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ACHIEVING CARBON NEUTRALITY IN MARITIME INDUSTRY

Investigating the possibility of complementing reductions by voluntary carbon offsetting with common reed

Master's thesis

Management in Sustainable Business

Autumn 2023

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Häme University
of Applied Sciences

Management in Sustainable Business — Abstract
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Subject Achieving carbon neutrality in maritime industry - investigating the possibility of complementing reductions by voluntary carbon offsetting with common reed
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The aim of this thesis was to investigate benefits voluntary offsetting can bring to a company and discover if common reed (*Phragmites australis*) in the form of biochar could fit as a compensation tool to offsetting market. The commissioner of this thesis, operating in maritime logistics, is searching for ways to reduce emissions, and considering voluntary offsetting as one option for reaching carbon neutrality.

The theoretical framework of the thesis focuses on voluntary compensation markets in general and presents the current problems related to them with some suggested solutions to prevailing problems, and specially what are the minimum criteria for a good offset. For voluntary compensation there does not exist yet unified regulation, only recommendations. Credible and ethically correct emission offset should always be based on outcomes that fulfil the minimum criteria that is internationally set which includes aspects of additionality, solid baseline, robust calculation method, monitoring and reporting, stability, avoidance of carbon leakage, authenticity, transparency and certifiability, avoidance of double counting, and avoidance of significant harm.

The empirical part of the thesis was conducted as a qualitative case study with semi-structured and in-depth interviews of experts in the field. The data analysis was conducted to themes related to potential of the common reed, its current problems and solutions suggested to these problems. Biochar from reed could be a good alternative unit to voluntary offsetting markets, but the price of the operation is currently too expensive being reasonable and there are problems related to the harvesting of common reed. But as legislation becomes easier and technology with innovation develops, there is much potential in the use of common reed. Reed biochar would not have the problem of double counting and additionality, like in domestic forest-related compensation projects. With the knowledge gained both from literature review and interviews, it meets the minimum criteria for good compensation in all aspects. By cutting common reed, nutrients are removed from sea and methane and CO_2 emissions reduced, and in carbon sequestration the biochar remains in the ground in a permanent way. Therefor biodiversity perspective can be considered very highlighting in the matter of common reed. Climate neutrality reached by voluntary offsetting can be beneficial not only for the environment but for the company too to gain competitive advantage.

Keywords carbon neutrality, voluntary offsetting, common reed, biochar

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1 Introduction

1.1 Background

The most productive ecosystems on the earth are wetlands and the water cycle is a prerequisite for sustaining life on earth. It has been disrupted due to climate change. The increase in atmospheric carbon dioxide concentration increases the dissolution of carbon into the seas. This has caused the pollution of the Baltic Sea and the annual increase in blue-green algae rafts. There is an urgent need to reduce eutrophication of the Baltic Sea and one solution to this problem could be eliminating the widespread plant common reed (*Phragmites australis*). Several ongoing projects are harvesting maritime biomass from the Baltic Sea for eutrophication mitigation and utilization of the recovered biomass. Some of this biomass comprises of common reed, one of the most widespread vascular plants on earth. (Risen et al., 2013). The purpose of this thesis is to investigate whether the common reed could also act as an offsetting tool in voluntary emissions trading and what other possibilities common reed could have.

United Nations (2023) reports emissions happening anywhere are affecting people globally everywhere. International level cooperation and coordination is needed to tackle this wicked problem. European Union (2021) declares climate actions taking place on multiple levels. When talking about terms of agreements and treaties they are in global level and each state has set goals on a national level and states and cities have their own CO_2 reduction strategies.

The sustainability crisis needs to be addressed on all levels of society; thus, companies cannot be excluded from acting. Political and legislative changes are introduced to mitigate the climate crisis, which further encourage companies to act. Investors are also giving further pressure to companies to introduce climate change actions and increasingly demand companies to have risk management strategies in place. (Pattberg, 2012, p. 30)

Ovrum et al. (2023, pp.15-16) have visioned the maritime forecast for the future and there is a big pressure for shipowners to reduce their carbon footprint. They say that the fundamental regulatory and commercial drivers are regulations and policies, access to investors and capital, and cargo owners, and consumer expectations. The path for decarbonization has taken an initial track and both regulatory, and commercial drivers are allowing the framework for this. The use of alternative fuels has increased, and technology has enabled development

onboard. But still the process is slow and there should be more effort to bring down barriers and speed up the progress of next-generation carbon-neutral ships. There needs to be a stronger emphasis on system-level thinking and integration of all available technologies. (Ovrum et al., 2023, pp.15-16)

Companies and organizations are hurrying to set their own targets for emission reductions. The commissioning company of this thesis is searching for ways to reduce emissions and considering voluntary offsetting as one option for reaching carbon neutrality. Tactics commonly used by shipping companies to reduce fuel consumption and thereby reduce the environmental and climate burden are reducing the speed of ships, optimizing speed, optimizing routes according to weather conditions, optimizing scheduling at sea and on the pier, and technical improvements related to the fleet. (Mansouri et al., 2015, pp. 3-18)

Laine et al. (2023 p. 12) present that the voluntary carbon market has the potential in achieving the Paris 1.5-degree goal. In voluntary compensation the harmful climate impact associated with a certain amount of greenhouse gas emissions is eliminated by reducing or sequestering an equivalent number of emissions to be offset elsewhere. Compensation and some claims related to it, like carbon neutrality, are a means of implementing the operator's responsibility strategy, voluntary goals, and/or marketing strategy. High quality voluntary compensation allows public and private actors to bear responsibility of the climate harm caused by their own emissions entirely. This can be done even if they have not managed yet to eliminate all their emissions themselves. (Laine et al., 2021)

There has been time to time media coverage of failed carbon offset projects from third countries and a lot of ambiguity has been involved in emissions trading. The theoretical framework of the thesis will focus on voluntary compensation and what are the minimum criteria for good offset, considering credibility, prerequisites, and avoidance of double counting and what benefits it can bring to a company. For voluntary compensation there does not exist yet unified regulation, only recommendations. Instead, many international and national actors have developed their own, partly contradictory recommendations for good compensation practices. As one source will be used recent publication of Finnish Government by Laine et al. (2023): *Guide to good practices for supporting voluntary carbon markets* and a publication of Ministry of the Environment by Laine et al. (2021): *Regulation of voluntary emissions offsetting.*

According to Laine et al. (2021, p.11) already for about 20 years emission offsetting has been implemented, both based on voluntary actions as well as for fulfilling obligations. More

ambitious climate actions can be done with compensation, rather than only with emission reduction. Compensation projects can have many other benefits besides avoided or bound emissions. These include, for example, benefits to nature, such as increasing biodiversity, and many social benefits, such as improving the local economy, that can be achieved with projects. The UN's sustainable development goals (SDG´s) are often the background of project planning. (Varpula, 2020, pp. 26,37)

From the beginning motivating factors for voluntary compensation have been ethical and societal responsibility, willingness of operators to bear climate responsibility, and the pursuit of carbon neutrality. As voluntary carbon offsetting is not subject to public regulation, the system largely relies not only on certificates but also on mutual trust. (Finnwatch, 2021, p.4)

1.1.1 Introduction of commissioner

Meriaura Invest Oy is a Finnish investment and holding company that is the main owner of Meriaura Group. Meriaura Group is a listed company that has two business areas: maritime logistics and renewable energy.

The shipping company Meriaura transports dry cargo and executes demanding project deliveries in Northern Europe. The company offers CO_2 reducing marine transport services based on the use of recycled, in-house produced bio-oil. The company's vision is to be the leading forerunner in environmentally friendly, innovative, and solution-oriented maritime transport. Company´s target is to reduce its emissions by 4% per year. (Meriaura, n.d.)

The commissioner of this thesis, Meriaura Invest, is investigating ways to sequester carbon and implement emission compensation by voluntary offsetting in its business. This thesis concentrates on the emission compensation of Meriaura, the daughter company specialized in sea transport. When referring to the commissioner, it refers to Meriaura and/or the parent company Meriaura Invest.

1.2 Objective and research question

The purpose of this study is to investigate both the benefits voluntary offsetting could bring to a commissioning company, and the ethical criteria for good offsetting, since voluntary carbon markets are not under legislative regulation, yet. Other aim is to investigate the potential of common reed, and especially if the biochar produced from it could fit as a tool to the

offsetting markets. Removing reed from the Baltic Sea also reduces eutrophication which brings additional benefit to protection of biodiversity.

Financial institutions, cities, regions, and companies play a critical role in getting the world to reduce emissions and achieving net zero by 2050. The commissioner of this thesis Meriaura Invest has taken into consideration for not only reducing emissions but for reaching carbon neutrality by voluntary offsetting. The topic and research question of this thesis is" Achieving carbon neutrality in maritime industry - investigating the possibility of complementing reductions by voluntary carbon offsetting with common reed."

Recently published SITRA´s Megatrends 2023 point out that limits of the earth's carrying capacity can be adapted by investing in ecological reconstruction to quickly phase out fossil fuels and put a stop to the overconsumption of resources (Wartiovaara et al., 2023). The commissioning company is currently developing a ship concept that is based on bio-oil and battery technology, and targets to carbon neutrality. The energy needs of shipping industry cannot be met with battery technology and the company has been seeking different ways to make the green transition. Voluntary carbon offsetting is something that the company is considering doing. The pressure for this transition is also coming from their customers who have shown interest to pay more for a carbon-neutral transportation, as well as the entire maritime logistics sector who is under pressure moving towards green transition. (Meriaura, n.d)

When talking about the subject it is important to remember the mitigation hierarchy; offsetting is the last tool when other actions have already been made to reduce emissions. There have been biochar trials of reed already in Turku University of Applied Sciences and Aalto University, and John Nurminen Foundation has many projects ongoing with common reed, of which some will be introduced later

in the thesis.

1.3 Societal and regulatory trends related to case company and thesis topic

Sustainability related matters are emerging in the form of stricter legislation and at the request of various stakeholders, also customers. Stakeholder pressure is considered the most visible and influential factor and reason for companies' environmental strategies (Buysse & Verbeke, 2003). Corporate climate actions nowadays are defined by corporate

climate claims such as carbon neutrality, climate neutrality, and net zero (Kaskeala et al., 2023, p. 3). Commissioner Meriaura Invest employs less than 150 people and Corporate Sustainability Reporting Directive (CSRD) concerns companies having more than 500 employees which releases them from the legislative pressure of CSRD reporting. Yet, since 2020 the company has been publishing annual sustainability reports, which have been based on voluntary transparency. Starting in 2025, shipping industry will move into emissions trading and EU requirements will change; companies will have to submit a verified emissions report to the administrative authority, the flag state, and the European Commission. European Union has set their goal to be climate-neutral by the year 2050.

The UN Agenda 2030 for Sustainable Development Goals (SDGs) are a call to action to end poverty and inequality, protect the planet, and ensure that all people enjoy health, justice, and prosperity. The commissioning company follows the SDG´s and has set their objectives for the following key areas: 05. Gender equality, 07. Clean energy, 12. Responsible production and consumption, 13. Climate action, and 14. Life below water. Measures have been done for putting these objectives in practice and on implementation both on land and on sea. (Hytti et al., 2023).

The regulatory trends of sustainability must be considered at the company´s own industry, also and in addition to SDG´s the company is considering the recommendations of International Maritime Organization (IMO), which has defined its own objectives for how the measures will be implemented in the practical activities. From the voluntary offsetting perspective another authority to follow is ICVCM, The Integrity Council for the Voluntary Carbon Market, since the policies of emission offsetting is still in process and rapidly changing. (The Integrity Council for the Voluntary Carbon Market, n.d.)

The European Green Deal was approved in 2020 and is a set of policy initiatives by the European Commission with the common goal of making EU climate neutral in 2050. In the European Green Deal the Commission committed to ensure that consumers are empowered to make better informed choices and play an active role in the ecological transition. More specifically, the European Green Deal sets out a commitment to tackle false environmental claims by ensuring that buyers receive reliable, comparable, and verifiable information to enable them to make more sustainable decisions and to reduce the risk of ‘green washing´. (European Commission, 2023, p. 1).

In Spring 2023, the European Commission submitted a proposal, officially named Proposal for a Directive on substantiation and communication of explicit environmental claims (Green

Claims Directive). The Green Claims directive is a proposal which must be adopted by the European Parliament and Council through the ordinary legislative procedure. After that, the Directive must be implemented in national legislation in the EU Member States. The estimated time for the actual implementation is from two to three years. Under the proposal, Member States will have to designate competent authorities and give them all necessary powers of investigation and enforcement, to ensure compliance with the Directive and establish a regulatory and sanctioning regime (Rinne & Salo, 2023). As part of the European Green Deal, one of the actions of the Circular Economy Action Plan is a proposal for companies to substantiate their environmental claims using robust, science based and verifiable methods. The green claims proposal is closely linked to other EU policies. (European Commission, 2023)

European Commission (2023, p. 59). declares the objective of the proposal on Green Claims being “to increase the level of environmental protection and contribute to accelerating the green transition towards a circular, clean and climate neutral economy in the EU.” From the offsetting point of view, the Green Claims directive´s initiatives are that climate-related claims should report offsets used separately from the product’s greenhouse gas emissions. Another initiative is that reporting should also specify the share of total emissions that are addressed through offsetting, and whether these offsets relate to emission reductions or removals enhancement. In addition, the used methodology should also be informed. Correct accounting of offsetting should reflect coherently and transparently the resulting impact on the climate action. Initial expectations were that the Green Claims Directive would regulate the use of carbon removal credits and associated corporate claims. However, this has been left out of the proposal. (Rinne & Salo, 2023)

Regarding the proposal from the voluntary offsetting point of view it seems that it brought no desired clear clarifications and requirements on this field. The current directive is a step in the right direction, but it is not sufficient to stop greenwashing. The non-profit foundation Compensate points out, that the EU Green Claims Directive was a missed opportunity to end greenwashing. The directive had no legally binding requirements for setting an emission reduction pathway compatible with the Paris Agreement, and it is not replying on the question whether the offset claim covers the whole value chain or not. (Rinne & Salo, 2023)

The Green Claims proposal did not provide any concrete tools to voluntary offsetting market and the proceeding with the topic is part of the company´s own climate neutrality goal. Developing sustainable solutions for greener shipping and as the regulations comes later

than innovations there is a risk that an innovation and future regulations do not meet. A dialogue with government officials is therefore important.

Legislative changes are usually very slow, and therefore voluntary actions around sustainability issues will continue to be important for Meriaura. Regarding regulatory trends the year 2025 will be a turning point for the commissioning company, when a verified emissions report must be submitted to the administrative authority due to EU legislative requirements. (Hytti, 2023)

Ministry of the Environment (n.d.) point out that the development of voluntary carbon markets in Finland is guided by EU regulation and international agreements, which includes the Paris Agreement. On a national level, Finland goes on a higher level in reducing CO_2 emissions it generates, as it has set an aim to become the first carbon neutral welfare state in the world by 2035. The goal of becoming carbon neutral is achieved by introducing drastic political changes, which support sustainability, for instance in construction and energy industries, and to support the development of circular economy. The government also states that taxation and legislation need to be renewed to serve the purpose. (Ministry of the Environment, n.d)

When reviewing the societal trends on the subject both from the perspective of commissioner as well as the research question the concept of Blue Economy appears. Lee et al. (2020) define that Blue Economy concept refers to ocean economy or maritime economy that is aiming to improve human and societal wellbeing as well as targeting to reduce environmental risks and ecological scarcities, especially ensuring sustainability of the oceans. It can clearly be seen associated with United Nations´ SDGs 14–17. “Blue economy aims to move beyond business as usual and to consider economic development and ocean health as compatible propositions.” (World Bank and UN Department of Economic and Social Affairs, 2017) Since common reed causes eutrophication in the Baltic Sea, it is strongly related to the concept of Blue Economy.

2 Theoretical framework

2.1 Literature review to carbon offsetting

This chapter will focus on the academic literature and expert reports that already exist on voluntary carbon offsetting. Firstly, research about the subject, following with organizational perspective (both global and national) regarding offsetting. The scope of this chapter is on

research that has been conducted in the field of economy and entrepreneurship. Emission offsetting is familiar from the consumer side as well, like voluntary compensations in aviation industry. Thus, this literature review has been limited on purpose mainly on emission offsetting involving companies, not making the subject too wide. Also, studies and articles about offsetting in the research field of natural sciences have been left out.

To keep the lines of the Paris Agreement, that was set for the rise of global temperatures only to 1,5 degrees Celsius, there is an urgency for reduction of greenhouse-gas emissions. Some companies and organizations have the possibility to adopt new technologies, energy sources, and operating practices, and in that way can achieve the necessary deductions. But many will need to use carbon credits as a supplement to reach the net-zero. (Blaufelder et al., 2021, p. 6)

Carbon neutrality goals as a set target by companies and organizations worldwide have received significant attention as a needed step against climate change. Trowloon et al. (2023) studied companies´ understanding of the use of carbon credits, and they pointed out about clarity and transparency, and three key dimensions that are: firstly what the intention is to use carbon credits, secondly understanding the framework and means of headline terms that are carbon neutrality claims versus net-zero, and thirdly the status aspect of claims, whether they are stated achievements versus aspirational commitments. (Trowloon et al., 2023)

Xu et al. (2023) investigated on research literature, and studies that exists about carbon neutrality between the years 2000 and 2022. According to their study the number of publications on carbon neutrality has demonstrated an enormous growth trend between 2020 and 2022. The differences related to carbon neutrality research are notable across regions and countries. Two leaders of carbon neutrality research have been US and China. The areas of concentration have been practical, technical, policy, and economic aspects of carbon neutrality, but also research hotspots have been renewable energy sources, carbon capture and storage technologies, as well as carbon conversion technologies. (Xu et al., 2023)

Wang et al. (2021) reviewed on technologies and perspectives for achieving carbon neutrality, and according to that study the current path will not make the world to achieve the climate neutrality goal by 2050, unless the development of new crude oil and coal would have stopped by 2021. There is an urgent need for putting more effort into the transformation process of energy sector. For accomplishing the target cutting-edge research is needed, and

collaboration between technology, civil, and environmental engineering as well as combining bio- and nanotechnology. (Wang et al., 2021)

Roemer et al. (2023) studied about consumers´ perspective on emission reduction and carbon offsetting. Their study discovered that if the service has a lower carbon footprint most of the consumers are willing to pay more. Another thing the research brought up was that consumers value approximately equally internal emission mitigation and purchasing carbon offsets for those emissions that are uncontrollable. Roemer et al., 2023, p. 2950)

2.1.1 National perspective

Finnish Ministry of the Environment reports that the volumes of voluntary carbon offsetting are still quite small in Finland. The market is growing, however, both nationally and internationally. From national perspective the creation of new mandatory national legislation on voluntary offsetting is currently not a viable policy instrument, due to the freedom of trade and contracts and the European Union wide harmonization of consumer law. (Laine et al., 2021)

In 2020, the Finnish Chamber of Commerce launched a climate commitment, in which participating companies and communities undertake to be carbon neutral in terms of energy consumption and logistics by 2035 or by 2040 at the latest. According to the newest *Annual climate report* by Finnish Ministry of the Environment due to the significant decrease of the current carbon sinks, most probably Finland will not reach its targets and will have to acquire an equivalent amount of reduction credits from other EU member states. (Siljander et al., 2023, p. 31)

Eloranta (2020*)* studied on his master´s thesis Finnish companies' views on gaining added value on their brand by offsetting transportation emissions. The results revealed that companies who have set themselves a carbon neutrality goal, had compensated emissions in the past more than companies without this set target. According to the study companies had insights that a certificate for compensating transportation emissions could bring added value to their company image or product. There is a connection between the offset project type and the company´s willingness to pay extra for such services. The study pointed out, that carbon neutral transportation service seems to be the most appealing to companies who have set themselves carbon neutrality goals. Investing in renewable energy and forestry-related projects seemed to be the most appealing offset project types. (Eloranta, 2020)

A master's thesis by Hildén (2020*)* investigated corporate attitudes towards emission compensation and found through interviews on selected Finnish companies' representatives, that organizations who have climate targets are more interested in compensating their emissions. The thesis found out that regarding compensation services companies are targeting or aiming for better branding to be able to utilize them more efficiently in marketing. But the research revealed as well that that voluntary climate compensation market in Finland is still slightly minor. Some companies are considering the possibility of compensation, but they lack either incentives or they have hesitations about the usefulness or reliability of the service. (Hilden, 2020)

2.1.2 Organizational perspective

In 2022 in Sharm El Sheikh, Egypt where the 27th United Nations Climate Change conference (COP27) was held, UN appointed High-Level Expert Group on Net-Zero Emissions to highlight corporate greenwashing around net zero targets. According to this report non-state actors and standardization bodies have an important role in guiding best practices and empowering leadership coalitions based on voluntary efforts to build support in the transition towards net zero. But even with these actions there is still lots of development needed since majority of the largest companies are still lacking carbon neutrality goals. That brings up the urgency of regulation since all companies and organizations are not voluntarily fulfilling their Corporate Social Responsibility (CSR). Optimistic news is that the regulations around carbon neutrality areas are growing rapidly involving the areas of claims, product standards, transition plans, procurement, and disclosure. (High-Level Expert Group of United Nations, 2022)

At the report there are ten recommendations for companies and financial institutions to improve their environmental actions and avoiding greenwashing, of which one is using voluntary credits. "High integrity carbon credits in voluntary markets should be used for beyond value chain mitigation but cannot be counted toward a non-state actor's interim emissions reductions required by its net zero pathway." (The High-Level Expert Group by United Nations, 2022, p. 19*)*

Mark Carney (n.d.) claims there to be four aspects in complimentary offsetting: firstly, it is complimentary for companies and organizations to reduce emissions, reporting about them, and after the compensation itself. The second aspect is the new breakthrough technologies that need to happen for reaching net zero that economics will follow. The third point is the potential of cross-border cooperation since the market is global. The fourth aspect points out

the enormous potential that the offset markets can have for co-benefitting biodiversity, SDG´s and transparency. (United Nations, n.d.).

The COP27 has been considered as a big disappointment when referring to the number of decisions made, and goals achieved but many important initiatives were announced on the sidelines of the official negotiations. A new climate finance fund will be established to help poor countries most affected by the climate crisis. Climate action shouldn't be dependent on the outcome of the annual COP meetings. The main driver is now for companies investing into the green transition and advocating for it. (Kaskeala, 2023).

2.2 Main concepts of carbon offsetting

Carbon offsetting and carbon neutrality

In voluntary compensation or offsetting the harmful climate impact associated with a certain amount of greenhouse gas emissions is eliminated by reducing or sequestering an equivalent number of emissions to be offset elsewhere. (Laine et al., 2021)

Carbon neutrality means the cancellation of climate harm related to emissions. A carbon-neutral product, activity or company is therefore not emission-free, but the climate harm of the emissions caused by it has been compensated by producing a corresponding amount of additional climate benefits, in which case the combined effect on global net emissions is zero. (Laine et al., 2021) If a company has done all actions in mitigating its emissions and the last percentages have been compensated with carbon offsetting, it can call itself a carbon neutral company.

Regulatory Market vs. Voluntary Market

There are two categories that carbon offsetting can be divided into: Regulatory market (CDM = Clean Development Mechanism) and Voluntary market (VCM = Voluntary Carbon Market). Both markets have the same basic principle: purchasing carbon credits by investing in reduction of carbon emissions to offset carbon dioxide emitted elsewhere (Tsai, 2020).

The larger of these two is the Regulatory market, which is used both by governments and companies, who purchase offsets to meet their mandatory emission reduction targets. Regulatory market, CDM, was established in Kyoto Protocol in 1997 and was considered being both inflexible and very bureaucratic. Voluntary market, VCM seemed as more flexible,

and effortless method for compensation. But it is important to keep in mind that in VCM there are issues such as local community involvement and reduction measurements, that are more difficult to regulate due to the informality of some actors. (Lovell, 2010, pp. 353-362)

Standards and certifications

International projects as well as private programs certify emission reductions. These certificates ensure, that the compensations meet the criteria set for them. Certification systems guarantee a certain baseline of project documentation transparency. The most important certificates are the CDM under the United Nations, as well as the private Gold Standard and VCS.

The voluntary offset market has developed various standards, that can also be described as certification systems: Voluntary Gold Standard (VGS) certified offsets are audited according to the Kyoto protocol rules, and one criterion is that they must show also social benefits for local communities. The Voluntary Carbon Standard (VCS), administered by Verra, world's most widely used greenhouse gas offset crediting program, is less bureaucratic and therefore has more allowance on innovative small-scale projects. However, these certification systems have not always been able to guarantee the quality of offset projects and are particularly deficient when it comes to the impact of offset projects on human rights or local nature. Among the current certificates in the voluntary emission compensation market, the Gold Standard is the most comprehensive. Criteria are also made from different starting points: certification systems define what is required in practice, and various external parties, in turn, define what should be required. (Finnwatch, 2021, pp. 104-109)

Emissions trading

The development of emissions trading system affects the price of emission reduction units. In addition to voluntary emission reduction units, the global carbon market consists of emission rights. There are several emissions trades in the world, but the most significant of these is the EU emissions trade, which has been running since 2005 and covers 40 % of Europe's greenhouse emissions. (Laine et al., 2021)

Offsetting based on credit units

By far the most common and well-established practice is voluntary compensation based on credit units, but also emission rights and non-certified (verified or unverified) containment

results are offered and used for voluntary compensation. (Laine et al., 2021) The use of credit units for voluntary compensation takes place by invalidating them in the register of the credit standard. The compensation service typically includes the purchase of compensation units, and the actual cancellation on behalf of the compensator, as well as a certificate of cancellation. The use of emission rights for voluntary compensation takes place by invalidating (or in some other way permanently deactivating) emission rights. The purpose is to prevent a similar number of emissions from occurring within the scope of the emissions trading system. (Laine et al., 2021)

Authorized initiatives

The Integrity Council for the Voluntary Carbon Market (ICVCM) mandate is to host and maintain a set of Core Carbon Principles (CCPs) that act both as an initiative of standardization of high-quality carbon credits as well as a definer of methodology types and carbon-credit programs. Their other mandate is helping with the coordination between different parties and guiding principles for the sustainable growth of the voluntary carbon market. (The Integrity Council for the Voluntary Carbon Market, n.d.)

The Taskforce on Scaling Voluntary Carbon Markets (TSVCM), that was initiated by UN Special Envoy for Climate Action and Finance Mark Carney, is a private sector-led initiative that works for scaling both an effective and efficient voluntary carbon market to help meeting the goals of the Paris Agreement. (The Taskforce on Scaling Voluntary Carbon Markets, n.d.)

2.3 Problems related to carbon offsetting

The clean development mechanism projects, which were originally developed for interstate emission compensation, quickly expanded to private, voluntary emission compensation. Researchers and market players are having disagreements over definitions and even concerning basic questions about the role of the market. The ethical disagreement is also related to the subject, if the carbon market is essential tool for climate work or if it takes up resources that would be better spent elsewhere. (Morse, 2022)

Carbon offsetting has been blamed to deepen the economic gap between rich and poor countries, and as an easy way for companies to do greenwashing. Robust methodologies for making substantiated climate-related claims are still largely missing (Kaskeala, 2022).

The recognized problems in current voluntary carbon offsetting have been methodologies that have not always been transparent, accurate, or consistent. There also exists a risk of overestimations and double counting of avoided or reduced emissions. Among current offsetting markets there also lack permanent baselines and accurate accounting. Offset credits often have low environmental integrity and credibility that can mislead consumers. (Kaskeala, 2022)

If a company considers carbon offsetting, it is important to fully understand how it works and what it means in practice. Investments from private sector are crucial for achieving the Paris Agreement temperature goal by 2050. For the context the potential of voluntary carbon markets is big for emission reductions. But the lack of understanding and unclarity around the types of claims that can be both credibly and accurately made when integrating carbon credits into corporate climate strategies remains to be an obstacle for engaging a wider number of companies to voluntary carbon markets. (Trouwloon et al., 2023, p.14)

The pricing of the markets is also a challenge. Some credits have turned out to represent emission reductions that were questionable. Limited pricing data make it challenging for buyers to know whether they are paying a fair price, and for suppliers to manage the risk they take on by financing and working on carbon-reduction projects without knowing how much buyers will ultimately pay for carbon credits. (Blaufelder et al., 2021, p.2) Setting a price on carbon emissions is generally considered an important way to curb climate change. In the current market, companies have been able to nominally achieve carbon neutrality easily by buying the cheapest emission reduction units from the other side of the world, the effects of which cannot be accurately monitored. (United Nations, n.d.)

According to Boyle (2021) offsetting is allowing polluters to buy and sell permits to pollute instead of cutting emissions. In the debate of greenwashing the topic of offsets is discussed intensively and controversially. Trowloon et al. (2023) report that misleading claims have gained the reputational risks for companies as well as public awareness of ever more recurrent climate risks and impacts. The presence of civil society organizations makes it harder for companies to fake environmental engagement to increase perceived environmental legitimacy. (Trowloon et al., 2023, p. 14)

Many environmentalists and activists have been concerned for companies considering offsetting as a key element to achieve their climate goals, that often means reaching net-zero (Boyle, 2021). There exists a risk for offsetting not preserving natural resources, while maintaining a balanced carbon footprint. Offsets must be additional and permanent for

enabling sustainable compensation. As an example, the study published by the European Commission concluded that 85% of the projects considered did not meet the additionality criterion (Cames et al., 2016).

Calel et al. (2023, p. 3) point out that the role of voluntary carbon offsetting market is crucial for mitigating industrial greenhouse gas emissions, but challenges related to it are new regulators with narrow authority, or lack of legal precedent. The regulator's ability to verify the integrity of emissions reductions, either directly or by third-party audits, is often further circumscribed by allowing emissions permits to be traded across countries, and by allowing pollution offsets into the market from outside projects (Sigman & Chang, 2011).

2.4 Criteria for good offsetting

A credible and good offsetting should always be based on outcomes that can fulfill the minimum criteria that is set internationally. Claims should always be truthful, clear, unambiguous, and verifiable. In case not, the claim can be considered misleading or so-called greenwashing. (Laine et al., 2023 p.5) This chapter will focus describing what criteria there has been set for a good emission compensation in voluntary offsetting markets. According to *Guide to good practices for supporting voluntary carbon markets* a good emission compensation minimizes uncertainties and considers several perspectives, which are presented below. (Ministry of the Environment, 2023) The guiding principles of good offsetting will also be presented in Figure 1.

2.4.1 Additionality

When climate change mitigation measures are required to be additional, they target such measures that need additional support obtained through the sale of climate units to come true. (Laine et al, 2023, p.22). The condition of additionality is that the activity is not otherwise financially profitable or legally required. The additionality assessment is done in relation to the so-called baseline, i.e., the scenario of what would have happened without the compensation project. In certificates, the basis for additionality is often an estimation of costs, with which the implementer of the project shows the certifier that the project would not have been profitable without the additional income from compensation. A challenge in renewable energy projects is that they often change at some point profitable, but the realization of the project can demand a guarantee that additional income will be obtained from the compensation. (Finnwatch, 2021, pp. 14-15)

2.4.2 Robust baseline

The baseline refers to a scenario to which voluntary climate actions are compared with assess the climate benefits they produce. A robust baseline refers to an emission scenario without the realization of the relevant emission offset. The definition of a baseline is one of the minimum criteria for certified carbon removals proposed by the European Commission. The baseline can be defined in two ways: either as a Standardized Baseline, which is the EU's recommended approach, or as a Mitigation Action-specific Baseline. It is also important to update the baseline from time to time to reflect social, economic, environmental, and technological development. (Laine et al., 2023, pp. 31-32)

2.4.3 Robust calculation method

Applicable and recognized calculation methods must be used for the calculation of emission reductions, that are approved by international or national certification programs. The European Commission has proposed carbon removal certification, which means that carbon removals must be calculated in an appropriate, and comparable manner. Calculation of uncertainties must also be reported and considered to reduce the risk of overestimation. (Laine et al., 2023, pp. 35-36).

2.4.4 Monitoring and reporting

The results must be monitored according to the selected calculation method. Results must be reported transparently and in accordance with the selected calculation method in the follow-up report. The monitoring report must be verifiable, and the results and calculation must be checked by an independent verifier. (Laine et al., 2023, pp. 43-44)

2.4.5 Stability or permanence

For the results to be truly useful in mitigating climate change, they should basically be permanent. Stability is an important feature for climate units that are used to cancel emissions or permanently promote national climate goals. It is important that potential permanence risks are monitored and managed, and any releases of carbon stocks into the atmosphere should be fully compensated by an appropriate compensation system. (Laine et al., 2023, pp. 46-47)

Stability is especially related to projects that increase carbon sequestration and means that the promised climate impact is permanent. For example, an afforestation project, achieving stability requires that the forest remains a forest and is not cut down later, for a construction project. In practice, permanence often means a period of one hundred years, which is considered long enough in the context of combating the climate crisis. (Finnwatch, 2021, p.17)

2.4.6 Avoidance of carbon leakage

Avoiding carbon leakage means that voluntary climate actions should not cause a decrease in the carbon storage or an increase in greenhouse emissions elsewhere, that means outside the limits of the operation. Avoidance of carbon leakage is not relevant in all types of mitigation measures, but it must be considered especially in measures in the forest and land use sector. (Laine et al., 2023, p. 49) A challenge is that identifying a carbon leak is difficult and requires often monitoring of the development in the area. (Finnwatch, 2021, p.17)

2.4.7 Authenticity, transparency and certifiability

The authenticity of the mitigation result means that before the unit is put into operation and the buyer of the unit uses it, the emission reduction or carbon removal has already happened. The minimum criteria and quantity must be verified by a third party to launch the unit. For this, certification programs have been developed so that the quality of the units can be ensured. (Laine et al., 2023, pp. 51-52)

Transparency means that evaluation and supervision of the process should be commissioned by an external party and the documentation should be as widely publicly displayed as possible. (Finnwatch, 2021, p. 23) Transparency is needed from both users and intermediaries of compensation. Requiring transparency of controls and operations is a condition for the other criteria being considered reliable. Now on the UN's own services and both on the Gold Standard and Verra websites, anyone can view the use of individual compensation units. (Finnwatch, 2021, p. 23).

2.4.8 Avoidance of double counting

Avoiding double counting means that the same unit is not launched through different certification programs or used more than once by different buyers. The resulting emission

reduction can only be calculated once and only for the benefit of one operator. Avoiding double counting between the state and a non-state actor would require either that the emissions questioned are not counted as part of the state's goal, or that the state makes a so-called corresponding adjustment and removes them from the accounting related to the realization of its own climate goal. (Laine et al., 2023, p. 56)

Double counting can happen in three ways: double issuance, double selling, or double claiming. First in double issuance, when units are issued twice from one emission reduction an example of this would be that the emission reduction calculated from planting the same forest would be sold twice - for example to two different certification programs. Another way is to sell the same unit twice (double selling). The third way of double counting is the most difficult, as it can happen unintentionally - without cheating or abuse: double claiming of the emission reduction achieved through compensation. (Finnwatch, 2021, pp. 18-19)

Double counting has been a burning topic both in Finland as well as internationally. It concerns whether what is achieved is counted in the compensation emission reduction or carbon sequestration alone for the benefit of the compensator paying for it (as for example in traditional developing country projects in the absence of an actual climate goal) or also to the benefit of the project's host country, such as, for example, in domestic forestry projects. Avoiding double counting is a challenge for domestic forest projects since all Finnish forests are included in the calculation of emissions and sinks from the land-use sector in the same way, regardless of whether there is growth, that has been happening with offsetting in the background. (Finnwatch, 2021, pp. 18-20)

With the Paris Agreement, almost all countries in the world now have their own climate targets. Therefore, to avoid double counting completely, either the project must target a sector without a national emission reduction target, or the climate benefit of the offset must be kept separate in greenhouse gas accounting through so-called "corresponding adjustments". Another way to avoid double counting is to allocate offsets to sectors for which no national targets have been set. (Finnwatch, 2021, pp. 18-20)

2.4.9 Avoiding significant harm

Avoiding significant harm means that mitigation measures should minimize and, if possible, completely avoid negative environmental, economic, or social impacts. Values related to sustainable development, such as biodiversity or social and cultural values must not be

compromised. In planning and implementation of the action, the environmental and social effects of the project must be considered. (Laine et al., 2023, pp. 58-59)

Projects very often have some form of impact on the local population. Positive impacts may include, for example, increased energy supply or employment, cleaner water, or protection of areas with cultural importance. However, projects may also have negative impacts that can be related to issues such as the land rights of local people or reduced food availability. In practice, the only concrete requirement in this is the hearing of stakeholders. (Finnwatch, 2021, p. 23)

Demonstration of fulfilling the minimum criteria in emission offsetting must be conducted in the mitigation action description document. The document is delivered to an independent verifier, who checks its correctness, on site, if possible, in order that the initial situation can be checked too and the correctness of the given information. (Laine et al., 2023, p. 63)

Figure 1. Guiding principles of good voluntary offsetting

2.5 Types of offsetting projects

Voluntary carbon offsetting has traditionally focused on projects in developing countries, but new methods already have emerged or are emerging, such as improving carbon sequestration in coastal and aquatic plants or various negative emission technologies that remove carbon dioxide directly from the atmosphere or capture it for bioenergy production. As the range of project types expands, offset projects are also increasingly being

implemented in industrialized countries and the trend for voluntary offsetting is moving to local within national borders. (Finnwatch, 2021)

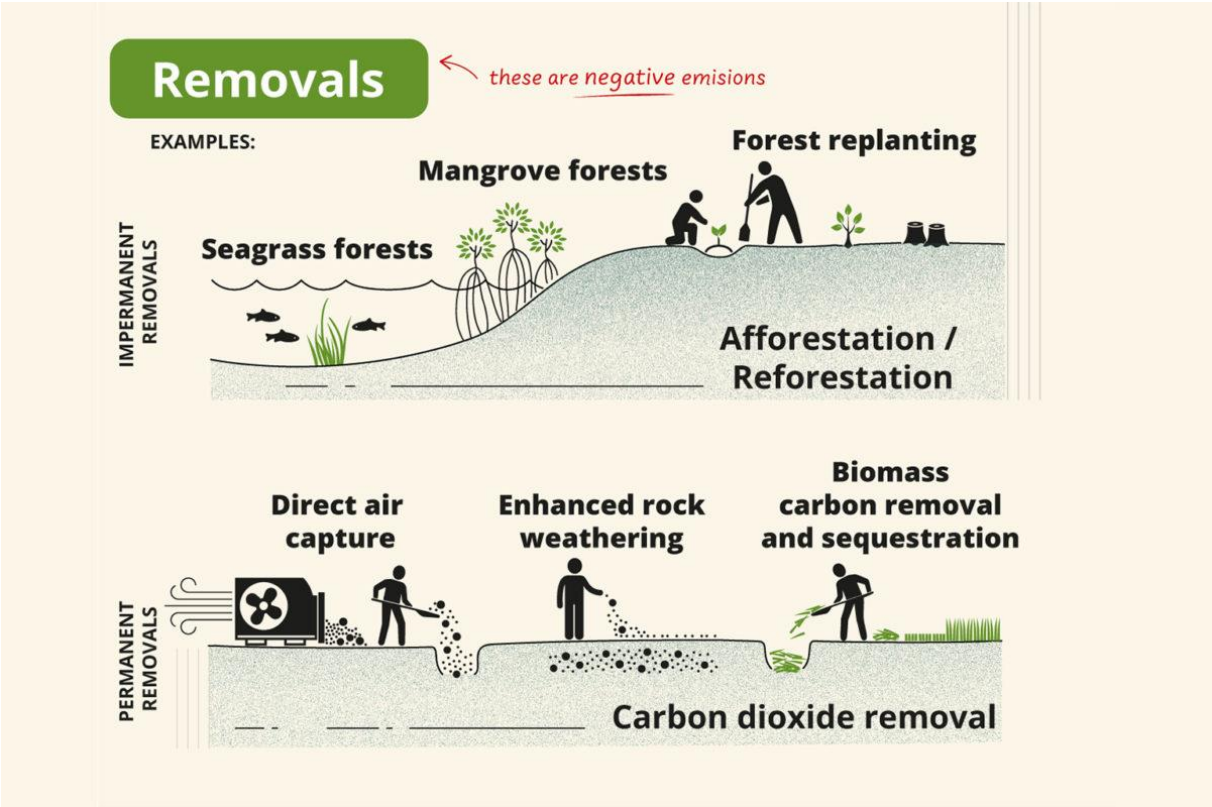
Types of voluntary emission offsetting projects include Renewable Energy Projects, Forestry Projects, Industrial and Landfill Gases, Energy Efficiency and Program Projects, and Negative Emission Technologies. (Finnwatch, 2021, pp. 27-37)

Negative emissions technologies include various biological and technological methods, of which one is biochar. Biochar, on the other hand, uses pyrolysis to produce long-lived carbon from biomass that can be used, for example, as a soil improver or filter material. Both biochar and soil carbon sequestration, or 'carbon farming', are currently being developed in Finland and Gold Standard certification is being sought for the method used. Biochar will be presented more at the following chapter. In Finland, two companies have so far received environmental permits for biochar production. One of the pyrolysis plants will start operating in Hämeenlinna in 2024. (Kemiamedia, 2023)

For Negative emission technologies, it is important to distinguish between what may be a reasonable offset now and what may be a long-term plan for offsetting emissions. Biochar production from wood is already a commercial activity in Finland. Other methods of carbon sequestration include the use of minerals or coastal plants to promote marine carbon sequestration (blue carbon) and the natural carbon sequestration of certain minerals. (Finnwatch, 2021, pp. 37-38) In Figure 2 there is illustrated examples of Negative emission projects.

Negative Emission Technologies or in other words carbon dioxide removal (CDR) projects may have the largest potential to contribute to real carbon reductions in the atmosphere. These projects have contributed to the market’s image, but they comprise only a little part of the total trade volume. (Morse, 2022)

Figure 2. Examples of Negative emission projects (Mongabay, 2022)



2.6 Biochar

2.6.1 Generally, about biochar and carbon sequestration

One objective of this thesis was to investigate if a common reed-based biochar could act as a compensation tool and therefore biochar will be introduced in this chapter from its beneficial side. Since this thesis does not have a background on natural sciences or an engineering approach, this study will not go too much into details of the technical properties or calculations of biochar.

Biochar is made from biomass using a low-oxygen combustion process, pyrolysis, and the material has several applications. In pyrolysis, organic solids are broken down by heating without oxygen affecting the process. Different parameters of pyrolysis change a lot of the process of biochar. Significant parameters include, for example, temperature, residence time, burning rate, and various properties of the feed material, such as structure and nutrient content. Other carbon materials, such as charcoal and barbecue charcoal, are produced using similar processes, but biochar refers exclusively to material made from biomass. (Lehmann & Joseph, 2009, pp.1-3.) Biochar can be produced from all types of biomasses.

The characteristics of biochar are most influenced by the raw material used to produce it and its processing. (Bioenergia, n.d.)

2.6.2 Benefits and possibilities of biochar

The carbon sequestration potential of biochar is high. In carbon sequestration, carbon is captured or stored. In carbon sequestration, sooner or later the biomass breaks down, because of which the carbon dioxide it contains is released back into the carbon cycle. This cycle can be tackled by producing biochar from biomass, which is stored for hundreds or thousands of years in the soil. (Bioenergia, n.d.).

Biochar acts as carbon sink and therefore, biochar has an important role in achieving the goals of the Paris Climate Agreement. The advantage of biochar is that it creates permanent negative emissions and has clear opportunities in carbon sequestration, and with this in compensating CO_2 emissions. (Carbons, n.d.)

Varpula (2020) studied about possibilities of biochar in offsetting greenhouse gas emissions. He highlighted that the compensations achieved with biochar are currently too expensive compared to other compensation methods, but also quite a new concept.

The most significant strengths of biochar when compared to other compensation methods are the possibilities to create real and permanent carbon sinks without significant need for land use changes, while obtaining energy and utilization of otherwise useless biomass. Uncertainty in the work is caused by the lack of wider literature on, for example, the prices and markets of compensations. Especially for biochar, prices are also uncertain due to the small size of the market. (Varpula, 2020, pp. 32-33)

Biochar can be used in many other ways also, for example in cosmetics, as a heat and sound insulator, or as a roofing material. Almost 60 different uses have been found for biochar. (Carbons, n.d.)

When used wisely, biochar has many opportunities to bring solutions to several sustainability challenges, from climate change to soil erosion and to circular economy solutions. Biochar has numerous positive effects that compare well with other compensation methods and improve the competitiveness of biochar in the compensation market. Biochar is a genuine carbon sink and is not based on avoided emissions, unlike, for example, renewable energy. (Varpula, 2020, p. 27)

Common reed and its possibilities as a biochar in a compensation needs further investigation but there have been trials of it already in Aalto University and Turku University of Applied Sciences. Possible uses for reed biochar include fossil coal substitute in the steel industry and carbon compensation. Experiments with reed biochar in technology have brought good results, probably because of reed biochar's hollow, tubular, and irregular structure. (Tornikoski, 2022)

2.6.3 Standards and regulations related to biochar

The quality requirements of biochar include standards such as the European Biochar Certificate (EBC) and the International Biochar Initiative (IBI) certificates. The EBC was developed to limit the risks of biochar usages and to help the users and producers of biochar to prevent any hazard for the health or the environment while producing and using biochar. (European Biochar Certification, n.d.) In addition, it is related to the EU Fertilizer Preparatory Act. National fertilizer regulation (539/2006) must also be considered. (Tornikoski, 2022)

There is a deliberate focus on sustainability in biochar production, and the certification of biofuels sets certain criteria for their certification and sustainability. Such criteria include sustainability criteria for growing biomass, recovery of pyrolysis gases and oil, heat recovery in pyrolysis and prohibition on burning biochar (Bioenergia, n.d.).

The Bioenergy Association represents the interests of the bioenergy sector in Finland. The goal of the association is to increase the share of renewable and domestic energy. The use of sustainable bioenergy is increasing in Finland, while the use of peat in energy decreases, but the use of peat in materials is in increase. Finland has set the target quitting the energy use of coal by 2029 and achieving climate neutrality by 2035. (The Bioenergy Association of Finland, n.d.)

2.7 Improvements suggested to carbon markets

According to the report by UN main recommendations in voluntary offsetting are that non-state actors must prioritize urgent and deep reduction of emissions across their value chain. “Voluntary carbon markets need to be built on a rights-based approach, which fully respects, protects and considers the rights of Indigenous Peoples and local communities. (The High-Level Expert Group, 2022)

To ensure reliable and acceptable offsetting operations and respect for consumer protection, harmonized minimum criteria and clear rules are needed for the sector that specify the content of the different concepts and determine the environment where the operations are to take place. It is important to develop the sector in a way that is market-driven, but a central government party responsible for the carbon offsetting scheme is also needed. A scientific expert panel could also be established to support the consumer authority and different stakeholders. A good option is a voluntary register for offset producers, which could also provide a way to avoid double counting with the state's climate targets. (Laine et al., 2021)

One of the leading consulting companies McKinsey together with TSVCM (The Taskforce on Scaling Voluntary Carbon Markets) propose identified six areas, that could increase the value chain of carbon credits and improve scaling of the voluntary carbon market. Both the problems and solutions will be introduced below.

1) There is a lack of liquidity that is necessary for efficient trading. As a solution to these shared principles should be created for verification of carbon credits and a quality criterion. (Blaufelder et al., 2021, pp.1-6)

2) Currently the problem has been that the carbon credits are heterogenic, which means that the trading volumes have been too small for generating reliable daily price signals. When the core of carbon principles and standard attributes have been established, for carbon trading exchanges could create reference contracts. (Blaufelder et al., 2021)

3) Developing contracts with standardized terms would benefit a clear daily market price. (Blaufelder et al., 2021)

4) For the problem of skepticism that occurs at the market nowadays a solution could be creating a consensus about the proper use of carbon credits. (Blaufelder et al., 2021)

5) For the problem of integrity of the voluntary carbon credits that can create errors, there is a suggestion for installation of safeguard mechanisms. This would also improve the transparency and minimize money laundering. (Blaufelder et al., 2021)

6) Now market data and transparent references have a limited access and difficult to track. As a solution to this McKinsey suggests establishing trading and post-trade

infrastructure. This improvement would make the voluntary carbon markets effective, resilient, and flexible. (Blaufelder et al., 2021)

7) There should be transmitted clear signals of demand, that could help encourage project developers to grow the supply of carbon credits. (Blaufelder et al., 2021, pp.1-6)

2.8 Ethical recommendations for companies or organizations considering offsetting

The mitigation hierarchy is essential: the use of offsetting requires an explanation of why the compensated emissions could not be reduced, as well as a plan on how and on what schedule these emissions could be reduced. (Finnwatch, 2021, p. 106)

Carbon neutrality should be the goal in the corporation value chain and operations. The mapping and utilization of emission reduction opportunities should be continued actively even after the decision to start with emission compensation has already been made. (Finnwatch, 2021, p. 106)

The chosen compensation method must meet all the criteria for high-quality compensation, which were presented in the chapter 2.4. None of the criteria can be deviated from on the grounds that the project is particularly strong regarding some other criteria (Finnwatch, 2021, p. 106).

In the procurement of compensation, the same due diligence regarding human rights must be observed as in all other procurements of the company. Evaluation and monitoring of the method used at the project must be continuous. (Finnwatch, 2021, p. 106)

Supporting the development of Negative emissions technologies by using them for compensation is worthwhile. At best these methods avoid a large part of the challenges and risks associated with other compensation projects. (Finnwatch, 2021, p. 106)

2.9 The drivers and benefits of voluntary offsetting for companies

According to Climate Corporation (2020) companies trying either to reduce their carbon footprint or targeting net-zero level have constantly been growing the voluntary offsetting

market. The Taskforce on Scaling Voluntary Carbon Markets (TSVCM), sponsored by the Institute of International Finance (IIF) with knowledge support from McKinsey, estimates that demand for carbon credits could increase by a factor of 15 or more by 2030 and by a factor of up to 100 by 2050. (Blaufelder et al., 2021, p.2)

The motive for this has been corporate social responsibility as well as a green company image. A study by Finnwatch (2021. p. 81) reports that improving a company's reputation or building a green brand are the main reasons for companies to compensate for emissions. The attention has widely increased towards companies and organizations which benefit or harm social welfare. Corporate initiatives and acts in the field are commonly referred to as either CSR (Corporate Social Responsibility) or ESG (Environmental, Social and Governance). (Gillan et al., 2021)

This chapter will process the drivers for corporate carbon offsetting that are not based on compulsion. ESG promotes transparent business operations and improves the competitiveness of responsibly operating companies. Corporate sustainability is important for reducing negative impacts of corporate activities while improving economic performance in a balanced manner. According to Farnham (2022) another motivating aspect is that companies are under public pressure to improve their ESG performance. Reporting results and transparency effects the company´s potential as an investment, business partner and supplier. If the carbon footprint of a company is high, in short term corporate carbon offsetting can be the only realistic way to achieve significant reductions in carbon emissions. There is a broader ethical aspect involved also, and it can also be recognized “as right things to do” without a hidden motive background. (Farnham, 2022)

For mitigating the processes affecting the environment, companies establish environmental strategies. These two strategies can be categorized into reactive environmental strategies and proactive environmental strategies. Reactive strategy mainly focuses on fulfilling the minimum regulatory requirements, for example avoiding pollution sanctions. Proactive strategy, on contrary scope on preventive actions on pollution as well as generally strengthening environmental capabilities of the company. (Wang et al., 2020, p. 12) The commissioning company has been focusing on the latter one, proactive strategy.

Laszlo & Cooperrider (2011) define corporate sustainability as a dynamic state that occurs when a company produces value for its stakeholders and owners. According to Babiak & Trendafilova (2010) companies that can build competitive advantage, improve their revenues, and improve the attractiveness of resources to a company. The target of

environmental strategies is not only in mitigating the impact of companies' actions has on planet, but environmental performance also helps significantly to sustain the competitive advantage of companies. This can be interpreted that a proactive culture of social and environmental responsibility in the company is becoming a competitive advantage. (Prayag et al., 2017, p. 26)

Dissertation by Laari (2016) claims that it is possible for a company to increase its environmental friendliness and competitive advantages with green supply chain management. The customer's environmental requirements can be a significant factor in the company's internal operations. It is possible for companies to respond to this pressure by transferring requirements to their own suppliers; this can be done either through environmental cooperation or environmental monitoring. Companies must adapt their supply chains to meet the demands of country stakeholders and integrate internal supply chain management resources with suppliers and customers. In this way the environmental impact is even bigger. Green supply chains are not included in the business strategies of all companies. (Laari, 2016, pp. 98-99)

Tien-Shang (2011) studied the pivotal roles of corporate environment responsibility and the results of the study show that companies must practice environmental orientation to gain the competitive advantage to their company. If a company has environmental strategy in their business, which they are actively implementing, it can be the source of competitive advantage.

Roemer et al. (2023, p. 2950) studied about consumers´ perspective on emission reduction and carbon offsetting. At their study they discovered that if the service has a lower carbon footprint most of the consumers are willing to pay more. Another thing the research brought up was that consumers value approximately equally internal emission mitigation and purchasing carbon offsets for those emissions that are uncontrollable. According to Haller et al. (2022); and Nielsen (2018) many surveys worldwide show that an enlarging number of consumers consider sustainability of a product or service as important in their purchasing decisions. As companies are responding to this trend, it leads to a growing market of sustainable products and services.

Blaufelder et al. (2021, p. 2) write that voluntary carbon credits also direct private financing to climate-action projects that would not otherwise maybe start at all. This kind of project can provide supplementary environmental and societal benefits like pollution prevention, biodiversity protection, as well as job creation, and public-health improvements. Another

beneficial thing carbon credits can bring are the investments done in innovation to decline the cost of climate technologies. (Blaufelder et al., 2021, p. 2)

As with anything new, there has been skepticism around carbon offsetting. Farnham (2022) believes that there is enough evidence for carbon offsetting not only to help, but also to give solution the global problem of greenhouse gas emissions if the current problems related to it can be solved. It is a necessary step on the net-zero path, widely agreed by experts. Blaufelder et al. (2021, p.7) support this and claim that voluntary carbon markets have a big potential to support the advancement for reaching a low-carbon future and this can be done by supporting and enabling more carbon offsetting.

As a conclusion to this chapter there can be noticed that climate neutrality reached by voluntary offsetting can be beneficial not only for the environment but for the company too, since it gains a good reputation. (Chen, 2021 p. 2) declares that “The internationally concerted effort toward carbon neutrality could be the largest international agreement achieved in human history. This is a positive sign of international societal development but could also be regarded as an act of desperation to protect ourselves from damages caused by ourselves.” For reaching the low-carbon future there should be enabled more carbon offsetting based on voluntarism to take place. (Blaufelder et al. (2021, p. 7)

2.10 Common reed – ongoing projects

According to research by Findlay et al. (2003); Zimmerman et al. (2018) the condition of water bodies improves permanently with regular and cost-effective common reed harvesting operations. There is a demand for reed material. Despite the identified benefits and the possibilities, the commercial utilization of reed is still low. (Turku University of Applied Sciences, n.d.)

As there is currently still a relatively small number of publications available on common reed, as one source of information are the ongoing reed projects, which aim, among other things, at finding value chains and making greater use of common reed. Common reed and its utilization possibilities have been studied in various projects over the years, both internationally and regionally. Both Turku University of Applied Sciences and John Nurminen currently have several ongoing projects of which few of them will be introduced shortly, of which scope is in the business-minded and innovative perspective. During the thesis writing process the author of this thesis took part in several seminars related to common reed for gaining deeper knowledge and understanding of the subject.

Utilizing common reed! – New technologies and procedures of water protection

The project *Utilizing common reed!* by Turku University of Applied Sciences running in 2021 - 2023 was mainly funded by Ministry of the Environment together with local companies, and municipal authorities. The goal of the project was both research and development work to remove bottlenecks in the reed business and to develop functioning production chains for utilizing reeds harvested in different seasons for different end-use purposes. The aim was also to develop efficient production chains for the use of common reed harvested in different seasons for different end uses, such as raw material for replacing peat, for biogas production, as soil improver in fields, for construction, combustion, and textile fibers. (Turku University of Applied Sciences, n.d.)

Coastal Reed and Baltic Reed -projects

John Nurminen Foundation is leading a Coastal Reed Project running in 2020 – 2024 and Baltic Reed Project running in 2023 - 2026. The goal of the Coastal Reed Project is to recycle the nutrients from the coastal waters to the ground that are bound to the reed areas. In the Baltic Reed project, the objective is to develop common reed-based business activities with partners in Finland, the Åland Islands and Sweden. (John Nurminen Foundation, n.d.)

3 Methodology and research process

Scientific research and scientific knowledge have some general characteristics. One general aspect is that they are public and accessible, and scientific knowledge and claims need to be publicly justified. Scientific research is also critical, and the research is based on real interaction between the researcher and the research object, not on beliefs or authorities. Objectiveness is other thing that defines scientific research; the research object and its characteristics are independent from opinions. Scientific research is autonomous or in other words independent which means that research should not be affected by economic, political, religious, or moral desirability or undesirability of the results. Other aspect of scientific research is its progressiveness; new scientific knowledge adds on existing scientific knowledge. Scientific knowledge is informative and generalized knowledge. (Pekkanen, 2000)

Different scientific philosophical orientations have different ideas about the nature of knowledge and reality. Methodology is part of all research and the review of research. In qualitative research, methodological literature can be divided into different categories, such

as "continental European approaches" or "American approaches". European approaches are more strongly oriented to the philosophical approach, while the American approach is methodically oriented. There are many and often conflicting understandings of methodology in qualitative research. The methodology examines the sense of the data collection method used in the research, while the method justifies the information generated in the research. (Tuomi & Sarajärvi, 2017, pp. 16-18)

Often, the discussion of research methodology can be summed up in two concepts and their commitments: ontology and epistemology. Ontology includes the question of the way of being, i.e., in qualitative research, the concept of human being, while epistemology includes the question of the possibility of knowing. Philosophically, methodology is a broader and more versatile question, and there is no consensus on what the methodology covers in terms of content. (Tuomi & Sarajärvi, 2017, p.18)

There are many traditions associated with qualitative research and taking them into account is also refreshing from the point of view of criticism of qualitative research. It is important that students writing their thesis also understand what they are reporting when conducting and reporting qualitative research. (Tuomi & Sarajärvi, 2017, p.13)

Because the research question is so practical, the philosophy of science is not so essential in this work and for that reason was chosen the American approach. The thesis is conducted as a qualitative case study. The study was chosen to be a qualitative, since the objective of the thesis wanted to find an answer to a specific question that cannot be explained by numbers or sample size. The commissioning company had a very specific topic that is innovative and still under research. For this study being able to answer to the research question, theoretical information about the global emissions compensation market was needed as well as very detailed information related to biochar and common reed, which could only be found out by chosen methods that will be presented in following chapters. The methods used are literature reviews, semi-structured, and in depth-interviews and observation that will be presented at the following chapter.

3.1 Introduction to qualitative research

When talking about the literature on qualitative research, there are many ways of classifying, treating, or typifying a body of qualitative research. The development of traditions in the philosophy of science has strongly influenced the development of qualitative research and its field. (Tuomi & Sarajärvi, 2018, pp. 30-31) Qualitative research strongly involves both a

theoretical framework and empirical analysis. Both types of research: theoretical and empirical, can investigate the same phenomenon. One of the fundamental cornerstones of qualitative research is the theoretical nature of the findings. The importance of theory in qualitative research is obvious and essential. (Tuomi & Sarajärvi, 2018, pp. 23-25)

Qualitative research indicates an examination of concepts, and their meaning and interaction in specific concepts. Fawcett et al. (2014) define qualitative research as a scientific inquiry which relies on storytelling to make sense of dilemmas in the real-world. Qualitative research is often defined as a contrast to quantitative research, that is usually statistical or numerical. This means that qualitative research is not based on measurements, and the results cannot be brought into numerical form. (Fawcett et al., 2014, p. 6)

Qualitative and quantitative research have many things in common, for example the requirement for repeatability of observations and that the results must be justified. According to Mahoney & Goertz (2006, p. 14) research field and community often divides qualitative and quantitative research being opposite of each other, since they both have their specific norms, believes and values. As the methods of data collection and analysis are different, they both have the same primary function: giving answers and insights into specific question or research problem. Qualitative research almost always operates by analyzing individual cases. A qualitative research process is reflexive, which means that the conductor of the study has an integral part of the research process. Researcher´s subjective views, as well as the subjective views of the interviewed people, are part of the interpretation of the material. (Eriksson & Kovalainen, 2016, p. 32).

Tenny et al. (2017) claim the core of qualitative research is asking open-ended questions, which answers to questions like “how” and “why”, answers that cannot be easily put into numbers. Quantitative research is linear, when qualitative research has the ability of explaining patterns and processes of human behavior that cannot be quantified. The evaluation criteria for quantitative and qualitative study differs in many ways. For evaluating quantitative data there are four well-established criteria for it, which are internal validity, external validity, reliability, and objectivity. The concepts that correlate with them in qualitative research are credibility, transferability, dependability, and confirmability. (Tenny et al., 2017)

When conducting qualitative research, it is important to ensure that the concepts have been understood and well thought out, to eliminate or at least mitigate potential problems to arise. Gammelgaard (2017) points out that following questions should be asked and defined when

starting a qualitative case study. Firstly, what is the aim of the case study and how were the cases selected? Other questions to consider are the quality of the case study research and the epistemological foundation of the case research. Which kind of approach is suitable to the exact case study and last the information that will be provided to the audience. (Gammelgaard, 2017, p. 910-913)

Maxwell (2008, p. 216) claims similar questions to consider when designing a qualitative study. There are five components that are essential for the study coherency. These questions will be presented below with answers from the conductor of this thesis.

The first question concerns the goals of the research. What are the issues a researcher wants to clarify, and which are the policies and practices worth influencing. Another question to think is what the motives for are conducting the specific study. (Maxwell, 2008)

The goal of this study is to seek for an answer whether common reed biochar could both theoretically and practically fit to voluntary emission offset markets as an actual tool for fulfilling the criteria of a good offset, and benefits offsetting can bring to a company. One aim is also to find potential for the reed use in general and find the problems that are related to it now. The current trend in national offsetting has been based nowadays on land and on forests, even there is potential for widening the area into the Baltic Sea as well. The study is also aiming to bring evidence that promoting environmental actions together with the economic profitability can be a good path for corporate strategies. The motive for choosing this specific topic came from the commissioner.

The second question concerns the conceptual framework of the research. What theories and prior research findings are guiding the research. (Maxwell, 2008)

The theories were presented at the theoretical framework chapter. It brought information of previous research and academic literature conducted about carbon offsetting related to business and corporate perspective, as well as the societal and regulatory trends that are related both to the commissioner of the thesis and to the research questions. Previous research findings clearly brought evidence that carbon neutrality can bring a competitive advantage to a company.

Organizational perspective was presented with reports from United Nations, European Union, Sitra, and Finnish Ministry of the Environment, who have been writing declarations about carbon offsetting ethically as well as corporate carbon neutrality goals. Another scope

is the previous studies about common reed and biochar. Understanding the interaction of all this in a bigger picture is relevant for the coherence of the thesis.

The third question concerns the research questions. In this phase the researcher must think about what he/she wants to learn or understand by doing the study and what is the relation between the research questions. (Maxwell, 2008)

This qualitative case study is pondering the benefits that carbon neutrality can bring to a company and aiming to clarify the standards of a good offset. It aims to gain answer to the question whether common reed could meet the criteria and be used as a compensation tool and clarify the obstacles that are related to the problem now.

The fourth question concerns the research methods. It is important to carefully think and plan what is essential to do for conducting the study. Which approaches and techniques will be used for analyzing the data. (Maxwell, 2008)

The thesis is conducted as a qualitative case study. The methods used are literature reviews, semi-structured, and in depth-interviews and observation that will be presented at the following chapter. The study was chosen to be a qualitative, since the objective of the thesis wanted to find an answer to a specific question that cannot be explained by numbers or sample size. The commissioning company had a very specific topic that is innovative and still under research.

The data will be conducted from the basis of the interviews. The experts were chosen by their knowledge, experience, and innovative thinking on the matter. Both knowledge on voluntary offsetting as well as knowledge of common reed have been acting as a common thread for choosing the cases.

The fifth question concerns validity the research and how are they dealt with. How can data support or/and challenge the ideas that the author already has. There are generally two problems related to the qualitative study which are bias and reactivity.

Bias refers to how data collection or analysis are distorted by the preconceptions, values, or theory of the researcher. In qualitative research it is important to understand that researcher´s values and expectations can affect the conduct or conclusions of the study. Reactivity refers to the dilemma, that the interviewer, and the interviewee can affect on each

other. This can be seen as a minor dilemma when the researcher is aware of these two threats. (Maxwell, 2008 p. 246)

Answer to the fifth question concerning validity: being transparent and objective throughout the research process is highly important. In this type of qualitative case study that has no sensitive information or anonymous data collection, there are no ethical considerations, except keeping the interview data stored in a correct way. The author of this thesis is committed to the ethical principles and guidelines of Häme University of Applied Sciences (HAMK). Everyone has the personal responsibility for the materials they produce.

3.2 Data collection methods

Research methods should always be chosen based on the specific task at hand, and methods should act as servants or tools, not as rulers (Silverman, 2010, p. 9). The most common methods for data collection in qualitative research are interviews, surveys, observation, and information compiled from various documents and sources. These can be used either together, alongside, or alternatively, depending on the problem under investigation and the resources of the research. (Tuomi & Sarajärvi, 2018, p. 83)

The types of qualitative study methods used during the data collection process were semi-structured interviews as well as in depth interviews. As an observation method the author of the thesis took part in several seminars that were organized in 2023 related to common reed projects by John Nurminen Foundation and Turku University of Applied Sciences.

3.2.1 Interviews

The simplest qualitative interview study is based on a single set of questions from all interviewees asked in the same way. The main instrument guiding the interview is the interview frame, which has two main functions. Firstly, it outlines the interview and ensures that the researcher asks all the necessary questions. Secondly, it ensures that the interview proceeds as naturally as possible, and the interviewee is allowed to answer in his or her own words. (Koskinen et al., 2005, pp. 106-109)

Magaldi & Berler (2020, p. 4825) define a semi-structured interview as an exploratory interview to gather clinical data to a qualitative research process. There are two aspects in

this type of interview: the other one is beforehand planned general structure, but it also allows some looseness for discovery if the conversation unfolds.

Semi-structured, i.e., theme interviews and in-depth interviews have both in common the openness. In a themed interview, the interview proceeds according to certain key themes that have been selected in advance, as well as detailed questions related to them. The interview aims to find meaningful answers related to the research question or research problem. An in-depth interview, which is also called an open interview, is phenomenon-oriented, which means that the reference framework of the research does not determine the direction of the interview. The researcher has an important role in keeping the interview on topic, but the interviewee is allowed to speak freely. (Tuomi & Sarajärvi, 2018, pp. 87–89)

In-depth interviews are a qualitative research method, that targets in exploring respondent's point of view, experiences, feelings, and perspectives in a deeper level. One of the main methods used in qualitative data collection process are in-depth interviews. This type of interview method is often referred and described as a form of conversation which has a specific purpose. What differs it from a normal conversation is that there always is an objective as well as the role of the interviewer (researcher) and interviewee are quite different. (Legard et al., 2003, p. 138)

The key features of in-depth interviews are that firstly its intention is to combine structure with flexibility. Second key point is the interaction between these two parties. Thirdly the researcher must use a variety of different techniques, like explanation, exploration, and penetration to get the answers in a deeper level. The interviewer also must have a deeper understanding of the topic and the interviewee´s meaning. (Legard et al., 2003, p.142)

Work between interviews, observational data, audio-recordings, and visual data must be systematical. It is highly important to keep in mind the transparency of the whole research process. Each of the interviewed experts were willing to have their names published, which makes the transparency of the whole process easier for the author of this thesis, since it does not include sensitive data.

3.2.2 Observation

Observation is considered the second most common method of data collection in qualitative research. Observation is a valid method of obtaining information, for example, when little is known about the phenomenon under study. (Tuomi & Sarajärvi, 2018 pp. 93-94)

3.3 Data collection process

For gaining a more holistic view on the topic the author of the thesis wanted to investigate the topic both from the governmental and business perspective as well as from the sustainability perspective. All the interviewed experts had somehow background or interest towards common reed. The interviewees represented both organizational as well as corporation perspective from following fields: maritime sector, innovation sector, research sector and offsetting sector.

People interviewed were representing the following organizations: University of Turku, Turku University of Applied Sciences, John Nurminen Foundation, Business Turku, NGS Finland, and the commissioner Meriaura Invest. The names and short presentations of the interviewees can be found below.

1. Jerome Tornikoski, project engineer working in several common reed projects, Turku University of Applied Sciences. Interviews took place on April 24th and November 10th in 2023.

2. Antti Laakso, a development director of NGS Finland, that meets the needs of companies in the field of climate change and provides offsetting services. Interviews took place on May 17th and November 13th in 2023.

3. Jyrki Heino, project coordinator of Meriaura with long-term interest towards sustainability related matters and common reed. Interviews took place on May 19th and November 10th in 2023.

4. Timo Suutarla, network manager of Business Turku with background in the forest industry working for more than 35 years as a manager of paper mills around the world. Interview took place on November 13th, 2023.

5. Kalervo Väänänen, former rector of University of Turku, a professor of cell biology, and a board member of the Academy of Finland. Interview took place on November 14th, 2023.

6. Sonja Jaari, director of the Baltic Reed project, John Nurminen Foundation. Interview took place on November 16th, 2023.

The interviews took place in two timeframes. First round was during April 24th, May 17th, and 19th of three of the experts with in-depth -approach and they happened face-to-face.

The second round of interviews took place with virtual meetings in Teams during November 10th to 16th in 2023. Six experts on the field were interviewed in Finnish with a semi-structured approach. The interviewed participants were selected either according to their specific knowledge about common reed or interest towards it, or due to their knowledge of voluntary offsetting.

The same list of beforehand-decided questions was asked from each of the interviewees, with freedom to talk out of the subject also, in case they wanted to. The questions were originally in Finnish. The interviewees were asked about their background with common reed and the arguments in favor of using common reed, both from the offsetting perspective and from general perspective. The interviewees had the freedom to answer on both aspects or just the other one. The questions also considered difficulties related to common reed now and their perspectives how these current difficulties could be made easier. They could also estimate the development related to common reed in the near future (5 to 10 years) and tell their vision for 2050 for the use of common reed. The interview questions can be found on appendix 2.

Each interview was recorded and after transcribed into text format in Finnish, and after translated into English. When processing the data collected same things emerged from the responses, from which codes were formed and from these codes it was possible to outline themes. The thematic analysis constructed from the interviews will be presented at the chapter of Data analysis.

3.4 Introduction to applied thematic analysis

Content analysis is a basic method of analysis that can be used in all traditions of qualitative research. Analysis of qualitative research can be roughly divided into two categories: theoretical analysis or applied analysis. Applied analysis also includes content analysis and thematic analysis (Tuomi & Sarajärvi, 2018, p. 103).

Thematic data analysis focuses on identifying and describing the data in themes. For capturing the complexities of meaning within a textual data set a thematic analysis is considered being the most useful. (Guest et al., 2011, pp. 10-11) There should always be crucial links between theory and method and understanding the relevancy to research topic.

Data should always be analyzed critically without rushing to conclusions (Silverman, 2010, pp. 17-43). Herzog et al. (2019) claim thematic analysis being a popular and thorough method, that can be identified as a cornerstone of qualitative data analysis. It has the focus with the identification and analysis of patterns of meaning (themes). Thematic analysis can be described as a widely applicable, flexible, and cost-effective tool for exploratory research. Herzog et al., 2019)

Applied thematic analysis approach is a set of procedures, that are designed for identifying and examining themes from textual data in a way that is transparent and credible. The method has a broad range of several theoretical and methodological perspectives, but the primary focus is analyzing text generated through in-depth interviews. (Guest et al., 2011, p. 14)

Ayton (2023, pp. 197-199) writes that applied thematic analysis involves five elements, which are text segmentation, creation of the codebook, structural coding, content coding, and themes varying in scopes. Below these elements will be explained more detailed.

During text segmentation meaningful segment of the text and its boundaries are being identified. This is helpful with transcriptions of long interviews. Text segmentation can be for example a participant's response to an interview question, a concept or keyword in context. The segment of text can be both little and large sections of text. (Ayton, 2023, pp. 197-200)

Creating a codebook is an essential element of applied thematic analysis. After the segments of texts have systematically been coded and categorized, the codebook can be created. First, the codes and their definitions are descriptive and after as the researcher has been examining the commonalities, differences, and relations between the codes, they become as explanatory codes. (Ayton, 2023, pp. 197-202)

Structural coding means that the structured question is the structural code in the codebook, and the reply of the interviewee as well as any dialogue that has been followed question should be included in text segment. (Ayton, 2023, pp. 197-202)

In content coding the segmented text is classified in different ways to explore descriptions, relationships, hierarchies, and explanations of events, similarities, differences, and consequences. The content of the text segment should be read through many times for identifying patterns and the meaning. (Ayton, 2023, pp. 197-203)

Themes vary in scope. Researchers must remember that the themes have a higher conceptual level than codes, and usually, multiple codes are leading to a theme. Going through again with research questions will help the researcher to identify themes. Some examples how themes can be identified include the use of metaphors and analogies, the repetition of concepts within and across transcripts, key phrases, and common phrases used in an unfamiliar way. (Ayton, 2023, pp. 205-202)

Applied thematic analysis is accessible approach for beginner researchers. But it is important to keep in mind, that the flexibility and accessibility of thematic analysis can also lead to limitations and challenges if a thematic analysis is done poorly or misapplied. It is important to connect thematic analysis into a theoretical framework, to avoid the risk analysis becoming descriptive, rather than interpretive. (Ayton, 2023 pp. 205-206)

4 Data analysis

In the following chapters the analysis of the interviews is being presented and summarized. When coding the interview material, clear themes emerged based on what was emphasized most in the interviews. Inside each theme there are subthemes that were formed from the codes of the data. These subthemes were formed from the things mentioned or highlighted the most during interviews. First, the results of the interview are viewed at a general level and small snippets of the interviewees' answers are also presented. Not all the issues raised in the interviews can be presented in this paragraph but will be reviewed in the analysis. A thematic analysis is conducted from the following three perspectives: 1. Benefits and potential of common reed, 2. Problems related to common reed, and 3. Suggested solutions.

4.1 Findings of the interviews

When coding and segmenting the interview data there were clearly same common things mentioned, as the structure of common reed. Other things than the chemical structure there were highlighted other benefits related to its yearly renewal, since the forest renews itself in much slower timeframe.

“Common reed has the same plant fiber structure as wood, and the biomass yield is even higher than wood has.” (interview with Jerome Tornikoski, November 10th, 2023)

“The yield of common reed per hectare per year is 2-4 times better than the same figure in the forest.” (interview with Timo Suutarla, November 13th, 2023)

The versatile qualities of common reed were highlighted in each of the interviews.

“Common reed binds carbon efficiently. Common reed is a fast-growing, unpretentious biomaterial that clears the ground as it grows. It thrives in soil that can't be used in many other ways than for biomass production.” (interview with Sonja Jaari, November 16th, 2023)

Many of the interviewees highlighted specially the suitability of common reed biochar for voluntary compensation.

“Using common reed biochar as an emission compensation tool would be justified. The forest usually always gets the largest land space, but it would be reasonable to expand the carbon sinks to the blue carbon side, which would cover both algae, reeds, and wetland plants.” (interview with Jerome Tornikoski, November 10th, 2023)

“Common reed is a natural resource that both sequesters and releases carbon.” (interview with Jyrki Heino, November 16th, 2023)

“The fact that common reed biochar can act as a carbon sink and is an easily traceable and calculable unit whose production, sale, and sequestration can be fully traceable and certified it would be justified it to fit in the markets of voluntary offsetting.” (interview with Timo Suutarla, November 13th, 2023)

“Since common reed does not yet have a purpose on industrial scale, it would be the optimal tool in terms of compensation and would fulfil the additionality condition particularly well. And there is not a problem with double counting as with forest related projects.” (interview with Antti Laakso, November 13th, 2023)

One of the questions asked from the interviewees were if common reed biochar could be a tool for emission offsetting. All the interviewees replied “yes” to this question. But the doubt was whether the reed volumes are sufficient for the amount needed for the biochar production method and that it is commercially viable.

In addition to common reed suitability as biochar and potential tool for offsetting purposes there were several times mentioned the suitability of common reed for a wide range of uses, like as replacing peat.

“The demand for growing pads will increase enormously, there are already research results in Finland that from reeds can be made as competitive growing pads as from peat”. (interview with Kalervo Väänänen November 14th, 2023)

Other thing brought up during the interviews was the innovative perspective of common reed and the potential in exporting or being a material of the future.

“In the pilot project, Finland could be a leading forerunner by showing how it would be possible to improve the condition of the Baltic Sea by putting biochar back into the field. The vision for the year 2050 is that common reed is in beneficial use around the world.” (interview with Timo Suutarla, November 13th, 2023)

“In Finland, it would be important to ease the legislation so that common reed could be utilized. It would certainly also give rise to new technology; it would also be potential in the production of packaging material and e.g., as a growing pad as an alternative to peat.” (interview with Kalervo Väänänen November 14th, 2023)

“In 2050, common reed will be a raw material like everything else and can be used effectively, I believe. If compensation can be made to work, it has good potential.” (interview with Antti Laakso, November 13th, 2023)

Biodiversity was highlighted in each of the interviews.

“In addition to the removal of nutrients, it also has another benefit related to climate change: reducing methane emissions when they can be recovered.” (interview with Kalervo Väänänen November 14th, 2023)

“It is an organic material that grows without pesticides and is not dependent on irrigation. The nutrient is bound to the reeds, and by removing the reeds, the nutrients from runoff are removed from the Baltic Sea. Nutrient removal and protection of the shores are John Nurminen's perspectives, and a well-planned reed harvesting could also be a beneficial for the nature.” (interview with Sonja Jaari, November 16th, 2023)

With the data related to the qualities and versatileness of common reed the first theme of the data analysis is related to the possibilities and potential common reed has and the codes under this section will be presented at the following chapter Benefits and potential of common reed by themes.

The second theme discussed during the interviews were the problems related to common reed. The difficult permit policy was highlighted in several interviews.

“Issues related to permits and obtaining them are a big complication. In growing areas, harvesting of common reed requires the same permits as dredging. Permitting should be made much easier and the cutting of reed should be separated from dredging into a notifiable matter instead of the current cumbersome and lengthy permit process.” (interview with Timo Suutarla, November 13th, 2023)

“Permits from owners are needed. Ownership of a small area can consist of several cooperatives. Unorganized associations are not subject to the Community Land Law and do not have a meeting requirement, i.e., permission is needed from each member of the association to harvest reed. If there are several shareholders in a partnership, this is very cumbersome and time-consuming, and an external party must organize the meeting.” (interview with Jerome Tornikoski, November 10th, 2023)

Another often mentioned thing was the lack of technology.

“The underdevelopment of harvesting technology is a major obstacle, which also causes the underdevelopment of the whole logistics chain. In general, biorefinery technology in Finland is still in its infancy.” (interview with Timo Suutarla, November 13th, 2023)

The problem of paradigm also was highlighted in many of the interviews.

“The main problem has been the mindset; the focus has been only on forest exploitation and there is a strong forest mentality in Finland.” (interview with Sonja Jaari, November 16th, 2023)

“The mindset has not yet been realized; bold interdisciplinary thinking is needed.” (interview with Jyrki Heino, November 16th, 2023)

“The problem has also been unconsciousness, i.e., not understanding the chemical properties and potential of common reed. For example, the fraction can be used to separate

cellulose, hemicellulose, and lignin from each other." (interview with Timo Suutarla, November 13th, 2023)

At the interviews there were highlighted the price and logistics. Also, other issues were pointed out, like the importance and usefulness of vertical integration.

"Harvesting reed is expensive and a bit challenging both from land and sea, the location is logistically challenging, there is no infrastructure. There is no end-user and no one for whom common reed would be a profitable business. Now there are many small players on the field." (interview with Sonja Jaari, November 16th, 2023)

"It would be easier and more rational to have one coordinating body to manage the whole process, from harvesting to transporting and manufacturing of the final product." (interview with Jyrki Heino, November 16th, 2023)

The third widely discussed theme were the solutions how these problems related to reed could overcome.

"Under the current legal framework, associations could organize themselves and merge. Large water areas could be authorized a single chairperson. There could be an incentive for owners to do this, e.g., a small financial reward." (interview with Jerome Tornikoski, November 10th, 2023)

"Someone should identify a great benefit potential common reed has and create action opportunities for it. The harvesting of reeds should be changed to a free activity or else their managed utilization should be made possible. If the permit requirements are to be adhered to, the society could offer a formal reward to the owners of the area for the harvesting rights they give, and these rights could be further auctioned." (interview with Jyrki Heino, November 10th, 2023)

"If there was already a usable product, it would speed things up. An incentive or operator would be needed for which reed would be financially profitable and to coordinate the entire reed chain and drive the issue with determination." (interview with Sonja Jaari, November 16th, 2023)

Also, technological solutions for agile harvesting technology and seamless logistics were presented.

“Modern equipment and addition of machines are needed (as, for example, in advanced forestry and agricultural machines). Providing public support for prototype development and testing related to harvesting technology.” (interview with Jerome Tornikoski, November 10th, 2023)

During the next three chapters the data analysis will be presented under three themes. The Theme 1 will focus on the benefits and potential of common reed, Theme 2 focuses on the current problems related to reed and the Theme 3 presents the suggested solutions to the problems presented in Theme 2. Under each theme there are gathered subthemes that were conducted from the data of the things mentioned most. The data is presented and conducted solely on what emerged from the interviews and the author´s own preferences have no influence on them.

4.2 Theme 1 Benefits and potential of common reed

First, the benefits and potential of common reed will be presented in subthemes that were highlighted the most under this theme. The benefits and potential of common reed are compiled in Figure 3.

4.2.1 Advantages of common reed from voluntary offsetting and biochar perspective

Under this theme were pointed out the benefits common reed biochar has when compared to wood. Common reed does not compete for land use, like the forest and it renews itself every year, while forest renewal is very slow. Common reed has the same plant fiber structure as wood, and it has a higher biomass yield than wood. The stability of biochar is hundreds of years, depending on the purpose of use. Biochar from common reed can act as a carbon sink and is an easily traceable and calculable unit, therefor it would be justified it to fit in the markets of voluntary offsetting. A carbon offsetting perspective would also help with the difficult cost structure of reed.

The fact highlighted was that since common reed does not yet have a purpose on industrial scale, it would be the optimal tool in terms of compensation and would fulfil the additionality condition particularly well. Arguments in favor of common reed as a compensation tool is that the problem of double counting in Finnish forests is not concerning common reed. In theory common reed fulfills the criteria of a good offset in other aspects as well.

4.2.2 Innovation perspective

Under this theme were highlighted the innovative perspective in common reed and the untapped potential it has in technology. Finland could have the potential to act in the global common reed market as a pioneer making it even an export product, since common reed is a widespread alien species around the world. There is already a high level of know-how in the forest industry, and because of this background, there are also prerequisites for developing the same for common reed. It has potential being material of the future in replacing peat, wood, and even plastic.

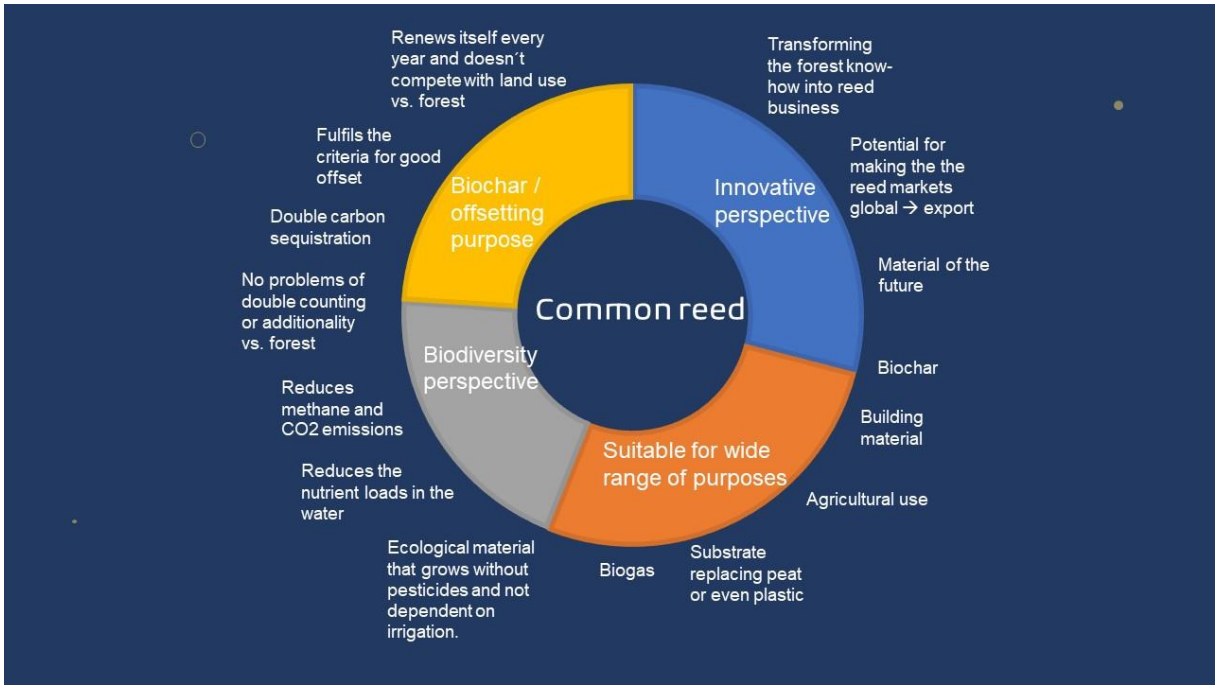
4.2.3 Biodiversity perspective

Each of the interviewees emphasized the biodiversity benefit that common reed removal brings. The annual removal of common reed would be one way to reduce the nutrient load in the water. In addition to the removal of nutrients, it also has another benefit related to climate change: reducing both CO_2 and methane emissions. Methane emissions generally come from the acidification of common reed. Now, monoculture prevails in areas that have been invaded by common reed, which is an obstacle to the success of underwater and above-water species.

4.2.4 Multifunctionality of common reed

Common reed can be used as a low value-added product such as replacing peat, biochar, for agriculture use, biofuel, and as growing pads. Common reed suits also for high value-added products such as textiles, packaging material to replace plastics, and as carbon fiber. It is a good material for construction too. The timing for cutting the reed should be chosen according to the purpose: green summer reed, is better suited for example as a soil improver for fields, while the brown winter reed is better suited for building material and for biochar. In addition, it is an organic material that grows without pesticides and is not dependent on irrigation.

Figure 3. Potential of common reed.



4.3 Theme 2 Problems related to common reed

This chapter focuses on the main problems and barriers for greater use of common reed that emerged from the interviews. Four biggest problems conducted to themes were bureaucracy, lack of technological development, lack of innovative thinking and problematic cost structure. These problems will be described more detailed below and are illustrated in Figure 4.

In addition to these themes presented, the interviewees highlighted the lack of an intermediate market as a problem. It would be easier and more rational to have one coordinating body to manage the whole process, from harvesting to transporting and manufacturing of the final product that could be achieved with vertical integration. In vertical integration a company is expanding by owning or controlling all stages of the production process, from the sourcing of raw materials to the final consumer of the product.

4.3.1 Bureaucracy

During the interviews there was repeatedly highlighted the main problem that has slowed down and hampered the exploitation of common reed and the business around it: licensing policy and its complexity. Harvesting or cutting the reed requires permits from both owners and shareholders of the area. Shareholders' associations include both organized and unorganized associations. Organized shareholders' associations can decide on a harvesting

permit at a meeting, but for unorganized associations, a permit is required from each individual member of the association and their contact details are difficult and time-consuming to find. Contacting each of them separately is taking a lot of time resources as well. The problem is not only landowners' permits, but also the permits required by the authorities for harvesting reed.

4.3.2 Lack of technological development

Technological underdevelopment emerged as the second biggest obstacle. Problems related to this theme include underdeveloped harvesting machinery, which also makes cutting technology slow. The lack of harvesting technology also causes the underdevelopment of the whole logistics chain. The interviews revealed that the technology already exists to process common reed into biochar, but the technology and logistics of the harvesting process itself should be put in place first.

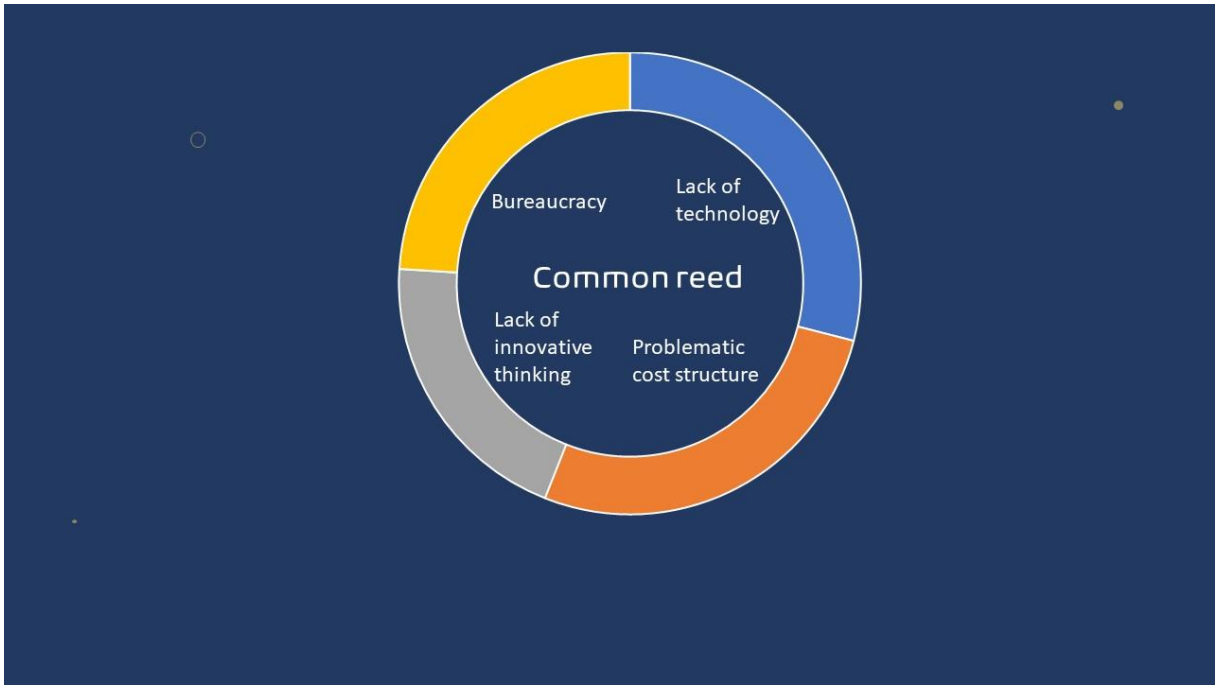
4.3.3 Lack of innovative thinking

The third major current obstacle identified was that the lack of innovative thinking; potential of common reed is not yet commonly realized, or it has been somehow forgotten as a multipurpose material. In Finland, there is a long-standing way of thinking that forests and peatlands have always come first. Common reed has not yet gained wider visibility. There may also be a lack of understanding of the chemical properties of common reed. Someone should generally recognize the high potential of common reed and create opportunities for actions. Bold interdisciplinary thinking is needed on this issue.

4.3.4 Problematic cost structure

The problematic cost structure associated with the common reed was the fourth theme mentioned by several interviewees. The processing chain for common reed is long and the necessary investments are expensive, and large volumes are yet missing. The harvesting areas are also currently too small due to the difficult licensing process. There is a lack of end-user for whom common reed would be a profitable business and who would create markets around the topic.

Figure 4. Problem statement: biggest barriers of common reed use.



4.4 Theme 3 Suggested solutions

This chapter will present the proposed solutions to problems of bureaucracy, lack of technological development, lack of innovative thinking, and problematic cost structure. The suggested solutions emerging from the interviews are presented in three themes: facilitating the authorization process and amending the regulatory framework, advances in technology and innovative thinking, and support for prototype development. Solutions will be explained more detailed under each theme. The suggested solutions are also presented in Figure 5.

4.4.1 Facilitating the authorization process and amending the regulatory framework

The following options were proposed to facilitate the current burdensome and lengthy authorization process and to change the regulatory basis:

Under the current legal framework, associations could organize themselves and merge. Large water areas could be authorized by a single chairperson. There could be an incentive for land or water area owners to do this, e.g., a small financial reward. For example, in fisheries management areas, there is a somewhat similar model where owners of the water area receive fisheries management fees.

Cutting common reed should be made a notifiable issue instead of the current difficult and long permitting process. A legislative initiative is currently going to the parliament of Finland to make the permitting process easier and more reasonable. The amendment would remove the biggest bottleneck with the common reed now.

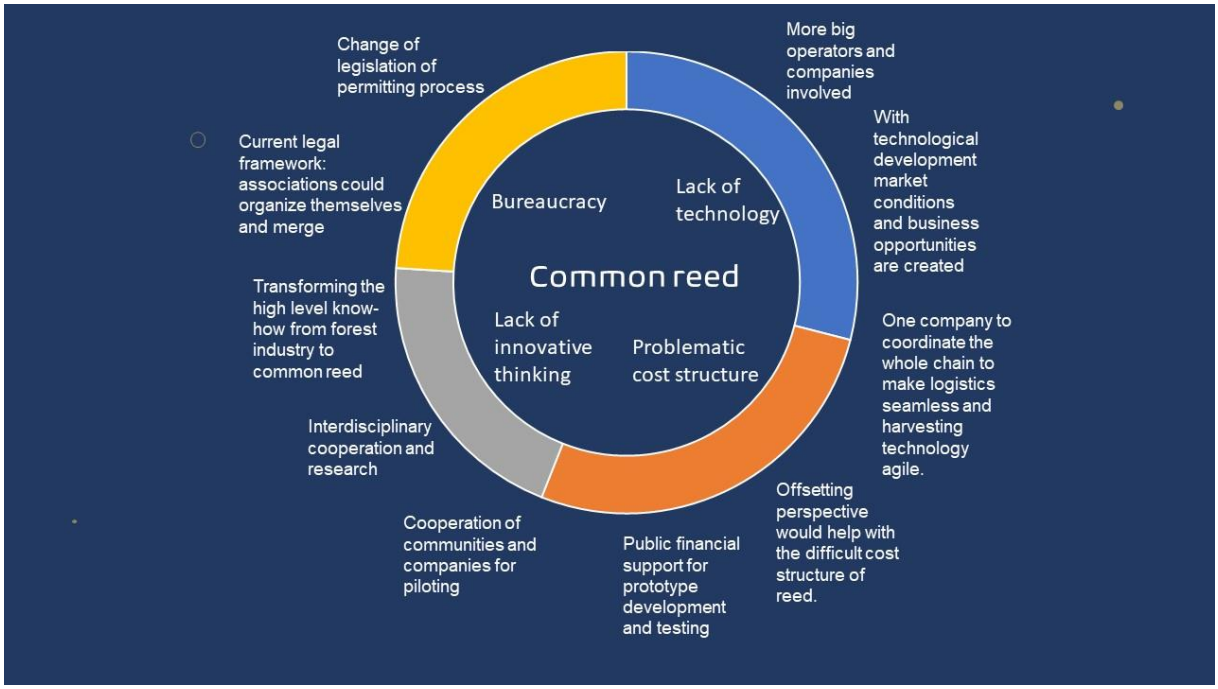
4.4.2 Advances in technology and innovative thinking

The technological development proceeding with innovative mindsets go hand in hand and therefore they were placed under the same theme. In the context of technological development, there is need for larger players in the field (corporations) rather than the current small ones. This would also provide larger potential for product development of common reed. As the technology increases, the capacity to harvest larger areas can increase too. This leads to a guarantee of annual biomass availability, what will also make the business more attractive. With the cooperation of municipalities and communities and companies, pilot projects on harvesting reed and transforming it into biochar in pyrolysis could be carried out in areas with high nutrient loads.

4.4.3 Financial support for prototype development

Public financial support for prototype development and testing for the cutting technology was suggested several times of which after market conditions would emerge. The forest industry has well-developed equipment and the same is needed for common reed projects. There is also a need for bigger operators from the private sector who would also have financial resources to invest in development work of the machinery.

Figure 5. Suggested solutions for the problems related to common reed.



4.5 Recommendations and discussions

This thesis was written based on the sources and recommendations available at this certain timeframe. It is important to remember that the whole field of voluntary emission offsetting is still under ongoing regulatory control and the recommendations are changing within time. Common reed markets are on their initial phase in Finland and still lack wider societal awareness and the number of publications available is limited.

Forest wood biochar is already included in emissions trading, but if common reed biochar can be included in offsetting markets, further research on its negative value would be needed and what kind of quality types of carbon can be produced. Due to the very limited research data of common reed as a biochar, it would be important that, the suitability of domestic reeds would be studied more in terms of biochar. Further studies would also be needed on how to include common biochar in emissions trading, but this aspect needs to be clarified by the intermediaries.

The research question of the thesis was approached first by examining the ethical recommendations for voluntary carbon offsetting and the market for offsetting in general. Biochar and its potential were also discussed in the theoretical framework. The research part focused on common reed and its suitability as a biochar, and interviews were conducted to explain its potential suitability as an offset tool and the things related to it. The study united

both voluntary emissions trading, biochar, and common reed to the extent that can be combined within the current framework.

As the wider exploitation of common reed is only at its beginning in Finland, the author of the thesis considered it is important to raise both these options: emission offset potential and the commercial/innovation potential even they cannot happen simultaneously. According to the criteria for a good offset, a company cannot have an economic benefit of common reed if it wants to use it as an offset.

An interesting fact that was not included in the research data appeared based on interviews and seminars related to common reed: neighbor countries Sweden and Estonia have already much larger utilization for common reed and there are value chains for it. The reason behind this was pondered to be at least due to both the complicated permit process for harvesting, and the fact that Finland has had traditional “forest-first” way of thinking. This difference between Finland and neighboring countries in the use of common reed would also be an interesting topic for further research.

According to the facts learned during the empirical part of the research, common reed has even better properties than wood and thus, in theory, it would be excellent as an emission compensation tool. When cutting reeds, both nutrients and methane are removed from the sea, and when used for emission compensation, it would bind carbon, which could be a double benefit from an environmental point of view. Compensation projects for negative emissions technology will probably increase in the future, and common reed would be a suitable alternative for this market.

As the study progressed during the data collection the commercial and innovative potential for common reed were clearly identified in the interviews. Common reed is suitable for a wide range of purposes, but the criterion of additionality in voluntary compensating requires that the activity is not otherwise economically viable or legally required. In other words, if profitable economic value chains were to develop around reed, its ethical value in terms of potential emission compensation would not be realized according to all good criteria. Using common reed both for commercial purposes and as biochar for compensation at the same time is not recommended considering the ethical guidelines on the criteria for good emission compensation. This matter can be considered as a significant finding in terms of this study.

5 Conclusion

To prevent a climate disaster, it would be vital that carbon neutrality is achieved as widely and quickly as possible. After a targeted emission reduction compensating greenhouse gas emissions by purchasing emission reduction units is a viable way to achieve carbon neutrality.

The topic and research question of this thesis was “Achieving carbon neutrality in maritime industry - investigating the possibility of complementing reductions by voluntary carbon offsetting with common reed”. This question was approached in the theoretical part of the thesis by first examining the ethical recommendations for voluntary carbon offsetting and the markets for offsetting in general. Biochar and its use in offsetting were also discussed in the theoretical framework. The research part focused on common reed and its suitability as a biochar, and interviews were conducted to explain its potential suitability for offsetting. The study combined both voluntary emissions trading, biochar, and common reed to the extent that can be combined within the current framework.

Referring to the theoretical framework of the study there clearly is evidence that companies´ environmental strategies strengthen their performance and attractiveness. Previous studies mentioned at the literature review enhance the claim that this thesis proposes: it is clearly beneficial for the company to reach their climate targets and carbon neutrality can bring a competitive advantage for the commissioner.

In voluntary offsetting there rises both the importance of transparency and use of high-quality carbon credits. All operations must be in line with the goals of global climate targets and remembering the hierarchy is highly important: buying carbon credits must be the last act after all CO_2 emission reduction has been put in implementation first. A good offset includes additionality, robust baseline, robust calculation method, monitoring and reporting, stability, avoidance of carbon leakage, authenticity, transparency and certifiability, avoidance of double counting, and avoidance of significant harm. Claims should always be truthful, clear, and verifiable.

As the study progressed no barriers were found, why common reed biochar could not be suitable for offsetting markets, in theory. For the information available now, it meets the good criteria for emission offsets, especially the additionality criterion. There clearly are arguments that it would be worthwhile to proceed with the matter.

Greenwashing remains to be a burning topic on the global media and offsetting has been seen as a one tool for it. There has been widespread media coverage of failed carbon offset projects in Africa and Asia that have done more harm than good to the region, as these kinds of distant projects are difficult to monitor. Regional perspective and offsetting happening in Finland would be important for the creation of carbon sinks that would make the use of common reed justified.

Common reed biochar as an emission compensation tool would not have the problem of double counting and additionality as in forestry projects. Supporting the development of negative emissions technologies by using them for compensation is worthwhile. At best these methods avoid a large part of the challenges and risks associated with other compensation projects, it would therefore be justifiable to look beyond the forest and move from land to sea also from an emission compensation perspective.

However, the practical problem is the need for large volumes for biochar production, and current estimates suggest that the volumes available now would not be sufficient for investing in pyrolysis plant. For biochar being utilized to its full potential, both additional research and a decrease in the costs of biochar production and an increase in the value of carbon sequestration would be needed, and calculations if there are enough reedbeds for the amounts needed for producing biochar in an effective way. There are technologies being developed to measure carbon, but there are not yet clear practices for verifying these technologies.

Common reed has also many possibilities other than biochar in offsetting. Therefore, the study also presents other types of commercial use for common reed, which were clearly identified in the interviews. Reed is versatile and from the innovation perspective its possibilities of replacing peat, plastic and wood use emerged from the interviews. Common reed fits to many purposes of use in different sectors in technology and it has clear potential for being the material of the future, since it is an organic material that grows without pesticides and is not dependent on water for irrigation. Common reed is also inexpensive to grow and does not compete with traditional agriculture for land use.

If reeds were to be used for purposes other than biochar, it would introduce the problem of additionality and thus not all the criteria of good compensation would be fulfilled from an ethical point of view. Using common reed both for commercial purposes and as biochar for compensation at the same time is not recommended considering the ethical guidelines on the criteria for good emission compensation.

When referring to the empirical part of this study same topics were risen to be issues, which have been slowing down the innovation concerning the use of common reed. Both the bureaucracy involved in permits of cutting the reed as well as the lack of innovation and technology involved in the cutting and logistical process, as well as the difficult cost structure were named to be the biggest bottlenecks.

Solutions for these bottlenecks have already been developed or are under development. Overcoming the obstacles related to common reed now needs financial resources both from public and private sector, as well as further research, advocacy, and innovation. With technological disruption and the fast developing and changing markets this can be possible soon.

By cutting common reed, nutrients are removed from sea and methane and CO_2 emissions reduced. Common reed biochar as an emission offset tool could serve a model example in offset markets as a project that considers both environmental and climate change aspects in a comprehensive way. Harvesting the reed prevents CO_2 emissions from natural processes and in carbon sequestration the biochar remains in the ground in a permanent way - this could be thought of as a reverse process to the use of fossil substances. Therefor biodiversity perspective can be considered very highlighting in the matter of common reed.

One of the questions asked from the interviewees were if common reed biochar could be a tool for emission offsetting. All the interviewees replied yes to this question. But the doubt was whether the reed volumes are sufficient for the amount needed for the biochar production method and that it is commercially viable. However, a conclusion can be drawn from this to the research question. Common reed biochar has great potential to act as an emission compensation tool and thus helps the company's goal of achieving complete carbon neutrality.

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Appendix 1. Thesis data management plan

THESIS DATA MANAGEMENT PLAN

1. Management and storage of research data

Data for the thesis “The benefits and way of achieving 100 % carbon neutrality for the case company in maritime transport – investigating the possibility for use of voluntary carbon offsetting with common reed” conducted by Anniina Urponen, were collected with the methods of in-depth interviews and semi-structured interviews that were recorded, and after transcribed into text form. Each of interviewees gave a consent for recording their interviews as well as storing the data in the computer/online data storage with limited access. Each person interviewed gave consents for presenting at the thesis with their own name.

The data is stored in an online database “Kuha” that is managed by the commissioning company Meriaura. The access to the research data is limited and protected, and only few members of the commissioning company and the author of this thesis have the access there.

2 Processing of personal data and sensitive data

No sensitive data was collected, and no personal contact details. The information gained from the interviews is not secretive as all the interviewed persons gave a consent to publish the data collected and use their names. Each of the interviewees were asked this at the beginning of the interviews. This thesis was not conducted with a survey, the data consisted of in-depth interviews and semi structured interviews with six different experts on the topic.

The data of the interviewed persons consists of their names, email addresses and their answers to the questions asked. It consists both of vocal and textual data and it will not be given to any third-party members. It is accessible only for the author of the thesis (interviewer) and some members of the commissioning company Meriaura.

3 Ownership of thesis data

The data is owned by the author of the thesis, but it has been agreed to be available also for the use of commissioning company Meriaura and only with very limited access.

4 Further use of thesis data after the work is completed

The author of the thesis will not want to utilize her research data or make it available for further use, except having it available for the commissioning company, if necessary. The author of the thesis stores the data in a secure manner for a period of one year from the date of approval of the thesis, so that the results of the thesis can be verified and deleted in a secure manner, if necessary.

Appendix 2. Interview questions

1. Why are you interested in common reed and what is your background in it?
2. What are the arguments in favor of using common reed in general? What about as a biochar/emission offsetting tool?
3. What has made it difficult for it not to work yet?
4. What could be done to make the process easier or faster?
5. How do you see things developing on a 5- or 10-year cycle and what is your vision for 2050 for the use of common reed?
6. Would there be possible ways/ideas to improve attractiveness of markets related to common reed?
7. Could common reed biochar be a tool for emission offsetting?
8. Would it be possible within a single company to offset its own, i.e., self-generated, carbon emissions? In other words, the whole chain from harvest/ collection of common reeds to offsetting itself would be coordinated by one and the same operator*?

* Question number 8 has been excluded from the data and analysis on purpose and was an additional question.