion

The aim to move toward a bioeconomy poses governance challenges in terms of the coherence of policy goals across the economic sectors affected, the consistency of instruments and the congruence between the two. The bioeconomy strategies examined largely ignore these challenges, particularly coherence, either because the conflicts are not pressing enough or because mentioning conflicts is generally avoided to prevent far-reaching policy reform. Still, our results indicate that coherence and consistency can be expected to be addressed if the forest utilizations are attributed as having a certain market potential for which a trade-off is assumed or experienced. This is more often the case for countries in which the forest sector is economically less important and based on a multifunctional forestry paradigm. We argue that this is an important aspect that should also be strengthened in the future for countries with a 'multipurpose forestry' paradigm. Adhering to multifunctionality in a strict way, i.e. trying to safeguard a high number of forest functions within one and the same forest stand, may become increasingly challenging in the context of a bioeconomy.

Our findings demonstrate that bioeconomy strategies advance the integration of forest policy with other sectors in very selective ways and without challenging the underlying forest management paradigm. Trade-offs in and with the forest and wood sectors that are inherent with a shift toward a bioeconomy are not (yet) fully addressed by these strategies and references to related strategies are rare. However, the latter is more frequent in the more recently published and more comprehensive bioeconomy strategies of Norway and Germany. As efforts to develop the bioeconomy accelerate in the years to come, forest-related trade-offs are likely to become more pronounced in practice. While perhaps having missed opportunities to pre-emptively lay the ground for smooth coordination across sectors affected by a bioeconomy, it remains to be seen whether bioeconomy strategies will improve their potential to foster policy integration toward a bioeconomy.

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