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European Energy Transition versus Biodiversity: Win-win effects or tradeoffs?

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Affidavit

I, **VALENTIN FRICK, BA**, hereby declare

1. that I am the sole author of the present Master's Thesis, "EUROPEAN ENERGY TRANSITION VERSUS BIODIVERSITY: WIN-WIN EFFECTS OR TRADEOFFS?", 81 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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Abstract

The European Union has made the transition toward renewable energy sources a priority. At the same time, the protection and restauration of biodiversity is attributed greater significance. This thesis answers the questions whether the Renewable Energies Directive II (RED II) and the Biodiversity Strategy for 2030 are compatible. While renewable energy sources like hydropower, wind power, solar power, biomass and biofuels help reduce CO_2 emissions, there are also possible effects on biodiversity. The research in this thesis found that the RED II and the Biodiversity Strategy for 2030 are widely incompatible as their implementation impairs the achievement of the respective other policy goals. However, the RED II defines extensive sustainability criteria for bioenergy to protect biodiversity, making biofuels an area of exception in which efforts to protect biodiversity are expressly considered. Furthermore, the reduction of greenhouse gas emissions by switching to renewable energy sources also promotes biodiversity as it protects vulnerable natural systems and habitats.

The hypothesis that this evident disconnect between the two policy areas can be bridged with the help of Environmental Impact Assessments (EIA) only partly holds true. On the one hand, such an assessment considers the possible effects of a renewable energy project on biodiversity. On the other hand, however, in the absence of an actual integrated approach which also comprises the requirements of other related directives, there is still a significant divide between the two areas. In order to bring them closer together, both the RED II and the Biodiversity Strategy for 2030 would need to specifically address key challenges in relation to the opposite policy area. Currently, this is only the case for bioenergy.

Table of Contents

List of Abbreviations

APG. *Austrian Power Grid AG*
BMDW. *Bundesministerium für Digitalisierung und Wirtschaftsstandort; Austrian Ministry for Digital and Economic Affairs*
BMK. *Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie; Austrian Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology*
BMLRT. *Bundesministerium für Landwirtschaft, Regionen und Tourismus; Austrian Ministry for Agriculture, Regions and Tourism*
CH_4. *Methane*
CO. *Carbon monoxide*
DG. *Directorate-General*
EAG. *Erneuerbaren Ausbau Gesetz; Austrian Federal Law on the Promotion of Renewable Energies*
EERE. *United States Office of Energy Efficiency and Renewable Energy*
EIA. *Environmental Impact Assessment*
GWh. *Gigawatt hour*
IEA. *International Energy Agency*
IPCC. *Intergovernmental Panel on Climate Change*
IUCN. *International Union for Conservation of Nature*
kgoe. *Kilogramm oil equivalent*
kV. *Kilovolt*
KVO. *Kraftstoffverordnung*
KW Gratkorn. *Hydropower plant Gratkorn*
kWh. *Kilowatt hours*
kWh/m^2,a. *Kilowatt hours per square meter and year*
LKÖ. *Landwirtschaftskammer Österreich*; *Austrian Chamber of Agriculture*
LROÖ. *Landesregierung Oberösterreich*; *Upper Austrian Regional Government*
Mtoe. *Mega tonnes of oil equivalent*
MW. *Megawatt*
N_2O. *Nitrous Oxide*
NMVOC. *Non-methane volatile organic compounds*
NO_x. *Nitrogen oxides*, *Nitrogen oxides*
PCI. *Project of common interest*
PV. *Photovoltaic*
RED II. *Renewable Energy Directive II*
RED III. *Renewable Energy Directive III*
SO_2. *Sulfur dioxide*
TFEU. *Treaty on the Functioning of the European Union*
TWh. *Terawatt hour*
UVP-G. *Umweltverträglichkeitsprüfungsgesetz; Austrian Federal Law on Environmental Impact Procedures*

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I would like to thank my supervisor, Dipl.-Ing. Dr. Klaus Rapp for his help throughout this research and writing process. I am especially grateful that I was given the chance to get practical insight into the topic of my thesis during an internship at VUM Verfahren Umwelt Management GmbH. During this internship, I also had the opportunity to interview two experts who have helped me better understand the complex interconnected nature of this topic. For this, I would like to express my sincere gratitude to Mag. Martin Schönberg and Dr. Andreas Kleewein.

Furthermore, I would also like to thank my family and friends, who have always shown me unconditional love and support – not only during the writing of this thesis but throughout my entire academic career.

1 Introduction

There is widespread consensus in the international community about the fact that a shift towards renewable energies and away from fossil sources is incumbent to combat climate change. The Intergovernmental Panel on Climate Change (IPCC) is only one of many organizations which are pointing out that *"[limiting] global warming will require major transitions in the energy sector*" (IPCC, 2022). In addition to combatting climate change, the shouts for increased efforts in the area of renewable energies in Europe have grown even louder in 2022 in relation to the ongoing war in Ukraine which has exposed Europe's dependence on Russia regarding energy supply. In this context, increasing renewable energy generation in Europe is also seen as a way of achieving energy security and sovereignty (Hockenos, 2022).

At the same time, the importance of biodiversity for the resilience of the Earth system is widely agreed upon. Pires et al. (2018) are among the authors discussing the interdependence of biodiversity loss and climate change. They emphasize that the relationship between climate change and biodiversity is two-sided. Not only does climate change lead to increased biodiversity loss, but also conserving and restoring biodiversity are necessary for the functioning of our Earth system. Consequently, the protection of biodiversity should not be overlooked in the discourse about environmental protection.

Therefore, despite the obvious necessity of promoting the use of renewable energy sources to reduce greenhouse gas emissions, this thesis offers a new perspective on the European energy transition by discussing it in the context of the conservation and restoration of biodiversity.

In this context, this thesis aims to answer the following question regarding the European strategies in the areas of renewable energies and the protection of biodiversity:

Is the European Union's energy transition strategy (in the form of the Renewable Energy Directive II) coherent with the Biodiversity Strategy for 2030? Furthermore, in which areas are possible incoherencies located?

In other words, it is the primary aim of this thesis to analyze the compatibility and coherence of the EU's strategies in the areas of renewable energies and biodiversity. The author expects to find a significant incoherence between the two policy areas, which could potentially be bridged through procedures which assess the environmental impact of large projects like building renewable energy infrastructure.

In order to find out whether this initial assumption holds true, this thesis will be structured as follows: After this introductory chapter, chapter 2 will describe the state of the art with regard to the topic of this thesis. In this respect, the history and current developments are discussed for five of the most common renewable energy sources: hydropower, wind power, solar power, solid biomass and biofuels. In addition, the concept of biodiversity is briefly introduced. Thereafter, the potential effects on biodiversity in relation to those renewable technologies are discussed. Furthermore, the expansion of transmission grids and the biodiversity considerations in this respect will also be discussed in chapter 2. Consequently, chapter 3 provides the necessary background information about the policy documents which are analyzed in this thesis. This includes the Renewable Energy Directive II (RED II), the Biodiversity Strategy for 2030 and the Environmental Impact Assessment (EIA) Directive. To provide an insight as to how these European laws and requirements are transposed into national law, the Austrian equivalents will also be elaborated on. Before the analysis, which is at the heart of this thesis, chapter 4 outlines the methodical framework for the analysis. Chapter 5 then outlines the results of the analysis on the coherence of the EU strategies in the areas of renewable energies and biodiversity. Finally, the results and findings of this thesis will be critically discussed in chapter 6 before the most important takeaways are summarized in the conclusion.

2 State of the Art

2.1 Renewable Energies in Europe and Austria

It is the purpose of this section to briefly introduce the forms of renewable energies, which are most common today. After a general introduction to the technology, the energy sources will be described with respect to their relevance in Europe and Austria.

However, due to the vast amount of already existing and emerging renewables, this thesis will only focus on five renewable energy sources, namely hydropower, wind power, solar power, biomass and biofuels. The decision of excluding other established renewable energy technologies such as geothermal energy and tidal energy was taken due to the fact that their application is limited to certain regions.

A closer look at the total electricity production of the EU-27 in 2019 shows that out of 2,904.01 TWh of electricity generated, 1,005.27 TWh came from renewable sources (DG Energy, 2021). However, this number has to be considered with precaution as it only looks at electricity generation.

According to current data form the DG Energy (2021), the total energy generated in the member states of the EU-27 amounts to 617.52 Mtoe of which 224.98 Mtoe come from renewable energy sources. This would suggest that roughly 37% of the energy generated in the EU-27 comes from renewable energy sources.

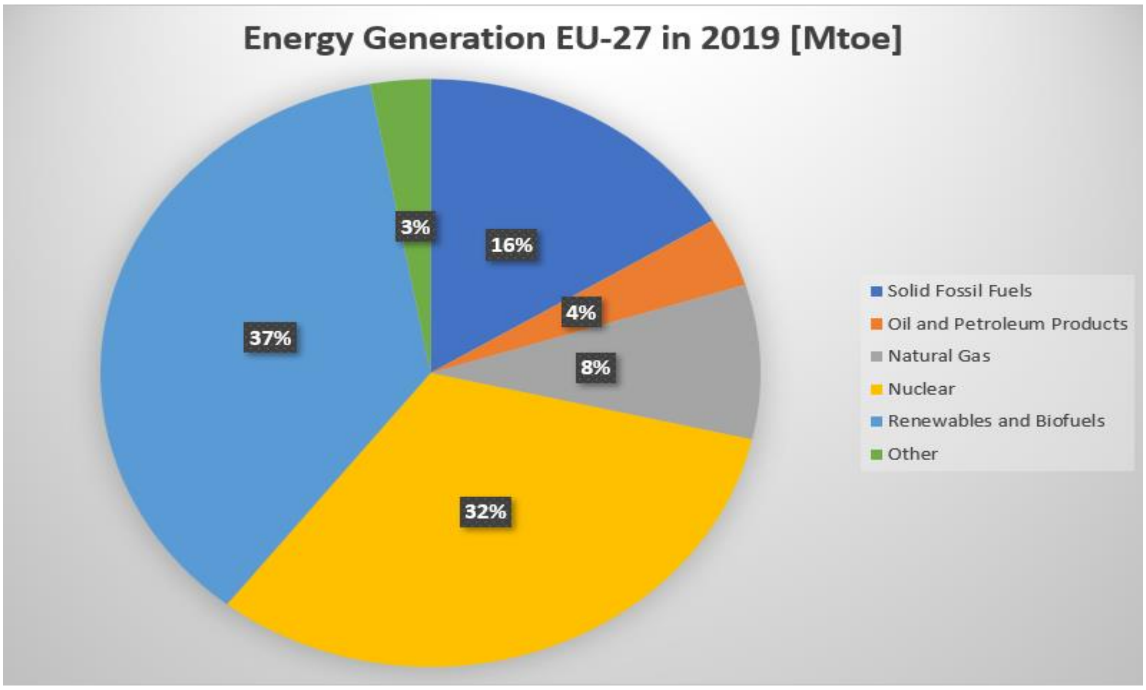

Figure 1: Share of different energy sources for the total energy generation

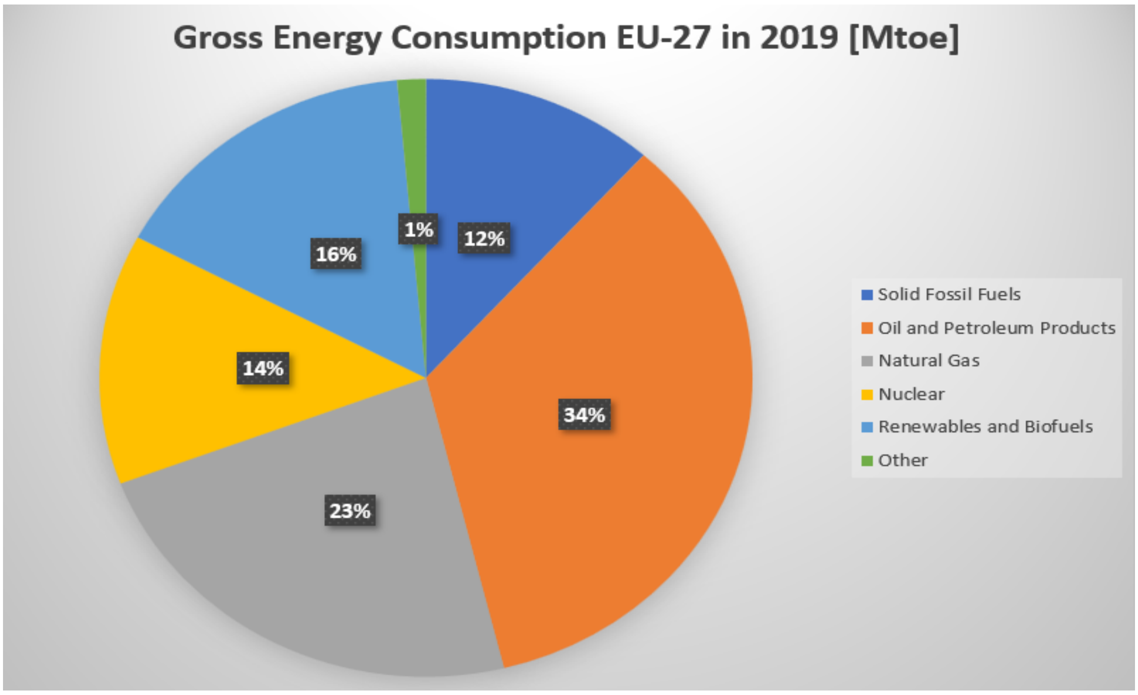

Figure 2: Share of different energy sources in gross energy consumption

However, as the EU is a net importer of energy, it also has to be considered how the imported energy is generated. Out of the total quantity imported (909.11 Mtoe), only 4.91 Mtoe come from renewable energy sources and an overwhelming 903.62 Mtoe are generated using fossil fuels such as coal, oil, or natural gas. Consequently, the share of renewables in the European gross consumption was actually below 17% in 2019.

2.1.1 Hydropower

Most simply put, hydropower is a renewable energy source in which the potential or kinetic energy of flowing water is converted into mechanical energy. The term hydropower is usually reserved for run-of-river power plants and power plants using reservoirs (storage power plants) as well as pumped storage power plants[1] while other waterpower sources (e.g. wave or tidal power) are mostly studied separately. If and to what extent a country can use and promote hydropower generation depends strongly on certain regional parameters such as elevations, rivers and precipitation. Hence, it lies in the nature of this energy source that different regions have a different potential for generating hydropower. (Mohtasham, 2015)

Following a categorization proposed by Egré and Milewski (2002), two of the most common technologies used are run-of-river hydropower plants and reservoir type hydropower plants. The basic principle is the same in these two types of energy generation; however, the way in which they operate is different as are the services they can provide. On the one side, "*[reservoir] projects involve impounding water behind a dam*" (Egré & Milewski, 2002, p. 1227) in a reservoir which can cover an area of more than 5,000 square kilometers. On the other side, run-of-river projects "*[utilize] the flow of water within the natural range of the river. Therefore, no or little reservoir impoundment takes place*" (Egré & Milewski, 2002, p. 1227).

These significant differences in design of the hydropower plants consequently also lead to variations regarding the services they can provide. Evidently, both types are designed for the generation of electricity. However, run-of-river plants can only generate a constant "*base load with limited flexibility*" (Egré & Milewski, 2002, p. 1226). In contrast, reservoir type hydropower plants can not only generate a base load of electricity but also make it possible to store energy in the form of potential energy of the water stored in a

[1] Pumped storage hydropower plants are a way of storing hydro energy by pumping water up a mountain and releasing it when it is needed. As this thesis focuses primarily on the generation of renewable energy, the pumped storage hydropower plants will not be discussed in more detail.

reservoir. This stored energy can be used to generate electricity to cover energy supply during peak demand. (Egré & Milewski, 2002)

It should, however, also be pointed out that modern hydropower installations are mostly not limited to just one type of hydropower generation. Often complex systems of reservoirs and pumped storage power plants are developed as it is the case in Kaprun, Austria. (Verbund AG, 2022a)

Similarly, Egré and Milewski (2002) emphasize the possibility of combining reservoir type plants with downstream run-of-river plants, effectively re-using the water. This can help to "*[reduce] the environmental and social impacts relative to power production*" (Egré & Milewski, 2002, p. 1227). What exactly these impacts are, will be explained in more detail in chapter 2.3.1, which deals with the biodiversity considerations related to hydropower.

2.1.1.1 Hydropower in Europe

In the context of the annual electricity production through hydropower, it is important to be aware of the significant differences in hydrological potential and hydropower production across European countries. For instance, Norway boasts a potential of over 210,000 GWh/year while Portugal only has a hydrological potential of around 20,000 GWh/year. Particularly interesting are the cases of Turkey, Iceland, Bosnia-Herzegovina, *Bulgaria*[2], *Greece*, *Slovakia*, *the Czech Republic*, North Macedonia, Moldova, Greenland, *Hungary*, Belarus and *the Republic of Cyprus*. In 2018, less than 50% of the economically feasible hydropower potential has been tapped in these countries. (Hydropower Europe, 2022)

The European Union's strong commitment towards the utilization of hydrological potential in energy generation becomes evident when taking a closer look at the countries above. Out of the 13 countries which are least exploiting their hydrological potential, only 6 are EU member states.

In concrete numbers, the total installed capacity in the EU-27 was roughly 150 GW in 2019. The year 2019 also recorded a gross electricity generation of 345.26 TWh, making hydropower generation the renewable energy source with the second biggest electricity generation. (DG Energy, 2021)

[2] EU member states are written in *italics* to highlight them.

2.1.1.2 Hydropower in Austria

Hydropower has a significantly long and important history in Austria, which has its beginning as early as 1840. The subsequent expansion of hydropower in Austria did not follow a linear growth but was marked by strong fluctuations. For example, the year 1890 recorded only 14 new hydropower plants while 80 new plants were opened in the following year. Despite fluctuations in newly added plants, the constant increase in total installed power is clearly correlated with the growing energy demand. Today, hydropower plays an important role in satisfying the Austrian energy demand (Wagner, et al., 2015)

Recent calculations show that, in total, Austria has a hydropower potential of 56.1 TWh (Wagner, et al., 2015). It should be noted at this point that this potential was not only calculated based on the technical feasibility but also included an economic perspective. A recent report about hydropower generation in Austria indicates a total of 40.1 TWh generated through hydropower in Austria, accounting for a realization rate of just over 71% (Pöyry & Austria's Energy, 2018). According to the DG Energy's (2021) country energy datasheets, 43.83 TWh of electricity were generated in Austria in 2019.

2.1.2 Wind Power

Similarly to how hydropower converts the motion of water into electrical power, wind turbines are driven by the movement of air masses (Mohtasham, 2015). An important distinction should be made here between on-shore wind power and off-shore wind power. Both technologies come with their advantages and drawbacks. One main advantage of offshore wind farms is that the wind they run on is significantly steadier and consequently so is the energy generated. In Germany, 3000 full load hours are expected in a year for off-shore wind generation and only 1600 for on-shore wind power (Lauf, et al., 2019). The drawbacks relating to the issue of biodiversity will be discussed in greater detail in chapter 2.3.2.

The potential of a country or a region for the production of wind power depends strongly on the consistency and the velocity of the wind it receives. Even regions with strong wind might experience fluctuations in energy production due to inconsistent and unpredictable winds. (Lauf, et al., 2019)

2.1.2.1 Wind Power in Europe

Wind power is essential to the European Union's energy transitioning efforts. This enormous significance is highlighted by the European Commission, which expects wind energy to "*provide the largest contribution to the EU renewable energy targets for 2020 and beyond*" (European Commission, 2020a). This ambition is also reflected in the prediction for the future, stating that "*[by] 2030 it could reach 350 GW, supplying up to 24% of [the] electricity demand*" (European Commission, 2020a).

Since the beginning of the 21st century, however, Europe has lost its position as pioneer in the field of wind energy (Kaldellis & Zafirakis, 2011). At the beginning of the 21st century, Europe and the EU were leading the way in terms of the installed capacity and also energy generation, providing almost 75% of the global installed capacity and just over 70% of the global wind energy generation. Despite continuing expansion efforts, the European share has plummeted significantly. Already in 2009, European installed wind capacity only accounted for less than 50% of the global capacity.

The most recent available data (DG Energy, 2021) shows a total of 367 TWh of electricity generated in EU member states in 2019. Already in 2019, the installed capacity of wind power across the EU-27 amounted to almost 170 GW, making it the renewable energy source with the biggest installed capacity on Union level. The European Commission (2020a) even estimates that the installed capacity is far beyond 200 GW by now.

2.1.2.2 Wind Power in Austria

According to data from the Austrian Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK, 2020a), wind energy plays a big role in Austria's primary energy generation. More specifically, wind power contributed 10.2% to the local electricity generation in 2019. This constitutes a significant growth of more than 8% compared to 2005. In absolute numbers, Austria has generated a total of 7.47 TWh of electricity in 2019 from an installed capacity of just over 3.2 GW (DG Energy, 2021).

A 2017 report by the International Energy Agency (IEA) supports the statement that wind power is a big part of Austria's energy mix. However, the report continues to point out that the further expansion of wind energy in Austria has been stalling due to lacking incentives and rising political uncertainties in this area. (Maringer, et al., 2017)

2.1.3 Solar Power

Solar power is a broad term and refers to the utilization of the radiation energy that we receive from the sun. This includes the use of photovoltaics (PV) to generate electricity but also other ways in which the sun's energy is harvested, such as solar thermal collectors. However, this thesis will concentrate on PV as they play the most significant role in Europe's energy transition efforts.

Until rather recently, PV was widely regarded as not economically feasible due to the elevated cost of PV cells (Mohtasham, 2015). However, in recent years this price has dropped significantly, making solar power a viable option for the present and future (IEA, 2021). In fact, the IEA even labelled solar energy the cheapest energy source: "*For projects with low cost financing that tap high quality resources, solar PV is now the cheapest source of electricity in history*" (IEA, 2020).

A significant problem area is the uncertainty of the energy generation from solar energy: "*Although some solar energy can be collected during even the cloudiest of days, efficient solar energy collection is dependent on sunshine. Even a few cloudy days can have a large effect on an energy system, particularly once the fact that solar energy cannot be collected at night is taken into account*" (Mohtasham, 2015, p. 1292).

2.1.3.1 Solar Power in Europe

The growing affordability of PV also leads to the European Union shifting its focus more and more towards solar energy. A recent report labels PV "*the renewable energy technology with the largest scope for cost reduction and efficiency gains*" (Sample, et al., 2020, p. 3), further pointing out that the drop in prices is due to "*rapid technological development, not just scaling up existing systems*" (Sample, et al., 2020, p. 3). The report goes on to emphasize the importance of setting international standards to "*[ensure] market transparency, [help] to cut costs and [strengthen] investor confidence*" (Sample, et al., 2020, p. 3).

By 2019, almost 120 GW of PV cells were installed in Europe. The electricity generated from this amounted to 125.72 TWh. (DG Energy, 2021)

Another important factor in relation to solar energy in Europe are significant differences in the received radiation throughout the year (Brauner, 2016). For instance, in an average year, the Greek Peleponnes region receives roughly 1700 kWh/m^2,a while the Scottish Edinburgh receives only roughly 950 kWh/m^2,a.

2.1.3.2 Solar Power in Austria

The relatively big number of single family detached houses is one of the reasons why Austria has great potential for energy generation from PV cells (BMK, n.d.). The number of PV installed in Austria has grown significantly (Biermayr, et al., 2021). More specifically, PV cells with a total maximum capacity of 340.8 MW were newly installed in the year 2020. In total, PV cells with a cumulative power of 2,043 MW were operating in Austria by the end of 2020, generating at least 2,040 GWh of electricity.

While PV operation at high altitudes is possible – and has in fact been shown to be more efficient due to increased radiation received and lower temperatures (Kahl, et al., 2019) – the greater number of PV cells in Austria are installed in the less mountainous parts of Austria (Statistik Austria, 2021).

2.1.4 Biomass

Before this chapter emphasizes the use of solid biomass as a renewable energy source, it is important to provide a definition of biomass for the purpose of this chapter: "*The biomass resource can be considered as organic matter, in which the energy of sunlight is stored in chemical bonds. When the bonds between adjacent carbon, hydrogen and oxygen molecules are broken by digestion, combustion, or decomposition, these substances release their stored, chemical energy*" (McKendry, 2002, p. 37). Hence, the term biomass can be used as an umbrella term for "*all organic material that stems from plants (including algae, trees and crops)*" (McKendry, 2002, p. 37).

Literature most commonly differentiates between 4 types of biomasses: woody plants, herbaceous plants, aquatic plants and manures (McKendry, 2002). The use of biomass as an energy source is either achieved directly through combustion or by conversion to a biofuel, which can then be used in an engine. This chapter focuses on the combustion of solid biomass since biofuels are discussed separately in the next chapter.

As biomass is essentially a fuel, it is important to consider the energy content, which lies in the range of 17-21 MJ/kg (McKendry, 2002, p. 46). To put the average energy content of dry biomass into context, Figure 3 shows the energy content (lower calorific value) of some common fuels.

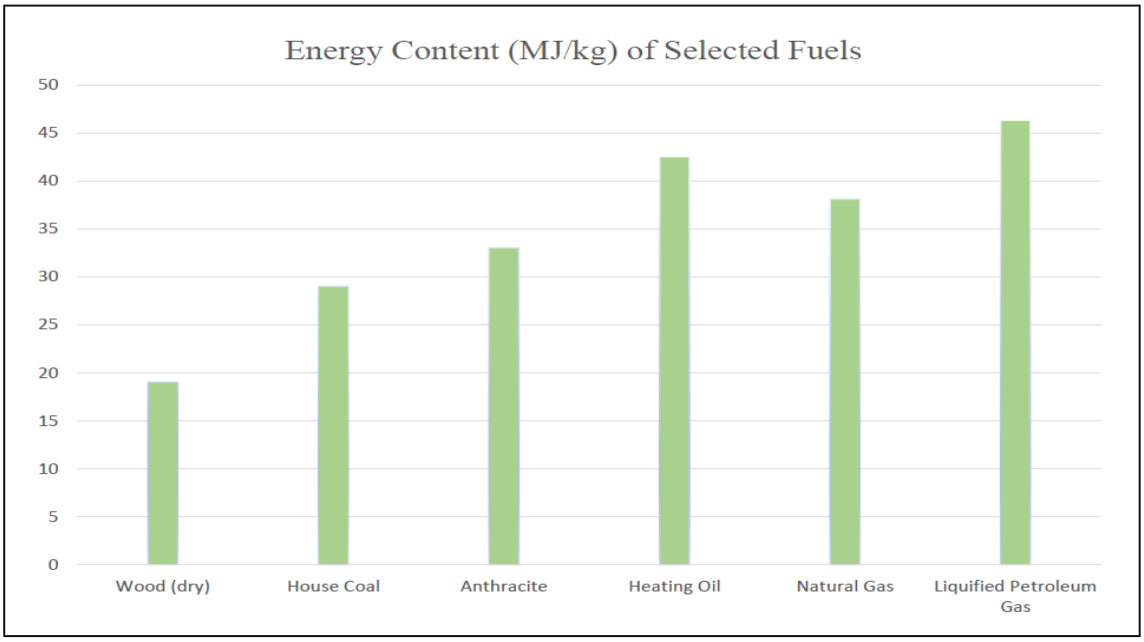

Figure 3: Energy Content of Selected Fuels (Forest Research, 2022)

2.1.4.1 Biomass in Europe

Biomass is an essential part of Europe's energy mix, particularly with regard to heating, with more than 90% of all renewable heat generated in the EU coming from the burning of biomass in 2014. The EU is keen on achieving maximum efficiency with regard to the use of biomass. Therefore, a well-structured approach was developed to assure an efficient balancing of heat, electricity, and biofuel production. (European Commission, 2020b)

The graphic below shows the composition of inputs and outputs in the use of biomass as an energy source. A combination of heat, electricity and biofuels assures minimum losses. (Bioenergy Europe, 2022)

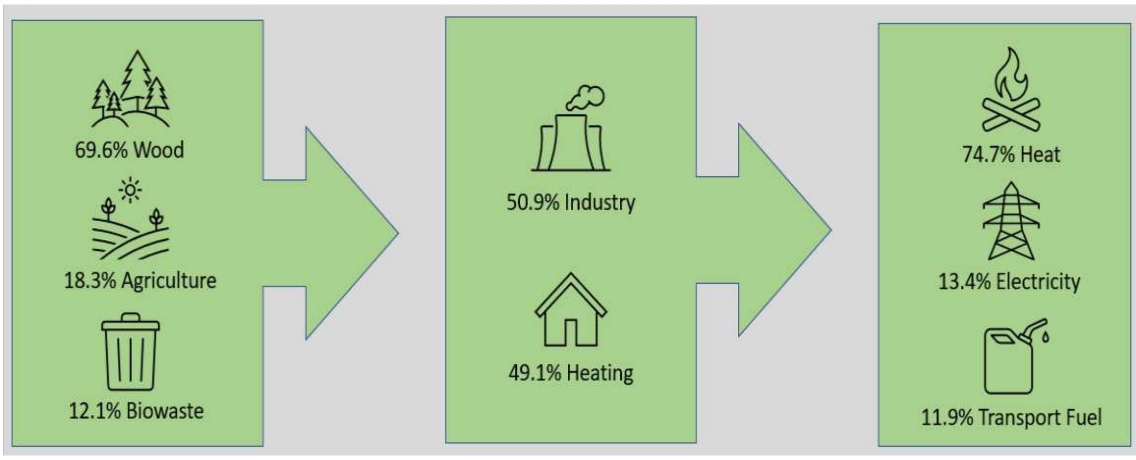

Figure 4: Inputs and Outputs in the Use of Biomass for Energy (Bioenergy Europe, 2022)

The graphic above shows that bioenergy is derived to a significant portion from wood, with smaller fractions also coming from agriculture or biowaste. Almost half of the biomass is used directly for heating of private houses etc. while the other half is further processed industrially. The energy output from biomass is mostly in the form of heat, but electricity and transport fuels are also produced.

In total, biomass accounts for almost 60% of all renewable energy generated in the EU (Scarlat, et al., 2019). While roughly 12% of this goes towards the production of biofuels, the generation of heat and electricity from biomass still makes up roughly half of the renewable energy generated in the EU.

Considering the electricity generated from solid biomass, 99.80 TWh electricity were generated in 2019. Nevertheless, as can be seen from Figure 4 above, this only covers a rather small part of the total energy generated from biomass. The total energy generated from solid biomass in 2019 can be expressed as 92.57 Mtoe. (DG Energy, 2021)

The significance of biomass for the EU is partly also due to the fact that a huge majority (96%) of the biomass used for energy in the EU is also produced in member states (Scarlat, et al., 2019). This is particularly important with regard to energy security as it limits the dependence on other countries for energy production – an issue which is currently discussed intensively due to the ongoing war in Ukraine.

2.1.4.2 Biomass in Austria

Biomass for energy is very important in Austria, and the country is among the EU countries with the highest annual biomass consumption per capita with 668 kgoe/capita (Scarlat, et al., 2019). The greatest significance of solid biomass certainly lies in the heating sector: According to the Austrian Biomass Association (Pfemeter & Liptay, 2018), biomass is the second most important source for heating in Austria (30.5%), second only to natural gas (34.6%). In contrast, the role of solid biomass in the generation of electricity is significantly smaller with only 3.6% (Pfemeter & Liptay, 2018). In absolute numbers, the electricity production from solid biomass in 2019 amounted to 4.13 TWh (DG Energy, 2021).

2.1.5 Biofuels

As mentioned above, biofuels are strictly speaking a type of biomass energy. Nonetheless, due to the growing importance of biofuels in Europe and Austria, they will be discussed separately here.

Biofuels are produced by refining biomass into a liquid fuel. The two most commonly produced and used biofuels are bioethanol and biodiesel. They are produced from a different feedstock and are designed for the use in different engines (gasoline engine versus diesel engine). (Bioenergy Europe, 2022)

Bioethanol is mainly produced from cereals such as wheat or corn (74%) and sugars (21%) (Bioenergy Europe, 2022). Biomass is converted to bioethanol through fermentation – a process during which "*microorganisms metabolize plant sugars and produce ethanol*" (EERE, 2022). Bioethanol is mixed with gasoline as a means of reducing carbon monoxide (among others) emissions. The ratio at which ethanol is mixed with gasoline is most commonly E10, meaning that 10% are ethanol. The maximum ethanol percentage which can be used in a conventional gasoline engine is 15%. (EERE, 2022)

According to Bioenergy Europe (2022), biodiesel is produced from a wide range of biomass, the most relevant being rapeseed oil (44%). However, used cooking oil has been becoming more and more relevant as a potential base for biodiesel. EERE[3] (2022) describes biodiesel as a non-toxic and biodegradable alternative fuel, which also burns significantly cleaner than traditional, petroleum-based diesel. They furthermore state that biodiesel can be mixed with traditional diesel at various rates (e.g. pure biodiesel or 20% biodiesel) and used in conventional compression-ignition engines.

2.1.5.1 Biofuels in Europe

According to the DG Energy (2021), a total of 15,655.14 ktoe of liquid biofuels were consumed in EU member states in 2019. At the same time, 15,821.5 ktoe of liquid biofuels were produced. Figure 5 shows the increase in the production of biofuels over the past three decades. The share of bioethanol and biodiesel used in transportation fuels is still rather low at 5.6%; however, a slight but steady increase has taken place over the course of the past decades. The increase in the percentage of biofuels in transport fuels for both bioethanol and biodiesel are depicted in Figure 6. (European Commission, 2021a)

[3] The Office of Energy Efficiency and Renewable Energy (EERE) is a sub-branch of the US government that specializes in researching and promoting renewable energies.

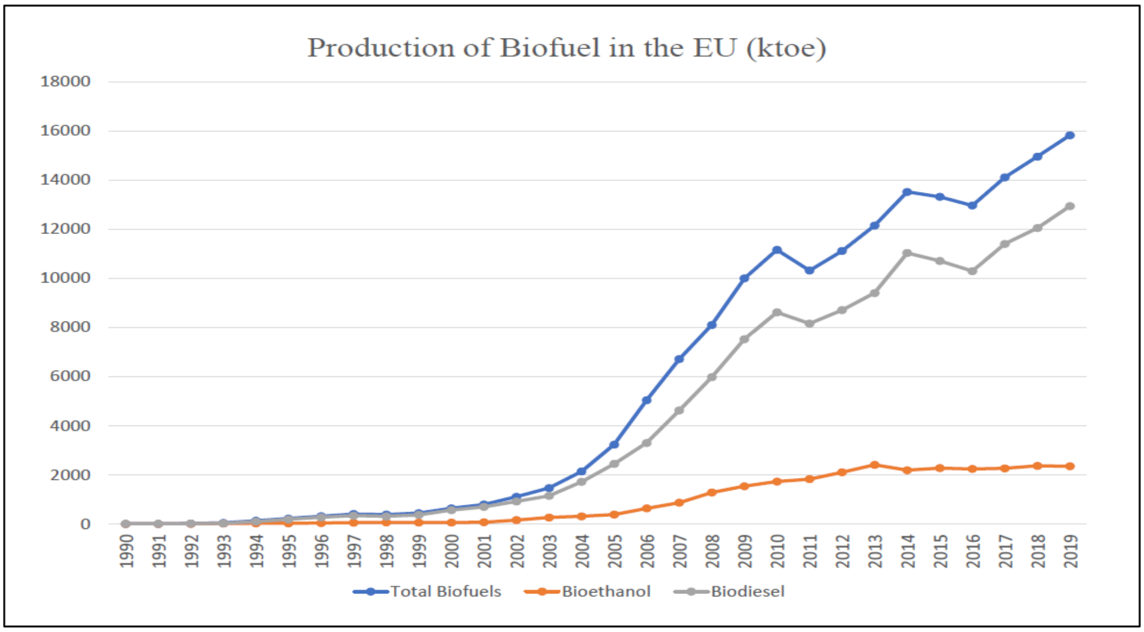

Figure 5: Expansion of the biofuel production in the European Union (European Commission, 2021a)

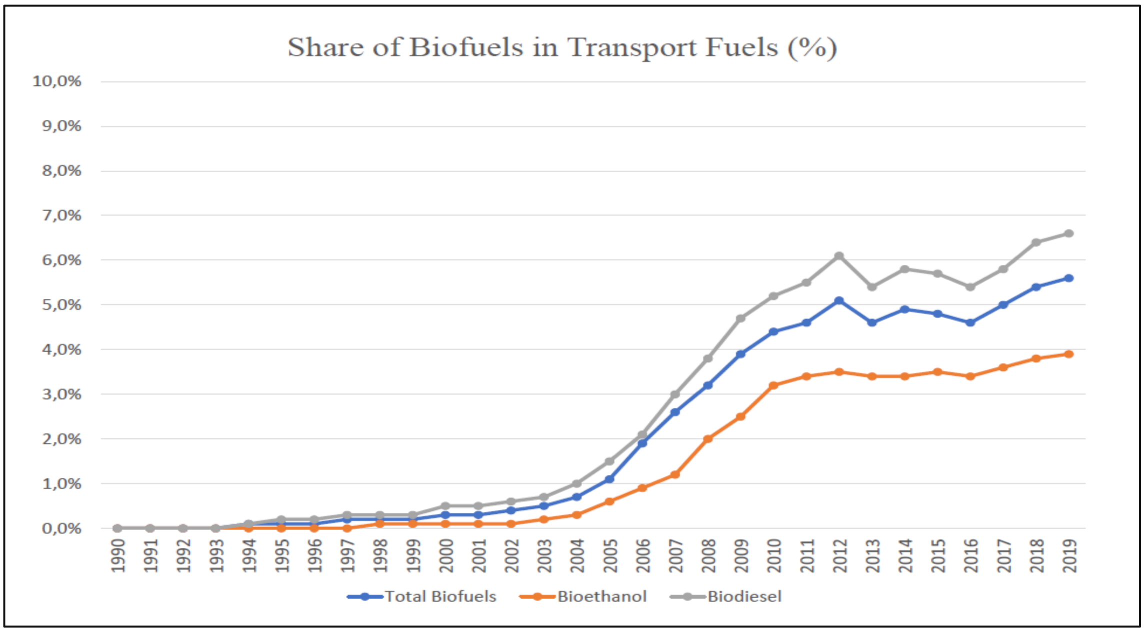

Figure 6: Increase in the percentage of biofuels in transport fuels (European Commission, 2021a)

The EU's legal framework regarding the use of biofuels as well as expected changes to this framework in the near future will be discussed in later chapters.

2.1.5.2 Biofuels in Austria

According to the Austrian Biomass Association (Pfemeter & Liptay, 2018), 5.6% of the fuels used for transportation in Austria are biofuels, with 3.9% being biodiesel and 1.1% bioethanol. The remaining 0.6% are made up by other biogenic fluids. The Association concedes that the decarbonization of the transport sector is too big of a challenge to be solved through biofuels alone. They therefore suggest to additionally focus on the electrification of the transport sector and modern mobility concepts.

Legally, the use of biofuels in the transport sector is regulated through the *Kraftstoffverordnung (KVO)* from 2009, which has since been adapted various times. The KVO sets a minimum goal, which corresponds to adding around 7% biodiesel and 5% bioethanol respectively. (Aichmayer, et al., 2021)

On the production side, Austria counted 7 registered biodiesel producers in 2020 with a total production volume of 292,583 tons, covering roughly 70% of Austria's consumption in 2020. The biomass base used in the production are predominantly used plant-based cooking oils (40%) and rapeseed oil (28%). The biggest share of the raw materials used in the biodiesel production came from Austria, but significant volumes were also imported from Slovakia, the Czech Republic, Hungary and Italy. (Aichmayer, et al., 2021)

Bioethanol is only produced in two locations in Austria, which have a combined production capacity of roughly 227,000 tons. Due to this massive production volume and the limited consumption in Austria, more than half of the produced bioethanol was exported. The three most frequently used raw materials are corn (32%), wheat (27%) and starch sludge (25%). (Aichmayer, et al., 2021)

2.2 Biodiversity

Biological diversity, or biodiversity, has become more and more important over the past decades, both in the academic and in the political sphere. Despite this increased interest in the protection and promotion of biodiversity, Kaennel (1998) and Feest et al. (2010) highlight the fact that the term is lacking a universal definition. Moreover, as Simpson (2002) points out, this inconsistence regarding the definition of biodiversity is also manifested in the absence of a clear measurement for biodiversity.

Swingland (2001) criticizes that biodiversity is consequently reduced to simply the quantity of species. However, the correct term for this would be species richness, which is only one of three aspects which make up biodiversity. In addition to species richness (sometimes also labelled alpha diversity), other measures such as those of "*beta and gamma diversity, endemicity, and higher taxon richness*" (Swingland, 2001, p. 377) should also be considered in the determination of the biodiversity of an area.

The European Environment Agency chooses a broad definition for biodiversity, describing it as "*the variety of ecosystems (natural capital), species and genes in the world or in a particular habitat*" (EEA, 2020). As this thesis operates within the framework of European legislation and strategies, this is also the level at which biodiversity will be discussed.

Another important specification to be made about the protection of biodiversity is that it is mostly done by identifying different species and areas to be protected. Consequently, the assessment of potential effects of a renewable energy infrastructure can be done by assessing which species and areas might be affected by a project. Therefore, the potential effects on biodiversity can be broken down according to the species and areas to be protected, which are affected by certain renewable energy projects. A matrix can be constructed which shows the potential impacts renewable energy infrastructure projects on different species and areas to be protected. The species and areas considered in this thesis are fauna, flora, soil, water, air, climate and landscapes. To illustrate what such a matrix could look like, Table 1 shows an empty matrix. The next chapter of this thesis will assess potential effects on biodiversity, which will finally be added to this matrix.

Table 1: Illustrative (empty) matrix showing the potential effects of different renewable energy infrastructure on biodiversity

	Renewable Energy Sources					
	Hydropower	Wind Power	Solar Power	Biomass	Biofuels	Transmission Grids
Fauna						
Flora						
Soil						
Water						
Air						
Climate						
Landscape						

2.3 Renewable Energies and Biodiversity

Before the next subchapters will specifically deal with potential effects of the five chosen renewable energy sources on biodiversity, this short introductory part has the purpose of mentioning an aspect which is universal across all renewables (mining) and provide additional general information about the approach taken in this chapter.

The impact of mining on biodiversity is not a new phenomenon, but a well-established and researched concern. "*Mining affects biodiversity at multiple spatial scales (site, landscape, regional and global) through direct (i.e. mineral extraction) and indirect processes (via industries supporting mining operations, and external stakeholders who gain access to biodiversity-rich areas as the result of mining)*" (Sonter, et al., 2018, p. 2).

Existing literature often identifies and addresses intensified mining as a necessity for the expansion of renewables. Sonter et al. (2020) have recently emphasized an exacerbation of mining threat, which is connected to the increasing demand of many metals. What is particularly alarming about the research is that they have found an overlap between mining areas and priority conversation sites. In this respect, they established that "*[approximately] 8% of the global area potentially influenced by mining overlapped with [protected areas]*" (Sonter, et al., 2020, p. 3).

Furthermore, it is important to be aware of the fact that potential effects of renewable energy sources on biodiversity can and should not be generalized. Instead, they are to be studied on a case-to-case basis. Consequently, the following chapter merely represents a non-conclusive list of the most common impacts – which of these effects become relevant for a specific project would have to be assessed separately. In order to visualize what challenges regarding the conservation of biodiversity in a specific project looks like, brief case studies of an Austria hydropower project and a transmission grid project will be discussed in the respective chapters.

Table 2: Matrix showing the potential effect of different renewable energy infrastructure on biodiversity

	Renewable Energy Sources					
	Hydropower	**Wind Power**	**Solar Power**	**Biomass**	**Biofuels**	**Transmission Grids**
Fauna	− +	−	−			− +
Flora	− +		− +	−	−	+
Soil				−	−	
Water	−			−	−	
Air	+	+	+	− +	− +	
Climate	+	+	+	+	+	+
Landscape		−				−

For a quick overview of the findings of this chapter, Table 2 shows a matrix highlighting species and areas to be protected which could potentially be influenced by energy infrastructure projects. The green plus sign marks areas in which a possible positive impact on biodiversity was found. The red minus marks areas in which a possible negative impact on biodiversity was found. It should be remembered, however, that this matrix merely indicates a potential impact and only means that this has to be considered for specific projects.

2.3.1 Hydropower and Biodiversity

Due to the long-standing history of hydropower in the world, this is also the renewable energy where we have accumulated the greatest knowledge about the influence it has on biodiversity (Gasparatos, et al., 2017). Since hydropower plants exist in varying sizes and capacities, Gasparatos et al. (2017) offer a distinction between small hydro (<10MW) and large hydro (>10MW). According to Hastik et al. (2016), such a distinction is especially necessary because small hydro is shown to impact a bigger surface area than larger constructions, relative to the energy output of the plants. More specifically, they have calculated the average technical energy potential for small and large hydroelectricity plants in the Alps region. Large hydropower plants have an average annual potential of 23.8 GWh per square kilometer of impact while small installations only achieve an average value of 5 GWh/km^2.

Across existing literature many potential effects on biodiversity have been identified (Mohtasham, 2015; Hastik, et al., 2016; Gasparatos, et al., 2017). Among the most frequently cited are flow regime changes and the blocking of migration routes by hydropower infrastructure. Both of these impacts are known to affect biodiversity and changes of flow regimes have also been shown to potentially cause deteriorating water quality (with regard to sediment loading and nutrient cycles) and flooding of adjacent areas by reservoirs. While this effect on water quality primarily affects aquatic species, the inundation of adjacent land areas also impacts the habitat of wildlife on land. In conclusion, hydropower can impact biodiversity in rivers and on land in many different ways.

Despite such potential adverse effects on biodiversity, Gasparatos et al. (2017) also highlight some potential positive impacts of hydropower installations. For instance, they can be useful to regulate water supply, to control droughts and flooding, and to facilitate agricultural irrigation.

Another – seemingly evident – advantage of hydropower is the carbon-neutrality of hydropower, which helps combat climate change. As shown in various studies, climate change would also cause significant adverse effects on biodiversity (Pires, et al., 2018). Hence, the reduced CO_2 output can also be considered as a positive impact of hydropower on biodiversity. However, while the existing literature mostly confirms this assumption of carbon neutrality (Gasparatos, et al., 2017), the neutrality of some hydropower plants with big reservoirs in the Amazonas area is questioned (Fearnside, 2014). This is based on significant amounts of CO_2 and CH_4, which were found to be emitted from these reservoirs. As mentioned before, such emissions are not a relevant concern for most European or Austrian hydropower plants.

This is also shown by Lauf et al. (2019) who present a calculation of the gaseous emissions in Germany which are caused by hydropower (including pumped storage power plants) in comparison with the avoided emissions. In total, they have found a net-prevention-factor (in g/kWh) of 670.37 for CO_2. Additionally, the other studied pollutants (CH_4, N_2O, SO_2, NO_x, dust, CO, NMVOC) also have a positive prevention factor, meaning that the avoided emissions outweigh the emissions which can be attributed to hydropower plants. In the context of this thesis, this is relevant because climate change threatens biodiversity.

Another highly interesting approach to biodiversity impacts of hydropower is the footprinting approach by Hastik et al. (2016). As briefly mentioned before, the authors related the energy output of hydropower plants in the Alps to the area in which these power plants impacted biodiversity. On this basis, they calculate an alternative hydropower potential for the Alps region, which would help protect the biodiversity in the area. This approach reduces the hydro-potential of the European Alps to 145 TWh, 69% of which were already realized in 2016.

One of the most impactful ways of mitigating the effects on biodiversity caused by hydropower installations is to avoid areas which are particularly rich in biodiversity (Hastik, et al., 2016). Further mitigation measures proposed by Gasparatos et al. (2017) include the employment of least impactful technologies and the addition of biodiversity-friendly elements. Regarding the use of technologies, which were shown to have a lower impact on biodiversity, they found that "*establishing optimum operational characteristics for hydropower development can be quite challenging, especially considering variable local contexts and the need to balance multiple impacts on ecosystems and human wellbeing*" (Gasparatos, et al., 2017, p. 165). The addition of biodiversity-friendly elements seems easier to implement, for instance, through fish ladders or fish-friendly turbines. Lastly, Gasparatos et al. (2017) mention innovative policy action as a possible mitigation measure:

> *[Regulatory] measures and market-based conservation schemes could improve the environmental performance of hydropower generation. For example, issuing hydropower generation licenses for a limited term after which the operators can renew them only if they manage to comply with current environmental laws, could ensure that hydropower installations comply with the latest environmental legislation.* (Gasparatos, et al., 2017, p. 165)

In Austria, such a system is already implemented to assure that permits for hydropower generation are only valid for a limited term (BMLRT, 2022).

In order to provide guidance for renewable energy project developers, the EU has published a guidance document regarding hydropower requirements (European Commission, 2018). In addition to previously discussed mitigation measures, one of the most important suggestions made in this document is to modernize existing hydropower plants instead of building additional facilities. This should help to improve the plant's impact on ecosystems and biodiversity while also increase the energy output.

2.3.1.1 Example: The Run-of-river Hydropower Plant in Gratkorn

The run-of-river power plant in Gratkorn, Austria (KW Gratkorn) is a joint project of *Verbund* and *Energie Steiermark* and is expected to become operational in 2024. With an installed capacity of 11 MW and an expected electricity output of 54.2 GWh/a, the project is part of Austria's ambitious renewable energy expansion plans. (Verbund AG, 2022b)

Having already passed the necessary environmental impact procedure, KW Gratkorn is currently under construction since fall 2021 (Verbund AG, 2022b). However, the initial application for this project was already submitted as early as 2009.

In order to protect and promote the local ecosystems and biodiversity as much as possible – and in accordance with the provisions of the permit – a series of measures in over 30 thematic areas are accompanying the implementation of the project. The area reserved for such additional measures amounts to 133,680 m^2. (Verbund AG, 2022c)

Some examples for such measures are specifically aimed at snakes, birds, bats and fish while others are more generally concerned with the conservation of vital ecosystems. Before the construction works had even begun, the stock of local snake species was assessed, and they were largely relocated before construction works started. Birds and bats nesting in local trees which had to be cut down for the project, were also relocated preemptively. Furthermore, fish ladders will be constructed at the power plant to facilitate fish migration across the plant. This measure is also accompanied by an extensive monitoring program for which each fish was documented according to size and species. On a more general level, construction areas are to be replanted immediately after construction works have been completed. (Verbund AG, 2022c)

This chapter merely gave a brief insight into the wide array of measures that accompany this project. It should nonetheless become clear that it is common practice in Austria that renewable energy projects are planned according to a holistic approach and ecological impacts are considered long before construction starts. Consequently, these biodiversity measures go hand in hand with a project as large as the KW Gratkorn.

2.3.2 Wind Power and Biodiversity

In comparison to hydropower, the potential effects on biodiversity are less broad for wind energy. However, there is an important distinction to be made between on- and off-shore wind power (Gasparatos, et al., 2017). Therefore, this chapter will first elaborate on the considerations related to on-shore wind energy and then move on towards off-shore wind energy. Finally, common mitigation measures for both types will be discussed in the end.

According to Hastik et al. (2016), onshore wind turbines have an average annual technical energy potential of approximately 8.8 GWh per square kilometer occupied. While this impacted area is relatively small, the presence of wind parks is nonetheless often related to a deterioration of the landscape aesthetics[4].

The possible effects of wind turbines on biodiversity on land are mostly concentrated on birds and bats (Gasparatos, et al., 2017). Regarding the effects on avian fauna, Mohtasham notes that the main concern is the "*killing of, or interfering with, migratory birds*" (Mohtasham, 2015, p. 1292). However, this almost never leads to habitat loss for

[4] It should be noted at this point that the Author does not consider aesthetics to be an important factor in terms of biodiversity and will therefore not focus on this aspect in this thesis. However, this should in no way contradict the assessment of Gasparatos et al. (2017), who considers this to be very important with regard to public acceptance.

avian species but results mostly in habitat change (Gasparatos, et al., 2017). Gasparatos et al. (2017) further point out that the avian species affected by this are mostly larger, less agile birds.

With regard to the location of wind parks, Gasparatos et al. (2017) found that those located near bird feeding areas or in migratory routes have the potential to be problematic. They also identified an interesting dilemma between accommodating the needs of humans and animals. For humans, wind turbines are often perceived as a nuisance, which would suggest building them away from settlements. However, many of these remote locations are important migratory routes for avifauna, an aspect that should be considered for wind power projects in such areas.

In 2020, the European Commission has published a guidance document in which the potential environmental effects of on-shore wind farms are discussed. Among other things, the document highlights that those effects can occur at all stages of the life-cycle of a wind farm – from pre-construction to decommissioning. According to the Commission, the most significant impact lies in habitat loss. Additionally, birds and bats are particularly affected by wind farms due to the risk of collision. (European Commission, 2020c)

Off-shore wind turbines necessarily lead to some habitat loss since "*any (...) offshore wind pole will result in the direct loss of a small habitat area, as the section of the sea and the bottom occupied by such units will be unavailable for aquatic species*" (Gasparatos, et al., 2017, p. 169). Additionally, the International Union for Conservation of Nature lists "*potential collisions with wind turbines, deviation of the migratory routes of birds and whales, noise and electromagnetic disturbance and navigational hazards for ships*" (IUCN, 2010) as potential impacts, which have to be closely observed. Another concern, which affects the construction phase, is the generation of noise which can disrupt some aquatic species (Gasparatos, et al., 2017). The European Commission (2020c) confirms the abovementioned concerns and lists fish, birds, bats and marine mammals as particularly affected species. Furthermore, it adds that EMF and its influence on marine wildlife have to be considered as a potential concern.

Gasparatos et al. (2017) and Hastik et al. (2016) agree that the most important and impactful mitigation measure is to avoid constructing wind turbines in areas with great avian biodiversity. Furthermore, Gasparatos proposes to "*[halt] power generation during* *critical migration periods (…) or times of high activity, e.g. just after sunset, during high insect activity or episodic/ad-hoc moments when threatened species are detected or predicted*" (Gasparatos, et al., 2017, p. 164) in order to avoid avian casualties.

The European Commission (2020c) confirms that the choice of location is extremely important. Furthermore, to minimize impacts during the construction phase, critical periods should be avoided for construction and decommissioning work. In addition, deterrents (visual or acoustic) can be deployed to reduce the collision risk. One measure, which only applies to off-shore wind power and should mitigate potential EMF effects, is to bury the cables (at least 1 meter deep). (European Commission, 2020c)

With regard to air-borne emissions, a German report showed that both on- and off-shore wind power perform very well with a positive net-prevention-factor for all analyzed pollutants (CO_2, CH_4, N_2O, SO_2, NO_x, dust, CO, NMVOC). (Lauf, et al., 2019)

2.3.3 Solar Power and Biodiversity

Existing literature identifies "*multiple ways throughout [the] lifecycle [of a photovoltaic cell]*" (Gasparatos, et al., 2017, p. 162) in which the generation of solar energy can impact biodiversity. However, a significant body of literature is focusing on the raw material side when it comes to the effect of PV on the environment (Heidari & Anctil, 2022). This focus was also emphasized during the expert interviews which were conducted for this thesis.

Generally, Gasparatos et al. (2017) found that peer-reviewed studies about environmental impacts of PV are scarce. Nonetheless, the space requirement of solar panels and the habitat change it necessarily causes are well established. In fact, Gasparatos et al. (2017) found that this space requirement (for installations outside of urban areas) is about 2.5 times bigger than the panels themselves – this is due to necessary supporting infrastructure such as access roads.

The installation of photovoltaic panels brings a lot of flexibility to the generation of electricity as they can be installed basically everywhere where they receive sunlight. This feature also makes them "*ideal for integration into the urban environment or manmade structures*" (Gasparatos, et al., 2017, p. 162). This way, unnecessary interaction with wildlife can be avoided to minimize the impact on biodiversity caused by panels. Therefore, Gasparatos et al. (2017) suggest an installation of rooftops or building facades.

Furthermore, solar panels in remote areas can potentially lead to pollution (Lovich & Ennen, 2011). This is mainly caused by dust suppressants and herbicides which are employed to makes sure that the panels receive enough radiation. In contrast, Lauf et al. (2019) state that the employment of PV in Germany does not cause gaseous emissions while the productions side should be closely analyzed. Their report shows a net-prevention factor of 570.37 g/kWh CO_2. The only pollutant which has a negative prevention factor is carbon monoxide (-1.07). These emissions are accumulated during the production of PV cells.

All of the points mentioned above would suggest that it is most sensible to install PV on urban structures rather than in green spaces. This option would additionally bring the positive effect that the energy is generated right where most of it is needed, decreasing the necessity of storage and additional transmission grid capacities. In fact, Brauner (2016) argues strongly for the implementation on building roofs and a decentralization of electricity generation through solar power.

However, there is also a significant body of literature arguing that the installation of PV on fields does not harm biodiversity, but rather promotes it. Montag et al. (2016) compared the biodiversity of areas which were covered by solar farms with control areas. In their study, they found a substantial increase of botanical biodiversity at PV sites and a slight increase in biodiversity with regard to invertebrates (butterfly and bumblebee species), birds and bats. Similarly, a report by Peschel et al. (2019) suggests that biodiversity is enhanced by PV in comparison with the surrounding environment. This was found to be particularly true for insects and reptiles.

Another possible site for PV installations are surface waters, using so-called floating panels. However, the small body of existing literature on this topic suggests that the effect on the amount of sunlight that is available for the waterbody could possibly impact water properties such as oxygen availability. (Lammerant, et al., 2020)

In conclusion, the biodiversity concerns caused by the operation of PV are mostly minor and of a hypothetical nature, especially when they are constructed on existing urban infrastructure. Additionally, there is even some evidence for positive effects of rural PV installations. However, close attention must be paid to the supply side to minimize the potential adverse effect caused during the mining of necessary raw materials and the production of PV cells.

2.3.4 Biomass and Biodiversity

Energy generation through burning biomass encompasses two important steps during both of which biodiversity can be affected. Firstly, impacts of growing and harvesting of biomass crop or wood must be considered. Secondly, the effects of possible emissions during the combustion of biomass are to be taken into account.

As pointed out in previous chapters, the biomass used in the renewable energy sector is mostly wood, followed by agricultural outputs and biowaste. The latter will not be considered here further as the 'generation' of biowaste does not cause any additional adverse effects on biodiversity.

Mohtasham (2015) attributes great significance to the type of biomass that is used. In this context, he urges to avoid certain types of biomasses to avoid causing harm to the environment. Firstly, "*[energy] crops that do not compete with food crops for land*" (p. 1294) should be chosen as feedstock. Furthermore, it is important that the biomass (especially wood) is harvested sustainably.

According to Gasparatos et al., the most significant potential effects on biodiversity are related to "*land use change effects from the expansion of biomass feedstock for energy production [which] have resulted in habitat and biodiversity loss (...), especially when large-scale land conversion using mono-cultural feedstock production is adopted*" (Gasparatos, et al., 2017, p. 166). In some cases, however, the newly created landscape can be more welcoming for certain species than intensified agricultural sites (Gasparatos, et al., 2017).

Regarding the emissions from the combustion of solid biomass, a report from the German Environmental Ministry (Lauf, et al., 2019) offers a comprehensive approach on calculating the net avoided emissions for different frequently occurring emissions. According to the report, only CO_2 and CH_4 have a positive value for net avoided emissions, with carbon dioxide having a significant positive impact (614 g/kWh) and the impact of methane being rather minor (2.31 g/kWh). At the same time, the value for many other pollutants is negative, which means that this renewable form of energy generation causes more emissions than it prevents over its life cycle. For instance, solid biomass burning avoided 5,171 tons of NO_x but also caused 12,528 tons in 2018, leading to a net value of -0.68 g/kWh. Since this section of the thesis focuses on biodiversity, these increases of emissions are significant as they contribute to a deterioration in air quality.

Furthermore, in relation to the aforementioned drawbacks of biomass use, Mohtasham urges to "*distinguish between biomass resources that are beneficial in reducing net carbon emissions, those that have an ambiguous impact, and those that increase net emissions*" (Mohtasham, 2015, p. 1294).

2.3.5 Biofuels and Biodiversity

The most important biodiversity consideration in relation to biofuels is the feedstock. Gasparatos et al. (2017) list two main factors influencing the gravity of habitat loss and change: the type of land used, and the feedstock used. With respect to the type of land, Verdade et al. (2015) distinguish two types of impact on ecosystems, depending on the natural environment used in the feedstock production. While the occupation of natural land like grasslands or forests directly causes habitat loss, the use of abandoned lands is rather associated with typical agricultural side-effects such as soil contamination and groundwater eutrophication.

The size of the area affected is presented by Webb and Coates (2012), who offer a comparison of various renewable energy sources and fossil energies with regard to the area required to drive 100 kilometers. According to their estimates, biodiesel produced from rapeseed oil requires 53.6 square meters and ethanol from sugar beets 17.2 square meters. In contrast, a wind turbine only occupies a land area of 1 square meter.

In order to mitigate biodiversity loss, Gasparatos et al. suggest to "*design multifunctional bioenergy landscapes that employ a variety of biodiversity-friendly elements such as mixed-cropping for food/feed/bioenergy, crop rotation, habitat corridors, and conservation area remnants with native vegetation*" (Gasparatos, et al., 2017, p. 168). Furthermore, it is important to choose the right location to grow the feedstock. In this respect, it is better to use formerly cultivated land instead of biodiversity-rich grasslands or forests (Gasparatos, et al., 2017). Verdade et al. (2015) support this assessment and further add that any type of feedstock production should be accompanied by extensive long-term monitoring of the impacts on biodiversity.

2.4 The Relevance of Transmission Grid Expansions

Existing literature widely agrees on the fact that simply promoting and expanding energy production from renewable sources is not the solution to our energy crisis (Schroeder, et al., 2013; Bertsch, et al., 2016; Kim, et al., 2021). This assessment was also confirmed by the two experts which were interviewed for this thesis.

According to Schroeder et al. (2013, p. 140), "*[the] geographic disconnect between power generation resources and demand hubs is an important issue in the European electricity sector*". For this reason, and also because of the non-dispatchable character of many renewable energies (solar and wind power in particular), an expansion and revision of the existing transmission grid structure in Europe will be necessary. For this purpose, various possible scenarios are identified, which could be used to bridge this gap. Taking the purpose of this thesis into account, a deeper analysis of the different options is not necessary, and so the main message of this chapter should be the necessity of expanded transmission grids for a successful energy transition. (Schroeder, et al., 2013)

Another important factor to consider is the notion of public acceptance, which plays a very important role when it comes to the actual implementation of energy projects. In the area of renewable energies, there is some resistance especially when it comes to wind and solar energy. Interestingly enough, this skepticism towards wind and solar expansion is mostly rooted in the aesthetics of wind turbines etc. (Gasparatos, et al., 2017) and not the previously discussed aspects related to biodiversity.

Despite these negative voices about renewables, the resistance against renewable energies is nowhere nearly as pronounced as that against the expansion of transmission grids. A recent study from South Korea has analyzed public opinion about the energy transition and has found a significant gap between renewable energies' acceptance and transmission grid expansions' acceptance (Kim, et al., 2021). Similarly, Bertsch et al. (2016) found that the acceptance of transmission grid projects in Germany is rather low, particularly in rural areas.

For the specific case of Austria, necessary transmission grid expansions until 2030 are outlined by the APG[5] (2021) in the most recent network development plan 2021. In accordance with the Austrian *Erneuerbaren Ausbau Gesetz (EAG),* a significant expansion of wind, hydro and solar energy is planned. More specifically, the EAG requires an additional 27 TWh of annual renewable energy generation. While the biggest expansion is required in the areas of PV (+11 TWh) and wind power (+10 TWh), an additional 5 TWh are planned for hydropower as well as 1 TWh for biomass.

[5] It should be noted that while most of Austria is covered by the APG power grid, the region of Vorarlberg has a separate grid managed by VÜN (Vorarlberger Übertragungsnetz GmbH). However, the latter will not be considered in this thesis.

In this respect, the report emphasizes the specific power grid needs in relation to meteorologically dependent renewable energies like wind and solar energy. Due to the rather small amount of full load hours of a wind park (2,000) compared to a hydropower station (5,400), almost three times the capacity of wind energy needs to be installed to generate the same amount of electrical energy. Furthermore, this maximum capacity must be able to be fed into the grid at all times. Hence, for the sizing of the power grid, the installed capacity (in MW) is relevant and not the total energy output. (APG, 2021)

In their report (APG, 2021), various transmission grid projects are listed, which need to be realized until 2030. These projects allow Austria to make the integration of renewable energies into the network possible. They note, however, that in order to integrate a total of 19 GW of renewable energies (according to the *EAG*), the realization of further projects would be necessary. Among the projects on that list is the *380-kV-Line St. Peter – Staatsgrenze DE*, which will be discussed in more detail as an example in the next chapter.

In his book, Brauner (2016) makes a compelling argument for smart solutions of solar and wind power, which do not require such extensive adaptations and expansions of our existing power grids. He states that it is important to not simply consider the energy generated in a year by a renewable energy source but also consider the cost and impact of extensive transmission grid projects. For photovoltaics, he sees integrated PV solutions for buildings as the way forward as this would allow to generate the energy where it is needed and decrease the necessity for energy storage solutions and expanded power grids.

Brauner's (2016) suggestion for wind power lies in the use of weak wind turbines, which require lower grid capacity and reach a greater amount of full load hours. By using a reduced generator capacity of (e.g.) only 3.3 MW, up to 3,500 full load hours can be reached in on-shore wind generation, whereas off-shore, the potential lies beyond 5,000 full load hours, which can be compared with the full load hours in hydropower. In comparison, conventional wind turbines with bigger generator capacity usually only reach up to 2,000 full load hours. As the reduced installed capacity also allows for more full load hours, the amount of energy generated is actually also increased. Additionally, the capacity of the grid does not have to be increased as it is the case with conventional wind energy.

2.5 Transmission Grid Expansions and Biodiversity

In the absence of other, significant impacts, Biasotto and Kindel (2018) identifiy the barrier effect to be the main impact of power grids on biodiversity. Simply put, this effect describes that a structure that was not previously there affects animals and plants in their behavior. At the same time, overhead lines are also found to be used as a resource by birds in particular. While this increases their population size around power grid installations, it can also lead to bird casualties. Effects caused by possible noise pollution as well as fire risk or the loss of habitat are assessed to be minor.

The presence of electromagnetic fields does not affect biological wildlife, as was found during the expert interviews. The EMF detected is far below the legal thresholds and is therefore unlikely to have a negative impact on humans, animals or plants. It was also pointed out during the interviews that not only negative effects are mitigated, but grids are even connected to increases in biodiversity.

In Austria, the APG's report promises a serious commitment to minimizing the impact of transmission grid projects on the environment, which also entails the promotion of biodiversity. More specifically, their efforts entail the avoidance of protected areas with high biodiversity and the implementation of route bundling. This means that grids are designed and planned along existing infrastructure such as existing overhead lines or streets. (APG, 2021)

2.5.1 Example: The 380-kV-Line St. Peter – Staatsgrenze DE

The *380-kV-Line St. Peter – Staatsgrenze DE*, for which constructions are currently already underway, is a transmission grid project which is implemented by the Austrian Power Grid AG. The total line has a length of 89 km; however, only roughly 3 km are located in Austria. (APG, 2021)

Due to its significance for meeting the Austrian as well as European energy targets, the project is among those labelled PCI-projects by the European Union. Such projects of common interest (PCI) are considered to be of outstanding importance for the climate goals and the energy security of the European Union. This specific line is designed to increase the energy security and is part of the process of creating a transmission grid which is primed for the feeding in of increased amounts of renewable energy. (APG, 2021)

Naturally, the construction of a 380-kV-line requires the realization of an environmental impact assessment. Under Austrian law, this is regulated in the *Umweltverträglichkeitsprüfungsgesetz,* short *UVP-G 2000*. In December 2015, it was decided at first instance that the project is permitted according to the *UVP-G 2000*.

The corresponding permit (LROÖ, 2015) considers potential impacts which should be considered on the environment and biodiversity, which will be summarized here. Several provisions related to geology, hydrology, and other disciplines are included in the document. Note, however, that this summary is in no way comprehensive but merely constitutes an indicative list of some of the most important provisions.

With regard to contamination of the soil through oil spills, it is necessary that primary measures are taken to avoid such spills in the first place (e.g. machinery without dripping losses). Should spills still occur, sufficient quantities of oil binding agents (>100 liters) have to be stored at the site and ready to be employed immediately. Spills of substances which are particularly hazardous to water (e.g. mineral oils) need to be treated and removed instantly. Furthermore, all significant accidents in this respect have to be reported to the responsible authorities. The threshold for this is a volume of 5 liters. (Genehmigungsbescheid 380 kV-Deutschlandleitung, 2015)

Affecting the soil, there is also a clear rule regarding the excavation of soil material. Excavated material of different quality must be stored separately and put back accordingly. This whole process and other procedures regarding the integrity of affected soils are to be supervised by a soil scientist who is responsible for the compliance with the provisions.

Furthermore, potential adverse effects on flora and fauna are considered. More generally, the document requires the project management to report all unexpected incidents which may have a negative impact on flora or fauna. To avoid bird collisions with the powerline, so-called bird flappers, which are designed to increase the visibility of the line, have to be installed and readjusted in case it still comes to collisions. The influence of tree clearing on local microclimates is to be mitigated through the planting of fast-growing pioneer plants. Upon completion of the construction of the powerline, a comprehensive report on the ecological impact of the project must be submitted.

Lastly, with regard to electrical and magnetic fields, the operator is required to measure these fields during the operation of the line. In conclusion, the impacts and mitigation measures mentioned in the *UVP-G* permit refer mostly to the construction phase, suggesting that this is the most critical part for a transmission grid project. Furthermore, while some rules are defined, the approach taken relies heavily on continuous reporting and reassessment.

3 Political and Legal Framework

3.1 Legislation Regarding Renewable Energies

3.1.1 European Union: Renewable Energy Directive II

Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, often referred to as *Renewable Energy Directive II (RED II)* is a recast of the Renewable Energy Directive form 2015 (European Union, 2018). The amendments should reflect the European Union's continuous and increased efforts in the promotion of renewable energy sources. The general purpose of the directive is given in its first article, where it states the following: "*This Directive establishes a common framework for the promotion of energy from renewable sources. It sets a binding Union target for the overall share of energy from renewable sources in the Union's gross final consumption of energy in 2030*" (European Union, 2018, art. 1). Article 2 outlines important definitions. The term gross final energy consumption is given a very broad definition, which includes all energy consumption in all sectors and also private energy consumption (European Union, 2018, art. 2.3). Furthermore, renewable energy is defined as "*energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas*" (European Union, 2018, art. 2.1).

However, in the area of biomass energy further criteria have to be fulfilled in order to qualify as a renewable source. More specifically, article 29 outlines the "*[sustainability] and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels*". On the one hand, the biomass has to be sustainably sourced with respect to its impacts on the environment (European Union, 2018, art. 29.2-29.7). For example, this entails that it does not come from areas with high biodiversity or with a high carbon stock. On the other hand, a minimum percentage of greenhouse gas emission savings must be reached (European Union, 2018, art. 29.10). The percentage required is set at 50% for biofuels coming from installations in operation before October 2015 and gradually increases for newer installations. Installations commissioned after January 2021 will require a greenhouse gas saving of 65%. For the use of biomass fuels for heating, cooling or electricity production, a greenhouse gas saving of at least 70% (commissioning after January 2021) is required. This threshold will also be increase at the end of the year 2025.

At the heart of the directive stands the binding goal of at least 32% renewables in the European Union's gross final energy consumption. While this goal is to be reached in a comprehensive effort by all member states, each member state is required to define their national contributions accordingly. In their efforts, member states shall be supported by reduced capital costs, grid expansions and other aid programs. (European Union, 2018, art. 3)

The directive also defines a framework under which statistical transfers and joint projects with other member states as well as third parties are permissible to facilitate and support their effort towards an increased share of renewables (European Union, 2018, art. 8-14)

Article 15 states that administrative procedures which are necessary for the construction of new power plants or the increase of the capacity of existing ones should not constitute an unnecessary burden for the expansion of renewable energy production:

> *Member States shall ensure that any national rules concerning the authorisation, certification and licensing procedures that are applied to plants and associated transmission and distribution networks for the production of electricity, heating or cooling from renewable sources, to the process of transformation of biomass into biofuels, bioliquids, biomass fuels or other energy products, and to renewable liquid and gaseous transport fuels of non-biological origin are proportionate and necessary and contribute to the implementation of the energy efficiency first principle.* (European Union, 2018, art. 15.1)

This commitment towards a streamlined approval process for renewable energy projects (also including relevant transmission grid projects) is underlined by article 16 which states that contact points are to be established at national competent authorities. Furthermore, the maximum duration for the approval process of a new power plant is set at 2 years (+1 year under special circumstances) for new power plants and 1 (+1) year for plants below 150kW. However, this article also reiterates that this streamlined process is without prejudice to other provisions of European environmental law. (European Union, 2018)

Furthermore, the directive specifies additional goals for the heating/cooling sector as well as the use of renewables in transportation. The share of renewables in heating/cooling shall on average be increased by 1.3% each year (European Union, 2018, art. 23). For the transportation sector, the goal is set at a renewables share of 14% by 2030 (European Union, 2018, art. 25).

Lastly, article 36 covers the transposition into national law of the respective member states. As this thesis places particular emphasis on the case of Austria, the transposition of the RED II will be briefly discussed in the next chapter. (European Union, 2018)

Before moving on to the national legislation of Austria, it should be mentioned that a revision of the RED II has already been initiated by the European Union. The recast, often referred to as Renewable Energy Directive III (RED III), is deemed necessary by the EU as the current directive is no longer considered to be ambitious enough. Consequently, the RED III will most likely at a 40% renewable energy share by 2030. Furthermore, modern strategies including hydrogen should be included in the revised version. In addition, the sustainability criteria set out for bioenergy should be reinforced. (European Commission, 2021b)

Even more recently, the EU has committed to an even higher target for renewable energies. On 18 May 2022, the Commission has released a Communication titled *REPowerEU Plan* in which they suggest to aim for a renewables share of 45%. (European Commission, 2022)

However, since a definitive decision on this revision is not expected before the end of 2022, this thesis will use the targets and measures which are outlined in the RED II.

3.1.2 Austria: *Erneuerbaren-Ausbau-Gesetz (EAG)*

In Austria, the *EAG*[6] has replaced the *Ökostromgesetz* in July 2021 and has since already been amended in January 2022 (BMDW, 2022a). Since the analysis in this thesis focuses primarily on the European policy, this short excursus will only discuss the main target outlined in the most recent version of the *EAG*.

The goal set by the *EAG* is to cover 100% of Austria's total electricity demand with energy from renewable electricity sources (BMDW, 2022a, §4). This should be reached by installing renewables capable of producing an additional 27 TWh per year until 2030, including 11 TWh PV, 10 TWh wind power, 5 TWh hydropower and 1 TWh biomass. With regard to biomass, the *EAG* directly follows the lead of the RED II and reiterates

[6] Official title: *Bundesgesetz über den Ausbau von Energie aus erneuerbaren Quellen*.

that liquid and solid biomass must fulfill the criteria set out by the European Union in order to be considered as renewable energy sources. (BMDW, 2022a)

3.2 Legislation Regarding the Conservation of Biodiversity

3.2.1 European Union: Biodiversity Strategy for 2030

The European Union's approach and ambition towards the promotion and protection of biodiversity is best captured in a Communication by the Commission which is titled EU *Biodiversity Strategy for 2030 – Bringing nature back into our lives* (European Commission, 2020d). The Communication emphasizes the importance of biodiversity for the well-being of our planet but also lists positive effects of nature on mental and physical health as important factors. Most importantly, however, a healthy environment is essential to increase the Earth system's resilience against global disasters like climate change. Furthermore, the Commission highlights that biodiversity efforts do not only have ecological motivations but are also necessary from an economical point of view.

> *The business case for biodiversity is compelling. Industry and companies rely on genes, species, and ecosystem services as critical inputs for production, notably for medicines. Over half of global GDP depends on nature and the services it provides, with three key economic sectors – construction, agriculture, and food and drink – all highly dependent on it.* (European Commission, 2020d, p. 1)

In the light of all this – and despite the existence of biodiversity strategies – the Commission harshly critiques the inadequate nature of existing measures. More specifically, it labels protection efforts "*incomplete*", restauration projects "*small-scale*", and legislative action and enforcement "*insufficient*" (European Commission, 2020d, p. 3). Hence, it stresses the importance of developing an ambitious and comprehensive biodiversity strategy. The European Union's line of argumentation makes it evident that the aim is not to preserve the status quo but to actively restore nature. Following this logic, the biodiversity plan formulated by the Commission is structured in two parts – the protection of nature and the promotion of biodiversity. For both objectives, various targets are formulated.

The Nature Protection Plan has three objectives, all of which relate to a better, more comprehensive network for the protection of nature across Europe. In this respect, 30% of land area and 30% of the sea should be protected. Additionally, 10% of both spheres should be strictly protected. Among other things, the latter target requires that member states "*define, map, monitor and strictly protect all the EU's remaining primary and old-*

growth forests" (European Commission, 2020d, p. 4). Lastly, the protection network shall be effectively managed and monitored.

The Nature Restauration Plan is even more comprehensive and includes 14 objectives. The targets range from the reduction in the use of hazardous pesticides and chemicals to the restoration of rivers. One point of the plan is also to define binding targets to nature restauration in the aforementioned 14 areas. More specifically, such "*[legally] binding EU nature restoration targets [are] to be proposed in 2021*" (European Commission, 2020d, p. 14).

In direct reference to the RED II, the Communication states that protection of biodiversity remains a priority even in the light of the imminent energy transition. However, the mentioned protection efforts almost exclusively refer to the increased sustainability criteria (see chapter 3.1.1) for biomass and biofuels. Potential conflicts regarding land use are not discussed. (European Commission, 2020d)

3.2.2 Austria: Biodiversity Strategy Austria 2030

Austria is currently in the middle of the process of revamping its biodiversity strategy in order to reflect its increased efforts towards 2030. The measures which were suggested by a committee of experts are currently undergoing a consultation process, which allows all stakeholders to comment on the proposition. (BMK, 2020b)

Their suggestion consists of five main points which are accompanied by supporting measures. The first two measures are congruent with the previously discussed EU targets of reaching 30% of the land area being protected and 10% being strictly protected. The third measure states that all areas of significantly degraded ecosystems should be restored. Fourth, the daily land use should be reduced to as little as 2.5 hectares. Lastly, incentives and subsidies for biodiversity-damaging activities should be phased out. (BMK, 2020b)

The consultation process for the strategy is still ongoing and the propositions are not undisputed. Particularly the Austrian Chamber of Agriculture (*Landwirtschaftskammer Österreich; LKÖ*) is a vocal opposition of the proposed strategy. (Jung-Leithner, 2022)

3.3 Environmental Impacts Assessments

Under the umbrella of article 191 TFEU (Treaty on the Functioning of the European Union), many regulations and directives have been adopted to protect the environment and promote a more sustainable use of our planet's resources. Many of them require separate assessment procedures, which project developers have to be to undergo. Because of this plethora of requirements to fulfill, a project may have to comply with various other requirements in addition to those of a traditional environmental impact assessment. For instance, a hydropower project may be subject to transposed European requirements of the Water Framework Directive, the Habitats Directive, the Floods Directive and the Birds Directive. While the European Union openly advocates an integrated approach to this issue, this is often difficult in practice in the light of the differing requirements. (European Commission, 2018)

Nevertheless, the EIA is the closest to a comprehensive approach in this context. Therefore, this thesis will concentrate on the environmental impact assessment procedures according to the EIA directive.

3.3.1 European Union: Environmental Impact Assessment Directive

Already since 1985, the assessment of the environmental impacts of large-scale projects has been an integral part of Union law. Currently the due process regrading such assessments is regulated in *Directive 2011/92/EU* (European Union, 2011) which was amended by *Directive 2014/52/EU* (European Union, 2014).

The directive regulates the "*assessment of the environmental effects of those public and private projects, which are likely to have significant effects on the environment*" (European Union, 2011, art. 1). In this context, it is relevant to know which projects are considered to fulfill these very broad criteria. Article 4 of the directive lays out which type of projects are subject to an environmental impact assessment. For this purpose, Annex I contains a list of projects which are always subject to complete an environmental impact assessment. Additionally, Annex II contains a list of project types for which the requirement of an assessment must be decided on a case-to-case basis by the competent national authority. (European Union, 2011)

In the field of renewable energies and transmission grid projects, the following projects can be found in Annex I:

> *Thermal power stations and other combustion installations with a heat output of 300 megawatts or more.* (European Union, 2011, Annex I, 2(a))
>
> *Dams and other installations designed for the holding back or permanent storage of water, where a new or additional amount of water held back or stored exceeds 10 million cubic metres.* (European Union, 2011, Annex I, 15)

> *Construction of overhead electrical power lines with a voltage of 220 kV or more and a length of more than 15 km.* (European Union, 2011, Annex I, 20)

While point 2. (a) could theoretically apply to biomass combustion plants, there is only one biomass plant worldwide which exceeds this threshold (Power Technology, 2020). In Annex II, the third point is labelled "*energy industry*" and contains a list of energy projects. The following projects are relevant within the context of this thesis:

> *Industrial installations for the production of electricity, steam and hot water (projects not included in Annex I);* (European Union, 2011, Annex II, 3(a))
>
> *Industrial installations for carrying gas, steam and hot water; transmission of electrical energy by overhead cables (projects not included in Annex I);* (European Union, 2011, Annex II, 3(b))
>
> *Installations for hydroelectric energy production;* (European Union, 2011, Annex II, 3(h))
>
> *Installations for the harnessing of wind power for energy production (wind farms);* (European Union, 2011, Annex II, 3(i))

Consequently, almost all projects related to renewable energies and transmission grid expansions discussed in this thesis (with the exception of biofuels) are included either in Annex I or II. In practice, however, almost all new renewable energy projects (even those which fall under Annex II) require an environmental impact assessment.

Once it has been established that an environmental impact assessment is necessary for a specific project, the process of executing the assessment can be summarized as follows:

> *[The] developer may request the competent authority to say what should be covered by the EIA information to be provided by the developer (scoping stage); the developer must provide information on the environmental impact (EIA report – Annex IV); the environmental authorities and the public (and affected Member States) must be informed and consulted; the competent authority decides, taken into consideration the results of consultations. The public is informed of the decision afterwards and can challenge the decision before the courts.* (European Commission, n.d.)

3.3.2 Austria: *Umweltverträglichkeitsprüfungsgesetz (UVP-G)*

Evidently, the EIA directive was also transposed into Austrian law in the form of the *Umweltverträglichkeitsprüfungsgesetz* (BMDW, 2022b). Since the general process is very similar, this chapter will only discuss the projects for which *UVP* procedures are required. Which projects are subject to an assessment is stated in §3 which refers to Annex 1. This Annex includes a table that lists projects that require an EIA and those that require a simplified procedure. Projects requiring a simplified procedure are also often subject to decisions on a case-to-case basis regarding the necessity of an EIA procedure. (BMDW, 2022b)

A threshold is defined for hydropower installations with an output of more than 15 MW or also in the case that more than 100 million m^3 of water are redirected in a year. Beyond this threshold, a regular EIA procedure is required. Smaller installations might only require a simplified procedure. Wind power projects only require a simplified procedure, and this only applies for wind parks with a total capacity of over 30 MW or above 15 MW for wind parks at an altitude of over 1,000 meters altitude. The combustion of biomass or energy generation through photovoltaics are not mentioned in the Annex. Lastly, a regular procedure is required for transmission grid projects of 220+ kV and a minimum length of 15 kilometers. (BMDW, 2022b)

4 Methodological Framework

The methodological framework used in this analysis aims to assess the coherence between the European Union's strategies and targets in the areas of protection/restauration of biodiversity and the promotion of renewable energies. For this purpose, an existing framework proposed by Nilsson et al. (2012) for the assessment of the policy coherence in an EU setting will be adapted to the needs of this analysis.

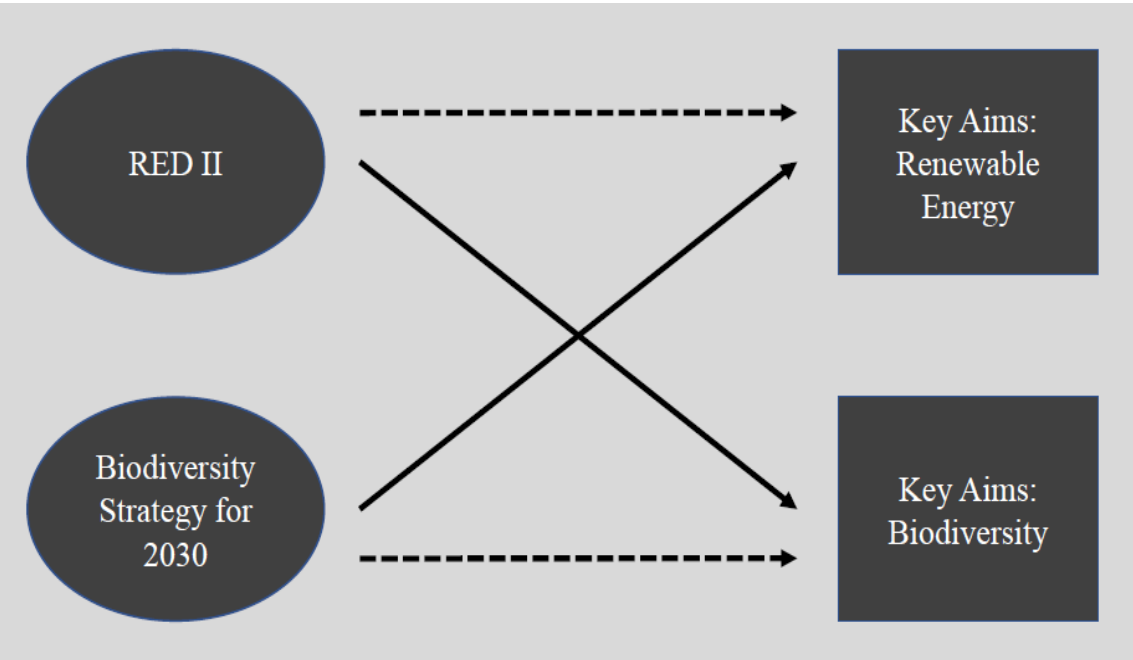

Figure 7: Visual representation of the analyses conducted

Whereas Nilsson et al. (2012) looks at a certain policy and assesses it with regard to its coherence with the EU's environmental ambitions, this analysis identifies and evaluates the level of interaction between the two policies and the overarching targets they pursue. Consequently, the first step in the analysis will be the identification of four key aims pursued by the two analyzed instruments. Once those key aims are defined, four separate brief analyses are performed, each assessing the compatibility of one instrument with the sets of key aims. Figure 7 provides a visual representation of the four relationships between policy documents and key aims which will be assessed. Consequently, the following four analyses will be performed in the following chapter (Figure 8).

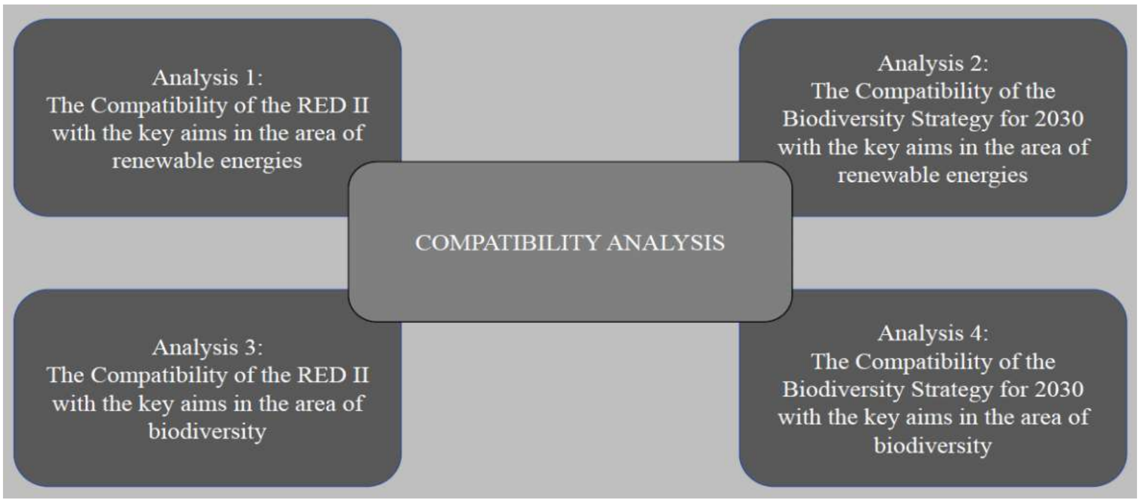

Figure 8: The four separate topics of analysis

While *analyses 2* and *3* constitute a cross-reference between the two areas and are a valid indicator for the coherence of the two policies, *analyses 1* and *4* serve as control group analyses. In Figure 7, the dotted arrows represent the control group analyses.

In these analyses, each relationship will be assigned a value form 1 (strong incoherence) to 5 (strong coherence). More specifically, this is aimed to assess whether the policy document impairs (=*incoherence*) or supports (=*coherence*) the key aim. The value 3 will be assigned to *neutral* relationships. This can be the case either where no relevant influence is found or when positive influences compensate negative ones and vice versa. Furthermore, the values 2 and 4 are used for relationships which are *moderately (in)coherent*. Based on these results, radar charts will be designed to illustrate the coherence or incoherence of the two strategies.

Figure 9 shows an illustrative example for such a radar chart for an example policy labelled 'policy 1' and its level of coherence with the exemplary key aims which are labelled 'key aim A-D'. The closer the line is to a key aim, the more coherent the policy is with this particular aim.

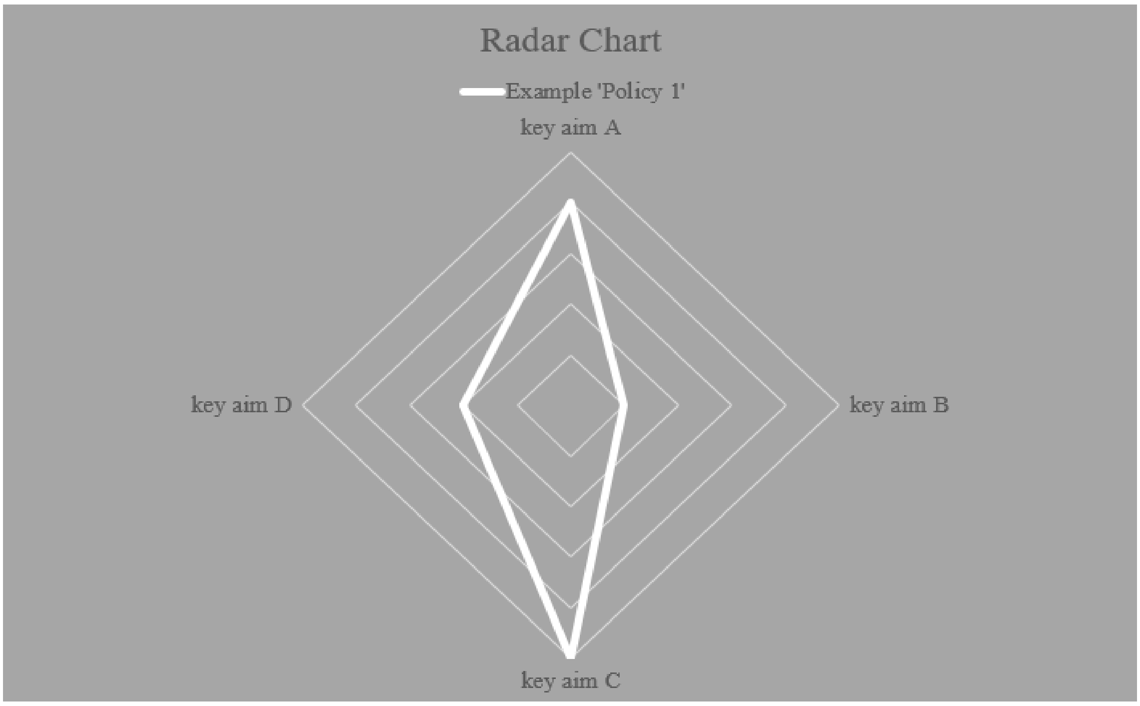

Figure 9: Example Radar Chart

5 Compatibility Analysis

5.1 Identification of Key Aims

The objective of this first introductory step is to identify and define the main aims which are pursued by the RED II and the Biodiversity Strategy for 2030 in order to use them in the next steps of the analysis.

With regard to the Biodiversity Strategy, the Commission's Communication makes it clear that the two overarching targets are the protection and the restauration of biodiversity in European land and sea areas (European Commission, 2020d). Nilsson, on the other hand (2012, p. 400) structures the EU's biodiversity targets into 4 key aims: "*Well functioning natural systems, habitats, wild flora and fauna*", "*Limiting emissions of eutrophying pollutants*", "*Reverse negative species trends*" and "*Keep fishing within safe limits*".

In an attempt to combine these two inputs, the 4 areas for the EU's key biodiversity aims in this analysis will be: *functioning natural systems*, *limiting eutrophication*, *restoring biodiversity*, and *protecting biodiversity*.

In accordance with the preamble of the RED II (European Union, 2018), the four key aims in the area of renewable energy are focusing on the following areas: *renewable energy production*, *renewable transport fuels*, *affordable prices for renewable energy*, and *energy security*. To better visualize these categories, Figure 10 below shows possible radar charts for the areas of biodiversity and renewable energies.

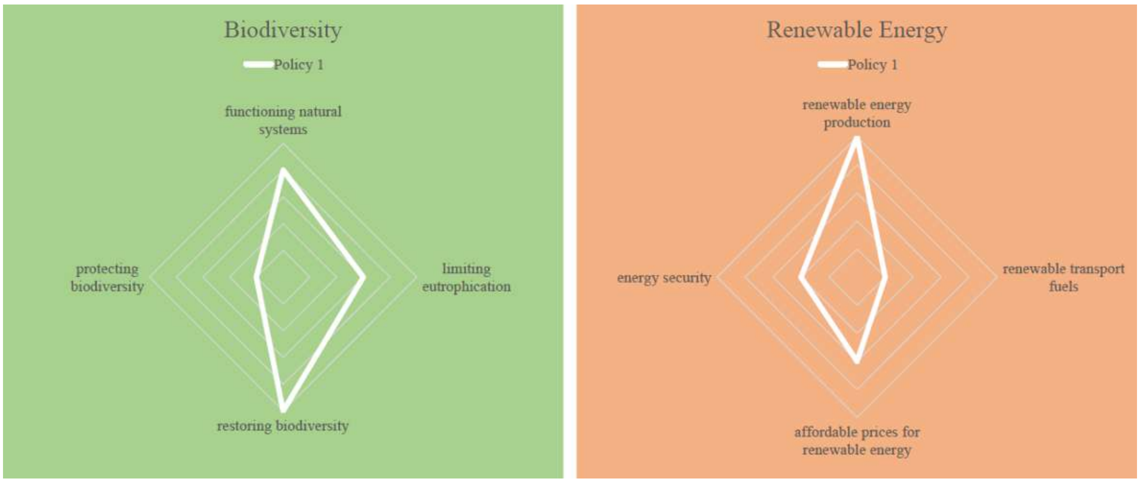

Figure 10: Example for the analysis of a fictional 'policy 1'

Both charts show the example of the coherence of an exemplary policy (*policy 1*) with the key aims in the areas of biodiversity and renewable energies, respectively. Such an outcome of the analysis would mean that the fictional *policy 1* is very coherent with regard to the production of renewable energy and the restauration of biodiversity. It is also moderately coherent with the functioning of natural systems. Furthermore, it is indifferent to the limiting of eutrophication and affordable renewable energy prices. The policy is also moderately incoherent with assuring energy security and strongly incoherent with the protection of biodiversity and renewable transport fuels.

5.2 Evaluation of the Compatibility

Before the following chapters describe the process and outcome of the four areas of this analysis, it should be kept in mind that there is a significant difference between the RED II, which is a directive and must thus be transposed into national law, and the Biodiversity Strategy for 2030, which is formulated as a Communication by the European Commission and merely states what should be done to increase biodiversity. However, despite this difference between the two documents, a meaningful comparison can nonetheless be made as they both represent the official position of the EU in their respective area.

5.2.1 Analysis 1

The purpose of this section is to determine if and to what extent the RED II stipulates targets and requirements that contribute to the reaching of key aims in the area of renewable energies. To this end, the directive will be examined with regard to each of the four aforementioned key aims.

The promotion of *renewable energy production* lies at the heart of the RED II, thus making it obvious that the directive has a strong positive influence on this aim. The directive set the target at a 32% share of energy from renewable source in gross final consumption. This is already an ambitious goal, which is set to be further increased in the planned revision (RED III). Consequently, the relationship is assigned the value 5, which indicates strong coherence.

Similarly, the promotion of *renewable transport fuels* is also a central element of the directive as it aims to mainstream the use of renewables in the transport sector according to article 25 of the directive. An ambitious goal of lifting the renewables share in the transport sector up to 14% is formulated, which should lead to a minimum of 70% in greenhouse gas emissions savings. Therefore, the RED II is also found to be strongly coherent with this key aim (=5).

Assuring energy security for Europe is currently a much-discussed topic, which has received a lot of media attention in the light of the ongoing war in Ukraine. While the directive refers to assuring energy security in the form of efforts to expand and improve the European grid, no specific measures are proposed in this direction. In the absence of such specific measures but keeping in mind that the promotion of locally generated renewable energy is essential in assuring independent and secure access to energy, this relationship is assigned the value 4 (moderately coherent).

Finally, the last key aim in this area is to assure *affordable prices for renewable energy.* Article 3.5 of the directive states that the Commission should support member states in their efforts of promoting renewable energies. Consequently, article 4 offers different support schemes. Among these schemes is also article 4.3 which states that "*direct price support [should be offered] in the form of a market premium*". This shows that the directive has the ambition to keep energy prices at a reasonable level, even when renewable energy production would be more cost-intensive in the beginning. However, these measures will not result in a reduction of energy prices for consumers as the purpose is to keep prices constant and not lower them. Therefore, this will not help in the case of over 34 million Europeans who are already unable to afford current heating prices

(European Commission, 2020e). Consequently, this relationship is also assessed to be moderately coherent (=4).

Table 3: Results of Analysis 1 assessing the coherence of RED II with the renewable energy key aims

Key aims: Renewable Energy	**Analysis 1 Results**	**Numeric value**
Renewable energy production	Strongly coherent	5
Renewable transport fuels	Strongly coherent	5
Affordable prices for renewable energy	Moderately coherent	4
Energy security	Moderately coherent	4

5.2.2 Analysis 2

In order to assess the coherence or incoherence of the EU's biodiversity targets with the goals that are pursued in the area of renewable energies, this section relates the Commission's Biodiversity Strategy for 2030 with the renewable energy key aims.

Generally speaking, the promotion of the *production of renewable energy* is in a general conflict with the ambitions set out in the biodiversity strategy. As the strategy aims to legally protect 30% of the land area (and 10% strictly), this would exclude many areas as possible sites for renewable energy infrastructure or at least make the approval process significantly more difficult. However, the strategy also includes a section about finding "*win-win solutions for energy generation*" (European Commission, 2020d, p. 10). This section demands win-win solutions for the areas offshore wind, solar-panel farms, ocean energy and bioenergy. However, the main focus lies on bioenergy, with direct reference being made to the sustainability criteria included in the RED II. Overall, the strategy is therefore nonetheless strongly incoherent (=1) with this key aim.

The general idea for the promotion of *renewable transport fuels* is the same: Protecting large areas of land leaves less areas for growing feedstock for biofuels. However, this is the area which is most considered in the strategy as the Commission proposes a comprehensive development of sustainability criteria for bioenergy. This makes it possible to combine the promotion of biofuels with efforts to protect and restore biodiversity. Considering all these factors, the value 3 is assigned to this relationship as the careful consideration of both sides leads to a neutral relationship.

To assure *energy security* for the EU, it requires the ambitious promotion of locally sourced renewable energies in order to be less dependent on energy and fuel imports from other countries. However, necessary renewable infrastructure projects and grid developments are slowed down when areas are legally protected. Consequently, the biodiversity represents a significant but indirect obstacle for the assurance of European energy security and is therefore moderately incoherent (=2).

Similarly, when we consider *affordable prices for renewable energies*, there is again no direct reference in the biodiversity strategy. Nonetheless, it is likely that additional requirements for project approval will eventually also lead to a higher cost of renewable energy production. While the RED II promises to buffer this, this does not change the fact that the Communication is at least moderately incoherent (=2) with this aim.

Table 4: Results of Analysis 2 assessing the coherence of the Biodiversity Strategy with the renewable energy key aims

Key aims: Renewable Energy	**Analysis 2 Results**	**Numeric value**
Renewable energy production	Strongly incoherent	1
Renewable transport fuels	Neutral	3
Affordable prices for renewable energy	Moderately incoherent	2
Energy security	Moderately incoherent	2

5.2.3 Analysis 3

In this section, the RED II is assessed in the context of the key aims regarding biodiversity. It is thus examined how the directive is likely to influence the progress positively or negatively in the four identified key aims for biodiversity.

The central aim for biodiversity is the *functioning of natural systems*. Evidently, the expansion of the renewable energy infrastructure in Europe could potential to cause some level of deterioration in the functioning of natural systems, as can every human intervention into nature. Nonetheless, by switching to renewable energies, the amount of greenhouse gases emitted into the atmosphere is significantly reduced. This leads to a mitigation of climate change, which is one of the main pressures affecting the Earth systems. Consequently, and considering the significance of the two sides in this balancing act, the RED II is actually found to be moderately coherent (=4) with the aim of assuring functioning natural systems.

Limiting eutrophication is another key aim in the area of biodiversity. Some major renewable energy sources (hydropower, solar power, wind power) neither negatively nor positively impact this endeavor. A significant negative impact could, however, be seen in relation to feedstock for biomass and the use of nitrogen fertilizers in this context. While this is a serious concern, it is buffered by the fact that bioenergy is strictly governed by the sustainability criteria in RED II, which are even set to be reinforced in RED III. Consequently, the value assigned to this relationship is 3 (=neutral), as the negative impact is minor and widely mitigated.

The directive's impact on *protecting biodiversity* and *restoring biodiversity* is slightly negative for both leading to a score of 2 (=moderately incoherent) for both. This is founded in the fact that, even though energy projects are accompanied by thorough assessment procedures and sustainability requirements, tradeoffs between expanding infrastructure and protecting and restoring nature are inevitable.

Table 5: Results of Analysis 3 assessing the coherence of RED II with the biodiversity key aims

Key aims: Biodiversity	**Analysis 3 Results**	**Numeric value**
Functioning natural systems	Moderately Coherent	4
Limiting eutrophication	Neutral	3
Protecting biodiversity	Moderately Incoherent	2
Restoring biodiversity	Moderately Incoherent	2

5.2.4 Analysis 4

This last part of the analysis deals with the capacity of the targets formulated by the Commission in the area of biodiversity to fulfill the key aims in this area. Again, the four key aims are examined separately.

The first key aim in the area of biodiversity is to assure *functioning natural systems*. Simply put, this is also the overarching aim of everything that is proposed in the Commission's Communication of the Biodiversity Strategy for 2030. Hence, the strategy is strongly coherent with this first key aim (=5).

Another key aim is to *limit eutrophication*. Without using the word eutrophication, the Communication nonetheless proposes some measures and initiatives which are essential in order to control and limit eutrophication. This includes a commitment to zero nitrogen pollution as well as a target of decreasing nutrient losses by at least 50%. In addition, the use and distribution of phosphorus should also be monitored and managed. This makes it clear that the Communication is coherent with a serious commitment to limiting eutrophication. However, in the absence of any concrete measures in this direction until today, the assigned value is 4 (=moderately coherent).

Furthermore, *restoring biodiversity* as well as *protecting biodiversity* are important aims in this area. These are the two big pillars of the EU's biodiversity strategy for 2030. For the protection of biodiversity specific numbers are given for the share of land and sea area that should be protected (30% respectively) or strongly protected (10% respectively). However, as was also confirmed in the expert interviews for this thesis, there is no clear indication of what exactly this would entail. Due to this absence of clear direction, a value of 4 is assigned, meaning that the strategy is moderately coherent. Regarding the restauration plan, the situation is very similar. The Communication clearly demands the development of a comprehensive nature restauration law with binding targets in 14 areas, which is currently being developed. However, no comprehensive list of measures is available yet. Again, the combination of clear commitment to the cause but lacking action is expressed in a moderately coherent relationship (=4).

Table 6: Results of Analysis 4 assessing the coherence of the Biodiversity Strategy with the biodiversity key aims

Key aims: Biodiversity	Analysis 4 Results	Numeric value
Functioning natural systems	Strongly Coherent	5
Limiting eutrophication	Moderately Coherent	4
Protecting biodiversity	Moderately Coherent	4
Restoring biodiversity	Moderately Coherent	4

5.3 Results

As expected, *analyses 1* and *4* (control group) showed that the biodiversity strategy is compatible with the biodiversity key aims and the RED II with the renewable energy key aims. Due to the non-binding nature of the Commission's Communication, the lack of definitive measures leads to a less explicit and thus more moderate coherence in this area.

Analysis 2, which relates the biodiversity strategy to the renewable energy key aims has found significant gaps between the two policy areas when it comes to the promotion of renewable energy production. A small positive is the promotion of renewable transport fuels, which is considered more clearly in the Communication. Overall, however, the result of this analysis is that the Biodiversity Strategy for 2030 represents an obstacle for achieving the EU's key aims in the area of renewable energies.

In contrast*, analysis 3* relating the RED II to the biodiversity key aims has yielded a more promising result. While the *protection and restauration of biodiversity* are impaired by the directive, the aim of assuring the *functionality of natural systems* is actually supported by the provisions of this directive due to a significant reduction of greenhouse gas emissions. Furthermore, the directive is neutral regarding the aim of *limiting eutrophication*. To summarize, there are definitely areas of conflict between RED II and these aims, but some win-win effects can also be detected.

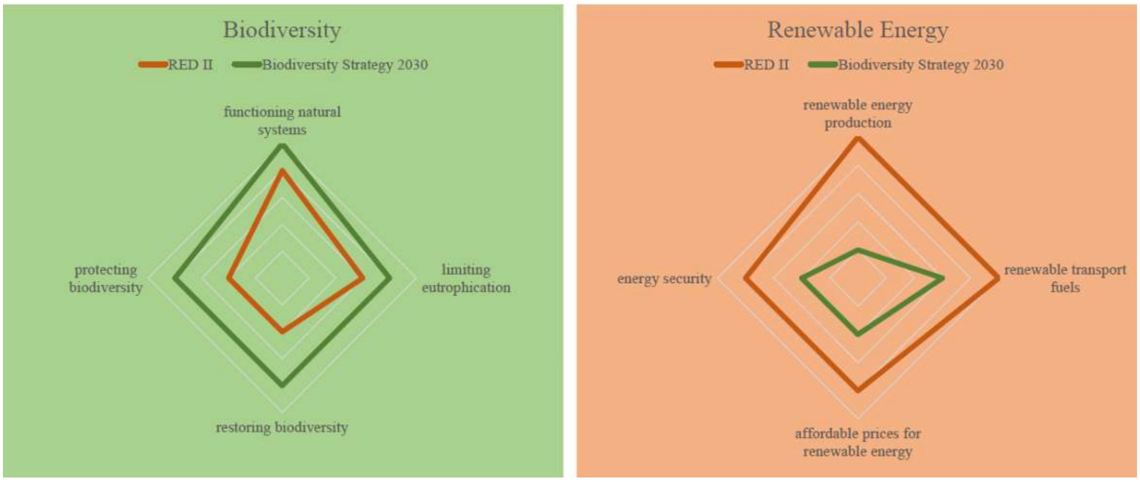

Figure 11: Overall results of the compatibility analysis

Figure 11 above is a graphical illustration of the results of the conducted analysis. The two control group analyses have yielded high compatibility scores while the two cross-reference analyses have scored rather low overall. What becomes particularly visible in the radar diagrams is that compatibility is particularly high regarding the key aims of *limiting eutrophication* and *promoting renewable transport fuels*. For both of these aims, the cross-reference analyses resulted in a value of 3 (=*neutral*). In addition, the RED II is even assessed as moderately coherent with the biodiversity key aim for *functioning natural systems.*

6 Discussion

As was already stated in the introduction to this thesis, the central aim was to find out whether the European Union's strategies, approaches, or targets in the areas of energy transition and biodiversity are coherent. What is important to know in this context is that the European energy transition, of course, goes far beyond just renewable energy sources.

Over the course of this thesis, it was established that the expansion and the reinforcement of grids play an extremely important role. At the same time, it was also established that the European Union's efforts concerning biodiversity have moved far beyond protecting biodiversity and that the EU is committed to restoring biodiversity across Europe.

The conducted analysis has confirmed the previous assumption that there is a significant disconnect between the two policy areas. Thematically, the most significant incoherencies are located in the promotion of renewable energies. The concurring topics of limiting eutrophication and promoting bioenergy were found to have a neutral relationship. Surprisingly, there even was one area in which moderate coherence was found, namely the RED II directive being coherent with the biodiversity aim of assuring functioning natural systems. On a policy level, it was found that the biodiversity strategy is mostly incoherent with renewable energy aims while the RED II directive has shown more potential for coherence with biodiversity aims.

In conclusion, a clear incoherence was found between the two strategies. However, could this gap potentially be bridged by the assessment procedure laid out in the EIA directive? Generally, it should be stated that most significant energy infrastructure projects are sizable enough to require an EIA (European Union, 2014). This would suggest that renewable energy projects are scrutinized regarding their potential adverse effects on the environment. In addition, it must also be considered that the RED II contains a provision stating that EIA procedures should not represent an unnecessary obstacle for renewable energy infrastructure projects (European Union, 2018, art. 15). In the light of all this, the EIA directive could be considered as a way of uniting the two policy areas; however, it does not lead to a – much desired – fully integrated approach within European environmental policy. The reason for that, according to the expert interviews for this thesis, is mostly a problem of implementation. For instance, article 15 of RED II defines the maximum length for the administrative procedures for a large power plant to be 3 years (European Union, 2018). In practice, as could be seen from the examination of the KW Gratkorn, this process often takes much longer.

The question comes up whether there are potentially other influences reducing the level of incoherence between the two areas. As already mentioned in earlier chapters, there are many other directives which relate to the biodiversity of European land and sea areas. For instance, the Water Framework Directive and the Nature Directives both separately list requirements for interventions into the respective areas. However, because there is no integrated approach, these additional requirements tend to make the matter at hand more complicated instead of uniting the two policy areas (European Commission, 2018). Another possible source for clarifications are guidance documents published by the European Union. For instance, such documents specifying possible biodiversity concerns, mitigation measures and best practices are available for hydropower (European Commission, 2018) and wind power (European Commission, 2020c). While they contain very useful clarifications and guidelines, the problem with these documents is that they only specify the requirements for energy infrastructure in Natura 2000 habitats, leaving open questions as to their application in other areas. In conclusion, there is certainly not a lack of EU documents which are designed to and could potentially fill the gap between renewable energies and biodiversity. What is lacking, however, is clarity and structure.

From the findings in this paper, an alternative way forward can be proposed. It was found that the concurring topics of eutrophication and biofuels can coexist as both concerns are explicitly mentioned in both policy documents. I would therefore suggest defining (and including into the RED III) clear criteria to ensure the protection of biodiversity for all renewable energy sources as well as transmission grids. At the same time, the legislation following from the biodiversity strategy should expressly mention how the win-win solutions for renewable energy and biodiversity could look – not just for bioenergy but for all renewable energy sources.

7 Conclusion

This thesis had the goal of exploring and assessing the relationship between the European Union's Biodiversity Strategy for 2030 and its renewable energy goals according to the RED II. In a first step, five major renewable energy sources (hydropower, wind power, solar power, biomass and biofuels) were presented focusing on their history and potential in Europe and Austria. While this chapter highlighted the great potential that Europe still has to expand energy production from renewable sources, it also hinted at possible side-effects of renewable energy projects which may lead to biodiversity loss. After a brief subchapter about biodiversity in general, these concerns were discussed in more detail, finding possible impacts on biodiversity during all stages of the lifecycle of a renewable energy project. However, while the biggest impact of some technologies lies in the mining for raw materials (photovoltaic), others might lead to effects during construction and operation (hydropower, wind power). Furthermore, biomass-based energy generation was found to potentially have considerable impacts on biodiversity both in the harvesting of feedstock and the combustion process (operation).

In general, two very important aspects could be derived from existing literature as well as the two conducted expert interviews. First of all, possible effects on biodiversity have to be considered in project planning from the start as part of an integrated approach. Second, the site selection is a key factor when it comes to a project's impact on ecosystems and biodiversity. On the one hand, the level of biodiversity that is found at a site has influence on the project's possible impact on biodiversity. On the other hand, the specific situation at the site also dictates which accompanying measures are economically, technically, and ecologically the most effective. On the example of the *KW Gratkorn*, it was shown which specific mitigation measures can be chosen for a large-scale hydropower project.

Another very important aspect in the context of the energy transition are grids and the expansion thereof. After establishing the necessity of grid expansions to secure energy supply and create a grid network that meets the needs of a renewable future, specific biodiversity considerations were discussed. Overall, the effects of grids on biodiversity are mostly minimal and related to the construction phase. Specific impacts and mitigation measures were shown for the *380-kV-line St. Peter – Staatsgrenze DE*.

Furthermore, the complex interplay of EU legislation and other EU guidance documents, which governs the process regarding biodiversity considerations in renewable energy projects, was outlined. Next to the RED II and the EU Biodiversity Strategy for 2030, which are the two counterparts in the subsequent analysis, the most important provisions of the EIA Directive were also reiterated.

The compatibility analysis related the provisions and targets of the two policy documents (RED II and Biodiversity Strategy) to the key aims which the EU pursues in the policy areas of renewable energies and biodiversity.

The central research question of this thesis was whether or not the RED II and the Strategy for Biodiversity 2030 are compatible. During the analysis, it was established that there is a substantial gap between the respective policy documents and their targets and aims. However, regarding the biodiversity aim of *limiting eutrophication* and the renewable energy aim to *promote renewable transport fuels*, the two policy areas are considerably more compatible. This is due to the sustainability criteria which are part of RED II and also the section in the Biodiversity Strategy which recognizes the necessity of coordination between the renewable energy sector and the promotion of biodiversity. A similar approach regarding other renewable energy sources could bring the two policy areas closer together. Furthermore, the RED II is even moderately compatible with the biodiversity key aim regarding the functionality of natural systems. This can be explained by the fact that decreasing carbon dioxide emissions and mitigating climate change are important factors in assuring functioning natural systems. Despite these positive aspects, the overall analysis has nonetheless exposed a significant disconnect between the two policy areas.

The second part of the research question to this paper aimed to assess in which areas this disconnect is mostly located. Apart from the abovementioned positive exceptions, incompatibilities were found regarding all other key aims. In other words, it was shown that the Biodiversity Strategy for 2030 is incompatible with the renewable energy key aims of *increasing renewable energy production*, *assuring affordable energy prices* and *assuring energy security*. Similarly, the RED II is incompatible with the biodiversity key aims of *protecting* and *restoring biodiversity*. Overall, it was also found that the incompatibility is stronger from the side of the Biodiversity Strategy.

As the assumption before this thesis was that this disconnect could be bridged by means of impact assessments and permission procedures, this hypothesis was also explored. It was found that, theoretically, the EIA directive lays out a comprehensive assessment procedure, which does not lead to unnecessary delays in energy projects. In practice, however, a complicated web of additional procedures and a lack of implementation lead to the fact that there is still a considerable disconnect between the two areas.

While this thesis has explored the important relationship between the most important policy documents regarding the energy transition and the promotion of biodiversity, there remain many other open questions, which could best be answered by further research. For example, as we are currently waiting for the RED III and for the legislative act implementing the biodiversity strategy, it would be interesting to revisit this topic and assess how the equilibrium between those two areas has shifted. Furthermore, it will be interesting to see which role the EU taxonomy will play in this context. Additionally, in the light of the International Finance Corporation's sustainable performance standards, it will be interesting to see how important the influence of the finance sector will be in this regard.

Overall, most of these questions (as well as the research question for this paper) depend strongly on the answer to one pivotal question which we, as a society, will have to answer in the near future. Despite the obvious necessity of both the mitigation of climate change and the protection and restauration of biodiversity – the question is, which of the two issues is more pressing. And this, finally, will also be the decisive factor as to if and how these two areas will be compatible in the future.

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List of Figures

List of Tables

Annex

Annex I: Expert Interview with Mag. Martin Schönberg

Valentin Frick: Before we start with the actual interview, I would just like to ask you to briefly state your academic as well as professional background that makes you an expert in this field.

Mag. Martin Schönberg: Thanks. My name is Martin Schönberg and I am currently employed at VUM Verfahren Umwelt Management GmbH in Klagenfurt, Austria. I work as an environmental project manager, currently being in charge of issue management and the implementation of legal acts and norms into practice in the fields of renewable energies, biodiversity, and health and safety.

VF: Ok, thank you very much. In this case we will jump right into the next question. In this thesis, five examples of renewable energy sources are presented regarding their potential adverse effects on biodiversity/the environment. In your expert opinion, what are the main concerns (related to biodiversity) of the following renewables. The first of these renewables is solar energy and photovoltaics specifically:

MS: The first issue that comes to my mind is related to lifecycle emissions and possible adverse effects on the environment not on the operation site but rather related to the production of modules.

VF: Ok, then let's move on the next, which is wind. Here I would like to hear your input on both on-shore and off-shore wind power.

MS: I think the most mentioned possible adverse effects are related to birds. And I think this is the case for both on- and off-shore.

VF: And is there anything in particular regarding one of the two areas, meaning and impact that we only see in either on- or off-shore?

MS: Of course, but this is largely site-specific. The same is true, I think, for all RES but also even for other technologies or industries. All adverse effects are site specific. And this then is also true for the measures that have to be taken. You have to really look into the site: What are the specific characteristics? What are the species that are there? Is this a specific zone for endangered species? Is there any specific flora that you have to take care of? My main point is that no matter what you do – look at the site.

VF: Ok, thank you very much. The next renewable energy is hydropower.

MS: I would say that the adverse effects that are mentioned very often are related to flowing rivers and fish continuity. But it is also again site specific. When thinking about pumped storage hydropower, of storage reservoirs without connected rivers or in high alpine areas without any fish habitat, then of course this does not make any sense.

VF: Exactly. Then the next two renewables are both connected to biomass. One would be the combustion of solid biomass, mostly for heating but also for electricity or the production of other fuels. And the other one would be biofuels, namely biodiesel or biogasoline.

MS: I think for both we have the same main issue which related to transport or rather call it import dependency. It's an issue where you grow the biomass.

VF: Ok, thank you, then let's move on to the next question: Related to the biodiversity threats listed before and maybe also some other threats that you can think of – which are the most promising mitigation measures off the top of your head.

MS: Well, like I said before it's not that simple to think of specific measures because measures should and shall be chosen to be the most economically effective ones, to be the most ecologically effective ones, and technically effective ones. So usually all kinds of measures are chosen, adapted site-specifically. Usually, there are guidelines and/or legislation that guarantee that a full set of measures is being considered, and various decision / and agreement processes (including independent experts, authorities, project promoters,…) are in place with the aim to choose the most effective ones for the specific location.

VF: Thank you for this. I can see that site specifics obviously play a very important role in this whole process. We are still staying on the topic of biodiversity threats, but what I would now be interested in how important the role of transmission grid expansions in two areas is: One, how necessary is it and why is it necessary? And two, how severe are possible biodiversity threats coming with those expansions of transmission grids.

MS: Thank you. Firstly, the necessity of expanding grids, including transmission as well as distribution grids , being crucial for the deployment of renewables. As you might know, we have to head towards a higher share of renewables, , especially in Austria with a 100% RES target. And we are even expecting higher European targets. We need grids to connect the sites of production and the sites of consumption. In Austria, the aim is to close what is called the 380-kV ring. There are still decisive parts missing but we have already been proceeding.

VF: Thank you for that. Also, coming back to the possible adverse effect on biodiversity, what would be something that you could think of here?

MS: I think for transmission grids, possible adverse effects are – again – site-specific. Much effort has already been done to minimize such effects. This is done by careful planning procedures and cooperation with environmental experts. Best practice examples show that biodiversity can even be improved by projects, when old lines are replaced by newer ones that are located in a bigger distance to protected habitats. A case in point is the Weinviertelleitung in Northern Austria where an old grid line has been replaced by a new power line. Grid lines are today often seen as green corridors as there are best practice examples of sustainable habitat management beneath and next to grid lines, sometimes even including special mowing concepts and the creation of biotopes. Further, grid operators (but also all RES project promoters) have been showing their commitment by financing research projects and cooperating with universities, NGOs and experts. By this many research gaps could have been closed (for instance when it comes to species migration, behavior, living conditions, etc.)

VF: Thank you so much for your elaborations on this. The next question is a bit wider. I know that you are familiar with the Renewable Energies Directive II and the European Commission's Biodiversity Strategy for 2030. So the question here would be: In your opinion, how compatible are the targets set in those two documents if they are at all compatible and what are problem areas and where would you think that they actually are well-aligned?

MS: When simply looking at the figures, you have the 30% of protected areas and 10% of strictly protected areas. On the other hand, we know how much additional deployment of renewables would be necessary across Europe. When just looking at these figures, one might say that land consumption and land use might not be a problem at all. But when looking into regions where exactly you need the additional energy infrastructure, then land use becomes a critical question. And this is mainly related to the key fact that you need space for additional RES and grid expansion. You need space for PV, wind, for hydropower plants, for grids, for transformer stations,… Now it is on high time to discuss and think about different forms of land use, nature conservation as well as restoration, public interest, trade-offs and win-win effects. .

VF: Okay, thank you very much. We are staying on the same topic. The next question would be: With the proposed revision of the Renewable Energies Directive II, which will most likely entail both a reinforcement of the sustainability criteria for bioenergy but also a more ambitious goal in terms of the share that we want to reach with renewables. In your opinion, will this bring the two policy areas biodiversity and renewable energies closer together or move them further apart?

MS: I would say that we are still far away from balancing different targets and needs, i.e. we are miles away from having an integrated approach when looking into EU legislative acts. And this is sadly also true for only the environmental field. I would say that thinking of the biodiversity strategy together with the Water Framework Directive, with the Nature Directives, we have even diverging targets and issues within the environmental acquis itself. This is mainly related to the paradigm shift in environmental policy: from nature conservation to nature restoration, whereas both approaches are still reflected in current legislation. On the energy side, like RED II and III, we are seeing more and more environmental considerations finding their way into energy legislation. This is also true for economic files, such as the EU Taxonomy, where environmental criteria are being considered as key criteria.

VF: Thank you so much for that. Actually, a very similar topic as to what drives the changes that we see or what actually makes our practices in this field more sustainable. Apart from European and also national legislation, what else do you see as a driver for a shift towards more sustainable practices in the renewable energies sector?

MS: This is a hard question, to be honest. First of all, I think we should define what is sustainable, what is a sustainable practice, what kind of sustainability are we speaking of, do we speak about soft sustainability criteria or are we referring to the EU Taxonomy ecological criteria? Let’s put it like this: I would say that when comparing different countries or even comparing continents and the situation in the world, we in Europe – with the European environmental and energy – respectively the RES-legislation – we are thinking quite ahead. What has to be done now? I think we have quite strong criteria and we have made a lot of progress especially in the recent years and we see a lot of proposals and new legislation all the time. But what is lacking a little bit is the implementation. And this, on both sides – achieving the environmental objectives but also realizing the renewables target. What we have to focus on now is the implementation, mainly on the national and regional levels. Therefore, we have to look into existing national and regional legislation - and implementation - that is still hindering the deployment of renewables and also hindering us from reaching the environmental objectives.

VF: Thank you so much for that. Even though it was a very difficult question, it was nonetheless a very insightful answer. We are coming to the last question now. In this thesis, the coherence of the EU's strategy against biodiversity loss and for the promotion of renewable energies is analyzed. For the purpose of the analysis, the key aims of both RED II and the EU's biodiversity strategy have to be identified. In your own words, which are the key aims which are pursued by the RED II and the Biodiversity Strategy for 2030?

MS: First of all, we have to make a quick analysis: the renewable energies directive is a directive, so it has to be transposed into national law. The biodiversity strategy, for me, is harder to grasp – it is "only" a strategy and we are still expecting the dedicated law and the mentioned guidelines that will put it into practice. I do not know exactly what the biodiversity targets mean. For instance, they are referring to 30% of protected areas on land and sea. What is a protected area? Does this include natural reserves? Does this include only Natura 2000 habitats? What does strictly protected mean in this context? Would strictly protected mean that we cannot have any kind of development there anymore? No human interaction? So there are still many definitions that are missing or are expected

VF: Alright, thank you for that. Before we end this interview, I would like to give you the chance to add anything that you feel might still be important about this topic.

MS: Maybe to sum up again. It is really hard to speak about possible adverse effects on the environment of single technologies or projects because we simply have to look at the site, the flora, the fauna, the local environment, the current uses of this site and what kind of human use or even industrial use has happened on the specific site. So this means that a new installation can always mean progress compared to the past use. But even a small plant does not always mean that there are small effects. And this is my hint at the very end: We should not make the same mistake as many reports and many people do and generalise that a specific activity leads to specific adverse effects on the environment. We have to focus on specific projects, on the plant levels, on all forms of uses, on the environmental media on all levels (local, regional, national…) in order to guarantee a sustainable and nature-friendly deployment of renewables and the related necessary expansion of grid infrastructure.

Annex II: Expert Interview with Dr. Andreas Kleewein

Valentin Frick: Bevor wir anfangen, könntest du bitte kurz beschreiben, was dein akademischer und professioneller Hintergrund ist, der dich zu einem Experten im Bereich Biodiversität und Biologie macht?

Dr. Andreas Kleewein: Ja, mein Name ist Andreas Kleewein. Ich habe an der damaligen naturwissenschaftlichen Fakultät der Universität Wien, heutige Fakultät für Lebenswissenschaften, das Diplomstudium absolviert, habe im Naturhistorischen Museum in Wien meine Diplomarbeit geschrieben und gearbeitet. Die Arbeit hat das Thema Neuropteren behandelt, das sind Netzflügler also Insekten. In diesem Ökologiestudium war der Bereich Naturschutz aber auch sehr schwerwiegend, und ich habe mir in diesem Bereich ein breites Spektrum aneignen können, aber das ist alles nach dem Studium erfolgt. Die andere Seite war die Zoologie, wo ich im Studium auch die Ausbildung genossen habe, und ich habe dann aufbauend nach ein paar Jahren das Doktorat ebenso an der Universität Wien, Fakultät für Lebenswissenschaften absolviert aber mit der Fragestellung zu den Auswirkungen der nicht heimischen, also der allochthonen Wasserschildkröten in Österreich auf die heimische Fauna und Flora im und um das Wasser. Also das heißt, wir haben so schon zwei grundlegend unterschiedliche Themenbereiche: Das eine sind die Insekten, das andere sind die Reptilien. Und hauptberuflich habe ich überwiegend mit Vögeln gearbeitet, bin aber immer wieder mit anderen Organismengruppen in Kontakt gekommen, also von Insekten über die Reptilien, Weichtiere, Muscheln zum Beispiel, und habe auch darüber gearbeitet und so aus dem Grund heraus immer wieder spezielle Arten herausgepickt und dort Fragestellungen erörtert. Das sind häufige Arten gewesen, das sind aber auch seltene Arten gewesen. Warum? Weil es immer wieder irgendwo die Vernetzungen gibt zwischen den einzelnen Organismengruppen. Also das heißt in der Ornithologie habe ich auch diese Insekten, Reptilien, Aspekte usw. gebraucht und miteinbeziehen können und habe deswegen auch immer über den Tellerrand darüber hinausgeschaut, weil die Vernetzung ist das Entscheidende, sonst ist man bekannterweise mit Scheuklappen unterwegs und ist gedanklich nur in seinem Bereich. Dann ist man zwar Spezialist in einem Gebiet, aber das große Ganze, da fehlt einem die Übersicht.

VF: Okay, sehr gut, vielen Dank. Zur nächsten Frage: Im Rahmen meiner Masterarbeit werden 5 Arten von erneuerbaren Energiequellen besprochen. Das ist Hydropower, Wind Power, Solar Power, dabei Fokus auf Photovoltaik, sowie auch Biomasse und Biotreibstoffe. Ich würde dich jetzt bitten, dass du für diese einzelnen Bereiche beschreibst, was Probleme sind, die für den Bereich Biodiversität, generell für die Ökosysteme in diesen Bereichen, auftreten könnten durch den Ausbau von diesen erneuerbaren Energien. Fangen wir vielleicht mit dem Bereich Solarenergie, also insbesondere Photovoltaik an.

AK: Bei der Photovoltaik ist es so, dass die Anbringung auf Gebäuden nicht so kritisch ökologisch zu betrachten ist wie auf der freien offenen Fläche. Es wird halt sehr, sehr viel Fläche dafür benötigt. Das heißt in Folge geht mir auch bis zu einem gewissen Grad der Lebensraum verloren, aber es ist so: Wenn ich jetzt einen intensiv bewirtschafteten Acker habe, also im landwirtschaftlichen Bereich, der ist zum Beispiel davor Maisacker gewesen oder Getreideacker, konventionell bearbeitet, also das heißt gedüngt, gespritzt, mehrmals im Jahr bearbeitet. Dann ist sicher die Photovoltaikanlage mit entsprechendem Aufbau darunter, also das heißt der Anlage einer extensiv genutzten Wiese, biodiversitätsmäßig von Vorteil, weil da habe ich dann mehr geschaffen als durch den Mais- oder Getreideacker. Das muss man einmal grundlegend sagen. Es gibt Untersuchungen, wo man die Artenvielfalt bei Photovoltaikanlagen auf solchen Freiflächen erhoben hat, und da hat sich doch herausgestellt, dass dort eine große Artenvielfalt sein kann. Aber nehmen wir jetzt einen Lebensraum, der zum Beispiel ideal wäre oder schon ideal ist, mit einer guten Struktur oder einer Brachfläche - mit Struktur meine ich, dass Hecken zum Beispiel schon angelegt worden sind, Gewässer, kleine Tümpel dort sind, dann ist diese Anlage kritisch zu betrachten, weil dann zerstöre ich einen guten Lebensraum. Aber etwas anderes noch, es kann bei den Photovoltaikanlagen auch dazu kommen, dass Vögel zum Beispiel das als Wasserfläche erkennen. Also das heißt, vor allem bei Enten ist es so, die nehmen dann je nach Spiegelung diese große Fläche so an, dass sie eine Wasserfläche ist und landen dann darauf, also kann man sich vorstellen, dass das schon eine Bruchlandung ist. Also Konfliktfälle vor allem in der Ornithologie gibt es bis zu einem gewissen Grad. An Gebäuden ist es weniger kritisch von der Biodiversität her und sind mir jetzt auch eigentlich keine Kollisionen bekannt, aus der Literatur heraus, wo Vögel mit an Gebäuden angebrachten Photovoltaikanlagen kollidieren. Es kommt wieder darauf an, wo und wie gestalte ich das.

VF: Okay, das ist sehr interessant, was vielleicht noch auch in diesem Bereich wichtig wäre, wenn man weggeht von der Anwendung der Photovoltaikanlagen und hin zur Produktion und eventuellen Problemen bei der Gewinnung von Rohstoffen, die nötig sind für Photovoltaik. Gibt es da vielleicht noch Aspekte, die relevant sind?

AK: Der Abbau, egal was es eigentlich ist, ist natürlich auch immer der erste Faktor, der einen Eingriff erzeugt auf den Lebensraum von verschiedenen Organismengruppen. Ich bezeichne es immer als Organismengruppen, damit man nicht in jedes Detail hineingehen muss – also die ganzen Lebewesen, ob Tiere oder Pflanzen. Der Abbau ist sehr wesentlich, weil gelegentlich kommt es zum Abtrag von großen, zum Beispiel Gesteinsflächen, das heißt, ich zerstöre da ja auch wieder einen Lebensraum, der ursprünglich von verschiedenen Arten besiedelt worden ist und zum anderen auch wenn ich es aus der Erde heraus gewinne, irgendwelchen Rohstoff, ich sag es jetzt einmal allgemein, dann ist natürlich auch dort wieder die Veränderung des Bodenaufbaus, weil ich entnehme ja die Erde und ich kann nicht wieder die gleiche Erde hineingeben, da sind wir dann schon im Mikroorganismen Bereich. Aber das ist schon sehr speziell. Also ja, der Abbau ist auch kritisch zu sehen, muss man auch immer abwiegen. Wo geht es, wo kann man es vertreten und wo sind doch zu große Konfliktfälle, wo ich dann einfach einen großen Eingriff in die dortige Biodiversität schaffe und dadurch erzeuge, wären die Fragen im Vorfeld des Abbaus.

VF: Okay, vielen Dank. Der nächste Bereich wäre dann Windenergie. Dabei vielleicht einzeln zu besprechen: Onshore und Offshore Windanlagen.

AK: Fangen wir bei den Offshore Windanlagen an. Natürlich vom Betrieb her ideal, sicher die größte Ausbeute – da zahlt sich der Wind aus. Auch da muss man halt wieder die Vogelwelt berücksichtigen. Da kann es zu Konflikten kommen, aber vielleicht eher unkritischer zu betrachten, fast schon als zum Beispiel Onshore. Da ist es vor allem jetzt, das Thema in Österreich die Bergrücken: bis zu welchem Grad darf man die trotz der Verpflichtung des Ausbaus der Erneuerbaren dafür heranziehen? Zum einen ist es das Landschaftsbild, was entscheidend immer wieder mit hineinfließt in diversen Gutachten und Beschwerden. Zum anderen ist es aber natürlich der Vogelzug, auch da wieder, also Vögel sind immer ein heikler Bereich. Aber auch der Fledermauszug. Fledermäuse ziehen auch, sind nicht nur auf einen Standort gebunden, und da kann es auch zu gravierenden Einflüssen kommen. Was man grundlegend bei der Errichtung selbst im Vorfeld bedenken muss, welche Fläche greife ich auch da wieder an? Mache ich das jetzt praktisch auf der Parndorfer Platte, überspitzt gesagt, wo zum einen schon viele Windkraftanlagen stehen und ich auch intensiv bewirtschaftete Äcker dort hab und eventuell dort jetzt nicht ein Bereich ist, wo der Vogelzug sehr groß ist, sondern vielleicht sowieso nicht nachgewiesen werden konnte bisher, dann ist der Einfluss gering. Stelle ich auf den Bergrücken ein Windrad, oder beziehungsweise Windparke auf, dann hat es doch eine große kumulative Wirkung, zum Beispiel beim Zug. Also das heißt, wenn ich so wie es in Kärnten geplant ist über den Höhenrücken hinweg von der Saualpe und Koralpe und dort viele Windpark Anlagen hintereinander habe, dann wird sich natürlich für die Vogelwelt eine gewisse Barrierewirkung bilden. Das ist das eine, natürlich auch für die Fledermäuse. Aber das ist dann wieder in der Betriebsphase. Bei der Errichtungsphase muss man auch Bedenken, wo muss ich meine Zu- und Ableitungen graben? Gehe ich da jetzt entlang der bestehende Forststraßen, dann ist der Einfluss geringer auf die Biodiversität. Oder gehe ich mitten ins Gelände hinein, verändert durch die Verlegung des Kabels, des Erdkabels, zum Beispiel wieder den Bodenaufbau, schaffe ich dadurch auch eine Barrierewirkung für zum Beispiel Käfer. So seltsam es klingen mag, aber es gibt dann schon durch den unterschiedlichen Bodenaufbau natürlich eine unterschiedliche Vegetationszusammensetzung in diesem Bereich, und das kann wieder zur Barrierewirkung führen, so dass der Käfer nicht von der einen Seite auf die andere kommt. In Folge kann es dann auch zu Verinselung kommen und zum genetischen Zusammenbruch, weil der genetische Fluss nicht mehr gewährleistet ist, also zum Zusammenbruch der Population.

VF: Ok, vielen Dank, alles wirklich sehr interessant und noch viel dabei, was ich noch nicht in meinen Recherchen so herausfinden konnte. Der nächste Bereich wäre dann Wasserkraft.

AK: Wasserkraft hat natürlich sicher einen sehr sehr großen Eingriff auf ein Ökosystem, vor allem bei unseren Fließgewässern. Durch die Möglichkeit, mit Fischaufstiegshilfen und dergleichen ist sicher einmal ein positiver Aspekt geschaffen worden, das andere sind aber wiederum die Turbinen, wo es doch zu einer großen Mortalität, also Sterblichkeit von Fischen kommt. Da gibt es auch eine Untersuchung dazu, die sich dem gewidmet hat. Also das bedeutet die Zerschneidung des durchgehenden, oder des ursprünglich durchgehenden Fließgewässers ist das eine, aber diese neue Herausforderung mit den technischen Einbauten, also die Turbine ist dann wieder das andere. Da könnte es dann auch wieder zur Mortalität kommen. Die Zerschneidung und die Veränderung des Lebensraumes ist deswegen so entscheidend, weil man eigentlich davor ein Fließgewässer hat und danach hat man in gewissen Bereichen wieder ein Stillgewässer, denn diese Stauräume und Stauseen haben einen Stillgewässer-Charakter. Die Fließgeschwindigkeit ist sehr gering, das heißt, es verändert sich auch das Umfeld dadurch. Das Umfeld bei den Fließgewässern kann entscheidend anders sein als bei einem Stillgewässer.

VF: Dann gehen wir weiter zu Biomasse und Biotreibstoffen. Die beiden Punkte können wir auch gern, je nachdem wie es dir besser passt, als gemeinsame Punkte besprechen.

AK: Kann man eigentlich zusammenfassen, weil in Heizkraftwerken, also in Fernwärmeanlagen, für das Anheizen auch noch immer Öl zugeheizt wird. Für mich irgendwie schockierend, weil man denkt da an eine grüne, unter Anführungszeichen, Heizalternative zu anderen Möglichkeiten und dann steht da auch wieder Öl dahinter. Ja also die Erzeugung von zum Beispiel Hackschnitzeln oder Festholz ist sicher eine sauberere Lösung als vieles andere, was wir vorher schon genannt haben, wenn es denn nicht zu einem Eingriff auch wieder in Flächen kommt, die schützenswert wären oder mit vielen Arten ausgestattet sind. In der Regel ist es aber dann so, dass eben durch ein Windwurfereignis oder ein Borkenkäfer Ereignis es dann zur Entfernung von den Bäumen kommt, und dann ist es natürlich auch eine Möglichkeit, dass man Hackschnitzel daraus macht. Sind dann wieder Sträucher und so weiter betroffen, die irgendwo geschwendet werden und dann zu Hackschnitzel produziert werden, dann ist es natürlich wieder ein Verlust des Lebensraumes. Aber grundlegend ist diese Methode vor allem bei uns in Österreich und Europa, wo wir mit Wäldern sehr reich ausgestattet sind eine interessante Alternative. Aber man verbrennt ja jetzt das Holz und da geht es dann auch wieder in die Luft mit dem CO_2 und die Abgase sind halt eben da. Also nicht gerade auf lange Sicht gesehen derart förderlich wie zum Beispiel jetzt die anderen erneuerbaren Energiemöglichkeiten.

VF: Okay, vielen Dank. Vielleicht eine Rückfrage noch bezüglich der schützenswerten Bereiche und dass man die nicht verwenden sollte. Wenn man sich jetzt anschaut, dass mit der Biodiversitätsstrategie der EU bis 2030 30% der Landflächen geschützt sein sollen, und 10% davon stark geschützt. Wenn man da jetzt nach Österreich schaut, ist dann wirklich noch viel übrig, wenn man sagt, man schützt 30% der Landesfläche und nimmt dafür natürlich die begrünten Teile Österreichs. Bleibt dann noch etwas übrig, das man verwenden könnte, wenn eigentlich 30% geschützt werden müssen?

AK: Ja, es bliebe sicher noch genügend übrig. Es wird dabei eine Zonierungsfrage sein, und zwar, wenn man Windkraftanlagen hernimmt, so wird man sicher mit dem Mittel der Zonierungen arbeiten müssen. Zonierungen sind so zu verstehen, es gibt Regionen, wo die Windkraft und die Aufstellung von Windparks in Ordnung ist, und Ausschlusszonen, weil eben dort sensible Lebensräume sind oder weil dort entsprechend geschützte Arten vorkommen oder weil auch der Vogelzug oder der Fledermauszug dort nachweislich mit großen Zahlen zu belegen ist, wodurch es dann zu vielen Todesopfern kommen würde. Also ich würde sagen ja, es kann möglich sein, es wird sich dann komprimieren und auf einzelne Flächen und diese Flächen sind dann vielleicht aber doch auch idealere Flächen, dass man sagt, na ja, dort wo die Windausbeute groß ist und ich dort noch ein Ausbaupotenzial habe, wird es dort günstiger sein als neue Flächen anzugreifen.

VF: Okay, vielen Dank. Um eben dann festzustellen, ist ein Ort geeignet, um dort erneuerbare Energien aufzubauen, gibt es da moderne Technologien? Wie kann man da Drohnen, Remote Sensing und solche Dinge verwenden, um quasi schnell und effektiv festzustellen, ob eine Fläche, ob einen Bereich geeignet ist, um dort erneuerbare Energien ausbauen zu können?

AK: Also die Erhebungsmethodik bei den biologischen Kartierungen. Ja, da wird vielfach natürlich mit Technik gearbeitet, Drohnen bis zu einem gewissen Grad, die man einsetzen kann, aber es ist von der Wildtierkamera angefangen, um ganz einfache Sachen herzunehmen, bis hin zu Batcordern, die die Fledermausaktivität und die Rufe aufnehmen, bis hin zu Geräten, die den Vogelgesang aufnehmen. Natürlich die Drohne, insbesondere bei der Bestimmung von Biotop-Typen also, da sind wir im vegetationsökologischen Bereich, da ist die Drohne sicher ein sehr gutes Mittel, um das nachweisen zu können. Kristallisiert sich anhand des Drohnenbildes schon heraus, dass ich dort einen speziellen Biotop-Typ habe? Oder ist es Fichtenforst und nicht zwangsläufig mehr? Also die technischen Mittel sind da, werden meines Wissens auch genutzt. Was jetzt da vielleicht auch nicht uninteressant ist, sind Vogel-Radar-Geräte, die eingesetzt werden an bestimmten Standorten, wo etwas aufgestellt werden sollte. So ein Vogel-Radar zeichnet dann 24 Stunden die Aktivitäten zum Beispiel von Vögeln auf und da merkt man dann, dass in der Nacht eben die größere Anzahl an Vögeln unterwegs ist als am Tag.

VF: Vielen Dank. Bei der nächsten Frage geht es dann wieder um diese Biodiversitätsprobleme, die auftreten könnten durch verschiedene erneuerbare Energien. Es werden jetzt natürlich auch mit den ganzen Umweltauflagen, die wir haben, wenn ein Wasserkraftwerk gebaut wird, wenn Windanlagen gebaut werden, werden noch alle möglichen begleitenden Maßnahmen angewandt. Was sind denn da die vielversprechendsten Ansätze, wo man sagt, ok, ich habe eine Auswirkung von dem Wasserkraftwerk, aber es ist möglich, diese Auswirkungen so gering wie möglich zu halten.

AK: Also praktisch Ausgleichsflächen und Maßnahmen, die doch wieder die Biodiversität erhöhen in Bezug auf Wasserkraft. In Bezug auf Wasserkraft wäre es da sicher so, dass in gewissen Bereichen man auch den Bootsverkehr einschränken kann, weil ich schaffe dadurch wieder etwas anderes. Das ist ein Bereich, der vielleicht zuvor Wildwasser-Charakter hatte, und da können wir auch Kleinkraftwerk hernehmen, und danach ist es dann doch mit einem aufgestauten Bereich, der langsam rinnt. So ist es vielleicht dann so, dass man zumindest die Kanufahrer und die Paddelbootfahrer oder Rafting-Aktivitäten dadurch etwas eingeschränkt hat, weil sie dann eigentlich nicht mehr in der Art möglich sind. Natürlich Ausgleichsmaßnahmen in Form von möglichen Revitalisierungen von Altarmresten. Also das heißt, wir haben hier eine Begradigung der Flussufer in Österreich und natürlich auch darüber hinaus in den letzten hundert Jahren erlebt, wo man einfach den sich dahinschlängelnden Charakter eines Gewässers fast auf eine gerade Linie zurückgestuft hat. Mach ich jetzt ein Wasserkraftwerk und staue dort sozusagen das Gewässer auf, dann verliert es auch wieder an dieser Struktur und ich habe etwas Geradliniges. Aber es ist so, wenn ich diese Altarmreste wieder revitalisiere, und das hat man zum Beispiel bei der Gail gesehen, das hat man aber auch bei der Lavant und der Drau gesehen, dass solche Lebensräume dann wieder sehr interessant sind. Also das heißt die noch bestehenden Feuchtflächenreste von diesem einstigen Flussverlauf, die kann man revitalisieren. Und man schafft dort Stillwasserbiotope, also das heißt wieder interessant für Amphibien, wieder interessant für diverse Wasservögel, natürlich findet man dort Insekten, das ist schon etwas Positives.

VF: Vielleicht, wenn man die Frage jetzt dann noch ausweitet, auch auf andere Bereiche, also Wind oder Photovoltaik.

AK: Bei Wind wird es dann schon schwieriger mit den Ausgleichsflächen. Da betrifft es, wenn man jetzt die montanen Regionen hernimmt, hauptsächlich die Raufußhühner, also Auerhuhn, Birkhuhn, Haselhuhn, Schneehuhn. Und da Ausgleichsflächen zu schaffen, ist nicht ganz einfach. Das heißt ich brauche dementsprechende Flächen, die ich auch dementsprechend herrichten muss, also das heißt den Lebensraum Anforderungen des jeweiligen Vogels entsprechend herrichten muss, und man kann sich vorstellen, dass man einen Auerhahn nicht einfach von einem Standort auf den anderen setzen kann, also entweder wird er es von sich aus machen, weil dieser neu geschaffene Bereich doch interessant ist, aber einfach so ein Tier versetzen ist kaum bis schwer möglich. Somit sind Ausgleichsflächen zwar ein wunderbares Instrument, aber sind nicht immer von hoher Wirksamkeit gekrönt. Bei Photovoltaik, wenn zum Beispiel eine ausreichende Fläche rund um diese Photovoltaikanlage entsteht, wo auch wieder Brachflächen entstehen können oder späte Mähtermine dort praktiziert werden, dann ist es natürlich auch von einem Vorteil. Aber es geht so oder so nicht mehr ohne Ausgleichsflächen, weil einfach der Eingriff teilweise zu groß ist.

VF: Perfekt, vielen Dank, dann sind wir eigentlich schon bei der letzten Frage und bitte nicht falsch verstehen, ist auf jeden Fall provokativ gefragt. In der jetzigen Landschaft bezüglich Klimawandel und allen Problemen, die wir gerade haben, ist es ja ganz klar, dass erneuerbare Energien ausgebaut werden müssen, dass da was passieren muss. Warum oder inwiefern sind Naturschutz und Erwägungen bezüglich Biodiversität trotzdem wichtig? Obwohl Klimawandel so drückt und CO_2 Emissionen so hoch sind?

AK: Meine persönliche Meinung ist, und die ist sehr hart, weil es die Tiere und Pflanzen länger schaffen werden als der Mensch. Das heißt, das was ich jetzt als Mensch von der Tierwelt noch erhalten kann, das wird uns im günstigsten Fall überleben, weil ich glaube, dass der Mensch es trotz dem Ausbau kaum schaffen wird, aber jetzt auf Jahrhunderte gesehen, nicht von heute auf morgen. So, der Mensch ist ja eine etwas jüngere Erscheinung in den erdgeschichtlichen Abfolgen und Zeiten, und ich glaube, dass der Mensch sich entweder zu einer Urform zurückbilden wird oder vielleicht wirklich komplett aussterben wird, weil es einfach für ihn zu heiß sein wird. Aber das ist jetzt etwas philosophisch, auch fast schon biologisch-philosophisch. Zur konkreten

Beantwortung der Frage, eigentlich ja, es wird ein Miteinander sein müssen. Man hat eine Verantwortung. Man kann nicht nur auf sich selbst schauen, also das heißt der Mensch muss auch auf die Lebewesen schauen. Wie schon gesagt, der Mensch ist eine jüngere Erscheinung. Da ist die Verantwortung sehr groß für den Erhalt, denn es haben die verschiedensten Organismengruppen eine spezielle Funktion im Ökosystem. Und wenn ich jetzt nur hernehme die Bienen mit ihrer Bestäubungsfunktion, aber auch viele andere Insekten mit Bestäubungsfunktion, dann ist es etwas Entscheidendes, weil gewisse Pflanzen dadurch weiterleben können durch diese Bestäubung. Fehlen mir dann die Insekten, dann ist es sehr schwierig. Das heißt, der Mensch muss beides parallel eigentlich forcieren, weil sonst wird es nicht funktionieren. Das ist natürlich ein schwerer Weg und das eine schließt das andere oft aus. Jetzt baut man einen Windpark oder eine Wasserkraft-Anlage und eine Photovoltaikanlage und dann ist dort ein seltenes Tier und dann stellt sich natürlich die Frage was ist jetzt wichtiger, dass ich den Klimawandel reduziere oder dass ich diese Tierart, die dort vorkommt, aber vielleicht an anderen Standorten auch, fördere, oder auch nicht? Was aber bei diesen ganzen Sachen noch zu berücksichtigen ist, das ist das Vorkommen von Endemiten. Also das heißt, das ist dann sozusagen die Superlative in der Biodiversität insgesamt. Ein Endemit ist eine Art, also eine Tier- oder Pflanzenart, die nur auf einem speziellen Standort vorkommt. Und dieser spezielle Standort ist nur einmal auf der Welt, und sonst gibt es das nirgends.

VF: Gibt es da Beispiel vielleicht?

AK: Ja, verschiedene Käferarten zum Beispiel. Ich kann dir jetzt keinen mit der Art als solchen sagen, aber es sind verschiedene Käferarten, die zum Beispiel wirklich nur in diesen einem Lebensraum-Typ und vor allem in dieser einen Region vorkommen. Das Thema Endemiten war ja auch bei den Windparks bei den Einreichungen in Kärnten immer wieder ein Thema. Also, das heißt es kann schon sehr, sehr speziell sein, wenn ich Endemiten habe. Aber wie gesagt die Verantwortung, die wir haben als Menschen für den Erhalt dieser Tiere und Pflanzen und dieser Diversität ist enorm. Macht man nichts, dann wird es bald traurig in unserer Landschaft ausschauen.

VF: Vielleicht zum Schluss noch ganz kurz, falls es noch irgendetwas anderes gibt, wo du das Gefühl hast, das wäre noch wichtig, in diesem Kontext, wäre jetzt die Möglichkeit dazu.

AK: Also das letzte Thema war ja, wie es sich mit dem Ausbau von erneuerbaren Energien und dem Thema Biodiversität verhält. Also es wird beides vonstattengehen müssen, aber es werden Vertreter von den Betreibern und auch NGOs und auch Sachverständige noch näher zusammenrücken müssen, weil sonst wird man keine Energiewende schaffen und wird man auch keinen Biodiversitätserhalt schaffen. Also ich bin der Meinung, dass die Zusammenarbeit viel, viel enger sein wird müssen, dass man alle Beteiligten konstruktiv schon in frühen Prozessen miteinbeziehen wird müssen und an einen Tisch bekommen wird müssen.

VF: Und für wie realistisch hältst du es, dass wir das in den nächsten 10 bis 15 Jahren so erleben werden?

AK: Es kommt auf die Menschen an, weil es oft eine psychologische Komponente hat. Also grundsätzlich wäre es natürlich möglich. Jeder wird Abstriche machen müssen, aber grundsätzlich wäre das zu schaffen. Aber ich schätze fast, dass es daran scheitern kann, weil tatsächlich zu viel Menschlichkeit und zum Teil Unwissenheit von einem Bereich, den man nicht kennt, dazukommt.