

Sustainability of Forest-Based Bioenergy—A Case Study of Students Surveyed at a University in Finland

Tapio Ranta * , Antti Karhunen and Mika Laihanen

School of Energy Systems, Lappeenranta-Lahti University of Technology LUT, Yliopistonkatu 34, 53850 Lappeenranta, Finland; antti.karhunen@lut.fi (A.K.); mika.laihanen@lut.fi (M.L.)

* Correspondence: Tapio.Ranta@lut.fi; Tel.: +358-408644994

Received: 30 April 2020; Accepted: 13 July 2020; Published: 15 July 2020



Abstract: With the increasing use of forest biomass, concerns about negative impacts have been raised in the debate. The aim of this study was to find out the attitude of university students towards the energy use of forest-based biomass and how different areas of sustainable forest operations were addressed. The survey was conducted over two years (2018–2019) with both full-time students at university and distance learning students who study alongside their work. Background information such as gender, nationality and field of study was collected from students. Most of the students currently considered the energy use of forest biomass to be sustainable. Many replies stressed that the situation could change if the use of forests is increased from the present circumstances. The main factors mentioned that led to forest-based bioenergy being sustainable were positive felling balance, compliance with forest certification, use of waste fractions and implementation of the Renewable Energy Directive (RED II) directive, while the loss of biodiversity, over-exploitation of forests, C debt and the cascading principle were factors that led to forest-based bioenergy being unsustainable. Student background variables had no effect on responses except for the field of study.

Keywords: sustainability; forestry; forest residues; climate change; education

1. Introduction

1.1. Sustainability in Forest Management

This study seeks to find out the opinions of university students on the sustainability of forest-based energy biomass. They will be future decision makers in the industry, so their views will have an impact on future choices. With the increasing use of forest biomass, concerns about negative impacts have been raised in the debate. In order to assess possible negative impacts, we need to understand the concept of sustainability. Sustainability is defined by the Brundtland report as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1]. The continuous growth of forests needs to be ensured through sufficient investments in forests. Sustainable forest management addresses a great challenge in matching the increasing demands of a growing human population while maintaining ecological functions of healthy forest ecosystems [2]. The climate change perspective calls for a change in perspective for forest operations ecology from the local and regional scales to the global scale [3]. The effective implementation of sustainable forest management practice depends on carrying out forest operations in a sustainable manner. In fact, the silvicultural practices of forest operations may also have a strong effect on environmental, economic and social performances, and hence sustainability. Therefore, the focus of sustainable forest operations (SFO) should be widened from forest and environmental ecology. A recently renewed concept of SFO is based on a broader focus and different scales of sustainable development, consisting of economy, environment, society, ergonomics and quality optimisation. Its purpose is to balance the performance

of forest operations across economic, environmental and social sustainability objectives [4]. It includes five performance areas: environment, ergonomics, economics, quality optimisation, people and society, all of which contain more specific key indicators.

Sustainability indicators include forest area, growth/loss ratio or maximum logging volume, which can be maintained without compromising future felling opportunities. During the last ten years, about 0.1% of the forest area, or almost 19,000 hectares per year, has been taken up for other land use, but on the other hand, growth is clearly higher than drain [5]. Other indicators to be monitored include forest biodiversity, health and vitality [6]. Today, common storm damage and diseases affecting forests also alter the condition of forests. The forthcoming EU Biodiversity Strategy of the European Commission proposes a number of measures to enhance biodiversity. One of the most important means of biodiversity management of commercial forests is to preserve valuable habitats and to exclude some trees from felling. The Forest Act defines particularly important habitats, the characteristics of which must be preserved in forest management [7].

In addition to the sustainability of wood supply, ecological, cultural and social sustainability has been required for forest use. Natural Resource Institute of Finland (LUKE) has developed an online tool called Metsämittari, which allows users to view the impact of forest usage scenarios uploaded to the service in a multidimensional way [8]. In its calculations, LUKE also takes dimensions of sustainability into account, which give an estimate of the maximum maintained harvest, which gives a somewhat lower felling estimate than the previous mentioned sustainable harvest level.

1.2. Use of Forest Chips in Finland

In its climate and energy policy, the European Union is committed to the objectives of reducing greenhouse gas emissions. Bioenergy will play a key role in achieving the targets and its use will increase significantly in the next few years [9]. Therefore, ensuring the sustainability of forest-based bioenergy is essential for the acceptability of its use. In 2017, bioenergy was the largest source of renewable energy in the EU, accounting for 57% of renewable energy [10]. In Finland, bioenergy accounted for 78% of renewable energy and consisted mainly of wood-based energy [10]. In recent years, wood fuels have produced over a quarter of total energy consumption in Finland. Indeed, wood fuels are now the single most important source of energy in Finland since they have been more important than oil, coal or natural gas since 2012 [11]. The energy wood produced in Finland is largely based on the by-products of the wood processing industry and forestry. Typically, wood energy resources are used in highly efficient district heating (DH) systems and combined heat and power (CHP) plants [12].

Over the last seven years, the use of forest chips in thermal and power plants has varied between 7.2 and 8.0 million cubic metres and has averaged 7.5 million cubic metres per year (approximately 15 TWh) (Figure 1). In recent years, more than half of the forest chips have been chipped from small sized-trees, i.e., small-diameter energy wood, and are harvested especially in connection with silvicultural activities on young forests. The next most used are logging residues. The rest consist of stumps and rotten log wood, whose uses have remained low. The use of forest chips in Finland is thus based in particular on wood parts that are not suitable for pulpwood or dimensional lumber in mechanical forest industry. Forest silvicultural activities ensure the supply of marketable wood. In addition, sensitive and valuable natural sites are typically protected and are not included in felling.

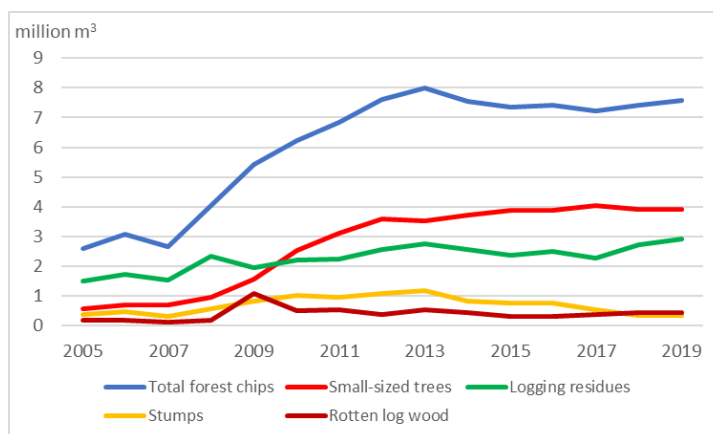


Figure 1. Forest chips use by raw material (2005–2019) [11].

1.3. The Aim of the Study

The aim of this study is to find out the attitudes of university students towards the energy use of forest-based biomass and how different areas of sustainable forest operations were addressed. Students are asked to justify their attitudes. The questionnaire is used to assess the impact of students' background variables on their opinions. The research is topical because there are many different views on the sustainability of energy use of forest biomass. The EU has defined a set of sustainability criteria to ensure the sustainability. Rigorous requirements are set in the Renewable Energy Directive (RED II) on the minimum level of GHG savings, appropriate land use, as well as monitoring requirements for any potentially adverse effects. These criteria will cover all biomass use in transport and in large-scale heat and power to ensure the sustainability. However, especially the carbon neutrality of biomass use has received a lot of attention in the debate. Depending on their characteristics and local circumstances, forests can play different roles in the carbon cycle, from net emitters to net sinks of carbon. Wood energy can be considered carbon-neutral if the source forest is sustainably managed and sequesters at least the same amount of CO₂ released during the production process of energy from the wood. This sink effect is determined in the LULUCF (Land Use, Land Use Change and Forest) sector [13]. Therefore, changes in carbon sinks must be considered in national and international climate policies more extensively than before, since the goals of the Paris Agreement cannot be achieved without strengthening global carbon sinks [14]. Moreover, it is necessary to find out the attitudes of students from time to time in order to see how attitudes change in relation to previous research.

Similar studies on the sustainability of forest energy have been conducted for Chinese university students [15] and school students in Finland [16] and some other countries [17]. Chinese students showed a positive attitude towards renewable energy in general, but slightly less positive towards forest-based bioenergy. They expected to receive more information and knowledge about renewable energy and forest-based bioenergy [15]. The school students in Finland appeared to be very critical toward bioenergy production from forest biomass, particularly with the issues related to its sustainability, environmental friendliness, and the future role of wood energy in overall bioenergy production. This study showed statistically significant gender and residential (urban–rural) differences among the students related to their perceptions of forest-based bioenergy production [16]. The international study among young students toward bioenergy in Finland, Slovakia, Taiwan, and Turkey found statistically significant differences in students' bioenergy knowledge with respect to the countries. Most knowledgeable students appeared to be very critical of bioenergy and especially of the issues related to bioenergy production from forests [17]. Various surveys on attitudes towards bioenergy [18], forest bioenergy [19] or certain fractions [20] have also been conducted in the past or, more specifically, to implement sustainability criteria for bioenergy [21–23]. An interesting observation in the study, “Young people's acceptance of bioenergy and the influence of attitude strength on information provision” was

that the school lecture weakly contributed to building attitude strength, rendering opinion changes less likely in the future [17].

2. Materials and Methods

2.1. Implementing the Survey on Moodle

The survey was conducted over two years (2018–2019) for both full-time students at Lappeenranta-Lahti University of Technology (LUT) University and distance learning students who study alongside their work. LUT University (Lappeenranta-Lahti University of Technology (LUT)) is a science university in Finland, bringing together the fields of science and business. The questionnaire was targeted at both full-time and distance learning students in the Bioenergy course, who were given the opportunity to answer questions electronically at the end of the course. Responses were not given anonymously, and respondents were aware of this. Full-time students have regular face-to-face lectures, while distance learners self-study through the digital platform Moodle. Both groups had the same lecture material available; only the teaching method was different. Distance learning students also had the opportunity to ask questions of the teacher through a digital platform. The survey was conducted in a digital learning environment. Moodle™, “Modular Object-Oriented Dynamic Learning Environment”, is a free, open-source object-based learning platform, i.e., virtual learning environment (VLE). Moodle can be used to build courses that allow you to publish material (e.g., in a timed fashion) and conduct experimental tests. Moodle provides tools for interaction, content production and material sharing, among other things. The Bioenergy course was conducted in this environment for both student groups. One of the topics of the course was the sustainability of bioenergy supply and use. All dimensions of sustainability, such as environmental, social and economical, were included in the definition of sustainability. In a digital learning environment, each group of students was able to answer the question option in their own time and justify their answer. Answers were not graded and there was no length limit to the justification of the answers. The choice question offered three options, “yes”, “no” and “don’t know”, from which the respondent chose one.

The questions were:

- How do you see the current woody biomass use for energy in Finland? Is it sustainable?
- Can you justify your previous choice of sustainability?

There was no attempt to guide the students in their answers, because there could be reasons to be either positive, negative or not know opinion. In practice, the course material and the way it was delivered may affect responses compared to a hypothetical reference group that would not have seen the teaching material. Therefore, the group of students taking the course are not representative of a broader population of students that didn’t just learn about sustainability and bioenergy. However, students were encouraged to think critically and source criticism. The course does not tell whether the use of forest-based bioenergy is sustainable or not but highlights various methodological choices which may influence to the outcome. Those are, e.g., definition of reference (no bioenergy) scenario, time frame of evaluation period, spatial scale, scope (like one product life cycle or system level assessment) and metric choice. The survey gave an idea of how these different groups view the use of forest-based bioenergy and how different options were justified.

The number of distance learning students was larger than the number of full-time students each year, and the number of students increased in 2019 (Table 1). The response rate for full-time students was 70% and 100% for distance learners who completed the query as part of the course. A total of 273 students participated in the study. For full-time students, answering was voluntary, resulting in a lower response rate.

Table 1. Student population.

Group	2018	2019	Total
Full-time students	43	59	102
Distance learners	77	94	171
Total	120	153	273

Background information such as gender, nationality and field of study was collected from students (Figures 2 and 3). Nationality was classified into groups of Finnish and foreigners because the group of foreigners was divided into so many nationalities. The background information was obtained directly from the system and did not need to be requested separately. Full-time students could also be graded according to the progress of their studies, either bachelor's (BSc) or master's (MSc). All distance learning students were master's students. The group of distance learning students clearly differed from the group of full-time students. It was more male dominated, the majority were Finns, and the study fields were more concentrated. The group of distance learning students were working people who had a bachelor's degree and were generally older and more experienced than full-time students. However, age was not collected separately, but there was a difference in age between groups.

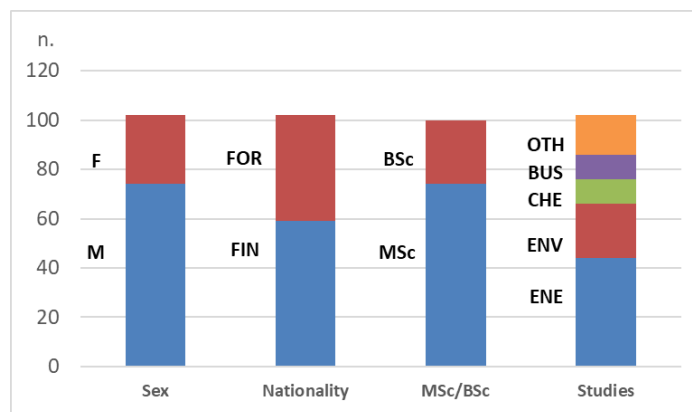


Figure 2. Background variables for full-time students (2018–2019). Sex: male (M), female (F); nationality: Finnish (FIN), foreigners (FOR), master's students (MSc), bachelor's students (BSc); studies: energy (ENE), environmental (ENV), chemical (CHE), business (BUS), other (OTH).

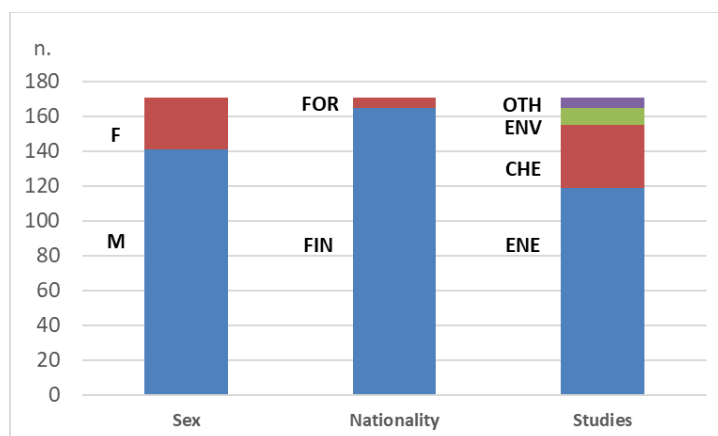


Figure 3. Background variables for distance learning students (2018–2019). Sex: male (M), female (F); nationality: Finnish (FIN), foreigners (FOR); studies: energy (ENE), environmental (ENV), chemical (CHE), business (BUS), other (OTH).

2.2. Testing the Background Variables

Responses were cross tabulated for background variables. This was to determine whether the background variable had an effect on the response. In cross tabulation, observations were presented in number distributions and a hypothetical tabulation with no dependence on background variables was constructed. The numbers in the hypothetical table are called expected frequencies. In order to make the frequencies high enough (>5), the answers “no” and “don’t know” were combined, as were the individual observations in the field of studies, under the group “other”. Testing the difference between the observed table and the hypothetical table is not reliable if the numbers of the hypothetical table, i.e., the expected frequencies, are too small as in the groups “don’t know” and “no”. “Don’t know” is not a same as “no” answer, but they were expected to be more sceptical than those who answered “yes”. However, the justification for all response options was further analysed. The justification was categorised under certain keywords which describe the answers in the best possible way, but students were not encouraged to use any keywords.

The difference between the observed and the hypothetical table was measured by the Chi-square test variable (X^2). The Chi-square test variable is known to follow a roughly Chi-square probability distribution, whose exact shape depends on the degree of freedom (df). The degrees of freedom are calculated from the table (number of rows–1) \times (number of columns–1). The value of the Chi-square test variable is higher the more the observed frequencies deviate from the expected frequencies.

3. Results

3.1. Student Response to the Query

Most full-time students considered the use of forest biomass in energy production sustainable (82%) (Figure 4). There was no significant difference between the years. There was also no significant difference in the other background variables except for the field of studies (Table 2). Environmental engineering (ENV) students were more sceptical about sustainability.

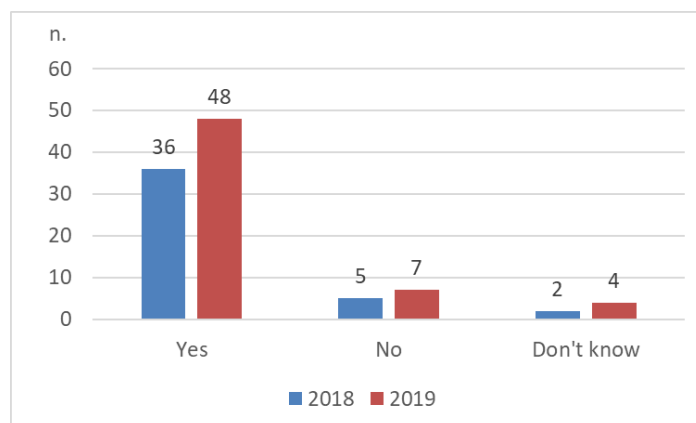


Figure 4. Full-time students’ views on the sustainability of forest biomass use in energy production in 2018 and 2019.

Table 2. The significance of background variables for full-time students.

	df	X ² -Value	p-Value
sex	1	0.001	0.973
nationality	1	0.047	0.829
BSc/MSc	1	0.614	0.433
studies	4	14.268	0.006

The use of forest biomass in energy production was also considered sustainable by most distance learning students (87%) (Figure 5). Equally, for them, of all the background variables, only the study fields influenced attitudes towards sustainability (Table 3). Chemical engineering (CHE) students were more sceptical about sustainability. Within each group, the majority were energy technology students, and they found forest biomass use sustainable. Moreover, there was no significant difference in the attitudes towards sustainability between full-time and distance learning student groups.

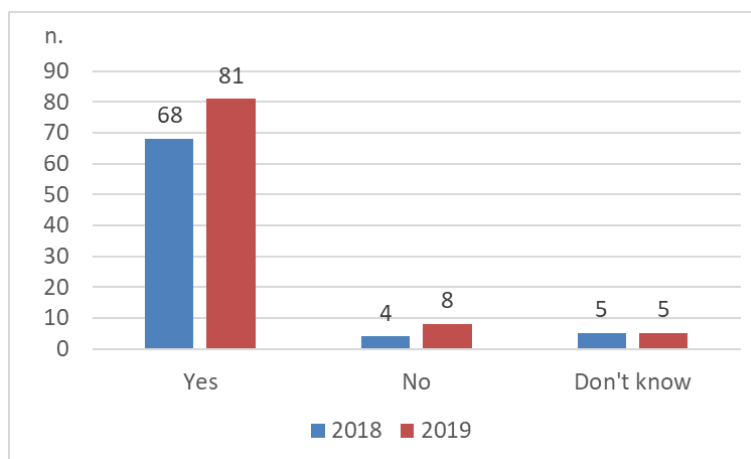


Figure 5. Distance learning students' views on the sustainability of forest biomass use in energy production in 2018 and 2019.

Table 3. The significance of background variables for distance learning students.

	df	X ² -Value	p-Value
sex	1	6.182	0.013
nationality	1	0.080	0.777
studies	3	19.94	0.0002

3.2. Students' Justification

The open answers were categorised into the four most mentioned topic themes, which were given keywords that best describe the theme. Synonyms can be found for keywords that mean the same thing. However, no other themes with more mentions were found. In practice, several themes could appear in a single response. The lengths of the responses also varied considerably. Students were not given keywords as answer options as they could influence student choices. The four most mentioned themes described by keywords in the "yes" answers were: felling balance, certification, waste fraction, directive (REDII). Whereas the four most mentioned themes described by keywords in the "no" answers were: biodiversity, overcapacity, C debt, cascading. The content of each theme is opened in more detail in the following chapters. Table 4 summarises the named keywords, which describes both positive and negative responses to sustainability among students. Keywords are ranked according to how many answers could be placed under them. However, no detailed analysis of their mutual significance was made.

Table 4. Summary table of justifications.

Sustainable	Not Sustainable
Felling balance	Biodiversity
Certification	Overcapacity
Waste fraction	C debt
Directive (RED II)	Cascading

3.3. Students' Justification of Choices: Yes, Sustainable

Initially, the fact that forests grow more than they are felled, or forest felling fell below the sustainable felling level, were the most frequently cited reasons for a sustainable alternative. It was also mentioned that forests continue to function as a significant carbon sink. Several justifications stressed that this is the case at present, but the increasing use of wood may make the situation unsustainable.

Second, different policy instruments, such as forest certificates (PEFC, FSC) and laws mean that woody biomass use in Finland is largely sustainable. Forest laws require, among other things, that forests must be replanted after felling. Finland also has a long history of wood use and forestry, whereby knowledge and know-how of the long-term balance of forest management is known. For example, the Finnish Forest Centre produces forestry guides that have the aim of maintaining biodiversity and reducing the impact of forestry on the environment.

Third, it was mentioned that the sustainability of forest bioenergy production is always context- and feedstock-dependent. In Finland, bioenergy is mainly produced from process by-flows, residues and small diameter stems from forest operations as a result of integrated systems that deliver bioenergy and other forest products. Forests are not grown for bioenergy but are a by-product of cultivation and processing.

Fourth, the new Renewable Energy Directive (RED II) has sustainable criteria for all biomass used for energy use or biofuels [24]. Respondents saw this as a guarantee of sustainability. The Renewable Energy Directive (RED II) was published in December 2018. The directive contains binding EU-wide sustainability criteria for biomass used for energy production. The sustainability criteria aim to ensure that the increasing use of bioenergy in the EU produces significant reductions in greenhouse gas emissions compared to fossil fuels. In addition, sustainability criteria include requirements for growing biomass in forests, fields and grasslands. The new RED II Directive will extend the criteria to include solid energy biomass for electricity and heat production from July 2021. In addition to environmental and ecological sustainability, social and economic sustainability were also mentioned as measures of sustainability. Many studies emphasise social sustainability and the employment opportunities offered by forest biomass for energy use [25–27].

3.4. Students Justification of Choices: No, Not Sustainable

First, loss of biodiversity, flora and fauna was mentioned in several justifications as a factor negatively affecting the sustainability of forest biomass. Forest management practices favour monoculture, and the proportion of unmanaged forests is decreasing. The preservation of native species of wood, the amount of decayed wood, valuable habitats and the structure of forests are linked to the maintenance of biodiversity.

Second, the increasing use of forests was seen as a threat to sustainability. There are many projects in Finland that aim at increasing the use of wood in the forest and energy industries. The use of wood can only be increased to a limited extent and there is a great deal of regional variation in supply and demand in Finland. Increasing the use of energy in biomass also means extending harvesting to sites with a lower biomass balance than before, which may imply a deterioration of the nutrient balance. Increasing the use of wood can also lead to an increase in wood imports, whose sustainability might be a challenge.

Third, biogenic carbon dioxide emissions were also mentioned, which raises atmospheric CO₂ and accelerates the rise in temperatures. The CO₂-balance of bioenergy is neutral from a long-term perspective, but the warming impacts of forest bioenergy needs consideration. C debt is a measure for the global warming potential (GWP) of biogenic CO₂ as it has a longer atmospheric residence time. This is affected by the type of biome (boreal, temperate, tropic) and type of forest product (residues, thinning, low- or high-quality stem wood). Logging residues are better in this regard compared to stumps or stem wood.

Lastly, other responses that questioned sustainability included the cascade principle and poor biomass efficiency in energy use. The cascade principle means prioritising the use of raw materials

for resource efficiency. For example, wood is first made into higher-value products that are reused or recycled and lastly converted into energy. In particular, electricity can be generated from other renewable sources (solar, wind) and biomass can be used to replace fossil-based chemicals and products. Renewable electricity can be used in conjunction with Power to X-technologies where atmospheric CO₂ and hydrogen from water are converted into synthetic fuels (methane, methanol, dimethyl ether). The poor efficiency of biomass use was mentioned in the context of electricity generation in condensing plants and long biomass supply chains. Potential GHG emission reductions will decrease as transport distances increase, but this is dependent on the logistics system.

3.5. Students Justification of Choices: Don't Know

The reason for not being able to respond to either option was the conflicting views of the different parties. The lack of consensus within the science community regarding the essentiality of carbon sinks raised questions about forestry and sustainability. Different methodological approaches exist, and the perspective has shifted from narrow to system-level thinking, which has led to different conclusions. Biomass supply is characterised by numerous alternative value chains from forest to end product, which means that the impact of forest biomass on net GHG emission savings is context- and feedstock-specific, due to the fact that many factors vary across regions and time.

4. Discussion

4.1. Student Responses and Justification

Most of the students considered the current energy use of forest biomass to be sustainable. Many replies stressed that the situation could change if the use of forests is increased from the present. Student background variables had no effect on the response to the first question, except for the field of studies, where environmental technology and chemical engineering students were more sceptical about the energy use of forest biomass. The effect of background variables on the second question, the justification, was not assessed. Attitudes about the sustainability of forest-based bioenergy were more positive than in a study of Chinese students who were more sceptical [15]. Moreover, the schoolchildren appeared to be very critical of bioenergy and especially of the issues related to bioenergy production from forests [16,17]. In those studies of schoolchildren, gender and residential (urban–rural) distribution played a role in attitudes, whereas in this study, gender had no effect. For university students, gender seems to have less of an impact than for schoolchildren. A university of technology may have more like-minded students than the general population. These earlier studies emphasised also the need to increase knowledge among students and it would seem that increasing knowledge is changing attitudes in a more positive direction based on this survey.

The balance of forest use was highlighted in the responses of positive attitude. LUKE's calculations on forest growth and use were considered to be reliable sources [28–30]. In many responses, students used external sources of information to justify their answer. The justification ranged from single sentences to multi-paragraph responses. Forest laws, certifications and various recommendations and guidelines were considered to ensure the sustainability of forest use. The preservation of forests as a sink is a prerequisite for their sustainability [30]. Part of the forest must be outside economic use.

The current use of forests was considered to reduce biodiversity, when most of the forests are commercially exploited. This is linked to the current level of forest use, which some respondents felt was too high and therefore unsustainable. Even though the biomass going into energy would come from side fractions, it does increase the carbon dioxide in the atmosphere after combustion, causing global warming potential (GWP). The phenomenon called C-debt was mentioned, which is a measure of the amount of C released from the soil and plant C stocks following the conversion of an area for bioenergy production. The cascading principle was pointed as a relevant argument for side fractions for which alternative end uses can be found instead of energy use, such as in the chemical industry.

4.2. *Emphasis of Student Responses to the SFO Concept*

Of the five performance areas of SFO-concept, the environment area was most emphasised in the student's responses, being either a positive or negative attitude towards sustainability. The keywords (cf. Table 4) felling balance, overcapacity, C-debt and biodiversity collected and named from the students' responses fall into this environment area. These terms can be seen key responses relative to the SFO concept indicators. The second most emphasised areas were economics and quality optimisation, where the keywords certification, waste fraction cascading and directive (RED II) can be included in this area. The people and society area, which includes a wide range of ecological, political, economic, social and cultural systems and processes that are necessary for people and society, was very poorly addressed. It may not have been perceived as important in forestry in industrialised countries compared to developing countries, where the well-being of local communities should be prioritised. Moreover, the ergonomics area, which focuses on individual aspects of the work conditions of forest workers, was not addressed by respondents. On the other hand, this topic was not covered in the bioenergy course, as it relates in detail to forest harvesting operations. This may also be more relevant to forestry in developing countries, where the mechanisation of logging is at a lower level and a shortage of training is more obvious. It seems that the more traditional environmental, economic and social designations of sustainability, will be better suited to the definition of sustainability discussed in the course with an emphasising on the first two areas.

4.3. *Validity and Reliability of the Study*

Validity expresses how well the measurement method used in the study measures the characteristic of the phenomenon being investigated, which is what it is intended to measure. This study was conducted in the form of multiple-choice questions and justification for the answers was required. The concept of sustainability in relation to the research question is not necessarily unambiguous and involves different interpretations that emerged in the justification of the answers. Measuring sustainability requires previous research data and related studies and calculations. The need to rely on previous models and calculations is typical when measuring sustainability concepts.

The answers were not graded, and the query was obligatory for distance learners and voluntary for full time students. Thus, the grading had no effect on the results, which is important for validity. As a result, the study provided information on the factors on which the sustainability of forest biomass was chosen. This was in fact a more important result from the study than the proportions of the alternatives. This study was valid for this university student group at this time and the results cannot be generalised more widely. This is because the results of these type of studies are time and place dependent. Extending the survey to a wider population, for example among university students, would improve validity.

Reliability refers to how reliably and reproducibly a metric is used to measure a desired phenomenon. If the reliability of measurement is poor, it also results in poor validity. The opposite may not be true. Query surveys can have many random errors that need to be eliminated beforehand. In this survey, the respondents were not anonymous, but the answers could be associated with the respondent and this was known to the participants. In this study, anonymity would not have added value to the responses, since it would not have changed the answers. Thus, it has no effect on reliability. It was stressed to the students that all the options are "equally correct" if the answer is justified. Now the study was conducted twice in the same way in 2018 and 2019, and there was no significant difference in the results between the different years. This repetition improves reliability.

One possible factor that influences a respondent's answers is the time it takes to respond, such as a quick interview or a written response within a certain time. The students had several weeks to answer the question and justify their answer, so the time had no effect on the answer, and the students could study the matter in their own time. Questions must relate to the respondent's field of experience or motivation in order for the respondent to be able to answer. In this case, "no opinion" responses will decrease. The students were also well placed to answer the questions because they had studied the

subject in the course. This makes the group more homogeneous with respect to the lecture material on the topic. Some students had more experience-based knowledge because they were working and engaged in distance learning compared to full-time students at university. No significant difference was found between these groups in the responses. Possibly applying for the same type of technical education means that the group of students is more homogeneous regardless of the way the study takes place. Distance students are, on average, older, so age does not change attitudes. The research question was related to the situation and circumstances in Finland, so one would assume that students with a foreign background may have different attitudes towards sustainability, but no difference was found in the answers to this background variable either. The study of similar course material may have been the reason for this. The respondent must have the motivation to answer the questions, which was not a problem in this study. The questionnaire was part of the course, so all the distance learners and most of the full-time students answered the questionnaire.

4.4. Possible Recommendations and Future Research

If it is to be assumed that some of the respondents are not in a position to form an opinion of the argument, the response options on the Likert scale could be: ‘totally agree, somewhat agree, somewhat disagree, disagree, no opinion’. This kind of questioning could have added value for a study where there is justifiable disagreement. It is assumed that responses to the different categories would have been more evenly distributed than in the current survey, because there are also answers between yes-no opinions. The field of study influenced the opinion, but the reason remained open. There are more female students in environmental and chemical engineering, but based on the crosstabulation, gender had no effect. Further clarifications could be made as to what factors influenced opinion in these fields of study. Since this group of students already enrolled in this class it shows a level of interest and possibly bias on the topic relative to the general population.

Finally, examining sustainability in connection with the use of bioenergy will become more important in the future as the use of bioenergy increases. The targets set for Finland’s use of bioenergy are a good example of this, as the additional use of renewable energy in traditional energy production (heat/electricity) and transport will rely heavily on bioenergy over the next decade.

Author Contributions: Conceptualization, T.R.; methodology, T.R.; validation, T.R., A.K. and M.L.; formal analysis, T.R.; data curation, T.R.; writing—original draft preparation, T.R.; writing—review and editing, T.R., A.K., M.L.; visualization, T.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. World Commission on Environment and Development (WCED). *Our Common Future*; Oxford University Press: Oxford, UK, 1987; Available online: <http://www.un-documents.net/our-common-future.pdf> (accessed on 23 June 2020).
2. MacDicken, K.; Sola, P.; Hall, J.E.; Sabogal, C.; Tadoum, M.; de Wasseige, C. Global progress toward sustainable forest management. *For. Ecol. Manag.* **2015**, *352*, 47–56. [CrossRef]
3. Heinimann, H.R. Forest operations engineering and management—the ways behind and ahead of a scientific discipline. *Croat. J. For. Eng.* **2007**, *28*, 107–121.
4. Marchi, E.; Chung, W.; Visser, R.; Abbas, D.; Nordfjell, T.; Mederski, P.S.; McEwan, A.; Brink, M.; Laschi, A. Sustainable Forest Operations (SFO): A new paradigm in a changing world and climate. *Sci. Total Environ.* **2018**, *634*, 1385–1397. [CrossRef] [PubMed]
5. Total Roundwood Removals and Drain, 2019 (Provisional). Natural Resources Institute Finland. Available online: https://stat.luke.fi/en/total-roundwood-removals-and-drain-2019-provisional_en (accessed on 23 June 2020).

6. Lier, M.; Korhonen, K.T.; Packalen, T.; Savula-Seppälä, T.; Tuomainen, T.; Viitanen, J.; Mutanen, A.; Vaahtera, E.; Hyvärinen, J. Suomen metsät 2019: Kestävän metsänhoidon kriteereihin ja indikaattoreihin perustuen. Available online: <http://urn.fi/URN:NBN:fi-fe2019091628401> (accessed on 23 June 2020).
7. Forest Act. 1093/1996. Ministry of Agriculture and Forestry. Available online: <https://www.finlex.fi/fi/laki/smur/1996/19961093> (accessed on 23 June 2020).
8. Miina, J.; Hallikainen, V.; Härkönen, K.; Merilä, P.; Packalen, T.; Rautio, P.; Salemaa, M.; Tonteri, T.; Tolvanen, A. Incorporating a model for ground lichens into multi-functional forest planning for boreal forests in Finland. *For. Ecol. Manag.* **2020**, *460*. [CrossRef]
9. Calderón, C. (Ed.) *Statistical Report*; Bioenergy Europe: Brussels, Belgium, 2019; Available online: <https://bioenergyeurope.org/statistical-report.html> (accessed on 23 June 2020).
10. Ranta, T.; Laihanen, M.; Karhunen, A. Development of the bioenergy as a part of renewable energy in the Nordic Countries: A comparative analysis. In Proceedings of the 6th Central European Biomass Conference, Graz, Austria, 22–24 January 2020.
11. Wood in Energy Generation 2019. Natural Resources Institute Finland. Available online: https://stat.luke.fi/en/wood-energy-generation-2019-provisional_en (accessed on 23 June 2020).
12. IRENA. *Bioenergy from Finnish Forests: Sustainable, Efficient, Modern Use of Wood*; International Renewable Energy Agency: Abu Dhabi, UAE, 2018; ISBN 978-92-9260-012-9; Available online: https://www.irena.org/media/Files/IRENA/Agency/Publication/2018/Mar/-IRENA_Bioenergy_from_Finnish_forests_2018.pdf (accessed on 23 June 2020).
13. Glossary of Climate Change Acronyms and Terms. UNFCCC. Available online: <https://unfccc.int/process-and-meetings/the-convention/glossary-of-climate-change-acronyms-and-terms#l> (accessed on 23 June 2020).
14. Hildén, M.; Soimakallio, S.; Seppälä, J.; Liski, J. *Forest Carbon Sinks Must Be Included in Bioeconomy Sustainability Assessments*; SYKE Policy Brief; Suomen ympäristökeskus: Helsinki, Finland, 2016; ISBN 978-952-11-4580-3; Available online: <http://hdl.handle.net/10138/164797> (accessed on 23 June 2020).
15. Qu, M.; Ahonen, P.; Tahvanainen, L.; Gritten, D.; Mola-Yudego, B.; Pelkonen, P. Chinese university students' knowledge and attitudes regarding forest bio-energy. *Renew. Sustain. Energy Rev.* **2011**, *15*, 3649–3657. [CrossRef]
16. Halder, P. Perceptions of energy production from forest biomass among school students in Finland: Directions for the future bioenergy policies. *Renew. Energy* **2014**, *68*, 372–377. [CrossRef]
17. Halder, P.; Prokop, P.; Chang, C.-Y.; Usak, M.; Pietarinen, J.; Havu-Nuutinen, S.; Pelkonen, P.; Cakir, M. International Survey on Bioenergy Knowledge, Perceptions, and Attitudes Among Young Citizens. *Bioenergy Res.* **2012**, *5*, 247–261. [CrossRef]
18. van Dael, M.; Lizin, S.; Swinnen, G.; van Passel, S. Young people's acceptance of bioenergy and the influence of attitude strength on information provision. *Renew. Energy* **2017**, *107*, 417–430. [CrossRef]
19. Mayfield, C.A.; Foster, C.D.; Smith, C.T.; Gan, J.; Fox, S. Opportunities, barriers, and strategies for forest bioenergy and bio-based product development in the Southern United States. *Biomass Bioenergy* **2007**, *31*, 631–637. [CrossRef]
20. Rahman, A.; Khanam, T.; Pelkonen, P. People's knowledge, perceptions, and attitudes towards stump harvesting for bioenergy production in Finland. *Renew. Sustain. Energy Rev.* **2017**, *70*, 107–116. [CrossRef]
21. Stupak, I.; Joudrey, J.; Smith, T.; Pelkmans, L.; Chum, H.; Cowie, A.; Englund, O.; Goh, C.S.; Junginger, M. A global survey of stakeholder views and experiences for systems needed to effectively and efficiently govern sustainability of bioenergy. *WIREs Energy Environ.* **2016**, *5*, 89–118. [CrossRef]
22. Buchholz, T.; Luzadis, V.A.; Volk, T.A. Sustainability criteria for bioenergy systems: Results from an expert survey. *J. Clean. Prod.* **2009**, *17*, S86–S98. [CrossRef]
23. van Dam, J.; Junginger, M. Striving to further harmonization of sustainability criteria for bioenergy in Europe: Recommendations from a stakeholder questionnaire. *Energy Policy* **2011**, *39*, 4051–4066. [CrossRef]
24. Report from the Commission to the Council and the European Parliament on Sustainability Requirements for the Use of Solid and Gaseous Biomass Sources in Electricity, Heating and Cooling. COM(2010)11 final. Available online: <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0011:FIN:EN:PDF> (accessed on 23 June 2020).
25. Eker, M.; Spinelli, R.; Gürlevik, N. Recovering energy biomass from sustainable forestry using local labor resources. *J. Clean. Prod.* **2017**, *157*, 57–64. [CrossRef]

26. Valente, C.; Spinelli, R.; Hillring, B.G. LCA of environmental and socio-economic impacts related to wood energy production in alpine conditions: Valle di Fiemme (Italy). *J. Clean. Prod.* **2011**, *19*, 1931–1938. [CrossRef]
27. McKay, H. Environmental, economic, social and political drivers for increasing use of woodfuel as a renewable resource in Britain. *Biomass Bioenergy* **2006**, *30*, 308–315. [CrossRef]
28. Forest Resources. Natural Resources Institute Finland. Available online: <https://stat.luke.fi/en/forest-resources> (accessed on 23 June 2020).
29. NFI Computing Service. Natural Resources Institute Finland. Available online: <https://vmilapa.luke.fi/#/?locale=fi-FI> (accessed on 23 June 2020).
30. Official Statistics of Finland (OSF): Greenhouse Gases. Available online: http://www.stat.fi/til/khki/index_en.html (accessed on 23 June 2020).



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).