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Assessment of attitudes towards bioenergy by forestry experts in the Republic of Karelia

Abstract
The Republic of Karelia is situated in the northwestern part of Russia and represents approximately 1 % of the country's territory. Forests cover 53 % of the total area, with 70 % of the total forest area available for harvesting. The bioenergy sector is relatively significant as it contributes 10 % to the total energy supply in Karelia, which as a fossil fuel deficient region is highly dependent on imported energy resources from other regions of the country. Therefore, the purpose of the study was to assess the role and position of bioenergy in the Republic of Karelia. It was done by exploring the perception of forestry professionals and forestry students towards bioenergy production in comparison with other forest uses. The role and position of bioenergy was identified through the assessment of the importance of landscape elements, ranking of adverse environmental effects on surrounding landscapes, input to the local economy and importance in planning principles. The results indicate that bioenergy production is perceived to have a low negative effect on the surrounding environment but also a low economic input to the local economy of the region. In addition, bioenergy is perceived to have a low influence on planning principles according to the opinions of the respondents. Statistically significant differences were found between the opinions of respondents with different occupations in regards to the main factors that negatively affect the surrounding environment. In general, the respondents indicated that bioenergy production is of moderate importance, although more research is needed in this field.

Keywords: attitudes, bioenergy, Republic of Karelia

Introduction – Importance of the forest sector and development of bioenergy

A relationship between people and forest landscapes was the subject for the research in various disciplines (Schama 1995, Pretty 2007). Some researchers study the difference in value towards landscapes and its perspectives to the future (Hinds & Sparks 2008). The importance of perception and acceptance is crucial in forestry landscapes and associated activities in Russia (Yaroshenko 2012). Forest landscapes cover approximately 53 % of the Republic of Karelia (RK) (Forest Plan of RK 2008) and forests have always played an important role in the area as a source of wood materials and non-wood

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forest products, especially for rural communities (Piipponen 1999). Approximately 70 % of the forest area is comprised of commercial forests where harvesting is mainly done (over 90 % in terms of area) in the form of clear cutting with a maximum area of 50 ha permitted (Forest Plan of RK 2008). The southern parts of RK (e.g. the Lahdenpohskiy district) are located in the middle taiga zone (3.4 million ha) and are on average 2.5 times more productive than the northern parts (e.g. the Kalevalskiy district), which are located in the northern taiga zone (11.1 million ha). Forest productivity in RK is also highly correlated with the distribution of two main tree species; pine stands dominate in the north and spruce dominates in the south.

The mechanization of harvesting operations has increased rapidly during the last 17 years. In 2000, the tree-length method accounted for 58 % of harvesting operations, but was less than 5% in 2016. Since 2003, the predominant method of harvesting in RK is the cut-to-length method, which has exceeded 95 % in the total volume of harvesting since 2011 (Forestry in Karelia 2017). Thus, the increased levels of mechanization employed in harvesting operations and the gradually increasing share of commercial thinnings has created technologically favorable conditions for bioenergy use in RK (Goltsev et al. 2011). Moreover, Karelia is one of six regions in Russia chosen as a pilot territory (in 2015) to evaluate innovative approaches related to the intensive forest management concept (Ministry of Natural Resources 2015). The intensive forest management concept includes proposals for the reduction of the minimum age for regeneration harvestings, more intensive thinning and more efficient regeneration measures (Trishkin et al. 2017). Thus, from a legislative point of view it also creates favorable conditions for bioenergy development in RK, and for the potential use of small-diameter trees from thinnings. Nevertheless, the forest sector is perceived as untrustworthy by the general public in Russia due to weak enforcement of forestry regulations and the existence of loopholes (Pappila 2013). In addition, poor handling of forestry implementation activities at the ground level have resulted in a low deployment and uptake of many important initiatives.

The total amount of harvested timber in RK varies from 5 to 6.5 million m^3 annually and the potential for bioenergy production from harvesting operations is estimated at about 2.3 million m^3 (Ministry of Natural Resources and Ecology RK 2017). Current wood processing capacity provides approximately 1 million m^3 of by-products (Gerasimov & Karjalainen 2011). Despite the high biomass potential in Karelia, the majority of logging residues and small-diameter trees from thinnings and a significant amount of non-industrial roundwood are currently left in the forest; only non-industrial wood is used for heating purposes by local residents in the form of firewood, which contributes less than 10% (Rakitova 2012). The majority of bioenergy products from RK (mainly in the form of wood chips or pellets) are exported to European Union (EU) countries through major hubs in Karelia or the Leningrad region (Infobio 2016). In addition, the domestic use of bioenergy is hindered to some extent by the current federal policy of "gasification", the expansion of gas pipeline networks to the regions and by the intensification of energy generation from other renewable sources, mainly hydro energy (Energeticheskaya strategiya 2009). At the same time, regions that are not connected to the natural gas grid are highly dependent on costly fossil fuels. The long transportation distance is a major factor in the increased delivery costs of fossil fuels to the regions of Russia (International Energy Agency 2003). As a fossil fuel deficient region, RK faces frequent fuel shortages due to adverse weather and transportation conditions, and the preference of suppliers to export fossil fuels (Infobio 2016). Moreover, according to Gribanov (2011) the gas pipelines have a highly negative impact on the surrounding environment and forest landscapes due to inappropriate installation of pipelines and the neglect of natural landscape boundaries. Often those factors are not taken into account and cause severe environmental disasters.

Notwithstanding, the government of RK launched two programmes with the objective to increase the proportion of locally produced fuels (e.g. firewood and wood chips) in energy production and to decrease the dependence on fossil fuels (Regional'naya celevaya programma 2007, Regional'naya strategiya razvitiya 2010). However, the bioenergy concept, as such, is rather new in RK and woody biomass is a relatively new fuel in larger scale for municipal and industrial energy production, but as firewood it is a common energy source for households, especially in rural areas (Trishkin et al. 2016). Several projects to substitute fossil fuels with local biomass resources (e.g. Essoyla in 2011, Veshkelitsa in 2012, Kharlu in 2012 and Suoyarvi in 2014) have been successfully implemented in recent times (Infobio 2014). The importance of perception and acceptance is crucial in forestry landscapes and associated activities in Russia (Yaroshenko 2012) and should be studied as it may be a source of local

conflict among interest groups and instigate regional clashes (Albrecht & Trishkin 2017). Therefore, the purpose of the study was to assess the role and position of bioenergy among the other uses of natural resources in RK. An analysis of attitudes among two groups of respondents (forestry students and forestry professionals) was carried out in order to check if there are differences between the responses in regard to actual experience (professionals) versus expectation (students). Similarly it was also done to test the responses between genders. More specifically, the analysis included a ranking of landscapes elements (1); factors that negatively affect the surrounding landscapes (2); factors that affect the local economy in the region (3); the main factors that influence planning principles (4). The next section describes methods, followed by results, discussion and conclusions.

Methods – Geographical scope

The Republic of Karelia is part of the northwestern Federal District of the Russian Federation and represents 1.06% (180,500 km^2) of the country's territory. The western border of Karelia is the state border between the Russian Federation and Finland. The population of the Republic of Karelia is about 627,000, with over 80 % living in urbanized areas. There are three main towns in Karelia of regional significance: Petrozavodsk (population 278,000), Kostomuksha (population 29,000) and Sortavala (population 24,000) (Kareliastat 2017). The population density in RK is less than four inhabitants per km^2 (The Republic of Karelia, 2014). For comparison, the population density in Finland is 17 inhabitants per km^2 (Eurostat 2015). The administrative-territorial division of RK consists of 18 districts (The Official Karelia, 2004) (Figure 1).

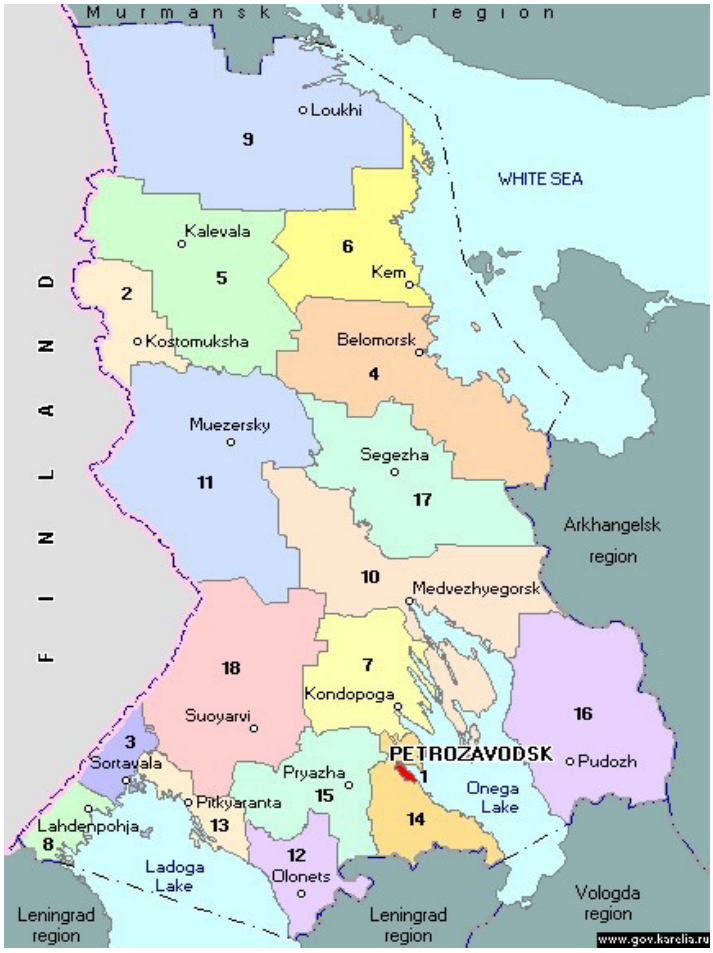

Figure 1. Administrative divisions in the Republic of Karelia (The Official Karelia, 2004).

The Republic of Karelia is one of the most advanced regions in the forest sector in northwestern Russia (NW Russia) due to its proximity to European markets, and plays a key role in domestic and international wood supplies (Karvinen et al. 2010). Forests in RK also play a significant social role, particularly in regard to the utilization and importance of non-wood forest products in rural areas. At the same time, people from urban areas appreciate more with recreational and leisure time activities in comparison to non-wood forest products (Corbachik 2016).

Sampling and questionnaire form

A structured questionnaire with pre-defined questions was the main method employed to approach respondents. The questions were defined during a pre-testing phase together with forest and environmental specialists from RK based on their feedback regarding relevance, applicability and appropriateness. Pre-testing was conducted in January 2014 in order to ensure that the questions were understandable, reasonable and logically structured. After pre-testing, the survey form was corrected accordingly and then the main survey was conducted over a 4-month period (February-May 2014). The respondents were also provided with background information explaining the aim of the questionnaire. The questionnaires were completed by respondents in both an online form (28%) and in paper (72%) versions. In total, 111 completed questionnaires were analyzed. The responses were categorized as follows: by gender (43 male and 68 female), by occupation (70 forestry students with bachelor degrees and 41 forestry professionals).

The questionnaire form was divided into two parts: personal information and a specific section. Provision of personal data was compulsory in order to ensure integrity and honesty of the responses. The specific part of the questionnaire form is essential for analysis of the data, where the questions were grouped into four sets. In the first set of questions, landscape elements provided the background input data required for further analysis, while the environmental, social and economic importance of bioenergy in comparison with the utilization of other natural resources was then addressed. A seven-point Likert scale was used to measure perceived attitudes towards landscape values; where 1 corresponded to very low importance and 7 to very high importance. The reliability of the four sets of factors was tested using the Cronbach's alpha coefficient, which showed a high satisfactory level for internal consistency (Table 1).

A reliability coefficient above 0.70 is normally considered as acceptable and desirable for a consistency level (Prokop et al. 2007; Prokop et al. 2007). The specific questions were formed into four sets and were analyzed separately. The collected data were analyzed with SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Although the sampling was not purely random, indicative significance testing was used. A Mann–Whitney U-test showed significant differences between the groups. In addition, the data used to estimate the values and associated activities for all groups of respondents were re-coded in SPSS from a 7-scale to a 3-scale system, where 1 = very low and 2 = low importance were combined to produce 1 = low importance; 3 = moderate, 4 = neutral, 5 = significant were combined to produce 2 = moderate importance; 6 = very significant, 7 = greatly significant were combined to produce 3 = high importance.

The test was carried out with respondents from different occupations (forestry professionals and forestry students) and responses between male and female. Statistical tests among groups with different occupations are a common practice among natural and social sciences (e.g. Prokop et al. 2007; Zyadin et al. 2014) and were repeated in this study. In addition, as female respondents have been shown to give higher scoring values in general due to the difference in attitude in many aspects compare with male respondents (Prokop et al. 2007), the statistical test was also applied to determine differences in responses between genders.

Table 1. Cronbach alpha coefficient

N	Factors	Parameters	Valuation	Values
1	Landscape values	17	1 to 7	0.84
2	Negative effect on surrounding landscape	9	1 to 7	0.63
3	Importance of economic impact	9	1 to 7	0.76
4	Importance of planning principles	7	1 to 7	0.63

Results

The majority of respondents were urban based and represent educational institutions, research organizations, forestry businesses, specialists from protected natural areas (strict nature reserves, nature parks etc.), non-governmental organizations and governmental bodies. The respondents considered water bodies (6.3) and old-growth forests (5.8) to have the highest importance among the landscape elements (Table 2). Afforested pastures (4.1), ditched mires (4.0) and grazing lands (3.9) were considered of medium importance and abandoned agricultural lands (3.3) were considered of low importance. Furthermore, a statistically significant difference was found between specialists with different occupations for the following factors; agricultural fields, grazing lands, modern settlements, natural open mires, traditional settlements, ditched mires and forest infrastructure. Moreover, a statistically significant difference was found between specialists of different genders in relation to agricultural lands. Factors that are in a natural state or untouched by humans received the higher importance values, with the exception of managed forests, which were considered to be of high importance (5.2). This could be associated with the fact that the respondents also included forest industry specialists. Moreover, a statistically significant difference was found between the respondents of different genders for abandoned agricultural lands.

The highest negative impact on the surrounding landscapes (Table 3) were considered to come from construction (5.7), mining (5.8) and clear felling (5.6); moderate impacts were assigned to selective and gradual felling (4.0) and agriculture (4.1); low impacts were assigned to bioenergy production (3.2) and

Table 2. Landscape elements and their importance in the Republic of Karelia.

Factor	Mc	SD	Importance of factor					
			Low		Moderate		High	
			N	%	N	%	N	%
Agricultural fields*	4.1	1.688	20	18	69	62	22	20
Grazing land*	3.9	1.475	24	22	76	68	11	10
Abandoned agricultural lands**	3.3	1.612	39	35	62	56	10	9
Old-growth forest	5.8	1.482	3	3	30	27	77	70
Forest meadows	5.1	1.633	7	6	55	50	47	43
Modern settlements*	4.3	1.637	18	16	63	57	30	27
Natural open mires*	4.6	1.696	14	13	66	59	31	28
Traditional settlements*	5.0	1.449	3	3	64	58	43	39
Managed forests	5.2	1.539	6	5	53	48	51	46
Water bodies	6.3	1.028	0	0	24	22	87	78
Afforested mires	4.4	1.499	13	12	72	65	25	23
Afforested pastures	4.1	1.373	16	14	77	69	18	16
Ditched mires*	4.0	1.510	21	19	76	68	14	13
Roads	4.9	1.668	12	11	52	47	47	42
Young forests	5.5	1.494	5	5	45	41	61	55
Forest paths	4.2	1.607	16	14	67	60	28	25
Forest infrastructure*	4.1	1.802	21	19	62	56	27	25

* $p < 0.05$ – by occupation
** $p < 0.05$ – by gender
c mean ranking is based on seven-point scale, where 1 = very low and 7= very high importance

Table 3. Main factors that are perceived to negatively affect the surrounding landscape in the Republic of Karelia.

Factor	Mc	SD	Importance of factor					
			Low		Moderate		High	
			N	%	N	%	N	%
Selective and gradual felling	4.0	1.462	17	15	79	72	14	13
Clear felling	5.6	1.500	5	5	44	40	62	56
Wild-life tourism	3.6	1.755	37	33	57	51	17	15
Infrastructural tourism	4.4	1.625	14	13	68	61	29	26
Bioenergy	3.2	1.745	46	41	50	45	15	14
Constructions	5.7	1.240	3	3	39	35	69	62
Mining	5.8	1.382	2	2	42	38	67	60
Agriculture	4.1	1.600	17	15	73	66	21	19
Peat production	4.7	1.601	10	9	64	58	36	33

* $p < 0.05$ – by occupation
** $p < 0.05$ – by gender
c Mean ranking is based on seven-point scale, where 1 = very low and 7= greatly high importance

wildlife tourism (3.6). Thus, bioenergy production was perceived to have the lowest negative effect on the surrounding landscape. This could be associated with the fact that biomass for energy purposes is considered as a by-product and therefore does not directly affect the surrounding landscape. Moreover, no statistically significant differences were found among the nine factors listed in Table 3.

Factors such as clear felling (5.6), mining (5.6) and construction (5.4) were perceived by the respondents to have the highest importance to the local economy; agriculture (4.4) and wildlife tourism (4.7) were considered moderately important; bioenergy (4.1) and peat production (3.9) were considered of low importance (Table 4). In addition, statistical significant differences were found between specialists with different occupations in regard to wildlife tourism, infrastructural tourism, bioenergy

Table 4. Main factors that are perceived to affect the local economy in the Republic of Karelia.

Factor	Mc	SD	Importance of factor					
			Low		Moderate		High	
			N	%	N	%	N	%
Selective and gradual felling	4.9	1.626	8	7	62	56	41	37
Clear felling	5.6	1.503	6	5	38	34	67	60
Wildlife tourism*, **	4.7	1.646	14	13	62	56	35	32
Infrastructural tourism*	5.1	1.672	9	8	51	46	51	46
Bioenergy*	4.1	1.737	25	23	60	55	25	23
Constructions	5.4	1.437	7	6	44	40	60	54
Mining	5.6	1.290	4	4	47	42	60	54
Agriculture	4.4	1.553	13	12	70	63	28	25
Peat production*, **	3.9	1.572	26	23	67	60	18	16

* $p < 0.05$ – by occupation
** $p < 0.05$ – by gender
c Mean ranking is based on seven-point scale, where 1 = very low and 7= greatly high importance

Table 5. Main factors that are perceived to affect planning principles in Republic of Karelia.

Factor	Mc	SD	Importance of factor					
			Low		Moderate		High	
			N	%	N	%	N	%
Maximization of nature utilization* , **	5.2	1.657	2	2	48	43	61	55
Preservation of valuable habitats	6.4	1.002	0	0	19	17	92	83
Tourism*	4.9	1.158	2	2	77	69	32	29
Bioenergy	5.0	1.414	4	4	64	58	43	39
Mining	4.5	1.628	19	17	65	59	27	24
Forest protection	5.6	1.360	2	2	48	43	61	55

* $p < 0.05$ – by occupation
** $p < 0.05$ – by gender
cMean ranking is based on seven-point scale, where 1 = very low and 7= greatly high importance

and peat production. Moreover, statistically significant differences were found between specialists of different gender in regard to wildlife tourism and peat production factors.

Preservation of valuable habitats (6.4) was perceived to have the highest influence on planning principles in the region (Table 5), whereas maximization of nature utilization and forest protection in general have a moderate influence; bioenergy (5.0), tourism (4.9) and mining (4.5) are considered to have the least influence on planning principles. The low importance attached to bioenergy in this respect might be associated with the fact that it is also by-product. Statistically significant differences were found between specialists with different occupations in the following factors: maximization of nature utilization and tourism. Moreover, statistically significant differences were found among specialists of different gender in regard to the maximization of nature utilization factor.

Discussion and conclusions

The importance of bioenergy in RK is growing with technological advancements and increasing demand for small diameter trees due to competition between the energy and forest sectors. Moreover, the government of RK has made concerted efforts over the last 10 years to enforce two main regional strategies that aim to utilize local fuel resources and develop the domestic energy sector. Thus, the bioenergy sector in the region is highly important as a potential alternative to fossil fuels and as a substitute to more conventional renewable sources of energy, such as hydro power generation. The use of bioenergy (e.g. woody biomass) for energy production in the region contributes to 10 % of total energy supply and most of the wood is combusted for heat generation (Grigoryev 2007); although the proportion of bioenergy in the mix is constantly increasing (Syunev et al. 2009). Since 2014, several municipalities have shifted from crude oil and coal to bioenergy residues, mainly in the form of wood chips (Infobio 2014). In general, woody biomass in RK is utilized either in the form of firewood (households) or wood chips (municipality boilers), although the majority of domestically produced woody biomass for energy purposes is exported to Finland (Trishkin et al. 2017). On one hand, the current development of the bioenergy sector in the region is driven by external factors, e.g. demand and close proximity to EU countries (Goltsev et al. 2011), while on the other hand, the development of the domestic bioenergy sector is hindered by the expansion of gas pipelines and by lobbying in many districts of the region. However, the regional development programme for the expansion of gas pipelines in RK during the period 2015-2020 does not include sparsely populated districts in the region that have either no or limited heavy industry (e,g. Suoyarvskiy, Muezerskiy, Belomorskiy and Kalevalskiy districts) (Razvitie gazosnabzheniy 2014). Thus, the lack of accessibility to fossil fuels in remote districts is potentially attractive for bioenergy development. However, the overall success of bioenergy development in the aforementioned districts or in the region as a whole is highly dependent

on acceptance by forestry specialists and the general public. Therefore, the importance of assessing the attitudes for bioenergy production in this study cannot be overstated.

One of the main drawbacks of this study is the use of predefined questions in a structured form and the absence of open questions, which restricts the expression of opinions by the respondents, and a lack of freedom or flexibility in their responses in general. However, during the pre-testing period the questions were tested and the relevance of these questions were acknowledged by the respondents. In total, 111 individual responses were received from the Republic of Karelia. However, a high level of gender imbalance was found; female (61%) and male (39%). Similarly, an imbalance was found across occupations; forest professionals accounted for 37% of respondents and 63% were forestry students with bachelor degrees. In addition, it should be noted that the majority of respondents were urban based, which may have influenced the diversity of responses.

In regard to the importance of landscape elements (Table 2), the second highest value was given to old-growth forests (5.8), which might be a potential barrier for acceptance of bioenergy production in the future by the general public. At the same time, high values were also given to young forests (5.5) and managed forests (5.2). This may be associated with the fact that the majority of the respondents are "forestry" people, although it could be also due to the fact that logging operations and bioenergy production (as a by-product) have gained a more positive image due to increased awareness regarding the adverse effects of fossil fuels.

Bioenergy production (with a mean value of 3.2) was perceived by the respondents to have the lowest negative effect on the surrounding landscape among the nine factors examined. This could be associated with the fact that bioenergy products are by-products from final fellings, thinnings and other types of felling. It was also noted by the respondents that the current level of bioenergy production has low economic benefits (mean value of 4.1) to the local economy of the region, in comparison to mining and clear felling (mean value of 5.6 for both factors). This clearly reflects the current position of bioenergy utilization (mainly in the form of firewood in rural areas) and with limited number of implement projects on municipality level. At the same time, the importance of bioenergy at the household level is much higher taking into account economic and technical accessibility, however its actual input to the local economy has never been estimated in monetary terms. Furthermore, bioenergy aspects (mean value of 5.0) were identified by respondents as having a low influence on planning principles. This could also be associated with the fact that bioenergy is a by-product of wood processing and mainly has an export-oriented value.

Statistically significant differences were found between the respondents of different occupations in regards to the main factors that negatively affect the surrounding landscape. This could be associated with the actual difference in experience of the respondents, i.e. "experience" (forestry professionals) versus "expectations" (forestry students). Thus, forestry specialists were more inclined towards the fact that bioenergy products are mainly associated with final fellings (clear, gradual or selective), while forestry graduates instead associate bioenergy products with both final fellings and intermediate thinnings (small-diameter trees).

According to Prokop et al. (2007) female respondents are generally more positive in their responses in comparison to males. However in this study, significant differences were only found in a few factors, i.e. wildlife tourism and peat production (among the factors that affect the local economy) and maximization of nature utilization (among the factors that influence planning principles). This could be associated with the fact that the respondents represent a homogeneous group of people of varied forestry backgrounds.

In summary, the results from this study indicate that bioenergy is perceived as moderately important among the groups of respondents. Moreover, technological advances in harvesting operations and legislative initiatives, which promote the use of local resources for energy purposes, may create favorable conditions for future development of the bioenergy sector. At the same time, more power should be given to regional and local authorities in regard to the enforcement of those initiatives, particularly given the existence of a strong fossil fuel lobby at the federal level. In addition, it should be noted that more research is needed with respect to discerning the attitudes of different interest groups, which would allow for a more structured analysis.

Acknowledgements

This work was supported by the Academy of Finland project "Contesting Bioenergy Governance" [grant number 14770] and the strategic funding of the University of Eastern Finland project "Developing Bioenergy Governance" [grant number 931429].

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