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How could companies and authorities improve their risk communication regarding Biomass usage as an energy source in Finland?

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Abstract

Biomass as an energy source has relatively long history in Finland but still experiences growth as an industry. Biomass-based energy is prioritized by the government in the form of legislation that favors biomass or disfavors fossil alternatives it competes with, but the overall knowledge of the technology and the risks related to it are not completely clear among professionals and lay people alike.

In this study the aim was to chart the current knowledge of lay people and professionals to establish and examine the gaps and overlaps in the knowledge of the risks and benefits and overall awareness related to these technologies. This was achieved by interviewing professionals in the field of biomass and lay people with varying levels of knowledge about biomass and the risks and benefits it poses.

After reviewing these findings from the study, they were reflected in relation to the relevant academic literature regarding risk communication, risk science, risk governance, risk-benefit and risk-risk tradeoffs.

In the end of the study there are conclusions and suggestions that companies and decision-makers can research further and use in their own risk communication and governance processes in the future.

Keywords: Risk communication, Risk Governance, Biomass, Bioenergy

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Chapter 1 Introduction

1.1 Motivation

Finland had the second highest percentage of energy produced by renewables in the EU in 2020. End energy usage stats from 2020 state that 40% of end energy consumed in Finland was generated by renewable sources compared to 37% that was produced by fossil alternatives including peat. This was the first time in Finnish history that renewable energy sources surpassed the fossil energy sources. But Finland does not want to stop there, the goal is to increase the amount of energy created by renewables to over 50% in the course of 2020's. (*Bioenergia*, 2021) In 2020 28% of the total energy consumption was done by forestry products. Despite bioenergy being the number one energy source in Finland the knowledge about the potential, viability, risks, and benefits associated with biomass as an energy source vary.

For properly to understand the transition from fossil energy sources to more renewable and possibly environmentally friendly technologies, it is vital to understand the driving forces and reasons behind the transition.

For example, at 2007 paper done by international risk governance council, it was stated that new palm oil plantations can generate over 10 times the CHG emissions than burning coal to achieve same level of output energy. (Florin, 2007)

So, it is vital to discover all the aspects of the technologies at hand and not just use them for short term gains locally or for political purposes.

The people are also entitled to in depth knowledge about the risks that these technologies contain and benefits that are gained, therefore the risk communication is vital in understanding these transitions and risk-benefit scenarios on a larger scale.

The transition from the fossil energy sources to the renewables does not come without risks. In their 2006 article Farrell and Brandt discuss their views within the risks of oil transition, they do not particularly discuss the biomass related risks, but the overall transitional nature is

the same within the biomass context, since it tries to replace the fossil-based fuel alternatives. Risks mentioned in that article are economical, strategical and environmental of nature and this is also the case with bioenergy transition. (Farrell, Brandt 2006)

Professor Ragnar Löfstedt had conducted a study in the 1990's in Växjö, Sweden, in which he studied the VEAB:s bioenergy endeavors and interviewed local actors in the field and lay people like on how they view bioenergy in their area and municipality (Löfstedt 1996). This sparked an idea to partially recreate the study to chart the knowledge and views of the people in 2021 in Finland regarding bioenergy and analyze and compare the results in a current framework with the latest academic knowledge on effective risk communication.

Risk communication is a field where there is no strong consensus on the matter of what constitutes effective risk communication, even though some practices are more favored over others (Balog-Way et al., 2020). The objective of the study is to research how the current risk communication is practiced in Finland regarding biomass and how it corresponds to the preferred methods among scholars.

Risk science is mostly used as a decision support by decision makers to compare alternative courses of action. Therefore hazards, risks, and the benefits of the biomass as an energy source are interesting to study from the perspective of lay people and the professionals of the field as well.

The main objective of the study was to find out how the decision-makers, biomass- and bioenergy producers could improve their risk communication in Finland.

This was done by completing a case study charting the current views of the people on biomass and how well the technology and the benefits and risks associated with the technologies involved are known and understood and then reflecting them in an academic framework of risk, risk communication, risk-risk tradeoffs, risk-benefits. Another objective of the study was to compare the results received from the interviews to the study done by Ragnar Löfstedt in 1996 in Växjö, Sweden, to study how attitudes and knowledge about these technologies have been altered in the 25 years since that study was conducted.

A few professionals of the field have also participated in the interviews to see how their perspectives and knowledge differ from the lay people, to better understand the possible developments and improvements in the field of risk communication regarding the biomass in Finland.
This was done alongside with initial data gathering from the government's documents, news outlets and various interest groups in the field of Bioenergy to build a picture of possible improvements that could be conducted by the authorities and companies to develop their risk communication in Finland.

1.2 Scope and limitations of the study

The thesis in question applies the risk theories and risk communication in relation to the relevant and up to date academic knowledge of the risk field and prioritizes relevant knowledge that has been studied in relation to biomass and other relevant topics in the thesis. Risk sciences classification as an independent field and branch of science has been discussed and more on the subject is discussed later in the literature review.

Even though biomass is widely used and developed in Finland, there is still lack of domestic research, specially linking the risks and benefits of the biomass usage in such an extent that it is conducted in Finland. Also as stated by one professional in the field of forestry during the interviews, there is a culture of not wanting to share and speak in the field, which may explain the limited number of professionals willing to take part in this study. The study's interview questions had to be balanced in order to gain answers from both the professionals and the lay people alike, which limits the depth of the data gathered when the questions can not be tailored to either of the groups specifically.

Chapter 2 Literature review

2.1 Risk Science

Defining risk science as its own field is controversy on its own. This is argued by professor Aven in his article from 2017. (Aven, 2017) Risk analysis is often viewed as a multidisciplinary field borrowing practices and methods from psychology, social sciences, engineering, and medicine among others. It is argued that because uncertainty is involved there is no concrete way to measure risk and the methods therefore are not purely scientifical. (Aven, 2017) Aven argues that Risk science is dependent on the sciences and builds on it but can not be objectively treated as such since there is no objective truths to be discovered. (Aven, 2017)The objective of risk science can be divided into to segments, providing operational and decision support to other activities and branches and then actually developing theories and other tools in order to manage, understand, characterize and communicate risks for example.
Risk management and assessment cannot be used synonymously, risk assessment is used to create decision support for decision makers and risk management provides the frameworks needed to conduct these assessments. (Aven, 2017)

Hansson and Aven conclude in their 2014 article that risk analysis is scientific when considering "*primarily of (i) knowledge about risk-related phenomena, processes, events ,etc., and (ii) concepts, theories, frameworks, approaches, principles, methods, and models to under-stand, assess, characterize, communicate, and man-age risk, in general and for specific applications*" (Hansson & Aven, 2014)

2.1.1 Definition of Risk

As Aven and Renn argue in their 2009 paper the definition of Risk is not widely agreed upon. In the article some risk definitions are mentioned, but they can be roughly divided into two categories, the probabilistic approach where risk is portrayed by probabilities and expected values and the other approach defines risk by events and uncertainties (Aven & Renn, 2009)

Since there is not a single definitive definition risk that is widely approved among the field there is always a chance that people, for example policy makers and scientist use different definition of risk when implementing policies and that causes problems, since the parties are defining risk differently and therefore trying to achieve different objectives.
The use of probabilities, state preference and utility can be used to characterize the uncertainties and expose the components of the risk, but this only applies to the perceived risks and leaves the unperceived risk unaccounted for (Holton, 2004).
In this thesis concern is not the exact definition of risk and the risk science as a generic field of science. The main goal of the thesis is to find ways to improve risk understanding and perception in a given industrial framework.

2.2 Risk Governance

We can diverge from the risk as concept towards risk governance. The idea of the risk governance is to help risk professionals to familiarize themselves with the concepts of risk. (van Asselt & Renn, 2011) In the same article Van Asselt and Renn propose three principles of a risk governance.

Communication and inclusion

Integration

Reflection

These principles should not be seen as separate “check points”, but rather as a parallel system that needs to be visited at every stage of the process. (van Asselt & Renn, 2011)
Communication can be seen as key to this process, the different actors of different areas are needed to communicate with each other to tackle the problems related to finding the uncertainties and ambiguines related to the problem at the discussion. In the article there is a strong case presented that the risk and uncertainties should not be identified just by experts, since it is not inclusive and by that there is a chance of missing important aspects of the risks and uncertainties. (van Asselt & Renn, 2011)

Integration principle argues that to understand the nature of complex risks, there must be integration of knowledge between scientific fields of study and tacit knowledge that can reflect the societies or cultures values. (van Asselt & Renn, 2011) This is to better understand the nature of the complex and systemic risk which effect societies and people in many different areas. If integration is not performed, it is easy to build a separate realm of risk analysis and management that is detached from the real world and its events.

Reflection principle can be argued as an aim for constant development of the risk governance. With the reflection principle there must be constant balancing of pros and cons regarding uncertainties and processes handled and imposed by these governance systems. It must be taken into consideration also that the communication and inclusion must always be present in this to be able to effectively collaborate with the different stakeholders in the processes and projects. (van Asselt & Renn, 2011)

2.3 Risk Communication

Risk communication can be characterized as such:
"*Risk communication is an interactive process of exchange of information and opinion among individuals, groups and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risk, that express concerns, opinions, or reactions to risk messages or to legal and institutional arrangements for risk management."* (*Improving Risk Communication*, 1989, p. 21)

2.3.1 The field of risk communication

The field of risk communication is not a unified field by any means, risk communication research is widely dispersed between different scholars and viewpoints, some of them not even in the world of academia. The field of risk communication has been evolving constantly from the 1980s, when the consensus was more on the side of that the risk communication and risk is to be judged by experts and little to no weight was given to the perspectives of the lay people. (Balog-Way et al., 2020) The deficit model of the time was to try to align the views of the lay people to correspond the ones of the experts and by that affect the actions of the lay people. (Balog-Way et al., 2020) This has then evolved, and risk communication is focused

more on the risk perception of the lay people and their views and a constant dialogue between stakeholders. The previous case is mostly in academics, in actual governance the authors of the article argue that the deficit model is still used widely in the government and local authorities. (Balog-Way et al., 2020)) The study done by Löfstedt and Bouder in 2010 points to the same direction stating that the risk communication is still often practiced and seen as a top down process. (Löfstedt & Bouder, 2010)

2.3.2 What is effective risk communication?

In the article previously cited it is acknowledged that there is no one size fits all solution towards risk communication. Given that knowledge, the next step is to look at some studies in the field that try to quantify good risk communication.

On their 2010 study, Löfstedt and Bouder argue that good risk communication should be truthful and honest to begin with. They also advocate for a broad dialogue with the public and other stakeholders from the beginning of the activity, so that the trust is built already before risk materialize or accidents happen. It is better to seek discussion rather than confrontation according to this study, which can be seen very instinctive. The communication should be based on the best available scientific knowledge and involvement of highly trusted individuals can help in building the trust and getting the communication through in a meaningful way. They also suggest that involving the local authorities and the decision-makers as early as possible in the decision-making process to communicate the benefits to that community and even help the projects forward even against some public opposition. The responsibility factors of the decision makers also can play a role in communication and decision-making processes. (Löfstedt & Bouder, 2010)

In their same 2010 study Löfstedt and Bouder suggest that in order to create state of the art risk communication the actors should participate in active dialogue between different stakeholders and to build trust among others. They also state that confrontation between the parties will destroy the public trust and media is likely to amplify the effects. It is also suggested than when in dispute, all of the parties should rely on the relevant scientific knowledge. (Löfstedt & Bouder, 2010)

The lastly mentioned plays a large part in this thesis, since a lot of the bioenergy debate is based around the view that bioenergy is better and greener option to the fossil fuels and the responsibility of the decision-makers is then guided towards lower emission or footprint products.
Balog-way, McComas and Besley in their review emphasize the level of the trust that the "sender" or "messenger" of the communication possesses towards the public is vital to effectively communicate risks towards the people. They also suggest that high trust individuals are in a key role towards trust building in a society and transparency of the process helps in building the trust. The trustworthiness of the risk communication, along with almost every other type of communication these days is in the question. This is due to increasing usage of social media and the possibility to share "fake news" in these outlets, containing information that has no actual value or possibly even to share information that is put in place to disinform people. (Balog-Way et al., 2020)

The Risk and Regulation Advisory Council suggest in their Practical guide for public risk communication that effective risk communication constitutes of five key elements.

- Assembling the evidence
- Acknowledgement of public perceptions
- Analysis of options
- Authority in Charge
- Interacting with your audience

(A Practical Guide to Public Risk Communication The five essentials of good practice, 2009)

When assembling the evidence, the organization needs to consider the following. The overall costs and benefits need to be understood and all of the aspects of risks need to be explained. The risks need to be addressed and backed up with scientific knowledge, ideally high-quality knowledge with low level of uncertainty. It needs to be understood that evidence and knowledge is rarely conclusive and straight causations cannot be drawn. It must be also acknowledged that the situations are not static, but rather in constant state of change.
(A Practical Guide to Public Risk Communication The five essentials of good practice, 2009)

When assessing the public perceptions, it must be addressed that the public is not homogenous group with similar risk perceptions. The nature of the risks can also affect the public perception, for example risks that are voluntary, you have control over, natural, have high probability of occurrence but low consequences, are familiar or only affect adults are more likely to be accepted by the public as their opposites.
(A Practical Guide to Public Risk Communication The five essentials of good practice, 2009)

When analyzing the options, a broad range of options must be thought trough. When communicating this to public they should be made aware of the cost and benefits of the options presented and that tradeoffs are well thought and grounded. Also, conflicting interests must be addressed among actors. There is a variety of options to identify these costs, benefits, tradeoffs and no size fits all solution cannot be made, but rather find the ones that suit the situation at hand.
(A Practical Guide to Public Risk Communication The five essentials of good practice, 2009)

Authorities in charge should consider their limitations when dealing with risks. Should the organization take the responsibility for the risk at all or decide not to take part in it. It is often discussed that government should take the responsibility, but the case with some risks is that they are better addressed by other actors such as private companies or individuals. The limits of organizational responsibility and involvement should be addressed too. For less trusted organizations or actors, scientific actors at their back could improve the confidence and the receptibility of the message. (A Practical Guide to Public Risk Communication The five essentials of good practice, 2009)

When interacting with the audience the messaging should be concise and suitable for the intended audience in complexity and depth. This can be achieved trough consulting the audiences and having effective internal and external communication to allow for productive dialogue between different actors. (A Practical Guide to Public Risk Communication The five essentials of good practice, 2009)

By looking at these points it can be interpreted that the successful risk communication involves two-way communication, but it can still have elements of the top-down risk

communication process, especially with the recruitment of high trust individuals and backing up the process with latest scientific data.

2.3.3 Building an effective message to the correct audience

Message plays a vital role in the risk communication since it is the thing that the stakeholders and public receive. Ortwin Renn argues in his 2008 guidelines about the message, that the messenger should be transparent about their intentions and deliver the message as simply as possible without making it inaccurate and then add complex additions as the message gets longer. (Renn, 2008, pp. 251–255) The message should also be put in the social context and the messenger should not put themselves in a position which the target audience could receive as dictating or superior towards them. (Renn, 2008, pp. 251–255)

Balog-way, McComas, Besley state in their review that the evaluation of risk messages is vital to provide effective risk communication and to avert unwanted results.
The audience that receives the message plays an integral part in the risk communication process, since different audiences have different interests and needs (Löfstedt, Bouder 2010) and their risk perception might be different from other group of actors (Balog-way, McComas, Besley 2020). This is important to know when planning the messages and strategies. Race, gender, age, political orientation, education, and personal experiences all have an impact on person's risk perception, but it cannot be generalized over populations and countries. (Balog-Way et al., 2020). Renn also suggests in his guidelines for effective risk communication that needs of the intended audience should be anticipated and the different audiences should be targeted with differing messages. (Renn, 2008, pp. 251–255). Since the audiences differ, there is a possibility to distance the core audience by trying to include peripheral audience and the messenger has to be aware of these developments. (Renn, 2008, pp. 251-255) This effect can be seen for example on the elections when politicians try to gain votes from the edges of their potential constituents and they might leave their core following with a less of an attention and maybe even lose their trust and votes in the process.

2.3.4 Known failures in the risk communication

Many of these theories and guidelines can be used in reverse when discussing failures in the risk communication. For example, the lack of trust in an organization or individuals will cause

the opposite effect than trust and so forth. In the study by Löfstedt and Renn from 1997 they discuss some of the known failures that have been made in the risk communication regarding the Brent Spar situation in the North Sea. The situation was that Exxon and Shell were trying to figure out in 1994, what to do with a redundant oil storage platform and how to dispose it. (Löfstedt & Renn, 1997)

In this study, the researchers found out that the Shells strategy for risk communication went bad. There were serious transparency issues about the situation that Greenpeace brought to daylight. This on the other hand takes away the proactive possibility for discussion since it is done by a third party. Shell also lost the media game in this situation, and the media portrayed the narrative of a greedy international company that led to boycotts of Shell products and retail stations. Also the fact that public and the media had sided against the Shell meant that politicians in other countries apart from UK and Norway were able to collect votes by promoting environmental agenda at the cost of the actors such as Shell and UK officials. (Löfstedt & Renn, 1997)

The company and UK government had implemented a top-down communication strategy which is believed to have alienated and distanced lay people from their point of view. They also were not proactive enough to address to these issues in time, but rather were on defense. The psychological feelings of the audience were also ignored by the Shell and officials. People wished that the deep sea should remain pristine and free of man-made pollutants. Furthermore, the company was not able to establish trust again after being put on defensive mode, due to irrational and mixed messaging. (Löfstedt & Renn, 1997)

2.3.5 Summary of Risk communication

As per previous chapters, the field of risk communication is not unanimous about how to communicate risk properly, but there is a certain consensus among the experts that some ways of performing the risk communication are better than others. If we take a look at the two last chapters about good communication and bad communication, there is a trend that these are opposite scenarios and the problems could have possibly been avoided if the action was taken according to the principles of good risk communication. Although it must be recognized that some of these authors have cross written articles with each other and there can be found bias towards their own earlier work or the work of their research colleagues. And therefore, they might be more inclined to make reversible suggestion of their own principals.

2.4 Risks in energy sector

Not many fields of industry have earned the limelight in discussion about safety and risk as the energy sector. Energy production and harvesting of the resources have experienced its fair share of disasters with great impact at the industry as today. These disasters and accidents have had great humane, environmental, and economic effects. Almost everyone has heard about Fukusihma, Tshernobyl and British Petroleum disasters which have caused large consequents for the environment and people alike. From the Norwegian energy sector most of the people are familiar with the Alexander Kielland accident which lead to 123 lost lives at the North Sea on March of 1980.

But the energy sector includes many other challenges and risk other than the ones caused by disasters and accidents. These risks include environmental risks, economical risks, and strategical risks (Farrell & Brandt, 2006).

Producing, transporting and using energy creates the greatest environmental load of any industry currently known to mankind. (Bilgen, 2014) The burning process of the fossil fuels create Sulphur oxides, Nitrous oxides, and Carbon dioxide emissions that cause acid rains and greenhouse effect which is leading to global warming. (Bilgen, 2014) Also the extraction of fossil fuels is an energy intense process and it creates emissions. These emissions are being tried to mitigate with electrification of offshore installations like here in Norway and producing the electricity with green alternatives, for example hydro power. The other way to limit emission in the extraction phase is to capture and reinject the hydrocarbons in the extraction process (Farrell & Brandt, 2006). Since the 1950s and 1960s nuclear power has been presented as a CO_2 free alternative to the fossil fuels in the electricity production. This does not come without tradeoffs either. The usage of nuclear power creates highly radioactive waste material that needs to be stored away for thousands of years and there is a potential for horrible disasters as Fukushima and Tshernobyl have demonstrated in the past 40 years.

Another aspect of the risks listed in the energy sector is the economic risk. Economics of the energy sector could fill many more thesis than this. Traditionally economy of energy sector can be described volatile, for example the price of an oil barrel has fluctuated between 20 dollars and 130 dollars per barre in the last ten years. This leads to a difficult task of assessing profitability and viability of different energy production methods. Current situation is that the substitutes for the classic petroleum require more initial capital investment and are also more expensive during the lifecycle of the production than the fossil counterparts (Farrell & Brandt,

2006). This imposes risk to the investors and might make the substitutes to fossil fuels even unviable, of course as a later discuss in this review, there is a governmental factor to these problems and the policies implemented might drive the risk of the investors even higher (Farrell & Brandt, 2006). By producing biomass based fuels, there could be a potential to provide additional supply to the energy sector and therefore lower the pressure of increased energy costs, but this might lead according to Farrell and Brandt to a lower and volatile prices and therefore mitigate the investments made into biomass based fuels, since they might not be profitable at the price levels imposed by the new markets. (Farrell & Brandt, 2006)
The last type of risk discussed in this chapter is the strategic risk. The strategic risk in this scenario can be described, potential of the operators in the energy sector to implement actions that create artificial conditions to the energy supply. This could be as described by Farrell and Brandt for example a pressure from OPEC, if they start to control larger share of the oil and energy markets. This could have a counter beneficial effect on the regulators in the worst case, by letting go of the environmental aspects and reducing the measures towards reduction of greenhouse gas emissions to comply with the limited supply created. (Farrell & Brandt, 2006)

2.4.1 Risk perception and trust in energy sector

Risk perception of the lay people has affected and can affect decision-makers' policies in the future as well. For example, in the nuclear industry the public pressure towards the authorities has made the nuclear option for energy generation quite unattractive in many areas from the late 1970s. (Whitfield et al., 2009)
Different populations can vastly differ in risk perceptions regarding energy generation methods. For example, regarding the nuclear risk there is indication that lower trust in the nuclear organization and lower education levels indicate a higher perception of nuclear risk. Gender, age. political orientation affects the risk perception of nuclear risk. (Whitfield et al., 2009)
In the same article it is argued that risk perception related to nuclear activity is directly related to the individuals trust and educational background. The trust towards nuclear activities is generated from generalized beliefs or worldview about human impacts on the environment. (Whitfield et al., 2009)
From this we can assume that increasing the populations' trust towards the energy generation technology at hand and educating the population could help in lowering the risk perception of

the given technology. Ragnar Löfstedt has reported similar correlation of high level of distrust and higher risk perception in his book Risk Management in post trust societies (Löfstedt, 2005)

In their 2000 article Siegrist, Cvetkovich and Roth acknowledge this situation, too. They argue that large social trust lowers the perceived risks and increases the perceived benefits on a given technology. (Siegrist et al., 2000) They state that individuals who do not possess understanding and knowledge of the risks on given technologies will have to rely to the assessments of experts when dealing with assed risk and possible benefits. They also note that experts on the fields differ in opinions and views, and people are then more likely to assimilate themselves with the experts that share their values when it comes to recognizing benefits and risks. (Siegrist et al., 2000)

2.5 Risk-Benefit and Risk-Risk tradeoffs

Since this thesis is about the transition from the fossil-based fuels, mainly oil and natural gas in this context, towards the biomass-based fuels, it is vital to talk about risk-benefits and Risk-risk tradeoffs.

The risk-risk tradeoffs are defined by Graham and Weiner in their 1995 book "*the change in the portfolio of risks that occurs when a countervailing risk is generated (knowingly or inadvertently) by an intervention to reduce the target risk"* This can be referred so that a reduction of the target risk by implementing risk management measures can create additional risks that were not intended.

In the 1995 book Graham and Weiner classify these risk-risk tradeoffs into four different categories.

1. Risk offset – Where the same outcome is created in the target population
2. Risk transfer – The same risk is shifted from a population to another
3. Risk substitution – The original unwanted outcome is replaced with another unwanted outcome in the same population
4. Risk transformation – Countervailing risk is different in the outcome and the population that it affects.

(Graham & Wiener, 1995, pp. 22–23)

These are important to consider, like argued before, since usage and production of the fossil-based fuels is a risky business. The goal of identifying the possible underlying risk-risk tradeoffs and finding possible risk-superior alternatives or risk-benefit alternatives is to help reduce overall risks involved in the energy sector. If these are identified, measures can be taken into action to mitigate these risks more than in a linear one-sided risk assessment. The goal of the transition cannot be to replace, transfer, substitute or transform risks posed towards the economy, society, and environment with other risks of similar magnitude.

Löfstedt and Schlag argue in their 2016 that Risk-Risk tradeoffs mainly come from rushing decisions with incomplete and scientific research behind those decisions. Regulations can be made without enough consideration and not taking account all consequences. This creates potential for risk-risk tradeoff to occur. They also state that media can amplify certain risks. (Löfstedt & Schlag, 2016) They also point out that the risk-risk tradeoff research can be seen as focusing on deregulation and focusing more on the risks involved rather than the benefits possibly gained. (Löfstedt & Schlag, 2016)
Public acceptance also plays a role in the accepting of the risks-risk tradeoffs. For example, the risks posed by nuclear industry and climate change can be seen as worrisome, but the Löfstedt and Schlag study suggests that in Britain the people were more likely to prefer the renewables in fighting the climate change. (Löfstedt & Schlag, 2016) If people are able and willing to work in an evidence-based regulatory environment the risk-risk tradeoffs can be addressed and possibly avoided, reducing the possibility of risk inferior or more costly solutions. (Löfstedt & Schlag, 2016)

Chapter 3 Methodology of the study

3.1 Methodology

The research was done within a few key elements. Firstly after an extensive literature review on subjects of risk, risk communication, benefits and trade-offs the research focused on qualitative information gathering with a combination of in-depth interviews with lay people and professionals a like to gain understanding of the level of knowledge and attitudes of the both parties and to see how they align or differ on the given questions and matters at hand. Research was also conducted by accessing the local and national news outlets, government documents and press releases to understand the current situation regarding biomass, knowledge on biomass in Finland and to chart the discussion in relation to biomass.

A case study approach was selected to study the current state of risk communication and governance in Finland regarding bioenergy and to compare it to the case study performed by Löfstedt in 1996 in Växjö. The data received from interviews was analyzed with the pattern matching technique and, on the questions recreating the Löfstedt study. The said study was used as background knowledge in additional to the other case studies and background knowledge mentioned in the literature review.

The people interviewed in this process can be classified in to three categories. They were two professionals of the biomass related industries, one student of the energy sector, which in this study is classified between the professionals and four lay people who have no connections or extensive prior knowledge to the area of biomass or energy industry.
One of the interviewed professionals is an expert on the forestry side of the business and the other is an expert within the more refined biomass based products, this was done purposefully to obtain a wider view of the industry and to see how the knowledge and attitudes lie on different parts of the industry.
The lay people were selected to the study to represent the ordinary Finnish people when it comes to dealing with this type of technologies. They vary in terms of prior knowledge and

position in life, some of the interviewed people are students in totally different areas and some of them are in the work force.

Questions set for the interviews were the same regardless of the prior knowledge or position in the industry among respondents to properly get a good impression on the level of knowledge among different focus groups. These differences and similarities provide the base for discussion on improving the risk communication in the field.
Participants are listed on this table (Table 1), by their role, professional, semi-professional or lay people. When these participants are referred to in the results sections, it will be done by this number that is indicated on this table or by their role. The lay people are not always indicated on the different answers since they are considered more as a group on the study as opposing to the professionals, who have deep knowledge and they give answers relation to their field of expertise.

ROLE	SEX	PROFESSION	REFERENCE
Professional	Male	Forestry development	Professional 1 Forestry professional
Professional	Male	Refined biofuels and sustainability	Professional 2 Refined biofuels professional
Semi-Professional	Male	Master's student at energy technology	Semi-professional Student of energy
Lay People	Female	Private sector	Lay People 1
Lay People	Male	Student	Lay People 2
Lay People	Male	Professional athlete	Lay People 3
Lay People	Female	Public sector	Lay People 4

(Table 1)

On this thesis ten questions were asked on the interview. One of the questions consisted of two parts, first without prior knowledge and then repeating the same question again. Most of the questions used are a recreation of the Löfstedt study in 1996, but some of the questions have been added to properly identify knowledge, attitude, and trust of the people in a current

political and technology-based climate. Questions asked in the interview can be found on the table below (Table 2)

QUESTION	BASIS FOR QUESTION
What do you know about biomass?	Charting overall knowledge regarding biomass in Finland, recreation of Löfstedt study
Do you think your area has potential for biomass harvest and usage?	Charting overall knowledge regarding biomass in Finland, recreation of Löfstedt study
Do you believe that biomass can be economically viable in your area without initial subsidies? Question asked again also with initial subsidy after the first answer.	Economic viability of biomass as an energy source, recreation of Löfstedt study.
What do you think is biomasses environmental impact, positive or negative? Asked again after initial information regarding technologies used in energy generation with biofuels.	Charting overall knowledge regarding biomass in Finland, recreation of Löfstedt study
What benefits do you see in using biomass as an energy source	Benefits perceived in biomass technology, recreation of Löfstedt study
What type of Risks or problems could you see in the usage/increasing usage of biomass?	Risk perception, hazard identification, overall risk knowledge, recreation of Löfstedt study
Do you know how your electricity or district heat is produced?	Overall knowledge and interest in energy, recreation of Löfstedt study
Do you think that the authorities and biomass providers should make biomass more visible and known? And what type of communication would you like to receive? The type of it and the contents.	Needs for communication and information and its contents

Would you be willing to pay more in electricity, heating and fuel if was done by biomass? How much more?	Economic viability of biomass as an energy source, recreation of Löfstedt study.
Do you trust that the government and authorities are making good decisions regarding energy in Finland?	Charting the trust towards decision-makers in relation to the risks and benefits perceived
Should peat be classified as a renewable by the rate it renews per year or in some other amount?	Attitude and knowledge about the current peat discussion in Finland

(Table 2)

The answers from interviews were recorded digitally and then transcribed and translated carefully. The need for translation was on most of the interviews since they were conducted in Finnish. The results of the interviews and other data gathered were then analyzed and studied in relevance to the research question "how could companies and authorities improve the risk communication regarding Biomass in Finland". These results will be discussed more on the Chapter 4 Results of the study and Chapter 5 Discussion and on the Chapter 6 Conclusions and recommendations.

3.2 Limitations

Limiting factors in conducting this study include limited number of experts in the field in Finland. Six invitations to the experts were send, but only two of the experts were willing to take part in these interviews. Professional number 1 also mentioned that the industry has a culture that does not promote openness or discussion between the experts on these matters. Also, the literature on the Finnish biomass and biomass related endeavors regarding risk are quite few on an academic level.

Lay people were reasonably easy to find to take part on the research, but the variety and understanding of the respondents might vary and the quality and knowledge of the answers might be a limiting factor in deeper analysis of the results.

Time is also a limitation when conducting research and interviews. Only 7 of interviews could be planned on the timeframe and some of the experts might have been able respond on a

different schedule. With the restricted access to the university's facilities and limited possibility for in person interviews must also be taken into consideration when assessing the quality of the study.

Chapter 4 Results of the study

4.1 Results gathered from the qualitative interviews

In this chapter the results from the qualitative interviews are dissected and analyzed.

4.1.1 Overall awareness and knowledge on Biomass in Finland

As one would expect, the experts and the one semi-expert on the field were well informed and knowledgeable on the topics of biomass and its potential ways of usage. Experts were aware of the different types of biomass, but in Finnish context they focused most on the wood and forestry products, which is very understandable given that nearly 80% of the biomass energy is produced in Finland by forestry products. The lay people's knowledge on the subject varied. Most of the people had some type of understanding what biomass constitutes, but two of the responders stated that they have absolutely no idea or prior knowledge on what biomass constitutes, but the responds were more on the forest side even than the professionals answers. After delivering this question, a small debrief on what biomass constitutes was held to the participants to help them to understand what biomass constitutes without going into more detail about the actual technologies. The interviewees were informed that biomass constitutes of the organic material that is used for energy production, in this context forestry products, agricultural products, animal and human produced waste were mentioned. The expert responder who works in a forestry industry stated that "biomass is vital condition of life in Finland" which can be interpreted as an economical, but also a personal statement giving the emphasis on the close relationship with the nature that people have in Finland.

4.1.2 Perceived potential of Biomass usage in Finland

Next question in the questionnaire was, do you feel that your region has a potential to harvest and use biomass and in which capacity. Again, the professional and the lay persons answers differed a little. Both of the professionals interviewed for the thesis stated that there is some potential in usage and specifically increased usage, but the potential at the moment is pretty well utilized and without technological improvements there is not a great deal of raw material

available for further use of biomass for the energy, within existing supply chains. The forestry industry expert thought that improvement in capacity could be found within refined biofuels, but the expert on the field of biofuels was bit more hesitant and addressed concern about the availability of feedstock that also concerns the refined biofuel industry.
The lay people and the student of energy business were much more optimistic regarding the usage and increased usage of biomass as an energy source in Finland. Most of the responders stated that there is potential for usage and to increasement of usage, and only one of the responders was concerned with the sustainability and availability of resources if the production of energy with biomass is increased in relation to this particular question.

4.1.3 Economic viability of the biomass as an energy source

The next question was structured as a two-part question. The first part it was asked if the biomass as an energy source could be economically viable without any government subsidies on the technology. Both professionals and the student of Energy were fast to answer that it is not economically viable without any subsidies with current technologies since the energy production and electricity production in Finland is subsidized also with other fuels as well. The expert in the biofuels field stated that the economic viability depends on the level of subsidies given to other producers of energy, barring biomass. The forestry industry expert also added that biomass in Finland cannot be seen just as an economically viable option, but the energy independence aspect must also be taken into consideration since the energy with these technologies can be produced and harvested domestically, and therefore it should be subsidized.
The lay people's views in this matter were mixed. One of the responders was outright that they thought that the biomass can be economically viable without any subsidies. Other responded stated that it is based on circumstances, for example availability of raw material at the near vicinity. One of the lay people answering the question had no beliefs to either way and did not want to guess. Last one of the lay people stated that it is probably not viable economically without any subsidies in any circumstances.
The latter part of the question was after informing the participants that the technologies at the moment indeed are not economically viable without some form of government's subsidies. After this added information the question was formed that could biomass-based energy be economically viable with initial subsidy from government.

The professionals were still somewhat skeptical about the viability, even with initial subsidy, but for a little bit of different reasons. The biofuels expert stated that the amount subsidies are reliant on the subsidies that other forms of energy receive too and the forestry industry expert stated that usage of biomass cannot be viewed purely on economical scale even with the subsidies. The semi-expert that studies energy thought that even with the initial subsidization of the production plants, the raw material cannot compete with the price against fossil fuels. All of the lay people interviewed believed with a varied degree of belief that the biomass-based energy can be economically viable with government's initial subsidy. Some thought it will be outright viable and others thought that it can be viable in some situations and circumstances.

4.1.4 Perceived environmental impacts of using biomass as an energy source

The refined biofuels professional stated that at the moment in the Nordics the net effects for environment are positive when using biomass-based energy sources but stated that it might not be the case overall in the world. The forestry industry professional stated that with advancements in technology even more positive environmental impacts can be made but acquiring the raw material must be sustainable and the forests must be tended and maintained properly. The student in the energy field saw the usage more positive than the fossil alternatives but acknowledge that the burning of raw material creates local emissions and greenhouse gases. He also believed that careful use and maintenance of forests have a positive impact on environment.

The lay people saw these impacts bit variedly. One participant stated that it has both negative and positive effects and emphasized that they still produce local emissions and greenhouse gases. Another lay people said that the effects are overall negative, specifying it that the local emissions will increase with usage of these technologies.

The third lay person believed that the overall environmental effects are positive and by allowing recycling, there is a chance for circular economy in the situations.

The last lay person stated that he feels that the environmental effects are less negative when comparing to the fossil alternatives available.

None of the responders switched from their perspective on the matter after given additional information about the technologies used per today to generate energy from biomass however they saw some additional benefits that we are discussing on the next subchapter.

4.1.5 Perceived benefits of using biomass as an energy source

The benefits listed by experts and lay people vary largely between individuals interviewed. Benefits that were listed multiple times by lay people and professionals include, reduction of greenhouse gases, increase in domestical energy production and a decrease in energy dependency. It also creates jobs in the biomass industry domestically, the products of forests are used in large extent, resulting in lower waste of these products. Some little less mentioned benefits were that the professionals mostly were interested in actually proven and calculated lowering of emissions, not just a belief in that, and the positive impacts it has on the carbon balance of the country and the fact that forests tie carbon in them in large quantities when properly maintained and used.

4.1.6 Perceived risks associated to the usage of biomass as an energy source

The professionals on the field were once again much better informed on the potential risks and problems regarding the biomass usage for energy production in Finland. The industry insider from refined biofuels stated that fraudulent branding and procurement of palm oil is a large risk that cannot be neglected, and the long and multilateral supply chains possess even greater risk in feedstock procurement. The forestry industry professional stated that the lack of relevant research poses a big risk in development of the biomass for further usage and that the decisions to invest and develop should be made more locally. He also stated that energy at the moment with current technologies is produced where it is cheapest, and the bioenergy is mostly condensed to the forestry industry's giants in Finland. He is also concerned about the fact that the decisions are made without consideration on the big picture and all sides of the matter. He also raised an issue in the future that the growth of wood constructions can cause problems in procurement of raw material. The student of the subject also added that the increased usage of biomass as an energy source poses a risk in sustainable forestry and that the whole lifecycle of the forest must be thought trough. He was also concerned about the possibilities of supply chain and procurement issues if usage is increased from the current level.

The risk awareness and the perceived risks differ wildly from lay people to professionals. The issues on the sustainable forestry and agriculture and the removal of carbon sinks was mentioned by one of the lay people and another responder stated that they believe that there is

negative environmental effects but did not wish to specify. Two of the four responders also stated that the procurement of the raw material can become issue if capacity is increased. 3 of the 4 lay people that responded also stated that they believe that regarding health, safety, and environment the energy produced with biomass is better than energy produced by fossil alternatives.

4.1.7 How aware are people about the fact how the energy they use is generated?

In this question people were asked if they know how their district heating, if applicable, and their electricity are produced.
The forestry industry professional and the student of energy were the only participants who knew how district heating in their area is mostly produced. In these areas biomass is largely used to produce the energy and they were aware of that. On the electricity side people were more informed on the matter how their electricity is produced. For example, three of the respondents stated that they believe or know that their electricity is done hydropower and one stated that it is also imported from Norway. One of the responders also stated that they have a green energy deal but was aware that it does not guarantee green energy as a per say, but it affects the overall levels of production in said companies. Three people of the seven were not sure of how their electricity is provided.

4.1.8 Should authorities and biomass providers make biomass more known and visible and which type of contents should it contain?

This is the question where professionals and lay people agreed mostly on that more information should be available and biomass should be made more known in the society. Although people wish to be more informed on the subject, the actual content of that communication that they wish to see or receive differs wildly between responders, also the content that they have received so far and perceive to construct their image of the biomass technologies differs wildly.
The forestry industry professional wishes to see fact-based information that is not affected by politics. In his opinion the communication at the moment is done the by different interest groups that have varied goals and methods to achieve those goals. And this on the other hand does not promote necessarily fact- and research based open communication on the field. He also points out the certification of forests to promote sustainable forestry industry, but this is

also somewhat of an interest group minded thinking to promote their interests in forest industry. So, the goal to make totally interest free communication is hard to achieve.
The other professional also advocated for more information to be available so that the consumers could make more informed decisions. He also stated that the not everything can be shared to the public to keep competitive advantage on the technologies.
The student of energy states that more information and communication is needed openly discussing all aspects of the technologies and usage in a neutral setting with no interests or aspects highlighted. He also feels that at the moment the communication and information available at the moment focuses on the risks and problems related to the technologies. He was also concerned about the people's willingness to actually conduct research and digest information regarding these technologies.
The lay people were also interested in improved amount of information available and the contents of it and communication. One of the lay people interviewed raised an interest on the similar system that electricity has in place, so that you could see how the energy is produced, how it affects your energy bill and so forth. They also stated that the risks should be better available also, stating that the benefits are known. Another lay people wanted overall more information and visibility of the matter but did not wish to specify on the aspects of that. Another lay people also wished more overall information to be available on the matter in an open form with no interests or prejudices from the authors of that information. Another lay person stated that he would like to see more information on the energy that is produced domestically and also they are interested in price and to know if the technology is viable economically and the overall environmental aspects of the biomass-energy compared to the fossil alternatives in the use.

4.1.9 Are people willing to pay more for their energy if it is generated with biomass compared to fossil alternatives

People overall expressed some interest to pay more if energy is generated on biomass or other renewables compared to the fossil alternatives. Only one of the responders, a lay person, stated that they are not willing to pay any extra. A couple of the responders stated that they would like to pay a bit more when making decisions, but they are not able to make that choice given the current prices and economical situations. They added that if their economic situation gets better, they are willing to switch to those.

Both professionals interviewed were in favor of paying a little bit extra on the energy when it is provided from biomass-based sources. They stated that they are still not willing to pay more than 10% difference in comparison to the fossil alternatives, given that the technology is not competitive then.
Some of the people stated on the question that they already have made decisions on for example switching to the water energy or green energy on their electrical provider and they could be willing to do that on the district heating and for example vehicle fuel, if the technology and price allow for that.
The people that were willing to give percentage ranges on how much more they are willing to pay on energy generated by biofuels fell on the range of 3-10% more.

4.1.10 Perceived trust regarding the Finnish authorities on energy policy

This was a question again where the lay people and professionals tended to agree. Only one of the people interviewed stated that they trust the Finnish government and authorities to make good decisions regarding energy in Finland.
The professionals were more in depth in explaining why they possess distrust on the governing bodies of Finland. The forestry industry professional stated that the governing authorities would probably make better decisions if the industry would have provided better research and more facts for the authorities to lean on when making these decisions. The refined biofuels expert believes that decisions are made too much to accommodate the certain actors in the sector. He also raised concern about the state ownership of certain companies and policies made to accommodate those companies. He states that government communicates their strategy and decisions clearly but does not believe that the transparency and intentions behind those said decisions is always impartial and not tailored to some specific actors on the scene.
Lay people expressed varying level of distrust. Some stated that they do not necessarily think that they make good decisions and one of the responders stated that they “do not believe for a second” that the government makes good decisions in relation to the energy, but did not wish to specify why. Last lay person who disagreed stated that he does not trust them a lot because matters are often discussed and determined from a single point of view only. The last lay person agreed that the government makes good decisions with good intentions behind them. The student of energy stated that he normally trusts the authorities, but in this given matter and at the given time, they do not agree with the decision makers in Finland.

4.1.11 Status of peat as renewable

Status of the peat in Finland has been on the frame lately, mainly because of the ban of its usage for energy in Finland. The interviewees were asked if peat should be classified on the rate of renewal per year for consumption as a renewable. No one advocated for the actual number of renewals to be the deciding number of usages. The forestry industry professional stated that it should be utilized on a level that ensures the protection of the bodies of water, but still promotes domestical energy production, knowhow and keeps harvesting peat as a relevant occupation, since decrease in energy peat can result in problems to procure peat for other usages for example as a platform for growth in forestry and agriculture. The student of energy stated that replacing the deficiency created from banning the peat can not be replaced with worse options for example natural gas. The professional in refined biofuels stated that peat should outright be classified as a fossil energy source.
Two of the lay people did not wish to make a mind on the matter, but one of them stated that it does not sound that renewable given the 3000-4000 years to completely renew. One of them said outright no, and the last interviewee said that they were about to sign that it should be renewable, but in the end was not ready to sign the petition for some undisclosed reason and therefore was ultimately against the classification of peat as a renewable energy source in Finland.

4.1.12 Summary of the interviews and their results

Interviews went overall well, and many fruitful discussions were had. The professionals were very knowledgably on the matters and their expertise filled each other's expertise well to have varied results on the interviews from the professional side. Due to limitations in time and availability of interviewees the overall number of the participants was not huge. Fortunately, their responses build an accurate image on what people know on biomass and the risks and benefits tied to those technologies.
Interestingly enough there were only a few questions where some kind of a consensus was achieved between different focus groups. The opinions and knowledge varied wildly on some of the questions.

4.2 Results from analyzing news outlets, press releases and government documents

4.2.1 Putting biomass in context

Many countries have implemented goals towards lowering the overall carbon emissions of their respected countries. These goals are driven by international agreements such as Paris agreement which hopes to stop the global warming at + 1,5 C in reference to the preindustrial era.

In this thesis we focus mostly on goals set by the Finnish governments briefing in the medium term on climate change control. This document and briefing are based and required by the Finnish Climate change act of 2015. (Ilmastolaki 609/2015, 2015)

In thesis we are focusing on the policies that involve usage of biomass.

The Finnish government has implemented a plan to reduce greenhouse emissions by 40% towards the year 2030 in reference of year 1990 emission levels. In this context the middle term plan is proposing a cut of emissions by 39% in reference to the 2005 level in selected sectors which are given as "weight carrying sectors" (Valtioneuvoston selonteko keskipitkän aikavälin ilmastopolitiikan suunnitelmasta vuoteen 2030 – Kohti ilmastoviisasta arkea, 2016)

In this plan traffic is listed as the most important sector in which reductions are to be found. These reductions are being tried to achieve by increasing the number of fully electric "zero local emission" vehicles, incentivizing of biogas- and ethanol-based cars and prioritizing of public transportation and walking and cycling in city settings. (Valtioneuvoston selonteko keskipitkän aikavälin ilmastopolitiikan suunnitelmasta vuoteen 2030 – Kohti ilmastoviisasta arkea, 2016) Agriculture is also incentivized towards production of biogas and fuels. (Valtioneuvoston selonteko keskipitkän aikavälin ilmastopolitiikan suunnitelmasta vuoteen 2030 – Kohti ilmastoviisasta arkea, 2016)

Since Finland is located mostly above the 60th parallel north the need to heat buildings and water is substantial. The government is prioritizing adding biomass-based fuels to the mixture when using oil as a heating source. It has proposed an 10% requirement of biomass-based heating oil in the mixture of heating oil. Regarding the heating of buildings and water the government incentivizes cleaner methods to burn wood and wooden pellets to create heat. (Valtioneuvoston selonteko keskipitkän aikavälin ilmastopolitiikan suunnitelmasta vuoteen 2030 – Kohti ilmastoviisasta arkea, 2016)

In the traffic sector there is also a distribution requirement, in which companies that distribute traffic fuels, must distribute certain percentage of their total supply as a biomass-based fuels. In 2021 this requirement is 18% which is to increase to 30% at 2030 (Laki biopolttoaineiden käytön edistämisestä liikenteessä annetun lain muuttamisesta 419/2019, 2019) This is enforced by a fine that is listed as 0,04 euros per megajoule, which is a large amount considering that liter of diesel fuel contains approximately 38 megajoules of energy thus making the fine per liter of diesel 1,52 euros which is slightly more than average consumer price of liter of diesel in Finland in 2021.

4.2.2 What are the technologies used to create energy from biomass?

Biomass has been traditionally been defined as a renewable organic material that can be converted to energy. This includes things such as agricultural crops, plants, crop residue, wood, algae, animal manure, construction debris, municipal waste, and solid waste.

Humas have been using biomass as an energy source since the discovery of fire. The earliest ways to generate heat and warmth were achieved by burning wood or other organic material in a fire. The importance of biomass as an energy source gradually declined during the 19th and 20th centuries by new technologies, such as fossil fuels, basically oil, coal and gas and the introduction of other ways to generate electricity for example nuclear and hydro. Now during the 21st century, biomass is rising again in popularity as an energy source due to limited stock of easily available fossil fuels and pursue to lower greenhouse gas emissions. Biomass can be used as is or processed to a more sustainable and usable form, such as biodiesel or biogas. In the following there is a short summary about different biomass-based energy sources used in Finland.

4.2.2.1 Biodiesel

Biodiesel is a diesel fuel that can be used without any conversions in a regular diesel engine and biodiesel can be produced for example from vegetable oils and animal fats. Biodiesel can also be mixed with traditional diesel fuel.

4.2.2.2 Biogas

Biogas is created by turning organic material, usually waste into gas and liquids and solid components in anerobic process. Typically, biogas is made from animal waste, food- or biowaste, crops directly or wastewater. There are two types of biogas: crude biogas that is not refined and can be used in heating and CHP (combined heat and power) generation. The residual solid and liquid can be used as a fertilizer for example. (Fact Sheet, EESI, 2017) Biogas can also be refined to renewable natural gas RNG in a process that gets rid of excess water vapor, carbon dioxide and other trace gases, so that it can meet the requirements for natural gas. From there this product can be used as a substitute for natural gas and it can also be compressed and liquified as regular natural gas. (Fact Sheet, EESI, 2017)

4.2.2.3 Ethanol

Bioethanol is a liquid fermented and distilled from plants. This can mean plants that are also viable for human consumption, waste of those plants or purely plants that are farmed for energy. These plants can be for example corn, sugar cane and many others. In Finland the most sold gasoline contains 10% of ethanol by volume. This can be used in most cars without conversions, but Flexifuel conversions allow mixing ratio of 85% ethanol and 15% traditional petroleum.

4.2.2.4 Wood

Wood is the most traditional usage of biomass to energy. In Finland, wood and forest industries' leftovers are used to generate heat and CHP. In Finland in 2019 wood was responsible for 74% of the renewable energy generated which accumulates to 27% of total energy generated in Finland. Wood is mainly used in energy and forestry sectors as a fuel, but households use 16% of wood used to generate energy. Wood used in energy production is in Finland always a byproduct of other forest activities. The products include hacking leftovers, small wood, stumps, bark, chippings, and other wood products that the forestry industry can use. (Tietopankki, Bioenergia Ry, 2021) In these calculations it must be noted that the wood can be processed into biofuels so it can be listed in biofuel and wood categories.

4.2.2.5 Peat

Peat is an organic material that is generated from decomposing organic material in an environment without oxygen, usually swamps. In Finland peat is not classified as a renewable energy source, which has been questioned lately. The consideration is that peat could be used as a renewable on the amount that is renewed every year. (Tietopankki, Bioenergia Ry, 2021) Peat is traditionally used mainly as a heat source in remote heating facilities.

4.2.3 Risk involved in usage of biomass as an energy source

Usage of Biomass based energy generation techniques does not come without any risks and problems. Ragnar Löfstedt has highlighted some of the problems regarding biomass in his 1996 study. These concerns are about safety and storage of the product itself and the transportation which is not that effective. The raw material must be readily available in close proximity for the plants since transportation of biomass is not economically viable over long distances. (Löfstedt, 1996) There has also been concerns related to the procurement of the raw material and in Finland especially the concern for imported biomass for energy. The biomass has also environmental issues related to it. Biodiversity can be neglected when farming crops for energy, water quantity and quality can be lowered, the biofuels and their processing still produce greenhouse gases, and soil erosion (Wu et al., 2018), the soil erosion can be avoided at least to some degree according to Löfstedt by redistributing the ashes from burnt biomass back to the soil. (Löfstedt, 1996) Biodiesel has also reportedly caused problems in engines, when it has stayed in the tank for too long, for example over winter, by producing algae on the fuel. (Tornberg, 2019)

Problems for biomass can also be economical since large capital investments are required to begin operations with biomass. It goes without saying that some form of government subsidies are to be had in place to make these investments possible. (Löfstedt, 1996)

Risks involving the viability and reasonability of the technology must be addressed too. The overall lifecycle carbon and CHG emission must be properly calculated to implement the best and most sustainable technologies and the viability, for example corn to ethanol, must be clear that the intentions of using biofuels do not create more emissions. (Florin, 2007)

Bioenergy field might also replace food producing crops that might lead to shortages of food locally or increase the prices of farming land and therefore the end product as well. It can also crate geopolitical risks between developed and developing lands. The subsidies and tariffs imposed by different countries can also affect the world trade. (Florin, 2007)

The benefits of bioenergy contain but are not limited to: Lessening energy dependency and increasing energy independence, lower total carbon emissions (Bioenergy is total carbon neutral according to calculations) as result of closed carbon cycle. It can also be used to controlling the energy prices and meeting growing energy needs. Developing opportunities to biomass producers and to agriculture and forestry industries. Providing jobs and recycling waste is another mostly regional benefit of bioenergy. (Florin, 2007)

Chapter 5 Discussion

5.1 Comparing the results of the study to the study conducted by Löfstedt in 1996 in Växjö, Sweden

One of the goals of this thesis was to recreate the Löfstedt study done in Växjö, Sweden in 1996 to see how and if people's views and knowledge had been altered in this 25-year span regarding biomass as an energy source. On the time of the Löfstedt study, the only discussion was on the wood as a renewable biomass for energy, but since then new and more refined technologies have been inducted and implemented in the field of energy. This gives a good starting point for discussion in this thesis.

5.1.1 Approval of the usage of biomass as an energy source

None of the responders in the interviews conducted expressed that they would like to see amount of biomass used in energy generation to decrease. So, the approval for usage was given at least on the current level, given that some negative sides were listed on the environmental impacts. Benefits seen and the reasons why to use biomass were different among interviewees, but consensus was that the technology should be used and implemented. The Löfstedt study in the 90's gives the exact same result. People were interested in the usage of biomass for energy purposes, but their reasoning why they want the biomass to be used as an energy source varied. (Löfstedt, 1996)

5.1.2 Problems regarding usage of biomass as an energy source

The problems and risks people listed in the interviews varied again, but professionals and lay people both were concerned about the sustainable forestry and the ethical procurement of feedstock, for example the palm oil case raised by the refined biofuels expert. People also raised concerns for the local emissions and greenhouses gases created. Logistical issues were also pointed out by a few of the responders.
In the 1996 study people interviewed were also concerned with the amount of nutrients returning to the forest i.e. sustainable forestry, but just explained in a more detailed manner in

this case. One of the interviewees in that study also raised the same concern about the local emissions stating that “is biomass really cleaner than oil?” Concerns made there were also economical in nature regarding the low prices gotten from the raw material at the time. (Löfstedt, 1996)

5.1.3 Public perception of biomass

Two of the persons interviewed out of the seven stated that they do not have any knowledge on biomass beforehand. The others were able to give detailed explanations on what they think constitutes as a biomass. Therefore it could be interpreted that the two responders who stated that they do not possess any knowledge could have had some knowledge but were hesitant to express it because they had not enough knowledge in their own minds to quantify biomass. Given that the people that were interviewed for this interview do not live in a same geographical area as opposed to the study, it is difficult to compare the results on the matter regarding the biomass richness of the area perceived by the lay people. But overall people recognized that there is a lot of biomass available in Finland, barring the central areas in the largest cities in Finland. People were bit divided on the matter if there is potential to increase the production. The professionals interviewed were more in line that with current technologies and supply chains the capacity is pretty well used, but the lay people saw more chances to add to the capacity, because they see forests everywhere in Finland. People interviewed for this thesis also had relatively poor understanding on how district heat in their area is produced, only the forestry industry’s professional and the student of energy were able to tell how their district heating is produced. The people were bit more informed about the electricity produced but given that it is harder to actually know how electricity provided is actually generated compared to district heat. Which is quite strange since district heat comes from more direct lines in opposition to electricity.

In the Löfstedt study from the 90’s 90% of the responders (n=100) stated that they have heard about biomass. 52% of the responders also answered that they believe that Växjö is located in a biomass rich area, given that Växjö area is one of the most forest dense areas in whole Europe. People interviewed for the study were also asked how their district heating is produced. The people who were part of the district heating system were generally well aware of how the energy is produced 39 out of 46. This is a bit larger number than in the study conducted for this thesis. But the fact that they are all part of the heating network and

therefore might have a larger interest than lay people who does not live in a house or apartment part of the district heating systems. (Löfstedt, 1996)

5.1.4 Environmental impacts perceived by the people regarding biomass

Environmental impacts seen by the people in this study are discussed more on the chapter 4 results. But the people were bit on the fence on classifying the impacts straight negative or positive. There were concerns about the sustainability and local emissions, but overall, the potential of biomass and the comparison to the fossil alternatives makes that the overall consensus on the matter is slightly positive among interviewees. The lay people and the student were also educated a little bit on the technologies available and the technologies that are developed to replace or at least redact. None of the interviewees changed their mind about the environmental impacts after given the additional information. This could indicate a higher level of understanding of the technologies discussed or the unwillingness to change their mind after given more information, or the need for even more information on the matter before changing their minds.

The study conducted by Löfstedt found out that 69% of the responders saw the biomass as an environmentally friendly source of energy without additional information given. After additional information was given the number of positive people increased and 86% of the people thought that they should increase the usage of biomass (Löfstedt, 1996), which differs slightly from the study conducted for this thesis.

5.1.5 Do people believe that biomass should be made more visible and known

On the interviews conducted for this thesis people were asked if biomass producers, energy providers and authorities should make biomass more known and visible and what type of communication would they want to see. All of the responders stated that they would like that biomass would be made more visible. The actual contents of the visibility and communication will be discussed more in the later chapters.

In the 1996 study 76% of the people stated that they would like that it would be more visible and known. Only 13% of the responders were against added visibility for the matter. (Löfstedt, 1996) The trend is very similar here and people feel like that they are not informed enough on the matters and they would like it to be more visible.

5.1.6 Economic viability of biomass

In the interviews conducted for this thesis people were divided on the matter if they would be willing to pay, most of the interviewees expressed some level of willingness to pay a bit more if the energy is provided by bioenergy. The professionals were informed about the situation that the biomass-based energy is not viable without any subsidies from government, but the lay people thought that it could be on a general level. Almost everyone was under the impression that it can be economically viable after some sort of initial subsidy by government. The student of energy also believed that it is not probably viable even judging by raw materials only and forgetting the other costs related to energy generation.
In the Löfstedt study most people were willing to pay some extra if the energy is produced with biomass. 80% of the people said that they are willing to pay more and additional 8% said maybe. 43% of the people interviewed for that study also thought that biomass is also cheap compared to the oil and coal for example. Overall people were not informed about the fact that the biomass-based energy can be economically viable if initial subsidy from the government is received to cover the large capital investments needed in the beginning. (Löfstedt, 1996)

5.1.7 Summary and comparison of the results of the studies

The studies have been conducted 25 years apart and in different countries. Studies were conducted using a slightly different research methods thus they cannot be compared directly but overall trends can be interpreted from both. The overall level of knowledge about biomass has not largely improved when comparing the lay people and professionals alike. Of course, developments have happened on the technologies and more products have become available, but the overall concerns relating to local emissions and the sustainable forestry and feedstock procurement have stayed relatively same. The lay people were more aware that there are large quantities of biomass available in Finland, but on the other hand they saw it abundant which the professionals did not agree with. The lay people interviewed in the Växjö study were less informed about the potentials of biomass usage and the amount of resources nearby.
The study's results are very consistent also when considering that the Växjö study was done partly as a quantitively and the interviews for this thesis were only conducted as qualitatively. But the overall trends in answers confirm the same trends on both studies and almost in every question. The surprising result is that people did not change their minds about the

environmental impacts after additional information was provided on this study but did do that on the Växjö study.
People also on both cases agreed that they do not know enough on the matter and would like that biomass would be more visible and communicated throughout.

Concerns that this replication of the study arises include the fact that Biomass-based energy is not economically viable without any subsidies 25-years after the study was conducted and over 40 years after the biomass operations began in Växjö in a larger scale. Another concern is the inability of producers, authorities and interest groups to actively educate and communicate to people about this type of energy since the level of knowledge has practically not increased in the 25-year span. This should be vital if governments, energy providers and municipalities wish to implement more biomass-based energy to the markets.

5.2 Role of risk governance

Risk governance plays a vital role in situations regarding energy, because as stated before in the literary review, energy is risky endeavor with multilateral risk pictures concerning many areas of the industry.
Farrell and Brandt state in their 2006 article that the risks involved in energy sector mainly are safety, environmental, economic and strategic of nature (Farrell & Brandt, 2006) but when conducting interviews, the professionals were aware of the economic difficulties in regards to these technologies, but did not classify them as risks per say, rather they discussed the viability and tried to see ways to make it more viable economically. The lay people were less inclined to take money into discussion, but one of the responders stated that personal economy is important when making decisions and comparing energy forms. People did not mention risks related to safety at all during the interviews. Strategic risks were mainly addressed again by the professionals, but more on a national level regarding regulation than global energy markets, but then again the viability of the technologies must be compared to global energy markets if there is no prioritizing of domestic energy production made by the authorities. Environmental risks and issues were raised by almost all the participants at least on some level.

If we are to reflect the principles of risk governance listed by Van Asselt and Renn we come to a following discussion.

Communication and inclusion is the first principle mentioned and discussed. Communication is going to take its own chapter later in the discussion, so that is going to be skipped here, and the focus is going to be placed on the inclusion on this paragraph. The professionals taking the interview were only people interviewed who at all touched the subject of the inclusion, stating that the decisions made regarding biomass are not as inclusive if the actor is not a forest industry giant and the decisions are made from the interest of different groups, given the current government making the decisions relating to energy in Finland. The lay people did not even mention being included in anything related to biomass, so inclusion does not penetrate to the average people's lives. By not including all the actors it is argued that important information on the uncertainties and ambiguities are lost and not all the relevant information and knowledge gets available on the decision-making process. (van Asselt & Renn, 2011) This process can be also seen undemocratic in a nation that values itself as democratic. But to be able to be contribute on this level social learning is necessary (van Asselt & Renn, 2011)

Integration is also an interesting topic on the matter. The results from the professionals indicates that integration and exchange of knowledge is not on a level that it could be the in a best-case scenario. The professionals were mostly concerned about the risks posed particularly on their respective field inside the bioenergy rather than mentioning and discussing risks more general on the field. Systemic risks concerning the whole industry are hard to understand fully, but to be able to identify them as best as possible, integration and inclusion is needed in order to make coherent and consistent analysis and decisions regarding future (van Asselt & Renn, 2011)

Reflection of the risks and benefits involved did not come up as topic during the interviews, although some reflection must be done if the first two principals are continuously used with at least some degree of success. Reflection is necessary to balance the risks and benefits of given technologies, if too much regulation and protection is empathized, the innovation might be lost and if the protection is neglected there might arise unwanted results of large magnitude. (van Asselt & Renn, 2011)

5.2.1 Role of trust in relation to governance

The results of the study regarding risk perception, benefits seen and the trust towards decision makers regarding energy in Finland is, to say at least, interesting. The lay people did not perceive technologies “risky” as a technology. Risks were somewhat addressed and known, but when comparing them to the alternatives, overall perception was neutral or positive on the most. The professionals were aware of the problems and risks and the benefits in a larger extent, but still advocated in the name of the technologies used and developed.
The overall trust among the people were low towards the decision makers in Finland regarding energy policy and the six out of the seven responders expressed at least some level of distrust towards policy makers.
As explored earlier in the literature review, many scholars have arrived at a conclusion that high distrust towards the policy makers relates to inflated risk perceptions and the lowers the possible benefits seen. (Löfstedt, 2005) (Whitfield et al., 2009), (Siegrist et al., 2000)

The distrust towards policy makers might also stem from different reasons. For example the professional in the refined biofuels had the distrust stem mostly from the lack of inclusion of all the parties involved and the weight given to some actors in the field in policy making and the impartiality of government owned companies in the field. But then again, they are very informed on the risks in the field and then the risks perceived are not communicated trough medians from government or trusted individuals, but rather than their own research, expertise, and knowledge.
The high distrust from the lay people not correlating with the findings of these studies could be explained by the people’s values and views that might tip the scale towards acceptance of risks regarding biomass even with low trust towards decision makers. There is also a chance that the people interviewed understood the question differently and expressed their overall distrust towards the policy makers in energy and did not think this from the perspective of biomass only. Some people might express distrust and disagreement when nuclear power is increased, and other people could feel distrust in increasing energy imports or increasing energy production from biomass. These are possible reasons why this study’s results do not correlate with the academic literature. On the other hand, this could be also due to a small sample size and thus it leaves potential for further research on this specific topic in the future.

5.3 Role of risk communication regarding biomass in Finland

All of the responders in the interviews advocated for an increase in communication and visibility regarding biomass as an energy source in Finland.
The professional in refined biofuels stated that communication received from the authorities is clear and concise, but the contents of that communication might be bit biased in favor to large companies for example. They also stated that their organization could communicate better and more openly towards lay people to help them make more informed decisions on their everyday lives, but not everything can not be disclosed or shared to keep the competitive advantage. The forestry industry's professional was concerned that the communication is mainly done from ideological or political perspective and objective facts can get forgotten on these processes and not all relevant information is disclosed.
With these findings in the interviews it can be interpreted that most of the risk communication done by companies and authorities can be seen as top-down communication, where the views of the lay people and some experts are ignored and the views are rather tried to influence by the governing authorities and large players in the field with significant leverage. This type of top-down risk communication also called the defiance model can be seen outdated. (Balog-Way et al., 2020) Löfstedt and Bouder reported in their 2010 paper that these practices are still in place (Löfstedt & Bouder, 2010) and the results of the study do not contradict these findings.
The argument is that the most efficient risk communication methods are two-way conversations but given the level of understanding of the risks from the lay people, some level of preliminary information needs to be given to be able to have fruitful two-way conversations. The student of the energy stated that people are lazy to find out facts about technologies and this can possess a threat to enabling two-way communication between authorities and lay people.

5.3.1 Contents of the risk communication

The lay people advocated for "cover all" type of information and communication that is based on facts. They want to be equally informed on risks, benefits and effects of those technologies implemented. Satisfactory message to all parties can be difficult to achieve. Renn argues in his 2008 paper that the message needs to as be simple as possible without losing context or details needed to comprehend this messaging, he also argues that the receivers of the message

should not feel that the messenger is superior to them. (Renn 2008) Also implementing the key elements from the Guide to risk communication towards public could be beneficial in creating effective risk communication strategies for the future in Finland.

So, based on the findings by Renn, Bouder, Balog-Way et. al, the risk communication should be tailored to its target audience to be able to portray the risk pictures accurately and on the other hand to educate people on possible benefits and risk related biomass as a energy source in Finland.

5.3.2 What can be learned from the communication on the Peat issue in Finland

A very actual discussion at the moment is the role of the Peat in the Finnish energy debate. People interviewed generally were against or neutral as classification of peat as a renewable, barring the interview with the forestry industry's professional, who saw additional uses for peat as well in addition to energy.

The rapid decline in peat production can be traced to somewhat surprising announcement from the Finnish parliament from 2020 that increased the tax on the energy generated by peat by almost 100%. This has caused a rapid declination of business in Peat industry and it can have effects on risks perceived on other energy industries too if the government is able to perform shocking decisions on short notice to some of the industries. This can cause hesitation on the willingness to invest and develop if there is a possibility that government sees that the technology is not sustainable. This has led to increase in energy imports at least on the short term and could create additional pressure on the forestry industry to produce more biomass to the energy generation facilities. The risks posed by this transition are, for example, the limited storage possibilities of biomass since most of the peat is to be replaced by forest leftover products, which according the study by Löfstedt relates of problematic storage issues. (Löfstedt 1996)

This can be seen very top-down communication that distances even the professionals in the field with not including them in the decision-making processes and taking livelihood from many people away practically overnight compared to the 10-year transition period proposed earlier (Schönberg, 2021). There have been also mixed signals given on the possible

compensations and easing of the rules for the smaller facilities and producers of peat, which does not promote trust towards the authorities and might affect investments in the future, too. Some of these points can be found from the case study regarding the Shell platform incident discussed in the literature review and this can not be seen as an effective risk communication by any means. (Löfstedt, Renn 1996)

5.4 Risks, benefits and tradeoffs related to biomass in Finland

The understanding of risks varies a lot between interviewees on the study. As expected, the professionals had better understanding of the risks and benefits perceived than the lay people. The lay people had understanding of the situation that the main goal of the transition from fossil fuels is to lower the overall carbon emission and this is being tried to achieve by technologies such as biomass. People also viewed it beneficial that the raw material is domestic, and it increases the energy independence percentage compared for example to fossil alternatives.
The risk-risk tradeoffs were not particularly discussed in the interviews to keep the discussions in given time frames and the number of questions limited. Also, the conceptualization of risk-risk tradeoffs was not in the given time frame.
The effects of given technology must be put into a framework of a given area. For example, when discussing the effects of burning fossil fuels in a district heating plant or a personal vehicle, risk-offset (Graham & Wiener, 1995, pp. 22–23) occurs from the local perspective since the emissions are created locally. The other possible Risk-risk tradeoffs must be identified in a given areal framework, to be able to make decisions that are beneficial from many aspects to the population, in which it aims to reduce those risks discussed.

One of the risks that is also important to notice is the possibility of risk-superior alternatives from different fields than biomass. For example, in Norway in 2020 54% of the new cars sold were fully electric, an increase of nearly 10 percentage points from 2019. If the current trend moves to Finland and increases, production and development of the biofuels for traffic purposes might become obsolete and economically unviable.

Löfstedt and Schlag argue that risk-risk tradeoffs are primarily made by rushing into decisions without relevant decision support (Löfstedt & Schlag, 2016). This can be seen in the peat example previously and this must be taken into consideration on future decision-making

processes regarding energy and biomass in Finland. It is obvious that further research on risk-risk tradeoffs in the energy sector from a Finnish perspective is needed.

Chapter 6 Conclusions and Recommendations

To conclude the study, the results and discussion must be stitched together in a concise matter. Below are a few conclusions and recommendations that could help the authorities and the actors in the field of bioenergy to improve their risk communication.

6.1 Conclusions

- The overall knowledge of the technology and the risk perception of the lay people has not drastically altered in the last 25 years as it is shown by comparing the Växjö study and the results of this study. The same risks and hazards are still perceived and discussed when it comes to sustainability and the local emissions of the technologies.

- The professional actors in the field possess a large understanding of risks related to their operations but have not been able to share that knowledge effectively among other professionals on the different side of the field or the lay people.

- The risk communication from the authorities can be seen as a top-down risk communication that does not include all the actors in the field or the lay people. Lay people are also generally not informed enough on the technologies to partake in a fruitful discussion with the decision makers. Failures in risk communication could have led to a magnified effect on the peat issue in Finland.

- Lay people and the professionals are generally not trusting the decision makers regarding energy in Finland.

- There is a need for a fact-based discussion and research in the industry in Finland with no biases from the behalf of the authors or communicators.

- Risk-Risk tradeoffs, risk-benefit and risk superior alternatives were not addressed or discussed, and this leads to the conclusion that these are not discussed or understood well enough by the professional, lay people or decision makers alike.

6.2 Recommendations

- Unbiased and factual information about the Biomass as an energy source should be made available in a form that is easy to access and digest, discussing the potential risks, hazards and benefits. The information should be made so that it is easy to start and with more interest more in depth information and actual scientific research is available for those who wish to deepen their knowledge.

- Communication, inclusion and integration between the different professionals, academics and the decision makers should be emphasized in order to understand the complex, multilateral risks better and improve the governing based on these findings. The communicators could also benefit from implementing the five keys of effective risk communication towards public in their procedures.

- The decision makers, academics and the providers of bioenergy should try to inform and educate the lay people and then include lay people and professionals from all across the board into the discussion to make the risk-communication process more of a two-way discussion rather than the top-down model that is mostly present today. The potential failures of the risk communication on the peat issue in Finland should be studied and analyzed for future reference regarding energy and governance in Finland.

- Even though the level of distrust did not correspond too negatively to the technologies in discussion in this study, the decision-makers should try to build trust towards the lay people and professionals alike to avoid situations in the future where distrust towards the decisionmakers could affect negatively adaption of new technologies in energy in Finland. The disputing parties and interest groups should also try find discussions instead of confrontation to build trust and not to create effect that destroys trust and is amplified by media. And this discussion should be based on the latest, relevant, and unbiased scientific information.

- The bioenergy industry and academics should provide fact-based bias free research to the decision makers about the risk, benefits and tradeoffs in the energy industry to

allow decision makers to make decisions to best of their ability on the research that is not influenced by politics or other interests.

- The understanding of concepts in relation to risk should be better understood in the industry to allow fruitful discussion between actors in different roles in the field to come together and identify potential risks, benefits and tradeoffs in regard to energy in Finland. The benefits and risks must also be put in a review locally, nationally, and internationally, not to create unwanted results or public distrust by for example exploiting other countries or using unethical feedstocks.

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