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Balancing wind power deployment and sustainability objectives in Swedish planning and permitting

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Abstract

Background: Wind power is a critical renewable energy technology in efforts to achieve the global climate targets. However, local impacts do occur, which demands careful consideration in planning and permitting. Sweden has set an ambition to triple land-based wind power by 2040, and municipalities play a key role in both the planning and permitting process, due to a planning monopoly and veto power in the permitting process. This calls for an investigation of Swedish wind power governance, with a particular focus on recent trends in municipal wind power planning, how wind power is balanced in relation to sustainability objectives in planning and permitting, and insights from practitioners regarding their capacities and drivers.

Results: The results show that about two-thirds of Swedish municipalities have conducted wind power planning in some form, but this basis for decision-making has become outdated due to a lack of institutional capacity at the municipal level. Secondly, the study finds that many municipalities perceive that there are insufficient incentives for a continued wind power expansion. Lastly, the study sheds light on a large heterogeneity within wind power planning practice concerning how trade-offs between wind power deployment and other sustainability aspects are handled, as well as a lack of coherence between planning and permitting.

Conclusions: It is concluded that the current state of municipal wind power planning raises questions regarding the legitimacy of municipal decision-making in terms of perceived justice among local inhabitants and highlights the need for updated wind power plans. Moreover, to promote local acceptance in the future, formalised financial compensation and strategic initiatives that enable the localisation of electricity-intensive industry within municipalities with large-scale wind power production can be two key components. The results also highlight the need for additional support at the municipal level, including access to critical competence and relevant knowledge to enable trade-offs between the different sustainability considerations in an informed and balanced manner. Finally, regional dialogue with key actors, such as the military, Sami representatives and grid operators, would facilitate the handling of inter-municipal issues, in particular by fostering co-operation regarding inter-municipal wind sites.

Keywords: Wind power planning, Wind power governance, Municipal planning, Permitting, Institutional capacity, Local acceptance, Sustainable development, Climate change mitigation

Background

With global temperatures continuing to increase and the impacts of climate change becoming increasingly tangible and severe, the need for climate action is evident and urgent [1]. Recent research on global carbon budgets suggests that global net-zero emissions must

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be reached by 2040 in order to have a 50% chance of keeping global heating under the 1.5 °C target, underlining the need for rapid decarbonisation [2]. However, as manifested by the adoption of the United Nation's 17 Sustainable Development Goals within the 2030 Agenda for Sustainable Development [3], the world faces numerous pressing environmental, social and political challenges. There is thus a need for a variety of actors at different levels to pursue multiple sustainability objectives simultaneously to avoid an irreversible impact on earth's life-supporting systems [4, 5]. Due to the pervasive impacts of climate change on all aspects of society and nature, climate action provides synergies with all seventeen of the Sustainable Development Goals, although it has the potential to undermine certain efforts taken to achieve twelve of these goals [6].

The most central part of addressing the climate crisis is the need to move away from fossil fuels to renewable energy production [7]. One viable renewable energy technology is wind power, for which the total installed capacity continues to increase while costs decrease [8, 9]. A key factor for lower costs is technological development, with the power capacity for each turbine increasing as they grow bigger in size (Ibid.). Nevertheless, although wind power provides renewable electricity, it can have certain impacts on the local level. Such impacts range from noise [10], impacts on the landscape and cultural environment [11, 12], collision mortality and habitat loss for birds and bats [13, 14], potential habitat loss for non-volant terrestrial wildlife [15], and obstruction of nomadic reindeer herding activities [16]. This highlights the need to carefully balance wind power deployment in relation to other sustainability concerns.

Sweden is one of many countries facing a rapid expansion of wind power. As a part of Sweden's ambition to have 100% renewable electricity production in 2040, the Swedish Energy Agency and the Swedish Environmental Protection Agency have developed a national wind power strategy. This strategy is based on a projected planning target of 80 TWh of land-based wind power by 2040 [17]. This would roughly equal a threefold increase compared to the annual production of 26.9 TWh in 2020 [18]. However, it has become increasingly more difficult for the wind power developers to gain a permit regarding their applications for onshore wind power, and for all the applied turbines which came to a decision during 2021, only approximately one fifth of the applied turbines gained an approval [19, 20]. This downward trend is likely to affect the pace of wind power deployment during the coming decades and Sweden's ability to reach the set planning target (Ibid.).

Wind power governance and planning

Swedish wind power governance and planning is situated in a multi-level governance context [21]. The 290 municipalities in Sweden, which represent the local governmental body closest to the citizens, could be regarded as the most influential actors in this multi-level landscape [22]. One reason for this is that they possess a so-called planning monopoly, meaning that they have sovereignty over spatial planning within their geographical area [23]. A key planning instrument is the municipal comprehensive plan (CP), which is a strategic plan that outlines the long-term use of land and water over the decades to come [24]. Through the CP, the municipalities convey how they will consider and negotiate between different local and national interests [25]. Municipalities also have the option to develop thematic amendments to a CP, where they can elaborate on issues not (fully) addressed in the adopted CP [26]. It is common for municipalities to utilise such thematic amendments to address wind power in their comprehensive planning, an endeavour that received national financial support from 2007 to 2010 [27]. The wind power developers, which are the actors ultimately responsible for executing the expansion of wind power, have not been given any formal role in relation to wind power planning [28], although they for example can leave review statements when a CP is out for consultation.

The reason for the previously mentioned centrality of the Swedish municipalities within wind power planning and governance is twofold. Apart from their planning monopoly, the municipalities play a decisive role within wind power permitting. Projects that include either two or more wind turbines with a total height over 150 m, or seven or more wind turbines with a total height over 120 m, require a permit according to the Environmental Code, which is issued by the County Environmental Appeal Delegation [29]. For a permit to be given, formal approval by the municipality is required [21]. This is commonly referred to as a municipal veto on wind power, since in practice the municipalities can deny a permit application for a wind power project (Ibid.). Moreover, there is no requirement for the municipalities to motivate their decision, and no requirements regarding when in the process this decision must be taken [29]. The municipal veto was introduced in 2009 when legislative changes to the permitting process for wind power were made in order to preserve the principle of local self-government [21]. Even though the legal reform was intended to streamline and simplify the permitting process, it has effectively added an element of insecurity for potential developers [30]. Since the reform was introduced, the suitability of the veto has been discussed, and in 2021, a Swedish Governmental Official Report 2021:53 [31]

included a proposal to formalise the municipal veto. This would mean that the veto power would need to be exercised at the beginning of the permitting process and that the grounds for this decision would need to be based on the municipality's view on the suitability of wind power as a land use at the planned site according to their CP.

It has long been recognised that the procedures in which municipal wind power planning is conducted can differ largely between different municipalities and affect both the potential for wind power deployment and opportunities for public participation [32]. Previous research has also highlighted that public resistance and the regulatory framework governing the planning and permitting procedures are central challenges for a continued wind power expansion in line with established national targets [33]. In a study comparing Swedish, Danish and Norwegian wind power planning and permitting, it has been found that the Swedish governance system leaves less opportunities for steering implementation of national policies at the local level [22]. In contrast, Liljenfeldt [34] showed that all wind power planning and governance systems of Sweden, Norway and Finland has shifted towards more top-down governance in order to enhance the output efficiency, with risk of eroding the legitimacy of the processes. Furthermore, a comparative study between Sweden and Germany concludes that the German regional priority areas for wind power has had a more profound positive impact on the expansion than the Swedish Areas of National Interest (ANIs) for wind power, whereas assignment of protected areas have entailed a more definitive exclusion in Sweden than in Germany [35].

When evaluating wind power planning in Sweden's neighbouring country Denmark, Sperling et al. [36] argues that an integrated framework is needed when analysing wind power planning and policy, encompassing (i) financial conditions for developers, (ii) means for local planning authorities to conduct wind power planning, and (iii) local and regional development and acceptance. Moreover, Denmark has endured similar challenges regarding designating suitable areas for wind power in municipal planning as well as gaining approval from municipalities for siting of wind power in recent years [37]. One potential solution to gaining local acceptance, recognized in Denmark, have been to enable local co-ownership of wind power [38, 39].

The previously mentioned downward trend regarding wind power permitting in Sweden has mostly been dependent on the rate of municipal approval and the balancing of different sustainability interests in the permitting process [19, 20]. Given these facts as a backdrop, there is a need to analyse the current practice regarding how the current wind power practice is constituted as well as how wind power is handled and weighted in relation to sustainability concerns (i.e. criteria) in municipal planning and decision-making as well as the permitting process. Insights regarding how this is handled in the planning and permitting process could also inform spatial analysis of multiple criteria and enrich discussions on the harmonisation of municipal planning and permitting. Furthermore, such insights can help identify ways the regional governance level can facilitate the continued swift deployment of wind power.

The overarching research question for this research paper is therefore set to:

- What are the main obstacles within Swedish wind power planning and governance that may hinder a continued rapid expansion of wind power, and what could be potential pathways forward?

Within the academic literature revolving around wind power planning and governance there has been fairly few papers utilizing quantitative approaches, although some exemptions exist [23, 35, 40–42]. These papers have all focused on different variables that can either affect or explain the rate and distribution of the deployment of wind power in different ways. To the authors' knowledge, quantitative methods have thus far not been employed to analyse broader patterns and trends within local wind power planning, with the local planning practice as the main entity of study. There is thus a methodological novelty in adding the quantitative document analysis as a part of a methodological triangulation within wind power planning research, which will be further detailed in the Methods section.

National and regional influence on Swedish wind power planning and decision-making

Areas of national interest are regulated in Chapters 3 and 4 of the Environmental Code. ANIs from the former chapter are decided upon by national sectoral agencies, which designate the areas either for specified land uses (e.g., energy production, national defence, reindeer herding, outdoor recreation) or as particularly ecologically and culturally sensitive environments [43]. Notably, ANIs for energy production include a specific type of ANI for wind power [44]. ANIs specified in Chapter 4 of the Environmental Code, on the other hand, are certain cohesive areas (e.g., certain coastal areas, mountainous areas, areas for tourism and outdoor recreation) where landscape and nature values are intended to be protected [43]. Different ANIs can overlap with each other or with other areas that are more formally protected through legislation, such as Natura 2000 areas, national parks, nature reserves and culture reserves [25]. Moreover, areas of national interest

and areas of importance for national defence should be given priority in relation to other ANIs listed in Chapter 3 of the Environmental Code (1998:808) [45]. Even though the intent of designating areas of national interest is to safeguard these interests, there is no definitive protection against other land use. Ultimately, the effect of a designation will be decided upon in decision-making processes for permit applications [43].

In addition to the municipalities, the county administrative boards (CABs), which are the regional representatives of the central state [46], also play an important role in wind power planning. With regard to ANIs, they are instructed to provide descriptions of the protected values for ANI of nature conservation, ANI of cultural environment, and ANI of outdoor recreation according to Chapter 3 in the Environmental Code, as well as for all ANIs in Chapter 4 of the Environmental Code [47]. Moreover, the CABs are also tasked with providing programmes, reports and other types of documentation that can serve as a basis for planning relating to sustainable land and water use within the county, of which the ANIs are a vital part (Ibid.). Furthermore, in the comprehensive planning process, the CABs are also tasked with supporting the municipalities in their handling of ANIs to ensure that the greatest consideration possible is taken and are responsible for producing a review statement addressing whether the ANIs are accommodated in the CP (Ibid.). Additionally, the county administrative boards are mandated to lead and coordinate the energy and climate transition within the county [48]. In the national wind power strategy, the national wind power target of 80 TWh has been divided into regionalised targets for each county, which are to be interpreted as the minimum amount of planned wind power in each county [17]. It is also suggested that the CABs should conduct regional analyses and investigate whether the regionalised targets for wind power deployment can be met (Ibid.).

Permit applications first go to the County Environmental Appeal Delegation [29]. If a decision by the County Environmental Appeal Delegation is appealed, the case may proceed to the Land and Environmental Court, and potentially the Land and Environmental Court of Appeal (prior to 2012, known as the Environmental Court of Appeal) (Ibid.). Any rulings made by the Land and Environmental Court of Appeal should establish a precedent and can thus be indicative of how the interest of deploying wind power is balanced in relation to other sustainability aspects in the permitting stage.

Methods

This paper has employed a research design that combines two parallel document analyses. Both municipal policy documents and precedential court cases have been collected and analysed separately. Key themes emerging from the qualitative content analysis of wind power plans were selected as focal points of the study. Within these themes, planning practices were analysed in greater detail. The synthesis of the precedential court cases mainly centred on the same themes to allow for discussions and to be able to draw broader conclusions regarding the harmonisation and interplay between planning and permitting. In order to corroborate the findings of the document analyses with qualitative insights, a focus group interview was conducted with municipal officials. By employing methodological triangulation, the validity of the findings can be strengthened [49].

Collection and analysis of wind power plans

All municipal policy documents focusing on wind power, jointly referred to in this paper as wind power plans, and all municipal CPs have been collected by examining each of the 290 Swedish municipalities' respective website. In the case of multiple versions of either wind power plans or CPs, only the most recent version was included. In total, 290 CPs and 198 wind power plans were collected. The wind power plans were classified by type, based on whether it was explicitly stated in the title or elsewhere that the policy document under assessment was to have the status of, for example, a thematic amendment to a CP. The wind power plans were also classified according to whether they had been produced through inter-municipal co-operation. In order to assess the current state of municipal wind power planning, while considering the potential integration of wind power plans into CPs adopted after the wind power plan, the municipalities were sorted in three different categories:

i) For municipalities that had only adopted a CP, it was assessed whether a spatial analysis of wind power had been conducted.
ii) For municipalities that had adopted a wind power plan the same year or later than the CP, this was assumed to be the main policy document for addressing wind power, and no analysis of these municipalities' CPs was carried out.
iii) For municipalities that had adopted a wind power plan prior to the adoption of their most recent CP, the handling of wind power in the CP was explored by examining a) whether a new spatial wind power analysis had been conducted within the realm of the comprehensive planning process, b) whether the previous wind power plan was considered to still be up-to-date and kept as a municipal policy document, and c) whether results from the spatial analysis in the previous wind power plan were integrated into the CP. If the wind power plan was considered out-dated

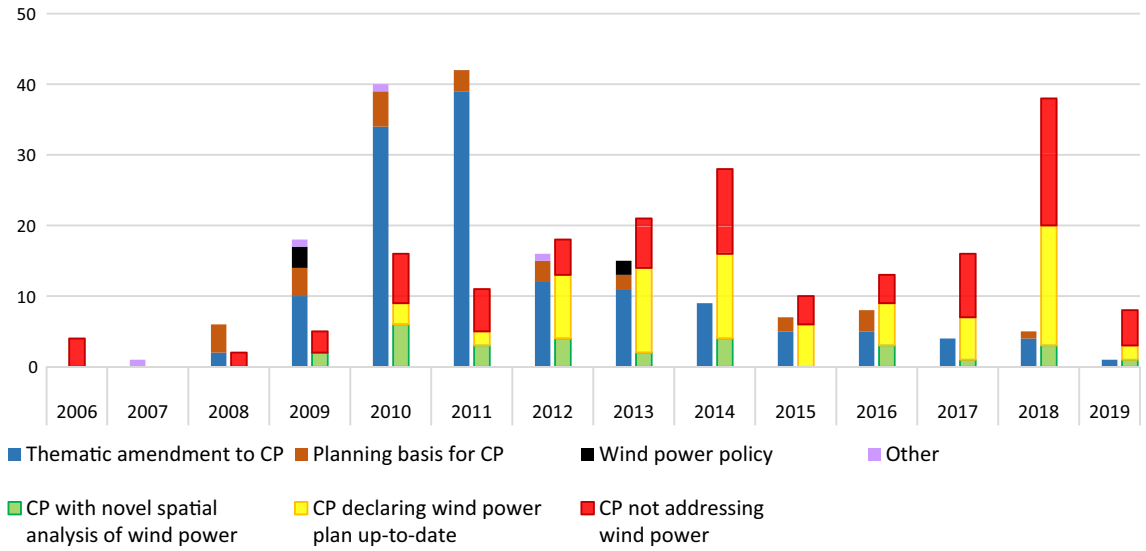

Fig. 1 Handling of wind power in municipal CPs and other policy documents by year

in the CP and the spatial analysis was not integrated into the CP, the preceding wind power plan was excluded from the results.

The analysis of the CPs was guided by a text search for the term 'wind power' in Swedish. When analysing potential integration into the CP, the title of the wind power plan was also utilised as a search phrase to find relevant statements. Descriptive statistics of the broader trends concerning the type of wind power plans and the role of the CP in relation to wind power were extracted and are presented in Fig. 1.

A selection of 37 wind power plans was analysed in more detail in a qualitative content analysis. These wind power plans and their associated municipalities were selected to be representative for the collected dataset as a whole with respect to the year of adoption, county (for geographical spread) and municipality type according to a classification made by the Swedish Association of Local Authorities and Regions [50]. The content of the wind power plans was iteratively scrutinised and clustered when commonalities in the material were identified. The key themes identified in the qualitative content analysis were Built environment, Nature conservation, Cultural environment, Recreation, Reindeer herding, Landscape considerations, and National defence. The document analyses of municipal wind power plans and municipal CPs were conducted through the use of NVivo [51].

Concerning ANIs for recreation, there is one type of ANI for outdoor recreation according to the Environmental Code Chapter 3, Sect. 6 and one type of ANI for tourism and outdoor recreation according to the Environmental Code 4 Chapter, Sect. 2. In the municipal plans, it was not always clear which type of ANI was being addressed, and these ANIs were thus treated jointly in the qualitative content analyses of the plans.

Collection and analysis of precedential court cases

Precedential court cases where wind power permits were examined according to the Environmental Code were gathered from the Land and Environment Court of Appeal for cases from 2012 through April 2021 as well as from the court's predecessor, the Environmental Court of Appeal, for the years 2000–2011. Such cases were found by searching for the term "wind" in the summary statements made by the courts to discern whether the case met the criteria for inclusion.[1] The court cases were then reviewed in more detail to select cases that addressed the key themes identified in the analysis of wind power plans. This was done by reviewing the legal grounds for the decisions and selecting cases that also had a spatial connection. Additionally, a meta-theme regarding the role of the CP in precedential court cases was added. In addition to the themes built environment (including noise and shadowing effect) and landscape considerations, the matters relating to the different themes addressed by the Land and Environmental Court of Appeal generally included different types of designated and protected

[1] The precedential court cases from the Land and Environmental court of Appeal were collected from the court's website [52], whereas precedential court cases from the Environmental Court of Appeal were collected from the database provided by Swedish Courts [53].

areas. This analysis was aided by the overview of court cases provided by Ardö [54].

Court cases that concern military interests are handled by the government of Sweden and have thus not been included in the analysis of court cases. However, a brief account of these specific rulings is provided in the results section and is based on a summary of these court cases written by Ardö [55] to enable a comparison between planning and permitting.

Focus group interview

A focus group interview was held with six municipal officials representing four different municipalities in Västernorrland County (a list of participants can be found in Table 1 in Appendix A). This is the county that produces the most wind power in Sweden at 3.8 TWh in 2020 (compared to the national total of 26.9 TWh) [18], and the municipalities within the county have experience in municipal wind power planning, municipal decision-making with regard to the exercise of veto power and the construction of large wind farms. The four municipalities represented at the focus group interview, namely Kramfors, Sollefteå, Ånge and Örnsköldsvik show some diversity regarding their characteristics in the sense that Örnsköldsvik is classified as a small town, with about 50 000 inhabitants, whereas the other municipalities as classified as rural municipalities, all with less than 20 000 inhabitants each [50, 56]. As recommended by Short [57], the focus group interview was guided by pre-defined questions (enclosed in Appendix B) to foster discussion and was moderated by the researchers. The interview, which was arranged through a digital videoconferencing platform, was recorded and subsequently transcribed. The transcribed data were clustered into overarching themes, guided by the pre-determined discussion questions, and summarised.

Results

National overview of municipal wind power planning practice

The quantitative results for wind power planning practice shows that 197 municipalities have spatially addressed wind power in their current policy documents, which constitutes approximately two-thirds of Sweden's municipalities. Thematic amendments to the CP are clearly the most common type of policy document that municipalities utilise when they conduct their wind power planning, representing two-thirds of the policy documents identified (Fig. 1). As depicted in Fig. 1, to conduct spatial wind power analyses within the ordinary comprehensive planning process is uncommon, as it represents 15% of all policy documents in which wind power has been spatially analysed. Still, 75 municipalities declared

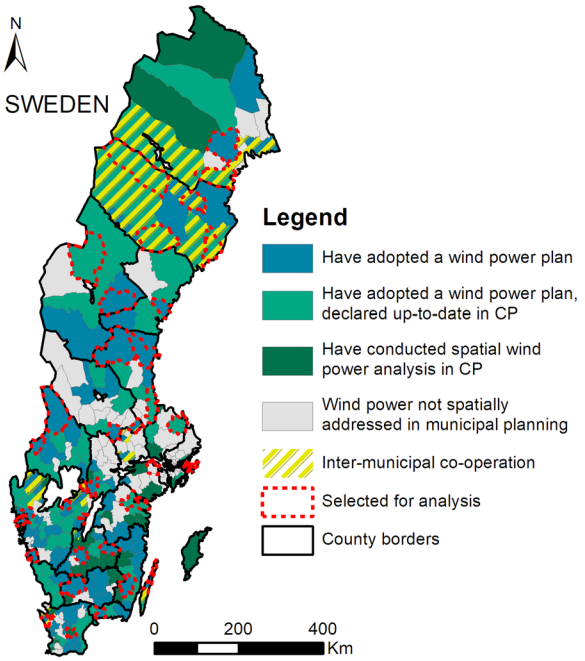

Fig. 2 Visualisation of quantitative mapping of wind power planning practice. Spatial data (c) Lantmäteriet

previously adopted wind power plans to be up-to-date in a CP adopted at a later stage, 53 of which also integrated results from the spatial wind power analysis into the CP (Fig. 1). However, Fig. 1 also highlights that nearly half of the analysed CPs (45%) have not spatially addressed wind power to any extent. A clear temporal trend depicted in Fig. 1 is that the number of municipal policy documents addressing wind power spikes in 2010–2011, with a steady decline in the following years. In total, less than one-sixth of all Swedish municipalities have conducted wind power planning in the sense that they have iterated a spatial wind power analysis in the latter half of the period studied (2014–2019).

Out of the collected wind power plans, one-fifth had been produced through inter-municipal co-operation. As can be discerned in Fig. 2, there are adjacent municipalities that have engaged in co-operation in joint planning processes. Furthermore, there are large regional differences regarding the share of municipalities that have spatially addressed wind power between the different counties (Fig. 2). In some of the more sparsely populated, northern counties (e.g., Jämtland, Västerbotten and Västernorrland), wind power plans have been adopted by virtually all of their municipalities, whereas some of the more urban counties in the southeast of Sweden, for example, Stockholm, Västmanland and Södermanland, have the lowest adoption rate at 15%, 30%, and 44%, respectively. As can be inferred by Fig. 2, the two-thirds

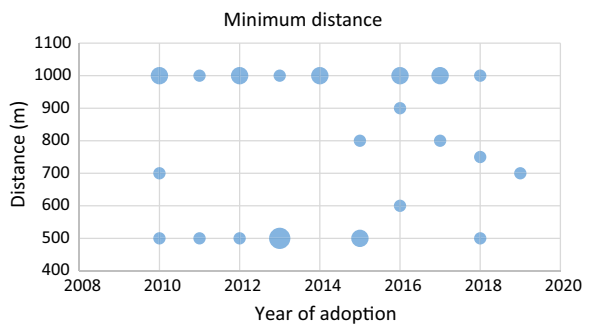

Fig. 3 Visualisation of established minimum distance. Based on 29 wind power plans with a static criterion

of the municipalities that have addressed wind power in some way during the studied time period represent approximately 80% of Sweden's land area.

Spatial sustainability considerations in wind power planning and permitting

Prior to unravelling the spatial sustainability considerations made in wind power planning and permitting, certain characteristics regarding the municipalities' trade-offs should be disclosed. One of the studied municipalities has explicitly stated that they do not want any more wind power to be established within their geographical area. Moreover, three municipalities have decided to only investigate where wind power is not suitable and will assess the suitability of all wind power projects in other areas on a case-by-case basis. Otherwise, the most common approach is to designate areas suitable for wind power, sometimes in combination with the designation of areas where wind power may be considered and/or areas where wind power should be avoided.

Built environment

The theme of built environment were in the qualitative content analysis further divided into the three sub-themes of *distance to housing*, *noise* and *shadowing effect*. The results for each of them are specified below.

Distance to housing For each theme or sub-theme presented in this results section, the results are structured to give an account for findings relating both to wind power planning practice and precedential court cases.

Wind power planning practice. As shown in Fig. 3, the required minimum distance to housing varies between 500 and 1000 m. The same figure depicts that there are no clear temporal trends concerning the established minimum distance to housing over time. In addition to these 29 plans with static criteria for minimum distances, it was stated in seven wind power plans that the minimum distance would be decided on a case-by-case basis, mostly depending on noise and shadowing requirements.

Precedential court cases. There are no general requirements on distance to housing established in precedential court cases. Instead, distances are dependent on the local impacts caused by the wind turbines, mainly noise and shadowing effects. In fact, one criterion for a general distance to housing of 1000 m was revoked in a court ruling, with the motivation that a criterion regarding maximum noise level adjacent to housing was sufficient [58].

Noise *Wind power planning practice* All but two wind power plans have established clear standpoints regarding noise limits for built-up areas. As highlighted in Fig. 4, the most common noise limit imposed for built-up areas is 40 dB(A). This is the same noise limit as currently specified by the national guidelines, and the municipalities that have stated that national guidelines ought to be adhered to thus have the same noise limits imposed, unless the guidelines would be revised in the future. In contrast, a number of other municipalities have set more strict criteria of 35 dB(A) (Fig. 4). Moreover, as presented in Fig. 4, seven of the 27 municipalities that set a 40 dB(A) noise limit in built-up areas have imposed noise limits in other areas as well, predominantly areas of local or national interest for recreation or silent areas.

Precedential court cases It has long been considered standard practice that noise levels should not exceed 40 dB(A) outdoors adjacent to housing.[2] More stringent requirements of 35 dB(A) have been established in some instances. An example of this is case M 2917–16 [67] in which 35 dB(A) was set as noise limit for certain holiday home areas. However, in more recent cases, it has been ruled that being a planned area for holiday homes does not constitute grounds to impose a stricter requirement of 35 dB(A) [70]. In another ruling, an area specifically described as a silent area in a municipal CP had a requirement of 35 dB(A), but only where it overlapped with a nature reserve [91].

Shadowing effect *Wind power planning practice* Out of the investigated plans, 22 included clear standpoints for restrictions on shadows from wind power turbines falling on housing. Out of those plans, 17 state that there should not be more than 30 h of theoretical shadowing time per year, and the factual shadowing time should not exceed 8 h per year or 30 min per day. The other five plans state that current guidelines should be adhered to.

Precedential court cases Numerous precedential court cases have established a requirement that sensitive areas

[2] Court cases supporting the 40 dB(A) requirement are: [58–91]

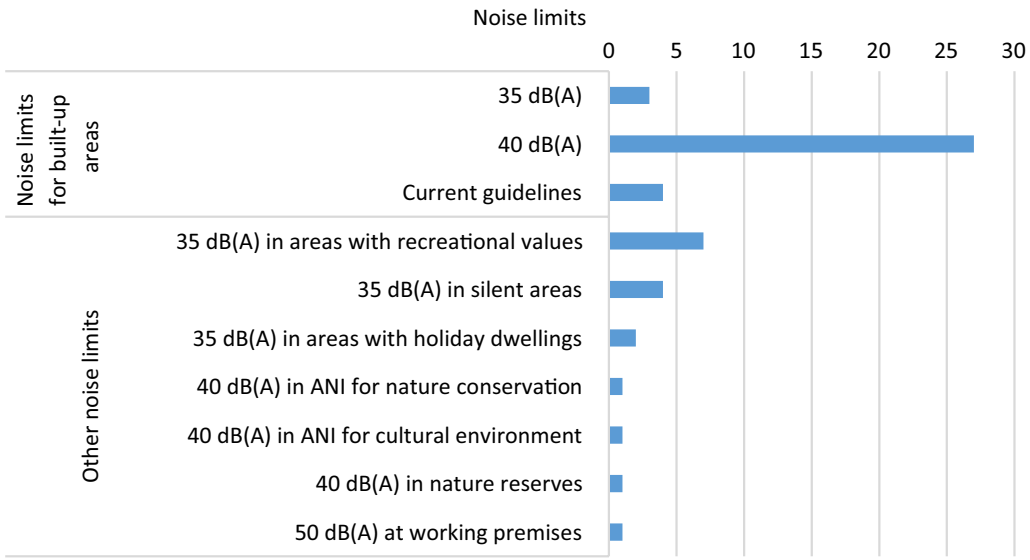

Fig. 4 Noise limits established in wind power plans

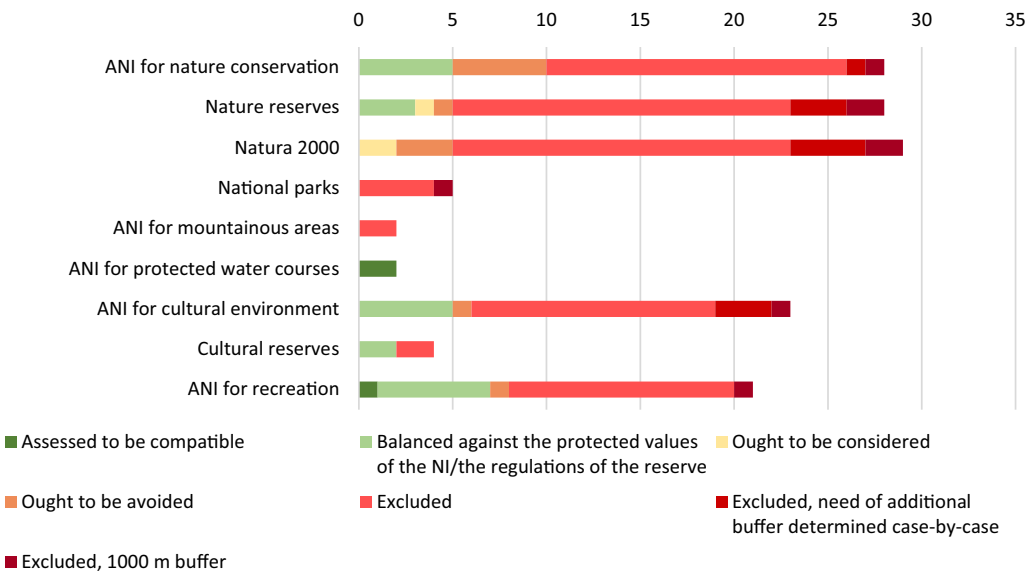

Fig. 5 Handling of key types of protected and designated areas relating to nature conservation, cultural environment and recreation in municipal wind power plans

of a residential property not should be exposed to more than eight hours of factual shadowing time per year.[3] When assessing the shadowing effect, the sensitive area in question has been determined to be an existing patio, or if this does not exist, an area of 5×5 m adjacent to the house [82]. If there is a risk that this threshold will be slightly transgressed, a permit can still be given, with the condition that shadow protection systems should be installed [93].

Nature conservation

Wind power planning practice Aggregated results concerning how some of the most common types of protected or designated areas related to nature conservation,

[3] Court cases supporting the restriction of a maximum eight hours of factual shadowing time per year are: [61, 62, 71, 82, 86, 92, 93]

cultural environments and recreation have been handled in Swedish municipal wind power planning are presented in Fig. 5, whereas the underlying results from the qualitative content analysis for each analysed wind power plan are displayed in Table 2 in Appendix C. The figure conveys that the most common way to handle ANI for nature conservation, nature reserves, Natura 2000 areas and national parks is to exclude the areas in their spatial analysis. ANI for nature conservation represents the designation where municipalities are most prone still to consider wind power deployment on a case-by-case basis, depending on the protected values of the ANI. A smaller number of municipalities have either required a buffer zone of 1000 m or stated that any additional buffer requirement would be determined on a case-by-case basis for these types of protected/designated areas.

Additionally, wetlands identified through inventories by the CABs are addressed by 14 municipalities, most often by excluding such areas. Moreover, two municipalities stated that RAMSAR areas were to be excluded, one of them with a one km buffer. Twelve of the plans addressed beach protection, excluding water bodies and beach protection ranging from 100 to 300 m. However, two of the municipalities decided on substantially larger buffer zones of 1.5 km around lakes. Additionally, seven municipalities deemed that key biotopes identified by the Swedish Forest Agency should be protected from exploitation. Four municipalities also exclude animal and plant protection areas, whereas two municipalities exclude biotope protection areas. Three municipalities highlighted the need to consider nature values documented in regional nature conservation programmes produced by the County Administrative Board, whereas two municipalities stated that municipal nature conservation programmes were also to be considered.

Two other types of areas of national interest relating to nature conservation were also addressed in the wind power plans, namely, ANIs for contiguous mountains and protected watercourses. Two different municipalities considered each of these designations in their wind power planning, with the result that areas concerning the former ANI, contiguous mountains, were excluded from the spatial analysis, whereas areas concerning the latter ANI were assessed to be compatible with wind power deployment and thus included in the continuing analysis.

When considering birds and bats in the wind power plans, many of the statements revolve around recommendations for inventories of birds and bats and the use of appropriate technology to mitigate the ecological impact of wind turbines. Three municipalities had statements with spatial implications, as they stated that wind turbines should not be located within 2 km of nests or breeding grounds for eagles. However, one of the municipalities emphasised that the exact safety distance would be settled in the permitting process.

Precedential court cases In cases involving nature reserves, there are examples of both wind power projects permitted within nature reserves [94] and examples of cases where proximity to nature reserves has been a part of the reason a project has been rejected [e.g., [95]. Precedential court cases where Natura 2000 areas are a substantial part of the consideration are rare, but in one particular case [96], a project partly located within a Natura 2000-area was rejected, since the protected values would be impacted by wind power development. Cases addressing national parks are also uncommon, but in a case addressing whether a wind measurement mast would be allowed in a national park, the need for the mast was not found to be grounds for an exemption from national park regulations [97].

Precedential court cases addressing ANI for nature conservation shows different approaches to balancing nature conservation in relation to wind power development. In one case, turbines bordering on an ANI for nature conservation were rejected, even though they were situated within an ANI for wind power, while other parts of the same project were approved [98]. In another project, two of the project areas were partially within an ANI for wind power, but overlapped an ANI for nature conservation, and were rejected due to concerns for nature conservation and an adjacent ANI for reindeer herding. In two other project areas, where turbines were situated mostly within an ANI for wind power and only small parts of the project area had been classified as an ANI for nature conservation, the development was permitted [99].

Cultural environment

Wind power planning practice The aspects of cultural environment most often considered in the CPs are seen in Fig. 5. Areas of national interest for cultural environment are the most frequently deliberated and follow roughly the same distribution as ANI for nature conservation. The main approach is to exclude such areas, potentially with the addition of buffer zones, though a handful of municipalities specify that it has to be balanced against the protected values of the ANI. Cultural reserves are less common to deliberate in the CPs, with two municipalities excluding them altogether and another two opening up for balancing of interests against the regulations for the reserve. Minimum distances to churches or other buildings with culture-historical value were required by 12 municipalities, ranging from 500 m up to 1000 m. Additionally, a few municipalities prohibited wind turbines if

they were within line of sight from identified culture-historical buildings.

Moreover, preservable agricultural landscapes, as classified by the CABs, are addressed by five municipalities, three of which excluded such areas in their spatial analysis while the other two stated that they should be considered. Seven municipalities highlighted the importance of municipal programmes for the cultural environment, and similar programmes produced by the CABs were highlighted by four municipalities. Ancient monuments are often addressed in the plans as well, but the general perception is that the impact on such monuments should be able to be resolved through the design of the wind power site.

Precedential court cases Court cases explicitly addressing cultural reserves and ANI for cultural environment are scarce. In one case, a project located 4 km from an ancient farmhouse designated as an ANI for cultural environment and a world heritage site was disallowed, since it could disturb the landscape view [100]. Another older project application for four wind turbines was, however, approved within an ANI for cultural environment [101]. In a previously mentioned case [95], an ANI for cultural environment situated approximately two km from the project site was not found to be a sufficient reason to prohibit the wind power project. The impact on the landscape view from this ANI was thus deemed acceptable, as the ANI for wind power was given priority.

Recreation

Wind power planning practice Twenty-two municipalities address areas of national interest for recreation (Fig. 5). The most common approach for this ANI is also to exclude it in the spatial analysis, although more than half as many are open for considering the purpose and protected value of the area and to allow wind power if the areas can co-exist. One municipality has also assessed that this ANI should be able to co-exist with wind power. In addition, many municipalities state that areas identified to be of local value should be avoided, some with a buffer up to 1000 m. Two municipalities also state that consideration should be given to hiking trails, bicycle trails and canoeing routes, with one municipality requiring a buffer of 1.5 × the total height of the wind turbines.

Precedential court cases The aforementioned project that was approved within a nature reserve was also situated within an ANI for tourism and outdoor recreation and an ANI for outdoor recreation [94]. Four turbines were permitted on the island of Öland, which has an overall designation as an ANI for tourism and outdoor recreation [101].

Reindeer herding

Wind power planning practice Eight of the municipalities have addressed reindeer herding. Four municipalities addressed this in terms of the national interest for reindeer herding, with half of them excluding these areas altogether and one stating that the areas should be avoided. The remaining municipality localises sites for wind power where areas of national interest for energy production overlap with the national interests of reindeer herding, leaving it to the permit process to balance between these national interests. Almost all of the municipalities address reindeer herding by stating that sensitive areas, such as areas for grazing, calving grounds and migration routes, must not be impacted. Other common themes were statements that wind power development should be concentrated in particular areas, near areas that have already been exploited (e.g., near hydropower dams) and lastly, that the construction should take the cyclical moving patterns of the reindeer into consideration.

Precedential court cases Concerning the balance of interests between wind power deployment and reindeer herding, there are several examples when each interest has been given priority over the other.[4] Previously, priority was often given to wind power, for example, in case M 10316-09 [111], where wind power development was approved in an area where the two ANIs in question overlapped. In a few more recent cases, the cumulative impacts on reindeer herding seem to have been given more consideration. An example of this is case M 6860-17 [95], where one of four project areas was rejected in spite of being within an ANI for wind power, due to the project area's proximity (800 m) to an ANI for reindeer herding, more specifically, between two migratory routes.

Landscape considerations.

Wind power planning practice Five municipalities specify a minimum distance between two wind farms, four of them placing such a requirement between 3 and 5 km, while another requires as much as 20 km. Four municipalities also address landscape scenery protection, with half of them stating it needs to be weighed on a case-by-case basis and the other two excluding such areas. Lastly, two municipalities prohibit wind turbines with a total height of more than 150 m that also require aviation obstruction lights, due to their impact on the landscape. Five other municipalities also address aviation obstruction lights, with one municipality stating that wind turbines with such aviation obstruction lights would not be approved

[4] Cases where reindeer herding has, at least in part, been given priority are: [95, 99, 102–104].
Cases where wind power has been given priority are: [98, 105–111].

outside of areas designated for wind power deployment and the other four requiring careful evaluation due to the impact on the landscape and nearby inhabitants.

Precedential court cases Due to the height of wind turbines required for projects to be subjected to permit examination under the Environmental Code, landscape considerations naturally come into play to some extent in virtually all court cases. This is especially true in court cases that concern ANIs described in Chapter 4 in the Environmental Code, which are based on the landscape approach. Thus, if a permit is approved, this implies that the impacts on the landscape view have been considered acceptable. One example where landscape view was a key consideration is in case M 2917–16 [67]. In this case, the Land and Environmental Court of Appeal stated that the proposed wind power expansion, which was situated within an ANI for wind power and within close proximity to existing wind power parks, would undoubtedly have additional impacts on the landscape view, but deemed this impact acceptable. In contrast, a permit was only approved for some project areas, where the permitted areas were partially situated within an ANI for wind power and the areas that were rejected had not been given this designation. The reason that not all sites were approved was that a village would have been surrounded by wind turbines, which was considered to be an unacceptable impact on the landscape view [85]. Furthermore, as previously mentioned, impacts on the landscape view within an ANI for cultural environment were prohibited due to the importance from a cultural-historical perspective [100].

National defence

Wind power planning practice Seventeen municipalities address areas of interest for national defence. These include both areas of national interest and areas of importance. In general, both ANIs and areas of importance are excluded during the municipalities' spatial analyses. An exception is the minimum safe altitude area around airports of interest for national defence, which is generally not excluded. Two municipalities differ from the rest in terms of their approach to national defence and have identified suitable areas for wind power that overlap with such interests, though they clearly distinguish where conflicts with the national defence are likely. These municipalities argue that co-existence should be possible and that they want to be prepared in case any precondition regarding the classification or weighing of military interests in relation to other societal interests does occur.

Precedential court cases It is reported by Ardö [55] that in court cases regarding national defence, which are decided by the central government, areas of military interest have consistently been given priority in accordance with Chapter 3, paragraphs 9–10 of the Environmental Code.

Role of the comprehensive plan

Precedential court cases Numerous precedential court cases address the role of the CP in the decisions issued by the courts. It has been well established that a current and well-prepared CP is of vital importance in determining the suitability of localisation for activities that require permits [92, 112]. Moreover, there are many examples where the fact that the permit application was in line with the CP has contributed to approval [67, 92, 101, 111]. On the other hand, in cases where the CP has not supported the project, this has been a part of the reason for denying a permit [112, 113]. Lastly, it has been clarified that other municipal policy documents addressing wind power, such as a wind power policy, should not be equated with a CP or a thematic amendment thereof, since a CP is a more well-established policy document. This question became relevant in a case where a CP was in line with a project application, whereas a wind power policy was not. The project was approved [114].

Insights from practitioners on municipal wind power planning

The current state of municipal wind power planning

All of the participating municipalities had developed a thematic amendment with the aid of the national funds allocated in 2007–2010. These thematic amendments have often functioned as a basis for municipal decision-making with regard to the municipal veto, at least initially. However, according to the interviewees, in recent years, the decision-making has started to diverge from the content of the plan and is currently much more dependent on the political will, which can vary within political parties and between terms of office. The wind power deployment that has been approved has predominantly been located within designated areas, although one municipality has also approved a site that was not suggested as a primary area in their wind power plan. They assess that their respective municipality has insufficient capacity to independently conduct spatial analysis that includes multiple criteria to identify suitable areas.

The interviewees express difficulty anchoring the proposed development with inhabitants, both in planning and permitting. If the plan is old, few inhabitants will be aware of its content, and it can regardless be challenging for the population to understand what type of consequences will actually occur merely by studying a map of designated sites. On the other hand, in the permitting

process, more inhabitants express that they are concerned by the development than what would be recognised by the County Environmental Appeal Delegation. In relation to this, when discussing the proposed revision of the veto, one interviewee expressed that if the CP were to become legally binding instead of indicative, it would pose a high risk that municipalities would be hesitant to designate sites as suitable. This is because they would need more information, for example, photomontages of the landscape view, in order to be able to give the public sufficient information and for the politicians to be able to make an informed decision.

Drivers and local benefits

Regarding the question of whether wind power planning is seen as a part of the municipality's energy and climate strategic efforts, the interviewees expressed that this was partly a rationale for their wind power planning, at least initially, on par with creating local jobs. However, many of the interviewed officials express that a common view is that their municipality already produces a lot of renewable electricity through both hydropower and wind power, often much more than the municipality itself consumes, and the general perception is that the local benefits are insufficient to motivate further expansion. They recognise the need for the systematic regulation of financial compensation. This could preferably be structured through a combination of funds, including funding allocated to adjacent villages and the municipality in which the development is located. This could enable investments with clear local positive effects within the closest vicinity to the wind farm, while still ensuring that all municipal inhabitants benefit to some extent. Currently, this is often negotiated on a case-by-case basis, which is recognised as unfair. Moreover, interviewees expressed a desire to benefit from renewable electricity production in terms of planning and building out the electricity grid in order to enable a larger electricity outtake within the municipality, which would allow the establishment of electricity-intensive industries.

Regional–local and inter-municipal co-operation

Generally, the participants underlined the need to allow the municipalities to retain their autonomy for decision-making in relation to wind power. Therefore, the municipal representatives expressed that designating suitable wind sites in a regional process would be perceived as too much of a top-down approach that would interfere with their planning monopoly, when a bottom-up process that is well-anchored with the public is what is perceived to be needed. They did, however, look positively on regional forums for co-operation and capacity building, where the latter could potentially include access to competence for spatial multi-criteria analyses and dissemination of knowledge regarding how to conduct such analyses in an informed and well-balanced manner. Otherwise, the interviewees stressed the need for inter-municipal co-operation, especially when potential wind sites are located at municipal borders, in order to gain a common view on the suitability of sites. It can, however, be difficult to find a suitable regional forum to address this, as pointed out by one interviewee, since the official's municipality border seven municipalities in three different counties. Moreover, one interviewee sought more regional co-operation in order to enable an expansion of the regional electricity grid where the local electricity outtake can also be increased. When discussing co-operation with the Sami people, interviewees thought that at least in the view of the municipalities, it was more vital to consult them in the comprehensive planning process than at a regional level. One of the municipalities provided an example of this, where concerned Sami villages had been given the opportunity to provide input concerning potential wind sites as a first step, before sending out the plan for formal consultation.

Handling of areas of national interest

The general view was that the municipalities had not made individual assessments regarding the potential for co-existence within different ANIs depending on the values of each specific designated area. If this were to be done, interviewees recognised that support from the CABs would be beneficial. However, they thought that this initiative needed to come from the local authority, as other sustainability aspects may still be negatively affected by development within ANIs. Furthermore, one of the interviewees expressed the need to apply an ecosystems perspective, by also placing value on areas connecting different ANIs.

Discussion

This paper examines Swedish wind power governance through a quantitative and qualitative content analysis of municipal plans and a focus group interview. The focus group interview was able to provide complementary insights, enriching the view of municipal wind power planning created from the document analysis. Regarding the precedential court cases, it is worth noting that some themes, such as noise and shadowing effect, have more generic traits, whereas other themes, such as nature conservation and cultural environment, are more context-dependent. The latter themes are thus more difficult to extrapolate into more general principles, but they could provide some knowledge regarding possible outcomes.

The downward trend in the number of wind power plans adopted annually and the failure of municipalities

to reiterate spatial wind power analyses within the comprehensive planning process show that if wind power has been spatially addressed at all by the municipalities, such spatial analyses were mostly conducted nearly a decade ago. Thus, as expressed by the focus group interview, there is a risk that these municipal policy documents have become outdated due to potential changes with regard to technological developments, updated standard practice, or political will, and no longer can serve as a proactive basis for decision-making. This could be exemplified by the minimum requirements for distance to housing, which in many cases presumably have lost its relevance since distance to meet noise requirements often will require longer distance anyhow with the previous and continuous enlargement of wind turbines.

This risk is exacerbated by the fact that the municipal veto, in its current form, enables municipal decision-making that is done in a more reactive, ad hoc fashion. Such a reactive approach can impede the legitimacy of the municipal decision-making process, since it has not been subjected to formalised planning processes that include stakeholder and public involvement [34]. This could give rise to local opposition, since local inhabitants may not feel that their voices have been heard or that they have been sufficiently informed, even though the general attitude towards wind power in Sweden is fairly positive [33, 115].

As highlighted by the interviewees, however, more site-specific information may be needed for inhabitants to be able to form an apprehension of the potential impacts of a wind power project and for the municipality to make an informed decision. Incorporating such procedural steps prior to decision-making could contribute to both enhanced procedural justice and equity in the recognition of local inhabitants, which are seen as key elements for gaining local public acceptance [116]. This suggests that even though a revision of the veto power is necessary to make the governance process more formalised and predictable, making the CPs legally binding in this regard may make municipalities less prone to designate suitable sites. Furthermore, as illuminated by the focus group interview, certain municipalities perceive that the incentives for continued wind power deployment are insufficient, and they have thus called for more regulated forms of financial compensation at the municipal level and compensation directed to the local community. Financial compensation can be conceptualised as a mechanism for reaching distributive fairness, that is, distributing more benefits to the people negatively affected by the local impacts [116]. This approach is more formally regulated in Norway through a property tax that goes to the concerned municipality and is identified as a key motivator for creating municipal support [117], which suggests that it could also be an effective measure in Sweden. However, in a study from Denmark regarding compensation schemes directed to nearby inhabitants, Leer Jørgensen et al. [116] note that compensation schemes can also be seen as unfair and underline the need to adapt the schemes according to local needs and concerns.

The general view of municipal wind power planning depicted in this study suggests that the institutional capacity of the municipalities, that is, their ability to address current social and environmental challenges in planning and decision-making [118, 119], is often insufficient for them to conduct wind power planning without national financial support. In particular, the key competencies needed to conduct spatial analyses with multiple criteria in order to identify suitable wind sites seem to be lacking. Municipalities will thus require support in some form to be able to conduct wind power planning processes with a more up-to-date basis for municipal decision-making. Moreover, the analysis of the precedential court cases illuminates the prominent role of the CP within environmental permitting. More up-to-date and well-informed municipal plans could thus aid as a decision-making basis in the permitting stage as well.

When comparing the wind power planning practice with the precedential court cases, the level of coherence between the two governance procedures differs for some key themes. Additionally, there is a large heterogeneity between different wind power plans regarding how the spatial analysis is structured, what the municipalities consider under each theme and the standpoints they have adopted. One such topic that stands out when investigating the level of harmony between planning and permitting is the handling of different ANIs. Within permitting, an ANI for wind power has in many instances been given priority in relation to other ANIs, such as nature conservation and reindeer herding. Furthermore, there is a precedential court case where a wind farm has been approved within an ANI for outdoor recreation as well as ANI for tourism and outdoor recreation, even though the site was not designated as an ANI for wind power. This shows that wind power could be deployed within potentially conflicting ANIs, either by prioritising ANI for wind power or by concluding that wind power would not significantly harm the protected values of the ANIs and that a wind power project could thus co-exist.

However, the municipalities predominantly exclude all such ANIs, apparently without making any assessment of the potential for co-existence for each specific designated area depending on the specific values that each area intends to protect. This general disparity between planning and permitting could prohibit wind power projects that might have been found permissible

in the permitting process, which could be an obstacle to the achievement of the national and regional wind power targets. Furthermore, when investigating Table 2 in Appendix C, it stands clear that there are trends in how the individual municipalities handle the trade-offs between wind power deployment and other interests. Some municipalities have generally been more prone to consider co-existence between wind power and other ANIs, whereas some other generally have been more restrictive, excluding protected or designated areas with additional buffer zones. Potentially, this reflects a difference in the general perception of the desirability of wind power deployment within the municipality, where the judgements regarding the different trade-offs could change if the local incentives could be enhanced. All in all, this points towards the need for updated guidance and knowledge support from the national level along with additional mechanism for creating local co- benefits.

Two themes that are seen as key hurdles within wind power permitting are reindeer herding and national defence [120]. The impacts of wind power on reindeer herding is a complex issue, but recent research suggests that wind power puts additional pressure on the pastoral activities of the indigenous Sami people by causing avoidance effects [16, 121]. Reindeer herding is subjected to a cumulative disturbance from many different human activities, and in a Norwegian study, it has been recognised that avoidance effects occur when these activities reach a critical level [122]. The idea to co-locate wind power near already exploited areas, as suggested by some municipalities, may thus be a suitable strategy if a critical level of disturbance has already been transgressed. It is critical that concerned Sami stakeholders are involved at an early stage if such assessments are to be made and that their indigenous rights are acknowledged. Moreover, the analysis reaffirms that national defence is a major stumbling block for wind power deployment, given the non-negotiable priority for areas of importance for the national defence. As shown by Lindgren et al. [123], the relationship between the wind power industry and the military has historically been one of conflict rather than dialogue, partly due to the sensitive nature of information regarding military operations. Recently, the Swedish Armed Forces were instructed to enhance their capacity for dialogue and co-operation in relation to wind power and to make suggestions for how national defence and wind power can co-exist [124], which indicates that there may be more room for negotiation in the future. Such approaches have previously been applied in Denmark and Germany [123], and these countries have also succeeded in deploying wind power to a great extent. In the meantime, the approach to plan for suitable wind power sites within areas of importance and ANI for national defence, but to clearly communicate this precondition, as opted for by a small amount of the studied municipalities, can be a suitable way to create planning preparedness at the municipal level in the event that circumstances change.

The county administrative boards have been given what can be characterised as a meta-governor role in the sense that they are tasked with leading regional efforts for decarbonisation in relation to the regional energy and climate strategy and presumably, the regionalised targets for wind power deployment as well [48]. Against this backdrop, the county administrative boards could potentially support the local level in a number of aspects addressed in this paper. One viable option to address the limited institutional capacity of some of the municipalities could be to arrange regional co-operative efforts for wind power planning, thus deliberating strategic inter-municipal issues with municipalities and other key stakeholders. Such actors could include Sami representatives, the military and regional electricity grid operators. It could also include the regions, especially if they have been given a regional spatial planning mandate. If regional electricity grid operators participate, there is a potential for discussions on both where the grid has the capacity to connect wind power and where increased outtake of electricity for the localisation of electricity-intensive industry could be suitable, which could enhance the local benefits of wind power.

However, the focus group interview reveals that conflicts may arise between the regional and the local level if the intent is to designate potentially suitable wind sites in such a regional process, as it would be perceived as too much of a top-down process that would restrict municipal decision-making autonomy. Thus, an alternative approach could be to support the municipalities so that they obtain sufficient capacity to conduct wind power planning, suggestively by assisting with knowledge and competence for conducting spatial analysis with multiple criteria. This could be a way for the CABs to contribute with knowledge regarding national guidelines and common practice in planning and permitting, while respecting the planning monopoly and providing better opportunities to deliberate the proposed actions with the local public. Nevertheless, regional spatial analyses of suitable sites for wind power may be able to function as an instrument to facilitate a regional dialogue with concerned key actors.

It should be noted, however, that the national overview reveals large regional differences regarding the

prevalence of municipal wind power planning, and the preconditions will thus vary across the country. If the CABs were to facilitate municipal wind power processes, for example, by aiding in spatial analyses, it would enable comparison between municipalities and could ensure that inter-municipal wind sites are coherently addressed. Another concrete way to address potentially suitable wind sites located at or near municipal geographical borders would be to produce inter-municipal wind power plans, as was the case for 20% of the collected wind power plans. This could also be a way of sharing competencies and resources, potentially enabling municipalities that are struggling to conduct wind power planning on their own due to a lack of institutional capacity to overcome this barrier by co-operating with neighbouring municipalities.

The CABs could also play a role if ANIs were to be handled more proactively, by assessing individual areas regarding possibilities for co-existence with wind power. Since the CABs are instructed to produce value descriptions for many of the different ANIs, they should be well-positioned to support the municipalities in making such preliminary assessments, either through a broader regional–local co-operation platform or in individual comprehensive planning processes. This could be a way for the regional authority to combine their task of safeguarding ANIs, where necessary, with their duty to lead the regional efforts to decarbonise the energy system. Nevertheless, it will require a shift in the perception of their governance efforts in relation to the ANIs, from a focus on ensuring that maximum consideration is taken, towards a more balanced approach, where possibilities for multi-use can be considered unless it threatens the values that the ANI intends to protect. As pointed out by the interviewees, for such an analysis to be fruitful, the initiative needs to come from the local level where the decision-making autonomy is situated.

Conclusions

This paper aimed to investigate the current state of Swedish wind power governance by creating an overview of trends in municipal wind power planning practice, examining how wind power is balanced in relation to sustainability objectives in planning and permitting and gaining insights from practitioners. The first main finding is that about two-thirds of Swedish municipalities have conducted wind power planning in some form; however, most spatial wind power analyses are around a decade old. It is thus indicated that the municipal CP (or any amendments thereof) has lost its role as a proactive tool for municipal decision-making with regard to wind power, potentially due to insufficient institutional capacity at the local level to independently conduct wind power planning, which raises questions regarding the legitimacy of municipal decision-making. Secondly, the paper shows that many municipalities perceive that there are insufficient incentives for continued wind power expansion, where formalised financial compensation and strategic initiatives that enable the localisation of electricity-intensive industry within municipalities with large wind power production can be two key components moving forward.

Lastly, the study sheds light on a large heterogeneity within the wind power planning practice concerning how trade-offs between wind power deployment and other sustainability aspects are handled, as well as a lack of coherence between planning and permitting. This suggests that municipalities would benefit from additional support from the county administrative boards, ideally through access to critical competencies and relevant knowledge in terms of standard practice and guidelines for making trade-offs between the different sustainability considerations in an informed and balanced manner. Moreover, the CABs could arrange regional dialogues with key actors to address inter-municipal issues, including efforts to foster co-operation regarding inter-municipal wind sites. If an interest arises at the local level to take a more proactive approach to handle areas of national interest to promote multi-use, the CABs could also assist in this endeavour. On the whole, this could lead to wind power planning and governance where new deployments are seen as a positive not only for global and national climate targets, but also for the municipality and local community, which could ultimately facilitate the achievement of established goals for wind power production nationally and regionally.

Appendix A

See Table 1.

Table 1 List of participants in the focus group interview

Position of Municipal Official	Municipality Represented by the Interviewee
Business developer	Kramfors
Environmental inspector	Kramfors
Business developer and communicator	Sollefteå
Business developer	Ånge
Spatial planner	Örnsköldsvik
Environmental strategist	Örnsköldsvik

Appendix B

Leading questions for the focus group interview:

1. Describe the current status of your municipal wind power planning.
    a. How indicative are the plans for the municipality's decision-making regarding wind power, e.g., municipal approval?
    b. Is municipal wind power planning seen as part of the municipality's strategic work in energy and climate issues?
2. Do you perceive that you have competence within the municipal organisation to be able to conduct wind power planning?
3. What types of opportunities and needs do you recognise for inter-municipal and regional–local co-operation in relation to wind power planning?
    a. Are there specific actors that would be relevant to involve at a regional level? Special inter-municipal issues?
    b. Do you think that regional analyses with the identification of suitable wind sites could contribute to or influence municipal planning? How would you want to, or how should you, be involved in such a process?
4. How do you perceive the role of ANIs in municipal wind power planning?
    a. Is it possible to (in a more proactive way) investigate the possibility of coexistence between wind power and other ANIs in municipal planning?
    b. Can the county administrative board assist the municipality in that process?
5. What obstacles or opportunities do you see linked to municipal wind power planning and a continued expansion of wind power?

Appendix C

See Table 2.

Table 2 Overview of results from the qualitative content analysis regarding handling of key types of protected or designated areas related to nature conservation, cultural environments and recreation in each analysed municipal wind power plan. The table uses the same symbology as Fig. 5, which provides an aggregation of these findings

Municipality	Year of adoption	ANI for nature conservation	Nature reserves	Natura 2000	National parks	ANI for mountainous areas	ANI for protected water courses	ANI for cultural environment	Cultural reserves	ANI for recreation
Avesta	2011									
Boden	2017									
Borgholm	2011									
Bräcke	2017									
Eda	2015									
Eksjö	2017									
Gullspång	2016									
Gävle	2015									
Götene	2017									
Hallstahammar	2013									
Helsingborg	2010									
Hjo	2015									
Hudiksvall	2014									
Härnösand	2013									
Hörby	2016									
Karlshamn	2015									
Krokom	2011									
Kungsbacka	2012									
Laxå	2018									
Ljungby	2018									
Ljusdal	2012									
Norrköping	2013									
Norsjö	2016									
Nybro	2015									
Orust	2016									
Piteå	2014									
Smedjebacken	2018									
Sorsele	2010									
Strängnäs	2013									
Torsby	2018									
Uddevalla	2016									
Umeå	2016									
Vaggeryd	2019									
Värmdö	2010									
Åsele	2010									
Åstorp	2013									
Östhammar	2012									

Abbreviations
ANI: Area of National Interest; CAB: County Administrative Board; CP: Comprehensive Plan.

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Author contributions
Research design: V.W., B.B, U.M.; data collection, data analysis and writing: V.W; supervision: B.B.; project administration and funding acquisition: U.M. All authors have read and approved the final manuscript.

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Data availability
The data sets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Informed consent was obtained from all subjects involved in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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