

From pure science to participatory knowledge production? Researchers' perceptions on science–policy interface in bioenergy policy

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Abstract

There is a plea for dialogue and interaction between researchers and policymakers, particularly in relation to burning and complex societal problems. However, day-to-day science–policy interaction remains a challenge. By investigating researchers' perspectives on challenges and opportunities of evolving interaction between science and policy, this article contributes to the ongoing discussions on workable and effective science–policy interface. The analysis, based on twelve in-depth interviews with experienced forest bioenergy researchers working at different organizations in Finland, shows that researchers appreciate a variety of roles and contributions from *pure scientist to participatory knowledge production*. Paradoxically, researchers ideologically still adhere to objective and linear knowledge production, which is, however, associated with multiple challenges such as politicization of science, disuse or misuse of scientific knowledge and communication. The article concludes that more nuanced consideration and acknowledgement of science–policy context as well as researchers' role in it could create mutual benefits for research and policy.

Key words: science–policy interface; scientific knowledge; boundary work; researchers' role; forest bioenergy policy.

1. Introduction

Researchers' role has changed. No longer can researchers be perceived as objective and autonomous knowledge producers sitting in ivory towers and speaking truth to power. For decades, this traditional view of science's linear and objective contribution to decision-making has been refuted by different scholars emphasizing the importance of various forms and uses of knowledge as well as blurred and interactive boundaries between science and society (Funtowicz and Ravetz 1993; Jasanoff 2004; De Pryck and Wanneau 2017). It has been pointed out that for current societal and environmental problems, often labelled as post-normal or wicked, dialogue and interaction between policymakers and researchers as well as other actors holding different views with respect to policy issues is essential (Funtowicz and Ravetz 1993; Whitmer et al. 2010; Doubleday and Wilsdon 2012; Turnhout et al. 2013). The term science–policy interface (SPI), defined as 'social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making' (van den Hove 2007: 807), has become established. An increasing number of funding agencies and research programmes nowadays strongly emphasize interactive knowledge

production, such as co-design, co-production and co-dissemination of research, as well as 'solution-oriented science engagement' (Mauser et al. 2013; Lee 2015; van der Hel and Biermann 2017).

These episodes have challenged academia to consider new roles and practices that are suitable and fruitful for researchers collaborating with policymakers in different political arenas (Cornell et al. 2013; Turnhout et al. 2013). As pointed out by Porter and Dessai (2017), SPI requires that researchers 'not only need to be committed and willing to interact with [knowledge] users but also have the capacity to listen to, understand, and respond to their needs'. Researchers should also be able to reflect and elaborate the context of SPI shaped by factors such as the complexity of the policy problem, the type of policy area, organisational norms, actor constellations and continuance and openness of information sharing (Saarela et al. 2015). In addition, Kunseler and Tuinstra (2017) have described that researchers need to navigate 'the authority paradox', a situation in which 'there is a need for objective scientific advice, but such advice can only be acquired from experts and expert agencies whose objectivity and hence, authority, are contested'. Sundqvist et al. (2017) have portrayed current attempts to describe and improve SPI as an ongoing and partly paradoxical attempt to balance between the two ideal-type interpretations: a 'two-worlds' and a 'one-world' perspective. The first considers science and policy

as separate spheres—and the separation is deemed problematic for SPI. The second understands science and policy as integrated—and the tight link is regarded as a cause for problems in SPI.

How researchers nowadays perceive their evolving roles in relation to policy processes is a relevant question, not only for individual researchers balancing in between research and policy, but above all for general understanding and improvement of SPI. In this article, the issue is approached by concentrating on SPI around forest bioenergy policy in Finland—a bundle of policies touching upon climate change mitigation, energy security as well as rural and national economy (Söderberg and Eckerberg 2013). Forest bioenergy policy is a topical example of an issue where ‘facts are uncertain, values in dispute, stakes high and decisions urgent’ (Ravetz 1986: 422) and which calls for researchers to employ new practices in interacting with and communicating policy. Hence, it acts as a ‘critical case’ (Flyvbjerg 2006) for investigating and reflecting researchers’ perspective in a real-world ‘competing claims context’ (Giller et al. 2008; Schut et al. 2014). With this article, I contribute to the previous research on SPIs by focusing on problems and opportunities of current SPIs and increased collaboration between research and policymaking from researchers’ perspective. By giving and reflecting examples of researchers’ perceptions, I will shed light on two specific research questions:

1. How do researchers perceive their evolving roles and contributions in relation to forest bioenergy policy processes?
2. What barriers and challenges researchers face in science–policy interaction, and what motivates researchers?

I begin the article by describing how researchers’ roles and associated challenges have been discussed in the literature, followed by a description of forest bioenergy SPI in Finland. The results from in-depth interviews and interpretative analysis portray researchers’ practical perspectives on their role in the policy processes as well as researchers’ illustrative examples of current science–policy processes. At the same time, I touch upon challenges related to the science–policy nexus and conclude with suggestions on how to improve the SPI.

2. Conceptual framework: researcher’s role, practices, and challenges in SPI

To understand, reflect, and advance the SPI, researchers’ roles in policy processes as well as researchers’ perceptions have been studied, discussed, and conceptualized in academic literature for decades with abundant approaches and by different disciplines (e.g. Hoppe 2005; Waterton 2005; Pielke 2007; Pohl et al. 2010; Turnhout et al. 2013; Spruijt et al. 2016; Kunseler and Tuinstra, 2017; Porter and Dessai 2017; Youngjae et al. 2017). A number of conceptual frameworks and typologies have been developed to explain and reflect various roles researchers may play in relation to policy processes and factors affecting the relevant roles and relationships (e.g. Weiss 2003; Hoppe 2005; Pielke 2007; Hoppe 2005; Michaels 2009; Turnhout et al. 2013; Schut et al. 2014; Spruijt et al. 2016; van der Hel and Biermann 2017). Although most of the typologies are oversimplified and present the role of researchers as general, static and idealized compared with real-world complexity, complementarity and flexibility of roles, they provide a solid analytical framework as well as a framework for reflection (Hoppe 2005; Pielke 2007; Turnhout et al. 2013).

A central observation is that researchers assume and employ different roles for communicating and translating scientific knowledge in different kinds of situations (Michaels 2009). Like Pielke (2007: 135) stated ‘scientists have choices about if, how, and when they decide to become actively engaged in policy and politics’. Therefore, in this article, a typology for researchers’ role in policy processes developed by Pielke (2007) and complemented by Turnhout et al. (2013) is adopted (Table 1). The roles demonstrate a spectrum of formal or informal interaction, so-called boundary work (Gieryn 1995) between researchers and knowledge users. The first role is *pure scientist* who focuses on research without consideration of its societal use and has no or very limited interaction with policymakers. Knowledge provided to policymakers is often data (Turnhout et al. 2008) and may take the form of paper exchange or an invited presentation. Thus, it closely resembles the traditional view of science’s linear contribution to policymaking, which emphasizes that ‘any engagement with policymakers or other potential users of knowledge is considered to be problematic because it signifies a lack of independence and objectivity and threatens the authority of science’ (Turnhout et al. 2013: 355). The second role is *science arbiter*, who acknowledges that policymakers may have particular questions that need to be addressed in (restricted) interaction with researchers. Science arbiter focuses on issues that can be resolved, in his/her view, by science and avoids normative questions, and may employ ‘interactional expertise’ (ability to master the language of a specialist domain in the absence of practical competence) and/or ‘referred expertise’ (use of an expertise learned in one domain within another domain) (Collins and Evans 2007). The third role, *issue advocate*, differs from the previous roles as it focuses on the implications of research for a particular political agenda. Here, the interaction between researchers and policymakers is accepted and even seen as necessary for advancing the special interest through policy. Providing arguments can be seen as the essential form of information (Turnhout et al. 2008). The fourth role is for an *honest broker*, who actively interacts with different actors to produce, signal, clarify and/or communicate knowledge-based alternatives for policymaking. Here, knowledge can include scientific knowledge and stakeholder concerns alike and interaction is actively managed. Interaction is often face-to-face, iterative and recurrent; they enable people to say more than they are able to write down (Snowden 2002). The distinction between the third and fourth role is that often advocacy is portrayed as a value-based and half-supported promotion, whereas honest brokering is portrayed as neutral mediating (Gitzen 2007; Pielke 2007; Garrard et al. 2016). To the typology by Pielke (2007), Turnhout et al. (2013) added a fifth role: *participatory knowledge producer*. This role acknowledges a need to actively engage policymakers in the production of knowledge-based policy alternatives and in the facilitation of more long-term learning. Interaction is thus intensive across blurred and socially constructed boundaries between science and policy (Gieryn 1995) in the spirit of co-producing knowledge and social order (Jasanoff 2004: 2).

It is essential that different kinds of roles and associated interaction means and outputs are appropriate for different kinds of policy problems or at different phases of the policymaking process, and that carrying out different activities requires different competencies (Michaels 2009). For example, a structured problem (that is a problem associated with certainty on knowledge and a high degree of consensus) might benefit from a data-type of knowledge provided by a researcher (a problem solver), whereas for an unstructured problem (neither a consensus nor certainty over issue exists) a

Table 1. Five roles for researchers in policy processes (based on Pielke 2007; Turnhout et al. 2008; Turnhout et al. 2013).

Role	Activity	Interaction with policymakers	Form of knowledge/information provided
Pure scientist	Focusing on knowledge production and facts	No or minimum interaction	Mainly scientific data
Science arbiter	Answering specific questions posed by the policymakers/decision makers	Low/restricted	Scientific data acquired from various sources
Issue advocate	Promotion one specific solution	Intermediate—intensive	Mainly arguments
Honest broker	Expanding and clarifying the range of alternative solutions	Intermediate—intensive	Alternatives based on various knowledge sources
Participatory knowledge producer	Addressing problems and developing solutions, joint knowledge production	Intensive	Co-produced knowledge

‘problem signaling’ approach could be more useful (Turnhout et al. 2008: 229).

Identification of SPI or taking on new roles has often proven to be challenging for a researcher who is educated to carry out research in a specialized field (Cash et al. 2003; Corcoran and Wals 2004; Cornell et al. 2013). Studies have also proposed that existing institutions, practices, professional norms, power balances, and views on researchers’ role that persist in academia and policymaking might also cause problems (Innes 1998; Owens et al. 2004; Edelenbos et al. 2011, Davies et al. 2014; Spruijt et al. 2016). The researchers themselves might also be reluctant to collaborate because devoting time to science–policy interaction might complicate publishing scientific papers (Sarkki et al. 2014; Hegger and Dieperink 2015) or be ‘inconsistent with real scholarship’ (Cash et al. 2003: 8090). In addition, the fast cycles of political decision-making is demanding for knowledge production and especially for scientific consensus formation (Collins and Evans 2002; Sarkki et al. 2014). Different challenges and facilitators in SPI can be categorized, as done by Mitton et al. (2007: 737) in their review of health policy decision-making. They categorized these factors into four groups: individual level, organizational level, communication, and time-related factors. van Enst et al. (2014) have also stated that researchers’ strategic actions in knowledge production (presenting knowledge selectively, competing knowledge coalitions of scientists and deliberately producing incomplete knowledge) as well as operational mismatch between science and policy (employing different time frames and levels of abstraction; differences in terms of discourses, goals and rewards; lack of clear research questions; and policymakers’ insufficient access to knowledge) can significantly impede SPI.

3. Material and methods

3.1 Research context

Current political as well as scientific debate on forest bioenergy is very polarized in Europe (Söderberg and Eckerberg 2013). Discussion has escalated particularly around the question of carbon neutrality of forest bioenergy, but sustainability challenges related to biodiversity, soil productivity, and economic consideration have been addressed as well (Söderberg and Eckerberg 2013; Pelkonen et al. 2014; Peters et al. 2015). Some emphasize that forest bioenergy is carbon-neutral as the carbon released in burning the fuel will be bound again while the forest grows, which makes it a desirable substitute for fossil fuels. The others point out that to tackle global warming, an immediate reduction of carbon and other greenhouse gas emissions is needed. Hence, societies should restrain from increasing the use of forest bioenergy. Debate has been ongoing in scientific publications, in media (newspapers, blogs, social media)

and in political arenas. For example, researchers’ conflicting views on the issue were discussed, mainly by researchers, in the national media after the release of a report by The Finnish Climate Panel on the climate effects of forest use and the development of carbon sinks (Seppälä et al. 2015). While writing this article in autumn 2017, a group of EU- and US-based scientists, including a number of Finnish researchers, sent an open and publicly available letter to EU decision-makers, warning that a planned increase in harvesting levels for bioenergy use risks have a negative impact on the climate, biodiversity, and ecosystem resilience (EU letter LULUCF 2017). The letter was targeted to the ongoing EU decision-making on land use, land use-change and forestry (LULUCF) regulation (EC 2017a) and sustainability criteria for biomass in the Renewable Energy Directive (EC 2017 b). At the same time, views for and against were amply presented in Finland as well.

However, debate on forest exploitation is not anything new. Finland, being Europe’s most densely forested country (Finnish Forest Research Institute 2014) and having traditionally depended on forest-based well-being, has a long history of utilization of forest bioenergy as well as institutionalized forest policy-related SPI. Throughout the history of intensive forestry, national, regional and local policies and management decisions have strongly been linked to the forest sector. Significant resources have been allocated to a governance system with forest-related inventories, administration, planning, and research (Siiskonen 2007; Åkerman and Peltola 2012; Primmer et al. 2016). So-called environmentally-concerned and pro-forestry-oriented researchers utilizing different means to justify their (sometimes advocative) statements have often had opposite views on forest use and management, like the cases of the Northern Finland forest conflict (Sarkki and Karjalainen 2012; Saarikoski and Raitio 2013) and of different coalitions in revising the Finnish Forest Act (Harrinkari et al. 2016) demonstrate.

Government-affiliated research institutes, particularly the Natural Resources Institute (and its predecessor, the Forest Research Institute), but also Finnish Environment Institute, as well as a number of university departments have long contributed to the body of policy-relevant knowledge, but also mediated scientific knowledge into forestry and energy-related decision-making and management processes. As pointed out by van der Hel and Biermann (2017: 212) different institutions differ in their institutional design, the context in which they operate, and the ways they pursue salience, credibility, and legitimacy. The research institute’s role and mandate is to produce and disseminate sector-specific and society-relevant knowledge for decision-making, whereas universities have focused on teaching and basic research. Quite recently, the third and fourth mission, ‘entrepreneurial university’ and ‘a societal transformer’, have been proposed alongside the first and second

missions (Trencher et al. 2014). Quite recently, in 2012, the Finnish Climate Panel, consisting of fifteen scholars with different disciplinary and institutional backgrounds, was established to act as a knowledge broker between science and climate policy.

Recent national policy processes that directly or indirectly target forest bioenergy include, for instance, implementation of one of the five strategic priorities in the current Government programme: ‘Bioeconomy and clean solutions’ (PMO 2016), the National Energy and Climate Strategy to 2030 (MEE 2016), national renewable energy action plan (NREAP Finland 2010), National Forest Strategy 2025 (MAF 2015), development of more targeted policy instruments (e.g. feed-in tariff for renewable energies), preparation of national guidelines (e.g. recommendations for sustainable bioenergy harvesting), and regional or local planning of forestry management (e.g. regional forestry programmes). All of them have included elements or processes in which the role of scientific knowledge or actors has been central, for example, in the form of National Forest Inventory, an extensive, regularly conducted inventory of forest resources and ownership (LUKE 2017), commissioned impact assessments or a decision-making-targeted project funded by the Government (PMO 2017).

3.2 Material and analysis

The main source of evidence for this research is in-depth interviews with experienced researchers in the field of forest bioenergy policy in Finland. Altogether twelve interviews were carried out to explore researchers’ experiences in, perceptions of and practical examples of real-world SPI in the field. Selection of the interviewees was preceded by a document analysis that aimed at identifying discussion on forest bioenergy and its impact, finding experts and organizations who recently published on the topic and gaining an understanding of the ways in which scientific knowledge has featured the forest bioenergy debate in Finland. Documents included scientific papers, non-peer-reviewed research reports, policy documents, newspaper articles, and social media statements. The selection of interviewees aimed at ensuring a wide range of perspectives and was therefore based on three characteristics of the researchers: long experience in forest or bioenergy-related research, experience in science–policy interaction in real-life policy or management processes, and representation from different disciplines that contribute to forest bioenergy research.

All interviewees had performed basic research at some point in their career. Their current research orientation varied from basic to applied research and/or to science that primarily targets policy-making (what Jasanoff 1995, called ‘regulatory science’). Discipline background of the interviewees included ecology, forestry, forest economics, economics, engineering, statistics, and environmental science—ten researchers from public research organizations (the Natural Resources Institute and the Finnish Environment Institute) and two from Helsinki University. Finnish-language interviews were semi-structured (Bryman and Teevan 2005) and lasted for 60–100 minutes. A test interview was carried out to test the suitability of the questions, background information, and definitions. Approximately twenty open interview questions were arranged in three broad themes: roles of researchers in policy processes, science–policy interactions and practices in policy-making, and researchers’ perceptions of challenges of science–policy interaction and means to overcome them. All interviews were recorded and transcribed. The transcripts were coded with NVivo software according to qualitative, directed content analysis (Hsieh and Shannon 2005) in which

theoretical framework was used as guidance for initial codes. An iterative approach to coding and actual analysis (Tashakkori and Teddlie 2016) that included reflections between theoretical literature and empirical material was utilized. Some predefined codes were subdivided or merged and new codes were generated. During the analysis, interviewees’ experiences and reflections were first coded according to researchers’ role typology presented in Section 2 as well as researchers’ perceptions of challenges and opportunities. Leftover texts, including sections with irrelevant questions, were revisited throughout the process. The actual findings are results from iterative analysis, reflection, and the writing process. In the end, quotes selected for the results section were slightly edited to make them more understandable.

4. Results

4.1 Researchers’ different roles in Finnish forest bioenergy policy

Finnish forest researchers take on different roles in forest bioenergy policy processes via institutionalized and informal pathways. All five roles along the continuum from pure scientist to participatory knowledge producer were acknowledged and illustrated by the researchers. The majority of the interviewees described that the role depends on the actual process and project, and that the researcher can and should change or modify the role and perspective according to the context and situation. For example, in policy-oriented research projects, researchers are more focused on knowledge production and synthesis, whereas in an ongoing political process, researchers’ contribution is often oriented towards dissemination, reflection, and interaction with policymakers and other actors.

The interviewees commented and reflected pure knowledge production perspective in many cases throughout the interviews. However, they did not have very many concrete examples of *pure scientists’* contributions to policy processes. The examples were related to direct and invited input of an individual researcher in a written or oral form such as expert hearings in parliamentary committees, written commentaries on a certain policy document, or sending scientific publications directly to policymakers. Several interviewees strongly and consciously subscribed to the role of pure scientist on an ideological level. They described that they would rather focus on data/knowledge production, preferably in isolation from policy processes, than on science–policy interaction. Many interviewees pointed out that maintaining a clear boundary between science and policy is important for the sake of autonomy and objectivity of science as the following quote illustrates:

It is very detrimental for reliability of a researcher—and for science in general—when a researcher starts to advocate a ‘subjective’ agenda. The one and only acceptable agenda is to act as an objective and neutral representative of the discipline.

The interviewees emphasized that *objective* data production, such as National Forest Inventory, is important in national forest policy development as it provides the policymakers with accurate information about forest growth and structure. Strong scientific discipline, like economics, as well as scientific publications were mentioned to be an important basis for a pure scientist. Although peer-reviewed publications were described to guarantee, at least to a certain extent, reliability and quality, researchers acknowledged that scientific publications may not be suitable in political processes as they only poorly reach the policymakers. These researchers admitted that

targeted reports and invited speaking engagements at seminars are the most effective means to disseminate information for policy-making. Pure scientists' successes in relation to policy processes were often linked to direct input and use of scientific knowledge in specific questions as the following quote illustrates:

Our [...] study succeeded well and I was very happy to notice that the convincing evidence had a real impact on energy wood harvesting guidance that was under preparation then.

Although many interviewees pointed out that the scientific results produced by themselves are the most significant backbone for researchers' contribution to a policy process, they also emphasized a need to refer to disciplinary theories and findings of a broader scientific community. On a practical level, they explained, the contribution of science to forest bioenergy policy processes often means digesting, combining, and mediating knowledge from academic community beyond a researcher's own expertise, i.e., acting as a *science arbiter*. It was acknowledged that a single study seldom has any impact on policymaking, but instead, what counts is a large body of knowledge that is synthesized in a targeted manner. In these cases, researchers' expertise, competence and experience, also in terms of their basic education and discipline, were mentioned as being crucial.

Most interviewees had adopted a science arbiter's role in many policy-oriented research projects that they are currently or have recently been involved in. These projects are most often funded by different ministries and are dedicated to support a particular policy process. The interviewees mentioned a number of large, multidimensional and multi-actor policy processes, such as the development of Finland's National Forest Programme 2015, National Forest Strategy 2015, The Forest Biodiversity Programme METSO, Energy and Climate Roadmap 2050, regional forest programmes, and forest management guidance documents. Examples also included commissioned reports for national ministries and EU Directorates on forest bioenergy harvesting potential and carbon balances. Often a researcher's contribution consists of carrying out social, economic, and environmental impact assessment in multidisciplinary teams. Acting as a science arbiter was illustrated with two kinds of cases: (1) a researcher builds bridges between different research findings and produces synthesis on specific questions, also beyond his/her own expertise, and (2) a researcher individually attempts to raise policymakers' awareness of different perspectives on the issue based on the results gained by the broader scientific community. The latter was illustrated by an interviewee as follows:

Knowledge production means that you are aware of what is going on in a wider context. So, what is relevant or controversial in relation to the issue at hand. That you point out [to the policymakers] that a certain viewpoint [such as the difference between various time frames in carbon accounting] exists as well without having any political agenda yourself.

In addition, the role of 'entrepreneurial researcher', who is able to tackle, reflect, and communicate emerging topics, was described as an important role in the interviews:

An essential or one of the big roles is the role of an initiator and a forecaster so that we [the researchers] are on the move before the questions have even been raised. And when the questions arrive, we are able to make synthesis, which are also understandable to those who are not scientifically acquainted. ... For example, biodiversity and climate change were discussed by academia long before they entered the political arena.

Although scientific debate on forest bioenergy, and on carbon neutrality in particular, has been politicized and polarized for long in Finland, the interviewees were mostly quiet on the role of *issue advocacy* or were very critical towards it. Several researchers strongly denied that they would have any advocative role or agenda in science-policy processes. Only one interviewee spoke on behalf of advocacy:

I also have intentionally promoted an opposite view in debates on energy and climate benefits from forest bioenergy. I have stated that storing carbon in forests is not necessarily rational ... I think the same person can have different roles and perspectives. And make a conscious decision on that. I always mention if I am presenting something as a citizen or from a forest or energy industry perspective.

However, most of the interviewees admitted, when directly asked, that researchers' values and interests affect the research and science-policy interaction. They were also quite eager to detect value-related issues in research carried out by other researchers, research teams, or institutes. For instance, some researchers/institutes were blamed for focusing only on ecological sustainability of forest bioenergy while others were accused of driving forestry interests. One interviewee reflected on the problematic nature of producing policy-targeted outputs and pointed out how clearly researchers' values and opinions sometimes affect the research process:

When we [a team of researchers] produced a report related to national forest policy, I noticed that the closer to conclusions and implications we came, the more researchers' own values came out and started to affect the work. It is very natural that every researcher has their own values, but what I find important is that then you should be transparent and state that this is my personal view and not based on results instead of hiding your personal views behind your results. This kind of action is quite obvious in this topic ... and is visible in its phrasing of research questions as well.

Honest brokering that includes active and clear communication and interaction between researchers and policymakers appeared to be a rather natural role for most of the researchers. By active communication, the respondents mainly meant hands-on, direct and frequent communication, but they also emphasized the importance of modification and targeting of the messages according to the audience. In addition, the respondents pointed out importance of frequent interactive events, such as meetings with policymakers or workshops with stakeholders, for discussing and reflecting the scientific knowledge in relation to the ongoing policy processes. The interviewees described ongoing policy processes in which their assignment has literally been planned for developing, discussing, and reflecting different forest or energy policy alternatives and their consequences in interaction with other researchers, policymakers, and stakeholders. Concrete case examples were related to highly political cases, such as Finland's entry into the European Monetary Union as well as to the strategic and targeted policy processes, such as development of national energy and climate roadmap. An honest broker might also be an initiator and bring out alternative perspectives on the policy problem as illustrated below:

Politicians and policymakers tend to over-simplify issues too much and avoid or skew alternative solutions. It is a researcher's responsibility to bring up different alternatives for the policymakers as impartially as possible.

Although the move towards *participatory knowledge production* in science–policy interaction such as joint and inclusive knowledge production has gained increasing attention during the previous decade, most interviewed researchers did not yet have experience on intensive collaboration with policymakers, or at least they were not able to detect it. Nevertheless, there were several who felt that research culture is changing and interaction with different actors is becoming more important, for example, due to requirements of new funding instruments and needs of policymaking. Many respondents also thought that past negative experiences have taught the researchers to consider the relationship between research and policymaking more thoroughly and modify their means of practical interaction. For instance, poor knowledge uptake in many cases made the researchers' deliberate communication and interaction practices more thoroughly than before.

4.2 Challenges and opportunities in science–policy interaction

The interviewed researchers described several challenges as well as opportunities in science–policy interaction in the forest bioenergy processes they have been involved in. These were related to the individual and organizational level as well as to communication and timing. On an individual level, according to the interviewees, it is often rather difficult for a researcher to identify and acknowledge the actual context of science–policy process and his/her role in relation to the process. The main reason mentioned for poor context consideration was limited time, but also institutional culture and lack of personal competence were reported. Although the policy process might be clearly named and stated, the complexity of related actors, processes, and objectives can turn out to be incomprehensible. The policy process itself might turn out to be very complex—and political—as one interviewee explained:

The government had a meeting. I presented my estimations and a forestry representative presented his [totally opposite figures]. The minister in charge said that it is very good that they have independent experts there, but that they just have to base the policy on the forestry figures [by the forestry representative] . . . I learned the name of the game then . . . some issues are so political that they have been agreed already and expert hearings are symbolic.

In between the individual and organizational level, and strongly linked to political context, lies a frequently mentioned challenge of policymakers' and other actors' preconceived idea of researchers' contribution. For instance, one interviewee lamented that researchers' role in interactive policy processes is often unclear and that it might be difficult for a researcher to position himself/herself as other actors already have a strong image of researcher's role.

In terms of the organizational level, respondents reported challenges related to politicization of science, disuse or misuse of scientific knowledge and communication. Politicization of science, such as intervention in publishable results or even methodological choices, occurring, for example, in advisory boards of the projects, appeared to be linked strongly to communication and political context. Interviewees gave examples of processes in which policymakers have not been open to knowledge that is conflicting with political aims. This was evident, in particular, in the ongoing political and scientific debate on carbon-neutrality of forest bioenergy as the following examples illustrate:

A policymaker of a considerable standing came to us and said 'the Finnish forest energy business will not prosper as long as these kind of reports are being published' and punched the report on the table.

One interviewee explained how difficult it is to present knowledge that disputes prevailing knowledge on a certain issue. The researcher illustrated that policymakers try to deny or weaken inconvenient scientific knowledge by appealing to influential scientists who, however, have not studied the subject at hand but who strongly defend certain aspects. He also had experienced that policymakers might directly diminish, oppose or even deny the results based on power relations between researchers and policymakers, or harness competing knowledge coalitions to discredit the scientific results.

It is very typical that various interest groups blame researchers for politicking if the researchers' message does not accord with their message. Then the ball starts rolling with the aim of running down researchers' message by characterising it as not being neutral.

The interviewees also lamented that disuse or misuse of scientific knowledge by policymakers is very common, which is very frustrating for a researcher who has put effort into the science–policy interaction and communication:

We [researchers] are worried about appreciation of scientific knowledge as it has weakened in many ways. Perhaps my best example is the Forest Act, on which researchers were asked to comment a couple of years ago. There were researchers both from a research institute and a university involved in writing the expert opinion. The researchers emphasized all shortcomings of the report as well. In the end, the ministry said 'we are not going to use this as we know this better'.

Challenges related to different time frames were also discussed in the interviews. It was lamented that as research resources are becoming scarce, there is no motivation to put more time on science–policy interaction and communication. Several interviewees also mentioned how poorly time frames and expectations sometimes match in unpredictable science–policy processes:

Researchers do not always know what is expected from them. Either requests come at short notice or it will be discovered later on that the expectations are something else. Perhaps this has something to do with the communication between researchers and the policymakers.

As emphasized earlier, some respondents were cautious about close interaction and collaboration between science and policy. Some highlighted that close science–policy interaction might negatively affect a researcher's reputation as reliable scientist. On a practical level, it was discussed that a researcher's personality, career plans, experience, and competence (particularly in terms of interaction and communication) affects in what kind of roles he/she is capable of working or willing to work. In addition, the trade-offs for being an active broker in policy processes were emphasized. It was, for example, mentioned that active contribution to the policy processes takes time from research activities and publishing, and thus makes it hard to maintain both roles, an active researcher and an active science–policy researcher.

In addition to challenges, several interviewees described opportunities and benefits from science–policy interaction. One advantage mentioned results from researchers' collaboration: one interviewee shared that sometimes interaction between different researchers is so

successful that they end up joining forces and knowledge on specific questions and provide the policy process with knowledge from different and new perspectives. Researchers' collaboration can also improve receptiveness of policymakers towards scientific knowledge and new insights as explained by one researcher:

I feel that during the process, they [policymakers] first shot down our suggestion . . . but as more knowledge was produced and fed into the process, their attitude and awareness started to change clearly. Perhaps they admitted that it is wiser to be prepared for different kinds of arguments than to shoot them down immediately.

On a personal level, most of the interviewees felt that it is a responsibility of researchers to actively contribute to policy processes. In addition, it is important for researchers' motivation to notice that the produced knowledge is usable and necessary. Interaction and reflection with knowledge users as well as with other stakeholders were also described to increase researchers' understanding about the meaning and significance of the results, give opportunities for placing the research in a broader context or even increase the societal impact of research. Interactive events were appreciated by the researchers as they can provide new questions, insights and reflections for research, and improve researchers' capacity for problem-based research. Interaction can also benefit the acquisition of research funding in the future through increased visibility, merits, and networks. A couple of interviewees explained that the actual interaction and mutual learning process might be the most important mutual benefit from collaboration. The collaboration can then also lead to more concrete and mutually rewarding outputs, as explained by one researcher:

In the end, we jointly managed to produce a paper, which was acceptable for all involved ministries and did not talk rubbish so that the researchers were able to sign it as well.

The interviewees emphasized that analytical and critical approaches and working methods are researchers' key strengths in tackling the challenges of science–policy interaction. At the same time researchers can, by harnessing these strengths, provide policy processes with a fresh input. The researchers were unanimous that actions in academia, society as well as between them are needed for establishing efficient interaction practices as well as for coping with the recognized challenges. The interviewees called for consideration and development of policy-targeted communication and interaction practices in research communities as well as utilization of communication mediators. Furthermore, one interviewee suggested that researchers should clarify, justify, and communicate policy-relevant issues that they are disagreeing on, for example, by producing synthesizing reports or having public discussions:

In relation to the recent disputed climate panel report, I think it would have been good if they [the authors] had listened to disagreeing researchers and tried to produce some kind of synthesis. A synthesis would not necessarily have to reach consensus, but could highlight why and on which topics researchers disagree and what does it mean for decision-making.

At their best, these kind of activities can recapitulate and elaborate the research arguments as well as elicit new perspectives. More generally, clarifying and recognizing the role in which a researcher or a research community is at its best and most usable for policymaking was also pointed out by some interviewees. One solution would also be an actor working in between science and policy, the so-called

knowledge brokers, whose role would be to relay knowledge in a suitable form and manner from knowledge producers to knowledge users. On an optimistic note, some interviewees felt that a knowledge broker would relieve researchers of communication and interaction, and would then enable more research on one hand and increase the research communication on the other. However, some pointed out that a knowledge broker may not be able to understand and disseminate the knowledge correctly, which might cause misinterpretations and misuse of the knowledge. Standing partially on both sides, academia and policymaking, might also cause critique.

5. Discussion and conclusions

The interview results show that forest bioenergy researchers in Finland appreciate and take on variety roles along the 'role continuum' in different science–policy processes. The interviewed researchers shared the view that researchers should and can contribute to societal decision-making by producing, compiling and disseminating relevant knowledge, providing new and alternative viewpoints or even by advocating certain solutions. The results show that researchers' roles are slowly evolving towards being more communicative, interactive, and variable. Researchers' experiences illustrate that roles of *science arbiter* and *honest broker*, for example, in the form of *interactional* or *referred expertise* (Collins and Evans 2007) or problem signalling (Turnhout et al. 2008) appear to be rather natural steps for a researcher moving towards more interactive science–policy processes.

The results were somewhat contradictory as most interviewed researchers appeared to strongly subscribe to the role of *pure scientist* and approached policy processes from a pure knowledge production perspective. Objectivity and credibility as well as maintenance of a clear boundary between science and policy were appreciated. This is quite understandable remembering how strong a role 'objective' data production such as that of the National Forest Inventory has historically had in Finland (Åkerman and Peltola 2012). At the same time, however, the interviewees emphasized critical personal, practical and epistemic challenges in current SPIs and suggested practical solutions, such as improving communication means and messages. The various practical problems and more fundamental challenges that researchers emphasized, which I further reflected on in this article, included: lack of individual competence and/or motivation; difficulties in or lack of SPI context understanding; unclear or unfair researchers' roles in SPI; politicization of science; disuse or misuse of knowledge by policymakers and impact of researchers' values in SPI.

Based on the results, the challenges in SPI appear to be tied to how researchers are able to identify and acknowledge the actual context of science–policy interaction. In other words, most of the interviewees lacked reflectiveness and reflexivity; serious consideration of the research itself and divergent perception of it and SPI (Stirling 2006). Putting more effort on the context, i.e., reflecting temporal, spatial, political, scientific and cultural factors (McNie 2007) of SPI, as well as on (re-)consideration of the spectrum of researchers' roles, could support the knowledge production, communication, and mediation activities that a researcher may carry out (Owens et al. 2004; Hoppe 2005; Pielke 2007; Saarela et al. 2015).

The researchers gave a general-level appreciation to increased and closer science–policy interaction that, by definition, blurs the boundary between science and policy. In reality, it is obvious that in the case of forest bioenergy policy drawing the line between science

and policy is difficult, if not impossible, since scientific arguments are used in policymaking and research is carried out for policy-related purposes. The results are in line with previous research (Edelenbos et al. 2011; Lang et al. 2012; Sarkki et al. 2014; Hegger and Dieperink 2015) suggesting that science–policy interaction can provide new opportunities and motivation for researchers as well as result in mutual benefits. For instance, an increase in personal motivation, understanding and reflection on the significance of the scientific results, networking opportunities, societal impact of research, and funding occasions were mentioned. Nevertheless, there are, as Sarkki et al. (2014) have also shown, trade-offs in SPI in terms of personal time, clarity versus complexity as well as supply-versus demand-driven research. A dynamic blend of personal and institutional opportunities as well as challenges either hinder or assist the development of productive SPI.

Practicality-oriented solutions might solve some of the daily challenges researchers face in science–policy interaction, but not the more fundamental ones related to the context of SPI and epistemological issues. This brings us back to emphasize that linear science–policy relationship, to which *pure scientists* strongly commit, is only partially capable of addressing value- and interest-intensive forest bioenergy policy. In addition, scholars of social studies of science have long pointed out that production of objective and value-free knowledge is epistemologically questionable (Berger and Luckmann 1967; Sison 1993), but as this research has shown, very much alive. Policy processes related to topical button issues such as forest bioenergy are often highly politicized—issues that researchers might frame as pure knowledge production are actually evidently political, which lead to competing claims and more value-laden debates over the scientific knowledge (Giller et al. 2008). Therefore, there is an apparent need for open dialogue between researchers and policymakers. It requires that researchers are willing to and capable of stepping outside traditional researchers' role, and that policymakers are open to discussion and new knowledge. Furthermore, to really provide the forest bioenergy debate with salient, legitimate and credible knowledge, dialogue should be opened up to other societal actors as well (Funtowicz and Ravetz 1993; Cash et al. 2003).

In this study, researchers' experiences and perceptions of their role and the SPI in forest bioenergy policy are obviously, but apparently unconsciously, illustrative examples of real-world balancing acts between the two opposite views of SPI: a 'two-worlds' and a 'one-world' perspective described by Sundqvist et al. (2017). The researchers are dissatisfied by the overly tight connection between science and policy, but on the other hand, they have experienced challenges in the gap between science and policy. However, juxtaposition of the two approaches or researchers' roles in general does not lead to improvements in SPI. Instead, different approaches should be seen as complementary and suitable at different levels of analysis or phases of the science–policy process (Michaels 2009; Schut et al. 2014; Sundqvist et al. 2017). Following Holmes and Clark (2008: 707), researchers should 'reject as false the dichotomy of being a "proper scientist" or a science advisor'.

Advancing interactive research and knowledge co-production which go beyond simply producing and communicating new knowledge is often proposed as a solution for increasing relevance of scientific knowledge in policymaking. From the perspective of researchers, they do not appear to be simple tasks to carry out.

Research has produced role and SPI typologies for researchers to consider, but in reality, roles are just taken or they follow earlier paths. Nevertheless, it might be helpful for researchers and research

organizations to utilize typologies as well as the results of empirical research on actual SPIs (such as the one carried out in this article) to identify and reflect on researchers' roles and science–policy contexts. They, when applied flexibly, deliberately and in parallel with each other, can support carrying out day-to-day science–policy activities, addressing challenges related to contested scientific knowledge, building personal and institutional competence as well as increasing the societal relevance of research.

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