Biodiversity Management in the Wind Power Industry

Examining Regulations, Incentives, and Corporate Practices Influencing Swedish Wind Power Companies

Thesis for the degree of Master of Science in Engineering 2024

LUND UNIVERSITY

LTH

FACULTY OF ENGINEERING

Tove Svegborn

Supervisors: Jamil Khan & Moa Rosén

Examiner: Lars J.Nilsson

2024

This degree project for the degree of Master of Science in Engineering 2024 has been conducted at the Division of Environmental and Energy Systems Studies, Department of Technology and Society, Faculty of Engineering, Lund University.

Supervisor at the Division of Environmental and Energy Systems Studies was Professor Jamil Khan.

Supervisor at RWE Renewables Sweden AB was Moa Rosén.

Examiner at Lund University was Lars J. Nilsson.

Division of Environmental and Energy Systems Studies
Department of Technology and Society
Faculty of Engineering
Lund University

ISSN: 1102-3651
ISRN: LUTFD2/TFEM—24/5207–SE + (1-87)
Lund 2024

Abstract

The world is transitioning towards a renewable energy system to combat climate change and the wind power industry plays a key role in this shift. However, with the expansion of wind power concerns about its impact on local biodiversity have been raised. This thesis investigates the incentives, regulations, and challenges that are influencing biodiversity management in the wind power industry. Through a literature review, a biodiversity management survey, and a case study on a biodiversity pilot project, the thesis explores emerging opportunities for synergies between wind power expansion and biodiversity conservation and restoration. Key regulatory frameworks, such as the Convention on Biological Diversity and the EU Biodiversity Strategy, which are shaping biodiversity policies that are influencing the wind power industry are discussed. Furthermore, it examines the challenges faced by companies in implementing biodiversity enhancement projects, including time constraints, cost estimations, and regulatory uncertainties. By analysing these findings, this thesis presents information and recommendations for wind power companies to integrate biodiversity management into their operations to improve environmental sustainability and regulatory compliance.

Keywords: Biodiversity Management, Wind Power, Environmental Policy, Corporate Sustainability, Infrastructure Habitats, Nature Positive

Acknowledgements

This master's thesis is the final project of my degree in Environmental Engineering with a specialisation in Environmental Systems at Lund University.

Firstly, I would like to thank my supervisors Moa Rosén at RWE Renewables and Jamil Khan at the Division of Environmental and Energy Systems Studies at Lund University for guidance, support, and encouragement throughout the process. I am also thankful to my examiner Lars J. Nilsson for valuable insights and constructive feedback.

I want to thank Svensk Vindenergi for helping me share my survey about biodiversity management with Swedish wind power companies. In addition, I want to thank all the energy companies that took the time to answer the survey, and especially the representatives who participated in interviews.

I would like to thank the team at RWE for being very generous, sharing knowledge, welcoming me to their office in Malmö, and letting me participate in an ongoing biodiversity pilot project. Moreover, I want to thank the involved representatives from the companies being a part of the pilot project and external experts on biodiversity for participating in interviews. Their expertise and dedication have significantly contributed to the quality of this thesis.

Lastly, I would like to thank my friends and family for supporting me during my education making the last five years a great experience.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ACA - Additional Conservation Action

CBD - Convention on Biological Diversity

CLIMB - Changing Land Use Impact on Biodiversity

CSRD - Corporate Sustainability Reporting Directive

EIA - Environmental Impact Assessment

ESG - Environmental Social Governance

ESRS - European Sustainability Reporting Standards

GBF - Global Biodiversity Framework

IPBES - Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

IPCC - Intergovernmental Panel on Climate Change

IUCN - The International Union for Conservation of Nature

KPI - Key Performance Indicator

LCA - Life Cycle Assessment

PAI - Principal Adverse Impact

SFDR - Sustainable Finance Disclosure Regulation

SDG - Sustainable Development Goal

UNFCCC - United Nations Framework Convention on Climate Change

WWF - The World Wide Fund for Nature

Color coding information box

Information box color coding

- Presenting general information or definitions

Information box color coding

- Example of policy application specific for wind power industry

1 Introduction

In the World Economic Forum Global Risks Perception Survey 2022-2023 the top four risks ranked most severe, in the coming 10-year period, are all in the category *of Environmental*. The four long-term risks ranked most severe are:

1. *Failure to mitigate climate change*
2. *Failure of climate-change adaption*
3. *Natural disasters and extreme weather events*
4. *Biodiversity loss and ecosystem collapse*

(World Economic Forum, 2023)

These four risks all influence each other and climate change and nature loss are highly interlinked. Failure to mitigate climate change can accelerate the decline in biodiversity by changing living conditions and ecosystem structures. To combat climate change, transitioning from fossil fuels to renewable energy is a key step. With the rapid increase in renewable energy infrastructure, questions about the direct and indirect impact on nature have risen. The impact on nature differs depending on the type of energy production and can be related to the production site or the value chain. Examples of on-site impacts from wind power are changes in vegetation cover, noise and sound pollution, and impacts on migration patterns. Examples of impacts originating from the value chain are the extraction of minerals in areas with high ecological values or the transportation of construction materials (World Economic Forum, 2023).

Sweden is party to both the CBD (Convention on Biological Diversity) Kunming-Montreal Global Biodiversity Framework and the UNFCCC Paris Agreement on climate change. The Kunming-Montreal Global Biodiversity Framework contains several goals that aim to halt and reverse global biodiversity loss and the ambitious target to protect 30 % of the Earth's land and ocean area by 2030 (Naturvårdsverket, n.d.-a). The Paris Agreement's goal is to keep the global average temperature increase well below 2 degrees Celsius compared to pre-industrial levels which requires a major reduction in greenhouse gas emissions (UNFCCC, n.d.).

One of the Swedish goals in reaching the Paris Agreement is to reduce greenhouse gas emissions by achieving 100 % fossil-free electricity production by 2040. Scenario analysis from the Swedish Energy Agency estimates that there is a need for an additional 100 TWh from wind power whereas 80 of 100 TWh is estimated to come from onshore wind power. This corresponds to 70 % of the electricity demand in 2021 (Energimyndigheten, 2021).

The expansion of onshore wind power comes with concerns about the area footprint. The majority of land used for onshore wind power in Sweden is forestland with active forestry. With increased demand for renewable energy, the area of Swedish forestland used for wind power is expected to increase by 70 % until 2040. The area corresponds to 3,5 % of the total area used for forestry and is comparable to the area of protected forest in productive forestland. The majority of the land is owned by forest companies and it is possible to combine wood biomass production with wind power (Svensson et al., 2023).

With the increased focus on the need for biodiversity conservation and restoration of natural values, there is an increased interest in using the space between wind turbines for nature restoration or conservation measures, instead of forestry or agriculture, to have a positive effect on the local biodiversity. That said, there are still many uncertainties on how to perform restoration or conservation efforts in a wind farm and how to evaluate if the measures made an impact.

Furthermore, to mitigate climate change and halt and reverse biodiversity loss several new regulations and voluntary incentives are in development. In addition, the business case for companies adapting to new policies and engaging in becoming nature-positive is emphasised. Hence, investigating how biodiversity policy impacts wind power companies, which are playing a key part in the transition to a renewable energy system, is of interest.

1.1 Aim and Research Questions

The degree project investigates what part renewable energy companies play in halting and reversing global biodiversity loss, with a deep dive into the wind power industry. The expansion of electricity production from renewable sources, e.g. wind power, is necessary to mitigate climate change a direct driver of biodiversity loss but with this expansion, deterioration of local biodiversity values should be avoided. Therefore, it is of interest to further investigate possible measures for the wind power industry to minimise negative impact and engage in restoration and protection of biodiversity values.

Halting and reversing biodiversity loss includes both strategies to mitigate biodiversity impact and integrate measures to restore and enhance biodiversity. Hence difficulties and opportunities for the wind power industry to engage in biodiversity regeneration will be investigated on both company and project scale. Moreover, current practices, targets, incentives, barriers, and resources related to biodiversity, relevant to the Swedish wind power industry, will be examined.

The initial part of the report addresses biodiversity policies, incentives, and regulations relevant to the wind power industry at a higher level. The second part investigates the current level of biodiversity management and biodiversity-related opportunities and challenges for wind power companies. The last part will concentrate on project-specific biodiversity enhancement. The research questions are presented below

Research questions

1. What incentives and regulations influence biodiversity management in the wind power industry?
2. What opportunities and challenges do wind power companies encounter in biodiversity management?
3. What are the key factors to consider when planning a biodiversity enhancement project in an onshore wind farm?

1.2 Limitations

International biodiversity frameworks, regulations, and incentives relevant to the Swedish wind power industry are included to gain a general understanding of the current policy status. A general

description of the direct and indirect impact on biodiversity from wind power is included, but the assessment is not covered in detail. Moreover, some incentives and regulations covered are still under development. Wind power companies contributing with knowledge all have operations in Sweden but can also have operations outside Sweden. The main focus of the report is onshore wind power, but some companies answering the survey have both onshore and offshore wind power projects. Due to the restricted time, it is not possible to determine if the pilot project will have a local positive biodiversity impact. The project development process is observed to assess the responsibilities, opportunities, and challenges of the project. The interviews contribute qualitative perspectives on the pilot project from different stakeholders. Impacts on reindeer husbandry and social impacts are not included.

1.3 Disposition

Chapter 1: Introduction

The first chapter includes an introduction to the subject and describes why it is important. Then the aim of the degree project, research questions, limitations, and the disposition of the report are presented.

Chapter 2: Background

The second chapter covers fundamental information on biodiversity, drivers of biodiversity loss, the general impact of renewable energy on biodiversity, and research on onshore wind power's impact on biodiversity in Sweden.

Chapter 3: Method

The third chapter describes the methodology used in the degree project. The procedure of the literature review, survey, and case study is presented. Further details are found in the Appendix.

Chapter 4: Biodiversity policy influencing the wind power industry

Chapter four describes biodiversity policies, regulations, incentives, and frameworks relevant to the wind power industry. The chapter starts with overarching conventions and moves on to EU policy, national law and policy, market incentives, and guidelines on best practices.

Chapter 5: Biodiversity management in the wind power industry

The fifth chapter presents the results of the conducted survey on biodiversity management in the wind power industry. The chapter includes results from the online questionnaire and conducted interviews.

Chapter 6: Biodiversity enhancement project in a Swedish wind farm

The sixth chapter presents results from the case study performed on a biodiversity pilot project aiming to enhance biodiversity in a Swedish wind farm.

Chapter 7: Analysis and Discussion

In the seventh chapter, the results presented in chapters 4, 5, and 6 are analysed and discussed to answer the research questions of the degree project.

Chapter 8: Conclusion

The eighth chapter is a conclusion presenting the key findings of the degree project.

2 Background

This chapter covers the fundamentals of biodiversity, the drivers of biodiversity loss, the state of knowledge on the general biodiversity impact of renewable energy, and research on biodiversity impact from onshore wind power in Sweden.

2.1 What is biodiversity and why does it matter?

When searching for the term *biodiversity* in the IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) glossary the following definition appears:

"The variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic, and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities, and ecosystems."

(IPBES, n.d.)

The definition is complex and covers both the abundance and variation of species, ecosystems, and genetics. A slightly more simple explanation is presented by WFF which describes biodiversity as the variations of life existing in one area. The Biodiversity concept includes all types of species, e.g., plants, animals, and bacteria, and the ecosystems they form by interacting with each other. Human vitality depends on the functionality of functioning ecosystems providing us with fresh water, soil, food, and much more (WWF, n.d.).

Biodiversity is closely interlinked with the concepts of Ecosystem Services and Natural Capital which refers to the services ecosystems provide that are beneficial for humans respectively the stock of resources that are valuable for humans. Natural capital can be renewable or non-renewable e.g., timber respectively oil. Ecosystem services are categorised as provisioning, regulating, or cultural, an example of regulating is pollination (United Nations, n.d.). The World Economic Forum estimates that more than half of the world's GDP is dependent on ecosystem services and natural capital. Hence, biodiversity degradation and the collapse of ecosystems impose a high risk for companies with direct or indirect dependency on nature (World Economic Forum, 2020). Integrating biodiversity into development plans on national, sectoral, local, and project levels is crucial to fulfilling several of the UN Sustainable Development Goals (SDGs), specifically goals 14 and 15 (OECD, 2018).

SDG 14 & 15

14. *Conserve and sustainably use the oceans, seas, and marine resources for sustainable development*

15. *Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*

Source: (United Nations, 2023)

In the Global Sustainable Development Report 2023, the trend of progress on the indicators for goals 14 and 15 are all labeled *Limited or no progress* or *Deterioration* (United Nations, 2023). Rapid progress in nature conservation and restoration actions and transformation of business practice are crucial to breaking the trend. A schematic illustration of the connection between global processes, biodiversity, ecosystem service, and human well-being is presented in Figure 2.1.

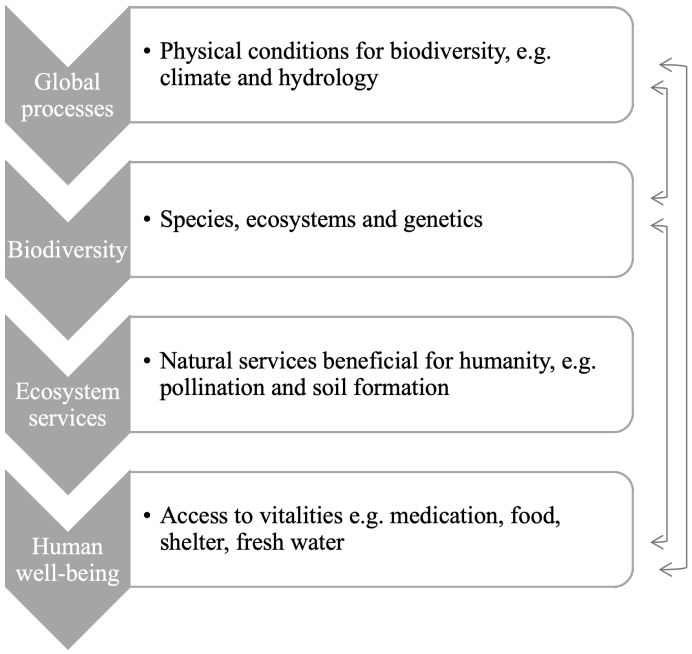

Figure 2.1: Schematic illustrations of the relationship between global processes, biodiversity, ecosystem services, and human well-being. Based on (Locke et al., 2021).

2.2 Drivers of Biodiversity Loss

In the global assessment report on Biodiversity and Ecosystem Services, IPBES estimates that 75% percent of the land on earth has been changed by human activity, 25 % of all species are threatened, and more than 1 million species risk extinction (IPBES, 2019). Moreover, WWF estimates a 70 % decline in the bird, fish, and mammal population size since 1970 (WWF Svergie, 2022). To combat the extensive degradation of nature and extinction of species the main drivers must be addressed.

According to IPBES, the main direct drivers of global biodiversity loss are changes in land and sea use, direct exploitation of nature and species, climate change, pollution, and invasive species. The impact of these drivers varies regionally and there are also indirect drivers impacting biodiversity, e.g., governance, conflicts, and economics. Land use change is the main driver of terrestrial biodiversity

loss with the conversion of natural areas to agriculture as an important factor. Direct exploitation of species, e.g., fishing is the main driver of negative impact on marine ecosystems but has also a large impact on terrestrial ecosystems from e.g., logging.

Climate change is causing changes in structures and conditions that are vital for species and ecosystems. Examples of changing conditions as a result of climate change are increasing mean temperature and causing sea level rise. The magnitude of climate change as a direct driver is expected to increase and have an amplifying effect on other direct drivers. (IPBES, 2019) Evaluations of current climate change mitigation policies and NDCs in the latest IPCC Climate Change Synthesis report note that the 1.5-degree target will likely be exceeded in the 21st century and that there is a risk of global warming of approximately 3.2 degrees by 2100 without a major strengthening of policy and reduction of greenhouse gases (IPCC, 2023). This can have an immense impact on biodiversity as studies estimate that the proportion of species that risk extinction due to climate change increases from 5 percent to 16 percent at a 2-degree respectively 4.3-degree warming (IPBES, 2019).

Additional direct drivers of biodiversity loss are pollution and invasive species. There are mixed trends regarding terrestrial and marine pollution with differences regionally. Globally there has been an increase in primarily plastic pollution. The risk of invasive species is continuously increasing globally as a result of human activities, both through intentional and unintentional introduction, e.g., transportation. The future negative impact of invasive species is hard to predict because of the connection to other drivers. Climate change and land use change can amplify the risk of increased spreading of invasive species (IPBES, 2023).

2.2.1 Human activities driving biodiversity loss in Sweden

According to the Swedish University of Agricultural Sciences, there are 2200 threatened species in Sweden and approximately 45 % of these species are dependent on natural forest habitats. Forestry and agriculture are the human activities that affect most red-listed species in Sweden. Intense forestry with clear-cutting, land preparation, and plantations has resulted in a loss of natural old-growth forest environments. Forest conservation measures and certifications have increased during the last 30 years but over 90 % of the harvesting is still performed with clear-cutting. The main negative impacts on the agricultural landscape come from the regrowth of pastures and the lack of variation in habitats. In marine environments overfishing, eutrophication and pollution have harmed ecosystems. The decrease in the natural freshwater environments is mainly caused by hydropower and the conversion of wetlands to forestry of agricultural land through ditching. Lastly, the increasing emissions of greenhouse gases globally will both pose a direct threat to ecosystems and amplify other drivers e.g., eutrophication. (WWF Svergie, 2022)

To combat the degradation of nature more land needs to be formally protected and degraded ecosystems should be restored. The Swedish Environmental Protection Agency states that the Swedish environmental quality goal to have *A rich plant and animal life* is far from reach with the current negative development. The Environmental Protection Agency recommends that the Swedish Government investigate the possibility of increasing economic incentives for the conservation and restoration of pastures and green infrastructure along roadsides, possible abolition of the reforestation requirement to enhance biodiversity in edge zones and forest verges, and regulation changes on water operations in the Swedish environmental law to facilitate restoration of drained land. (Naturvårdsverket, 2023e)

2.3 Renewable energy production and biodiversity

All types of infrastructure and energy production have an impact on biodiversity and surrounding nature. Looking at the bigger picture several steps in the value chain can cause negative impacts on nature for example sourcing materials, building roads, clearance of vegetation, emissions of greenhouse gases, and decommissioning of waste and materials. When comparing the impact on biodiversity from fossil fuels respectively renewable sources studies show that an energy system with renewable sources will be significantly less harmful to biodiversity. These studies are based on life cycle assessments of different energy sources with an evaluation of greenhouse gas emissions, pollution, ecotoxicity, freshwater impact, natural land transformation, etc. The studies include the impact of extraction of material, development, construction, transportation, and waste management. (WWF, The Biodiversity Consultancy, 2023).

An analysis made by Boston Consulting Group and WWF shows that a fast transition to a renewable energy system would be better than the current energy system, with fossil fuels (business as usual), in 27 of 30 sustainability metrics. The metrics were based on the categories mining, air quality, water quality, ecosystems and biodiversity, society and well-being, area footprint, water use, and free-flowing rivers. The only categories that possibly could be negatively affected by a rapid transition to a renewable energy system are the energy area footprint, water consumption, and free-flowing rivers. The impact on area footprint and water consumption is mainly due to the increased production of biofuels in the scenario analysis. The negative impact on free-flowing rivers is the result of possible expansion of hydropower. (WWF, BCG, 2023)

Although there would be significantly less impact on nature and biodiversity from a renewable energy system than business as usual it is important to address possible impacts and mitigation options. Transforming the energy system will demand an extensive development of renewable energy production sites. It is estimated that 90% of worldwide electricity has to come from renewable sources by 2050 to reach the Paris Agreement. Today the share of electricity from renewable sources is approximately 28 %. When comparing the environmental impact from different types of renewable sources bioenergy and hydropower have a larger impact than wind and solar power. The impact of bioenergy widely depends on the feedstock. The impacts are significantly higher if the bioenergy is produced from crops or wood compared to organic waste. (WWF, The Biodiversity Consultancy, 2023)

Although wind and solar power are have shown to be the preferred energy production to mitigate the impact on biodiversity there are geographical differences and local circumstances that should be considered. The main areas of concern when developing wind and solar power are the conversion of land, the impact on birds and bats, and the sourcing of metal and minerals. Offshore wind power can have an additional impact on iconic species during construction e.g.,, whales, dolphins, and fish.

Following the mitigation hierarchy and choosing a suitable location for wind and solar power is key to mitigating biodiversity impact. Production sites should be located on land that is already degraded or converted to avoid the conversion of natural areas. Moreover, a landscape perspective in the planning process can reduce the risk of fragmentation of natural value areas or landscape corridors. Studies come to different conclusions on the area footprint and loss of habitats that an energy system based on wind and solar would result in. The different results depend on different assumptions on co-production and location of sites. The footprint and habitat loss is less if the space between turbines and solar panels is used for ecological restoration, forestry, or agriculture. It is also possible to use degraded land used for fossil fuel production as future sites for renewable energy. (WWF, The Biodiversity Consultancy, 2023)

Additional impacts can emerge from the transition to a renewable energy system from the expansion of transmission lines and the development of storage facilities e.g., large-scale batteries and hydrogen

production sites. Hence, sustainable sourcing of metals and mineral mining and increased circularity are important areas of development. Transitioning to a renewable energy system will increase the demand for metals and minerals e.g., copper, lithium, cobalt, nickel, and aluminum. The demand for copper is estimated to increase by 40 % in the coming 20 years with increased wind and solar power development as one of the drivers. Copper is mined in countries that have large natural land areas with key biodiversity values e.g., The democratic republic of Congo, Chile, and China. It is important to ensure traceability in the supply chain to avoid harming natural value areas and conduct risk evaluations of mineral and metal sourcing. (WWF, The Biodiversity Consultancy, 2023) With this being said, estimations from WWF and BCG (2023) show that only 5 % of the metal production in 2050 would be used for renewable energy in the rapid transition scenario, and the land area used for mining would be 30 % less compared to the business as usual scenario. (WWF, BCG, 2023)

The main impacts of the expansion of transmission lines are fragmentation and risk for bird coalition. These risks can be mitigated through the burying of transmission lines and maintenance of surrounding nature. Green hydrogen production can cause habitat loss in site construction and impact ecosystems through freshwater demand. The main impact of large-scale battery production is the demand for metals and minerals, especially lithium, and the clearance of vegetation on site.

Still, the worst practice of wind and solar development is estimated to reduce biodiversity damage by 80-99 % compared to fossil fuel-based energy. (WWF, The Biodiversity Consultancy, 2023) Moreover, the loss of land because of climate change-induced coastal flooding, fires, and desertification in the business-as-usual scenario would cause a larger area footprint than the footprint from renewable energy in the rapid transition scenario. If the amount of bioenergy is decreased, the area footprint in the rapid transition scenario is even less. (WWF, BCG, 2023) There are still knowledge gaps and continuous knowledge sharing and research is needed to mitigate the impact on nature and biodiversity in the transformation to an energy system based on renewable energy.

2.3.1 Biodiversity impact from onshore wind power in Sweden

Generalised biodiversity impacts from onshore wind power that are highlighted by IUCN apply to Swedish conditions as well. As previously stated, the magnitude of the impacts depends on the localisation of the wind farm and local conditions. The main impacts in construction to be aware of are habitat loss and fragmentation through the clearance of vegetation, light and noise pollution, and the introduction of invasive alien species. During operation, the main impacts are bird and bat collations, change of routes for migratory birds, and barrier effects for terrestrial animals that avoid the site. (IUCN, 2021)

To further investigate the environmental impact of wind power the Swedish Environmental Protection Agency and Energy Agency have financed the research program *Vindval* from 2005 to 2023. The research studies are mainly executed in Sweden but have also compiled international results. The program includes, among others, studies on the wind power impact on mammals, the impact on birds and bats, the attraction of insects, and conflict and synergies in the integration of wind power in the Swedish landscape. (Naturvårdsverket, 2023f)

Mammals

Studies on the impact on Swedish mammals from wind power state that the limited amount of data makes it hard to come to generalised conclusions. With that said the largest impact on ungulates from wind power establishment is believed to be the increased human activity in previously isolated areas and the risk of increased hunting. Moreover, theories on the negative impact of noise pollution have not been confirmed. However, the impact of noise pollution is believed to depend on the previous conditions and the intensity and frequency of the noise. Larger ungulates can benefit from gaps in the

forest landscape which contributes to more pasture and forest edges. However, more knowledge on cumulative effects is needed to understand possible barrier effects on the landscape level. (Helldin et al., 2012)

Birds and Bats

Research on the impact on birds and bats from onshore wind power concludes that almost all types of birds are at risk for turbine collision while only a few bat species are subject to the risk. However, there is a larger risk on the population level for the bats that are hunting at high altitudes. (Rydell et al., 2017)

The birds that are at the highest risk of collision with onshore wind turbines are the ones living all year round in the area. The largest proportion of birds killed are small birds but larger birds seem to have a larger negative impact on population level. The negative impact of a wind farm is highly dependent on the localisation and different species avoid the site to varying extent. With the stated differences and uncertainties the estimated fatality is 5-10 birds per wind turbine and year. If individual turbines are considered the mortality increases with turbine size but if the bird mortality is compared to the energy output the mortality decreases with increased turbine size. This is because the larger turbines produce a larger amount of electricity, hence decreasing the number of turbines needed. It is hard to adjust the operation of wind turbines to avoid bird collision, hence protection zones are used to avoid locations close to threatened bird species. The Environmental Protection Agency suggests national planning of areas suitable for wind power as a complement to avoid cumulative effects and facilitate location choice for wind power companies. (Rydell et al., 2017)

Estimations show that the average bat mortality from collision with wind turbines is 5-15 per year and wind turbine but it varies largely between south and north Sweden with less collision in the north. There is a lack of data on bat population size, hence it is difficult to analyze the impact of these collisions. Studies indicate that some bat species actively seek wind turbines, unlike birds. However, it is possible to avoid bat collisions by turning off the turbine during high-risk conditions. It is difficult to conclude how often this is but estimates show that stopping the turbine for 10 nights per year could decrease the mortality by 60-90 %. To further understand the impact on bats national implementation of structured monitoring protocols is suggested by the Environmental Protection Agency. (Rydell et al., 2017) Studies indicate an increased abundance of insects around wind turbines which can attract more bats hunting for food. Hence, studies on how to attract fewer insects to wind turbines have been a part of *Vindval.* The study investigated the obstacle lights and the color of the turbines. The study showed that it was possible to attract fewer insects by decreasing the frequency of the flashing lights. However, this could cause less visibility for air traffic, which is a risk. (Victorsson et al., 2020)

Wind Power in the Swedish Landscape

Finally, a selection of conducted studies has been compiled in a report with recommendations for sustainable integration of onshore wind power in Sweden. The report concludes that the establishment of onshore wind power in Sweden is mainly located in environments that have been used by humans over a long period, e.g., forestry or agricultural land. Additional infrastructure can induce pressure on existing natural value areas but it is necessary to expand renewable energy production to mitigate climate change. The main location area for the future development of onshore wind power is forestry land. Wind power should be integrated as a part of multifunctional forest management. To ensure sustainable use of the forest areas with high natural values and old-growth forests should be protected, hence areas not suitable for exploitation should be mapped. Furthermore, examples of positive integration of wind power in the landscape should be highlighted to inspire sustainable practices. (Svensson et al., 2023)

3 Methodology

This chapter describes the methodology used to collect the information required for addressing the research questions. Initially, a literature review was performed to comprehend key concepts, current policies, and regulations related to biodiversity and wind power. Thereafter, a survey with complementary interviews was conducted to gain insights into the current practices, opportunities, and challenges in biodiversity management within the wind power industry. Lastly, a case study was conducted on a pilot project aiming to implement biodiversity enhancement measures in an onshore wind farm. The case study relied on the observation of project planning and interviews with stakeholders and experts on the subject. The design and procedure of the literature review, survey, and case study were based on guidelines from the book *Forskningsmetodik - För ingenjörer och andra problemlösare* (Säfsten and Gustavsson, 2019).

3.1 Literature review

To familiarise with key matters concerning biodiversity and wind power an initial literature search was performed. Biodiversity management is a rather new subject in the industry with several policies and guidelines in the development, hence both published scientific reports, government reports, and investigations and reports from NGOs were considered relevant. The initial searches were performed on Google, Google Scholar, and LUB Search. The search was performed in English and Swedish, see Table 3.1.

Table 3.1: Keywords for initial literature review

English keywords	Swedish keywords
Biodiversity policy	Biologisk mångfald och styrmedel
Wind power and environmental impact	Vindkraft och Miljöpåverkan
Conservation measures	Naturvård
Renewable energy and biodiversity	Förnybar energi och biologisk mångfald
The Mitigation Hierarchy	Hänsynshierarkin

From the initial search further relevant reports, research articles, websites, and laws were identified by using the snowball methodology. Titles, dates, and abstracts were analysed to evaluate it the source was relevant for answering the research questions in the degree project. From the initial literature search biodiversity policies, incentives, regulations, and guidelines relevant to wind power companies were further investigated to answer the first research question.

What incentives and regulations influence biodiversity management in the wind power industry?

Official webpages, legislative documents, and progress reports were mainly used for describing overarching policies and regulations on biodiversity originating from the UN, EU, and the Swedish government. Independent frameworks, guidelines on best practices, and market incentives were mainly

based on reports from NGOs and published scientific articles. Policies, regulations, incentives, and guidelines influencing the Swedish wind power industry were selected and analysed. Thereafter key objectives of the policy and content meaningful for the wind power industry were compiled.

3.2 Biodiversity Management Survey

The methodology chosen to investigate biodiversity management in the wind power industry was a descriptive survey. The survey was based on an online questionnaire and complementing interviews with representatives from wind power companies with operations in Sweden. The aim of the questions in the online questionnaire and the interviews was to address the following research question.

What opportunities and challenges do wind power companies encounter in biodiversity management?

To address this question the following themes were identified as relevant, see Box 3.2.

Themes for Biodiversity Management Survey

- The current level of biodiversity management and actions of the company
- Current or planned company biodiversity commitments and targets
- Current or planned use of biodiversity-related assessment tools and guidelines
- Evaluation of incentives for biodiversity engagement
- Evaluation of barriers to biodiversity engagement
- Evaluation of future incentives to increase biodiversity engagement
- Missing internal resources
- Missing external resources

From the identified themes an online questionnaire with a mix of close-ended and open-ended questions was made. The alternatives for the close-ended questions were based on the initial literature review. After all close-ended questions, it was possible to add an explanation or missing alternative in an open-ended question. The evaluation of incentives and barriers was designed as a Likert scale, see Box 3.2

Likert Scale Example Statement

Do you agree with the claim? Example statement:

- *Strongly Agree*
- *Agree*
- *Neither Agree nor Disagree*
- *Disagree*
- *Strongly Disagree*

The target audience for the online questionnaire was companies that develop or/and own wind farms

in Sweden. The online questionnaire was constructed in Microsoft Forms and distributed through e-mail in collaboration with the Swedish Industry Association for Wind Power, *Svensk Vindenergi*. The following advantages and disadvantages presented by Säfsten and Gustavsson (Säfsten and Gustavsson, 2019) were considered when choosing to conduct a survey:

Survey: Advantages and Disadvantages

- **Advantages:**
  - Effective data collection from a large number of companies
  - Possibility for companies to contribute with knowledge despite time constraints or geographic distance
  - Close-ended questions facilitate the compilation and analysis of data
- **Disadvantages:**
  - Non-response from uninterested companies or non-response on specific questions can result in misleading results
  - Difficulty in obtaining detailed information
  - Misunderstanding of questions or alternatives can result in misleading results.

Due to uncertainty on the expected response rate and level of detail in questionnaire answers, complementing interviews were scheduled with three energy companies with wind power operations in Sweden. These three companies all answered the online questionnaire and a semi-structured interview was conducted to obtain extensive answers to open-ended questions. The semi-structured interviews were based on the same themes as the online questionnaire but without close-ended questions. The interviews were performed via video call or face-to-face and notes were taken during the interview. Details on the questionnaire and the interviews can be found in section A.1 respectively A.2.

The online questionnaire was open for responses during November and December 2023. The online questionnaire was answered by 12 companies and out of these 12 companies additional interviews were conducted with three companies. After the online questionnaire was closed and all complementing interviews had been completed the responses were analysed. Relevant diagrams presenting results on close-ended questions were created with Microsoft Forms and answers from open-ended questions were analysed together with answers from the conducted interviews. Answers were thematically sorted according to themes in 3.2 and compiled into coherent sections. The sections chosen were: *Current policies and targets*, *Incentives and Barriers*, *Improvement areas and Resource gaps*.

3.3 Case Study: Biodiversity pilot project

Targets and policies to halt and reverse global biodiversity loss have been defined and published in international treaties and reports by NGOs but instructions on how companies can contribute by implementing voluntary measures to enhance biodiversity on production sites are few and generalised. Halting and reversing biodiversity loss requires mitigation, restoration, and additional measures. Mitigation and restoration are generally controlled by environmental law but enhancement or compensation measures are rarely enforced in Sweden. Hence, there is a need for more experience and knowledge on how this procedure should be performed.

Case studies are suitable for research on contemporary events in an undeveloped area of knowledge (Säfsten and Gustavsson, 2019). Hence, a case study on a biodiversity pilot project in a Swedish

wind farm was performed to address the second research question:

What are the key factors to consider when planning a biodiversity enhancement project in an onshore wind farm?

The pilot project is performed by RWE, referred to as the *Energy company* in the case study, in collaboration with a forest company and an energy investment company. The case study was based on direct passive observation of the project development and semi-structured interviews with stakeholders. The direct passive observation of the project development procedure consisted of access to internal background documents on the project site, passive participation in project development meetings with stakeholders, and a site visit. Enhancement measures were scheduled for implementation in October but due to delays and early winter, the implementation was postponed. Hence no measures had been implemented when the site visit took place.

The following advantages and disadvantages presented by Säfsten and Gustavsson (Säfsten and Gustavsson, 2019) were considered when choosing the method of passive observation:

Case study observation: Advantages and Disadvantages

- Advantages:
  - Access to a detailed understanding of ongoing complex projects
  - Insight into practical approach in a natural setting
- Disadvantages:
  - Depends on the observer's ability to identify and note key information in the present time
  - Difficulty in determining if results are applicable in other contexts

In the late stage of the project development, semi-structured interviews were conducted with all project stakeholders except the Energy investment company, see Table 3.2. The interviews aimed to complement the passive observation with thoughts from stakeholders and their different perspectives. The semi-structured interviews were based on questions aiming to understand opportunities and challenges in performing a biodiversity enhancement project. The questions are presented in section B.1.

Table 3.2: Stakeholders in biodiversity pilot project

Company	Roles
Energy company	Project developers (2), Site manager
Forest company	Landowner representative
Energy investment company	Investment company representative
Environmental consulting company	Biodiversity specialist

Observation of the project development took place from September to December and interviews with stakeholders were conducted from late November to late December. The interviews were performed face to face or by video call and notes were taken during the interviews. In January information obtained from the passive observation and interviews was analysed and compiled into coherent text in sections. The sections cover: background and aim of the project, roles and responsibilities of stakeholders, opportunities and challenges, and learnings and future undertakings.

Finally, semi-structured interviews were conducted with two experts working with nature-based solutions, restoration ecology, and measurements of biodiversity. The experts are not stakeholders in the pilot project. The interviews aimed to complement the stakeholder interviews by obtaining an objective perspective on key factors to consider when planning a project aiming to enhance biodiversity. The semi-structured interviews were based on questions presented in section B.2.

4 Biodiversity Policy Influencing the Wind Power Industry

In this chapter biodiversity regulations and incentives relevant for wind power companies with operations in Sweden are presented. The chapters start with the overarching international treaty on biodiversity, followed by policy for EU member states, national Swedish policy, and lastly voluntary market initiatives and guidelines on best practices. The overarching objective of the policies and specifics assessed as relevant for biodiversity management in the wind power industry are included in the descriptions.

4.1 The Convention on Biological Diversity (CBD)

In the 1980's the UN Environment Programme (UNEP) called for the need to initiate an international treaty with the aim of protecting biodiversity, and regulating fair distribution of natural resources and ecosystem services. After years of research and preparation, the Convention of Biological Diversity (CBD) was presented in Nairobi in 1992. The convention is part of the United Nations and has been ratified by all countries except the United States and The Vatican State. (Ebenhard, 2021)

The convention created the working definition of *Biological Diversity*, presented below, which is a common ground when integrating the concept into nations and sectors on different levels. The working definition includes species diversity, ecosystem diversity, and genetic diversity.

Definition

Biological diversity:

> *"Biological diversity is the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems."*

(The Convention on Biological Diversity, 2006)

CBD has created protocols for handling genetic resources, created a global environment fund, and is working to integrate knowledge from indigenous peoples with science. CBD is a framework convention which means that it is a legally binding treaty with broad regulations and objectives. Targets and actions are decided in detail at the recurring conference of the parties (COP) every two years. Furthermore, 10-year period strategies are decided on in the COP meetings. (Ebenhard, 2021)

The strategic plan 2011-2020 involved 20 biodiversity targets called the Aichi targets. The evaluation of the Aichi targets 2020 stated that none of the 20 targets were fully achieved. Six out of twenty were partially achieved, 13 showed no progress or moved away from the target and two targets were not possible to assess. The targets were perceived as ambitious but difficult to meet and the assessment showed that nationally implemented strategies during the period were not sufficient to be aligned with the CBD strategic plan. Although the targets were not fully met progress in economic valuation of biodiversity, increasing area of protected areas, and a decrease in deforestation and a

decrease in species extinction rate are identified as results of the measures taken. (Secretariat of the Convention on Biological Diversity, 2020) The strategic plans decided at the COPs are implemented on a national level by the Swedish Government. The proposition *En svensk strategi för biologisk mångfald och ekosystemtjänster* (Prop.2013/14:141) presented measures to achieve the Aichi targets and the Swedish environmental quality objectives. Suggested measures were for instance changes in the Swedish Environmental Law and the Forest Protection Act. The period for the Aichi targets has now expired and a new strategic 10-year plan has taken place called The Kunming-Montreal Global Biodiversity Framework or the Post-2020 Global Biodiversity Framework.

4.1.1 The Global Biodiversity Framework

The Kunming-Montreal Global Biodiversity Framework (GBF) was adopted at COP 15 in December 2022. As a result, a 2050 vision and 2030 mission to protect and restore biodiversity was agreed upon.

GBF 2050 Vision and 2030 Mission

2050 Vision:
The vision of the Kunming-Montreal Global Biodiversity Framework is a world of living in harmony with nature where by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people.

2030 Mission:
To take urgent action to halt and reverse biodiversity loss to put nature on a path to recovery for the benefit of people and planet by conserving and sustainably using biodiversity and by ensuring the fair and equitable sharing of benefits from the use of genetic resources, while providing the necessary means of implementation.

Source: (CBD Secreteriat, 2023)

To attain the 2050 vision and 2030 mission the framework contains four overarching goals for 2050 and 23 targets for 2030. The framework has been compared to the Paris Agreement because of the similar structure with ambitious goals and enhanced monitoring framework. The four goals include increasing the areas of natural ecosystems, sustainable use, and management of biodiversity, sharing benefits of genetic resources fairly with local and indigenous communities, and aligning financial, technical, and scientific resources with the 2050 vision for biodiversity. The 23 targets for 2030 include the ambition to protect 30 % of terrestrial, inland water, and marine environments and restore at least 30 % of degraded environments. Moreover, the role of non-governmental financing and the responsibilities of companies are included in the framework. Targets 15 and 19 aim to reduce negative biodiversity impact and promote positive impact from companies. (Convention on Biological Diveristy, 2022)

Target 15

Take legal, administrative or policy measures to encourage and enable business, and in particular to ensure that large and transnational companies and financial institutions:

(a) *Regularly monitor, assess, and transparently disclose their risks, dependencies and impacts on biodiversity, including with requirements for all large as well as transnational companies and financial institutions along their operations, supply and value chains, and portfolios;*

(b) *Provide information needed to consumers to promote sustainable consumption patterns;*

(c) *Report on compliance with access and benefit-sharing regulations and measures, as applicable;*

in order to progressively reduce negative impacts on biodiversity, increase positive impacts, reduce biodiversity-related risks to business and financial institutions, and promote actions to ensure sustainable patterns of production.

Source: (Convention on Biological Diveristy, 2022)

Target 19

Substantially and progressively increase the level of financial resources from all sources, in an effective, timely and easily accessible manner, including domestic, international, public and private resources, in accordance with Article 20 of the Convention, to implement national biodiversity strategies and action plans, by 2030 mobilizing at least 200 billion United States dollars per year, including by:

(a) *Increasing total biodiversity-related international financial resources from developed countries, including official development assistance, and from countries that voluntarily assume obligations of developed country Parties, to developing countries, in particular the least developed countries and small island developing States, as well as countries with economies in transition, to at least US$ 20 billion per year by 2025, and to at least US$ 30 billion per year by 2030;*

(b) *Significantly increasing domestic resource mobilization, facilitated by the preparation and implementation of national biodiversity finance plans or similar instruments according to national needs, priorities, and circumstances;*

(c) Leveraging private finance, promoting blended finance, implementing strategies for raising new and additional resources, and encouraging the private sector to invest in biodiversity, including through impact funds and other instruments;

(d) Stimulating innovative schemes such as payment for ecosystem services, green bonds, biodiversity offsets and credits, benefit-sharing mechanisms, with environmental and social safeguards;

(e) *Optimizing co-benefits and synergies of finance targeting the biodiversity and climate crises;*

(f) *Enhancing the role of collective actions, including by indigenous peoples and local communities, Mother Earth centric actions and non-market-based approaches including community-based natural resource management and civil society cooperation and solidarity aimed at the conservation of biodiversity;*

(g) *Enhancing the effectiveness, efficiency, and transparency of resource provision and use.*

Source: (Convention on Biological Diveristy, 2022)

Furthermore, a monitoring framework to review national strategies, targets, and implementations related to GBF was adopted at COP15. The monitoring framework consists of mandatory and voluntary indicators related to targets. In addition, national strategies for biodiversity have to be updated and enhanced to match the new framework. The national follow-up of the indicators should be reported in a standardised format that is reviewed in the coming COP meetings. (Naturvårdsverket, 2023d)

The Swedish Environmental Protection Agency published a proposal for a national strategy and action plan on CBD in November 2023 (Naturvårdsverket, 2023d). The suggested overarching goal aligned with GBF is that Sweden have halted and reversed biodiversity loss by 2030. To reach the target the Environmental Protection Agency has identified 21 fields of action within three categories. The fields of action include: The protection and restoration of land and water, sustainable practices within forestry, agriculture, and fishing. Integrating biodiversity impact into financial decisions and strategies. Increased incentives for all actors in society to engage in the conservation and enhancement of biodiversity. Along with that, the Sami people's rights and knowledge should be taken into account in decisions and actions related to biodiversity. (Naturvårdsverket, 2023d)

Assessment of the biodiversity status and results of implemented strategies will be reviewed on COP 17 (2027) and COP19 (2030). The assessments will be based on the national reports and scientific articles compiled by IPBES. (Naturvårdsverket, 2023d) IPBES, is an intergovernmental platform where research on biodiversity and ecosystem services is compiled and connected to policy. The IPBES working process is similar to the IPCC climate panel. IPBES conducts assessments on knowledge gaps identified by member states. The global biodiversity assessment reports are extensive and take two to four years to produce, undergo an open review, and the main conclusions are compiled in a summary for policymakers. (Stenseke, 2021)

Influence of CBD and GBF on Wind Power Companies

The CBD and GBF have a mandatory but indirect influence on wind power companies. The policies decided on in the COP meetings will affect the industry through the implementation of regulations on the EU and national levels. The 2030 mission of GBF emphasises the importance of halting and reversing biodiversity loss, making it a key sustainability topic for companies. Target 15 drives legislation on increased monitoring and assessment of biodiversity impact, and target 19 will increase financial resources targeted towards biodiversity, especially business activities finding synergies in climate change mitigation and biodiversity enhancement.

4.2 EU Biodiversity Policy

As a strategy to transition the European Union to a sustainable and competitive economy, the EU Green Deal was launched in 2020. The Green Deal is a selection of sustainability initiatives and environmental policies to reach climate neutrality in the EU by 2050. The Green Deal consists of several fields of action including The European Climate Law, an action plan for a circular economy, binding targets to increase renewable energy, and a strategy to protect and increase biodiversity (European Commission, n.d.-b).

The 8_{th} Environment Action Plan entered into force in May 2022 and is a legally adopted environmental policy that applies to EU countries until 2030. The policy is an instrument to deliver on international treaties and policies, e.g. the UN Sustainable Development Goals and The Global Biodiversity Framework. The targets in the action plan include greenhouse gas emission reduction by 55%, enhancing climate adaptation, increasing circular economy, aiming for zero pollution, protecting and restoring biodiversity, and reducing pressure on climate and nature from production and consumption (European Commission, n.d.-c).

As a part of the Green Deal, the European Commission has established a Biodiversity Strategy for 2030 (European Commission, Directorate-General for Environment, 2021). The strategy is based on the visions and targets from The Global Biodiversity Framework and the actions are divided into four categories. These four categories are protection of nature, restoration of nature, enabling transformative change, and supporting biodiversity globally. The main actions regarding the first two categories are increasing nature protection through extended Natura2000 areas, national nature reserves, and the Nature Restoration Law which is currently being reviewed. The strategy states that so-called win-win projects, that contribute with renewable energy and aim to increase biodiversity, will be prioritised. This could be offshore wind power that benefits local fish stock or onshore wind or solar power with vegetation beneficial for local biodiversity.

The main action to enable transformative change is the integration of biodiversity aspects into the financial system, unlocking sustainable investments, and, ensuring environmental and social sustain-

ability in business strategies. To support biodiversity globally EU will integrate biodiversity aspects into trade agreements, phase out subsidies harmful to biodiversity, and take the lead in international forums (European Commission, Directorate-General for Environment, 2021).

4.2.1 EU birds and habitats directives

Key parts of the EU's nature protection policy are the birds and habitats directives. The Birds Directive went into force in 1979 aiming to protect all wild birds and their habitats in the EU. The habitat directive was adopted in 1992 and aims to protect threatened species, both plants and animals, and rare habitats to ensure a lasting conservation status. The directives consist of two main parts, firstly to protect the species on the list of threatened species and secondly to select sites with habitats important to the species that need conservation or restoration (European Commission et al., 2015).

To ensure the protection of threatened species member countries are prohibited from capturing or killing the species in the wild, intentional disturbance, degradation or destruction of nesting or resting sites, and transport or sell species. The sites with key habitats that are selected for conservation or restoration together make the Natura2000 network. All Natura2000 sites have an individual management plan to accomplish the ecological objective of the area. It is prohibited to perform activities that can disturb or degrade species or habitats on the site. While some Natura2000 sites have a strict protection status the general intention is not to exclude socio-economic activities from the areas but to ensure sustainable management of the surrounding nature and dialog with local stakeholders.

Development in or near a Natura2000 site requires additional assessments to ensure that the conservation objectives are not harmed. The national authorities make the decision and have the right to approve the project if there is an overriding public interest. In this case, compensation measures can be imposed. Member states monitor the status of the species and habitats and report to the EU every sixth year for review (European Commission et al., 2015).

4.2.2 EU Sustainable finance framework

To meet the objectives of the Green Deal the European Commission has launched a selection of measures to increase financial investments, from private and public actors, in sustainable business activities. The aim is to increase the transparency and credibility of companies' sustainability ratings by creating common reporting and classification standards (Directorate-General for Financial Stability, Financial Services and Capital Markets Union, 2023). Important tools and standards adopted are the EU taxonomy, the Corporate Sustainability Reporting Directive (CSRD), and the regulation on sustainability-related disclosures in the financial services sector (SFDR). The EU taxonomy is a classification tool that states if an economic activity is sustainable. The classification system is intended to reduce the risk of greenwashing and facilitate investments in sustainable business activities. The taxonomy is used in the reporting of CSRD and SFDR. The CSRD regulates the quality and scope of companies' sustainability reporting and SFDR requires financial advisors and financial market participators to disclose funds level of sustainability based on data from CSRD (European Commission, n.d.-d). The latest addition to the sustainable finance framework is the Regulation on European Green Bonds which was adopted in October 2023. The European Green Bond Standard is a voluntary tool that will align bonds with the EU taxonomy to increase the credibility of bonds marketed as sustainable (Council of the EU, 2023). The new regulations require lots of data which can be challenging for companies initially but will also contribute to opportunities for companies with sustainable business activities.

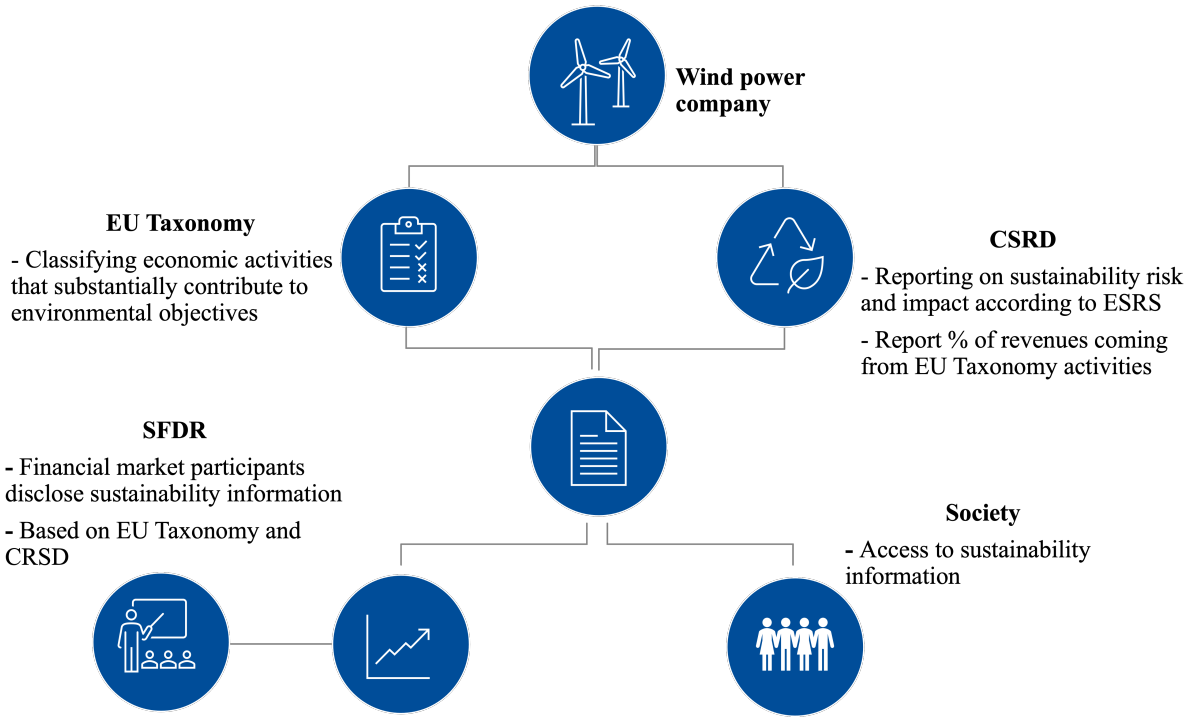

Figure 4.1: Schematic example of a wind power company and policy instruments in EU sustainable finance framework. Based on (European Commission, n.d.-d).

EU Taxonomy on Biodiversity and Ecosystems

The EU taxonomy is an important part of the sustainable finance framework as it serves as a common foundation for other corporate sustainability reporting standards in the EU. The taxonomy classifies business activities and not whole companies to create opportunities for companies to gradually transition. Activities in sectors not yet covered by the taxonomy are not by default unsustainable but have not been prioritised. (European Comission, 2023) The taxonomy covers six key environmental categories presented in the Box below.

EU Taxonomy Information

The taxonomy covers six key environmental categories:

- *Climate change mitigation*
- *Climate change adaption*
- *Sustainable protection of water and marine sources*
- *Transition to a circular economy*
- *Pollution prevention and control*
- *Protection and restoration of biodiversity and ecosystem services*

To qualify as a sustainable activity according to the taxonomy the activity must substantially contribute to at least one of the mentioned categories, not have any damaging impact on any of the other categories, and be socially just.

Source: (European Comission, 2023)

Not having a damaging impact is referred to as DNSH (Do no significant harm) and being socially just is regulated by minimun safeguards. Each category is covered in a delegated act where technical screening criteria describe under which conditions the activity qualifies as a substantial contribution

and DNSH (European Comission, 2023). Although biodiversity is indirectly affected by all six categories there are two situations where companies have to consider a direct impact on biodiversity and ecosystems in the taxonomy. The first case is to ensure that your business activity does not do any significant harm to biodiversity according to DNSH. The second case is when your business activity substantially contributes to supporting biodiversity and ecosystems (Schrems and Bär, 2021).

The generation of electricity from wind power is classified as a substantial contribution in the Climate Change and Mitigation Act (European Commission, Directorate-General for Financial Stability, Financial Services and Capital Markets Union, 2021). However, the activity must comply with the DNSH criteria for biodiversity and ecosystems. For wind power electricity generation criteria include a completed environmental impacts assessment, appropriate mitigation and compensation measures, and additional assessment for sites located in or near key biodiversity areas, e.g. Natura2000. If the wind power site is located offshore there are additional requirements regarding marine environments and the seabed.

If the business activity substantially contributes to the protection or restoration of biodiversity and ecosystems the criteria are covered in the Environmental Delegated Act (European Commission, Directorate-General for Financial Stability, Financial Services and Capital Markets Union, 2023). Environmental protection and restoration activities include *in situ* conservation or restoration of species, habitats, or ecosystems to a satisfactory level.

The conservation or restoration activity can be performed by any operator but the management plan must be approved by a qualified third-party environmental authority. The management plan requires detailed descriptions of current site conditions, the aim of performing the measures in a particular site, which species or ecosystems will benefit from the measures, a time plan, and a discussion on possible social conflicts. In addition and monitoring scheme with relevant indicators is required. The duration of the measure must be confirmed by official protected status or public or private arrangement where the site owner and operator guarantee the measures' permanency. Moreover, offsetting is not classified as a sustainable activity, only ecological net gain.

DNSH criteria that should be considered are the possible introduction of alien species, use of pesticides, and change of land with high carbon stock. Altering land with continuous forest cover or wetlands could result in significant harm to climate change mitigation and adaptation. (European Commission, Directorate-General for Financial Stability, Financial Services and Capital Markets Union, 2021)

CSRD and ESRS on Biodiversity and Ecosystems

The Corporate Sustainability Reporting Directive (CSRD) replaced the non-financial Reporting Directive (NFRD) in January 2023 intending to make companies' sustainability performance accessible and comparable for society. The amount of companies mandated to report has been quintupled and common reporting standards called the European sustainability reporting standards (ESRS) have been applied. The reporting requirements build on international policy, e.g. GBF, and are connected to the EU biodiversity strategy and EU taxonomy. (European Commission, n.d.-a).

The scope of the reporting is based on a double materiality assessment determining key sustainability issues relevant to the company. EFRAG has established 12 ESRS categories covering environmental and social sustainability. ESRS 1 describes general requirements and ESRS 2 covers disclosures mandatory for all companies required to do CSRD reporting. There are five environmental categories with additional requirements depending on the result of the double materiality assessment, climate(E1), pollution(E2), water and marine resources(E3), biodiversity and ecosystems(E4), and

resource use and circular economy(E5) (European Commission, 2023).

This means that the scope of the reporting on ESRS E4 - Biodiversity and Ecosystems will vary depending on the business activities of a company. However, reporting requirements on biodiversity included in ESRS 2 apply to all companies. *A transition plan for biodiversity* (E4-1) is included in ESRS 2 and energy production and utilities are named as one of the prioritised sectors by TNFD. This means that all companies with energy production must describe how they will integrate a transition plan for biodiversity into their business strategy, and how business development is connected to the transition plan. The transition plan should include how the company impacts drivers of biodiversity loss and possible mitigation measures. In addition actions and measures related to the mitigation hierarchy should be described and metrics and tools to monitor the outcome presented. Additional requirements in ESRS 2 are an assessment of possible business impact from biodiversity and ecosystem-related risks (SBM-3) and a description of the methodology used to assess impact, risks, and opportunities related to biodiversity and ecosystems (IRO-1). (EFRAG, 2023)

Additional parts of ESRS E4 are reported depending on the double materiality impact and include policies, actions and resources, targets, impact metrics, and financial effects related to biodiversity and ecosystems. Explanations on how policies and targets align with the mitigation hierarchy and international policies, e.g. GBF, are required. Descriptions of actions should include method, scope, geography, metrics, and monitoring plans. Furthermore, a description of metrics used to track targets and an assessment of the potential financial loss from identified risks and opportunities should be included. (EFRAG, 2023)

SFDR on Biodiversity and Ecosystems

The SFDR technical standard applies from January 2023 and requires market participants and financial advisers to inform investors about products and firms' sustainability performance. SFDR does not mandate investors to choose green funds but regulates the disclosure requirements from market participants to facilitate sustainable choices. Moreover, funds can be classified depending on their level of sustainability as dark green, light green, or grey. Sustainability is the main objective of dark green funds while light green funds contribute to environmental or social objectives as a sub-goal. Grey funds have no sustainability objective. The EU taxonomy is a tool used to assess the business activities in the funds. (European Commission, n.d.-e)

The SFDR contains mandatory and voluntary indicators for Principal Adverse Impact (PAIs) to increase transparency on investments with significant sustainability risks. There is one mandatory PAI covering activities that negatively affect key biodiversity areas.

SFDR: Biodiversity PAI and Metric

PAI: *Activities negatively affecting biodiversity-sensitive areas (e.g., Natura2000 or Unesco World Heritage).*

Metric: *Share of investments in investee companies with sites/operations located in or near to biodiversity-sensitive areas where activities of those companies negatively affect those areas.*

Source: (European Commission, 2022)

However, activities which are following EU and national regulations on EIA are not characterised as "*..activities negatively affecting biodiversity*". Additional voluntary PAIs related to biodiversity

are investments in companies that lack biodiversity protection policies and companies with business activities causing land degradation or desertification. (European Commission, 2022) Examples of how the presented EU policies can influence wind power companies are presented below.

Influence of EU Policy on wind power companies

EU Birds and Habitat Directives
Direct Mandatory
EU Birds and Habitat and the Natura2000 network directives regulate where wind farms can be built, putting pressure on wind power companies to avoid harming conservation areas. This requires extensive assessment and awareness of biodiversity impact.

EU Taxonomy
Direct Mandatory (Voluntary for companies not obligated to report to CSRD)
For wind power companies to substantially contribute to the environmental objective of climate change mitigation, they must prove that no significant harm has been done to biodiversity and ecosystem services.

CSRD and ESRS
Direct Mandatory
Wind power companies within the scope of CSRD must, at a minimum, publish a Transition Plan on Biodiversity and Ecosystems and show the integration of the transition plan into the company strategy and business model.

SFDR
Indirect Mandatory/Voluntary
Financial advisors must report to investors if wind power companies have business activities that negatively affect key biodiversity sites without eligible mitigation measures and permits. Additional indicators that financial advisors can choose to report on are whether the wind power company does not have a biodiversity protection policy or has operations that affect threatened species.

4.3 Swedish Environmental Law and Biodiversity

Protecting biodiversity to secure a sustainable environment for future generations is one of the main objectives of the Swedish Environmental Code (SFS 1998:808). Policies from international treaties and EU directives are implemented in the Environmental Code to obtain objectives set to protect and restore biodiversity. Biodiversity is covered in other Swedish laws, e.g. the Hunting Act, the Fishing Act, and the Forestry Act, but the Environmental Code covers the main instruments to protect biodiversity. The Environmental Code regulates nature reserves, the species protection regulation, and the implementation of the birds and habitats directives. The Environmental Code covers extensive protection for threatened species and habitats but has been criticised for lack of regulation on non-linear and cumulative impact on biodiversity, e.g. climate change. Moreover, nature lacks its own rights and must be identified as worthy of protection depending on the situation. (Christiernsson, 2021)

One of the regulations in the Environmental Code that highly affects wind power companies is Chapter 6 on Environmental Assessments. The objective of environmental assessments is to understand the possible environmental impact of the construction to avoid damage and ensure a sustainable future (SFS 1998:808, 1998).

4.3.1 Biodiversity in Environmental Impact Assessments

When a development project is classified as an environmentally hazardous activity according to the Environmental code, a specific environmental assessment is required before applying for a permit. The process starts with a consultation phase where the suitability of the chosen area is investigated by the operator, thereafter the plan is discussed with the county board, municipality, and local population. After consultation and possible modifications, a detailed environmental impact assessment is conducted as a part of the permit process. The main goal of the environmental impact assessment (EIA) is to identify possible environmental impacts from the development and present mitigation measures to avoid negative impacts. (Naturvårdsverket, 2022) The assessment is based on regulations in Chapter 6 of the Environmental Code where the second point in Paragraph 2 specifically touches on biodiversity (SFS 1998:808, 1998).

Swedish Environmental Code: Sixth chapter, second paragraph

In this chapter, environmental effects mean direct or indirect effects that are positive or negative, that are temporary or permanent, that are cumulative or not cumulative, and that occur in the short, medium, or long term on:

.. 2. animal or plant species that are protected according to Chapter 8, and biological diversity in general.

Source: (SFS 1998:808)

The chapter is based on the EU directive on Environmental Impact Assessments and is connected to regulations on the Birds and Habitat Directives (Naturvårdsverket, 2023b). The term biological diversity in the sixth chapter and second paragraph includes species, ecosystems, and genetic diversity, however, explicitly protected species require special attention in the EIA. Ideally, the chosen site should not impact any protected species, and if it does measures to mitigate impact are required. The EIA shall explain if any of the regulations in The Species Protection Regulation concern the site, how the site was chosen to avoid impact on protected species, and if the site development requires any type of exemption. It is crucial to investigate the site early in the project process as some protected species prohibit activities in the area (Naturvårdsverket, 2023a).

The inventory of natural values, species, and ecosystems is evaluated according to a Swedish standard. The standard is called *Biodiversity assessment – Survey and mapping of habitats and species – Requirements and guidelines* and was updated in 2023 (Svenska Institutet för Standarder, 2023). The inventory is based on geographical mapping of habitats, species, and areas that are valuable for biodiversity. Different levels of detail are required depending on the aim of the inventory, e.g. preliminary study, natural value inventory, or in-depth inventory. The performer will classify areas in the project site based on their importance for biodiversity. The updated standard consists of 7 classes where number 1 has the highest value and 7 is the lowest, with mapping of areas with classifications 5-7 as voluntary, see Table 4.1. The requirements for assessments of impacts on ecosystem services and cumulative impact in the landscape are not as detailed but are covered by Chapter 6 and requirements on landscape planning at national and regional levels are increasing (Naturvårdsverket, 2023b).

Table 4.1: Natural value classification in Swedish standard biodiversity assessment, based on 199000:2023 (Svenska Institutet för Standarder, 2023).

Classification	Description
1	Great importance for biological diversity. Area with natural ecosystems, threatened and red-listed species.
2	Natural ecosystems with good habitats for nature conservation and some red-listed and threatened species.
3	Habitats for conservation species.
4	Some conservation species and natural values important for green infrastructure.
5	Common species and has neither negative nor positive impact.
6	Lacks significance for biodiversity, influenced by humans.
7	Negative impact on biodiversity, e.g. hard surfaces.

4.3.2 Legal challenges for sustainable wind power development in Sweden

The pace and size of wind power development have a big impact on the mitigation of greenhouse gas emissions from the Swedish energy system. Since climate change is a direct driver of biodiversity loss the transition to a renewable energy system is an important factor as well as the protection of local species. The aggregated development time from start to finish is estimated to take between 10-12 years for an onshore wind farm in Sweden. Moreover, 31 % of the onshore wind power projects that applied for permits from 2014 to 2022 were rejected. The main reason for rejection was that the municipality stopped it (47%), but 21% were stopped due to conflicts of interest with species and habitat protection. The wind power industry has criticised the long lead times and experienced a negative trend in the share of granted projects despite increased demand for renewable energy. (Svenskt Näringsliv, 2023)

The Environmental Protection Agency and the Energy Agency have analysed legal requirements that affect the permit processes to meet industry demands. The industry has been asking for less stringent application of the species and habitat directive, more benefits for businesses that reduce climate impact, and increased possibility for permits with ecological compensation (Energimyndigheten, Naturvårdsverket, 2021).

The Swedish implementation of the birds and habitats directives has been considered to be more stringent compared to other countries, according to developers in the industry. The industry claims that the focus in Sweden is on an individual level and not the population level of the species (Energimyndigheten, Naturvårdsverket, 2021). Swedish court practice takes into account the impact on the population at both national and local levels. As examples the agencies present cases where wind farms are approved even though it exists bats in the area with the analysis that it will not affect the local population. Furthermore, there are cases where single turbines have been rejected from a project to increase flight paths for local and migratory birds but the wind farm still obtained a permit for remaining turbines (Energimyndigheten, Naturvårdsverket, 2021). According to the analysis of the agencies, the approach is similar in many other EU countries and not wrongly interpreted. Although, The Netherlands has made it possible for renewable energy projects to get exemptions more easily. The agencies concluded that it would be hard to give exemptions based on climate mitigation impact because of the difficulty quantifying the difference it would make. (Energimyndigheten, Naturvårdsverket, 2021) However, in December 2022 the EU regulation To Accelerate the Deployment of Renewable Energy was adopted and became directly applicable in all member states. The regulation is valid between 30th December 2022 and 30th June 2024. The regulation states that renewable energy is a public interest that can receive an exemption from regulation on species protection and Natura2000 (Naturvårdsverket, n.d.-b).

Furthermore, the industry has presented to possibility of using ecological compensation in the permit process with the argument that there could be a positive net effect on biodiversity if more wind power is built together with additional conservation or restoration measures for biodiversity (Energimyndigheten, Naturvårdsverket, 2021). It is possible to impose ecological compensation by Swedish law in special cases, e.g. development in Natura2000 sites. However, in Swedish court practice ecological compensation is evaluated after the decision on whether the project should be granted has been made. This means that ecological compensation can be used to mitigate the impact of a project that is deemed to have the right to be built but not as a tool to increase the possibility of obtaining a permit. The contemporary Swedish regulations lack support for ecological compensation aiming to facilitate permits in such a way(Energimyndigheten, Naturvårdsverket, 2021). But since it is used more frequently in other European countries it may change in the future. With that said, the EU strategy for no net loss in biodiversity also states that compensation is a last resort in the mitigation hierarchy (Energimyndigheten, Naturvårdsverket, 2021).

Influence of Swedish Environmental Law on wind power companies

Wind farms (multiple turbines over 50 meters), are classified as an environmentally hazardous activity according to the Environmental Code. This means that wind power companies must conduct an EIA where they show that the site location is well chosen with consideration for protected species and habitats to obtain a permit.

4.4 The Mitigation Hierarchy

The Mitigation Hierarchy is a guiding framework on which approaches and actions should be considered to have a minimal negative impact on biodiversity. The framework is not legislative and does not come with indicators but it serves as a foundation for many policies, national regulations, and reporting frameworks, e.g. EU Biodiversity Strategy, CSRD, and EIAs. Following the mitigation hierarchy in project development could help the developer avoid physical, financial, and reputation risks related to biodiversity and ecosystems (Ekstrom et al., 2015). The Mitigation Hierarchy consists of four steps including: *Avoidance*, *Minimisation*, *Restoration*, and *Offsetting*, see Figure 4.2.

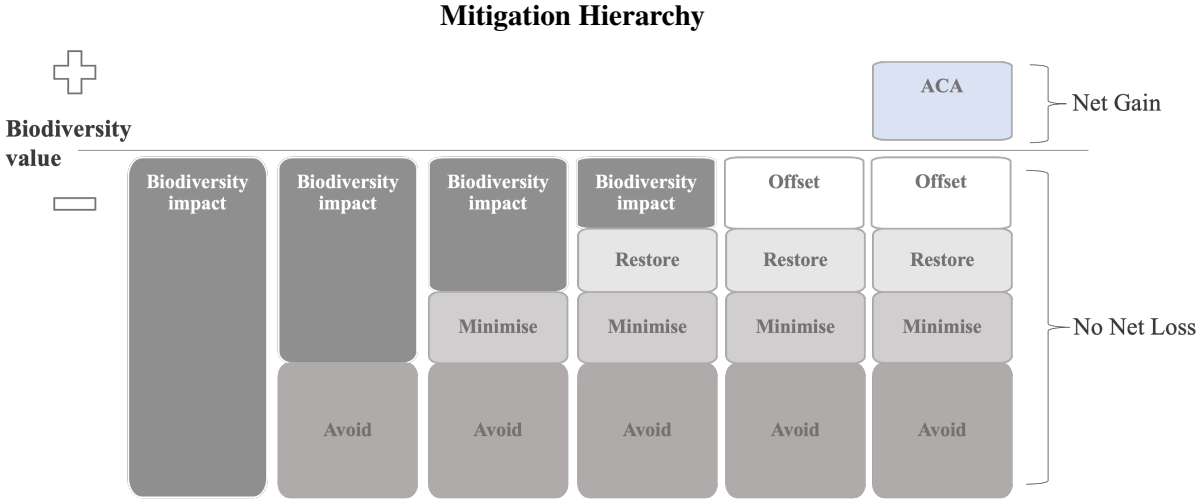

Figure 4.2: Schematic illustration of the Mitigation Hierarchy, NNL and NG. Based on (Ten Kate et al., 2018) and (Ekstrom et al., 2015).

Avoidance and minimisation measures are categorised as preventative while restoration and offsetting are remediative. The most important step of the Mitigation Hierarchy is to avoid harming biodiversity and ecosystems. Avoiding negative impact is often the most effective measure in both ecological and economic aspects. Efforts to restore or offset natural values can be difficult, time-demanding, and require monitoring and evaluation. Certain natural values are irreplaceable and can kill the project if they are not considered in the project planning. Moreover, avoiding negative impacts can facilitate the permit processing time. Key steps to avoid harm are to engage environmental professionals early, carefully choose site locations, and communicate with local stakeholders. When preventative measures to avoid harm have been taken actions to minimise unavoidable impacts should be taken. Actions to minimise impact include reduction of intensity and duration of disturbances during both the construction and operational phases. Key steps are the integration of environmental competence in construction and technical mitigation measures (Ekstrom et al., 2015).

When possible avoidance and minimisation measures have been taken restoration measures to repair damage or reestablish values should be taken. Restoration measures are aiming for no net loss (NNL) of biodiversity values on site. However, the feasibility of the restoration object should be examined early in the process to avoid the responsibility and cost of trying to restore values that are too complex. It is difficult to predict the cost of a restoration project as the result is highly dependent on surrounding ecological structures and the state of the initial condition. A restoration project comes with monitoring and assessment demands. The last step to consider in the planning process is possible compensation for lost values with offsetting. Offsetting, also referred to as *ecological compensation*, is defined as conservation measures outside the project areas aiming to compensate for lost natural values on site. Offsetting can be controversial as it indicates that a project harms biodiversity to an extent beyond recovery. Sometimes companies choose to do additional conservation actions (ACAs) to contribute with additional value aiming to reach biodiversity net gain or nature-positive targets. ACA projects have many practical similarities to offsets with the main difference being that ACAs should contribute with additional ecological value but do not implicate initial damage (Ekstrom et al., 2015).

When choosing an offset it is important to understand the scope of the harm, and the actions required to fairly compensate. There are two types of offsets; restoration offsets and protection offsets. Restoration offsets aim to enhance or reestablish biodiversity by applying conservation measures to degraded nature. Protection offsets aim to protect areas with key biodiversity values from exploitation or degradation. Restoration offsets require careful design of implementation measures with a

monitoring plan and assessment of results. Protection offsets require an assessment of additionality, longevity, and social impact on the local community (Ekstrom et al., 2015). Examples of measures taken to minimise biodiversity impact from a wind farm, aligned with the mitigation hierarchy, are presented below.

Example of Mitigation Measures in Onshore Wind Power Projects

- **Avoidance**
  - Micro-siting: Careful selection of turbine locations to minimise impact on sensitive areas.
  - Spatial planning: Utilising planning strategies to avoid high-value ecological zones during wind farm development.
- **Minimisation**
  - Scheduled construction: Implementing construction schedules to minimize disruption to wildlife and ecosystems.
  - Bat-friendly operations (e.g., batmode): Using operation techniques that are less harmful to bat populations.
- **Restoration**
  - Revegetation of temporary construction surfaces: Planting vegetation on temporary construction areas to restore natural habitats.
- **Offset**
  - Protecting habitats important for birds and bats: Establishing protected areas to offset potential negative impacts on bird and bat populations.

Source: (Bennun et al., 2021)

The Mitigation Hierarchy has been applied to development projects frequently but the applicability on a global scale or direct exploitation of species, e.g. agriculture or fisheries, is less understood. With an increase of national och corporate net-gain and NNL biodiversity targets there is a need to understand and apply the Mitigation Hierarchy on different levels. Key factors when using the Mitigation Hierarchy is to define the scope, targets, and indicators to evaluate if the implementation of the framework was successful. When deciding on the target the *SMART* abbreviation can be used to ensure that the target is Specific, Measurable, Ambitious, Realistic, and Timebound. Moreover, there is a need to decide on a baseline to be able to measure the positive or negative impact and then follow up with frequent monitoring and independent assessments (Arlidge et al., 2018).

There are differences in the policies related to the Mitigation Hierarchy depending on the scope e.g. local, national, or global scale. Likewise, there are differences in metrics, strategies, and scope between sectors but also between levels within sectors, e.g. project level, company level, and industry level. Several uncertainties should be addressed to ensure transparency and credibility decisions taken in alignment with the Mitigation Hierarchy. See table 4.2 below (Arlidge et al., 2018). Actions to minimise negative impact on biodiversity do not have to be limited to site-specific projects. Collaboration within the industry, between sectors, and with governments and research programs is important to address indirect and cumulative impact. Examples of mitigation actions on different levels are presented below.

Examples of Mitigation Hierarchy Measures in the Wind Power Industry

Project

- Implementing measures to avoid impact on local natural values
- Minimising the construction of roads and temporary construction surfaces within the project area
- Initiating restoration projects for affected ecosystems
- Enhancing the local biodiversity through specific conservation projects

Company

- Developing strategic plans and standards for environmental protection
- Assess and minimise biodiversity impact in the value chain
- Allocating project funding for dedicated restoration and enhancement efforts

Industry

- Forming joint commitments among industry stakeholders for collective mitigation
- Cooperating between sectors involved in the value chain to implement comprehensive mitigation strategies
- Providing common funding for research projects to advance industry-wide knowledge and best practices

Table 4.2: Key factors to address when applying the Mitigation Hierarchy, based on (Arlidge et al., 2018).

Key considerations	Description
Additionality	Assessing whether the proposed measure adds substantial value compared to the business-as-usual scenario, ensuring that the offset enhances biodiversity.
Compliance and Monitoring	The need for authorities to actively monitor and ensure compliance, tracking whether the offset has successfully achieved its intended purpose.
Biodiversity indicators	Identifying and mainstreaming indicators to measure and quantify changes in biodiversity, providing a complex understanding of the ecological impact.
Equivalency	Demonstrating the ability of the offset to contribute equal value compared to the ecological values lost due to the development, ensuring a fair and just compensation.
Least cost	Offsets with sufficient complexity to prevent situations where it becomes economically advantageous to cause harm and then compensate through offsets.
Longevity	Determining the temporal extent of an offset scheme, addressing the responsibility duration of a company, particularly in cases like the removal of an old-growth forest.
Reversibility	Clearly defining the extent to which a development's harm is reversible, with irreversible harm posing restrictions on compensatory measures.
Multipliers	Incorporating a discount rate for future biodiversity gains, accounting for the time value of ecological benefits accrued over time.
Substitutability	Providing clarity on when ecosystems, species, or populations are considered equivalent, ensuring a well-defined framework for substitution in offset measures.
Thresholds	Establishing specific thresholds for biodiversity losses that cannot be compensated, creating no-go zones to protect critical ecological areas.
Time lag	Deciding the duration required for the offset gain to effectively compensate for the harm caused by the development.

4.4.1 Biodiversity Net-gain and Nature-positive

Companies wanting to go above and beyond the last step of the mitigation hierarchy are to do additional measures (ACAs) aiming to attain a net gain in biodiversity. With increasing focus on the environmental impact of business, ambitions to reach net gain can result in a competitive advantage, improved reputation, and good relations with stakeholders (NPI Alliance, 2015). Distinguishing no net loss from net gain is not an easy task. The main difference is visible in the company's ambition to contribute with significantly greater natural value than that which was negatively impacted. To demonstrate Net-gain the project scope and baseline need to be defined and a management plan with monitoring and assessment is necessary (IUCN Business and Biodiversity Programme, 2017).

No net loss and Net positive targets for biodiversity in business are not new but have increased during the last two decades. One of the first No Net Loss targets was found in 2001 and by 2014 32 similar targets were found mainly among mining and energy companies. Back then, these targets were voluntary extra commitments from leading companies and the definitions of the goals to achieve net loss or net positive varied greatly (Rainey et al., 2015). In the last five years, the subject has received more focus and also received more attention in laws and policy. The United Kingdom, for example, has implemented a Biodiversity net-gain law where a minimum of 10 % net-gain, based on the mitigation hierarchy, in biodiversity is required by developers and should be maintained for the coming 30 years (GOV.UK, 2023).

In addition, the need for an overarching international goal for nature, similar to the net-zero ambitions

in the Paris Agreement, was advocated for by several NGOs and companies at the end of the last decade, which resulted in the nature-positive goal called *The Global Goal for Nature*. The vision for the Global Goal for Nature is illustrated in Figure 4.3 and the definition is to:

"Halt and Reverse Nature Loss by 2030 on a 2020 baseline, and achieve full recovery by 2050"

(Locke et al., 2021)

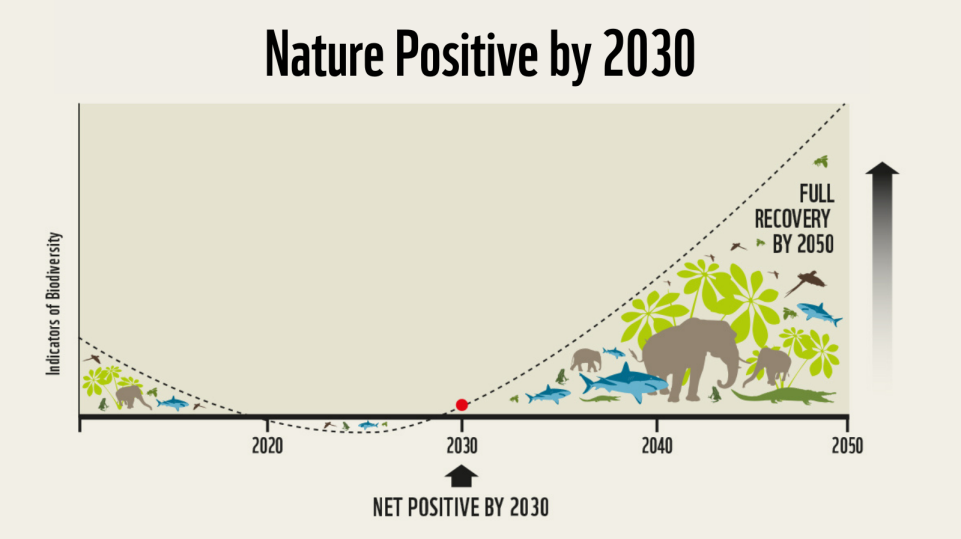

Figure 4.3: Illustration of The Global Goal for Nature. Source: (Locke et al., 2021)

The definition of Nature Positive includes the abundance, distribution, and quality of species, ecosystems, and genetics. The goal was adopted in the GBF at COP15 and the mainstreaming of *Nature Positive* is currently in progress. To achieve this goal, the protection of natural ecosystems, restoration of land degraded by human activity, and mitigating drivers of biodiversity loss have been identified as key factors. Moreover, the carbon-neutral and nature-positive goals are highly interlinked as success in one objective cannot be achieved without success in the other. (Locke et al., 2021)

To achieve these goals there is a need to shift the perception of sustainability. Since the Brundtland Report 1987, sustainability has been perceived as the compromise between sufficient standards in the society, economy, and environment. The problem emerging from this perspective is the misconception that the economy and society are disconnected from the environment. Degradation of nature will cause devastating impacts on society and the economy hence the environment has to be treated as the foundation for a sustainable society and functioning economy. Nature contributes to human health by providing clean air, water, and fertile soil, and the economy is derived from natural resources, see Figure 4.4 (Locke et al., 2021)

This shift in hierarchy requires a transformation of business where companies mitigate negative impacts on nature and engage in the conservation and restoration of natural values. This transformation will demand collaboration between and within sectors and governments. Companies and financial institutions play a major role in achieving nature positivity by 2030. With that said, demonstrating nature positivity as an individual company is difficult as it requires assessment across value chains and mitigation, conservation, and regeneration measures that outweigh negative impacts. Claiming to be a nature-positive company without sufficient assessments could be counterproductive resulting in a lack of trust from stakeholders. Yet, uncertainties are not a reason to refrain from acting. To contribute to the Global Goal for Nature companies are encouraged to assess their impact, make realistic science-based targets, transform the business to achieve targets, and transparently disclose progress. Increasing amounts of public data, technical aids, and collaboration across the value chain

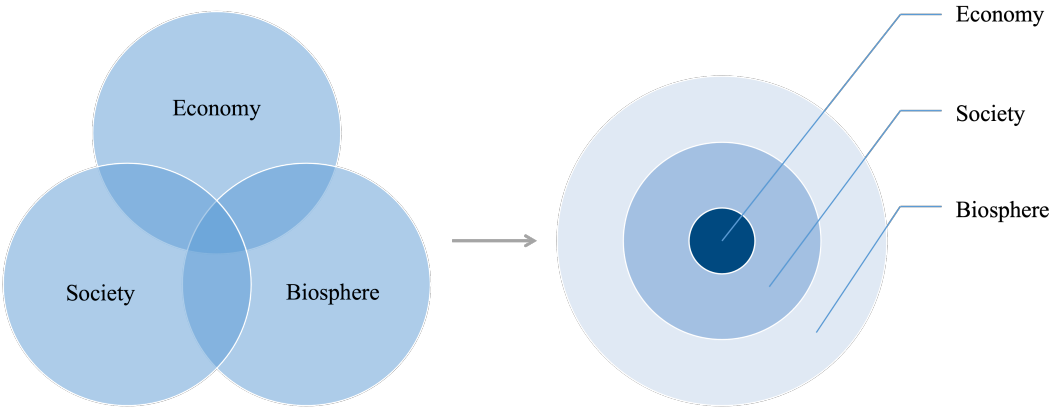

Figure 4.4: Schematic illustration of the shift in hierarchical relation between the biosphere, society, and economy. Based on (Folke et al., 2016).

could facilitate the transformation (Business for Nature, 2022).

Recent studies on the use of Nature Positive show that the use of the term is increasing but there is still some confusion about the meaning and lack of standards and common assessment tools. Moreover, there is a difference depending on the scope of the term used, e.g. project level or company level (Hallgren, 2023). Applying Nature Positive targets on the company level includes the assessment of biodiversity impact from the value chain and own operations. Additional differences between biodiversity no net loss or net gain and nature positive, highlighted by (zu Ermgassen et al., 2022), can be seen in Table 4.3.

Table 4.3: Differences between No Net Loss and Net positive vs. Nature Positive targets in corporate sustainability strategy. Based on (zu Ermgassen et al., 2022).

Categories	No Net Loss/ Net Positive	Nature Positive
Scope	• Based on Mitigation Hierarchy • Direct impact	• Transforming business • Direct impact, supply chain and end-of-life
Mainstreaming	• Knowledge isolated for employees involved in projects	• Including biodiversity in governance, business strategy and risk management
Integration	• Assessed as isolated direct environmental impact	• Assessment integrated with drivers, e.g. climate change, water use and other sustainability topics.
Ambition	• Ambitions set for site-specific impacts	• Aligning ambitions with global treaties, setting science-based commitments addressing key impacts

When companies on the GF100 2021 were reviewed, 70 % mentioned biodiversity in their sustainability reports but commitments mostly covered their own operations. Consistent with previous studies the energy sector had a comparatively high share of biodiversity commitments. Despite the increase in biodiversity commitments, the rate is not as impressive as the net-zero carbon commitments.(zu Ermgassen et al., 2022) This is not a surprise since there is a lack of consensus on how to make time-bound and measurable targets without universal metric systems for nature. Several assessment tools and metrics for biodiversity exist, however different metrics are suitable for differ-

ent levels and locations. A selection challenges hindering companies' *Nature Positive* commitments identified by (zu Ermgassen et al., 2022) is presented below.

Challenges in implementing Nature Positive business strategies

- **Metrics:** Improved methodologies are needed to assess both positive and negative impacts on biodiversity throughout the production process.
- **Transparency:** Many corporations lack sufficient transparency regarding the environmental impacts of their operations. Furthermore, available data may be incomplete or inadequately informative.
- **Financial and political challenges:** Ensuring environmentally beneficial practices often entails resource reduction, which may encounter resistance from entities prioritising financial gains. Additionally, political disagreement may arise from industries with substantial ecological impact.
- **Skills and training:** Lack of expertise regarding biodiversity conservation and sustainable practices can decrease ambition levels.
- **Cooperation and coordination:** Collaborative efforts among stakeholders are important to ensure fair distribution of responsibility for environmental impact.
- **Social fairness:** Decision-making processes concerning biodiversity must address considerations of social equity.

Source: (zu Ermgassen et al., 2022)

With the increased use of the term *Nature Positive* critical voices about the meaning of the term have risen. Criticism especially concerns the worry of diluting the meaning of being *Nature Positive* if measures to reach net gain are underestimated. As an example, an assessment of biodiversity impact from Oxford University stated that mitigation measures could decrease impact by 33%, and compensate by 4 % through restoration measures on own land, resulting in a need to offset 32 % (Milner-Gulland, 2022). Moreover, previous reviews of no net loss targets in environmental policy show that alternative scenarios rarely are described making it difficult to understand the impact of action(Maron et al., 2018). Lastly, the great differences in remaining natural ecosystems between countries raise questions on how to reach no net loss targets in a socially fair way as nature protection can result in less opportunity for the local population to use the raw material for economic growth (Maron et al., 2020).

4.5 Assessment tools and market incentives

Beyond regulations and legal requirements, there are several economic incentives and voluntary reporting and assessment tools that can be used by companies to take action in mitigating impact and engaging in biodiversity regeneration. Despite the perception of biodiversity as a challenging issue to assess, there are several voluntary tools and reporting platforms available and in development. The usability of these resources varies depending on the scope and aim of the assessment.

4.5.1 Disclosure frameworks and reporting standards

One of the most known platforms encouraging companies to set sustainability targets is The Science Based Targets Network (SBTN). SBTN initially encouraged companies to set science-based climate

targets that aligned company actions with the Paris Agreement. In addition, the first part of The Science Based Targets for Nature was launched in 2023 and covers targets related to freshwater, land use, biodiversity, and oceans as a complement to climate. The SBT for Nature consists of 5 steps, see Box below, whereas technical guidance on steps 1-3 has been published (SBTN, n.d.). Specific guidance on how to apply the procedure to biodiversity exists for steps 1-3, and additional resources for 4-5 are expected in 2024 (Hawkins et al., 2023).

Science Based Targets for Nature Framework

Steps for setting Science Based Biodiversity Targets:

1. **Assess:** *Assessing impact through materiality screening and value chain assessment.*
2. **Interpret:** *Interpret and prioritize by analyzing pressure intensity and the biodiversity value of sites to rank areas for targeting.*
3. **Measure, Set, Disclose:** *Set targets based on difficulty, working on target-setting methods focused on pressures, species, and ecosystem indicators.*
4. **Act:** *Act to avoid, reduce, regenerate, restore, and transform.*
5. **Monitor, Report, and Verify:** *Monitor, report, and verify the actions taken.*

Source: (Hawkins et al., 2023)

Another voluntary reporting platform that has expanded from climate (TFCD) to other sustainability topics is the market-led disclosure platform TNFD (The Taskforce on Nature-related Financial Disclosures). TNFD provides a framework for companies to assess risks and opportunities related to nature. The aim is to shift investments to sustainable companies by making impacts and dependencies related to natural values visible to society(TNFD, 2023b). To assess the impact and dependencies companies can use the LEAP framework, see Box below.

TNFD LEAP Framework

- ***L**ocate interface with nature*
- ***E**valuate dependencies and impacts*
- ***A**ssess nature-related risks and opportunities*
- ***P**repare to report and disclose*

Source: (TNFD, 2023b)

Moreover, TNFD is developing sector-specific recommendations to guide companies through the LEAP process. The sector-specific guidelines for Wind Power are still in development and examples from a draft with suggestions on assessment tools, disclosure indicators, and risk categories are presented below (TNFD, 2023a). Companies are encouraged to integrate SBTN and TNFD by using SBTN for target setting and TNFD for assessment and disclosure recommendations (TNFD and SBTN, 2023). Additional voluntary sustainability platforms are the non-profit disclosure platform CDP where companies publicly publish sustainability performance data (CDP, 2023) and GRI which provides common standards for sustainability reporting (GRI, 2021). UNEP and WWF recently published the report *Accountability for Nature: Comparison of Nature-Related Assessment and Disclosure Frameworks and Standards*, where content of CDP, ESRS, GRI, ISSB, NCP, SBTN and TNFD is reviewed (Tin et al., 2024).

TNFD Sector Specific Guidelines: Electrical Utilities and Power Generators

Special tools recommended for electrical utilities and power generators sector:

- AVISTEP: the avian sensitivity tool for energy planning
- TNC Paris to Practice and Energy Sprawl tools
- World Bank energy sector management assistance program rezoning tool
- Important Marine Mammal Areas e-Atlas and database

Risk assessment:
Physical:

- Damage to sites through extreme weather
- Change in wind patterns
- Risk of landslides

Policy and legal:

- Changes in legislation increasing cost of development and operation

Reputation:

- Opposing society if operations are causing a negative impact on surrounding nature

Proposed core sector disclosure indicators:

- Species casualties (number of birds and bats that die)

Source: (TNFD, 2023a), Draft.

4.5.2 Assessment tools

The difficulty in finding a common metric for measuring biodiversity and natural values is frequently identified as a challenge for corporate engagement in biodiversity. As previously stated there are several indicators for examining biodiversity and ecosystems. For example, The Biodiversity Indicators Partnership presents over 25 different indicators relevant to *Goal 15: Life on Land* (Biodiversity Indicators Partnership, n.d.). Moreover, there are attempts to create a Product Biodiversity Footprint by integrating drivers of biodiversity loss and ecological aspects with LCA (Asselin et al., 2020). However, the choice of a biodiversity assessment tool or indicator highly depends on the scope (WWF and BAIN, 2023). Examples of tools for sector-level assessment, value chain assessment, and site assessment are Encore, IBAT, respectively CLIMB.

Encore is a tool developed to help companies gain a sector-wide understanding of their risk related to natural capital. IBAT, *Integrated Biodiversity Assessment Tool*, contributes with data on key biodiversity areas and red list species (European Comission, 2022). IBAT is also connected to STAR, *Species Threat Abatement, and Restoration metric*, which is a quantitative metric aiming to show how restoration or conservation actions will reduce extinction risks for local species. The STAR metric shows that key biodiversity areas hold a high biodiversity value even though they do not cover a large land area. Moreover, actions within sustainable agriculture and forestry are identified as the actions with the largest potential for species threat abatement (Mair et al., 2021). IUCN is currently

developing guidelines for companies to measure Nature Positivity, which will be aligned with SBTN and TNFD, and the draft recommends IBAT and STAR as assessment tool and indicator (IUCN, 2023).

Lastly, there are national and site-specific biodiversity assessment tools in development. The model CLIMB, *Changing Land Use Impact on Biodiversity*, is a Swedish biodiversity assessment tool inspired by the Defra Biodiversity Metric 3.0 from the UK. CLIMB was developed to assess the local impact of land use change in Nordic conditions (CLIMB, n.d.-a). CLIMB is a tool that can be used to show how the mitigation hierarchy is applied within a specific site, e.g. an onshore wind farm. The first part of CLIMB is to calculate the biodiversity within the impact area by mapping and documenting habitats and value cores based on the standard presented in Table 4.1. Secondly, a present value calculation is conducted, factoring in considerations based on the landscape's characteristics. If the aim is to obtain biodiversity net gain, areas where interventions can be implemented to elevate the nature conservation status should be identified. Factors such as the size of the biotope, conservation status, landscape value, and the distance between the impact area and enhancement measures are taken into account. Lastly, a change assessment to determine whether the biodiversity in the area is improving, being lost, or experiencing deterioration is performed (CLIMB, n.d.-b).

4.5.3 Market incentives

Public economic incentives, such as taxes, fees, subsidies, and tradeable schemes related to biodiversity drastically increased between 1980 and 2010 but since then the increase has slowed down. The potential to increase economic incentives aimed at biodiversity is great. For example, biodiversity-related taxes only make up 0.92 % of the total amount generated from environmental taxes (OECD, 2022). However, the assessed gap in financing needed to protect and restore biodiversity to desired levels is believed to be too big to be covered by public funding. There is a need to generate private investments in biodiversity protection and restoration. Currently, public capital is generally aimed at the protection of biodiversity while private capital goes into sustainable supply chains and offsets (Karolyi and Tobin-de la Puente, 2023).

Business case

The economic benefits for companies to engage protection of biodiversity and ecosystem services are more than avoiding taxes and generating subsidies but the indirect benefits can be difficult to quantify. Examples of direct financial values are minimised environmental risk, increasing financial value of land, and competitive advantage on the market. Examples of indirect financial values are increased brand reputation, social acceptance for development, and improved staff satisfaction. The generated value from direct and indirect benefits compete with the cost of land management, employee resources, and avoiding maximum extraction of natural resources (Spurgeon, 2008). Moreover, the fossil fuel industry has experienced deinvestments and lawsuits due to the fact that they have understated the environmental consequences of greenhouse gas emissions. It is possible that companies with a large negative impact on biodiversity can expect similar consequences, hence facing a significant economic long-term risk (Karolyi and Tobin-de la Puente, 2023). Examples of different types of business risks and opportunities related to changes in the quality of ecosystem services are presented below (Finisdore et al., 2012).

Risk and Opportunities emerging from changing trends in ecosystem services

Operational
Risk: Disturbance of operations or shortage of raw material
Opportunity: Developing low-impact process facilities

Regulatory and Legal
Risk: Permit denial or lawsuits
Opportunity: License to expand operations

Reputational
Risk: Loss of ”social license to operate”
Opportunity: Improved brand reputation

Market and Product
Risk: Changing consumption patterns
Opportunity: Market for certified products, new revenue streams

Financing
Risk: Stricter lending agreements
Opportunity: Access to sustainable funds and investors

Source: (Finisdore et al., 2012)

ESG

The increased competitive value of sustainable business practices on the market has been shown by the fast-growing interest in ESG investing. ESG stands for *Environmental Social Governance* and the ESG score is supposed to show the company's level of sustainability performance in these categories. However, the ESG score has been criticised for being inconsistent with differences in metrics, subjective evaluators, and lack of transparency. Analyses show that there is a market bias where companies with larger market capitalisation and higher revenue often receive higher ESG scores than those with lower market capitalisation although their sustainability performance is at the same level (Boffo and Patalano, 2020). The new regulations on sustainability reporting and common standards in the EU e.g., CSRD and ESRS are a response to combat the shortcomings of the system.

Certifications

Other market instruments to prove sustainable practices are third-party certifications. Certifications for sustainable forest and fishery practices are well-established and in the energy sector, it is often possible to choose 100 % renewable energy sources in Swedish electricity agreements. Recently, certification for environmentally sustainable electricity was launched by the Swedish organisation *Bra Miljöval* (Bra Miljöval, n.d.). This certification has environmental requirements going beyond renewable energy sources. The requirements for onshore wind power are presented below.

Bra Miljöval: Criteria for Wind Power

- **Wind Power Restricted Areas:** Wind turbines with the ”Good Environmental Choice” label must avoid protected areas, as defined by local laws, international conventions, and Annex 5 Restricted Areas.
- **Software for Shutdown Regulation:** Wind turbines must have and disclose ”bat mode” software for bat protection. Exceptions may be considered after individual assessment by the Naturskyddsföreningen.
- **Residual Product Plan:** To qualify as ”Good Environmental Choice,” a wind power project must have a documented residual product plan.
- **Wind Power Outside Sweden:** Assessment for wind turbines outside Sweden involves collaboration with an independent local environmental organization. Unsuitable facilities, based on environmental considerations, won't be approved as ”Good Environmental Choice” electricity.

Source: (Naturskyddsföreningen and BraMiljöval, 2021)

Biocredits

Similar to the voluntary market for Carbon Credits a market for Biocredits (Biodiversity Credits) is expected to rise as a financial instrument to fund protection and restoration of biodiversity. Purchasing Biocredits is expected to be an additional action for companies following the mitigation hierarchy or companies with little direct interaction with natural capital (Hurd et al., 2023). The future use of Biocredits in the financial system is also discussed by the Swedish Environmental Protection Agency since it is a possibility mentioned in the GBF. However, there is still no uniform definition of a Biocredit, and resources are required to design verification systems (Naturvårdsverket, 2023c). The credibility of the voluntary Carbon Credit market has been questioned and accused of greenwashing and defining a scope for Biocredits without a uniform metric system is even more difficult (Karolyi and Tobin-de la Puente, 2023). Key issues to overcome significantly overlap with challenges related to offsets presented in Table 4.2 .

IIED (International Institute for Environment and Development) and UNDP (United Nations Development Programme) have analyzed three different voluntary Biocredits systems to find opportunities and challenges (Ducros and Steele, 2022). Diffrenenting Biocredits from Biodiversity offsets is mentioned as critical with the main difference being that a Biocredit is not designed to ecologically equalise or compensate for harm done. A Biocredit should be an instrument to fund the protection and restoration of nature. Three different types of Biocredits are presented below.

Different types of Biocredits

- **Avoided Loss credits:**
  - Preservation of ecosystems at risk, requires funding for protection.
  - Maintaining values to prevent degradation.
- **Restoration credits:**
  - Restoration of degraded ecosystems, requiring investments.
  - Aim to increase values relative to previous levels.
- **Supporting Values credits:**
  - Continued preservation of high-value ecosystems, requiring funding for sustainable land management.
  - Rewarding those who manage or own land to maintain ecological values.

Source: (Ducros and Steele, 2022)

Defining and quantifying a Biocredit is frequently identified as a difficult challenge. In the case studies, the credits were based on several different metrics aggregated. Examples of criteria taken into account are the reduced extinction risk for a species, the creation of connectivity in the surrounding landscape, and carbon sequestration. Additional challenges are proving additionally and preventing leakage. Proving additionally requires a baseline and choosing a baseline depends on the site objective. An *Avoided loss Credit* will not add additional ecological values but protect the current while a *Restoration Credit* aims to contribute with new ecological values to a degraded land. However, if external factors, e.g. extreme weather, affect the site it can be difficult to evaluate the results of the restoration actions compared to the baseline.

Leakage in the Biocredit market means that the protection of natural values in one site can cause increased resource exploitation in nearby sites to fulfill resource demands. Lastly, it is challenging to put an accurate price on Biocredits in a new market. A minimum credit value can be used to reduce the risk of companies using Biocredits as justification for harmful business activities. Additionally, verification of purchasing companies' alignment with the mitigation hierarchy is recommended (Ducros and Steele, 2022).

The role of the wind power company could be either the *Investor* purchasing Biocredits as a part of the company's sustainability strategy in addition to following the mitigation hierarchy for its operations. Or, the wind power company could differentiate business activities by becoming the *biodiversity custodian*, creating new revenue streams by performing restoration measures in combination with renewable energy production on degraded land. With that said, being the biodiversity custodian would require resources and competence to perform long-lasting restoration measures suitable for the local environment and which do not create conflict with energy production. An illustration of the roles in a possible Biocredit market is presented in Figure 4.5.

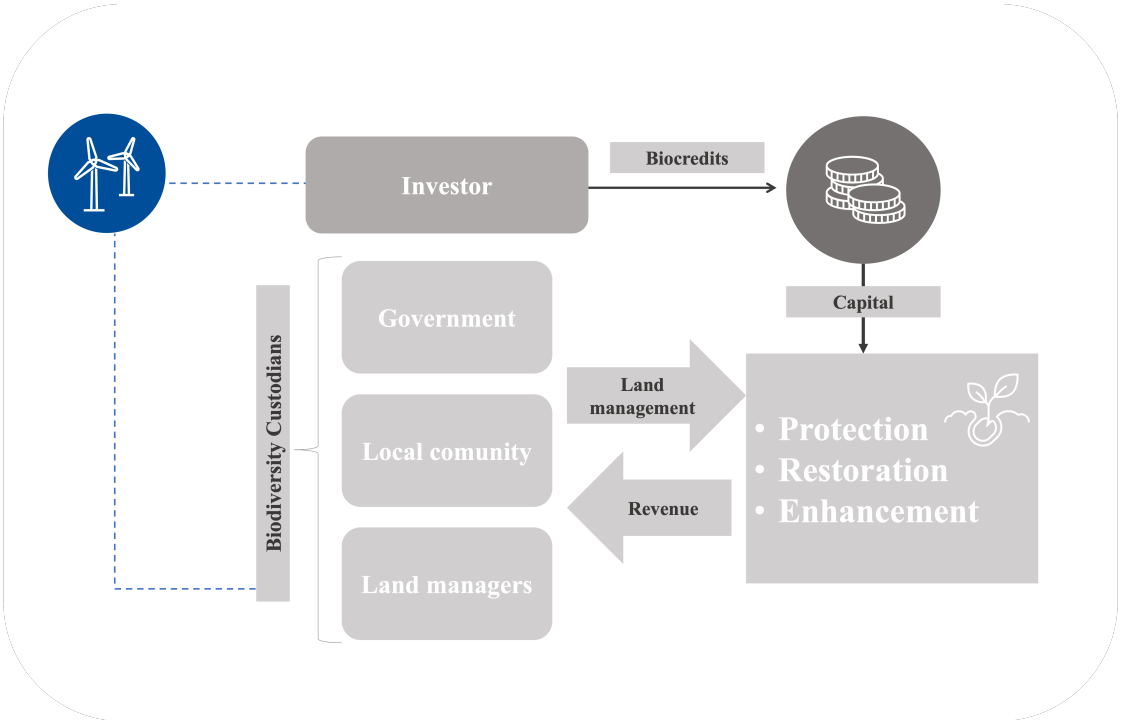

Figure 4.5: Example of wind power company position in voluntary Biocredit market. Based on (Ducros and Steele, 2022).

5 Biodiversity Management in the Wind Power Industry

In this chapter, the results of the survey on Biodiversity Management in the Wind Power industry are presented. The results are based on an online questionnaire distributed in collaboration with the Swedish Wind Energy Association (Svensk Vindenergi) and in-depth interviews with three energy companies with wind power operations in Sweden. The degree project is conducted in association with the energy company RWE. Interviews at RWE were conducted with representatives on a project level, company level, and holding company level to obtain a nuanced understanding of biodiversity management within the company. The results from close-ended and open-ended questions are compiled with open ended answers from interviews and divided in three sections. Section one covers current biodiversity practice, policies and targets. Section two presents incentives and barriers in biodiversity management for wind power companies. The third section presents possible improvement areas and missing resources in biodiversity management. Details on online questionnaire and interview questions are found in Appendix, A.1 and A.2 .

The online questionnaire was answered by 12 companies, including the companies that participated in additional interviews. In the invitation e-mail, the person responsible for biodiversity-related questions in the company was asked to conduct the survey. The role that is responsible for biodiversity-related questions in the wind power industry varies and the roles of the respondents are presented in Table 5.1. Three out of twelve companies solely operated in Sweden whereas the rest of the companies had operations globally.

Table 5.1: Roles of respondents in the biodiversity online questionnaire.

Roles of respondents	
Sustainability strategist	Business Development Manager
Development Manager	Project developer
Managing director	Project manager
Sustainability Coordinator	Head of Onshore Wind, Sustainability Manager
Senior Environmental Specialist	Environmental permit specialist, wind power
Environmental and Sustainability Coordinator	Environmental Specialist

5.1 Current policies and targets

Current biodiversity engagement in the Swedish wind power industry mainly consists of policies to reduce negative impact by following the mitigation hierarchy, engaging in enhancement or conservation measures, and participating in research programs and sustainability networks, see Figure 5.1. Only one-third of the companies answered that their company worked with an assessment of biodiversity impact in the value chain. Other ways that the companies worked with biodiversity were mainstreaming biodiversity and building up staff competence. Some respondents also expressed that they were unsure if strategies related to biodiversity were in place at headquarters.

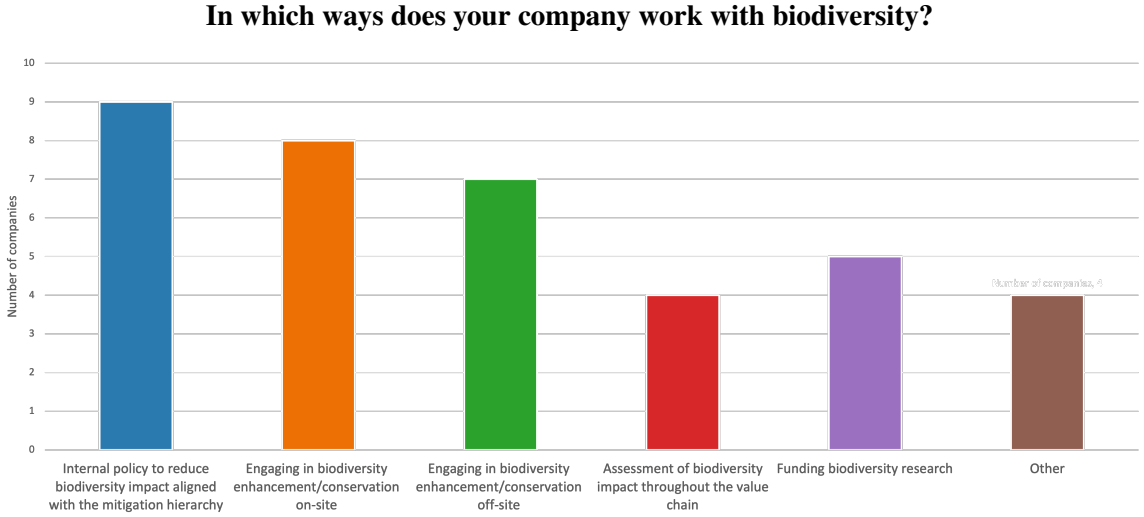

Figure 5.1: Survey question. In which ways does your company work with biodiversity?

Several companies stated that they were in the early stages of implementing policies and targets related to biodiversity. The target that was most common among the responding companies was to have a*"Net-positive biodiversity impact on wind power project sites"* (58%), see Figure 5.2. Moreover, the majority of these targets were set for 2030 or before. Targets related to the company value chain were less ambitious with 45.5% having no plans to implement it. With that said, one-third of the respondents already have site-specific targets and plans to implement targets related to the value chain within five years. No company had targets set for after 2050.

To set targets and assess biodiversity impact several novel biodiversity-related tools and guidelines have been launched. SBT for Nature, CLIMB, and TNFD are the most popular out of the presented upcoming tools and resources related to biodiversity. Out of the respondents, 67% are using or plan to use SBT for Nature, and 58% plan to use CLIMB, see Figure 5.3. IBAT, Encore, and STAR were not commonly used, e.g. 91.6 % have no plans of using STAR or have not heard about it. Additional resources mentioned were WBCSD guidelines and the BBCI model (Biotope Biodiversity Capacity Indicator). Moreover, respondents expressed the need for biodiversity guidelines adapted to Nordic conditions. Lastly, some respondents answered that they found competent staff more useful than generalised guidelines and tools or that they wanted to wait until the tools and guidelines were more mature.

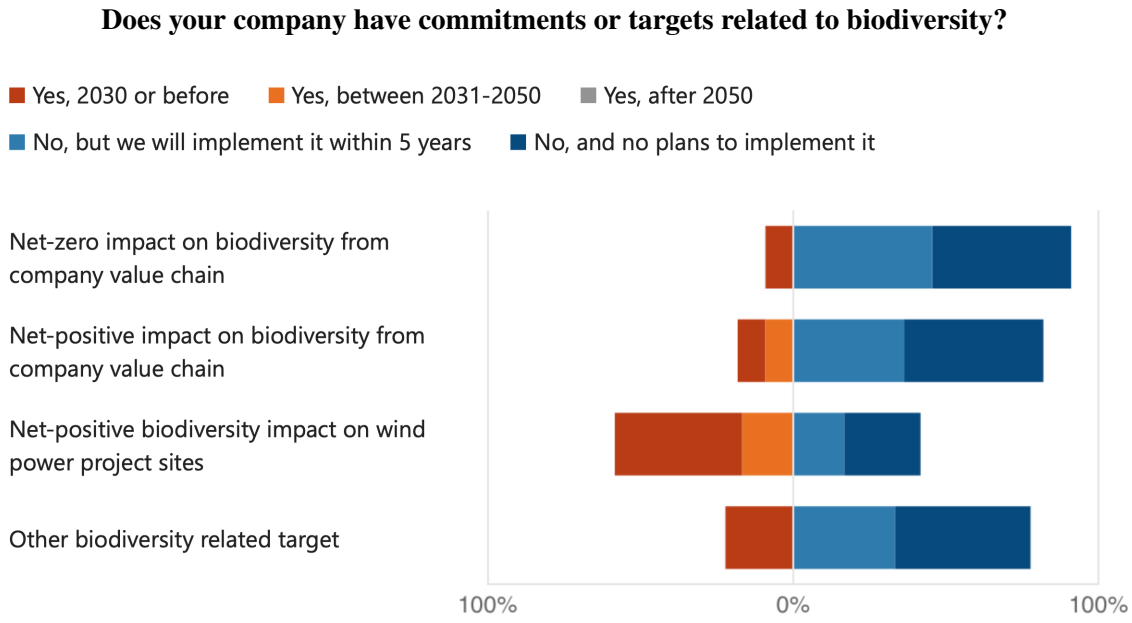

Figure 5.2: Survey question: Does your company have commitments or targets related to biodiversity?

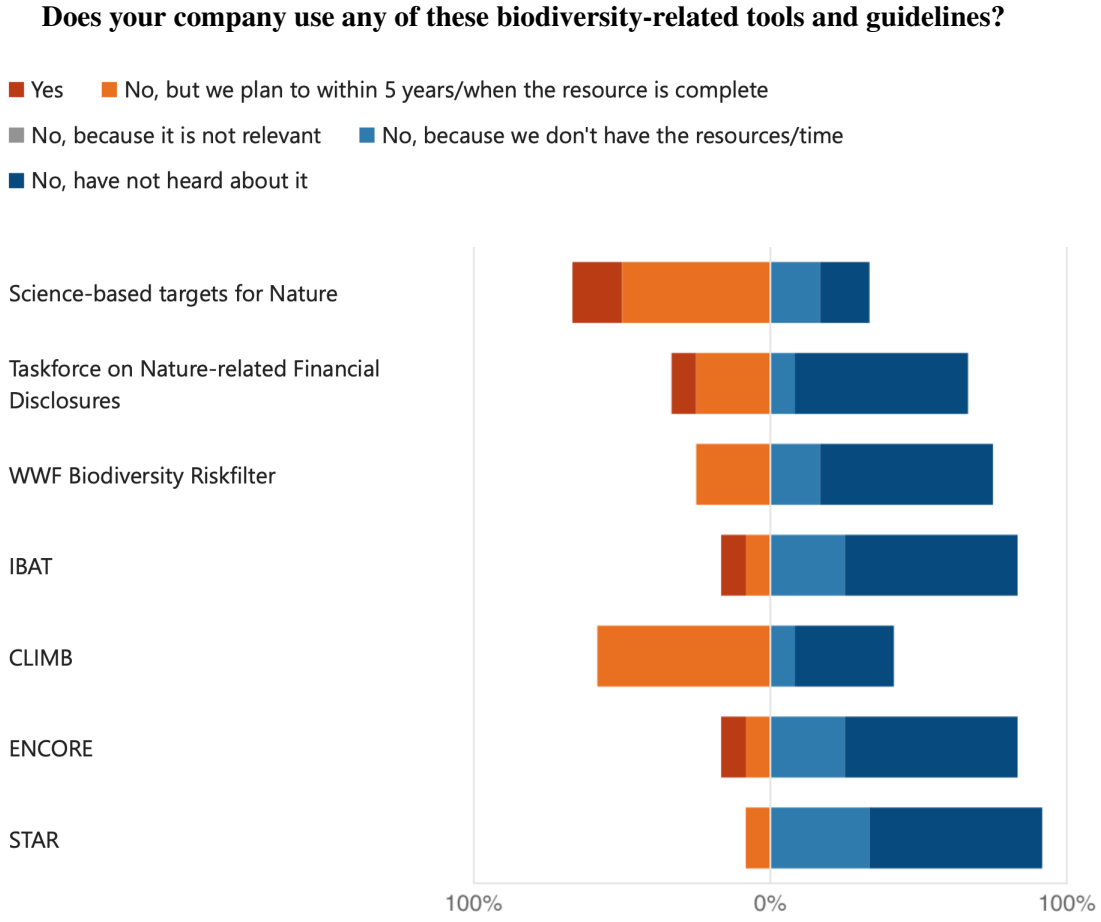

Figure 5.3: Survey question. Does your company use any of these biodiversity-related tools and guidelines?

5.2 Incentives and Barriers

When asked what the main incentives for biodiversity engagement in the wind power industry are, increased acceptance for wind power projects and compliance with current legislation for permits was most frequently answered. Moreover, having a green brand reputation, attracting staff, and showing that the industry cares about several environmental factors were mentioned as reasons to work engage in biodiversity management. Out of the suggestions presented in Figure 5.4 all claims were considered incentives. The strongest incentives were connected to brand reputation and local acceptance while the incentives related to economic benefits were weaker. Incentives related to international policy and regulation, e.g. CBD and CSRD, were also considered a strong incentive but not as strong as increasing acceptance and reputation.

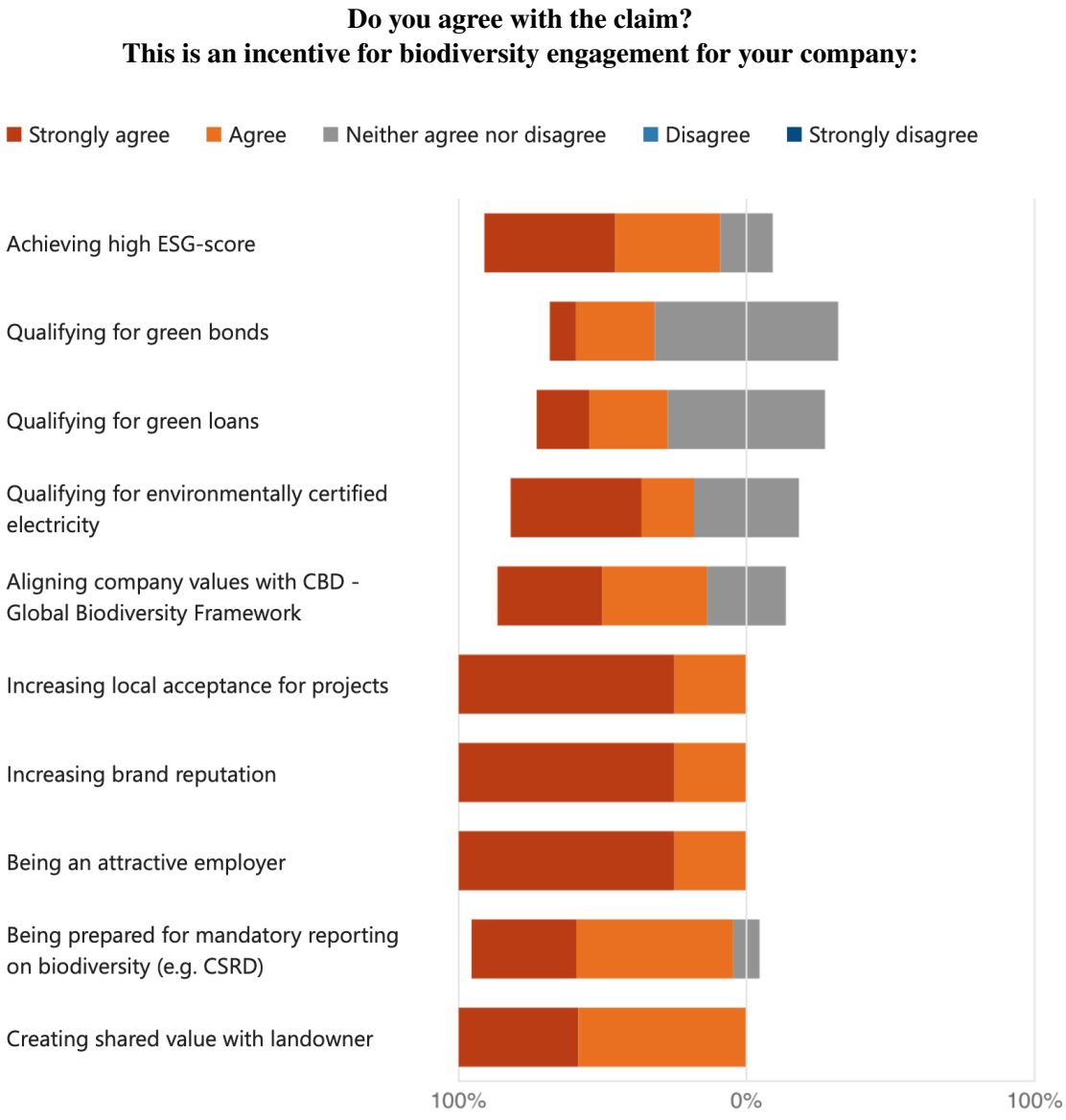

Figure 5.4: Survey question. Do you agree with the claim: This is an incentive for biodiversity engagement for your company?

When asked what barriers inhibited wind power companies' biodiversity engagement most respondents agreed with immature metrics, legal uncertainties, and difficulty in showing impact. However, most respondents did not consider biodiversity as a low-priority sustainability subject internally or to stakeholders, see Figure 5.5. Uncertainties regarding communication and cost were also considered barriers.

Discussing communication challenges, respondents found it difficult to communicate an international company's impact when many assessment tools or standards are adapted to local conditions or national legislation. Being forced to use different models in different countries could be resource-demanding for project developers and difficult to report to stakeholders. International companies are unsure whether they should aggregate different metrics to overall company score or not. Moreover, there are many uncertainties on when net positivity is achieved in a site, which results in a scare of green-washing accusations if communicated poorly. Moreover, offsets can be a controversial subject to include in biodiversity strategy, although it might be necessary to reach net positivity, if opportunities to perform restoration measures on-site are lacking.

When discussing cost and financing as a barrier to biodiversity engagement there was uncertainty about which unit that were responsible for financing implementation and maintenance of measures. Moreover, respondents found it challenging to receive financing from management when there are uncertainties on when results from the measures will be obtained. Furthermore, the risk of sustainability measures going beyond legislation being removed when external factors, e.g. war or pandemics, cause economic recession was mentioned as barrier. In addition, lack of transparency in the supply chain was mentioned as a barrier to performing a value chain impact assessment.

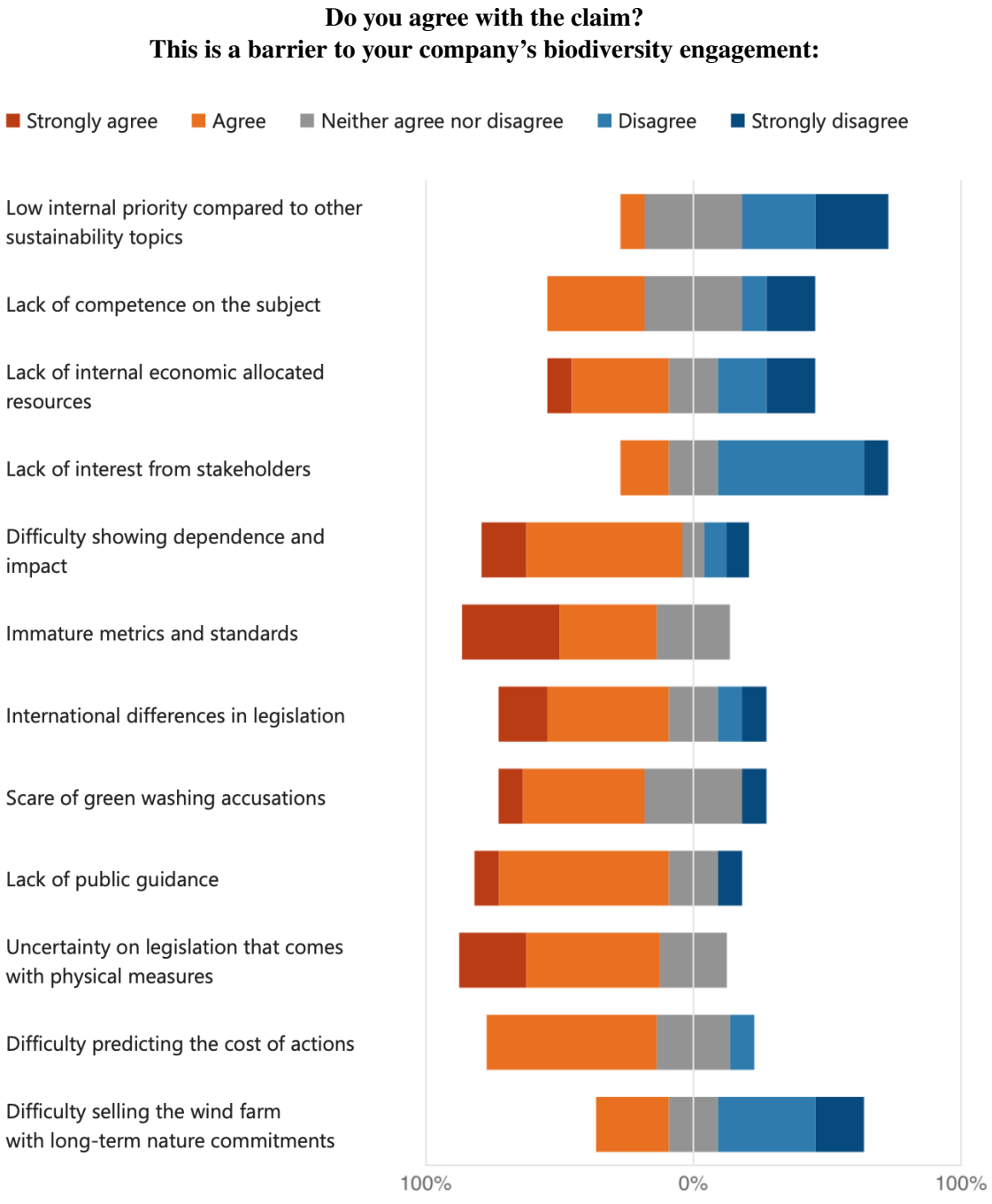

Figure 5.5: Survey question. Do you agree with the claim: This is a barrier to your company's biodiversity engagement?

5.3 Improvement areas and Resource gaps

When discussing future incentives that would increase biodiversity engagement in the wind power industry increasing the likelihood of getting a wind power permit was the strongest incentive. As mentioned before obtaining a social license to operate and general acceptance for the industry is an important factor, but several respondents also mentioned that they want the licensing authority to acknowledge biodiversity engagement in the permitting process. Whether or not stricter biodiversity reporting demands would increase biodiversity engagement in the company differs among respondents, see Figure 5.6. However, several respondents mentioned that regulations and legislation on biodiversity would even out the playing field and facilitate long-term economic financing for biodiversity management. Joint industry commitments and access to standardised guidelines would also facilitate biodiversity engagement. The possibility of generating additional income from Biodiversity credits could be a future incentive but not as strong as the other mentioned.

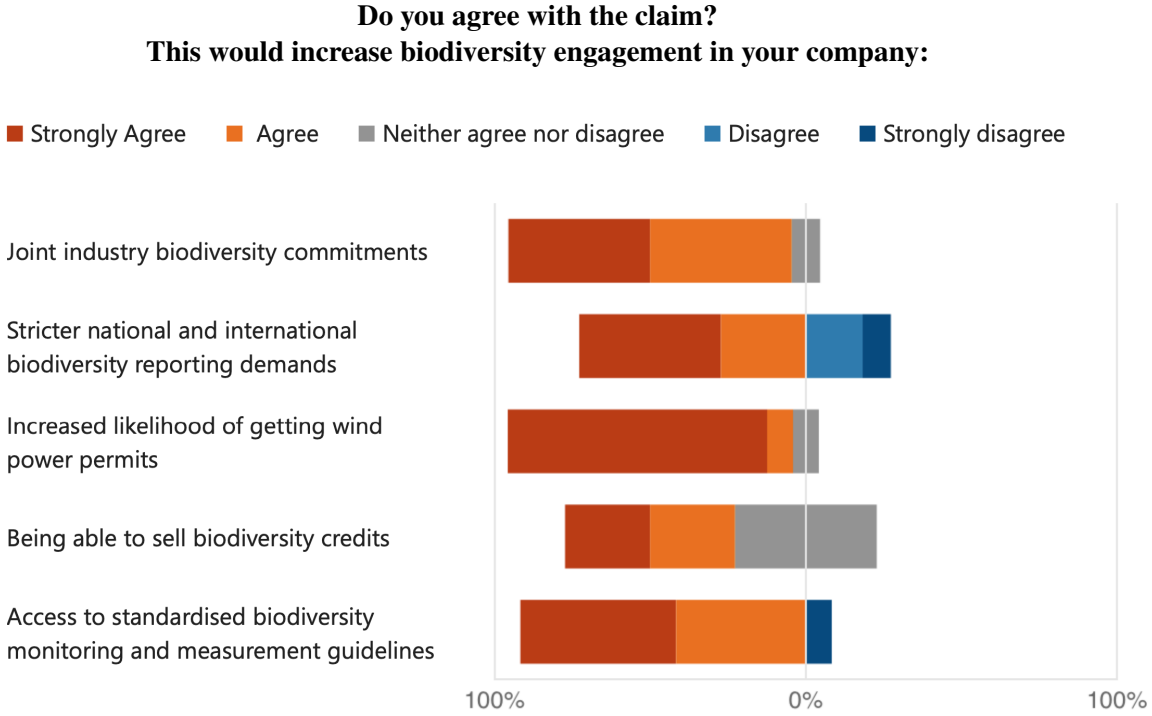

Figure 5.6: Survey question. Do you agree with the claim: This would increase biodiversity engagement in your company?

Suggestions on future internal resources that would facilitate biodiversity management in wind power companies mostly concerned hiring more employees with competence in biodiversity and creating clear roles of responsibility to reduce additional pressure on project developers. Moreover, internal learning material to increase general biodiversity knowledge in the company was desired.

Desired external resources that would facilitate management were clear guidelines from governments on best practices, desired reporting formats, and common definitions of nature-positive. Moreover, several respondents requested more involvement from landowners, investors, and collaboration with upstream companies in the value chain. Biodiversity requirements from investors are still considered low compared to requirements related to climate change. However, respondents have seen an increased interest in biodiversity from investors and believe that the requirements will rise in the coming decade. Additional topics that need further investigation are how to align environmental and social sustainability to ensure that increased measures to protect and restore nature don't harm local communities.

6 Biodiversity Enhancement Project in a Swedish Wind Farm

In this chapter, the results from the case study on the development of a biodiversity pilot project are presented. The results are based on observations in project planning meetings, interviews with stakeholders, documents with background material, and a site visit. Furthermore, results from interviews with experts on biodiversity projects and restoration ecology are presented. In the first section, the background and purpose of performing a biodiversity pilot project are presented. This section is based on company policy, internal desk studies, and conversations with project developers. Next, the findings from observations of the project development process and interviews with involved stakeholders are compiled and presented. Lastly, expert perceptions on key factors to consider in biodiversity enhancement projects are presented.

A summary of the biodiversity pilot project process and the scope of the case study for the degree project is illustrated in Figure 6.1. The scope of the case study includes phases 1 and 2. The enhancement measures have not been implemented yet due to delays, but are planned for spring/summer 2024. It was not possible to conduct an interview with the energy investment company, but key opinions from the project development meetings are included.

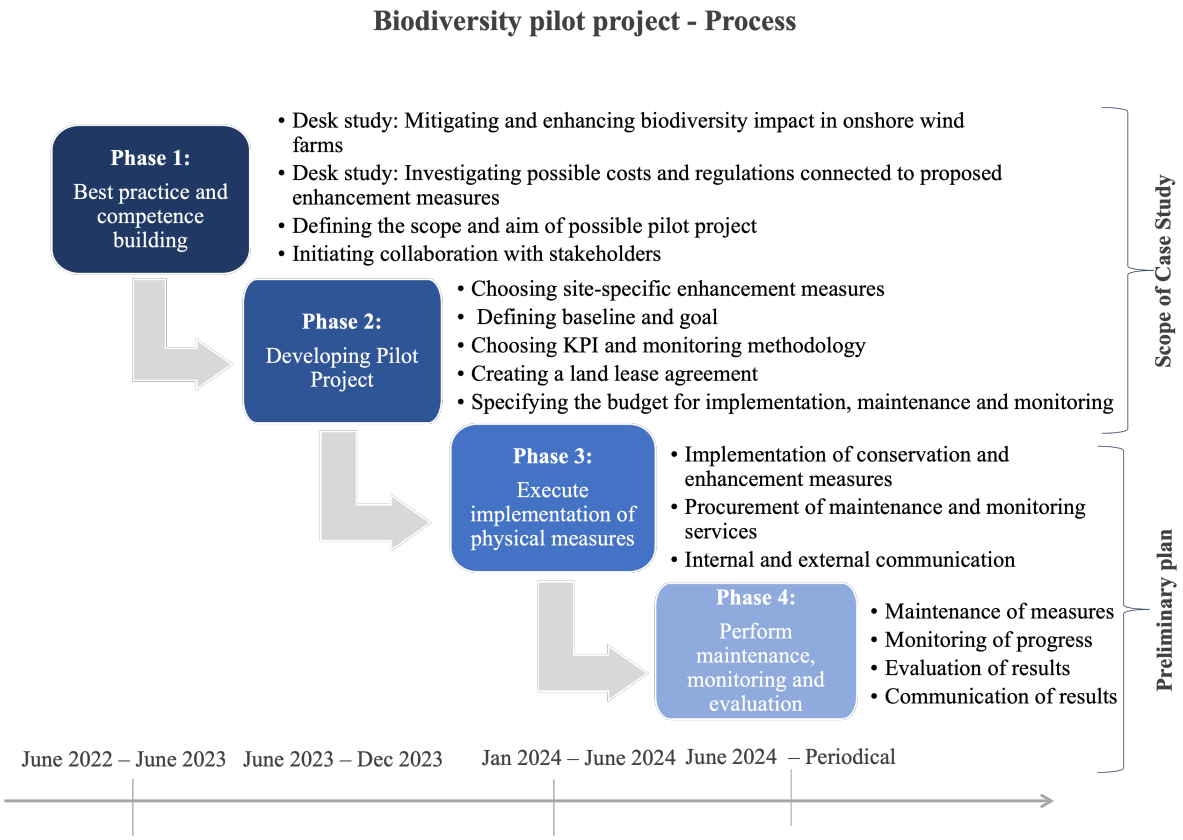

Figure 6.1: Schematic illustration of biodiversity pilot project process.

6.1 Background

RWE AG is a global energy company founded in Germany in 1889. RWE produces energy from a wide range of sources including gas, hard coal, hydrogen, hydropower, biomass, wind, and solar. The company is now in a transition to become climate neutral by 2040 and the subsidiaries RWE Renewables Europe and Australia GmbH and RWE Offshore Wind GmbH are key business areas (RWE, 2021). RWE is now one of the largest operators in renewable electricity production and is largely investing in the expansion of onshore wind power in Europe, America, and Australia (RWE, n.d.). In addition to becoming climate neutral, RWE aims to have a net-positive impact on biodiversity at new assets from 2030 (RWE, 2021).

RWE has a biodiversity policy that consists of a set of principles including following the mitigation hierarchy, aiming for a net-positive impact on biodiversity on new assets from 2030, aligning targets with SBT for Nature, and contributing to SDG 14 and 15, among others, see Box below (RWE, 2022).

RWE Biodiversity Principles

- For newly established assets, RWE's goal is to achieve a net-positive impact on biodiversity by 2030, unless local regulations mandate an earlier deadline.
- RWE strictly follows the mitigation hierarchy principles, prioritising avoidance, minimisation, regeneration/restoration, and compensation when necessary to address potential impacts on biodiversity.
- RWE actively gathers knowledge regarding the effects of the energy sector on biodiversity and wildlife.
- RWE aligns with best practices for setting science-based targets, with guidance from initiatives like Science-Based Targets for Nature (SBTN).
- RWE makes efforts to contribute to the UN Sustainable Development Goals, specifically Goal 14 and Goal 15.

Source: (RWE, 2022)

As a part of the strategy to contribute to net-positive biodiversity impact on new assets the possibility of increasing biodiversity in an onshore wind farm, by following the mitigation hierarchy and implementing enhancement measures, was examined in two desk studies by RWE interns. The scope of the studies was wind farms in Nordic forest environment. The desk studies resulted in the generic biodiversity enhancement measures, presented in Figure 6.2.

To understand the practical feasibility of implementing these biodiversity measures in a wind farm, a biodiversity pilot project was initiated by the onshore development team at RWE Renewables in Sweden. The aim of performing a pilot project was to attain knowledge on how to contribute to a net-positive biodiversity impact in a wind farm. The knowledge gaps the pilot project was aimed to fill are outlined in the Box below.

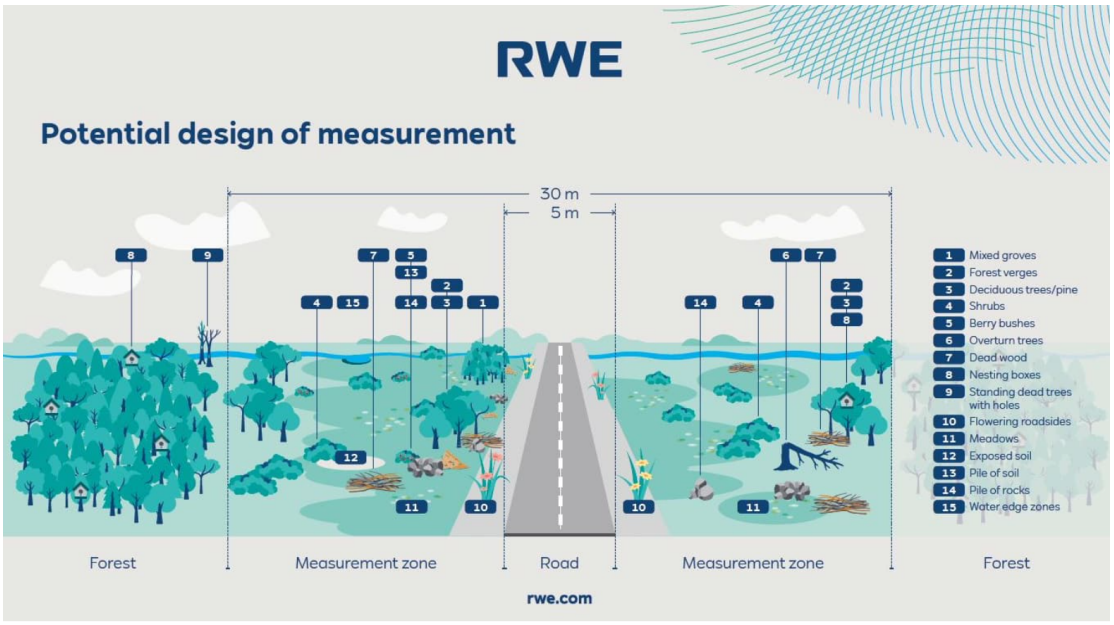

Figure 6.2: Examples of biodiversity biodiversity enhancement measures adapted for a wind farm in a forest environment. Source: RWE

Biodiversity pilot project: Knowledge gaps

- Biodiversity enhancement measures suitable to Nordic conditions
- Legal requirements for implementing biodiversity enhancement measures
- Suitable format for maintenance and monitoring plans
- Suitable KPIs and assessment models for evaluation of measures
- Cost of implementation, maintenance, and monitoring
- Content of Land lease agreement

Source: (RWE, 2023)

From this, a suitable wind farm for testing these measures in a pilot project was identified. When one of the landowners expressed interest in performing forest conservation measures in connection to the project site a collaboration was initiated and the location for the pilot project was decided. The site is located in the middle part of Sweden, and the wind farm has been in operation since a few years back. The landscape is characterised by hilly forests, primarily owned by large forest companies and private landowners. The Environmental Impact Assessment (EIA) indicated that the majority of the forest in the area has been utilised for forestry, featuring prepared production land with spruce and coniferous forest, along with some deciduous forest. About 18% of the area was classified as having ecological values in the natural value inventory conducted before the construction of the wind farm. The nature reserves in the surrounding area are primarily protected for their spruce and coniferous forest hosting red-listed lichens. (RWE, 2023)

In addition to RWE and the forest company owning the land, an energy investment company owning shares of the wind farm and an environmental consultant company were involved in the pilot project. The stakeholders that have been a part of the project development process are two project developers and a site manager from RWE (referred to as the energy company), the landowner representative from

the forest company, the investor representative from the energy investment firm, and a biodiversity specialist from the environmental consultant company, see Table 6.1. The roles and responsibilities of stakeholders are further explained in 6.2.2.

Table 6.1: Stakeholders in biodiversity pilot project

Company	Roles
Energy company	Project developers (2), Site manager
Forest company	Landowner representative
Energy investment company	Investment company representative
Environmental consulting company	Biodiversity specialist

6.2 Developing the pilot project

6.2.1 Opportunities and objectives of the pilot project

The involved parties saw several positive impacts and opportunities emerging from the pilot project. The energy company saw an opportunity to gather the knowledge necessary to reach company targets related to biodiversity, contribute to the local environment, and improve the relationship with the landowner. Moreover, the project developers and site manager expressed that the project contributed to a rewarding work environment as they share a personal interest in ecology. Possible economic benefits emerging from the pilot project were mentioned as a future opportunity. Since the forest company is a foundation, and participating in research projects is a key business activity, they saw an opportunity to contribute with knowledge to increase natural values in the area and create shared value with the energy company. In addition, they experience an increased interest in sustainable forest management from stakeholders and the project can contribute to increased brand value. The biodiversity specialist from the consultant company stated that there is an opportunity to increase the biodiversity in the landscape if feasible ACAs are integrated as a standard and implemented in multiple projects.

6.2.2 Roles and Responsibilities in the pilot project

Energy company

The main driver of the pilot project is the energy company. The project developers from the energy company work in onshore development of wind power and both have a background in environmental engineering and a personal interest in biodiversity. The project developers have been responsible for desk studies, coordinating involved stakeholders, financing measures, and managing the development of the project. In addition, the site manager of the wind farm was involved in the project. The site manager has responsibility for local contact, procurement of contracts, and control of daily operations related to the wind farm. In the pilot project, the site manager has had contact with the landowner and enabled site visits.

Forest Company

The landowner representative from the forest company has great experience working with forest

management in the local areas and is an educated forester. The forest company is a foundation with support for research and knowledge development as a main part of their business. The forest company has extensive experience with forest conservation measures and managing forests in alignment with sustainability certifications. In the pilot project, the landowner representative has contributed with knowledge of suitable enhancement measures in the local environment, provided the expected cost for implementation, and has responsibility for hiring contractors to perform measures. The forest company showed an early interest in using the area for conservation purposes and is co-funding the project.

Environmental consultant firm

The environmental consultant company was hired to involve biodiversity specialists in designing the pilot project. The consultant has an education in biology and experience in biodiversity, and forestry and has worked with biodiversity enhancement in previous projects. In the pilot project, the consultant have been responsible for suggesting and locating suitable enhancement measures, making maintenance and monitoring instructions, presenting suitable KPIs to follow up results, and documenting key information of the project in a report.

Energy Investment Company

The energy investment company owns a large share of the wind farm and has joined the pilot project as a co-funder. The representative has a background in environmental sciences and knowledge of biodiversity. The representative has been a part of the planning process contributing with thoughts on best practices and legislative risks.

6.2.3 Choosing biodiversity enhancement measures

The biodiversity specialist from the environmental consulting company was hired to recommend suitable site-specific enhancement measures, maintenance, and monitoring methods for the biodiversity pilot project. The biodiversity specialist performed an overarching field inventory on the site summer of 2023 together with the landowner representative and one of the project developers. With site-specific knowledge and access to previously performed desk studies, a selection of enhancement measures suitable for the site was presented by the biodiversity specialist.

The choice of enhancement measures to proceed with was discussed in the project development meetings. Key aspects that were discussed were possible regulations coming with measures, the size of the area required, possible conflicts with wind farm operations, the cost of implementation and maintenance, and the risk of attracting unwanted species to the site. It was decided to implement several enhancement measures with control areas instead of implementing one measure on a larger surface. This decision was made to gain knowledge on the feasibility of several suggestions for implementation in future projects. The enhancement measures chosen for the pilot project are presented below.

Biodiversity Enhancement Measures and Favored Species

- **Dead wood:** Favors insects, lichens, wood fungi, and mosses.
- **Shading water:** Favors aquatic organisms.
- **Sand beds:** Attracts birds and pollinators.
- **Forest edges:** Beneficial for birds and insects.
- **Flowering road sides:** Supports flora and insect fauna.
- **Willows:** Attracts pollinating insects and birds.
- **Favor deciduous trees:** Increase heterogeneity in the landscape.
- **Bird lumberjacks:** Habitats for small birds.

Source: (RWE, 2023)

6.2.4 Challenges in the pilot project

When discussing which parts of the project the stakeholders found challenging, the first trial concerned setting a common objective and ambition with multiple stakeholders involved and many uncertainties in expected outcomes. The project developers found it difficult to estimate the economic resources needed to implement and maintain the measures to attain objectives. In addition, specifying procurement agreements was difficult due to the novelty of this kind of project in the industry. Moreover, the involved parties expressed that the project development process was time demanding and this additional workload is not specified in their area of responsibility. However, involved parts found the work rewarding and stated that an additional project would require less time as this was a pilot project.

Further challenges that were discussed in the project planning were defining the scope of impact, baseline, and choosing KPIs to follow up results. When choosing the scope of the biodiversity impact there were discussions on how to choose the baseline, e.g. before or after the construction of the wind farm and how surrounding forestry practice could impact the pilot project. The energy investment representative stressed the importance of having science-based KPIs and follow-up measures to be able to show the impact of the pilot project.

Moreover, the legislative and ecological risks of implementing enhancement measures on the site were discussed. Legislative risks discussed were possible additional permit requirements according to the Swedish environmental law, e.g. implementing measures that could affect the hydrology of the area. Ecological aspects that were discussed concerned the risk of attracting animals, that could be negatively impacted by the operations, to the site. Lastly, the definition of net-positive impact and how to communicate the expected outcomes of the project was discussed. The communication challenge is highly connected to the scope and baseline of the project and without metrics tied to definitions of no net loss and net positive the interpretation becomes a challenge.

6.2.5 Takeaways and future undertakings

When discussing learnings from the project development process and possibilities for future projects the project developers stated that a clear objective of the scope, ambition, and baseline outlined early on facilitates the project's efficiency.

Moreover, having a clear time plan early on with regard to season-dependent activities would minimise the risk of delaying the project. The landowner representative also emphasised that early planning of suitable enhancement measures would create opportunities for finding synergies in the construction phase. Examples are, using machinery brought to the site for vegetation clearance for enhancement measures, using dead wood from removed trees, and being able to favour desired vegetation growing on newly cleared land.

Additional possibilities for future projects highlighted by the biodiversity specialist were finding synergies in the initial field inventories conducted for the EIA of the wind farm. The main focus in the field inventory is to avoid damaging natural values in the area but as an addition enhancement measures to support or connect existing values could be identified.

Lastly, expanding cooperation with more landowners to be able to perform actions over a larger surface would increase the opportunity the have a positive impact. All parties agreed that the enhancement measures should be covered in an agreement between the landowners and the energy company but not be included in the wind farm permit as it might delay the permit process which already is a critical issue. When discussing whether or not off-site conservation would be an alternative the project developers stated that it could be an option in second hand. An off-set project would lose the benefits of local connection and finding synergies in the early inventory and construction phase.

The next steps in the project include the physical implementation of the measures, procurement of maintenance and monitoring services, and communication plan. The involved parties without enforced future responsibilities expressed that they will continue to follow the project because of personal interest in the subject and the results. The landowner representative expressed interest in expanding the area if the measures show positive results.

6.3 Expert perceptions on biodiversity enhancement projects

To gain external perspectives on important factors to consider when planning a biodiversity project two experts on the subject were interviewed. The first interviewee is a senior lecturer at a Swedish University with competence areas in biodiversity impact from land use, mostly forestry and mining, and the complexity of defining and measuring biodiversity. The second interviewee is a landscape architect working as an environmental consultant with expertise in nature-based solutions, biodiversity projects, and biodiversity assessment models.

When discussing key factors to consider when a company is planning a biodiversity enhancement project having a clear understanding of the overall impact and baseline is mentioned as an important start. Are the measures supposed to compensate for the negative impacts on the site or contribute with additional value compared to pre-development? The definition of the objective is important, is the aim to increase the number of species, favor a specific habitat, or increase connectivity between value cores? Aiming to increase biodiversity is not a clear definition in itself. Moreover, there should be a plan to monitor and measure the impact of the project with science-based methods. Involving an ecologist early in the project planning can facilitate the planning process.

When choosing which measures to implement and if the project should be on-site or off-site there are several aspects to consider. One of the experts emphasised that financing the protection of threatened areas with high biodiversity values could have a greater positive impact than performing restoration measures on-site. It is important to assess site conditions and evaluate the possibilities of successfully creating long-lasting natural values suitable for the landscape. If this is not possible, financing the protection of biodiversity off-site through e.g. biocredits could be preferable. However, the second interviewee stated that mitigating impacts and performing enhancement measures onsite is a good

start for biodiversity engagement and that restoration and enhancement measures can have great value due to the large areas of land that have been degraded due to human activity.

If the company chooses to implement on-site measures it is important to create a management plan including maintenance, monitoring, and measuring methods. Key factors emphasised by experts are performing detailed field studies before and after implementation, using control areas, and choosing indicator species. Examples of monitoring methods are transecting or using E-DNA. Fixed species, e.g. fungi can be easier to follow up on if the project area is small. Moreover, using established standards (Table 4.1) for evaluation and the CLIMB model is recommended if measures to improve habitats on a large surface of the project area are implemented.

The fact that companies are engaging in protection and restoration of biodiversity is very positive according to the interviewees. There are opportunities for companies to collaborate with research programs and universities to contribute to science and make a positive impact. Moreover, performing a thorough assessment of biodiversity impact can facilitate communication with stakeholders on environmental performance and support material for project alignment with the mitigation hierarchy.

However, companies must be transparent in their communication showing both negative and positive impacts and being clear with assumptions, uncertainties, and improvement areas. Many of the assessment tools and guidelines of biodiversity assessment are rather novel and case studies are needed to evaluate if the objectives are met with these methods. Moreover, co-developing a biodiversity project with an infrastructure project is an iterative process. The project layout can change during the planning process due to several interests competing.

7 Analysis and Discussion

In this chapter, the results presented in chapters 4, 5, and 6 are analysed and discussed to answer the research questions of the report. Results from the literature review, survey, and case study are all taken into account to discuss different perspectives related to the research questions.

Research questions

1. What incentives and regulations influence biodiversity management in the wind power industry?
2. What opportunities and challenges do wind power companies encounter in biodiversity management?
3. What are the key factors to consider when planning a biodiversity enhancement project in an onshore wind farm?

7.1 Incentives and Regulations

The alarming rate of biodiversity loss has triggered the urgent need for action globally and aligning companies and financial institutions with the vision and mission of the Global Biodiversity Framework. There has been a notable shift in regulatory approaches, moving from traditional prohibition-based measures to more information-based engagement with corporations. This shift can be seen in the targets outlined in the Global Biodiversity Framework, particularly Targets 15 and 19.

The mainstreaming and implementation of biodiversity policies in both the public and private sectors are increasing. Recently adopted policies concern increasing requirements on monitoring, reporting, transparency, and risk awareness, aiming to facilitate investments in biodiversity and promote sustainable consumption patterns. These regulatory changes are taking shape in both EU regulations, e.g., EU Taxonomy and CSRD, and voluntary market initiatives, such as the Science Based Targets for Nature and the Task Force on Nature-related Financial Disclosures. With that said, many policies and tools are still in development, with implementation at the national level not yet in place. Moreover, economic instruments to finance protection and restoration, e.g. Biocredits and sustainability certifications, will likely play a big part in future biodiversity management. However, the launch of public Biocredits can take a long time to develop because of the difficulties in creating common metrics and guidelines for when a biodiversity enhancement measure has fulfilled the worth of a Biocredit. A compiled analysis of biodiversity policy influencing wind power companies in Sweden is presented in Table 7.1.

Furthermore, the trade-off between the expansion of renewable energy and the protection of local biodiversity is a complex dilemma. The use of nature-positive goals is increasing and wind power being a key factor in mitigating climate change complicates the equation as climate change is a direct driver of biodiversity loss. Whether or not the use of net-positive or no-net-loss biodiversity impact should be used to provide the industry with exemptions on regulations which are protecting local species is not clear. If the mitigation hierarchy is correctly followed avoidance of negative impact is best practice. However, if this would result in a global loss of natural values due to failure in climate change mitigation is it still the preferred choice? It is important to support the expansion of wind

power to be able to phase out fossil fuels but with this expansion negative impact on ecological values that are non-replaceable, such as primeval forest, should be avoided at all costs. Looking at the larger picture wind power has a low environmental impact compared to many other energy sources, meaning that the environmental impact from an alternative energy production scenario should be taken into consideration when rejecting a wind power project. With that said, it is difficult to calculate the indirect and cumulative impact on biodiversity from wind power, and moving away from following the mitigation hierarchy on-site could be a risk.

Table 7.1: Biodiversity policy instruments influencing the wind power industry, non-extensive.

Instrument	Type	Objective	Scope	Applicability for wind power companies
CBD - GBF	Regulatory	• Align global objectives and facilitate international cooperation	Global	Indirect mandatory
The Mitigation Hierarchy	Information	• Provide guidance on best practice	Global	Direct voluntary
TNFD	Information	• Facilitate risk awareness and transparency	Global	Direct voluntary
SBTN	Information	• Align corporate policy with science	Global	Direct voluntary
ESG	Information	• Redistribute capital, facilitate sustainable investments	Global	Direct voluntary
Certifications	Information	• Facilitate sustainable consumption patterns	Global	Direct voluntary
Biocredits	Economic	• Financing of biodiversity protection and restoration	Global	Indirect/Direct voluntary
Birds and Habitats directives	Regulatory	• Biodiversity protection	EU	Direct mandatory
CSRD and ESRS	Regulatory	• Increase transparency and common reporting standards	EU	Direct mandatory
Eu Taxonomy	Information	• Facilitate credible communication on sustainable activities	EU	Direct mandatory/voluntary
SFDR	Information	• Increase risk transparency and redistribute capital	EU	Indirect mandatory
EIA in the Environmental Code	Regulatory	• Biodiversity Protection	National	Direct mandatory

7.2 Opportunities and Challenges

The challenge of balancing renewable energy expansion with biodiversity protection is novel with lots of new rules and laws to navigate. Net positive project goals are becoming more popular being fairly easy to scope compared to value chain impact and addressing the direct impacts of operations is a solid first step. In the future, the wind power industry could benefit from biodiversity management collaboration with stakeholders in the supply chain as the demand for environmental impact awareness throughout the value chain is increasing.

There are lots of opportunities emerging from biodiversity management connected to wind power development, on both industry, company, and project levels. For the industry as a whole, wind power is already a competitive energy choice to mitigate climate change, especially when it is located to minimise environmental impact. Improved biodiversity management would address concerns regarding large area footprint from wind power expansion and could facilitate political support. On a company level, improved biodiversity management could attract investments, create new revenue streams, and improve brand reputation. Moreover, with an increase in mandatory sustainability reporting regulations including criteria on biodiversity impact, this would ensure that the company stays ahead of the regulatory curve. At the project level, obtaining local acceptance and contributing to local value is important. Proving that biodiversity management is a key matter of the company and project could facilitate regulatory permits and gaining a social license to operate. Although biodiversity enhancement measures going beyond Swedish legislation are not taken into consideration by the public permitting authorities, the initiative could improve relationships with landowners facilitating the project. Successful application of the mitigation hierarchy and ACAs could also enhance attractiveness to investors with requirements related to biodiversity protection and restoration.

Engaging in biodiversity management presents many opportunities, but it also brings challenges that must be addressed. The complexity varies depending on the scope, whether it involves direct drivers of biodiversity loss or solely the direct impact on local species. It is a critical task for wind power companies to streamline the permit process and maintain competitive prices while also minimising negative biodiversity impacts. Moreover, there is a lack of common metrics and definitions in the field and high competition for employees with expertise in biodiversity management. A compiled analysis of opportunities emerging from successful biodiversity management in the wind power industry is presented in Table 7.2. Further, a compiled analysis of challenges to address concerning biodiversity management in the wind power industry is presented in Table 7.3. The analysis is based on categories highlighted by (Finisdore et al., 2012) and split into industry, company, and project-specific matters for clarity.

Table 7.2: Possible opportunities emerging from successful Biodiversity Management in the Wind Power industry.

Opportunities	Industry	Company	Project
Operational	• Collaboration with universities and research programs	• Increased access to land if successful co-existence with nature conservation is demonstrated	• Improved relations with landowners and local business
Regulatory and legal	• Compliance with international treaties and GBF	• Compliance with mandatory reporting regulations, e.g. CSRD	• Compliance with EIA and permit process
Reputational	• Political support to expand when addressing both climate change and biodiversity loss	• Being an attractive employer • Having a green brand reputation	• Social license to operate, taking responsibility for local impact
Market and Product	• Combining renewable energy production and restoration measures on degraded land	• Aligning business activities with EU taxonomy • Market for certified products • New revenue streams	• Selling environmentally certified electricity • Creating shared value with landowner
Financing	• Governmental support for sustainable business activities	• Qualifying for green bonds and loans • Access to ESG investments	• Proving sustainable development of wind farm for investors

Table 7.3: Challenges to address concerning Biodiversity Management in the Wind Power industry

Challenges	Industry	Company	Project
Operational	• Establishing collaboration between sectors involved in supply chain	• Reduced access to land with increasing areas of no-go zones	• Increased maintenance and monitoring services required on-site
Regulatory and legal	• Aligning standards on best practices with differences in national legislation	• Uncertainty on additional permit requirements for ACAs with international differences in legislation	• Additional actions in the project development phase could extend lead times in the permit process
Reputational	• Balancing the need for a fast transition to a renewable energy system and local environmental protection	• Credibly communicate nature-positive or net-positive targets, avoiding greenwashing	• Showing the impact of measures with the risk of external factors affecting natural values on site
Market and Product	• Aligning standards on best practices with local differences in ecological conditions	• Prioritising actions contributing with greatest biodiversity value, e.g. onsite or offsite	• Land lease agreements restrict the ambition and longevity of site measures
Financing	• Including stop-areas "mitigation avoidance" can result in less access to land	• Showing return on investment for shareholders • Risk of price pressure in tendering	• Additional employee time and resources for project • Financing of ACAs

7.3 Project takeaways

With increasing amounts of corporate targets aiming to have a net-positive biodiversity impact on-site key factors to consider in the planning process have been examined. The analysis of possible challenges and recommendations are based on results from the case study and recommendations on best practices from the literature review. Factors and recommendations to consider when planning a biodiversity enhancement project in an onshore wind farm are presented in Table 7.4.

When planning a biodiversity enhancement project on an onshore wind farm it is possible to find synergies in the development and construction phases. Even if the enhancement measures are not included in the EIA and permit process there is a possibility to integrate enhancement measures in the development process as experts on local ecology, environmental law are involved. Moreover, machinery brought to the site for construction can be used for enhancement measures e.g., creating dead wood or thinning to favour natural value trees.

Defining project goals and objectives with a baseline is important as aiming to increase biodiversity has many different meanings, e.g., increasing the abundance of a threatened species or favouring specific habitats. Moreover, estimating the costs of the project involves not only implementation costs but also planning long-term financing of maintenance and monitoring in collaboration with landowners. Conservation and restoration measures require different levels of maintenance and have individual monitoring methods which impacts the long-term financing need. Depending on the budget of the project choosing enhancement measures suited to the local environment and deciding between on-site and off-site actions are important quality considerations. On-site measures enable synergies with the development process and create value for the local environment. However, in some cases, off-site protection of threatened key biodiversity areas could contribute to a greater biodiversity value as nature is complex, and the ability to perform successful restoration measures depends on the site condition. When enhancement measures are chosen a risk assessment is needed to address ecological and legal uncertainties with expert input. Lastly, clear roles of responsibility, transparent external communication, and clear long-term management and monitoring plans are important for project success. Choosing a measurement method to evaluate the result of the project can be difficult, the choice of measurement methods depends on the ecological conditions and the scope of the project, consult experts, and stay up to date with recommendations on best practices. As there are many biodiversity indicators to choose from, the most important part is to be able to motivate why the methodology was the preferred one for this specific project.

In the future collaboration in biodiversity management between sectors could increase as the sites for renewable energy production often co-exist with other business activities, e.g. forestry or agriculture. Land use and biodiversity impact are important topics for these companies too and there are opportunities for collaboration between sectors to perform larger actions to promote biodiversity. Additional future aspects to consider are increasing pressure on companies to take responsibility for historic emissions, stricter regulations on green claims, and social justice aspects. This pressure would require investments in technical carbon removal techniques or investments in natural carbon sequestration, such as wetland restoration or mangrove protections. While this report primarily focuses on biodiversity, it's important to also consider social justice aspects and minimise disturbances to local communities.

Table 7.4: Factors to consider when planning a biodiversity enhancement project in an onshore wind farm.

Factors in Project Development	Challenges	Recommendations
Time	• Risk of delaying project process • Seasonal dependence of ecological inventories and measures	• Choose to perform ACAs as a parallel process independent of the permit • Take advantage of possible synergies in filed inventories and construction phase
Cost	• Difficulty in estimating the cost to obtain a net-positive impact • Decision on long-term financing of maintenance and monitoring measures	• Collaborate with landowners having more experience with implementing conservation measures • Invest in pilot projects in different environments to obtain estimates of cost to obtain net gain
Risk	• Ecological: Uncertainty on impacts of attracting animals to the project site. • Legislative: uncertainty on measures requiring additional permits	• Have an open dialogue with the county board • Involve legal and ecology experts early in project planning
Scope	• Defining a clear objective for the project • Deciding if impact outside the land lease agreement should be taken into account • Defining a baseline to measure progress	• Specify if the aim of the project and adjust baseline. • E.g. to favour specific species, habitats, increase connectivity etc.
Quality	• Estimating which actions contribute to biodiversity values the most • Choosing onsite/off-site • Performing multiple smaller measures or few over a large area	• Allocate funding on company level to address key biodiversity impact • Include resources to perform feasible on-site enhancement measures in the project budget
Human resources	• Estimating the amount of time to allocate to project planning without clear roles of responsibility	• Hire biodiversity coordinators supporting project developers on a national level
Comunication	• Deciding how to communicate results from projects related to NNL/NP or Nature Positive targets	• Transparent communication on objectives, limitations and assumptions • Stay up to date on recommended best practices and assessment tools
Integration	• Deciding if the project should be integrated into the permit and construction phase of the wind farm or not	• Adjust integration depending on national legislation • Going beyond permit demands can still result in non-regulatory benefits
Procurement	• Designing clear procurement instructions for consultants without clear guidelines and standards restoration practices	• Collaborate with landowners who have more experience in this field and share knowledge within sector

8 Conclusion

There are several incentives and regulations that are influencing biodiversity management in the wind power industry and they have different objectives and exist at global, regional, and national levels. Globally, the main regulation influencing the development of regional and national biodiversity policy and market initiatives is the Convention on Biological Diversity and the Global Biodiversity Framework. The 2030 Mission in the Global Biodiversity Framework, to halt and reverse biodiversity loss, encourages companies to aim for a nature-positive business strategy and engage in both mitigation and regeneration of biodiversity. Moreover, Target 15 and 19 in the Global Biodiversity Framework have developed biodiversity policy from traditional protection of natural values to integrating biodiversity considerations into the financial system, improving transparency and information sharing, and facilitating greater biodiversity risk awareness among stakeholders. TNFD, SBTN, and ESG are global voluntary instruments facilitating sustainability information sharing and environmental risk awareness.

At the regional level, regulations on biodiversity play a significant role for wind power companies, particularly in the EU. Directives such as the Birds and Habitats Directives mandate whether or not a wind farm will obtain permission to operate depending on the risk of harming conservation species and habitats of the directives. Additionally, EU regulations like the CSRD and SFDR promote transparency and common reporting standards, encouraging wind power companies to disclose their environmental impacts and biodiversity management practices. Moreover, the EU Taxonomy facilitates credible communication on sustainable activities. Companies that are aligning their operations with the EU Taxonomy must address the six sustainability objectives including, climate change mitigation and biodiversity and ecosystems. Nationally, regulations like the EIA in the Environmental Code mandate wind power companies to perform comprehensive evaluations of localisation with regard to local biodiversity, ensuring that wind power projects undergo environmental assessments to mitigate their impacts on natural values. Lastly, the development of voluntary economic incentives like Biocredits and sustainability certifications is increasing, and there is a possibility of generating direct revenue from biodiversity conservation and restoration measures in the future.

Through a combination of surveys and interviews with wind power companies having operations in Sweden, key insights into the state of biodiversity management were obtained. Current biodiversity management in the wind power industry primarily focuses on mitigation strategies, conservation measures onsite, and research participation. However, a shift towards setting targets going beyond legislation, e.g. achieving a net-positive biodiversity impact on project sites by 2030 was noted. This shows a growing recognition of the importance of integrating biodiversity considerations into business operations. Key incentives for biodiversity management concerned enhancing acceptance of wind power projects, complying with regulations for permits, and obtaining a green brand reputation. However, several barriers hinder progress in biodiversity management, including immature metrics and guidelines, legal uncertainties on measures going beyond permit requirements, and communication challenges connected to net positive biodiversity impact. Addressing these barriers is important for advancing biodiversity management efforts within the industry. Looking ahead, there is a demand for clearer guidelines related to enhancement measures and biodiversity metrics, increased recognition from public authorities, and alignment with social sustainability to improve biodiversity management.

Wind power companies encounter both opportunities and challenges in biodiversity management. Opportunities include improved area footprint with successful coexistence with conservation efforts,

political support for climate-biodiversity initiatives, and access to green financing. Moreover, aligning business strategy with international treaties, regional incentives, and national regulations related to biodiversity offers regulatory advantages and increases the brand value. Market-wise, combining renewables with the restoration of degraded land and offering certified products could result in new revenue streams. However, operational challenges like collaboration within the supply chain and increased project maintenance costs are obstacles. Moreover, regulatory challenges involve aligning industry standards with differences in national laws. Barriers related to reputation and brand value concern balancing a fast transition to a renewable energy system with local environmental protection. Lastly, lack of internal knowledge on the subject and difficulty demonstrating when a positive biodiversity impact is obtained are obstacles that should be addressed.

To contribute to the 2030 mission to halt and reverse global biodiversity loss several wind power companies have targets to obtain a net positive biodiversity impact onsite. When planning a biodiversity enhancement project in an onshore wind farm, several factors should be addressed to obtain a successful implementation. Time management is important due to the risk of project delays and seasonal dependencies. Synergies from natural inventories and construction are easier to make use of with early planning and the implementation of nature conservation measures is dependent on seasons and weather. When making cost estimations long-term financing should be assessed with regard to maintenance, monitoring, and possible compensations for landowners. A risk assessment should be performed to address ecological and legislative uncertainties related to enhancement measures, requiring expert involvement. Defining the project scope and objectives, including baseline measurements, is essential for progress tracking and clear communication on results. Furthermore, considerations regarding the quality of the project involve identifying enhancement measures that are suitable for the local environment and deciding whether onsite or offsite measures would contribute to the largest positive impact. Moreover, detailed procurement instructions and collaboration with experienced partners could facilitate the implementation of enhancement measures. Lastly, clear roles of responsibility, transparent communication, and long-term management plans for the enhancement measures are essential for a successful project.

Finally, it is important the keep in mind that climate change is a direct driver of biodiversity loss. The transition to a renewable energy system with an expansion of wind power is in itself mitigating biodiversity loss. Wind power companies that are engaging in biodiversity conservation and restoration going beyond legislation are leading actors. Although there are uncertainties and challenges to navigate, these shouldn't discourage companies from engaging in biodiversity management efforts. Transparency and collaborative action within and between sectors and governments are vital in mitigating biodiversity loss and addressing climate change collectively.

References

Arlidge, W. N. S., Bull, J. W., Addison, P. F. E., Burgass, M. J., andTaylor M Gorham, D. G., Jacob, C., Shumway, N., Sinclair, S. P., Watson, J. E. M., Wilcox, C., & Milner-Gulland, E. J. (2018). A global mitigation hierarchy for nature conservation. *BioScience*, *Volume 68, Issue 5*, Pages 336–347. https://doi.org/10.1093/biosci/biy029

Asselin, A., Rabaud, S., Catalan, C., Leveque, B., L'Haridon, J., Martz, P., & Neveux, G. (2020). Product biodiversity footprint – a novel approach to compare the impact of products on biodiversity combining life cycle assessment and ecology. *Journal of Cleaner Production*, *Volume 248*. https://doi.org/10.1016/j.jclepro.2019.119262

Bennun, L., van Bochove, J., Ng, C., Fletcher, C., Wilson, D., Phair, N., & Carbone, G. (2021). *Mitigating biodiversity impacts associated with solar and wind energy development. guidelines for project developers.* Gland, Switzerland: IUCN; Cambridge, UK: The Biodiversity Consultancy. https://doi.org/10.2305/IUCN.CH.2021.04.en

Biodiversity Indicators Partnership. (n.d.). *The biodiversity indicators partnership*. https://www.bipindicators.net (accessed: 12.01.2024).

Boffo, R., & Patalano, R. (2020). *Esg investing: Practices, progress and challenges*. OECD Paris. https://www.oecd.org/finance/ESG-Investing-Practices-Progress-Challenges.pdf

Bra Miljöval. (n.d.). *El märkt med bra miljöval*. https://www.bramiljoval.se/omraden/elenergi/ (accessed: 12.01.2024).

Business for Nature. (2022). *How business and finance can contribute to a nature positive future now*. https://static1.squarespace.com/static/5d777de8109c315fd22faf3a/t/634d83b8e5d4747f24935a8c/1666024380378/Nature+Positive+Discussion+Paper_Final.pdf

CBD Secreteriat. (2023). *2050 vision and 2030 mission*. https://www.cbd.int/gbf/vision (accessed: 12.01.2024).

CDP. (2023). *Efrag and cdp announce cooperation to drive market uptake of european sustainability reporting standards*. https://www.cdp.net/en/articles/companies/efrag-and-cdp-announce-cooperation-to-drive-market-uptake-of-european-sustainability-reporting-standards (accessed: 03.12.2023).

Christiernsson, A. (2021). *Rätten som styrmedel för att bevara biologisk mångfald - biologisk mångfald, naturnyttor, ekosystemtjänster. svenska perspektiv på livsviktiga framtidsfrågor.*

CBM:s skriftserie 121, SLU Centrum för biologisk mångfald, Uppsala Naturvårdsverket, Stockholm.

CLIMB. (n.d.-a). *Changing lan use impact on biodiversity*. https://climb.ecogain.se (accessed: 03.12.2023).

CLIMB. (n.d.-b). *Metod*. https://climb.ecogain.se/method (accessed: 05.12.2023).

Convention on Biological Diveristy. (2022). *Cop15: Nations adopt four goals, 23 targets for 2030 in landmark un biodiversity agreement*. https://www.cbd.int/article/cop15-cbd-press-release-final-19dec2022

Council of the EU. (2023). *European green bonds: Council adopts new regulation to promote sustainable finance*. https://www.consilium.europa.eu/en/press/press-releases/2023/10/24/european-green-bonds-council-adopts-new-regulation-to-promote-sustainable-finance/#:~:text=The%20Council%20adopted%20a%20regulation,for%20their%20environmentally%20sustainable%20bonds. (accessed: 17.12.2023).

Directorate-General for Financial Stability, Financial Services and Capital Markets Union. (2023). *Sustainable finance package*. https://finance.ec.europa.eu/publications/sustainable-finance-package-2023_en (accessed: 16.12.2023).

Ducros, A., & Steele, P. (2022). *Biocredits to finance nature and people: Emerging lessons*. IIED, London. https://www.iied.org/sites/default/files/pdfs/2022-11/21216IIED.pdf

Ebenhard, T. (2021). *Vad är cbd? - biologisk mångfald, naturnyttor, ekosystemtjänster. svenska perspektiv på livsviktiga framtidsfrågor.* CBM:s skriftserie 121, SLU Centrum för biologisk mångfald, Uppsala Naturvårdsverket, Stockholm.

EFRAG. (2023). *Esrs e4 biodiversity and ecosystems*. https://efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2FESRS%2520E4%2520Delegated-act-2023-5303-annex-1_en.pdf

Ekstrom, J., Bennun, L., & Mitchell, R. (2015). *A cross-sector guide for implementing the mitigation hierarchy*. CSBI, The Biodiversity Consultancy Ltd. http://www.csbi.org.uk/wp-content/uploads/2017/10/CSBI-Mitigation-Hierarchy-Guide.pdf

Energimyndigheten. (2021). *Nationell strategi för en hållbar vindkraft*. Energimynigheten.

Energimyndigheten, Naturvårdsverket. (2021). *Analys av juridiska förutsättningar för en hållbar vindkraftsutbyggnad - underlag till nationell strategi för en hållbar vindkraftsutbyggnad*. Energimyndigheten. https://www.energimyndigheten.se/48ff35/globalassets/fornybart/strategi-for-hallbar-vindkraftsutbyggnad/analys-av-juridiska-forutsattningar-for-en-hallbar-vindkraftsutbyggnad.pdf

European Comission. (2022). *Finance for biodiversity: Guide on biodiversity measurement approaches - 2nd edition*. Business; Biodiversity. https://www.financeforbiodiversity.org/wp-content/uploads/Finance-for-Biodiversity_Guide-on-biodiversity-measurement-approaches_2nd-edition.pdf

European Comission. (2023). *A user guide to navigate the eu taxonomy for sustainable activites*. European Union Luxembourg. https://doi.org/10.2874/561427EV-03-21-657-EN-N

European Commission. (n.d.-a). *Corporate sustainability reporting*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en (accessed: 28.12.2023).

European Commission. (n.d.-b). *Delivering the european green deal*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en (accessed: 13.12.2023).

European Commission. (n.d.-c). *Environment action programme to 2030*. https://environment.ec.europa.eu/strategy/environment-action-programme-2030_en (accessed: 15.12.2023).

European Commission. (n.d.-d). *How does the eu taxonomy fit within the sustainable finance framework?* https://finance.ec.europa.eu/system/files/2021-04/sustainable-finance-taxonomy-factsheet_en.pdf (accessed: 16.12.2023).

European Commission. (n.d.-e). *Sustainability-related disclosure in the financial services sector*. https://finance.ec.europa.eu/sustainable-finance/disclosures/sustainability-related-disclosure-financial-services-sector_en (accessed: 18.12.2023).

European Commission. (2022). *Commission delegated regulation (eu) 2022/1288*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022R1288 (accessed: 28.12.2023).

European Commission. (2023). *Questions and answers on the adoption of european sustainability reporting standards*. https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_4043 (accessed: 28.12.2023).

European Commission, Directorate-General for Environment, & Sundseth, K. (2015). *The eu birds and habitats directives : For nature and people in europe*. Publications Office. https://doi.org/10.2779/49288

European Commission, Directorate-General for Environment. (2021). *Eu biodiversity strategy for 2030 : Bringing nature back into our lives*. Publications Office of the European Union. https://doi.org/10.2779/677548

European Commission, Directorate-General for Financial Stability, Financial Services and Capital Markets Union. (2021). *Commission delegated regulation (eu) 2021/2139*. European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2139

European Commission, Directorate-General for Financial Stability, Financial Services and Capital Markets Union. (2023). *Commission delegated regulation (eu) 2023/2486*. European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202302486

Finisdore, J., Hason, C., Ranganathan, J., & Iceland, C. (2012). *The corporate ecosystem services review: Guidelines for identifying business risks and opportunities arising from ecosystem change version 2.0*. WRI.

Folke, C., Biggs, R., Norström, A. V., Reyers, B., & Rockström, J. (2016). Social-ecological resilience and biosphere-based sustainability science. *Ecology and Society*, *21(3):41*. https://doi.org/10.5751/ES-08748-210341

GOV.UK. (2023). *Understanding biodiversity net gain*. https://www.gov.uk/guidance/understanding-biodiversity-net-gain#what-developers-have-to-do (accessed: 03.01.2024).

GRI. (2021). *A short introduction to the gri standards*. https://www.globalreporting.org/media/wtaf14tw/a-short-introduction-to-the-gri-standards.pdf

Hallgren, O. G. (2023). *From net-zero to nature-positive:perspectives on definitions and uses of an emerging concept*. Stockholm University, Master Thesis.

Hawkins, F., Roehrdanz, P., Masson, A., Vijay, V., Prescott, G., Brooks, S., Harrison, M., Church, R., Hill, S., Burgess, N., & Starkey, M. (2023). *Biodiversity in the first release of sbts for nature and an approach for future methods biodiversity short paper*. Science Based Targets Network. https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Biodiversity-Overview.pdf

Helldin, J. O., Jung, J., Neumann, W., Olsson, M., Skarin, A., & Widemo, F. (2012). *Vindkraftens effekter på landlevande däggdjur - en syntesrapport*. Naturvårdsverket.

Hurd, J., Schwab, N., & Khatri, A. (2023). *Biodiversity: 5 'nature-positive' trends to watch out for*. https://www.weforum.org/agenda/2023/04/five-nature-trends-to-watch-out-for-davos-2023/ (accessed: 28.12.2023).

IPBES. (n.d.). *Biodiversity*. https://www.ipbes.net/glossary/biodiversity (accessed: 20.11.2023).

IPBES. (2019). *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the intergovernmental science-policy platform on biodiversity and ecosystem services*. https://doi.org/10.5281/zenodo.3553579

IPBES. (2023). *Summary for policymakers of the thematic assessment report on invasive alien species and their control of the intergovernmental science-policy platform on biodiversity and ecosystem services*. https://doi.org/10.5281/zenodo.7430692

IPCC. (2023). *Summary for policymakers. in: Climate change 2023: Synthesis report. contribution of working groups i, ii and iii to the sixth assessment report of the intergovernmental panel on climate change*. https://doi.org/10.59327/IPCC/AR6-9789291691647.001

IUCN. (2021). *Mitigating biodiversity impacts associated with solar and wind energy development. guidelines for project developers*. https://doi.org/10.2305/IUCN.CH.2021.04.en

IUCN. (2023). *Measuring nature-positive: Setting and implementing verified, robust targets for species and ecosystems. commented version 1.0*. https://iucn.org/sites/default/files/2023-11/iucn-nature-positive-contribution-v1.0.pdf

IUCN Business and Biodiversity Programme. (2017). *Iucn review protocol for biodiversity net gain: A guide for undertaking independent reviews of progress towards a net gain for biodiversity.* Gland, Switzerland: IUCN. https://doi.org/10.2305/IUCN.CH.2017.08.en

Karolyi, G. A., & Tobin-de la Puente, J. (2023). Biodiversity finance: A call for research into financing nature. *Financial Management*, *Volume 52*, 231–251. https://doi.org/10.1111/fima.12417

Locke, H., Rockström2, J., Bakker, P., Bapna, M., Gough, M., Hilty, J., Lambertini, M., Morris, J., Rodriguez, C. M., Samper, C., Sanjayan, M., Zabey, E., & Zurita, P. (2021). *A nature-positive world: The global goal for nature*. https://www.nature.org/content/dam/tnc/nature/en/documents/NaturePositive_GlobalGoalCEO.pdf

Mair, L., Bennun, L., & Brooks, T. e. a. (2021). A metric for spatially explicit contributions to science-based species targets. *Nature ecology evolution*, *Volume 5*, 836–844. https://doi.org/10.1038/s41559-021-01432-0

Maron, M., Brownlie, S., Bull, J. W., Evans, M. C., von Hase, A., Quétier, F., Watson, J. E. M., & Gordon, A. (2018). The many meanings of no net loss in environmental policy. *Nat Sustain*, *Volume 1*, 19–27. https://doi.org/10.1038/s41893-017-0007-7

Maron, M., Simmonds, J. S., Watson, J. E. M., Sonter, L. J., Bennun, L., Griffiths, V. F., Quétier, F., von Hase, A., Edwards, S., Rainey, H., Bull, J. W., Savy, C. E., Victurine, R., Kiesecker, J., Puydarrieux, P., Stevens, T., Cozannet, N., & Jones, J. P. G. (2020). Global no net loss of natural ecosystems. *Nat Ecol Evol*, *Volume 4*, 46–49. https://doi.org/10.1038/s41559-019-1067-z

Milner-Gulland, E. (2022). Don't dilute the term nature positive. *Nature ecology evolution*, *Volume 6*, 1243–1244. https://doi.org/10.1038/s41559-022-01845-5

Naturskyddsföreningen & BraMiljöval. (2021). *Elenergi: Kriterier 2021:1*. Bra Miljöval. https://cdn.naturskyddsforeningen.se/uploads/2021/09/29162948/bmv-elenergi-kriterier-2021-1.pdf

Naturvårdsverket. (n.d.-a). *Konventionen om biologisk mångfald (cbd)*. https://www.naturvardsverket.se/om-miljoarbetet/internationellt-miljoarbete/internationella-miljokonventioner/konventionen-om-biologisk-mangfald-cbd/ (accessed: 20.10.2023).

Naturvårdsverket. (n.d.-b). *Påskyndad utbyggnad av förnybar energi*. https://www.naturvardsverket.se/vagledning-och-stod/miljobalken/paskyndad-utbyggnad-av-fornybar-energi/ (accessed: 28.12.2023).

Naturvårdsverket. (2022). *Specifik miljöbedömning – miljöbedömning för verksamheter och åtgärder*. https://www.naturvardsverket.se/vagledning-och-stod/miljobalken/miljobedomningar/specifik-miljobedomning/biologisk-mangfald-i-miljobedomning/artskydd-i-specifik-miljobedomning/ (accessed: 28.12.2023).

Naturvårdsverket. (2023a). *Artskydd i specifik miljöbedömning*. https://www.naturvardsverket.se/vagledning-och-stod/miljobalken/miljobedomningar/specifik-miljobedomning/biologisk-mangfald-i-miljobedomning/artskydd-i-specifik-miljobedomning/ (accessed: 28.12.2023).

Naturvårdsverket. (2023b). *Biologisk mångfald inom specifik miljöbedömning*. https://www.naturvardsverket.se/vagledning-och-stod/miljobalken/miljobedomningar/specifik-miljobedomning/biologisk-mangfald-i-miljobedomning/# (accessed: 28.12.2023).

Naturvårdsverket. (2023c). *Finansmarknaderna, klimatet och miljön*. Redovisning av regeringsuppdrag (M2021/01846 m.fl.) https://www.naturvardsverket.se/4af312/contentassets/0a2f9089cecf4d5b9ef951aebbebd592/redovisning-ru-finansmarknaderna-klimatet-miljon.pdf

Naturvårdsverket. (2023d). *Förslag till nationell strategi och handlingsplan avseende konventionen om biologisk mångfald (cbd)*. https://www.cbd.int/article/cop15-cbd-press-release-final-19dec2022

Naturvårdsverket. (2023e). *Förslag till regeringen - underlag till den fördjupade utvärderingen av sveriges miljömål 2023*.

Naturvårdsverket. (2023f). *Vindval*. https://www.naturvardsverket.se/vindval (accessed: 13.12.2023).

NPI Alliance. (2015). *Net positive impact for biodiversity: The business case*. Gland, Switzerland: IUCN. https://doi.org/10.2305/IUCN.CH.2015.06.en

OECD. (2018). *Mainstreaming biodiversity for sustainable development*. https://doi.org/10.1787/9789264303201-en

OECD. (2022). *Tracking economic instruments and finance for biodiversity 2021*. https://www.oecd.org/environment/resources/biodiversity/tracking-economic-instruments-and-finance-for-biodiversity-2021.pdf

Rainey, H., Pollard, E., Dutson, G., Ekstrom, J., Livingstone, S., Temple, H., & Pilgrim, J. (2015). A review of corporate goals of no net loss and net positive impact on biodiversity. *Oryx*, *Volume 49(2)*, 232–238. https://doi.org/10.1017/S0030605313001476

RWE. (n.d.). *Discover onshore wind*. https://www.rwe.com/en/our-energy/discover-renewables/onshore-wind/# (accessed: 20.01.2024).

RWE. (2021). *What esg means at rwe*. https://www.rwe.com/-/media/RWE/documents/05-investor-relations/finanzkalendar-und-veroeffentlichungen/veroeffentlichungen-und-praesentationen/21-12-17-RWE-ESG-presentation.pdf

RWE. (2022). *Biodiversity policy*. https://www.rwe.com/-/media/RWE/documents/09-verantwortung-nachhaltigkeit/rwe-biodiversity-policy.pdf

RWE. (2023). *Biodiversity pilot project*. Internal Document.

Rydell, J., Ottvall, R., Pettersson, S., & Green, M. (2017). *Vindkraftens påverkan på fåglar och fladdermöss - uppdaterad syntesrapport 2017*. Naturvårdsverket.

Säfsten, K., & Gustavsson, M. (2019). *Forskningsmetodik för ingenjörer och andra problemlösare*. Studentlitteratur AB.

SBTN. (n.d.). *Take action - setting science-based targets for nature: A step-by-step guide*. https://sciencebasedtargetsnetwork.org/take-action-now/take-action-as-a-company/what-you-can-do-now/ (accessed: 03.01.2024).

Schrems, I., & Bär, H. (2021). *Introduction to the eu taxonomy on biodiversity and ecosystems*. Forum Ökologisch-Soziale Marktwirtschaft (FÖS).

Secretariat of the Convention on Biological Diversity. (2020). *Global biodiversity outlook 5 – summary for policy makers.* Montréal.

SFS 1998:808. (1998). *Miljöbalk*. https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/miljobalk-1998808_sfs-1998-808/

Spurgeon, J. (2008). Economic incentives for biodiversity and ecosystem services. *Business Law Review*, *Volume 29, Issue 4*, 84–94. https://doi.org/10.54648/bula2008019

Stenseke, M. (2021). *Ipbes rapporter om kunskapsläget - biologisk mångfald, naturnyttor, ekosystemtjänster. svenska perspektiv på livsviktiga framtidsfrågor.* CBM:s skriftserie 121, SLU Centrum för biologisk mångfald, Uppsala Naturvårdsverket, Stockholm.

Svenska Institutet för Standarder. (2023). *Ss 199000:2023 - naturvärdesinventering (nvi) – kartläggning och värdering av biologisk mångfald – krav och vägledning*. https://www.sis.se/api/document/get/80042589

Svenskt Näringsliv. (2023). *Startprogram för mer vindkraft*. https://www.svensktnaringsliv.se/bilder_och_dokument/rapporter/1jgt33_startprogram-for-mer-vindkraftpdf_1197716.html/Startprogram+f%25C3%25B6r+mer+vindkraft.pdf

Svensson, J., Neumann, W., & Bjärstig, T. (2023). *Hållbar landbaserad vindkraft – synergi, integration och konflikt*. Naturvårdsverket.

Ten Kate, K., Hase, A., & Maguire, P. (2018). Principles of the Business and Biodiversity Offsets Programme. *Biodiversity Offsets: European Perspectives on No Net Loss of Biodiversity and Ecosystem Services*. https://doi.org/10.1007/978-3-319-72581-9_3

The Convention on Biological Diversity. (2006). *Article 2. use of terms*. https://www.cbd.int/convention/articles/?a=cbd-02 (accessed: 13.11.2023).

Tin, Y. K. F., Butt, H., Calhoun, E., Cierna, A., & Brooks, S. (2024). *Accountability for nature: Comparison of nature-related assessment and disclosure frameworks and standards*. https://www.unepfi.org/wordpress/wp-content/uploads/2024/01/Accountability-for-Nature.pdf

TNFD. (2023a). *Draft sector guidance: Electric utilities and power generators*. Taskforce on Nature-Related Financial Disclosures. https://tnfd.global/wp-content/uploads/2023/12/Draft_Sector-Guidance_Electricutilities-and-power-generators_Dec_2023.pdf?v=1701945338

TNFD. (2023b). *Executive summary of the recommendations of the tnfd*. Taskforce on Nature-Related Financial Disclosures. https://tnfd.global/wp-content/uploads/2023/09/Executive_summary_of_the_TNFD_recommendations.pdf?v=1695117009

TNFD and SBTN. (2023). *Guidance for corporates on science-based targets for nature*. Taskforce on Nature-Related Financial Disclosures. https://tnfd.global/wp-content/uploads/2023/09/Guidance_for_corporates_on_science_based_targets_for_nature_v1.pdf?v=1695138398

UNFCCC. (n.d.). *The paris agreement*. https://unfccc.int/process-and-meetings/the-paris-agreement (accessed: 10.10.2023).

United Nations. (n.d.). *System of environmental economic accounting, natural capital and ecosystem services faq*. https://seea.un.org/content/natural-capital-and-ecosystem-services-faq#What%20is%20natural%20capital? (accessed: 20.11.2023).

United Nations. (2023). *Global sustainable development report 2023: Times of crisis, times of change: Science for accelerating transformations to sustainable development* (tech. rep.). United Nations New York.

Victorsson, J., Håstad, O., & Ödeen, A. (2020). *Insekters attraktion till färger och hinderbelysning på vindkraftverk - slutrapport*. Naturvårdsverket.

World Economic Forum. (2020). *Nature risk rising: Why the crisis engulfing nature matters for business and the economy*. https://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf

World Economic Forum. (2023). *Global risks report 2023, 18th edition*. https://www3.weforum.org/docs/WEF_Global_Risks_Report_2023.pdf

WWF. (n.d.). *What is biodiversity?* https://www.worldwildlife.org/pages/what-is-biodiversity (accessed: 20.11.2023).

WWF and BAIN. (2023). *Swedish businesses the biodiversity crisis opportunities risks associated with biodiversity loss*. WWF. https://media.wwf.se/uploads/2023/02/swedish-businesses-and-the-biodiversity-crisis_final-1.pdf

WWF, BCG. (2023). *Building a nature-positive energy transformation: Why a low-carbon economy is better for people and nature.* WWF, Washington, DC.

WWF Svergie. (2022). *Living planet report 2022, vägen ut naturkrisen - en svensk sammanfattning*. The New Division.

WWF, The Biodiversity Consultancy. (2023). *Nature-safe energy: Linking energy and nature to tackle the climate and biodiversity crises*. World Wide Fund for Nature, Gland, Switzerland.

zu Ermgassen, S. O., Howard, M., Bennun, L., Addison, P. F., Bull, J. W., Loveridge, R., Pollard, E., & Starkey, M. (2022). Are corporate biodiversity commitments consistent with delivering 'nature-positive' outcomes? a review of 'nature-positive' definitions, company progress and challenges. *Journal of Cleaner Production*, *Volume 379(2)*. https://doi.org/10.1016/j.jclepro.2022.134798

Appendix A

Survey

A.1 Online questionnaire: Biodiversity engagement in the wind power industry

- *Title of respondent (e.g. sustainability manager)*

- *In which ways does your company work with biodiversity?*

- *In which regions does your company operate?*
  - *Sweden*
  - *EU*
  - *Globally*

- *In which ways does your company work with biodiversity?*
  - *Internal policy to reduce biodiversity impact aligned with the mitigation hierarchy*
  - *Engaging in biodiversity enhancement/conservation on-site*
  - *Engaging in biodiversity enhancement/conservation off-site*
  - *Assessment of biodiversity impact throughout the value chain*
  - *Funding of biodiversity research*
  - *Other*

- *Does your company have commitments or targets related to biodiversity?*
  - *Net-zero impact on biodiversity from company value chain*
  - *Net-positive impact on biodiversity from company value chain*
  - *Net-positive biodiversity impact on wind power project sites*
  - *Other biodiversity-related targets*

- *Do you want to explain your company's biodiversity engagement or target further?*

- *Does your company use any of these biodiversity-related tools and guidelines?*
  - *Science-based Targets for Nature*
  - *Taskforce on Nature-related Financial Disclosures*
  - *WWF Biodiversity Risk Filter*
  - *IBAT*
  - *CLIMB*
  - *ENCORE*
  - *STAR*

- *Do you want to add or elaborate on which type of tools or guidelines that would be helpful in your biodiversity engagement?*

- *Do you agree with the claim: This is an **incentive** for biodiversity engagement for your company:*
  - *Achieving high ESG-score*
  - *Qualifying for green bonds*
  - *Qualifying for green loans*
  - *Qualifying for environmentally certified electricity*
  - *Aligning company values with CBD - Global Biodiversity Framework*
  - *Increasing local acceptance of projects*
  - *Increasing brand reputation*
  - *Being an attractive employer*
  - *Being prepared for mandatory reporting on biodiversity (e.g. CSRD)*
  - *Creating shared value with landowner*

- *Do you want to add or elaborate on which incentives you find most encouraging and why?*

- *Do you agree with the claim: This is a **barrier** to your company's biodiversity engagement*
  - *Low internal priority compared to other sustainability topics*
  - *Lack of competence on the subject*
  - *Lack of internal economic allocated resources*
  - *Lack of interest from stakeholders*
  - *Difficulty showing dependence and impact*
  - *Immature metrics and standards*
  - *International differences in legislation*

  - *Scare of greenwashing accusations*
  - *Lack of public guidance*
  - *Uncertainty on legislation that comes with physical measures*
  - *Difficulty selling the wind farm with long-term nature commitments*
- *Do you want to add or elaborate on which barriers you find most discouraging and why?*
- *Do you agree with the claim: This would increase biodiversity engagement in your company:*
  - *Joint industry biodiversity commitments*
  - *Stricter national and international biodiversity reporting demands*
  - *Being able to sell biodiversity credits*
  - *Increased likelihood of getting wind power permits*
  - *Access to standardised biodiversity monitoring and measurement guidelines*
- *What future internal resources would facilitate increased biodiversity engagement in your company?*
- *What future external resources would facilitate increased biodiversity engagement in your company?*
- *Is there anything on the subject you would like to add?*

A.2 Complementing interview questions: Biodiversity engagement in the wind power industry

1. *What is your role and responsibilities?*
2. *In which ways is your company working with biodiversity?*
3. *Does your company have a biodiversity-related target or commitment?*
4. *What type of biodiversity-related tools or guidelines does your company use?*
5. *Which incentives motivate and facilitate your company's biodiversity engagement?*
6. *What barriers inhibit your company's biodiversity engagement?*
7. *What external resources could increase or improve your company's biodiversity engagement?*
8. *What internal resources could increase or improve your company's biodiversity engagement?*
9. *Is there anything on the subject that you would like to add?*

Appendix B

Case study

B.1 Interview questions: Stakeholders in biodiversity pilot project

1. *What is your role and responsibilities?*

2. *In which ways are you and your company working with the biodiversity pilot project?*

3. *What opportunities and positive impacts do you see in the biodiversity pilot project?*

4. *What challenges have you encountered in the biodiversity pilot project?*

5. *What have you learned from the project this far and what would you do different in a new project?*

6. *How will you and your company be involved in the project in the coming years?*

B.2 Interview questions: Experts on implementation and measurements of biodiversity

1. *What is your professional background, and what is your current role?*

2. *What factors should a company take into account when planning a biodiversity enhancement project?*

3. *When is it preferable to choose an onsite or offsite project?*

4. *How should biodiversity measures be monitored, measured, and evaluated?*

5. *In your perspective, what opportunities arise from corporate engagement in biodiversity?*

6. *From your standpoint, what challenges are associated with corporate engagement in biodiversity*