Sustainable Development of On-shore Wind Power

Integrated Landscape Character Assessment as a tool to improve assessment of on-shore Wind Power in Southern Sweden

Diego Mascareño Suarez

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Abstract

To meet the increasing demand of renewable energy and move from the fossil-fuel economy, Sweden aims to expand the onshore wind power production from 30 TWh today, to 80 TWh by 2040, with a strong expansion in Southern Sweden aiming to complement the infrastructure implemented in Northern Sweden. The implementation in Southern Sweden has created growing conflict as landscapes of cultural, ecological, and social importance try to accommodate this new energy landscape. The citizenry has also been affected, with their role or lack of it being crucial to the development of wind power in the South of Sweden. The aim of my analysis is to estimate the increase in these overlapping goals and how processes that improve decision-making at regional level and citizen participation can be crucial to the successful implementation of wind power in Southern Sweden. This aim will be mainly achieved through the answering of 4 main research questions: 1) estimate land ownership and land cover types in present and proposed onshore wind power developments Southern Sweden 2) How do present and approved wind power developments relate to National Interest areas in the southern counties of Skåne. Halland, Kronoberg and Jönköping? 3)How do present and approved wind power developments relate to National Interest areas in the southern municipalities of Falkenberg and Uppvidinge? 4) Have ILCA and similar assessments had an influence on successful Wind Power development implementation and Landscape Democracy in Falkenberg and Uppvidinge? All spatial analyses were carried out with a Geographical Information System.

My results showed an increase up to 50% in impacted Arable Land in nemoral regions of Sweden and 94% in Conifer forests in boreonemoral regions of Sweden, with these land covers being the most relevant in each respective region. Private landowners are also shown to bear the brunt of the impacted areas, with an increase of 124% and 194% in nemoral and boreonemoral regions, respectively. Wind Power sites were found to visually impact up to 50% of National Interest areas in Skåne, Halland, Kronoberg and Jönköping. 68% of National Interest areas impacted are present within 4km of proposed wind power sites in Uppvidinge, and 34% of National Interest areas impacted are present within 4km of proposed sites in Falkenberg. Finally, the existence of a landscape character analysis based on ELC principles prior to wind power implementation in Falkenberg linked with the successful implementation of wind power infrastructure in the municipality, while the opposite in Uppvidinge led to an unsuccessful implementation of wind power infrastructure. By highlighting the dimension of land use and actor conflict linked to wind power infrastructure, as well as the processes that can solve these conflicts and enhance regional planning and landscape democracy, I am confident I can provide with important information that can improve sustainable landscape planning in the multifunctional landscape of the present and the future.

Keywords: land use conflict, spatial analysis, landscape character assessment, landscape democracy, wind power.

Preface

Firstly, I would like to thank my supervisors Johan Svensson, Patrik Olsson, Wiebke Neumann and Therese Bjärstig for their expertise in land use conflict, the implantation of wind power infrastructure and the role of landscape planning in it. Thank you, Johan and Wiebke, for your efforts in helping me understand the dimension of wind power implementation in Southern Sweden and for letting me link it to the field Landscape Architecture and Planning. Thank you, Therese, for helping me give shape to my story. Thank you, Patrik, for keeping me tethered to social sciences and landscape architecture, and for highlighting the importance of landscape democracy in infrastructure planning.

Thank you, Elena Leuku, for bearing with me during the course of this Master´s course, for always being there to offer support, and for helping me find some time to relax during the course of the thesis.

During the Master Thesis, I gained a special interest into the role of landscape architecture in infrastructure planning, and how this might prove crucial in infrastructure planning and the energy transition. I have gained more knowledge on the dimension of the issues and our role in bridging conflict, which is something I will bring with me in my future career.

Lund, 14 September 2022.

Diego Mascareño Suarez.

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Abbreviations

NI. National Interest

ELC. European Landscape Convention

LCA. Landscape Character Analysis

ILCA. Integrated Landscape Character Assessment

EPA. Environmental Protection Agency

1. Introduction

1.1. *New Energy Landscapes and the threat of Climate Change*

The relationship between humankind and the landscape has changed in the last three centuries. Humanity has always had a reciprocal give and take relationship with the landscape, but the fear and utmost respect that we had for the landscape and it´s dangers instead has turned into an active embracing of the landscape and its various aesthetical and functional values (*Pasqualetti & Stremke, 2018*) or a clear, gender-based desire for control (*Rose, 1993; Setten, 2003*). Despite the perceived fragility of landscapes that authors such as Thoreau expressed (*Spirn, 1998*) and their inherent tendency to change, humankind has since then strived to preserve, change, augment or otherwise meddle with the values it associates with the landscapes it is in contact with. This constant influence gave birth to a particular definition of landscapes in which the shaping of the territory is the result of tangible and intangible social and cultural practices (*Olwig, 2007)*. Within this socially and culturally important set of landscapes, which are also defined as cultural landscapes by the ICOMOS *(Blair & Truscott, 1989),* exists a subset that is directly linked to the extraction and use of energy resources to sustain human life. These landscapes are defined as energy landscapes. Energy landscapes, or energyscapes, are defined as territories in which the primary character, as perceived by its inhabitants, can be directly linked to forms of production, distribution, and use of energy resources (*De Vos 2007*; *Howard 2013*; *Pasqualetti 2013; Pasqualetti & Stremke, 2018*). This definition is particularly useful when trying to analyse human-environment relationships and the way in which energy production impacts land-use and conflicts among different interests in land use. It also effectively considers how social dynamics regarding energy use directly translate into landscape and cultural dynamics. In Energy landscapes or energyscapes the concept of energy seeps into politics, societies, and technologies, creating ways of communicating and even thinking (*Lempinen, 2018).* Throughout history, and especially since the fossil-fuel led Industrial Revolutions, the consequences of society´s energy consumption has partly happened in localized areas away from the eyes of the "core" public or consumer. The damages to the landscape occurred in either far-away areas of the world or servient urban areas and were considered "collateral or necessary damage". While Pasqualetti & Stremke (2018) argument that the changes stemming from these practices happened mostly outside of important human population centres and were not firmly present in the collective mind, the reality is that in some cases, such as above-ground mining cities, the damage was accepted as a necessary evil in the quest for development (*Dutta Dey & Singh, 2021)*. Recently, anthropogenic activities causing changes in climatic conditions (from now on climate change) have firmly thrown these notions into question. Energy and the landscapes that accompany the energy transition have been propelled to the forefront of social and political debate in some of the most important political spheres, such as the EU (*Liljenfeldt, 2015*).

As per the latest IPCC headline statements (IPC 2022), the projected climate change trajectories would lead to climate and weather extremes that have already had irreversible detrimental impact to both human and natural environments, and it is estimated that between 3,3 and 3,6 billion people live in areas that are highly vulnerable to the effects of climate change. These changes are coupled with the patterns of unsustainable land use and inadequate governance tied to fossil fuel use. These often generate deteriorating social and ecological conditions that result in exacerbated poverty, inequity, oppression, and marginalization (*Dagget, 2018; Verweijen & Dunlap, 2021*). A key objective in the deacceleration of climate change would be a fall of Global Greenhouse Gas emissions derived from fossil-fuel energy systems by the middle of century, and almost negligible emissions by 2100 (*IPCC,2022*). The first challenges related to the use and development of new, renewable energy ecosystems is finding the ones that are most suited to countries´ hydrographic and meteorological conditions. The objective is to find an energy-production method that is efficient given the costs of the technology, the energy output versus required production energy and the lifetime CO^2 emissions of the approach. Wind Power represents a viable competitor, with average carbon emissions per kWh being 1/56 to 1/108 the emissions of carbon-based energy solutions such as coal-based thermal plants (*Li et.al., 2020*). Despite its efficiency, social and land-use conflicts linked to Wind Power remain a problem to be solved due to the higher land area needed in the short term (*Jones & Pechjar, 2013*). While it is recognized that these mitigation efforts for climate change require a drastic change in energy resource policies, further research shows the lack of progress governments have made towards this pledge (*UNFCCC, 2015b*). This demonstrates the complexity of the task at hand and the lack of clarity upon the process' achievability (*Li & Strachan, 2017*). It is within this context that the race for a new energy system takes place and drastically affects energy landscapes as we know it.

A key aspect of the transition to low-carbon energy landscapes revolves around the legitimacy of the processes that generate these new landscapes. Does the new energy revolution perpetuate undemocratic processes which traditional carbon-based energy sources have created? Golubchikov and O´Sullivan (2020) remark upon "energy peripheries", areas in which the resource extraction for any defined energy environment are performed but for which political and social agency over those processes remains weak. The term periphery is given due to the existence of "core" areas in which most of the consumption, benefitting and policy making is done. It is understood that for the energy revolution to be successful in the long-term it is needed for the processes surrounding it to achieve a level of democracy and participatory planning that the fossil-fuel economy has lacked so far (*Healy et al., 2019; Kanger & Sovacool, 2022*). Without the public´s support of energy transition processes, efforts to plan and realize projects such as wind power parks might face "planning barriers" that will hamper the transition in the long term (*Breukers & Wolsink, 2007; Toke et al., 2008; Liljenfeldt, 2015).* To enforce the infrastructure change needed to shift the energy systems, the engagement of multilevel stakeholders in participatory learning and decision making is necessary (*Pahl-Wost, 2009*). This by itself is not enough, and the power dynamics between the different stakeholders needs to be assessed (*Ballard, 2005*) to balance the input done by more powerful actors, such businesses and government, with the citizen´s individual and communal agency. If unattended, the power differential might hamper or impede decision making (*Armitage et al., 2008*) or directly heighten the vulnerability of communities (*Burns, 2014*). Consensus achieved through meaningful inclusion is needed to achieve renewable energy production goals.

While fairly committed to sustainable growth and policies, Sweden faces a challenge to effectively bridge rhetoric and practice (*Lidskog & Elander, 2012*). Amongst these is the highly decentralized spatial planning procedures, with municipalities monopolizing spatial planning (*Hrelja et al., 2012; Storbjörk & Hjerpe, 2014*). The is a risk then that a disconnection between the policies laid by the national government and the spatial planning carried out by municipalities might hamper ecological modernization (*Antonson et al., 2016*). It is in this void that the importance of regional institutions as a bridging actor is recognized (*Antonson et al., 2016*). Research by Daanevig and Aall (2015) found that regional coordination of climate adaptation facilitates knowledge exchange and improves local level planning through a "hybrid management space". It is then important to recognize, in the context of infrastructure planning and its effect on the landscape, which tools regional institutions can use to exercise the roll described by Daanevig and Aall. Amongst these, Landscape Character Analysis and Integrated Landscape Character Assesment represent tools through which planning can surpass the limitations single municipalities have when planning by expanding their scope of research, engage multilevel stakeholders and actors (*STA, 2018*) and setting a base knowledge base in which national, supranational, and local goals are equally important (*STA, 2018*).

1.2. *Aim and research questions*

The aim of this thesis is to assess the importance landscape assessment tools are in the quest to strengthen the decision-making at regional level and improve wind power infrastructure planning in Sweden while also achieving landscape literacy and democracy as defended by the European Landscape Convention. The study will focus on Boreal and Boreonemoral Sweden as it is where the Swedish Wind Energy Association has proposed an expansion to complement the production in Northern Sweden. There is also a knowledge gap on the kind of land use conflicts that exist and might exist in this area. A critique of the current planning framework, in the manner of the National Interest framework, will be carried out in the hopes of highlighting the importance of new tools that ease the "planning barriers" that Wind Power has experienced and might experience in the future. The role of Integrated Landscape Character Assessment and other similar assessments in regional planning, as an addition to national, municipal, and individual approaches, will be explored. ArcGIS tools are used to provide a background analysis to the present and future status of wind power development. These digital tools are also used to assess the impact ILCA and LCA have had in the respective municipal wind power development. The hypothesis is that LCA and ILCA might enhance effective participatory planning in the industry and help bridge the gap that currently exists between national land-use proposals, industry pressure, municipal planning, and the interests of Sweden´s citizens both regarding renewable energy production and changes in the landscape.

I will achieve the aim through the answers to the following research questions:

Q1) *In what way are land ownership and land cover types in present and proposed onshore wind power developments in nemoral and boreonemoral areas of Sweden spatially linked with present and future land-use conflicts?*

Q2) *How do present and approved wind power developments relate to National Interest sites, at a spatial scale relevant to human perception, in the nemoral and boreonemoral counties of Skåne. Halland, Kronoberg and Jönköping?*

Q3) *How do present and approved wind power developments relate to National Interest sites, and the landscape, at a spatial scale relevant to human perception, in the southern municipalities of Falkenberg and Uppvidinge?*

Q4) *Have ILCA and similar assessments had an influence on Wind Power development implementation and Landscape Democracy in the municipalities of Falkenberg and Uppvidinge?*

2. Theoretical Background

New Energy Landscapes

The first element that comes to the mind when talking about the transition from fossil-based energy resource systems to onshore renewable ones, in particular for wind and solar energy, is visibility (*Calvert et al., 2019*). Coal, oil, and natural gas can be considered "below the ground" varieties of energy resources: their storage is underground, the processes to extract them usually occur in faraway or less visible regions and due to their high energy density, it is possible to easily transport them long distances by rail, pipe, or cargo to their intended destination in population centres. Renewable energy sources mainly represent an opposite to this concept, with most of them belonging to "above the ground energy flows". This means that renewable energy processes are often decentralized and localized due to geography and weather conditions, with the means to extract and distribute them being much more visible to the general population (*Pasqualetti, 2011a; De Boer, 2015*). The visibility of renewable energies and their arrival in landscapes with an intensive human footprint has also meant that local or traditional land-based activities and economies must be reinvented to accommodate them, at times against the actors will *(McCarthy, 2016; Huber & McCarthy, 2017; Dagget, 2018; Poggi, 2018; Verweijen & Dunlap, 2021*). Some of these might involve wind power parks coexisting with recently unaltered cultural landscapes or nature reserves, resulting in a countermovement by the communities involved (*Johnsen Rygg, 2012*). The evidence shows then that the ecosystem that previously synchronized land-use activities and fossil fuel energy systems has become obsolete due to the transition being made to the renewable energy ecosystem. The new ecosystem, which is heavily impacted by the locality of land-use and renewable energy resources, faces the difficulty of accommodating several different types of uses, cartographies, meanings, and timelines in landscapes which have already experienced a heavy deal of impact and change due to existing land-use (*Calvert et al., 2019*). While the multi-spatial quality of renewable energy landscapes is easier to convey by focusing on its locality and over-the-ground character, conveying how they exist in multiples timelines, interweave into dynamic processes, and coexist with historical landscapes is perhaps a more difficult task. One theoretical construct that has proved successful is that of the palimpsest (*Gorostiza & Sauri,2017*). A palimpsest, per the archaeology and geology fields, defines an object which post-production is reworked beyond its original purpose to serve another while still maintaining remnants of the original one. In the context of landscape production, palimpsests are formed through the processes of accumulation, layering and erosion of natural and man-made phenomena. These processes create new features in the landscape and expose old ones as well. In the long term, it becomes difficult to recognize or pair features to their respective timelines and new meanings, associations and uses are created (*Calvert et al., 2019*). Pasqualetti (2013) adopts theoretical constructs that fit into the palimpsest category, but the new energy landscape constructs that can be derived from his work fail to fully consider the dimension and dynamics they represent. It is by resorting to Simandan´s (2015) theory of recursive cartographies that the construct can be improved upon. These new landscapes are made and remade through dynamic processes and events beyond the natural ones explored by the palimpsest ideology. Revolutions, landscape disasters, as well as other social disturbances work together to change a landscape, but once a landscape enters this phase it can very well continue to change due to the inertia and dynamic relationships they contain. New tools such as ILCA recognize the importance of these dynamics to provide a better knowledge base for future policy making (*STA, 2018*).

Sweden´s energy goals, wind power and existing framework

The threat of climate change and the search for new energy landscapes has deeply impacted European Union policy, with the main goal being for all countries to achieve carbon neutrality by 2050. This means that by 2040 all energy consumed by the countries must come from renewable energy sources (*EEB, 2020*). Sweden projects a consumption of 200 TWh by 2040, compared to an annual consumption 140 TWh in 2020 (*SEA, 2021; Swedish Wind Energy Association, 2021*). The reality is that, while efficient methods for each country´s geography might be found, the impact these methods have on the landscape from ecological, social, and economic points of view have proved to be a stumbling block from progressing with the aim to be completely fossil-fuel independent in the next two decades. Another aspect that might add pressure in the Swedish renewable energy debate is the economic and social impact of phasing out nuclear reactors. (*Khan et al, 2020*). These situations would put further emphasis in other available energy resources in Sweden such as hydroelectric power and wind power.
Wind power is, together with hydroelectric power, a strong contender in the renewable energy landscape due to economic cost per TWh and availability of the necessary geographical conditions for it to be efficient (*IVA, 2017*). Despite being feasible on paper, wind power has found stumbling blocks regarding the citizenry´s lack of appetite for additional landscape disturbances. Svensson et al. (2020a), in a study done for northern Sweden, also highlight the lack of physical land available to accommodate single uses, forcing land uses to coexist in either harmony or conflict. Of the 200 TWh projected for energy consumption in 2040, wind power would account for 100 TWh, an increase from 30 TWh in 2020, with 75-80 TWh of that share comprised by onshore wind power. The Swedish Wind Association also seeks to relieve some of the pressure on onshore wind power in the northern region of Sweden by dealing with the obstacles that impede complementary offshore and onshore wind power parks in the south of Sweden (*Swedish Wind Energy Association, 2021*).
The arising conflicts have thus prompted institutions such as the Swedish National Board of Housing, Building and Planning to explore which land use objectives might be compatible or incompatible in the search for the multifunctionality of the Swedish territory (*Boverket, 2017 5*). To achieve this objective, the national government has implemented a legal framework which sets the goals and requirements for parts of the territory. This framework is called the National Interest framework, and its goal is to promote sustainable use of land and water by safeguarding overarching interests for strategic exploitation or protection (*Solbär et al., 2019*). An important characteristic of the National Interest framework is that NIs do not belong explicitly to the chapter 7 of the Environmental Code, hence not being solely restricted to a

framework directing the ecological and natural reserves presented in the Swedish territory. Instead of this, NI form part of the economical rules (Hushållningsbestämmelserna), and as such are set to be able to work within social, economic, cultural, and ecological spheres (*Solbär et al., 2019; Svensson et al., 2020a*). Through their nature it is thought that NIs could mitigate conflict in the pursuit for more comprehensive planning (*Thune et al., 2013*).

National Interests conflict and synergy

NIs represent a tool for Sweden to set out national goals for the use of its territory It is also within their capabilities to suggest synergies between NIs. It is also within their capabilities to suggest synergies between land uses. Svensson et al. (2020a) outlines how in most cases there is just not enough physical territory available to satisfy all the national objectives, with northern Sweden experiencing a situation in which the area required by eleven NIs is about 2-4 times the physical territory available in the region. Until the beginning of the 21st century, high efficiency single-use land-use ecosystems had predominated in the management of the landscapes and largely guided their changes and disturbances. In the case of Sweden, multi-use landscapes with often local and small-scale impact of single uses have transformed the large monoculture forestry systems and natural conservation areas that must coexist with Sami reindeer herding in the north (*Svensson et al., 2020a*), and agriculture summed to natural conservation in the south *(Antonson & Jansson, 2011*). New energy landscapes implicitly throw these single-use systems into question due to the decentralized model they represent. This puts a great deal of importance in finding compatibilities between NIs, and in the case of renewable energies, the creation of new energy landscapes that can coexist, for example, with recreational, agricultural, cultural, or natural needs (*Solbär et al., 2019*). NIs then provide an effective framework to spread out the goals but complicates municipal planning efforts due to usually overlapping and conflicting NIs being located on similar geographical areas. A lack of comprehensive regional planning to bridge these national or supranational interests and the more physically focused municipal planning also impacts teamwork between different actors and skews land-use. In the end it is the bigger or more powerful actors, such as companies or governments, who shape planning decisions, in turn harming the stand of interests such as wind power in the eyes of the public, who often don´t see the benefits of wind power but directly experience the side-effects of it (*Oles & Hammarlund, 2011; Johnsen Rygg, 2012*). This is further evidenced by the fact that, as of today, nearly 70% of the new onshore wind power proposals do not get accepted by municipal councils (*Swedish Wind Energy Association, 2022*). A better communication tool between different agency layers is then needed if national interests are to match or be able to coexist with those of municipalities.

Landscape democracy

Post-War era planning in countries such as the US has been widely characterized as a top-down approach where professionals and government actors have had the most agency. (*Lundqvist, 1972*). Sweden during the Post-War era was no different, and examples can be seen spread through the Swedish territory: hydroelectric plants, transport infrastructure or the "Million house program" (Miljonprogrammet) are clear examples of top-to-bottom regional planning in which the State, with compliance from the population, has overruled any opposition in search for the nation´s development. These are perceived to be top-to-bottom planning as they were development decisions drafted by the national government, in response to perceived problems, and then imposed at a national scale in Sweden, with the burden of the construction and implementation being shared by actors such as construction companies and municipalities. Lately, the top-down approach to planning has been challenged, with recent studies by Stober, et.al. (2021), McGookin, et.al. (2021) and Rudge (2021) all suggesting the path forward needs to include less powerful actors in a meaningful way. Co-production as a grassroots movement prepares and educates the public to be able to work hand in hand with the elected officials in matters that directly impact them, such as planning. Co-production and public involvement in regional planning and actions that influences the landscape is an idea that ties in directly with the conceptual revolution that the European Landscape Convention (ELC) has led (*STA, 2018*). As argued by Kenneth Olwig (2007), the European Landscape Convention brought the concept of landscape out from the exclusive scientific arena that it had been in the past and defined it as "an area, as perceived by people, whose character is the result of natural/human interactions" (*ELC Article 1a*). This recognition posits the landscape as an arena of constant flux where social justice and injustice can be carried out. The elasticity that the holistic definition of landscape owns permits for social inclusivity topics to be addressed on the arena that landscape provides (*Egoz et.al., 2011*). Landscape has transformed into a medium that can give physical representation to social or cultural problems, with impact from tensions in one of them occurring in the other and vice versa. It is by linking this tangible and intangible importance of landscape to society with the Universal Declaration of Human Rights that a "right to landscape" can be argued upon. It is important not to limit this "right to landscape" to a right to be in a safe or adequate environment. Instead, "right to landscape" should focus on providing individuals with access to an environment that both resonates with their values and is physically healthy for them (*Egoz et.al., 2011).* Citizens should not be alienated from the landscapes that they identify with, even if the change provides for a healthier environment. Solutions to environmental issues should try to achieve solutions that satisfy the tensions on all fronts. Another key aspect to this right to landscape, hereafter landscape democracy, is how education and public participation not only helps to ease tensions but improves the level of dialogue by providing the public with "landscape literacy". When discussing about this concept it is first mandatory for us to explore what is literacy as a ground idea. Literacy is, as described by Freire and Donald Macedo a cultural policy that either works to "reproduce existing social formations" or "promotes democratic and emancipatory change" (*Freire &Macedo, 1987:141*). They argue that knowledge is a precondition for literacy and that the end goal of it is to transform or rewrite the world. It is easy to understand how this concept pertains to landscape use as transformation or relation to it is an innate human condition. Without landscape literacy citizens quickly take a backseat position in their own communities' development and reality, and this is a situation that frequently generates an impasse in the search for solutions as guilt and detachment counter citizen's ability to critically analyse and transform their environment. Spirn (2007) highlights a troubling aspect to the lack of landscape literacy, and that is a lost identity. The loss of this landscape identity often ends in either serious degradation of the citizen´s environment, or constant conflict due to a divergence in ideas. Achieving landscape literacy is a task that requires effective communication between educated professionals and the general population. Spirn (2017) remarks on the various educational workshops her students carried out in Mill Creek, Philadelphia. The main objective was to promote a degree of landscape literacy and identity that would facilitate the citizens´ involvement in planning and landscape decisions. It was also an objective for the general population to use the attained knowledge to improve their neighbourhood without the direct support of more formal actors. The knowledge gained by the citizens of Mill Creek and their involvement in their neighbourhood earned them national recognition and even resulted in planning proposals that would incorporate their knowledge and implication (*Spirn, 2017: 407)*. Sadly, the Philadelphia Streets Department took control of several of these projects and disregarded some of the key components that had been achieved through citizen participation (*Spirn, 2017: 408).* The case of Mill Creek highlights the meaningful and less meaningful way in which citizens can be included in planning decisions.

Landscape literacy is a prerequisite for citizen involvement in planning decisions, but even then, care needs to be taken so that the involvement is meaningful. This is precisely a topic that Sherry Arnstein debates in her article *A Ladder of Citizen Participation (2019)*. In it, she writes about citizen participation in planning procedures and how it can range from high to low. She calls this "the ladder of citizen participation" and the basis of it is:

- Manipulation (1) and Therapy (2) consist of "educating" or "tricking" citizens into decisions which are absolute and where they haven´t been involved.
- Informing (3) and Participation (4) are the lowest of meaningful citizen participation. Citizens express their opinion on decisions without them having any real power in the process. The information they provide is handed one-way, without any real debate.
- Placation (5) involves citizens in as advisors or planners, but the final decision is not taken by them.
- Partnership (6) allows for negotiation between planners and citizens, and the decision is taken together.
- Delegation (7) sees citizens having most of the decision-making power.
- Citizen Power (8) in which citizens are the ones to plan and make policies.

There are grounds to suggest that the description and vulnerability assessments of the landscape characters could be performed in partnership with the inhabitants of the same areas. Through landscape literacy, this could even reach a level in which citizens themselves can perform this analysis, as exemplified by Spirn in the Mill Creek project, allowing for full citizen power and meaningful impact on planning decisions.

ILCA as a tool to bridge injustice and mitigate conflict

An important question to the expansion of wind power developments in Sweden is which tools can we develop to strengthen the position onshore wind power has in Sweden while maintaining landscape democracy and promoting landscape literacy, as defined and defended by the European Landscape Convention. Landscape Character Analysis, LCA, as well as Integrated Landscape Character Assessment, can be important, if not vital, tools to reconciling national and municipal interest on the landscape, hence strengthening dialogue, and facilitating a deeper implementation of the European Landscape Convention in strategic planning (*Koç & Yılmaz, 2020*).

Landscape Character Assessment is an analytical method whose main objective is not to address landscape quality or value, but rather it´s character. Landscape Character is defined as a consistent set of element patterns that makes each landscape unique (*Swanswick, 2002*). The analysis aims to describe three main systemic aspects regarding the landscape: form, referred to the physical description of features in the landscape, ecology, which applies to all natural phenomena and actors implicated in the functioning of the landscape, and finally the historical time depth dimension of the landscape, which encompasses people and the actions throughout time that have shaped the landscape and act upon it during the present (*Swanswick, 2002; STA, 2018*). The qualitative judgments pertaining LCA are involved once a decision based on the study needs to be addressed. It´s important to highlight that LCA´s flexibility scale-wise is a very important characteristic, as it generates base knowledge in a scale that can range from the local to the supranational (*Swanswick, 2002*). The aim of the Landscape Character Assessment, as evidenced by The Countryside Agency and Scottish Natural Heritage first drafting it, is to provide a knowledge base on the individual landscape characters present on an area for conservation and heritage management.

Integrated Landscape Character Assessment is an analytical tool developed by the Swedish Transport Administration and developed from the LCA method previously described with the aim to tailor it to infrastructure planning and future development in the Swedish territory. It is important to note that the method described as ILCA was used in Sweden before it was formalized in 2018. It consists of a set of descriptive analysis used to provide a more holistic picture of an area in an effort to to help plan long-term infrastructure decisions at a bigger scale. The main differences between Integrated Landscape Character Assessment and its predecessor, Landscape Character Assessment, are (*STA, 2018:11-12*):

- Focus on the composition of landscape characters at a regional scale to provide in-depth knowledge for better decision-making, versus singular landscape character focus in the LCA
- Integration of different fields of knowledge that encourage creativity in the decision-making, providing a holistic approach to landscape composition
- Conceptualization of the landscape as a shared arena for planning, versus an environmental or conservation issue
- Focus on an area and how the different landscape characters present in it coexist and make it unique, versus the LCA´s focus on individual landscape characters
- The landscape is described in terms of present and future functionality and current character and potential changes.
- Focus on the landscape´s potential, and future state

As demonstrated by the differences highlighted above, ILCA as a method is much better suited for wide-area analysis incorporating various landscape characters and how they interplay, while the LCA is much better suited for deep analysis of single landscape characters.
ILCA is usually ordered by client (e.g. municipalities), and usually include several disciplines which contribute to the process working on many more levels than just the one describing the physical conditions of the landscape, as such, it has the capacity to transcend physical planning, which the NI framework heavily attains too, and serve as the tool with which the actors in the landscape can solve land-use conflicts and compute synergies into their own goals and activities. An example of how this process and ELC can support inclusive regional planning, but also about how it is limited by the actors and challenges present in it, is explored by Karin Hammarlund (2010). In her piece, Hammarlund writes about inclusive landscape planning approaches in Sweden and Italy. Hammarlund chooses these two countries because of their strong local identity and regional independence, as well as their decentralized planning system. When it comes to Italy, Hammarlund remarks on how the system should be very well-suited to provide landscape democracy and deal with landscape conflicts, but the lack of trust in the authorities and governance by the citizens impact civic life negatively (*Banfield, 1958; Putnam et al., 1993; Andrews, 2005; Pellegrini, 2011*). Wind power developments do not only need to be scrutinized from a landscape impact point of view, but the presence of mafia related actors wishing to exploit the subvention system given to renewable energies has turned wind power into a very glaring example of corruption. Wind power development then becomes the proxy for larger institutional failures (*Wolsink, 2000; Bell et al., 2005; Devine-Wright, 2005*). An important limiting factor of ELC-based landscape analysis and debate is exposed by Italy´s experience: the ELC´s focus on local actors should not avert its attention from both the existing constellations of power and governance and the existence of local destabilizing actors. It should be argued that while the right to landscape is universal, a careful assessing should be done of the goals of all actors present in conversations to avoid those that would destabilize society.
For Sweden assessing the county of Dalarna, Hammarlund (2010) applied ILCA´s predecessor: Landscape Character Assessment or LCA to include the public in the regional planning process. A criticism is made of the Environmental Code ruling most of the planning, with the Planning and Building Act of 2008 having lost its power. The conundrum here is that the Planning and Building act proposed a more localized path to sustainability that incorporated social, economic, and environmental concerns, while the Environmental Code firmly acts on the landscape as seen from a scientific point of view. This is directly conflicting with the ELC´s main premise which was to open the concept of landscape to fields outside the scientific sphere. It is important to note that the critique done by Hammarlund (2010) predates the Planning and Building Act of 2010, which has had a more powerful impact on infrastructure decisions and their role on societal development (*Boverket, 2010*). Dalarna´s dealing with wind power developments near Lake Siljan is an example chosen to determine the value of inclusive landscape debate. Dalarna´s historical development and lack of agrarian proletariat, the distribution of landowners was equitable, allows for a much more democratic debate regarding landscape issues in the region. This also fomented a very strong regional identity, with their inhabitant's pride and link to their landscape still being very prominent today (*Sporrong, 2008).*
As such, LCA was used to establish the impact wind turbines would have on the area, with more than 12000 people participating in the efforts. Afterwards, municipal plans were made,

but when the projects started to take form old issues remerged, mainly due to developers pushing for more area for their projects and municipalities asking for subventions if they accepted more wind power development in their area. This essentially shows the difficulty of addressing global issues, such as climate change and energy landscapes, in the local arena. At the same time, it was widely acknowledged that the LCA as a tool was an important starting point in Sweden if a balance between the global agenda and the local agenda was ever to be achieved. The Italy case though showed a need for an arbitration of the stakeholders present in the debate.

Democracy in Sweden´s infrastructure planning

Sweden is no stranger to the gravity of climate change, and such the nation has formulated a set of ambitious environmental goals (*Regeringen, 2018*) and as a collective has pushed several actors to work, or at least try to work, together on the matter of achieving its renewable energy goals. While there is a collective will to achieve these goals, the reality is that actors with higher agency over the matter, such as the government or private individuals within the energy sector, might be in the need to co-opt others when in need to resolve matters. This cooperation, while highly valuable, is also very fragile due to the difference in both interests and opinions. Bente Johnsen Rygg´s (2012) suggest that this conflict of groups eventually translates to a land use conflict, which involves not only the actors but is also related to the type of land cover present in the area where wind power is planned to be laid out. Creating new energy landscapes while avoiding the perpetuation of unequal energy peripheries, as described by Pasqualetti, is one of the main challenges. The renewable energy revolution has the chance to not only solve the energy crisis, but also to use changes in the landscape arena, as described by the European Landscape Convention, to tackle inequality. Sweden has mostly relied on a top-down approach, with the national government setting goals and policies that smaller actors, such as municipalities, try to achieve (*Hammarlund, 2010*). These goals become policy through the National Interest framework. As explored by Svensson (2020a, 2022), the NI framework is just not capable of contributing, by itself, to land-use conflicts, expensive and difficult negotiations, and a more inclusive decision-making process. This creates a risk that the brunt of the consequences of enforcing national wind power policies might be borne by the smaller communities (*Breukers and Wolsink, 2007*) or the wildlife (*Solli, 2010*). A starting point to tackle these inequalities is to identify present land use conflicts and predict where they might arise, based on the expansion proposed by the Swedish Wind Energy Association in their 2040 Roadmap. The lack of available physical land to accommodate, as well as the overwhelmingly increasing different aims for the landscape, has given birth to the aim of engineering multi-use, constantly remade landscapes in which coexistence is key. If these aims are to be perceived as legitimate by society, there is a degree of transparency and legibility that needs to be achieved for all actors to be on the same page. Synergies between different National Interests should be explored to engineer solutions to the lack of available physical area (*Svensson, 2020a & 2022),* as well as to solve conflicts. Pasqualetti (2000) points out that land use conflicts can be better solved by improving dialogue between the different actors in a search for a solution that suits both parties. This dialogue is of great importance in the case of Sweden, as it opens the door to a less conflictive energy transition and the corresponding landscape changes on already impacted landscapes. Landscape Character Assessments, and the recently developed Integrated Landscape Character Assessment, are valuable tools that not only meaningfully include the citizenry, but also enable cross-level dialogue between the different actors. Instead of focusing on a top-down or bottom-up approach, LCA and ILCA focus, through the concept of regional planning, on a two-way dialogue that enables participation and co-governance from the early steps of the planning process (*Hammarlund, 2010; STA, 2018).* Analysing the effect that current landscape character assessments have had, and what possibilities they have opened is imperative if the current planning processes are to be improved. It is through this improved mindset to inclusive infrastructure planning and dialogue that Sweden can achieve its energy goals from an economic, environmental, and social point of view.

3. Method and Material

3.1. *Study Area*

The study area includes all of Southern Sweden, from the county Skåne to the county of Uppsala, thereby covering two vegetation zones in Sweden: the boreonemoral and nemoral zones (Figure 1). The analysis of the counties in boreonemoral and nemoral Sweden serves to contextualize a more focused analysis of the counties of Falkenberg and Uppvidinge, as described in the aim.

The area faces regularly variable weather patterns due to the interaction between different meteorological phenomena. Low-pressure winds warmed by the Atlantic Current, coming from the southwest, generate mild but changing weather, and they meet with continental high-pressure systems from the east. These generate sunny weather as well as cold winter and warm summer weather. These phenomena cause winters in the boreonemoral and nemoral areas of Sweden that are a lot more variable than in the northern part of the country, with an average of 75 days of snow cover and January temperatures that usually vary between -5 and 0 degrees Celsius (*Rydin et al., 1999*). It is important to highlight that this climate data is due to change. Climate change has led to a rise in temperature, change in precipitation levels and made extreme weather events more frequent (*IPCC, 2022*). The geography in these areas is flat to gently rolling terrain. Lowest point, at 0m over sea level, is Hammarsjön in the county of Blekinge. The highest point is Eskilsberget in the county of Örebro, rising 445 meters over sea level (*Swedish Land Survey, accessed last 19/08/2022*).

The nemoral zone is mainly dominated by deciduous tree species, with *Fagus sylvatica* being the dominant species in mesic soils and other broad-leaved species, such as *Quercus spp., Betula spp, Populus spp.* and *Alnus spp.* present on drier soils (*Diekmann Martin, 1994; Rydin et al. 1999*). The previously rare Norway spruce (*Picea abies*) has become much more common due to planting, mainly for production purposes, sparking a biodiversity issue that still must be investigated in further detail (*Lindbladh et.al, 2014*).

In contrast, the boreonemoral zone is mainly dominated by the conifers *Picea abies and Pinus sylvestris*, with the previously mentioned broadleaves appearing in smaller quantities where climate and soil permits. The northern limit of the boreonemoral zone is described as the geographical limit for *Quercus robur*, but the once clearly delimited southern border, described as the geographical limit for *Picea abies*, is now unclear due to the propagation of the species in the nemoral zone (*Diekmann Martin, 1994; Rydin et al. 1999*).

The main land cover for the nemoral area of Sweden is arable land, with approximately 577 758 square kilometres of arable land present in the area (*Statistics Sweden, 2019; Swedish EPA, 2022*). In contrast, the main land cover in boreonemoral Sweden is forest, with 3 881 103 ,54 square kilometres of conifer forests and 1 806 309 ,56 of deciduous and hardwood forests (*Statistics Sweden, 2019; Swedish EPA, 2022*).

The main land use for the nemoral area of Sweden is agriculture, with this use representing 45,5% in Skåne, 23% in Halland, and 14% in Blekinge (*Statistics Sweden, 2019; Swedish EPA, 2022*). In contrast, the main land use in boreonemoral Sweden is forestry. In Kronoberg, for example, productive forest areas represent 95% of all forested areas, with the total area being 70% of the total area for the county (*Statistics Sweden, 2019; Swedish EPA, 2022*).
When it comes to owners, 49,72% of landowners are private persons, 23,59% are companies, 4,98% is owned by the state and 33% is water areas (*Swedish EPA, 2022*).

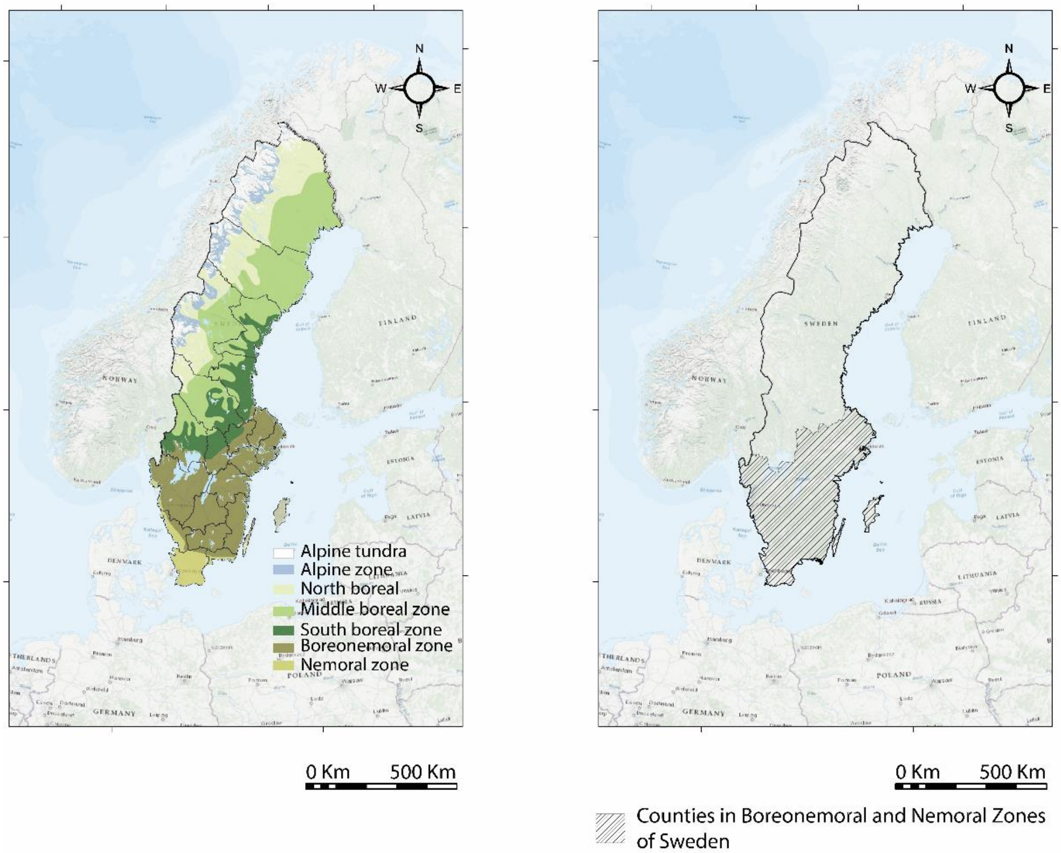

***Figure 1**:**Left)** Vegetation Zones and their distribution in the Swedish territory. **Right)** Counties included in the boreonemoral and nemoral vegetation zones in Sweden.*

3.2. *Geographical and Landscape Data*

The most important sets of data used for this analysis are the National Land Cover Data, National Landowner Data, National Interest Area Data, the ILCA of Kronoberg county and the Landscape Character Analysis done for the implementation of Wind Power in the county of Halland. The first two are provided by the Swedish EPA. The National Interest Data is obtained from the Swedish EPA, the Swedish Armed Forces and the Swedish Geological Survey. The ILCA and LCA are provided by the county board of Kronoberg and Halland, respectively. A further table is provided to indicate who the providers of each set are and in which cases information might have been digitized into ArcMap (Table 1).

Table 1: *Geodata used in the analysis. All data have the coordinate reference system SWEREF99TM*

Description	Source, Last Date Accesed	Format	Extent	Resolution
Ground Cover Data	Swedish EPA (2022), 19/08/2022	Raster.tif	Sweden	10x10
Owner Data	Swedish EPA (2022), 19/08/2022	Raster.tif	Sweden	10x10
National Interest Areas Data	Swedish EPA (2022), 19/08/2022	Shapefile.shp	Sweden	-
National Topography Data	Swedish Land Survey (2022), 19/08/2022	Raster.tif	Sweden	50x50
National Wind Speed Data	Swedish Land Survey (2022), 19/08/2022	Shapefile.shp	Sweden	-
Wind Power Sites	County Administration Board (CAB)	Shapefile.shp	Sweden	-
County Borders	Swedish Land Survey (2022), 19/08/2022	Shapefile.shp	Sweden	-
Electric Grid Data	Swedish EPA (2022), 19/08/2022	Shapefile.shp	Sweden	-
LCA for Wind Power implementation in Halland	County Administration Board (CAB)	Textfile.pdf	Halland	-
ILCA for Kronoberg	County Administration Board (CAB)	Textfile.pdf	Kronoberg	-

The National Land Cover data is not modified for the analysis, but for table visualization purposes and ease of reading a grouping of Land Cover types is done. The original Land Cover Raster is provided by the Swedish EPA. The grouping is based on major land cover types, which can be associated to land use (Table 2).

Table 2*: Table of Land Cover Types used. The data was adapted from Ground Cover Data provided by the Swedish EPA.*

Final Land Cover Types
Open Wetland
Arable Land
Open Land
Artificial Surfaces
Inland Water
Marine Water
Conifer Forest
Deciduous and Mixed Forest
Temporarily non-forest

The National Landowner data was provided by the Swedish EPA and simplified to the following categories for the purpose of evaluating actor conflicts (Table 3). The thesis focuses on 3 simplified actor types: private landowners, who own the land for exploitation and or recreation, the State, owning land for its nationally important recreation or exploitation, and companies that own land for exploitation.

Table 3*: Table Owner types used. The data was adapted from Landowner data provided by the Swedish EPA.*

ID	OWNER
1	State
2	Company
3	Private
100	Water

As for the National Interest Area dataset, 9 different definitions are used, with the one corresponding to Valuable Minerals, or areas of significant mining importance, being digitized due to the dataset not being available to the public (Table 4). The NI areas are chosen to explore possibilities for synergy and lack of it. NI areas with importance regarding Cultural Heritage, Outdoor Recreation and Recreation should be protected, according to point 6 of the Environmental Charter Chapter 3, from disturbances that might harm these characters. This focus leaves opportunities for the implementation of Wind Power if these characters and their connection to citizens ‘use and perception are not affected by it (*Boverket, 1998: 4,1*. Nature Conservation, Protected Waterway and Natura 2000 Habitat areas also permit coexistence with Wind Power development if biodiversity and ecological systems are not negatively impacted by the sites (*Boverket, 1998:4,1*). The Swedish Armed Forces NI area is important in context of this thesis since it will always take precedence over any other overlapping NI area, suggesting more difficult coexistence with Wind Power development (*Boverket, 1998:3, 10*). Valuable Mineral NI areas focus on exploitation of the land, provided it follows the Swedish EPA´s guidelines and does not impact the areas negatively (*Boverket, 1998: 4,1),* with the exploitation character allowing for synergies with Wind Power development. Finally, in Wind Power NI areas it is wind power development which takes precedence over any other overlapping interest, indicating the highest degree of coexistence.

Table 4*: Table of National Interest Areas data used. The data was adapted from National Interest Area data provided by the Swedish EPA.*

National Interest
Swedish Armed Forces
Cultural Heritage
Outdoor Recreation
Recreation
Nature Conservation
Protected Waterways
Natura 2000 Habitats
Valuable Minerals
Wind Power

Finally, the ILCA for Kronoberg (*CAB, 2018*) and LCA for Wind Power development in Halland county are (*CAB, 2011*) documents written in Swedish. By using ArcGIS, I seek to either validate or disprove the impact LCA and ILCA have had on their respective municipalities. It is important to note that there is no control group for this comparison, instead the focus is laid on two municipalities with very different success rates of wind power implementation. This quantitative analysis performed through ArcGIS is used to give context to analysis, results and conclusions regarding the state of Wind Power development, ILCA and LCA as tools and Landscape Democracy in the municipalities of Uppvidinge and Falkenberg.

3.3. *Approach*

Extent of Spatial Analysis

The analysis is performed on three different geographical scales: the regional scale, the county scale, and the municipality scale. For the first research question, which assesses the links between wind power, land cover, landowner and present and future conflicts, the research area is composed of the 14 counties which are in the boreonemoral and nemoral zones of Sweden. These 14 counties representing the regional scale are: Blekinge, Gotland, Halland, Jönköping, Kalmar, Kronoberg, Örebro, Östergötland, Skåne, Södermanland, Stockholm, Uppsala, Västmanland and Västra Götaland.

For the second question, assessing the link between NI areas and wind power, the analysis is centred on four counties in nemoral and boreonemoral Sweden: Skåne, Halland, Jönköping and Kronoberg. The analysis is conducted on a county level.

The remaining two questions require a much more in-depth. The analysis focuses on two municipalities with differing public opinion on Wind Power development: these municipalities are Uppvidinge and Falkenberg.

The national wind strategy (*Swedish Energy Authority, 2021*) has outlined proposals for the required land area dedicated to wind power development if the branch is to become a keystone of Sweden´s sustainability goals up to 2040.

To calculate the area impacted in future scenarios, a proxy needs to be created. This proxy is defined to be a coefficient that multiplies the current allotted area to wind power sites and can signify an increase in current area (>1), a decrease on current area (<1) or a lack of change in current allotted area (=1). To calculate this coefficient, I use the tables provided by the Swedish Wind Energy agency detailing current allotted areas, direct, or site area, and indirect, or planning area (*Swedish Energy Agency, 2021(2):22)* in a 100 twH scenario. The same document provides an estimate of the number and type of turbines needed for certain demand scenarios, such as 2,5 tWh, 5 tWh, etc. For this, I chose the 6 mW wind turbines and calculated the number of turbines needed per county and the total areas they would occupy in the 100 tWh scenario. By dividing the results of allotted area in the 100 tWh scenario by the present areas I was able to determine the corresponding coefficients. These results were interpolated to calculate the coefficients for the 80 twH and 120 tWh scenarios.

The regional scale´s purpose is to shed a light on the current demands wind power development has asked both in terms of actors and land use. The county scale relates to the demand of area national policies have, specifically under the National Interest framework. These two scales serve to provide a context to the more in-depth analysis of Falkenberg and Uppvidinge, performed at the county level. The focus on three different scales that exchange information with each other is crucial to provide an answer to the main aim.

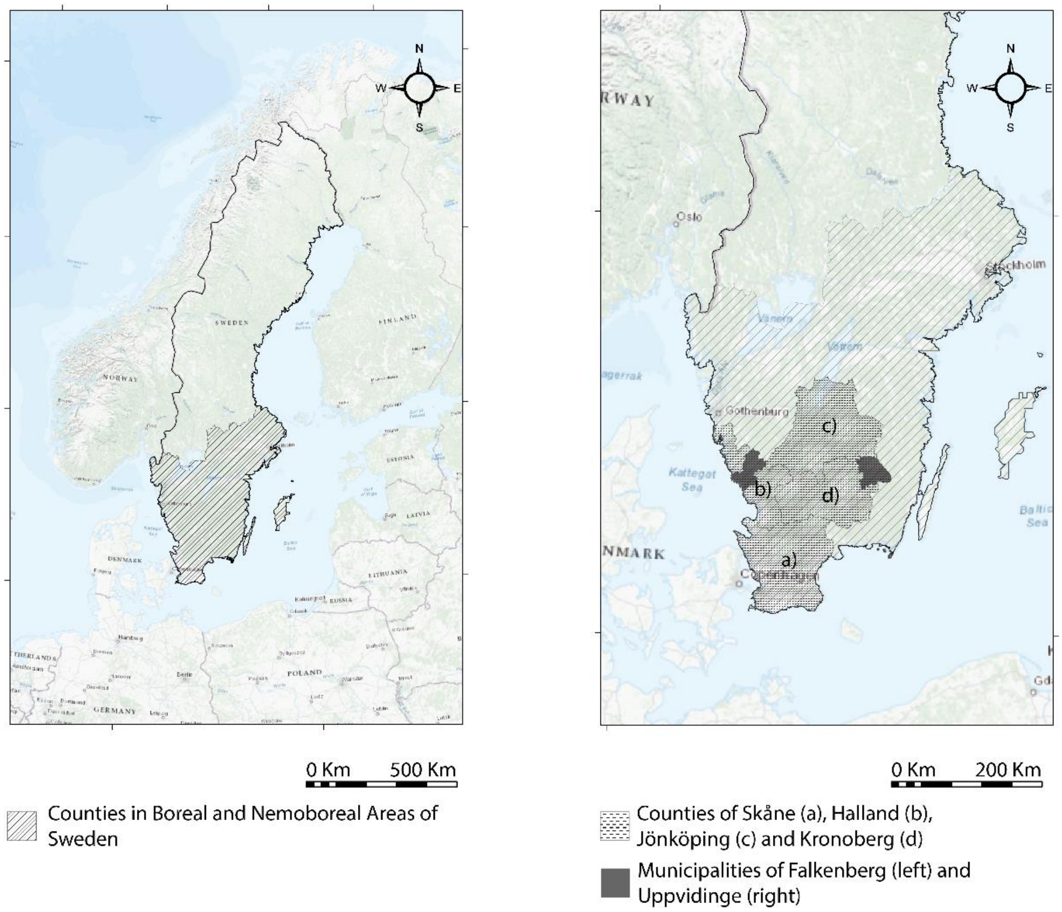

Figure 2:Left) *Extent of analysis for research question 1.* ***Right****) Extent of analysis for research question 2(in light grey texture: a,b,c and d) and research questions 3 and 4 (dark grey)*

Spatial link between wind power sites and land use or actor conflicts (Q1)

To draw a link between present and future wind power sites and land use or actor conflicts I needed first to estimate the impact of wind power sites on land cover and to establish who the owners of these areas are. I selected all built and approved wind power turbines within the counties in nemoral and boreonemoral Sweden. I coupled these spatial links to the national wind strategy by estimating the direct (site area) and indirect (planning area) impact of all wind power sites. The direct impact consists of the area that is covered by the turbines, with a 300 m buffer since the rotor blades prevent other use within this area. These can be defined as the site areas. The indirect impact is estimated to be three times the direct impact, with the purpose to give enough space for the planning of other infrastructure in connection to the wind power implementation (*Swedish Energy Authority, 2021*). To properly analyse direct impact, I generated a convex polygon enveloping the buffer area of the turbines present in any given site. Should there not be enough turbines present on a site (>2), the direct impact convex polygon coincided with the 300m buffer. Since the position, as a point in space, is used to represent the wind turbines, the 300-meter buffer is round. This would be different if the area occupied by the wind turbines on space would be used.

I merged and dissolved all polygons to prevent overlapping data and tabulated the intersection between these direct impact areas and the land cover and landowner to obtain the impacted land cover by county.

To estimate the indirect impact, I used the location and area of the direct impact. While the shape of the direct impact area is known to the turbines' placement, the shape of the indirect impact is unknown. I took the decision to use the centroid for each direct impact area and created a circular polygon, three times the size. This leads to a more consistent approach to each wind power site. I dissolved all polygons and tabulated again an intersection to estimate the indirect impact per county.

On top of this present time impact, I created two more scenarios: one for an electrification of 100 tWh and another one for 120 tWh. This is based on the report done by Svenska Kraftnät (2019) which presents electrification scenarios with the out phasing of nuclear power. The same report establishes the increase of wind turbines needed, per county, from present time to achieve these outputs. I use this increase as a coefficient to estimate an increase of direct and indirect impact in the future. These impacts are reflected as increases in land occupancy per land cover type. These increases in land occupancy, compared with the land cover type totals per county, are also analysed to establish land uses that are more at risk per county and on a regional level. These proportions yielded very low changes (<0,1%) and as such, were moved to the Appendixes.

Spatial link between wind power sites and National Interest areas in Skåne, Halland, Kronoberg and Jönköping (Q2)

As I explored earlier and based on studies by Solbär et al. (2019), Svensson et al. (2020a,2022) and Zhang et al (2022), one of the main aspects towards achieving multifunctionality in the Swedish landscape is the National Interest framework and how different NI areas can coexist with each other.

It is then necessary to estimate the spatial relationship between present Wind Power sites and surrounding NI areas. Taking all the presently built and approved wind power projects, I create 3 scientific buffers from every turbine. These 3 scientific buffers are 4, 8 and 12 km, and they are based on a visual impact and negative response research conducted by Bishop and Miller (2007). These buffers assess visual impact, since it is an important issue in the pursuit of coexistence between wind power and other uses (*Bishop & Miller, 2007; Oles & Hammarlund, 2011; Bente Johnsen Rygg, 2016*). They are also more conservative than the buffers proposed by Skarin et al. (2016,2018) when researching wind power site impact on local fauna.

I dissolve all the overlapping buffer polygons in each of the respective response distances and then tabulate an intersection between the 9 selected National Interests and the buffers per county. The result is compared with the total physical area present by county. The impact is measured in this way based on the research done on multifunctionality and coexistence between National Interest areas done by Svensson (2020a,2022).

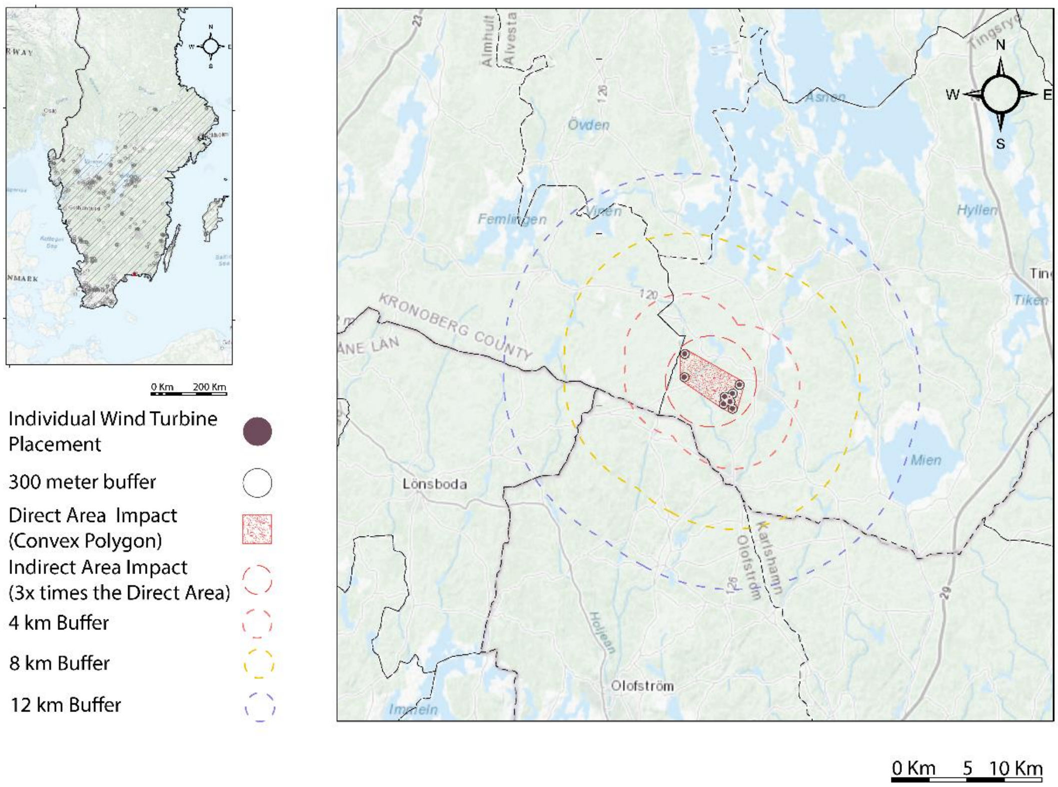

Figure 3: *Illustration of layout for direct and indirect area estimates and buffers.* ***Left)*** *Location of Skåramåla wind power site in Tingsryd County.* ***Right)*** *The spatial difference between the 4, 8 and 12 km buffers, which are based on studies of visual response to wind power sites, compared to the direct and indirect impact based on the demanded area for a wind power site in the national wind strategy. The direct and indirect impact is estimated with both a convex (i.e. more generous) area polygon. The indirect area impact is a circular buffer as it uses the centroid of the convex polygon versus the convex polygon itself.*

Spatial link between wind power sites and National Interest areas in the municipalities of Falkenberg and Uppvidinge (Q3)

The more in-depth analysis aims to use the same scientific buffers used in RQ#2 to determine the impact wind power sites have on the National Interest areas present in the municipalities of Falkenberg and Uppvidinge. Both municipalities have had a very different experience regarding Wind Power, an element confirmed by the fact that Falkenberg has built 100% of the wind power sites proposed and approved (84 from 84, own analysis), while in Uppvidinge this figure is only 4% (5 from 120 sites). The results of impacted area are once again compared to the total physical area the municipalities have.

Impact of ILCA and other landscape character assessments in wind power development and landscape democracy for the municipalities of Falkenberg and Uppvidinge(Q4)

Finally, the document drafted to assess the impact of Wind Power development in Halland county (2011) and the ILCA drafted for the county of Kronoberg (2018) are contrasted with the current positioning and visual impact of built and approved wind power sites in Falkenberg and Uppvidinge.
The main points to extract from the two documents are:

- Geographic, economic and social characteristics of the areas including the municipalities of Falkenberg and Uppvidinge. When not present the information will be complemented with the documents available through Statistics Sweden.

- Main landscape characteristics of the areas including the municipalities previously mentioned.

- Main general vulnerabilities of the landscape regions and those related to the implementation of wind power.

The information presented in these documents, pertaining vulnerable areas in the landscape, is contrasted with the current positioning and impact of wind power turbines. The impact of the wind turbine sites is assessed by performing a visibility analysis a illustrating the impact these wind power sites are having in the areas where placed. I use the height value each wind turbine point has and run a visibility analysis using the same distance limitations as in the scientific buffers. The overlapping raster is transformed into a polygon and then dissolved. To perform the visibility analysis, I chose a DTM (Digital Terrain Model) which contains the height value of the terrain, without accounting for trees, buildings and other features. What this implies, in contrast to, for example, using a Digital Surface Model which accounts for trees, buildings and other features, is that the results of the visibility analysis will show the upper bound of the visual impact by disregarding features that might block visibility on the wind turbines. This is chosen as the positioning of the wind turbines and their corresponding visibility impact, especially in Uppvidinge, are not perceived to be heavily influenced by other features in the terrain.   The resulting maps illustrate the visual impact, as established by Bishop and Miller (2017) on the municipalities. An intersection is also tabulated to determine the land area of the municipalities that falls in each one of the visibility ranges (4km, 8km, 12km). I utilize a Delaunay Triangulation of all wind power turbines to analyse the distribution and grouping of wind power sites of the landscape. A denser triangulation indicates a clear grouping of turbines, with bigger triangles indicating a lack of grouping. These groups are also graphically analysed to determine whether they present a clear directionality, i.e., a group of turbines in a straight vertical line would indicate a North to South directionality.

A flowchart detailing the analysis done in ArcGIS is provided in the Appendix section (*Appendix 1).*

Literature Study

The purpose of performing a literature study is two-fold: first and foremost, the objective of the literature study is to provide a picture of the present status of wind power development in Sweden, as well as future planning and probable changes in its implementation. The same is done to create a knowledge base on the status of participatory planning and landscape democracy in the context of infrastructure building in Sweden. The literature is selected and reviewed to build a background that provides context to the analysis done through ArcGIS and the further study of LCA and ILCA in the two selected municipalities in Sweden. To provide an unbiased background, I make no distinction on whether the literature at hand is in favour or against wind power development in Sweden, but I do make a point on restraining the literature review to scientific articles providing peer-reviewed and documented analysis of the topic at hand. In this way I avoid literature that might not be fact-checked or might otherwise mis-construct information to support the author´s opinion.
The review categories used fall under the keywords: “Wind Power Sweden” AND/OR “Wind Power Scandinavia” AND/OR “Energy Landscapes” AND/OR “Infrastructure Planning Sweden” AND/OR “Landscape Democracy” AND/OR “Participatory Planning” AND/OR “Energy Production Sweden” AND/OR “Land Use Sweden” AND/OR “Regional Planning Sweden” AND/OR “Landscape Character Analysis” AND/OR “Integrated Landscape Character Assessment” AND/OR “European Landscape Convention”.
Secondly, a literature study of the LCA of Halland county (2011) and the ILCA of Kronoberg (2018) is done. These documents have been accessed through the corresponding county´s policy database. This literature study is paramount to the assessment on whether these documents have been impactful in the successful implementation of wind power in Falkenberg and Uppvidinge. The texts are contrasted with the results of the analysis performed with ArcGIS, specifically the visibility analysis, and the data provided on successful wind power implementation per municipality. Of note is the careful review on the methods use to draft this documents, as participatory planning is a central point to this thesis.
This results in 106 articles, of which two are the landscape character assessments.

4. Results

The Swedish Energy Agency, together with the Swedish EPA. has laid out a plan pertaining to the increase in Wind Power development in the future to meet energy demands (*Swedish Energy Agency, 2021)*. Of main interest to the results of this thesis is the share of onshore wind energy production each county is projected to have in the future

The results are varied (Table 5) and highlight the disparity between many counties, with counties such as Kronoberg (0,91/0,98, signalling a demand for 98-99% of the current allotted areas) or Jönköping (0,93/0,94) already fulfilling their would-be quota in the 120 twH scenario. In contrast, counties like Uppsala (32,5/32,5) or Södermanland (11,6/11,6) would need a very steep increase (11400% and 32400%) of their current allotted areas for wind development to satisfy the demands presented by the Swedish Energy Association. The lowest demand of land occupancy in all scenarios is in the county of Kronoberg, with a range of 61% to 98% of the current occupancy, while the highest demand is for the county of Uppsala, with a range of 21570% to 32400% of the current land allotment.

Table 5: *Ratio of areal (direct/indirect) occupancy of wind power sites under different future scenarios of expansion in relation to current occupied areas per county in Southern Sweden, status 01 January 2022. Coefficients indicate an acreage increase (>1), decrease (<1) or no change (1).*

	Coefficient applied to current occupied area (Direct/Indirect) by scenario		
Counties	80 twH	100 twH	120 twH
Blekinge	1,6 / 1,6	2 / 2	2,4 / 2,4
Gotland	1,5 / 1,5	1,9 / 1,9	2,3 / 2,3
Halland	0,8 / 0,9	1 / 1	1,25 / 1,3
Jönköping	0,7 / 0,75	0,8 / 0,85	0,93 / 0,94
Kalmar	0,9 / 0,9	1,2 / 1,2	1,4 / 1,4
Kronoberg	0,6 / 0,6	0,8 / 0,8	0,9 / 1
Örebro	2,6 / 2,7	3,2 / 3,4	3,9 / 4
Östergötland	2 / 2	2,6 / 2,6	3,1 / 3
Skäne	1 / 1	1,2 / 1,2	1,5 / 1,5
Södermanland	7,7 / 7,7	9,7 / 9,7	11,6 / 11,6
Stockholm	7,5 / 7,5	9,4 / 9,4	11,3 / 11,3
Uppsala	21,7 / 21,7	27 / 27	32,5 /32,5
Västmanland	4 / 4,3	5 / 5,4	6 / 6,5
Västra Götland	1,3 / 1,3	1,7 / 1,7	2 / 2

Spatial link between wind power sites and land use or actor conflicts (Q1)

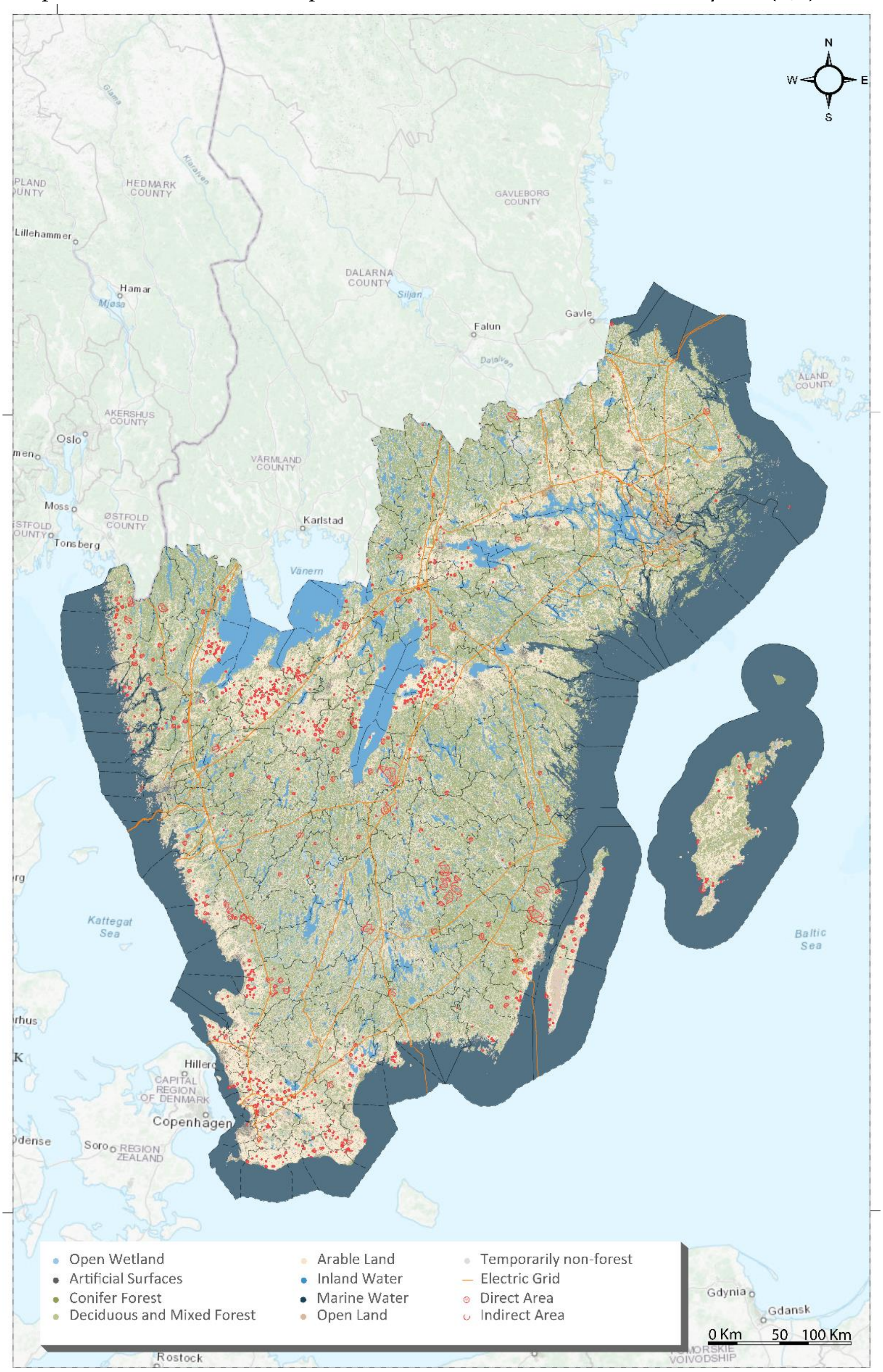

***Figure 4**: Illustration of the location of current and approved wind power sites and respective Land Cover types in Southern Sweden.*

Land Cover Impact

To put into context the results on the increase expected in land cover impact in both direct and indirect areas associated to wind power sites, it is important to contrast the expected development to the main land covers in nemoral and boreonemoral Sweden. The most common land cover type in nemoral Sweden is Arable land (17,6%), followed by Deciduous and Mixed Forests (12,6%) and Conifer Forests (11%). Built-up areas or Artificial Surfaces constitute only (3,4%). In contrast, the most common land cover type in boreonemoral Sweden important to this thesis ‘study is Conifer Forest (24,4%), followed by Deciduous and Mixed Forests (11,3%) and Arable Land (9,9%). Built-up areas or Artificial Surfaces constitute only (2,7%) (Table 6).

Table 6*: Total spatial coverage of Land Cover types in km^2 (percentage of total) in Nemoral and Boreonemoral zones of Sweden.*

Land Cover	Area in Nemoral Sweden (km^2) (Percentage of total)	Area in Boreonemoral Sweden (km^2) (Percentage of total)
Open Wetland	50 014 (1,5%)	351 869 (2,2%)
Arable Land	577 758 (17,6%)	1 571 832 (9,9%)
Open Land	243 418 (7,4%)	972 533 (6,1%)
Artificial Surfaces	111 684 (3,4%)	434 646 (2,7%)
Inland Water	70 774 (2,1%)	1 308 432 (8,2%)
Marine Water	1 267 721(38,7%)	4 338 210 (27,3%)
Conifer Forest	361 596(11%)	3 881 103 (24,4%)
Deciduous and Mixed Forest	415 222 (12,7%)	1 806 309 (11,4%)
Temporarily non-forest	181 044 (5,5%)	1 221 696 (7,7%)
Total	3 279 235 (100%)	15 886 635 (100%)

The highest land cover impact increase in the nemoral region occurs in Arable Land. The projection is an increase from 98 km^2 to 110 km^2 (80 TWh scenario), 122 km^2 (100 TWh) and to 147 km^2 (120 TWh) in the direct area and an increase to 324 km^2 , 366 km^2 and 432 km^2 in the indirect area totals (Figure 5). This accounts for a 12% increment in the 80 TWh scenario, 24% in the 100 TWh scenario, and 50% in the 120 TWh scenario. Other highly impacted land covers are the Conifer Forest and Deciduous and Mixed Forest land cover types, with increases in the 120 TWh scenario of 15 km^2 and 9 km^2 in direct area impact and 40 km^2 and 33 km^2 in indirect area impact, respectively. These account for a 40% increment on current impacted area totals (Figure 5). Overall, most land cover types are projected to have increments in impacted land cover of between 10% in the most conservative scenario (80TWh) and 50% in the most progressive scenario (120 TWh) (Appendix 2).

The highest land cover impact increase in the boreonemoral region occurs in the Conifer Forest cover type. The projection is an increase from 342 km^2 to 499 km^2 (80 TWh scenario), 555 km^2 (120 TWh scenario) and to 666 km^2 (120 TWh) in the direct area and an increase to 1383 km^2 , 1537 km^2 and 1845 km^2 in the indirect area. This accounts for a 45% increment in the 80

TWh scenario to a 94% increment in the 120 TWh scenario. Other highly impacted land covers are the Deciduous and Mixed Forest and Arable land cover types, with increases in the 120 TWh scenario of 105 km^2 and 262 km^2 in direct area impact and 359 km^2 and 818 km^2 in indirect area impact. These three land covers account for a 124% increment on current impacted area totals for Deciduous and Mixed Forest land cover and 145% increment for the Arable Land Cover type (Figure 6). In comparison to the nemoral area, most land cover types are projected to have higher increments in impacted land, i.e. 40% in the most conservative scenario (80TWh) and 185% in the most ambitious scenario (120 TWh). Marine water shows an increment of up to 523% and Artificial Areas show a change up to 271% (Appendix 3).

Overall, mean increases in land cover impact when compared to their availability in both nemoral and boreonemoral Sweden are small (<0,1%), but still provide an insight into the most impacted land cover types for all scenarios (Appendix 4).

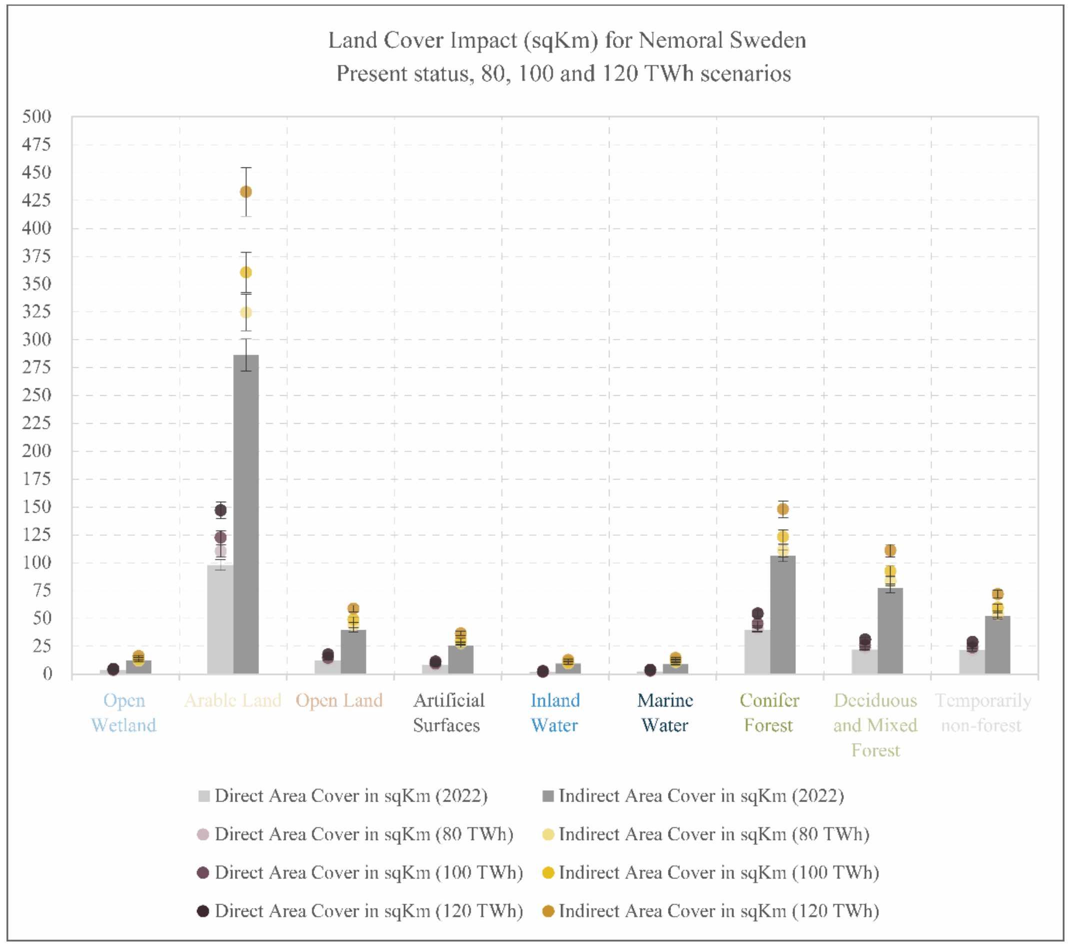

Figure 5*:Spatial Coverage of Land Cover types within wind power sites (direct area) and planning areas (indirect area) in the Nemoral zone of Sweden. The Spatial Coverage accounts for three different scenarios: present status (01/012022), 80 TWh, 100 TWh and 120 TWh. The error bars represent a 5% error margin, accounting for a 95% confidence interval for the plot.*

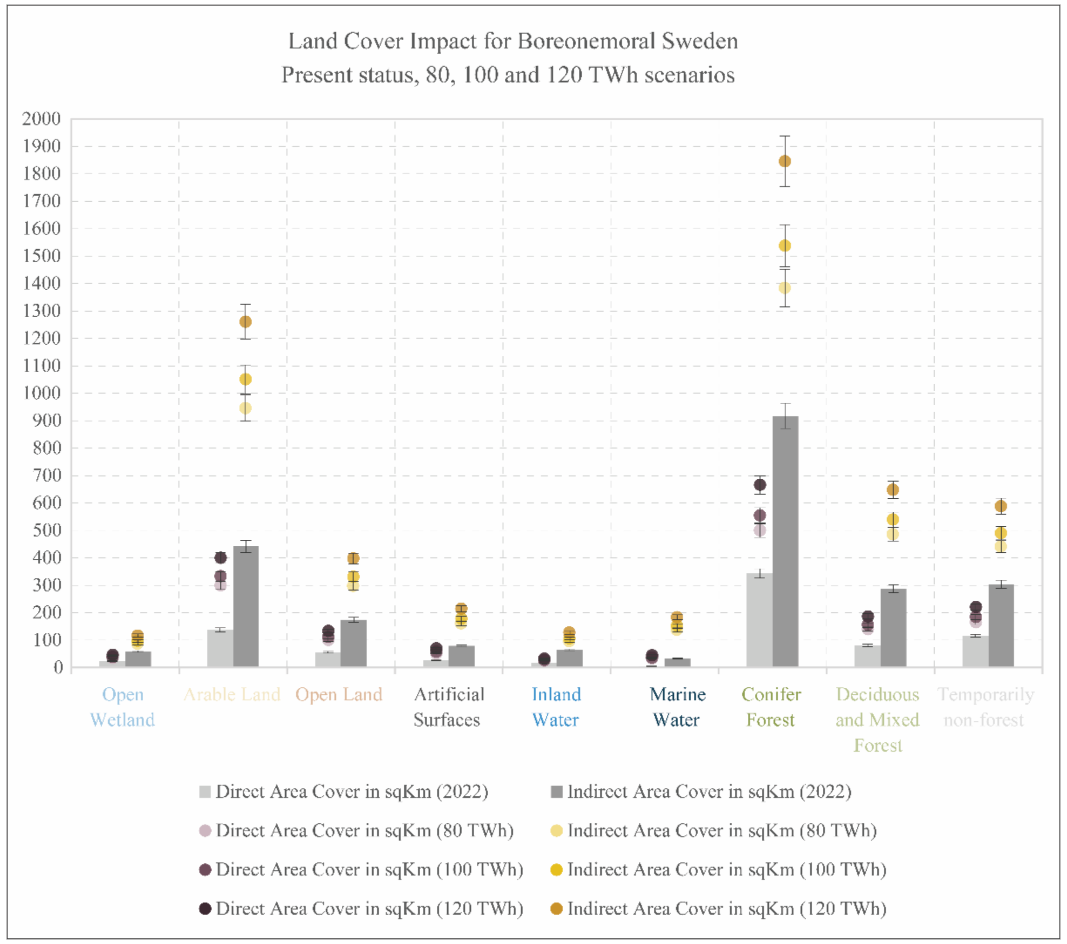

Figure 6*: Spatial Coverage of Land Cover types within wind power sites (direct area) and planning areas (indirect area) in the Boreonemoral zone of Sweden. The Spatial Coverage accounts for three different scenarios: present status (01/012022), 80 TWh, 100 TWh and 120 TWh. The error bars represent a 5% error margin, accounting for a 95% confidence interval for the plot.*

Landowner Impact

To put the results into context on the increase expected in landowner impact in both direct and indirect areas associated to wind power sites, it is important to determine who the main landowners are and their importance in nemoral and boreonemoral Sweden.

The main landowners in nemoral Sweden are private persons (84,7%) with companies and the state having almost similar shares at 8% and 7,3% respectively. Likewise, in the boreonemoral areas of Sweden the most common landowners are private persons (73%) with companies having a much larger share of ownership when compared to the state, at 19,5% to 7,5% respectively (Table 7).

Table 7*: Total spatial coverage of Landowner types in km^2 (percentage of total) in Nemoral and Boreonemoral zones of Sweden.*

Owner in Nemoral Sweden	Area in Nemoral Sweden in km^2 (Percentage)	Area in Boreonemoral Sweden in km^2 (Percentage)
State	143126(7,3%)	794413 (7,5%)
Company	157221 (8%)	2051659 (19,5%)
Private	1662415(84,7%)	7698346 (73%)
	1962762 (100%)	10544418 (100%)

The results show primarily an increase in direct area and indirect impact for private landowners particularly in nemoral Sweden (Figure 7). Increments are 7,5%, 19,3% and 43,5%. In the case of indirect area impact, the increments are 9,4%, 21,5% and 46%. Moreover, the data supports a higher occurrence of Private landowners in indirect areas compared to the State and companies. The difference nears +30% between the increments from direct to indirect areas, i.e., in the 120 TWh, the increment between private owned land in direct and indirect area is 199% (267 km^2 versus 800 km^2) while the same increment for company owned land is 164% (17 km^2 versus 45 km^2) (Appendix 5).

The trend observed in nemoral areas of Sweden repeats itself in boreonemoral areas of Sweden, with the main increase in the direct area impact being highest for private landowners. This is shown by increments of 63%, 81% and 118%. Indirect area increments are 66%, 84% and 121% (Figure 8). The trend then continues, with private person sharing the brunt of the indirect area impact increase, but in contrast to the nemoral area, the occurrence of private landowners is in line with the occurrence of the other owners in indirect areas (Appendix 6).

Mean increases in landowner impact when compared to total area in both nemoral and boreonemoral Sweden are very small, but still provide an insight into the most landowners for all scenarios (Appendix 7).

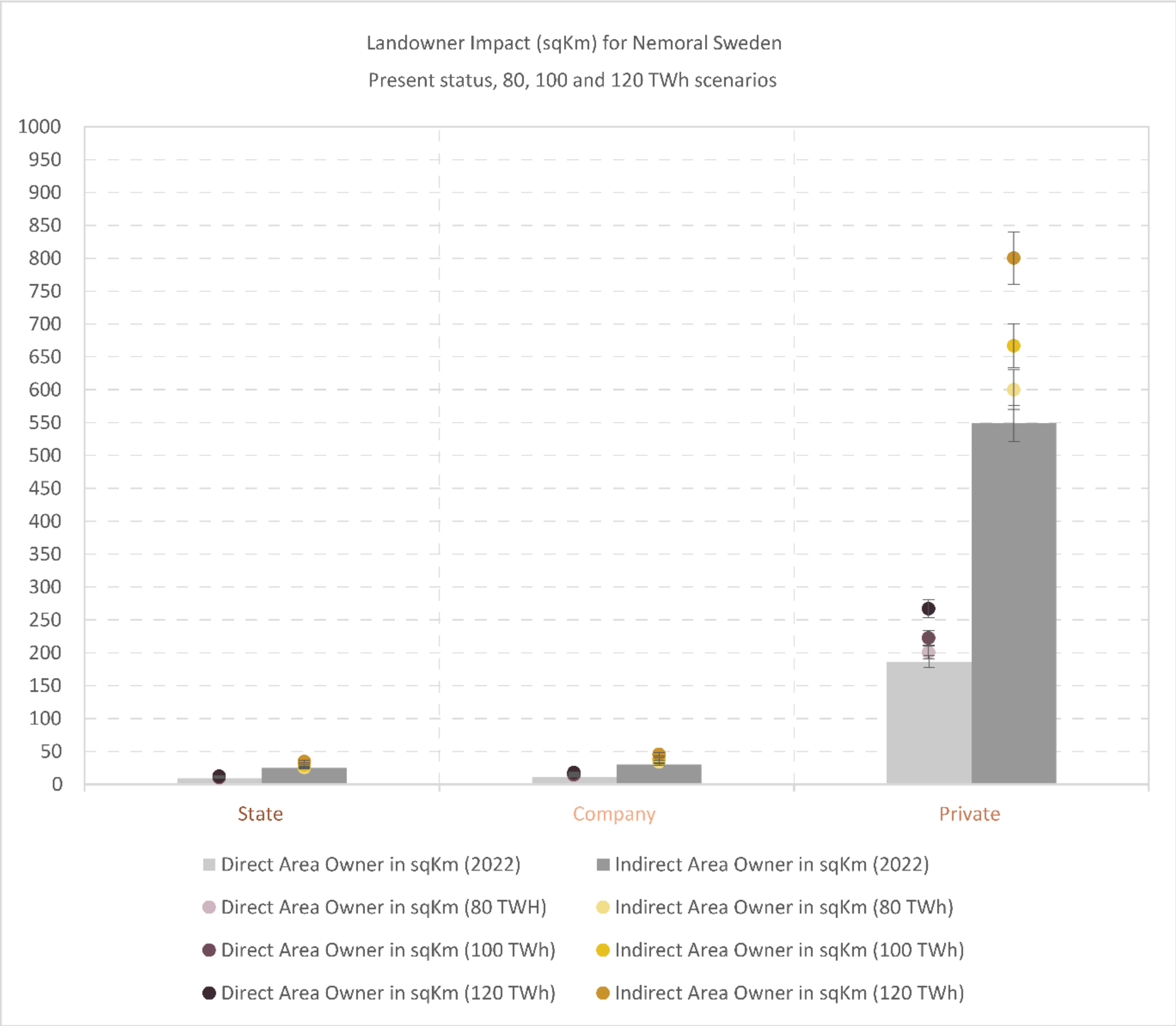

***Figure 7**: Spatial Coverage of Landowner types within wind power sites (direct area) and planning areas (indirect area) in the Nemoral zone of Sweden. The Spatial Coverage accounts for three different scenarios: present status (01/012022), 80 TWh, 100 TWh and 120 TWh. The error bars represent a 5% error margin, accounting for a 95% confidence interval for the plot.*

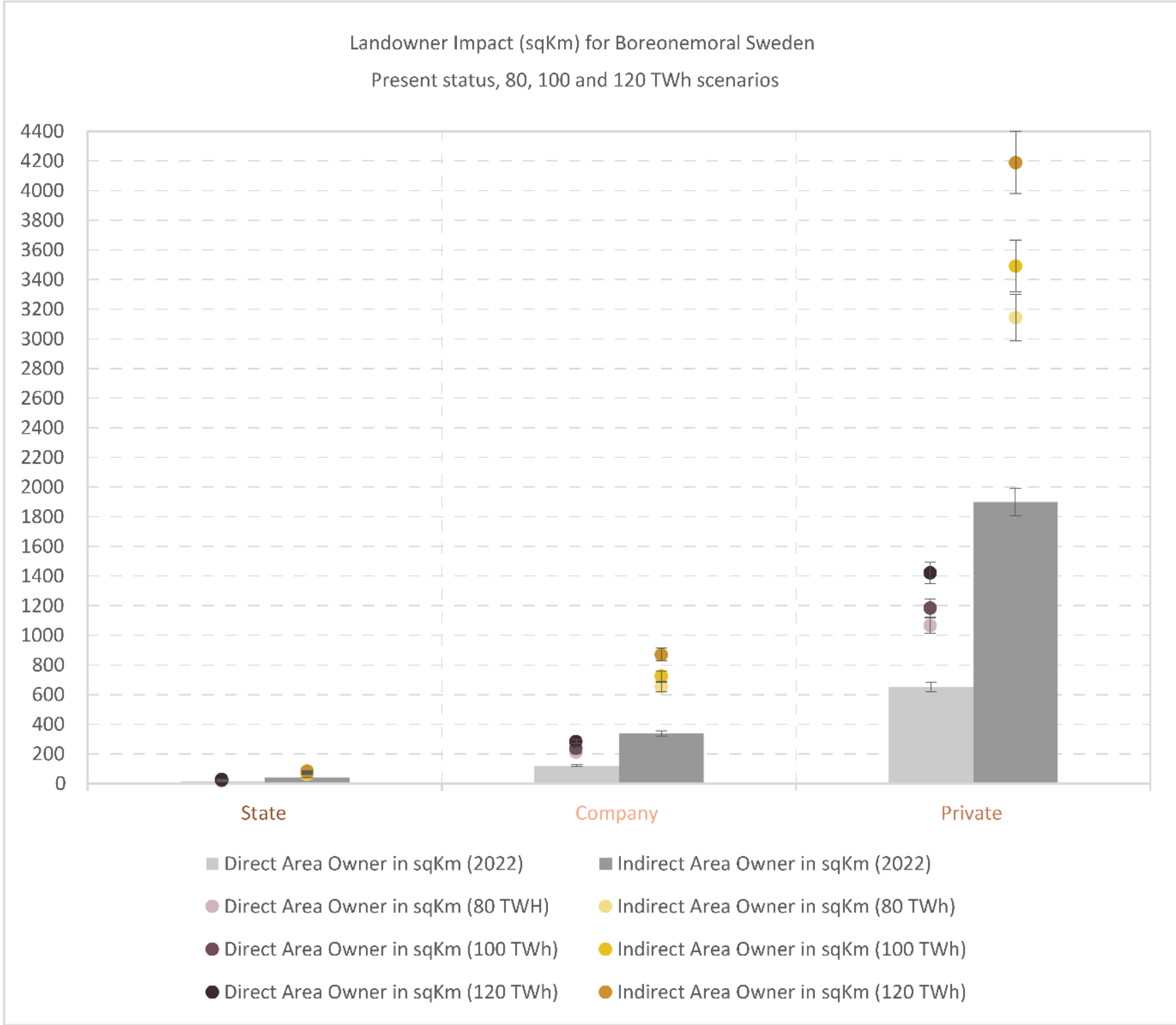

***Figure 8**: Spatial Coverage of Landowner types within wind power sites (direct area) and planning areas (indirect area) in the Boreonemoral zone of Sweden. The Spatial Coverage accounts for three different scenarios: present status (01/012022), 80 TWh, 100 TWh and 120 TWh. The error bars represent a 5% error margin, accounting for a 95% confidence interval for the plot.*

Spatial Link wind power sites and NI areas in Skåne, Halland, Kronoberg, Jönköping (Q2)

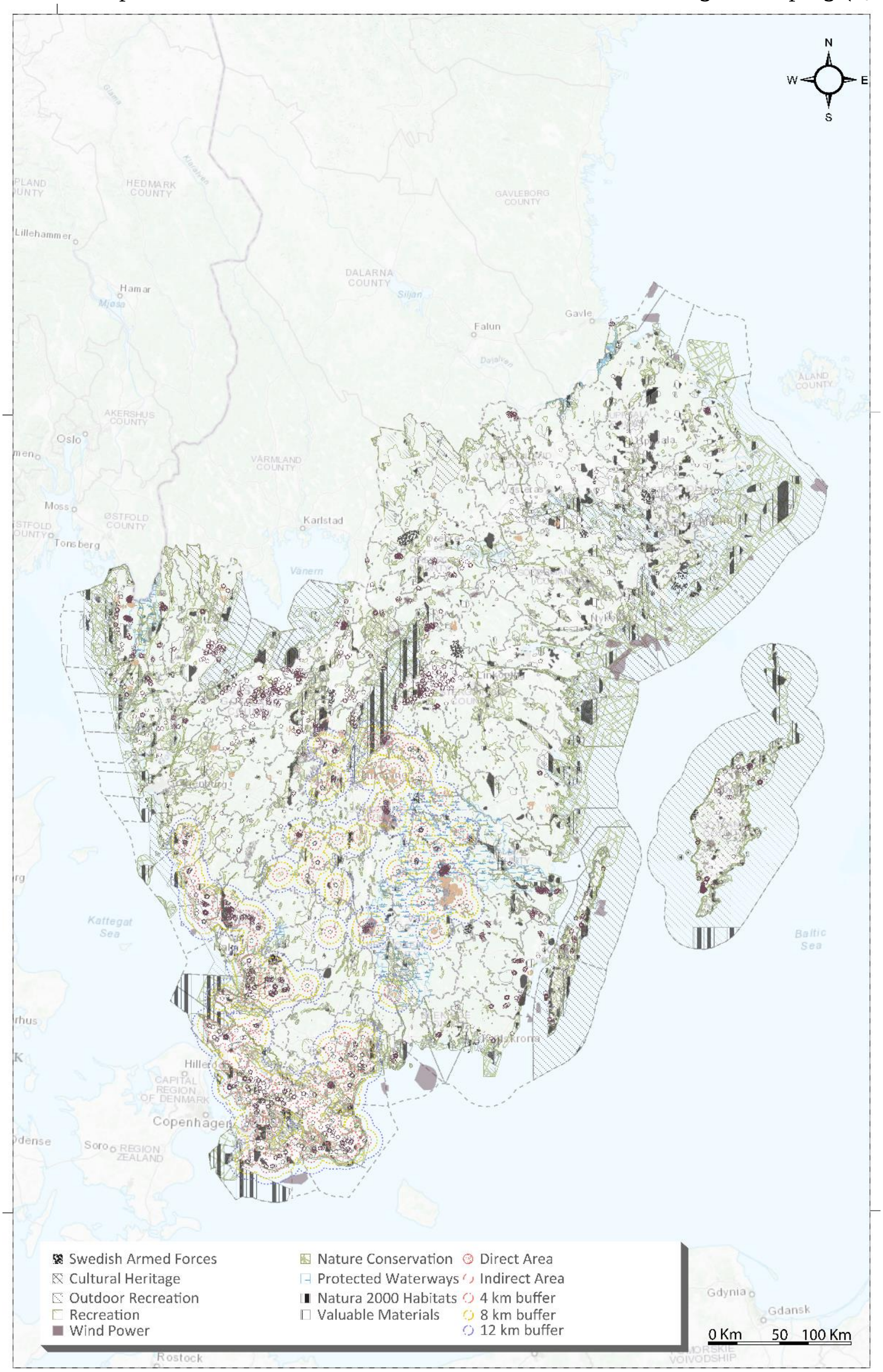

***Figure** 9: Illustration of wind power sites and 4/8/12 km buffers and their relationship with NI areas in Southern Sweden*

Within the 4, 8 and 12 km buffers from wind power sites, National Interest (NI) areas occupy an area that, when compared to the county in which they are present, ranges from 7% up to almost 50% of the county´s total area. (Figures 10, 11 and 12, Appendix 8, 9 and 10).

There is a noticeable difference between the composition of NI areas present (Figures 10,11 and 12, Appendixes 8,9 and 10). The counties representing nemoral Sweden, Skåne and Halland, feature a higher proportion of NI areas pertaining to Outdoor Recreation (1,8-14,2%), Recreation (1-12%), Nature Conservation (3-15%) and Cultural Heritage (2,2-6,7%). Wind Power designated NIs were not present in these counties.

The counties representing boreonemoral Sweden, in contrast, feature a higher proportion of NIs pertaining to Protected Waterways (4-21%). Nature Conservation NI areas feature heavily in Jönköping (2-11%), as do Natura 2000 Habitat Areas (1-6%). Wind Power designated NIs accounted for 1% up to 3% of the total area for both counties.

While the counties of Skåne and Halland presented more similar, heterogeneous compositions for the NIs present in their area, Kronoberg and Jönköping show very dissimilar compositions of NI present in their area. Jönköping´s features different types of NI areas in the 4km buffer and 7 NI area types in the 8 and 12 km buffers. Kronoberg features 4 NI area types in the 4km buffer, and up to 7 NI area types in the 12 km buffer. It is important to note that in the 12 km buffer, 17% and 3% of the total 25% NI featuring areas are Protected Waterways and Wind Power NI areas, respectively. This highlights Kronoberg´s more homogeneous NI area composition. (Figures 10, 11 and 12, Appendix 8, 9 and 10).

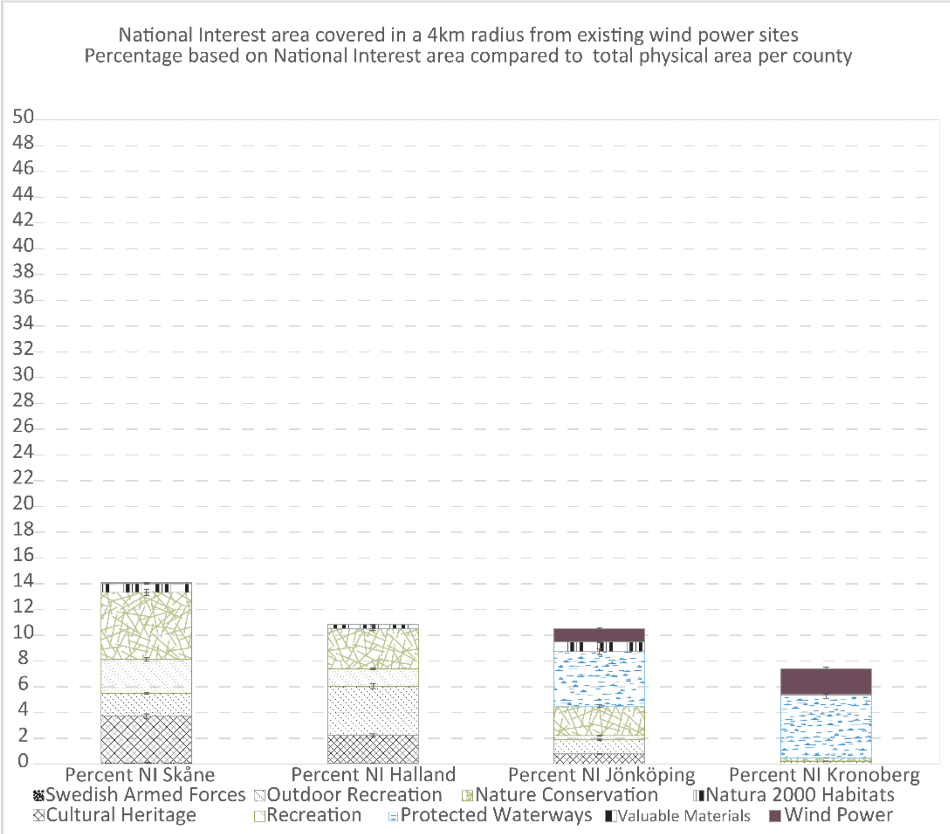

Figure 10*: Proportion of NI areas present in a 4km buffer from all wind power sites in Nemoral zone counties (Skåne and Halland) and Boreonemoral zone counties (Jönköping and Kronoberg) compared to total county area. 95% confidence interval.*

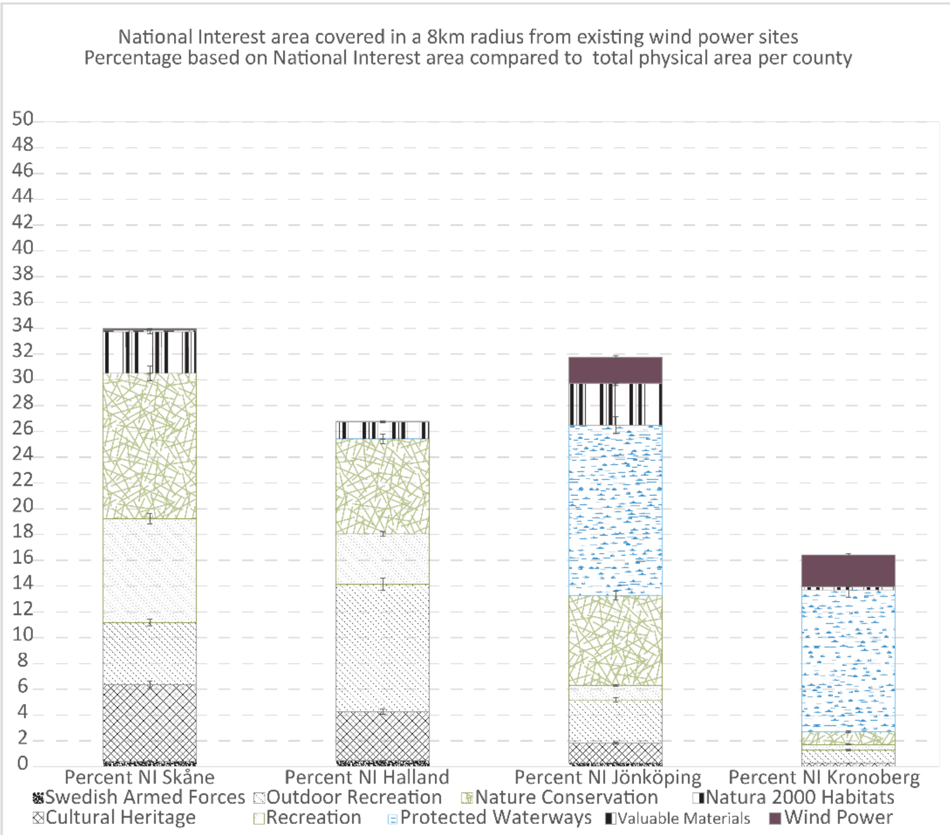

Figure 11(opposite page, below)*: Proportion of NI areas present in a 8km buffer from all wind power sites in Nemoral zone counties (Skåne and Halland) and Boreonemoral zone counties (Jönköping and Kronoberg) compared to total county area. 95% confidence interval.*

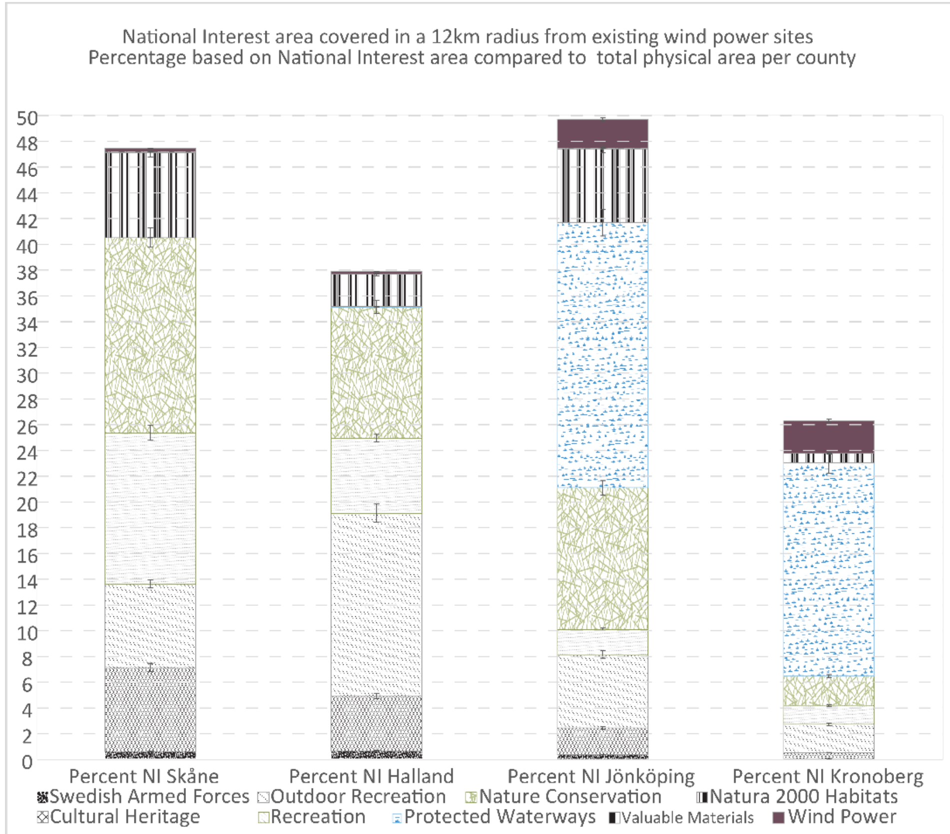

Figure 12*: Proportion of NI areas present in a 12km radius buffer from all wind power sites in Nemoral zone counties (Skåne and Halland) and Boreonemoral zone counties (Jönköping and Kronoberg) compared to total county area. 95% confidence interval.*

Spatial link between wind power sites and National Interest areas in the municipalities of Falkenberg and Uppvidinge(Q3)

Within the 4, 8 and 12 km buffers from wind power sites, National Interest areas occupy an area that, when compared to the municipality in which they are present, ranges from 15% up to 40% of the corresponding municipality´s total area (Figures 13, 14 and 15, Appendixes 11, 12 and 13).

Of the proposed Wind Power development made for the whole of Kronoberg country, 67% is in Uppvidinge. Interestingly, 68% of the National Interest areas impacted in the municipality are within 4km of these proposed development sites.

Wind Power developments in Falkenberg represents 33% of the total wind power developments, with 34% of the total NI area impacted being present within 4km of the wind power development sites.

NI area composition is very dissimilar between both municipalities. (Figures 13, 14 and 15)

Falkenberg´s most featured NI areas are Outdoor Recreation, ranging from 7% to 19%, and Cultural Heritage, ranging from 6% to 12%. Minor areas are occupied by Nature Conservation, Recreation and Natura 2000 Habitat Areas.

In contrast, Uppvidinge´s most featured NI area is Protected Waterways, ranging from 15% to 21% of the municipality´s total area. The next most prominent NI area is that assigned to Wind Power, and it ranges from 10% to 11%. By contrast, Wind Power in Falkenberg represents only 0% to 1% of the total area. (Figures 13, 14 and 15)

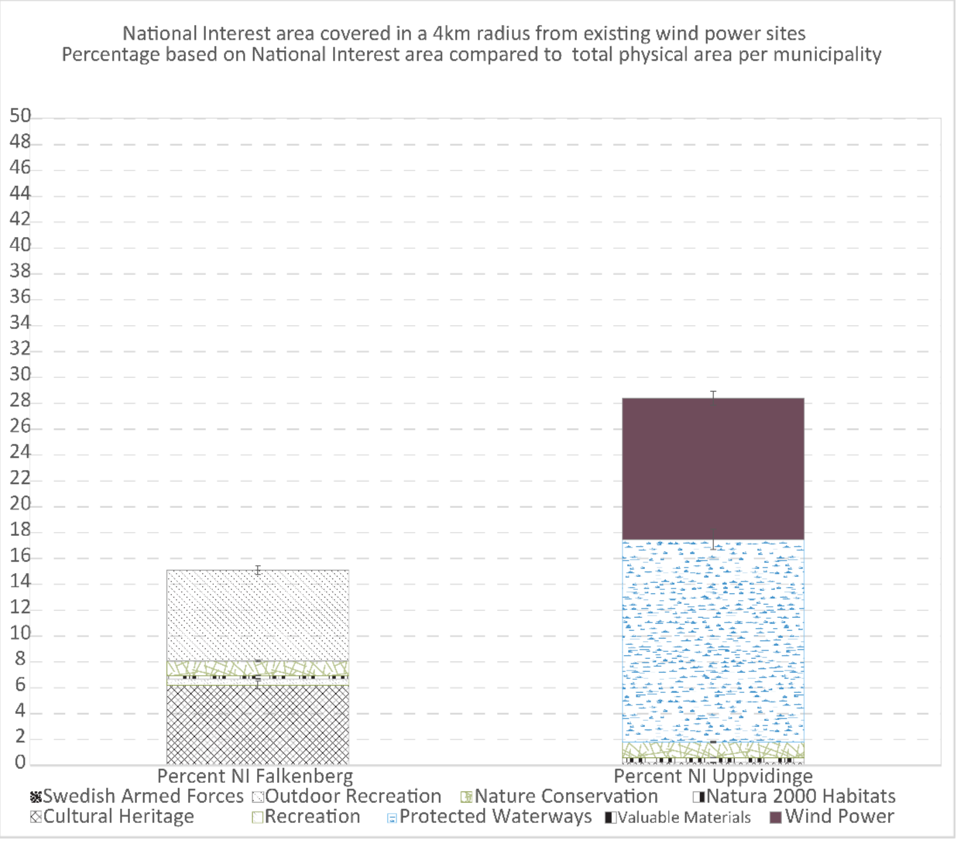

Figure 13*: Proportion of NI areas present in a 4km buffer from all wind power sites in Falkenberg and Uppvidinge compared to total municipality area. 95% confidence interval.*

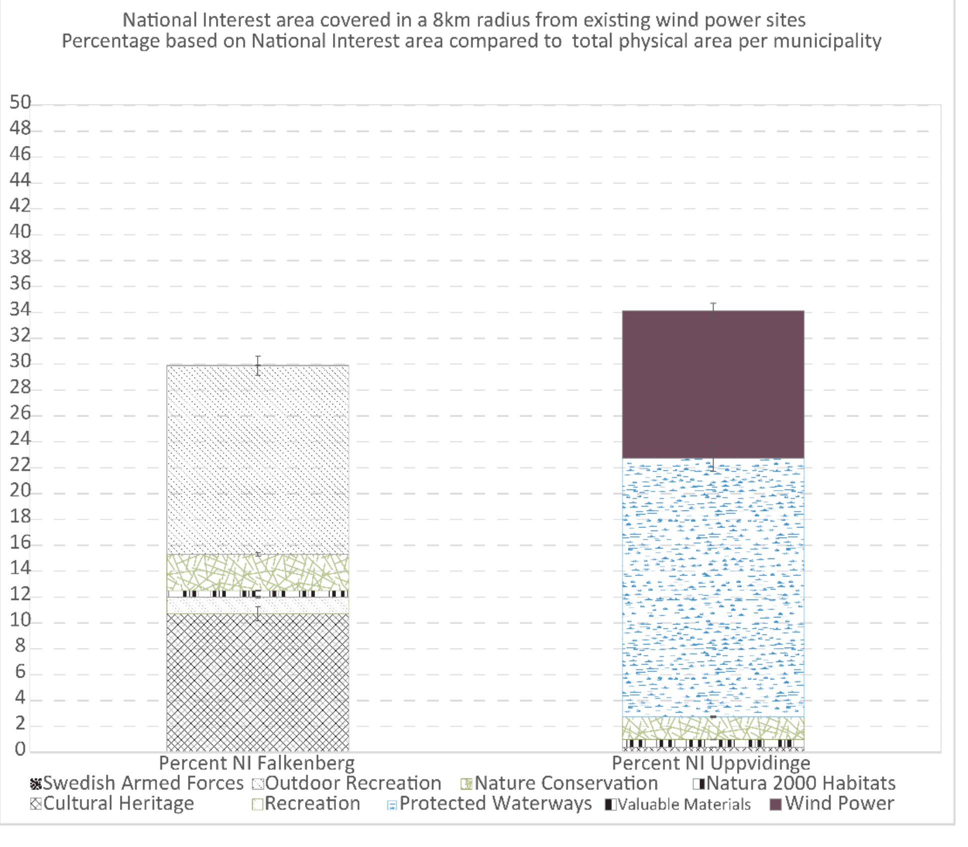

Figure 14(opposite page, below)*: Proportion of NI areas present in a 8km buffer from all wind power sites in Falkenberg and Uppvidinge compared to total municipality area. 95% confidence interval.*

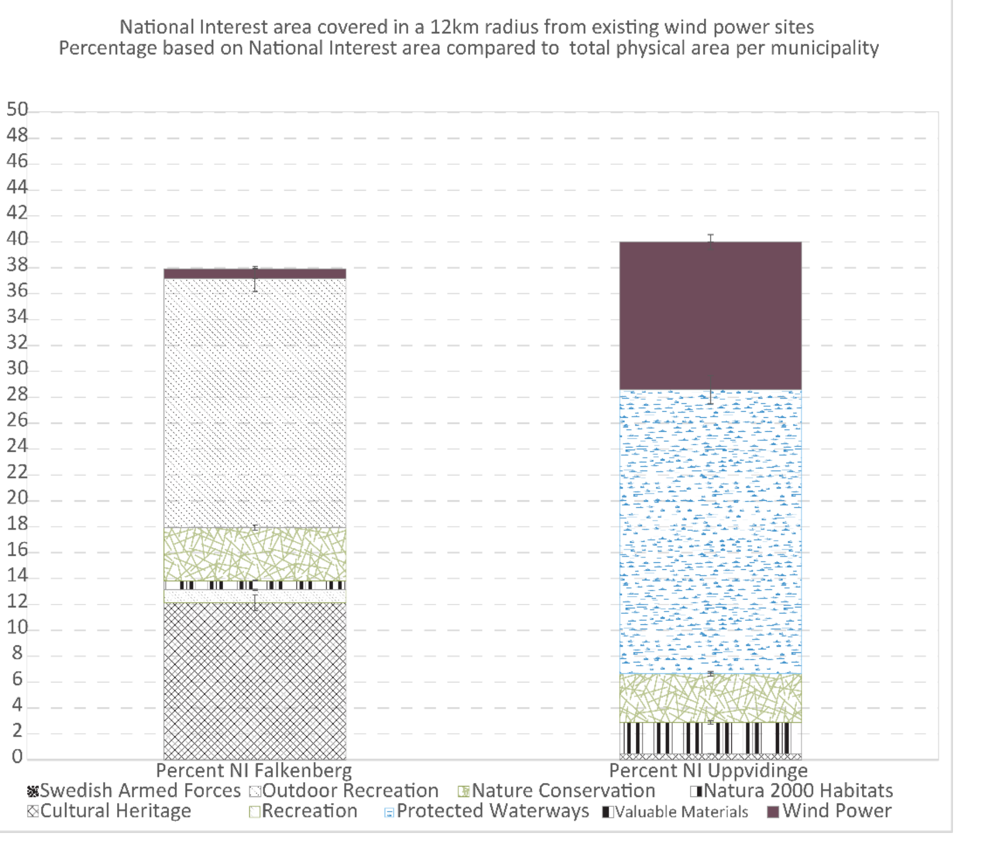

Figure 15*: Proportion of NI areas present in a 12km buffer from all wind power sites in Falkenberg and Uppvidinge compared to total municipality area. 95% confidence interval.*

Impact of ILCA and other landscape character assessments in wind power development and landscape democracy for the municipalities of Falkenberg and Uppvidinge(Q4)

The ILCA performed for Kronoberg county, including Uppvidinge, and LCA performed for the implementation of wind power in Halland county, incuiding Falkenberg, share similarities in how they address each county´s landscape (Tables 8,9,10 and 11), especially regarding the ecological, geographical and landscape composition of both counties and municipalities, but they also have differences in their method which I interpret as critical. These are:

- The ILCA performed for areas included in Uppvidinge provided an insight into the social and economic characteristics of Kronoberg and each landscape character present in the county, while the LCA for Halland did not address these issues.

- The LCA for areas included in Falkenberg provided very accurate analysis of the impact of wind power and, by association, big-scale infrastructure in the landscape, while the ILCA performed for Uppvidinge highlighted general vulnerabilities of each landscape character but did not remark on the impact of future planned infrastructure in the area.

- While the ILCA incorporates the citizenry in its assessment of the landscape, in line with the ELC, the LCA of Falkenberg does not specify whether it incorporated public opinion, and to which degree, in its assessment of the landscape characters.

- Uppvidinge is in a much more homogeneous geographical area, highlighted by the presence of only two distinct landscape characters in the area, while Falkenberg is located in a heterogeneous area with 4 distinct landscape characters.

Fact sheet on Falkenberg, based on the LCA performed for Halland

Table 8: *Overall Characteristics of Falkenberg and its landscape characters as described by the document drafted by the County Administration Board of Halland in 2011(CAB, 2011).*

Overall characteristics of Falkenberg
Falkenberg municipality forms part of the southern division of Halland county. It is a collection of different landscape characters tightly interlinked. The clear division in two Plateaus means there exists a clear connecting area between the different characters. From east to west one moves from the flat coast one moves through the flat plains, the rolling plains and into the forested highs in the west. The area has its main populated centres along the coast, with spread out smaller areas in the inland. The economy is mainly reliant on the services industry with 59% of the share, land resource exploitation representing 25% and the industrial sector representing 15% (*SCB Företagsregistret, 2021).* Joblessness stands at around 6%, which is lower than the national average of 8,5% (*SCB, 2021*).
Main landscape characters in Falkenberg
Flat Coast: Long coastline with flat coastal plains along it. Coastal plains are populated by low height recreational residences, plantations of *Pinus sylvestris* and beaches with sand dunes. Low hills between Falkenberg and Halmstad. High biodiversity and high recreational value. **Flat Plains**: Agrarian landscape with scale variations. Open expanses of land complemented with room quality areas with small forest plantations and traditional stone walls. Impactful features of the landscape are churches, grain silos and old wind turbines. The area is mostly a production landscape with recreational and cultural heritage values attached to the traditional farming areas. **Rolling Plains**: Rolling or undulating landscape creating a diverse perception with short and long lines-of-sight. It has a mix of small-scale agrarian landscapes, beech forests and deciduous or hardwood forests. Important presence of water bodies such as lakes, swamps**,** and rivers. High biodiversity, recreational and cultural heritage values. Area between Falkenberg and Halmstad presents remnants of higher mountains. **Forested Highlands**: Forested area with a high mix of small-scale areas connected to agrarian practices and communities linked to tree milling present in the major river valleys. High recreational and natural value.

Table 9: *Main landscape vulnerabilities of Falkenberg as described by the document drafted by the County Administration Board of Halland in 2011(CAB, 2011).*

Main vulnerabilities of the landscape regions to wind power implementation in Falkenberg
Flat Coast: Small-scale and long lines-of-sight make it hard to place big scale infrastructure without impacting visually. Grouping of infrastructure in previously non-industrial areas can lead to even higher disturbance. Interference between infrastructure and areas of high recreation and/or natural value. Opportunities to place near existing infrastructure (harbours or industry) or on areas which have been historically closer to industry, as well as to emphasize other landscape features when appropriate. **Flat Plains**: The area has already experienced the effect of wind power and other infrastructure, and new work would reinforce an unwanted industrial character. The small scale and flatness of the terrain makes placing big scale infrastructure difficult. Infrastructure placed on this area might also be visible from other landscape areas, heightening the impact of visual disturbances. The heterogeneity of this landscape might make some areas appropriate for placement, for example associated to production features in the landscape such as silos, but always respecting the existing structure present in the landscape. The unique area between Falkenberg and Halland should be left free of wind turbines. **Rolling Plains**: The rolling plains are very sensitive to infrastructure and wind power placement due to the experience of the different scales and changes of topography in the terrain. These could be adversely affected by the enormous scale of wind turbines or other infrastructure. If placed in the higher hills, the infrastructure could serve as a wall between the forested highlands and the coastal landscape, greatly impacting the perception and character of all existing landscapes. Turbines in this area would also adversely affect the picturesque perception of the landscape. **Forested Highlands**: Despite being a productive forest landscape, these areas are sensible to wind power and infrastructure due to the complex of small-scale areas connected to agrarian practices and communities linked to tree milling present in the major river valleys. It is important that built infrastructure is delimited to areas where they can work with already existing production infrastructure, reinforcing the quality of the latter but not surrounding it. It is also important to avoid disturbances in the lines-of-sight from major water bodies.

Fact sheet on Uppvidinge, based on the ILCA performed for Kronoberg

***Table 10**: Overall Characteristics of Uppvidinge and its landscape characters as described by the document drafted by the County Administration Board of Kronoberg in 2018(CAB, 2018).*

Overall characteristics of Uppvidinge
Uppvidinge municipality forms part of the northeaster division of Kronoberg county. It comprises of a forest dominated area with rugged flat or hilly terrain. Despite a distinct presence of water bodies, the area has very dry soil and a granite base that doesn´t absorb water. This, coupled with lower-than-average precipitation, can lead to forest fires. The area is divided into two zones: a southern one with a much flatter, but rugged terrain, and a northern part with distinctive topographic futures such as small hills. The area presents spread out populations with poor connectivity between each other. The lack of proper infrastructure has led to the municipality experiencing a decline in population. The economy is mainly reliant on the industry and raw goods production with 48% of the share. Healthcare and related branches represent 8% and the education sector represents 8%. Energy production and environmental activities don´t even reach 1% of the total share of employed. (*SCB Företagsregistret, 2018).* Joblessness stands at around 8%, which is closer to the national average of 8,5% (*SCB, 2021*).
Main landscape characters in Uppvidinge
Hilly forest dominated landscape/ "Högsmåland": This area can be described as a rugged, rocky, forest dominated landscape with differences in topography that range between 170-300 meters over sea level. The forest is dominated by spruce, with few areas having a mix of deciduous forests. Small production areas and farms are linked to the forest and series of grazed pastures. There's a high biological and cultural heritage value, with present efforts being made to promote tourism linked to them. **Flat and rugged forest dominated landscape/ "Glasriket"**: This area is a forest dominated landscape with few noticeable changes in topography and a rugged, rocky terrain. There´s a higher share of deciduous forest in comparison to the spruce dominated forest in northern and southern areas. Small lakes and rivers are present, with built-up areas associated to them. The landscape has had an influence by industrial processes such as ironworks and later glass works, with associated landmarks and factories tied to it. Important biological and cultural heritage values.

***Table 11**: Main landscape vulnerabilities of Uppvidinge as described by the document drafted by the County Administration Board of Kronoberg in 2018(CAB, 2018).*

Main vulnerabilities of the landscape regions to wind power implementation in Uppvidinge
Hilly forest dominated landscape/ "Högsmåland": There is a risk that the small-scale elements in the landscape could be affected by big scale infrastructure. Changes in the landscape might also affect biological and recreational values in the area. The loss of inhabitants, affected by landscape changes, might affect stewarding of culturally important areas tied to grazing. This loss in grazed areas linked to biological and cultural heritage values might be adversely affected if the industry linked to stock is lost. **Flat and rugged forest dominated landscape/ "Glasriket"**: There is a risk that the small-scale elements in the landscape could be affected by big scale infrastructure, and example being the view from lakes and rivers. Loss of inhabitants due to bad infrastructure and job opportunities might negatively affect landscapes linked to human influence. The spread of spruce will negatively affect biological and recreational values.

Visual Impact of existing and proposed wind power sites in Falkenberg and Uppvidinge

The positioning of the approved and established wind power sites (5) in the municipality of Uppvidinge have mostly been carried out in the northern area of the municipality, corresponding to the Högsmåland landscape character. One of the wind power sites has been built in the southeastern portion, a part of the Glasriket landscape character. These 5 wind power sites are visible, within a 4km radius, in 9% of the municipality, within an 8km radius visibility covers 21% of the municipality, and within a 12 km radius it covers 32% of the municipality. Had all approved projects been built (120), 37% of the municipality is within a 4km visibility radius, 54% is covered within an 8km visibility radius, and 65% within a 12km visibility radius (Figure 16, Appendix 14). Should all of projects been approved, 119 of 120 wind turbines would have been visible within 4km at all times in the northern portion of the municipality. Interestingly, Åseda, which is one of the most populated areas of Uppvidinge, is within this 4 km visibility radius,with the sites spreading to the northwest, west, south, southeast and east of the town (Figure 16).

The projects are even visible in 4, 8 and 12 km radiuses in the neighbouring municipality of Vetlanda.

Falkenberg has proposed, approved and built 84 wind power sites. They are spread out through the municipality, with sites in each of the 4 landscape characters. These wind power sites are visible, within a 4km radius, in 21% of the municipality, within an 8km radius these figure rises to 36% of the municipality, and within a 12 km radius it is 49% of the municipality (Figure 17, Appendix 13). It is important to note that there are no areas in which wind power groups from two different landscape characters are visibile, at the same time, from a 4km visibility radius, with just one wind turbine being present between the two clearly defined groups of sites (Figure 17).

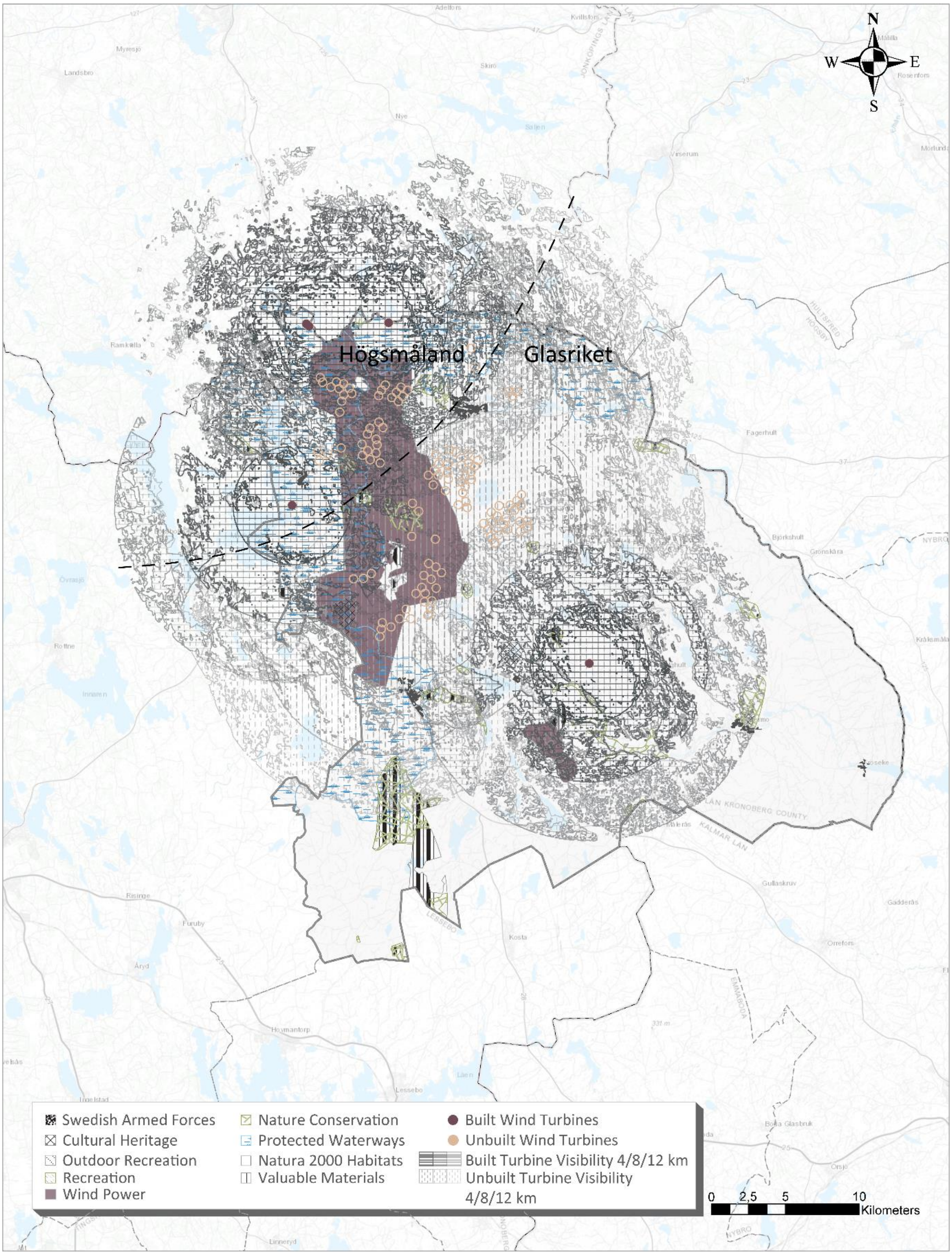

Figure 16*: Visibility Impact Analysis of Uppvidinge at 4km, 8km and 12km distances from built and built or approved wind power sites, together with existing NI Areas in the municipality and landscape character divisions.*

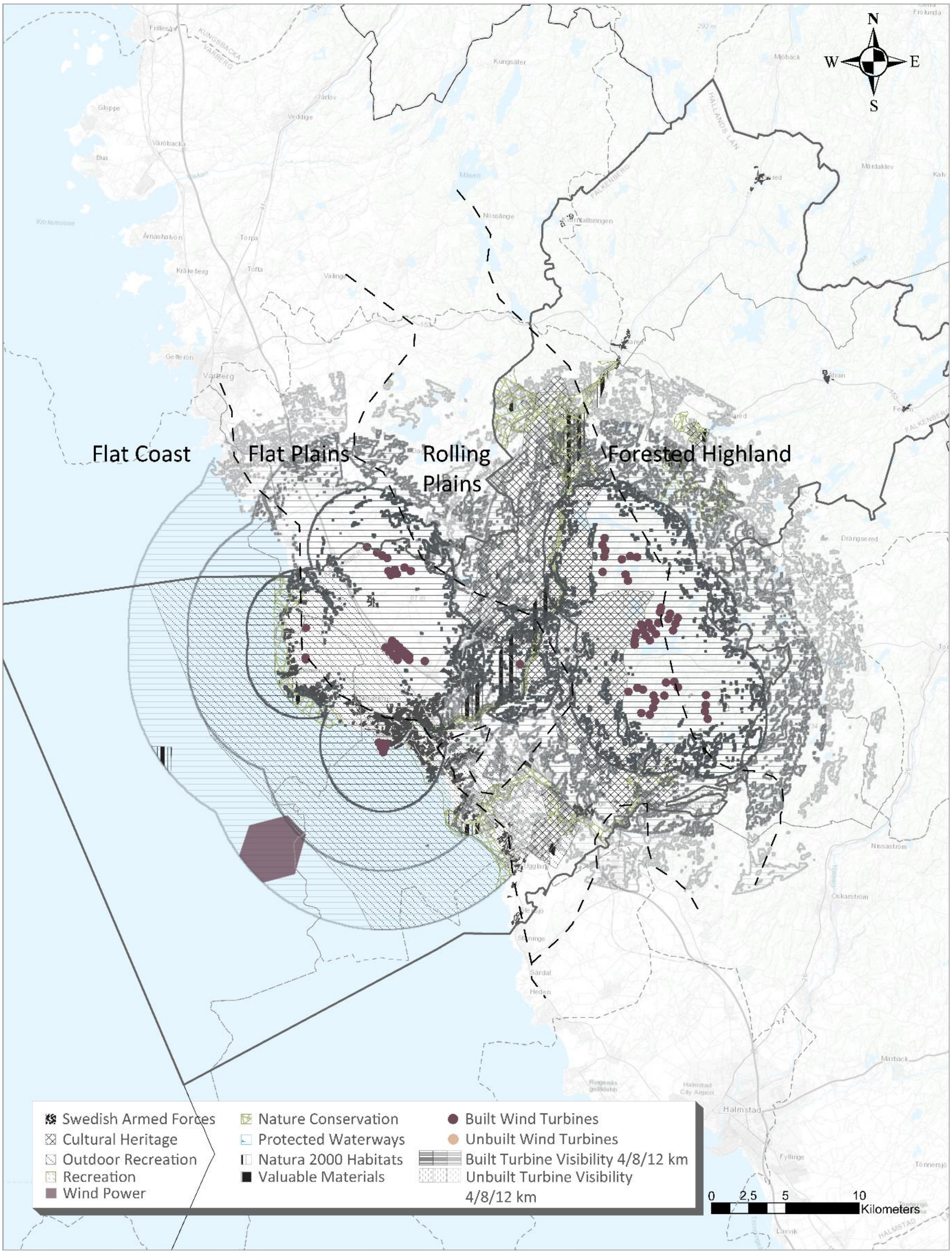

Figure 17*: Visibility Impact Analysis of Falkenberg at 4km, 8km and 12km distances from built and built or approved wind power sites, together with existing NI Areas in the municipality and landscape character divisions.*

The positioning of the wind power sites in Uppvidinge does not present any kind of clear spatial strategy, with wide, spreading groups located in the area north, west, east and south of Åseda, and only three of them presenting a clear directionality to their group (Figure 18, left). In Falkenberg, the northern part of the Forested Highlands landscape character is left outside of any visible influence of the wind power sites, with the vast majority of them being placed near the populated centers in the flat plains or the border between the rolling plains and the forested highlands. The projects placed in the flat plain areas present a clear southeast to northwest disposition parallel that of the spread of the city of Falkenberg. The groups present in the border between the forested highlands and the rolling plains form tight groups with no clear directional disposition. These groups, though, are placed in a clear North to South axis. (Figure 18, right).

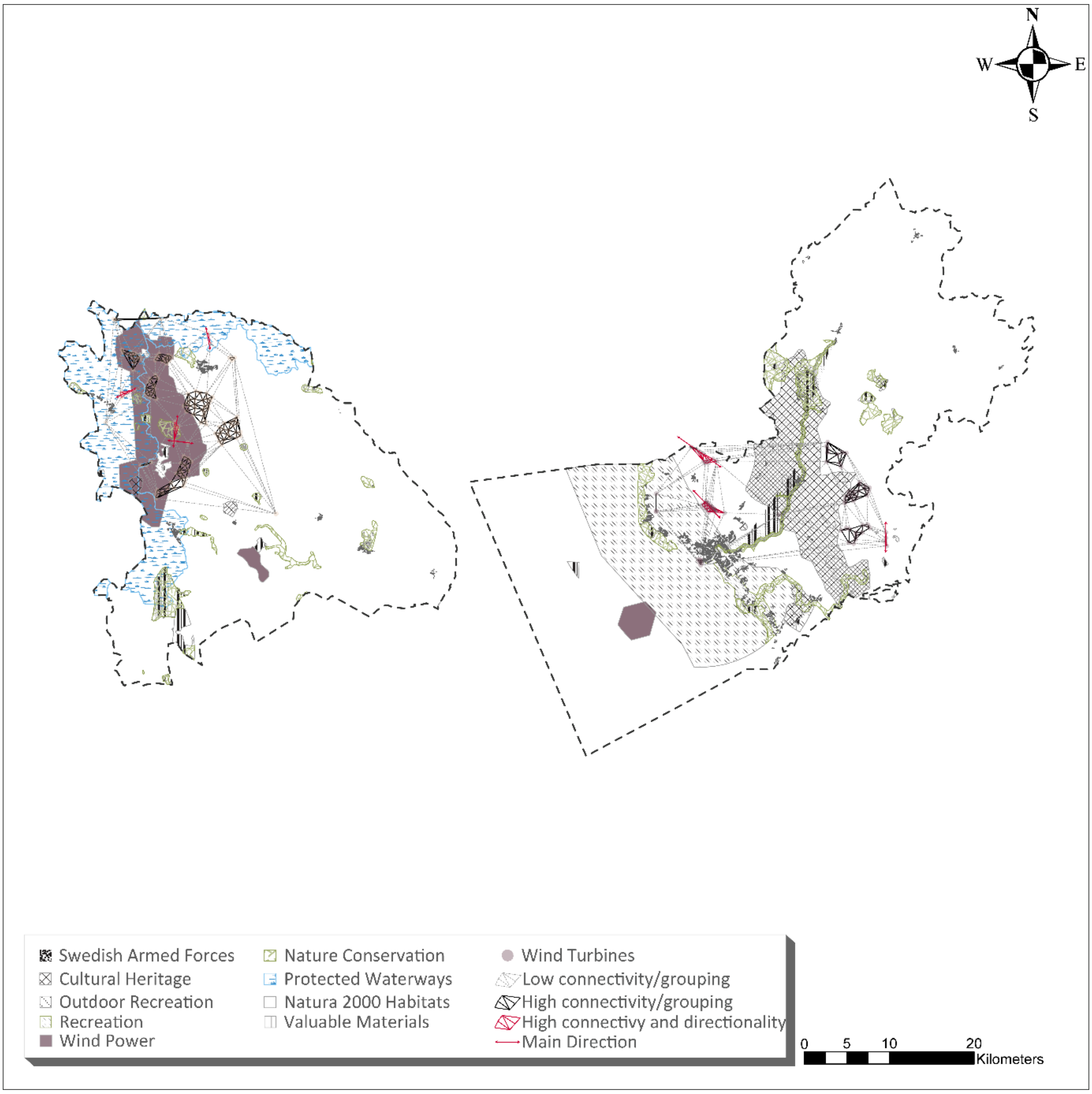

Figure 18: *Disposition of wind power turbine groups in the landscape of Uppvidinge (left) and Fakenberg (right). Grouping is assessed using a Delaunay Triangulation, with tighter (dark colored) triangles indicating a higher density and more defined grouping of wind turbines. If these groups face a distinctive directional axis, it is indicated in red.*

5. Discussion

An important effort needs to be performed if Sweden is to achieve its sustainable energy goals. Despite the increases in land cover and landowners being very small compared to the total available area, conflict will not be avoided where the impact increase.
Arable Land and Forests, vital not only to food production and the forestry industry, but also to ecological diversity, are the most impacted land covers, increasing the chances of conflict where these uses overlap with wind power infrastructure. At the same time, private landowners are the most common group affected when implementing wind power infrastructure, complicating the negotiating processes.
In the context of increases in current land demands for wind power sites, some counties are required to drastically increase the land area they allocate to wind power development. Uppsala, for example, would need to allocate 32,400% more land than it currently does to satisfy the proposed electricity production in the 120 TWh. According to the Swedish Energy Association (*Swedish Energy Agency, 2021(2):22),* this allocation of land is based on population, total land area, total electricity demands and, in certain cases, GIS-based analysis delimiting conflicts between energy production and other uses. The proposed methods fail to mention land allocation and exploitation to sustainable development and participatory planning, which in the case of rural areas, has been proved to improve the implementation of infrastructure policies (*Zachrisson, et al., 2021*). These methods, which leave aside the social component of energyscapes, risk replicating the thought-process behind the centralization and inequalities of current fossil-fuel based strategies, in turn creating energy peripheries, as defined by Pasqualetti (2013). A clear example of this is the thought process by which less populated non-urban areas are deemed more suitable for rapid and intense landscape transformation. The criteria constructed by the Swedish Energy Agency needs to be complemented by more in-depth analysis carried out at regional and local level to revise the land allocation for each separate county that would result in more democratic processes and less conflict. This was supported by the perceived correlation between the existence of analysis that address landscape from a social, ecological, and historical point of view at a regional level in Falkenberg and the successful implementation of wind power infrastructure in the municipality. The opposite was truth for the municipality of Uppvidinge, where the analysis was conducted after the initial implementation process of wind power infrastructure.

Spatial link between wind power sites and land use or actor conflicts (Q1)

Land Cover Impact

The projected land cover impact in direct and indirect areas of wind power sites happens on deeply contested land cover types, and negotiation will be needed to solve conflicts arising from it.

In the case of nemoral Sweden, the main affected land cover type is Arable Land, with it being the second most impacted land cover type in boreonemoral Sweden. Predicted increases in impacted land in the most progressive scenario range from 150 km^2 to 800 km^2.

According to the UN, global demand for food is projected to rise 50% by 2050 (*Gomiero. 2016*). The case of Sweden is no different (*Öhling, et al., 2020*), and while Sweden is not one of the European agricultural powerhouses, Southern Sweden has some of the most fertile soil in the continent (*SCAB, 2015*). Juhola (2017) states that despite climate change leading to more poor harvests, Sweden might become a food provider not only for its own citizens but for the European continent. This is, partly, due to climate change, which lengthens growing seasons and generates more favourable agricultural conditions. According to Statistics Sweden (2019), Sweden has approximately 30,000 km^2 of arable land, nearly one 10,000 km^2 less than 50 years ago.

Besides the production values, agricultural landscapes also exist in other realms of value, e.g., aesthetic, cultural, scientific, recreational, and social values (*Öhling, et al., 2020*). While able to coexist together due to similar infrastructure being created for them, there is no guarantee that there won´t be conflicting competition between wind power development and the agricultural industry. It is then imperative to determine the character and value of agricultural landscapes, with studies like the one conducted by Besette, et al. (2021) stating that production-focused agricultural landscapes are negatively correlated with opposition to wind power developments.

Another seemingly wind power compatible land use is forestry (*Svensson, et al., in rev*). Forest land cover types are the most impacted type in boreonemoral regions and the second most impacted in nemoral regions of Sweden, with increases up to 2000 km^2. The main issue when assessing land use conflicts between wind power and forest land cover types is the effect wind power development has on ecological and recreational values. Skarin (2016) highlights the negative effects of wind power sites on reindeer behaviour in northern Sweden, with Lundmark (2022) assessing the projected effects of wind power sites in the main food resource for reindeer. The impact of wind power infrastructure on ecological corridors and ecosystems is also mentioned in the study by Guo, et al. (2020). Johnsen Rygg´s (2012) study also highlights the way wind power sites impact people´s perception of recreational areas for the worse, providing yet another possible source of conflict in forested areas with these imbued values. On the other hand, Mäntymaa et al. (2021) explores how wind power development sites in productive forest areas in Finland can coexist. Wind power sites provide the owners of these areas with an additional income not linked to forestry cycles while using the forested landscape as a "shield" that lowers the visual impact they have on the landscape (*Mäntymaa et al., 2021).* The key aspect, once again, for coexistence, is an assessment of the imbued values and uses of the landscape and how they can lead to synergies or conflict with wind power. Given that forestry is a strongly dominating land use in forests, however, it may be assumed that the direct negative impact by land for turbines, roads and other infrastructure is minor, but also that forestry operations may benefit from the infrastructure that comes with wind power and thus that synergy effects might appear (*Svensson et al. in rev*.)

Finally, it´s interesting to highlight the increase in impacted artificial areas, and how they might present a possibility due to the perceived coexistence between wind power infrastructure and landscapes that present values tied to production (*Johnsen Rygg, 2012*). It should be noted that these synergies might be difficult to achieve due to the concentration of people in the Southern portion of Sweden (*SCB, 2019*), which might amplify the negative aspects of wind power infrastructure due to constant visibility, as explained by Bishop & Miller (2007).

Landowner Impact

The increase of private landowner impact on direct and indirect wind power site areas highlights a question that will always follow wind power development. Who do these developments benefit? Is it only the owners and companies who benefit from them while citizenry suffer the negative effects of them? This question was highlighted by the LCA performed for the area surrounding Lake Siljan in the county of Dalarna (*Oles & Hammarlund, 2011).* The LCA didn´t shed that much light on the impact of the wind turbines, but instead revealed the citizen´s shared historic and cultural values, as well as their worries regarding the number of turbines and who the owners of the projects would be. It also showed the citizen´s worry about economic and social injustice and how wind power projects could be proxies for those issues.

These issues between the different actors in the landscape are projected to take a more centre place in nemoral areas of Sweden, where the indirect area impact was 30% higher on privately owned land when compared to company owned land.

Spatial link between wind power sites and National Interest areas in Skåne, Halland, Kronoberg and Jönköping (Q2)

The substantial spatial overlap of National Interest Areas with wind power linked to present scenarios of Wind Power development highlight a heterogeneous set of objectives for the different counties analysed in the study. It becomes clear that the NI framework is, by itself, not enough to present solutions to the conflicts arising from the coexistence of Wind Power with other land uses and values, although it does aim suggest synergies (*Solbär, 2019*). Despite a similar set of land use objectives to Halland, as illustrated by the NI areas present in the buffers, the number of projects that have been cancelled between 2014 and 2021 in Skåne amounts to 21% of all applications for Wind Power development (*https://www.svt.se/nyheter/lokalt/skane/over-1200-vindkraftverk-stoppade-av-kommuner*, *accessed 02/09/2022*). The existence of Wind Power focused NI framework areas in Jönköping and Kronoberg would indicate a synergy with other land uses in these counties, but the data provided by the wind energy association shows that over 75% of all wind power development projects in Jönköping have not been constructed or have been subjected to municipal veto, with the same number rising to 83% in Kronoberg. This contrasts with Halland, with a completion rate of 82%, where Wind Power NI areas where largely not found within the buffers of implemented of wind power. This indicates a knowledge or processing limitation of the NI framework, with the land delimitation indicating possibilities but falling short of providing how these goals can be implemented.

Despite the unsuccessful implementation of wind power in Skåne, my findings suggest, based on the present NI areas in the buffers, that synergies between wind power and landscapes that have experienced significant human interference, such as areas of important cultural or industrial heritage, might be more easily achieved. Synergies in landscapes where human activity hasn´t left a noticeable imprint on the landscape might be more difficult to achieve due to the perceived incompatibility of infrastructure and natural values. This suggestion is supported by Bente Johnsen Rygg´s (2012) interviews with citizens of municipalities linked to wind power developments in Norway.

Solbär et al. (2019) remarks how the framework negatively impacts the comprehensive plan implementation at municipality level in the north of Sweden, with the set of goals attracting actors who then find difficulties when implementing their infrastructure and prioritizing land uses. The same study touches upon the top-down approach performed by the NI framework and how it imposes itself on the objectives set out at municipal level. There is a risk that the centralized approach of the NI framework might erode landscape democracy and overrule over Sweden citizens´ right to decide upon the changes the landscape experiences in favour of the goals set by the government. This scenario would continue with the range of practices that gave birth to energy peripheries. These energy peripheries would be areas where, through a top-down and undemocratic approach, the landscape and society are subjugated to the energy needs of the country.

Spatial link between wind power sites and National Interest areas in the municipalities of Falkenberg and Uppvidinge(Q3)

The spatial coincidence between wind power sites and NI delimited natural, cultural, and recreational areas, such as Cultural Heritage Areas, Outdoor Recreation, Recreation and Natural Conservation in Falkenberg, and Natura Habitats and Protected Waterways in the municipality of Uppvidinge emphasize the co-occurrence of different interests in land use, but also differences between municipalities. The success of wind power development in Falkenberg and not in Uppvidinge would suggest different degrees of possible coexistence between the aforementioned NI areas present in the municipalities and wind power development. There is a possible synergy between wind power in NI areas that show clear human interference e.g., Cultural Heritage areas present in Falkenberg. This synergy is difficult to achieve in areas with very clearly defined natural values such as Protected Waterways, which is present in a noticeable portion of Uppvidinge. This is further hinted by the higher occurrence of Wind Power NI areas intermixed in Uppvidinge´s landscape, with wind power development not being successful in its implementation. Addressing the impact of wind power implementation, given the fragility of natural areas and the values imbued into them, is of utmost importance, and it is also where the NI falls short by not recognizing these values into its framework (Solbär et al., 2019). This result suggests that analysis and documents that remark upon the impact of it in these landscapes are vital to ensure infrastructure work can be carried out successfully, with them providing a knowledge base for both municipal governments and private actors that the NI does not provide.

Impact of ILCA and other landscape character assessments in wind power development and landscape democracy for the municipalities of Falkenberg and Uppvidinge(Q4)

The documents that have addressed Landscape Character and their vulnerabilities, together with the success rate of wind power in Falkenberg and Uppvidinge, have shed a light on two very different scenarios regarding the resistance to landscape changes, landscape democracy and infrastructure implementation.

The document drafted for Halland in 2011 (*CAB, 2011*), which includes the municipality of Falkenberg, performs an in-depth LCA-based analysis that goes beyond describing the landscape from a geographical, social and ecological perspective. The document measured in a very detailed way what the impact of implementing wind power infrastructure would have on the landscape. It proposes synergies between wind power developments and the existing landscape, highlighting the importance of the imbued values and the time depth of the landscape and how they might coexist with wind power infrastructure. A clear example are the perceived synergies between landscapes linked to production and industrial values. These exist both close to the main urban areas in the municipality and the rural areas that have been historically linked to the production of goods. The document also remarks upon the unique values of certain areas that make wind power implementation difficult or impossible, as well as the overall link between these areas and how these landscape characters don´t exist in isolation but interlinked to each other. In this aspect, and despite not openly addressing the landscape as an arena for social debate, the document very much follows the line of thought proposed by the ELC.

The results from the visibility analysis confirmed one hypothesis, and that is that a vast majority of the wind power development sites present in Falkenberg, which were approved after 2011, follow the guidelines stipulated by it. The positioning of the built wind power sites follows a disposition that reduce their visual impact across different landscape characters, as evidenced by the lack of an important visual impact in the area between the flat plains and the rolling plains. The area between Falkenberg and Halland, deemed as invaluable, is left free of turbines, with the visual impact being mainly between the less critical 4-8 and 8-12 km buffers. In the coastal plains the wind power sites are associated to the existing built environment. Finally, there is a much smaller presence of sites in the Forested Highland landscape character, with a higher presence in those areas being associated to higher visual impacts. The result is a successful implementation of infrastructure that follows the knowledge imparted by a document addressing the landscape on a regional level and bridging the work of several actors whole remaining close to the ELC.

The case of Uppvidinge, and its rejection of wind power developments, is a completely different scenario. As part of the Swedish government´s goal of implementing renewable energy infrastructure, many investing companies turned their eyes to municipalities in the county of Kronoberg due to its suitability for wind power developments as recognized by the

NI framework delimiting suitable areas for it in the municipality. This infrastructure development was intensive, with the approved amount of wind power sites surpassing the production goal set for 2040. Despite the rapid implementation of wind power infrastructure, no document was drafted to assess the impact it would have on the landscape and Uppvidinge´s population, with most of the planned and approved wind power sites predating the ILCA done for the county in 2018. The result of this lack of integrating and impact assessment document is confirmed by the visibility analysis I performed and the noticeable rejection to wind power development that the municipality has experienced. The proposed wind power sites do not follow any organization, instead being widely dispersed in an area that the ILCA deemed as vulnerable to changes in scale (*CAB, 2018*). These changes in the landscape are further exacerbated by Uppvidinge's low and mainly rural-based population, leading to actor conflicts such as those described by Oles & Hammarlund (2010). The area has a distinctively high biological diversity and old-growth forests, but these highly diverse forests have been affected by the spread of Norway Spruce (*Picea abies).* This threatens to negatively impact the area from a biodiversity point of view. From a sociological point of view the area presents higher than average joblessness (10,9%) (*SCB, 2021*), population decline, especially amongst the younger generations, and bad infrastructure for its inhabitants (*CAB, 2018*), who mainly rely on private transport systems to carry out their lives. Neither of these situations seemed to be helped by the rapid implementation of wind power infrastructure, leading to the question of who it benefitted. The lack of meaningful topographic changes together with the social, cultural, and natural values imbued in Uppvidinge´s landscape character areas would suggest a lack of compatibility with the proposed disposition of wind power sites.

All of these suggest that the initial processes undertaken to develop wind power infrastructure in the municipality of Uppvidinge resembled those perpetuated by the fossil fuel industry in energy peripheries (*Golubchikov & O´Sullivan, 2020*). The evidence suggests that the actors that pushed for wind power infrastructure implementation in Uppvidinge disregarded the citizen´s connection to the landscape as well as the social issues, e.g., lack of viable infrastructure in the municipality. This is evidenced by the lack of a document that would link and their push for Wind Power with the needs of Uppvidinge. Instead, they focused on the apparent lack of population and small economy to push forwards a drastic infrastructure development. This is in turn evidenced by the fact that the proposed amount of wind power developments in Uppvidinge was in line with the most progressive scenario, which for the rest of Sweden would take until 2040 to achieve. Uppvidinge situation was that of an energy periphery, and this led to a municipality wide rejection and then veto of the wind power expansion.

The results highlighted the importance of region-based knowledge bases in the successful implementation of wind power infrastructure by municipalities, showing that a knowledge base that bridges the goals set by the national government through the NI framework and the physical planning of the municipalities is vital for its success. These documents permit, due to their nature, for there to be a constant flux of information between municipalities, as the documents are first addressed by them, then put into context at regional level, and finally used by the municipalities again to plan at physical level. This decision-making improvements at non-national level support the overhaul needed for holistic landscape management that Wu et al. (2017) recognize as vital to both infrastructure development in Sweden and the implementation of the objectives set out by the ELC. The case of Falkenberg suggests that the NI framework, when supported by regional level planning, can be a success in its balancing of land use interests and implementing sustainable wind power infrastructure in Southern Sweden. The same process could also be useful in Northern Areas of Sweden, which have also experienced land use conflicts (*Svensson et al., 2020a; Svensson et al., in rev*).

The landscape democracy issue was not directly addressed by any of the two documents, but the process description of the ILCA explicitly mentions the inclusion of citizens in its framework (*STA, 2016*). The decision-making processes in both municipalities didn´t highlight the involvement of citizens as important actors, although the municipal veto in Uppvidinge has followed citizen rejection of wind power development in the area. There is a case then that the documents, while decisive to achieve successful infrastructure implementation, could easily limit citizen participation, reducing the role of the citizenship to those in the lowest levels of the participation ladder that Arnstein (2019) theorized. This unmeaningful participation would in turn negate landscape democracy in the long-term. The results suggest that this lack of landscape democracy hamper the implementation of infrastructure. The existence of landscape democracy can then be seen as a win-win situation for all actors.

Documents that fully integrate landscape management decisions into the democratic arena and fulfil the objectives set by the ELC are crucial to improving the decision-making processes and success ratio of infrastructure developments.

Limitations

The thesis focused on uniform future increases of the wind power impacted land cover types. These provide good predictive capabilities regarding land use and landowner conflicts, but face limitations if an analysis of the impact to a specific land cover type is desired.

In the context of wind power expansion in Southern Sweden, my analysis focused mainly on two municipalities with very different degrees of success regarding wind power development, National Interest areas and existence of documents that influence decision-making at a regional level. This provided a good level of insight on the positive and negative outcomes of the two scenarios but fail to establish a general rule as there is not sufficient material analysed to perform a general statement on the decisiveness of analysis such as the LCA or ILCA. As such, there is the possibility of existing scenarios in which documents incorporating analysis such as LCA and ILCA have not been sufficient to improve the decision-making process, elevate landscape democracy or secure the success of infrastructure development.

Another limitation to the study is the choice to use a DTM (Digital Terrain Model) which showcases the upper bound of visibility impact on both municipalities, and further studies should be conducted using a Digital Surface Model to evaluate if the visibility impact is similar when taking into account features that might block the visibility of the wind turbines, especially in Uppvidinge.

Further Studies

Further studies should focus on assessing the importance of LCA, ILCA and similar analysis in a wider context. This could be done by assessing the impact, or lack of it, that they have had on all Swedish municipalities in the context of infrastructure or wind power implementation. It is through this that the true value of them can be ascertained.

6. Conclusion

Sweden is facing an energy transition that will have a noticeable impact on the landscape, the nation´s citizens and their own relationship with the landscape. With the transition to fossil-fuel, landscapes that had previously imbued values will now have to become energyscapes. Wind Power energyscapes are one of those that are posed to coexist. While still occupying a small area, wind power sites have already taken a place at the forefront of the renewable energy debate and the impact it has due to the noted impacts on already contested land covers and impacted private landowners. The projection is that this debate will only increase as the need for wind power implementation increases in the future, especially in vital landscapes with uses such as agriculture and forestry. The same can be said about landowner conflicts, with private citizens bearing the brunt of the impact wind power infrastructure will have in Southern Sweden. While the NI framework has provided a set of goals that aim to implement the infrastructure in an ecologically, socially, and economically sustainable way, the framework alone is incapable of linking this to the work of the municipalities, at times hindering their ability to sustain renewable development. It is then imperative that the synergies proposed by the framework are complemented by a group of analysis and documents that facilitate the link between actor spheres and aim to include meaningful citizen participation. Amongst these multilevel knowledge bases, ELC based analysis such as LCA or the Transport Administration's created ILCA proved decisive in the success of wind power infrastructure implementation, as shown in the municipality of Falkenberg. These knowledge bases focus on landscape as an arena for both democracy and infrastructure development, as well as the linking national, regional, and municipal goals while allowing for meaningful citizen participation. The benefits from properly introducing the ELC´s objectives into regional, national and local processes by strengthening ILCA as a tool can ease the energy transition while strengthening the importance of the landscape in the social, historical, and ecological strata. The transition would then comply with ELC and deviate from the damaging energy periphery framework that has been perpetuated by fossil-fuel energy systems and which found a similar in the wind power implementation processes in Uppvidinge. For Sweden´s goal of sustainable land use to be achieved, democratic landscape and infrastructure processes need to be implemented in all actor strata, and a strengthened and improved ILCA can play a decisive role in it.

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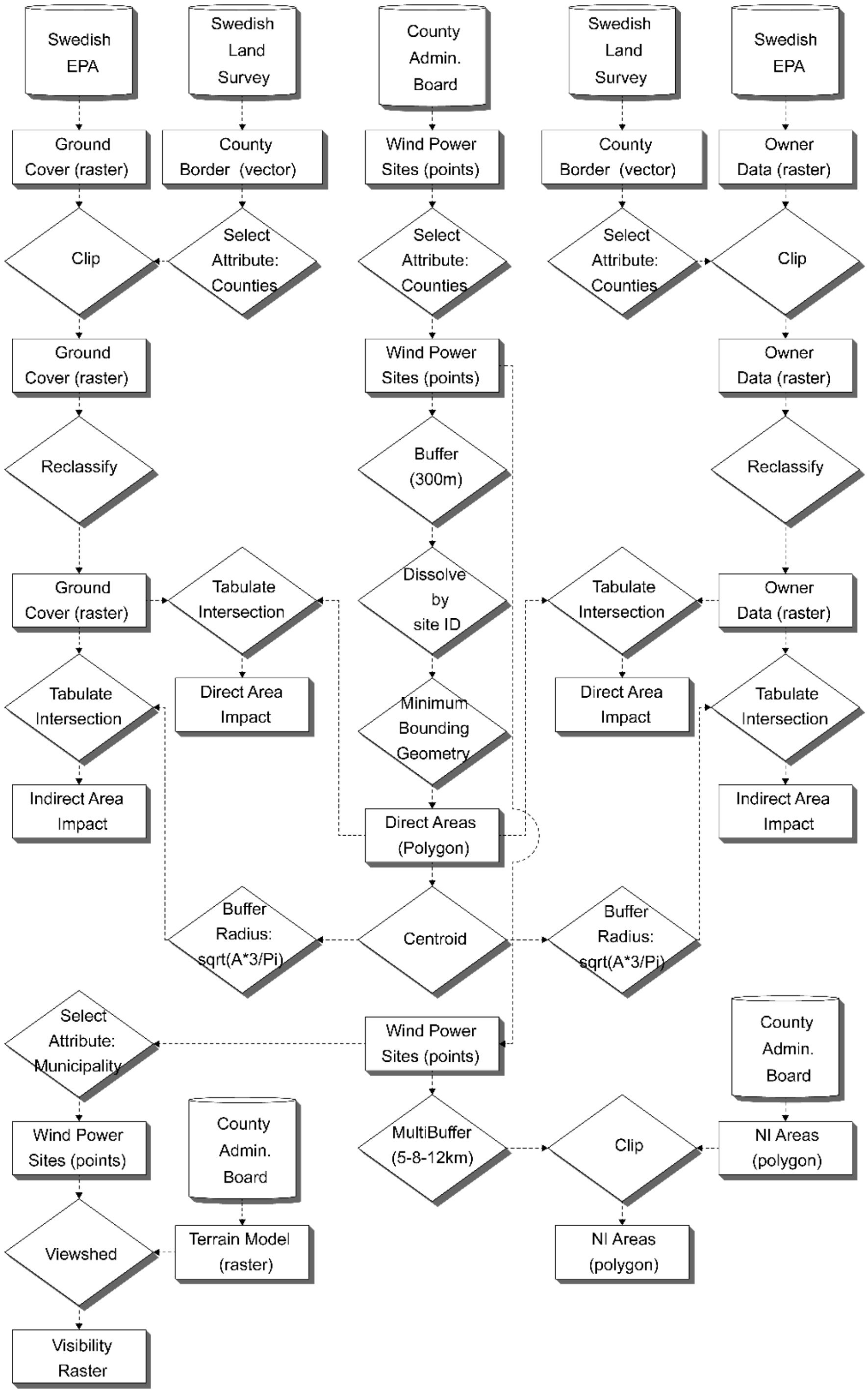
8. Appendix

***Appendix 1**: Flowchart of analysis performed using ArcGIS*



Appendix 2*: Spatial Coverage of Land Cover types within wind power sites (direct area) and planning areas (indirect area) in the Nemoral zone of Sweden. The Spatial Coverage accounts for three different scenarios: present status (01/01/2022), 80 TWh, 100 TWh and 120 TWh.*

Land Cover Nemoral Area	**Direct/ Indirect Area (km²)**							
	2022		80 TWh		100 TWh		120 TWh	
Open Wetland	3,44	11,91	3,38	11,99	3,75	13,32	4,50	15,99
Arable Land	98,00	286,33	110,28	324,48	122,54	360,53	147,04	432,63
Open Land	12,03	39,86	13,25	44,03	14,73	48,93	17,67	58,71
Artificial Surfaces	7,96	25,30	8,46	27,35	9,40	30,39	11,28	36,47
Inland Water	1,99	9,56	1,99	9,56	2,21	10,62	2,65	12,75
Marine Water	2,42	8,68	2,90	10,75	3,22	11,94	3,86	14,33
Conifer Forest	39,76	106,30	40,75	110,90	45,28	123,22	54,34	147,87
Deciduous and Mixed Forest	22,07	77,03	23,37	83,17	25,96	92,41	31,16	110,90
Temporarily non-forest	21,72	52,40	21,62	53,76	24,02	59,73	28,82	71,68

Appendix 3*: Spatial Coverage of Land Cover types within wind power sites (direct area) and planning areas (indirect area) in the Boreonemoral zone of Sweden. The Spatial Coverage accounts for three different scenarios: present status (01/01/2022), 80 TWh, 100 TWh and 120 TWh.*

Land Cover Boreonemoral Area	**Direct/ Indirect Area (km²)**							
	2022		80 TWh		100 TWh		120 TWh	
Open Wetland	23,40	59,16	34,83	87,44	38,70	97,16	46,44	116,59
Arable Land	137,66	442,13	299,74	945,70	333,05	1050,77	399,65	1260,90
Open Land	55,95	174,40	100,02	298,32	111,13	331,47	133,35	397,75
Artificial Surfaces	26,25	79,19	52,20	160,99	58,00	178,88	69,60	214,65
Inland Water	16,60	65,16	24,65	95,96	27,39	106,62	32,87	127,94
Marine Water	5,36	33,69	33,35	137,41	37,06	152,68	44,47	183,22
Conifer Forest	342,93	917,63	499,81	1383,84	555,34	1537,59	666,39	1845,08
Deciduous and Mixed Forest	81,65	288,32	140,12	485,74	155,69	539,70	186,83	647,63
Temporarily non-forest	115,87	303,83	165,67	441,13	184,07	490,14	220,89	588,16

Appendix 4: *Mean Proportion of Spatial Coverage Increases per Land Cover type within wind power sites (direct area) and planning areas (indirect area) compared with total area per land cover type in the Boreonemoral and Nemoral zones of Sweden. All future scenarios are used to calculate the mean increase.*

Land Cover	**Direct/ Indirect Area (km^2)**			
	Mean Increase Nemoral Area		Mean Increase Boreonemoral Area	
Open Wetland	0,006	0,021	0,011	0,021
Arable Land	0,027	0,082	0,014	0,082
Open Land	0,007	0,024	0,012	0,024
Artificial Surfaces	0,009	0,029	0,015	0,029
Inland Water	0,002	0,010	0,002	0,010
Marine Water	0,000	0,001	0,000	0,001
Conifer Forest	0,011	0,029	0,014	0,029
Deciduous and Mixed Forest	0,007	0,025	0,010	0,025
Temporarily non-forest	0,009	0,025	0,016	0,025

Appendix 5: *Spatial Coverage of Land Owner types within wind power sites (direct area) and planning areas (indirect area) in the Nemoral zone of Sweden. The Spatial Coverage accounts for three different scenarios: present status (01/01/2022), 80 TWh, 100 TWh and 120 TWh.*

Landowner Nemoral Area	**Direct/ Indirect Area (km^2)**							
	2022		80 TWh		100 TWh		120 TWh	
State	9,14	24,72	9,37	25,93	10,42	28,81	12,50	34,57
Company	11,36	30,05	13,41	34,36	14,90	38,18	17,88	45,81
Private	186,40	548,62	200,41	600,14	222,68	666,82	267,21	800,17

Appendix 6*: Spatial Coverage of Land Owner types within wind power sites (direct area) and planning areas (indirect area) in the Boreonemoral zone of Sweden. The Spatial Coverage accounts for three different scenarios: present status (01/01/2022), 80 TWh, 100 TWh and 120 TWh.*

Landowner Boreonemoral Area	**Direct/ Indirect Area (km^2)**							
	2022		80 TWh		100 TWh		120 TWh	
State	15,49	39,50	20,67	63,04	22,96	70,04	27,56	84,05
Company	120,74	337,72	213,15	652,62	236,83	725,12	284,19	870,14
Private	651,67	1898,4	1065,84	3142,1	1184,26	3491,2	1421,09	4189,3

Appendix 7*: Mean Proportion of Spatial Coverage Increases per Land Owner type within wind power sites (direct area) and planning areas (indirect area) compared with total area per land cover type in the Boreonemoral and Nemoral zones of Sweden. All future scenarios are used to calculate the mean increase.*

Owner	**Direct/ Indirect Area (km^2)**			
	Mean Increase Nemoral Area		Mean Increase Boreonemoral Area	
State	0,005	0,017	0,002	0,010
Company	0,014	0,033	0,015	0,044
Private	0,014	0,044	0,018	0,052

Appendix 8: *Proportion of NI areas present in a 4km buffer from all wind power sites in Nemoral zone counties (Skåne and Halland) and Boreonemoral zone counties (Jönköping and Kronoberg) compared to total county area.*

NI Area	**Percent of total area in a 4km radius**			
	Skåne	Jönköping	Halland	Kronoberg
Swedish Armed Forces	0	0	0	0
Cultural Heritage	3,6	0,78	2,17	0,03
Outdoor Recreation	1,78	1,1	3,82	0,17
Recreation	3	0	1	0
Nature Conservation	5	2	3	0
Protected Waterways	0	4	0	5
Natura 2000 Habitats	1	1	0	0
Valuable Materials	0	0	0	0
Wind Power	0	1	0	2
Total	14,38	11	11	7,2

Appendix 9*: Proportion of NI areas present in a 8km buffer from all wind power sites in Nemoral zone counties (Skåne and Halland) and Boreonemoral zone counties (Jönköping and Kronoberg) compared to total county area.*

NI Area	**Percent of total area in an 8km radius**			
	Skåne	Jönköping	Halland	Kronoberg
Swedish Armed Forces	0,40	0,3	0,43	0
Cultural Heritage	5,8	1,5	3,7	0,2
Outdoor Recreation	4,7	3,2	9,7	1
Recreation	7,8	1	3,8	0,4
Nature Conservation	11	6,80	7,2	1
Protected Waterways	0	12,9	0	10,7
Natura 2000 Habitats	3,1	3,1	1,3	0,25
Valuable Materials	0,1	0	0	0
Wind Power	0,1	1,95	0	2,4
Total	33	31	26	16

Appendix 10*: Proportion of NI areas present in a12km buffer from all wind power sites in Nemoral zone counties (Skåne and Halland) and Boreonemoral zone counties (Jönköping and Kronoberg) compared to total county area.*

NI Area	**Percent of total area in an 12km radius**			
	Skåne	Jönköping	Halland	Kronoberg
Swedish Armed Forces	0,5	0,3	0,6	0
Cultural Heritage	6,5	2,1	4,2	0,5
Outdoor Recreation	6,5	5,7	14,2	2,2
Recreation	11,7	2,0	5,8	1,5
Nature Conservation	15,2	11,0	10,2	2,3
Protected Waterways	0	20,6	0	16,6
Natura 2000 Habitats	6,6	5,7	2,5	0,7
Valuable Materials	0,1	0,1	0	0
Wind Power	0,2	2,2	0,2	2,5
Totals	47,4	50	38	26,2

Appendix 11: *Proportion of NI areas present in a 4km buffer from all wind power sites in the municipalities of Falkenberg and Uppvidinge compared to total municipality area.*

NI Area	**Percent of total area in a 4km radius**	
	Falkenberg	Uppvidinge
Swedish Armed Forces	0	0
Cultural Heritage	6,2	0,22
Outdoor Recreation	7	0
Recreation	0,5	0
Nature Conservation	1,11	1,22
Protected Waterways	0	15,64
Natura 2000 Habitats	0,26	0,37
Valuable Materials	0	0
Wind Power	0	11
Total	15,07	28,45

Appendix 12: *Proportion of NI areas present in an 8km buffer from all wind power sites in the municipalities of Falkenberg and Uppvidinge compared to total municipality area.*

NI Area	**Percent of total area in a 8km radius**	
	Falkenberg	Uppvidinge
Swedish Armed Forces	0	0
Cultural Heritage	10,7	0,4
Outdoor Recreation	14,6	0
Recreation	1,3	0
Nature Conservation	2,8	1,75
Protected Waterways	0	20
Natura 2000 Habitats	0,52	0,6
Valuable Materials	0	0
Wind Power	0,04	11,4
Total	29,96	34,15

Appendix 13*: Proportion of NI areas present in a 12km buffer from all wind power sites in the municipalities of Falkenberg and Uppvidinge compared to total municipality area.*

NI Area	**Percent of total area in a 12km radius**	
	Falkenberg	Uppvidinge
Swedish Armed Forces	0	0
Cultural Heritage	12,13	0,5
Outdoor Recreation	19,2	0
Recreation	1	0
Nature Conservation	4,1	3,75
Protected Waterways	0	22
Natura 2000 Habitats	0,7	2,4
Valuable Materials	0	0
Wind Power	0,8	11,41
Total	37,93	40,06

Appendix 14: *Proportion of NI areas present in a 4km buffer from all wind power sites in the municipalities of Falkenberg and Uppvidinge compared to total NI area in the municipality.*

Impacted NI areas	**Falkenberg**	**Uppvidinge**
Area in 4km Buffer km^2	232, 6	281,4
Total NI Area in km^2	680,3	412,1
Percentage of Total NI Area	34,19593237	68,27880547