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What influences windpower decisions? A statistical analysis of licensing in Norway

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Abstract

While windpower is expanding globally, so too is the concern over increased land-use pressure and the environmental impacts of large-scale power plants. In the literature, little is known about how local resistance and environmental impacts affect windpower licensing decisions. This article addresses this knowledge gap by investigating the weight accorded these factors in a licensing process. Using a new and comprehensive dataset based on all windpower project applications in Norway 2000–2019, we statistically analyse whether environmental impact and the stance taken by local authorities influence the final licensing decision. Both factors are found to have a strong influence: a high environmental impact substantially reduces the likelihood of obtaining a licence, and a negative hosting municipality in practice has almost veto power. Our findings have important implications for research on energy democracy, energy justice and fairness, environmental policy integration and the acceptance literature. As little quantitative research has examined how environmental factors and stakeholder positions affect licensing decisions, this article contributes general insights and an analytical approach which can be used comparatively across contexts and sectors.

Keywords:

Windpower Licensing; Environmental Impacts Assessment; Environmental Policy Integration; Local acceptance

1. Introduction

The transition to a low-carbon global economy will require increased renewable electricity production (Thygesen and Agarwal, 2014). Thanks to falling costs and support policies, renewables are expanding and currently comprise almost two-thirds of global capacity additions to 2040 (OECD/IEA, 2018). Windpower, too, has been spiking in many countries, as technological advances, reduced production costs and subsidies make for an attractive business proposition.

Norway is no exception. After a 'slow start', windpower development has soared in recent years. With all the projects currently under construction, Norway's windpower production is expected to increase significantly, exceeding 10 per cent of annual electricity production by 2021.

This development, while promising in terms of reducing greenhouse gas emissions, has significant spatial and environmental impacts. Increased windpower development has occasionally been followed by heated local and national debates (Batel and Devine-Wright, 2015; Saglie et al., 2020; Toke, 2005). These debates often reflect the underlying 'nature vs. climate' dilemma, demonstrating that climate-change policies and the proliferation of renewables come at a price, not least with regard nature conservation (Warren et al., 2005).

As with all major land-use changes, windpower development thus requires careful consideration and balancing of different political goals and stakeholder positions. This is usually conducted through a planning procedure referred to as *licensing* or *permitting* (Inderberg et al., 2019; Pettersson et al., 2010). While some aspects of this process have received significant research attention, like the prerequisites for acceptance, justice and stakeholder perceptions (Bailey and Darkal, 2017; Batel and Devine-Wright, 2015; Graham et al., 2009; Jenkins, 2018; Knudsen et al., 2015), other issues have received far less scrutiny. There has been little study of which factors actually influence the final licensing outcome (but note the exceptions Harper, Anderson, James, & Bahaj, 2019; Pettersson et al., 2010; Roddis, Carver, Dallimer, Norman, & Ziv, 2018; Thygesen & Agarwal, 2014; van Rensburg, Kelley, & Jeserich, 2015). Pettersson et al. (2010) have shown that the organization and placement of licensing authorities matter for the *rate* of windpower development; Blindheim (2015) shows that the pre-2010 licensing scheme in Norway was a delaying factor for development. Both Harper et al. (2019) and Inderberg et al. (2019) have indicated that municipalities yield considerable influence – but exactly *how* is not sufficiently understood. Importantly, surprisingly little research has been published on the impact of nature concerns.

This article seeks to address these research gaps. We develop an analytical framework for investigating whether and to what extent local authorities and environmental concerns actually influence windpower licensing, using Norway as case country. Based a novel data-set comprising all windpower project applications 2000–2019 we conduct a multivariate logistic regression analysis, asking*: To what degree do environmental impact and local authorities influence windpower licensing decisions in Norway?*

To our knowledge, this represents one of the first systematic, statistical tests of how local resistance and environmental considerations influence licensing outcomes (but see also Harper, Anderson, James, & Bahaj, 2017; Liljenfeldt & Pettersson, 2017; Roddis et al., 2018; van Rensburg et al., 2015). As such, it is a first step towards developing an approach that can be used to compare planning and licensing systems across jurisdictions, and a novel contribution to this research field. Particularly within the European Economic Area, with a regulated framework for Environmental Impact Assessments (EIAs), this approach may prove highly valuable. We would also argue that a case study of Norway's windpower licensing practice merits particular attention; it could in fact be regarded a critical case. On the one hand, building large-scale windpower in a country which already has a fully renewable electricity system, could be dismissed as an 'unnecessary cost' ('If nature cannot be preserved here, where could it be?'). On the other hand, Norway still has relatively large areas left unutilised (not to mention promising wind resources), and so if anyone ever had a 'backyard' worth developing, one could argue it would be the Norwegians. It is hard to envisage a context more open for weighing different viewpoints, and this article analyses how much weight is given to specific factors. Additionally, locally elected authorities in Norway have formally only the right to be heard in licensing processes, but given Norway's history as a unitary state where local interests have weighted heavily and have very high legitimacy (Selle and Østerud, 2006: 556) an effect of local democracy on licensing outcome is expected. If not found, however, it would be a substantial blow to arguments about local influence in policy formation processes, and therefore represents a critical case in this respect.

The article proceeds as follows: we begin by giving a brief overview of the Norwegian licensing process before we present our analytical framework, including the background for our two key hypotheses. Section 3 presents the variables and methods, including data acquisition, the iterative model-building process, the causal model and our analytical strategy. Section 4 presents our statistical results, while section 5 discusses their implications. Finally, section 6 offers concluding remarks, highlighting how our findings are important in a wider context of renewable energy licensing, for example by identifying boundary conditions for weighing factors that determine licensing outcomes more generally.

2. Analytical Framework: explaining windpower licensing

In order to better understand what influences licensing outcomes, and particularly the role of local authorities and environmental factors, a brief introduction to the Norwegian licensing process is in order. In Norway, windpower developers with projects above 10 MW must undergo a multi-stage licensing process before a final decision is made.[1] The process is illustrated below (Figure 1).

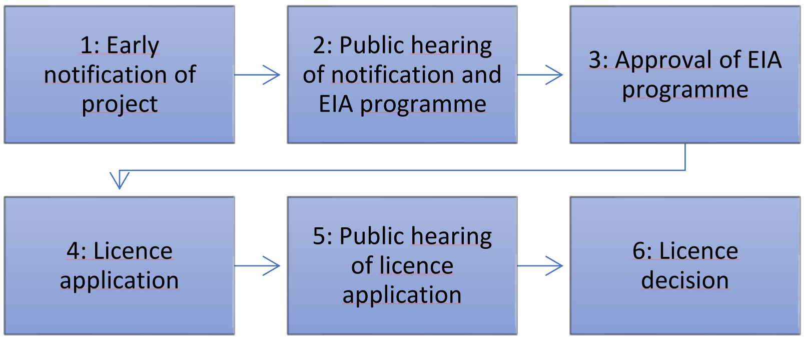


Figure 1: Main stages in the licencing process in Norway

The stages can be further described as follows (NVE, 2016):

[1] For projects smaller than 10MW a simplified EIA is conducted.

1. **Early notification:** the first official announcement of a planned project, with a notification to the national energy regulator, NVE. The intention is to give all stakeholders preliminary information about the project. The notification consists of a presentation of the project, its planned size and location, and possible impacts.
2. **Public hearing of Environmental Impacts Assessment (EIA)**. In this phase any party can offer input to the proposed project. This is done through a formal hearing procedure and through local public meetings where the project is presented and discussed.
3. **Approval of EIA programme**. This is done by the national regulator, NVE, on the basis of official requirements and guidelines, and based on input from the public hearing process.
4. **Licence Application and EIA**. The applicant collects sub-reports for the EIA on required topics (e.g., impacts on landscape, biodiversity …). These assessments are usually conducted by consultancy companies. The EIA is then submitted to the NVE together with the full project application, including adjusted project size and location. This forms the basis for the final project evaluation.
5. **Public Hearing of Licence Application and EIA**. A second hearing round is then conducted based on the full project licence application including the EIA. Local, regional and national authorities are included in the process, along with any other stakeholders who submit inputs. All aspects deemed relevant can be addressed.
6. **Final decision**. Based on the information compiled, and weighing the project's benefits against its negative impacts, the NVE either grants or declines a licence to build and operate the windpower plant. In case of appeals – which have occurred in 80 per cent of all cases – the Ministry of Petroleum and Energy (OED) takes over the case for a second evaluation and final decision.[2] Following the granting of a final licence, further detailing of the project takes place. This process is not examined here.

Although there are probably multiple factors affecting the final licensing outcome, this article will focus on two which *a priori* can be expected to have an influence: the project's local environmental impact, and the host municipality's official stance on the project. As for the latter, previous qualitative studies have highlighted the importance of local democratic authorities in windpower processes (Inderberg et al., 2019; Pettersson et al., 2010). As for the former, the role of a project's environmental impact has been much less scrutinized (though some studies have stressed the distinction between windpower's positive impacts on emissions reductions (often considered a 'global good'), and its negative impact on local environmental (usually considered a 'local cost') (Rygg, 2012; Saglie et al., 2020)). With growing concern and sometimes heated conflicts surrounding windpower developments, this factor, too, warrants further examination.

Both municipal stance and EIA-score is frequently mentioned in decision letters. For example, Skveneheii in the southern part of Norway was denied license in 2017. Deteriorating wildlife, reflected in a very poor EIA-score, and a negative municipality were reasons for rejection, but in common with many other decisions letters, these were two out of several reasons given for the decision, and it is unclear from the document the relative weight given to these factors. This ambiguity has been subject to quite some criticism (see Inderberg et al. 2019) and underscore the usefulness of a statistical approach where these factors' relative causal weight can be assessed more

[2] See Appendix Table B15A1 for a detailed overview of all classes of cases in terms of outcome at each stage in the notification, application, license, and appeal processes.

accurately. Moreover, very few studies have included cases where a license was *not* granted. This clearly warrants statistical analysis. Further elaboration and hypotheses derived for each explanatory factor is presented below.

2.1 Local environmental impact

The licensing process is so designed that a range of factors, including the environmental consequences, are taken into consideration. The impacts on nature are assessed by the principles of Norway's Nature Diversity Act (OED, 2016, p. 51). Windpower projects over 10 MW must conduct an Environmental Impact Assessment (EIA).[3] Such appraisals are in the European Economic Area (including Norway) regulated by the EIA Directive (Directive 2014/52/EU). They have become common practice for any land-use change or significant development internationally and have strong similarities, despite some variation between countries (Larsen et al., 2018; Morrison-Saunders, 2018). EIAs cover a wide range of issues – the impacts on vulnerable species, undisturbed nature, landscape and other issues. As such, they could be viewed as a tentatively objective measure (even a quantification) of a project's total environmental impacts.

These EIAs are not without limitations or flaws, however. It has been argued that they have a 'relatively weak influence on planning decisions' (Thygesen and Agarwal, 2014: 5); recent research also indicates that environmental concerns tend to be marginalized in favour of weightier economic interests, as regards hydropower (Rosendal et al., 2019) and windpower processes in Norway (Inderberg et al., 2019). Further investigation of the real impact of EIAs on licensing decisions seems warranted. Regardless, it would be surprising if the EIAs – the official tool for assessing a windpower project's environmental consequences – do *not* have any influence on the final licensing outcome, as that is the very purpose of their design. Our first hypothesis thus reads as follows:

H1: *High environmental impact of a windpower project will reduce the likelihood of a license being granted.*

2.2 Host municipality stand

Locally and regionally, the main public stakeholders in Norway's windpower processes are the host municipality, the County Administration, and the County Commissioner. Qualitative studies have found particularly the host municipalities to be crucial to the outcome of the licensing process (Inderberg et al. 2019), but how systematic this is remains unknown. This is partly because they bear the brunt of the impacts (positive and negative) of windpower projects, but also because Norway 's municipalities have achieved a greater *informal* role in the process – to compensate for loss of formal influence in 2009, when energy installation planning was removed from their mandate (Inderberg et al., 2019; OED, 2016, p. 193f). A windpower project can boost the local economy, through property tax, increased supply and services, and indirect effects on consumption (Førde et al., 2010:9). However, it is the local community, its residents and various interest groups that will be most affected by any negative impacts – including visual changes, loss of undisturbed nature, and changes in recreational areas. Thus, the host municipality will probably have a strong interest in whether a windpower plant is built or not.

[3] With smaller projects, a lightweight version of EIA is conducted.

Few studies have analysed the stances taken by local municipalities, but local anchoring has been shown to be important for public acceptance (Liebe et al., 2017; Rygg, 2012). Although the municipal role has not been extensively addressed in local acceptance research (Saglie et al., 2020), studies of renewable energy siting and licensing decisions indicate that perceptions of procedural justice (perceived fairness of the process), and trust in key actors, including local authorities, are important for local acceptance (Devine-Wright, 2011). The local municipality is thus a key actor. This is also recognized by the central authorities: the Ministry has acknowledged that, in dealing with licensing appeals, 'the host municipality's assessment of a windpower project will weigh heavily (….) when reaching a decision; to the degree they are compatible with national energy policy objectives (authors' translation)' (OED, 2009).

In their analysis of national licensing schemes, Petterson et al. (2010) found that the local municipal influence was considerable in *all* Scandinavian countries. They also found that the licensing design can influence the pace of development, with the Swedish system (formal veto right for the local municipality) representing a barrier to windpower development – in line with findings from case-studies from Norway (Blindheim, 2015). Previous studies (see e.g. Buan et al., 2010; Sjørbotten, 2013) also indicate that the municipality can enjoy significant leverage in the licensing process, although this has not been tested systematically. Based on the above, our second hypothesis reads as follows:

H2: *A positive host municipality will increase the likelihood of a licence being granted.*

3. Research Methodology

To conduct our analysis, we generated a brand-new dataset, based on publicly available information from 195 project applications in Norway, representing all planned and applied windpower projects above 10 MW, 2000–2019. EIA data were extracted and coded from all applications, together with information on host municipality stance and other key variables. All data were gathered using open, public sources. When supplementary data were needed, we contacted the NVE, OED, applicants or municipalities. (See Appendix for a complete list of cases and variables.)

3.1 Dependent variable: License outcome

Of the total 195 windpower project applications in our dataset, 113 had reached the stage of a formal licensing decision (NVE 2018). The remaining applications had either been stalled at the notification (6) or application (5) stage, or withdrawn at the notification (59) or application (12) stage (see Table B0A in appendix).

Of the 113 decisions made by the NVE, 38 were rejected and 75 granted (two licences were withdrawn after having been granted, see Table 1). A total of 88 were appealed to OED. We have analysed all these categories – licences rejected, granted, or withdrawn after being granted. As the latter category constitutes cases that did pass the formal 'bar' of being granted a licence, we merged this category with the other cases that were granted. After all, they passed through the same process as the other granted cases, with the same formal criteria applying. Including these in the 'granted' category was also done in order to be consistent, as there is no guarantee that other granted licences might not be withdrawn in the future.

There is a theoretical possibility that halted applications may eventually reach the evaluation stage, unlike withdrawn applications. Neither of these categories have been evaluated: they fall outside the scope of this analysis. They generally lack information on key independent variables such as the EIA.

Table 1. Dependent variable: Licence outcome

Status	Frequency	Percentage	Value dependent variable
Licence rejected	38	19.49	0
Licence granted	75	38.46	1
Announcement/application halted	11	5.64	NA
Announcement/application withdrawn	71	36,41	NA
Total	195	100%	

Our dependent variable, the licensing outcome, together with the other variables, were all manually coded based on documents downloaded from the official windpower licensing database (NVE, 2018). Of the 113 cases with a formal decision, 11 lacked information on the EIA,[4] reducing our total sample to 102 cases. However, the ratio of granted to rejected remains the same: two thirds of all applications being granted and one third being rejected.

3.2 Explanatory variables

3.2.1 Environmental Impact Assessments (EIA)

To capture and quantify the local environmental impact of a project, we use the project's EIA score on 'Nature Environment'. The EIA in general covers other matters as well, such as separate reports on landscape, recreational interests, cultural heritage and other topics. Ideally, we could have included these aspects in the analysis, but we have chosen to focus on the 'Nature Environment' report, since it specifically maps the project's consequences for local flora and fauna, and thus represents (on paper at least) a fairly objective and quantifiable measure of a project's environmental impact. The 'Nature Environment' score ranges from 'no or negligible impact', 'little impact', 'medium impact', 'strong impact' to 'very strong impact'. In the dataset, these categories have been quantified as 0–4, with higher values indicating a more negative impact.[5]

A potential weakness in using this assessment is reflected in the criticism that there have been challenges in establishing a coherent and consistent EIA methodology that is universally applied to all license applicants (Miljødirektoratet, 2015). However, the EIA is the only relatively consistent instrument used for appraising environmental conflicts within licensing. Furthermore, reading all the EIAs for the windpower cases included in this study gave us the clear impression that they have significantly improved in quality, becoming more standardized, precise and transparent since the early 2000s.

Initially we ran bivariate regressions with a continuous version of the EIA variable and licences, but to avoid problems with sparse cells in the underlying matrix (where three cells contain no observations,

[4] We were able to determine the municipality's stance in 108 out of the 113 finalized cases.
[5] Where impact was scored between these textual categories, the midpoint between adjacent integer values are used.

see Appendix) we chose to dichotomize this variable. It was coded 0 if the original EIA had a score of 2 or lower, reflecting moderately negative (2) to neutral impact (0) on the natural environment. Values of 2.5 and above reflect seriously negative or very seriously negative environmental impact, and were given the value 1. For robustness, we shifted the cut-off from between 2 and 2.5 to between 1.5 and 2 and also analysed the potentially problematic continuous measure. [6]

3.2.2 The municipality's attitude

We recorded the official stance of the major local and regional public stakeholders to the planned project as 'positive', 'neutral' or 'negative'. These actors typically include the municipality/ies that would host the windpower development, the County Governor office, and the County Council. The County Governor is a state representative, under the Environmental Agency, with responsibility for overseeing environmental issues, among other areas. The County Council is a regional political entity between the state and the municipality. As noted, the municipality is seen as the most important actor and is therefore the focus of our analysis.

Data on municipal stance were obtained in several ways. In most cases, the public actors' official stand was coded from the license application and decision documents from the NVE and/or the OED (see NVE, 2018). For a few cases, the stance was somewhat unclear; here we consulted the municipality website, or contacted the municipality directly with a request for the formal paperwork concerning the municipality's decisions on the project. As only one licence has been granted against local municipal opposition (causing problems with inferential statistics), we collapsed the values for negative and neutral municipalities which were assigned the value 0 on the resulting dummy variable versus cases of a positive municipality that were assigned the value 1. Although sub-optimal, this dichotomization entails a very conservative test of the effect of municipal attitude, as the cases where the municipality was neutral resulted in licences granted in nearly the same proportion as the instances where municipalities were positive. The results must be interpreted accordingly.

3.2.3 Possible confounders

Several factors in addition to those discussed above may influence licensing decisions. Our main concern is how other factors can render spurious the relation between the EIA and municipal attitude on the one side and licences on the other. Possible confounders and our variables of interest are depicted in Figure 3, where possible causal influence paths are illustrated with numbered arrows. The *a priori* expectations of correlations are included in brackets for each link in which a minus indicates an expected negative effect and a plus indicating a positive effect. Our two hypotheses are indicated with bold lines.

Economy is an important factor. The NVE normally evaluates four main factors in their project economy appraisal: wind resources, icing on the installations, the length and number of roads needed for the project, and ruggedness of landscape (topography influences turbulence and thereby electricity production). According to the NVE, these factors are complex and not always very precisely estimated in the application stage of the licensing process. Although some of these aspects

[6] Results with a continuous measure yielded largely similar results (see Appendix section C).

are less likely to influence the EIA or municipal attitude and are therefore less crucial to control for, we should somehow control for economic impact. We rely on a proxy – the consistently available information on project *installation size*, measured in megawatts (MW). This can influence the EIA, municipal attitude, and the licensing decision more directly. It reflects potential income for the local municipality but also environmental impact – larger MW means higher tax revenues, but also greater environmental impact. Size exhibits a weak but significant effect on the EIA score (see Appendix, TableB10A3) and is also significant at the 10% level in directly affecting licences when analysed with bivariate regressions (Appendix TableB9B). It does not affect municipal attitude, however (Appendix, Table B11A2).

Second, assuming that projects overlapping in time and in geographical placement are most likely to be evaluated against each other, we also assess the degree of *cumulative effect* on the licensing outcome. A clustering of granted licenses can cause greater caution in granting new licenses (fear of 'overload' on the local environment), or it can signal that certain zones are more attractive for further development. The licensing authority is also obliged to assess the cumulative effects of nearby power plants. While systematic tools for measuring and considering such cumulative impacts are still in their infancy, the licensing authorities are, at least on the discursive level, looking for approaches, and for some regions this has been done. For instance, the NVE has withheld evaluation of some projects, in order to manage the licensing processes for the region more holistically. Recently the NVE developed a national proposal for guiding windpower projects to certain areas assumed to be most suitable and less conflictual than others, but the proposal caused controversy and was withdrawn, underscoring the sensitivity of the issue.

It seems reasonable to expect that a high clustering of windpower projects, in time and placement, would lead to a higher failure rate, as a result of overload concerns. Our operationalization of this cumulative effect is the aggregate number of licenses already granted / granted the same year in the municipality or in contiguous municipalities (including sea border). As an indication of the influence of cumulative effects, we tested its bivariate effects on EIA and municipal attitude respectively: we found very little impact on EIA, and ambiguous effects on municipal attitude (Appendix, Section B8).

Third, because of learning effects, policy change, changes in capacity or other factors, there may be *changes in licensing practices over time*. This effect might be direct, or work through factors like neighbouring applications, installation sizes, EIA, or municipal attitude. To measure this, we used the year of the application decision, obtained through the NVE database.

Since time, project size, and cumulative effects act primarily as controls and because they were highly non-normally distributed, we converted them into square roots, which produced the closest approximation to a normal distribution, while also allowing for zero values in the original data. For ease of interpretation, the year variable was reversed. It was constructed by first subtracting the year of decision from 2019 and thereafter taking the square root of the value. Since larger values now represented lower years, we then multiplied the value by -1, to ease interpretation.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Prop 0/1
Licensing outcome	102	NA	NA	0	1	33.3/66.7
EIA very negative	102	NA	NA	0	1	69.2/30.8
Positive municipality	102	NA	NA	0	1	24.8/75.2
Licensing decision year (sq root, reversed)	102	-2.269	0.784	-4.359	0	NA
Sum of licences in municipality/neigh. municipality (square root)	102	1.340	0.990	0	3.873	NA
Installation size (MW, square root)	102	9.118	3.596	3.162	18.166	NA

Finally, other potential confounders merit a brief discussion. First, the EIA might affect municipal attitude. This was confirmed in bivariate regressions, but should be interpreted as a causal pathway through which the EIA affects the licensing outcome. Second, grid-access has emerged as an important factor in other countries, and is an important constraint also in Norway. Third, if there is an unknown systematic difference in probabilities between appealed and non-appealed cases, then excluding this factor could render results spurious. We tested the effect of appeals to the OED, but found no noteworthy effect (see Appendix Section B15).

Figure 2 summarizes our *a priori* expectations regarding our variables in focus and potential confounders. The symbols depict the theoretically expected relationship between the two variables connected by the arrow, while the numbers refer to each separate bivariate relationship which has its accompanying section in the Appendix.

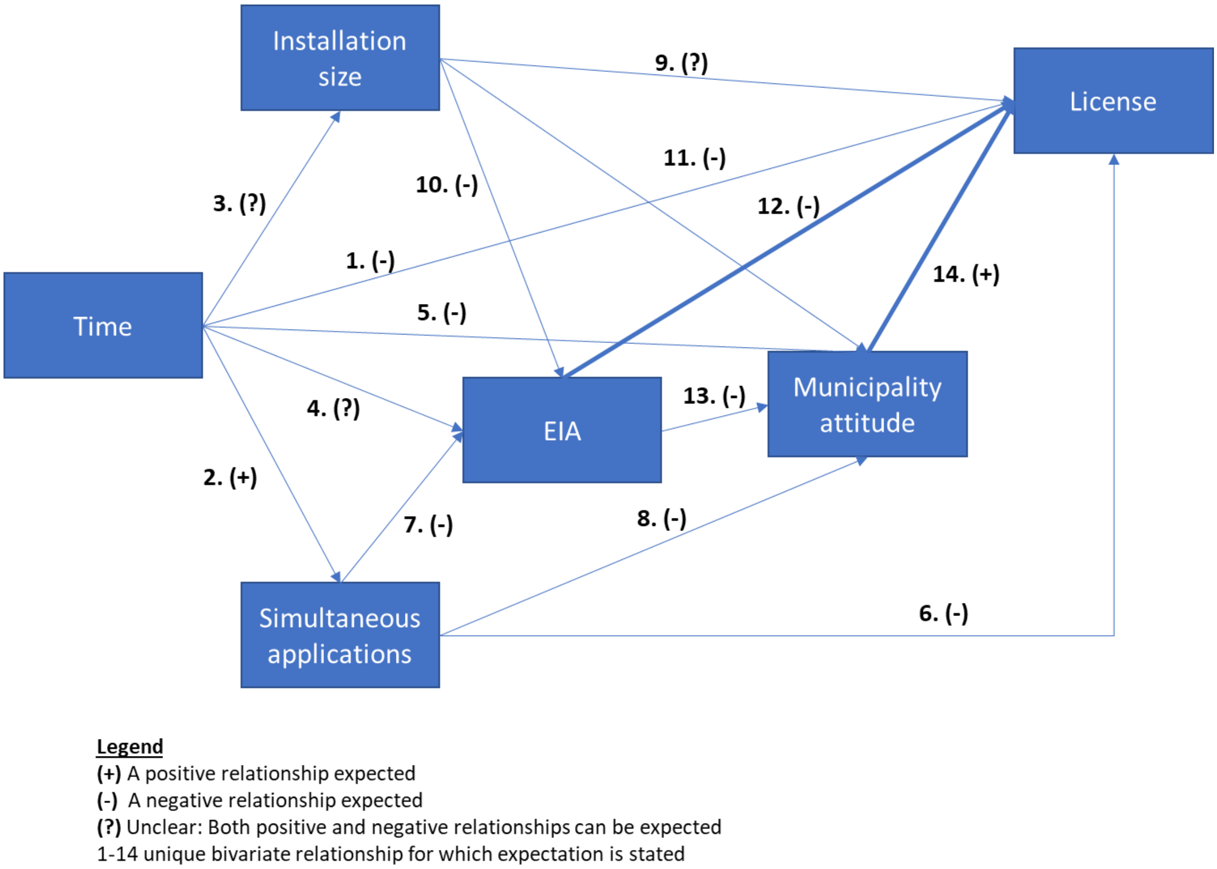


Figure 2: Causal paths, illustration of expected relationships.

3.3 Analytical strategy

We analyse the probability of a windpower developer being granted a license. Of the 102 cases there were 34 zeros and 68 ones, yielding an effective sample of 34 – which is at the lower end of where logistic regression is feasible. If the complexity of the model exceeds what the sample size allows, patterns may be detected that will fail to reproduce in future samples with no optimal solution (Babyak, 2004; Greenland et al., 2016). Various rules of thumb regarding minimum number of events per variable have been suggested (Peduzzi et al. 1996; Babyak 2004). In situations where one or only a few variables are in focus, Vittinghoff and McCulloch (2007) have shown that five to nine events per predictor can be acceptable. Our final model has five covariates.

Second, few observations could also yield cells in the underlying matrix containing zero or near-zero values.[7] The continuous EIA measure has no rejected applications for the best scores (0 and 0.5) and no accepted applications for the worst score (4) (see Appendix, Table B12B1). Although in line with expectations, statistically it causes mild separation in our model. We therefore dichotomize the EIA variable (see above). Moreover, our model converges with all estimates being reported and no evident problems, both for the dichotomized and original continuous measure. Finally, having few

[7] One could have been extremely lucky and discovered a social law, but in the event of complete separation there are few *statistical* ways out of this issue

observations may yield results biased *against* rejecting H0, as a small sample generally requires a greater effect size to attain sufficient test-power (Vittinghoff and McCulloch, 2007). We find support for our hypotheses, and see this as less of a concern in our case.

First, due to the dichotomous nature of the license -variable we ran a conventional logistic regression model (Hosmer, Lemeshow, and Sturdivant 2013) following Equation 1 below:

$$Pr.License_i = \alpha + \beta * EIA_i \ + \delta * Municipal\ attitude_i + \sigma * Controls_i \ (Eq.1)$$

Equation 1 models the probability of application $_i$ being granted license as a function of β the coefficient for EIA; δ the coefficient for municipal attitude; σ representing the coefficients for our controls; and the constant term α across all cases. Since conventional logit models may be unstable in small samples (King and Zeng 2001:146), we also report results using the ReLogit estimator (King and Zeng, 2001), suitable for situations with finite samples. A linear probability model is also reported, as its estimates are unaffected by the unconditional mean of the dependent variable (King and Zeng, 2001, p. 138). Moreover, being free from the scaling factor in logistic models it helps in assessing whether changes in the parameter estimates between nested and full models are genuine (Breen et al., 2013, p. 167ff). Finally, we also report Firth-logit models that uses a penalized ML-estimator producing consistent estimates of regression parameters in finite samples, as well as finite and consistent estimates of regression parameters when ML-logit breaks down due to separation problems (Rader et al., 2017). Since this fails to account for the increased variability of point estimates, we follow Heinze and Schemper's (2002) advice, and report the significance value of a likelihood-ratio tests of a full vs. nested model for the variables of interest.[8] The Firth-logit model therefore is the most robust predictor in our analysis.

4. Results

We began our investigation by testing bivariate relationships between EIA and licensing outcome, and municipal attitude and licensing outcome, respectively. We then added the controls, entering one at a time. The results for the two variables in focus were very stable and substantively very strong in the expected direction across estimators and operationalizations (see Appendix, Sections B and C). This is in line with previous qualitative research on the topic (Inderberg et al., 2019; Rygg, 2012; Saglie et al., 2020; Solli, 2010). It would take a very strong bias in our two substantive variables for the effect to become unsubstantial and turn insignificant. Although the exact point-estimates of our results should not be interpreted too literally, it is highly probable that the true effect for both variables is in the direction as detected here, and is also substantial and systematic.

Table 3 shows the distribution of each variable in relation to licensing outcome. For the dichotomized variables, we report the odds ratios and their confidence intervals for licenses for having a neutral or negative municipality and a very negative EIA score, respectively, relative to the other category of that explanatory variable. The odds of getting a licence when the municipality is negative or neutral as opposed to positive is 0.244 times lower and statistically significant. Even though we have

[8] See also Appendix Figure E1 for a graphical outline of our analytical strategy. We also tested an exact logistic regression (Hosmer et al. 2013, p. 387), but due to nonconvergence in our multivariate model, these results, although consistent with the others, are relegated to the Appendix.

collapsed the negative and neutral municipalities, creating a highly conservative test, the effect of a positive municipality remains substantively very strong.

Similarly, the odds of being granted a licence when the EIA is very negative are 0.187 lower than if the EIA is neutral to moderately negative.[9] Again, we see a substantial and significant effect in the expected direction for our variable of interest. Due to the potential problem of overfitting and separation in the multivariate analysis to come, we also display the results for our controls with t-tests for differences in means between granted and rejected applications reported. Few systematic effects can be seen, with the possible exception of plant size in MW.

Table 3. Distribution of predictor variables and controls in relation to licenses including tests of bivariate relationships.

Variable	**Concession**		**Difference and test**	
	Yes *n* **= 68 (66,67 %)**	**No** *n* **= 34 (33,33 %)**	**Odds ratio/diff in mean**	**CI odds ratio/t and prob.**
Municipal attitude				
Positive	57 (75.00)	19 (25.00)	4.090909	1.45 to 11.61
Neutral or Negative	11 (42.31)	15 (57.69)		
Environmental impact assessment				
Neutral to medium negative EIA	55 (78.57)	15 (21.43)	0.1866029	0.068 to 0.507
Very negative EIA	13 (40.63)	19 (59.38)		
Year (square root): mean (SD)	-2.33 (0.76)	-2.21 (0.69)	0.1206912	0.8035/0.4243
Number of concessions in area: mean (SD)	1.32 (1.01)	1.15 (0.86)	-0.176	-0.9190/0.3610
Size of plant (MW): mean (SD)	8.67 (3.60)	10.02 (3.46)	1.354489	1.8393/0.0702

N = 102

Table 4 reports the results for bivariate (above solid line) and multivariate (below solid line) regressions. For ease of interpretation, we report the change in probability for our two variables of interest, moving from 0 to 1 and keeping all other variables at their mean based on Model 1. While these overcome the interpretation-problem caused by the scaling of the logit coefficients, substantive changes in probability from the bivariate to the multivariate models could be due to genuine effects (conditioning, suppression etc.) or to problems related to overfitting and/or separation.

[9] A Fisher's exact test of the original 9-point EIA measure versus the dependent variable is highly significant with p=0.007. An alternative coding of our dummy, setting the cut-off between neutral/medium negative EIA vs. very negative EIA at between 1.5 and 2 (instead of between 2 and 2.5) yielded an odds ratio of OR= 0.26 with 95%CI: 0.07 to 0.81.

Table 4. Effect of EIA and municipal attitude on licences, bivariate and multivariate results.

	1. Logistic regression	2. Logistic regression	3. ReLogit	4. OLS	5. Firth logit
Very neg EIA	0.187***	0.187***	0.194***	-0.379***	0.193***
	(0.0864)	(0.0868)	(0.0883)	(0.0942)	(0.0882)
Constant	3.667***	3.667***	3.579***	0.786***	3.581***
	(1.068)	(1.073)	(1.027)	(0.0528)	(1.029)
Observations	102	102	102	102	102
prob-test/lr-test	13.88/0.0002				13.69/0.0002
Ch in prob EIA/z	-0.38/z=-3.79				
Municipality positive	4.091***	4.091***	3.971***	0.327***	3.974***
	(1.952)	(1.962)	(1.868)	(0.103)	(1.865)
Constant	0.733	0.733	0.742	0.423***	0.742
	(0.291)	(0.293)	(0.290)	(0.0890)	(0.289)
Observations	102	102	102	102	102
lr-test	8.95/0.003				8.87/0.0029
Ch in prob mun./z	0.31/2.95				
Very neg EIA	0.207***	0.207***	0.231***	-0.318***	0.229***
	(0.105)	(0.105)	(0.111)	(0.0954)	(0.111)
Positive municipality	3.602**	3.602**	3.272**	0.250**	3.291**
	(1.915)	(1.902)	(1.632)	(0.101)	(1.673)
Year (sq.rt.)	0.744	0.744	0.765	-0.0499	0.764
	(0.243)	(0.320)	(0.311)	(0.0565)	(0.238)
# of conc. in area (sq.rt.)	1.358	1.358	1.333	0.0491	1.334
	(0.354)	(0.336)	(0.312)	(0.0458)	(0.333)
MW (sq.rt.)	0.886*	0.886*	0.894*	-0.0199	0.894*
	(0.0612)	(0.0589)	(0.0562)	(0.0121)	(0.0589)
Constant	1.529	1.529	1.517	0.583***	1.517
	(1.626)	(2.155)	(2.020)	(0.192)	(1.548)
LR-test EIA	10.14/0.001				9.58/0.0020
LR-test municip.	5.91/0.001				5.56/0.0184
Ch in prob EIA/z	-.35/z=-3.17				
Ch in prob municip./z	0.29/z=2.38				
Observations	102	102	102	102	102

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The EIA-dummy behaves in a very similar manner across specifications and estimators, with the multivariate models reporting slightly weaker effects than their bivariate counterparts. The effect of moving from a neutral/moderately negative EIA to a very negative EIA decreases the probability of being granted a license by 37.9 percent in the bivariate case and by 35 percent in the multivariate case – a very strong impact considering that the maximum span is 1. The effect is highly statistically significant across specifications. That the effect of EIA barely changes when controls are introduced is not surprising, as the EIA score is set quite independently from other factors in the licensing process (see Section 2 above). If we rerun our models using the alternative cut-off for the EIA dummy, the effect of moving from 0 to 1 is weaker, but highly substantial, with the probability of being granted a license decreasing by 20 percentage points (z=-2.02). Alternatively, using the multivariate version of Model 1 but the continuous measure of EIA (ranging from best at 0 to worst at 4) a one-step-change reduces the probability of getting a license by 20.3 percentage points (z=-2.90). Finally, although the Firth-logit model reports slightly weaker effects, these are still quite similar to the others.

All in all, these findings strongly support our first hypothesis: *High environmental impact of a windpower project will reduce the likelihood of a licence being granted.*

As for the effect of the municipality being positive as opposed to being neutral/negative, we see a highly positive effect across specifications. The results from our conventional logistic estimator (Model 1) might be a bit inflated as the odds ratio for both of variables of interest is smaller in the Firth logit estimator (Model 5) in particular for having a positive municipality, but the effects are still very substantial and the results remain highly statistically significant. While moving from a negative or neutral municipality to a positive municipality raises the absolute probability of getting a license with 0.31 in the bivariate version of Model 1, the effect is only slightly smaller – 0.29 – in the multivariate case. This small reduction in effect size is primarily due to the introduction of the EIA-measure and the size of installations (MW), which in themselves affect a municipality's attitude (see Appendix B11).

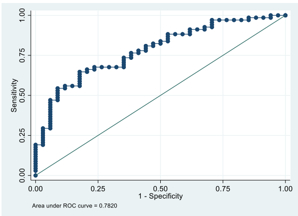
Our second hypothesis – *A positive host municipality will increase the likelihood of a licence being granted* – is therefore also strongly supported, both by our multivariate results and by our raw data, which show an informal near-veto for municipalities negative to windpower on their territory.

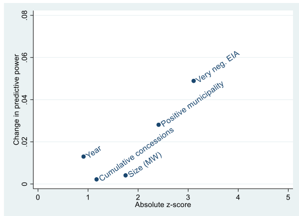
Although the near-perfect distribution of negative municipalities and negative license outcomes shows a very strong relationship, the lack of variation made regression results less reliable. However, the descriptive statistics strongly support the previous qualitative research finding that negative municipalities have had de facto semi-informal veto power against windpower in their areas (Inderberg et al., 2019) – except for the one case of the Raudfjellet windpower plant in Tromsø municipality. Merging the categories leads to a highly conservative coding of this variable, but the findings still indicate a very strong relationship: a positive attitude on the part of the municipality substantially and significantly increases the likelihood of a licence being granted.

Knowing the value for EIA and municipal attitude should therefore significantly help in predicting the licensing outcome. Figure 3 addresses this. Panel *a* (left), shows the accuracy of our model in correctly predicting whether licenses were granted or not. The steeper the rise from the bottom-left of the graph towards the top-right, the better the model is at predicting correctly. Thus, the greater the area under the dashed line (AUC), the better our model is at correctly predicting granted and rejected licenses based on the explanatory variables. The AUC ranges theoretically from 0.5 – which is depicted by the straight 45° line from the bottom-left to the top right corner – a situation where the model is no better than a random guess – to 1 which indicates perfect prediction. In the latter case, the curve would go vertically straight up to the top-left corner and thereafter run horizontally at the very top of the graph. This would constitute a situation where all outcomes were correctly predicted and therefore all of the area of the curve would be under it.

The dotted line represents the performance of our model, which yields an AUC of 0.782, which is quite good (Hosmer et al., 2013; Ward et al., 2010).[10] Panel *b* (right) plots the absolute z-score of each variable horizontally – representing the standardized change in probability for license - against the vertical axis which depicts the drop in the (AUC) from panel *a* when each variable is removed separately from the model on. The higher up vertically in panel *b*, the more the model's predictive ability suffers from the removal of the variable in focus. As AUC is 0.782 and its minimum is 0.5, the AUC drops by 0.05 and 0.03 if EIA and municipal attitude, respectively, are removed, corresponding to drops in predictive power of 17.7% and 10.6% respectively. Again, this lends strong support to our hypotheses, but shows that EIA has a stronger impact on our model's ability to guess the right outcome.

Figures 3 and 4. Predictive power





Explanation: Panel *a* (left) shows the Receiver Operator Characteristic (ROC) of the full model; panel *b* (right) plots the single-variable z-score vs. the drop in predictive power for the full model when removing one variable at a time from the model.

Examination of influential cases revealed that several applications with a positive municipality and a relatively 'good' EIA score (in terms of low local environmental impact), which should predict a licence being granted , were in fact rejected – largely due to conflicting interests with reindeer herding or wild reindeer herds. Conversely, in a few cases with ambiguous municipalities and quite negative EIA scores, licenses were granted – but in these cases the authorities had often set strict and specific conditions. Such cases are well-suited for further in-depth analysis of the licensing process.[11]

[10] Due to our small sample we use within-sample prediction only, which tends to increase AUC values (Ward, et al., 2010).
[11] Diagnostics (see Appendix) revealed no problem with collinearity among predictors (mean VIF was 1.1).

None of the controls influenced the effect of the main explanatory variables to any substantial degree. The closest – the size of windpower project – yielded a positive correlation with licensing outcome, significant at the 10% level. Windpower applications are somewhat clustered, particularly in south-western Norway and the coastal areas of Mid-Norway. A clustering in EIA-score or municipal attitudes that affects licensing outcome could therefore render our results spurious. Our time-control and the variable capturing the number of previously or simultaneously granted licenses are substantively weak and far from significance. Most importantly, however, they do not affect the effect of EIA and municipal attitude on concession – across a range of different operationalizations (see appendix) – hence the clustering of applications is unproblematic. Thus, although the NVE has sought to cluster licences in its evaluations – and from qualitative interviews we know that this has led to some licences being evaluated as a whole – there are few indications of such a general clustering effect.

While we have few indications of an additional multiplicative effect from having both a favourable EIA and a positive municipality, we tested an interaction of these two variables and found negligible differences in predicted values. In conclusion, the effects of our main explanatory variables remain stable across estimators and specifications.

5. Discussion

We find generally strong and consistent support for both our substantive hypotheses. Negative impacts on the local environment substantially reduces the chances of a windpower project being granted a licence. Likewise, a negative or neutral municipality reduces the likelihood of the windpower project being realized. This rather strong effect is evident also in the descriptive statistics: only one licence has been granted against the will of an officially negative municipality.

Although these findings concur with our expectations, they deserve further discussion. As mentioned in the introduction, the influence of EIAs on windpower licensing has, to our knowledge, never been systematically investigated before – which is surprising in itself, given that the EIAs are the primary tool world-wide for considering the environmental impacts of land-use changes (Larsen et al., 2018).

As the EIAs are performed by independent consultants – often by several consultancies with expertise related to the different sub-reports – they are generally considered to be fairly independent, even though they are not held to be above criticism. The score of the factor of interest here – 'nature environment' – should therefore reflect a certain objectivity, on paper at least. This suggests, on the rational level, that findings of high environmental impact would be accorded substantial weight in licensing decisions. However, public bodies and NGOs have argued that the Norwegian licensing process takes nature protection insufficiently into account, or is inadequately informed by observable environmental data (Inderberg et al., 2019; Miljødirektoratet, 2015; Rosendal et al., 2019). Earlier studies (Pettersson et al., 2010) have even indicated that national energy plans and nature protection considerations could be significantly at odds.

A few words on the wider context of windpower licensing in Norway may be in order. Construction has often been located to remote and pristine areas where wind resources are attractive, but where nature and the environment are still relatively untouched. This has given additional fuel to the 'climate vs. nature' controversy. And as windpower production has increased significantly over the last decade, opposition, too, has been on the rise (Vatn, 2019).

Our findings certainly indicate some reconciliation and balancing between these inherent conflicts of goals. This is highly relevant for Environmental Policy Integration (EPI) research, which concerns the incorporation and prioritization of environmental concerns in non-environmental policy sectors (Lafferty and Hovden, 2003; Nilsson and Persson, 2003; Runhaar et al., 2014). This literature has suffered from unclear metrics (Cashmore et al., 2010; Persson et al., 2018; Russel et al., 2018), and the approach applied here can be used for more accurately measuring and comparing actual integration and balancing of environmental values against other factors. An important caveat: the balancing examined here takes place at the national level – i.e. across projects – and does not say much about the integration of environmental goals *within* individual projects and licensing processes, for example in the form of adjustment requirements and adaptations to reduce a project's environmental impact. It should also be borne in mind that while our study shows that the 'nature environment' scores have an impact on licensing outcomes, that does not mean that the foundations of these scores – the fieldwork and assessments upon which they are based – could not be further improved with regard to methodology.

A second caveat should also be noted. Except for two projects that were scored as having neutral environmental impact, all projects in this study were scored as having negative impacts – perhaps reflecting the fact that all land-use changes come at a price. It could be argued that our study compares 'bad vs. worse' for the environment – and that only projects with extremely negative impacts are deemed sufficiently consequential to be halted.

Our findings also have implications for studies of energy democracy, energy justice and fairness, as well as for the acceptance literature. In particular, we see that local government has a significant impact on licensing outcomes. In Norway, the licensing authority is centralized, which could lead one to believe that the local level has less of a say. However, as Inderberg et al. (2019) have demonstrated, local anchoring takes place even if this is not a formal requirement. Other jurisdictions have different licensing schemes, often located at the local level – either independent of the local government but with formalized veto to the municipality, as in Sweden (Pettersson et al., 2010), or as a branch of local public administration itself (Graham et al., 2009). The procedural and democratic implications are likely to differ, depending on the set-up, but we have shown that in practice, even in a centralized arrangement like Norway's, local government weighs in heavily – which is important from the perspective of local energy democracy (Burke and Stephens, 2017; Szulecki, 2018).

Our findings also reveal that the host municipality's consent to a windpower project is a substantial condition for licensing. This implies that the municipality may represent a 'second arena' for licensing processes, where local actors recognize the importance of their municipality's stance on the project, again leading to high advocacy pressure on the local municipality. This accentuates important questions concerning compensation and perceptions of fairness, as well as transparency and local democracy (Saglie et al., 2020). Central here is how the burden of hosting a windpower plant is compensated for the municipality and its residents (outcome fairness), and how the various stakeholders are included in the process (procedural fairness) (Aitken, 2010), and whether conditions municipalities set for being positive are implemented by the developer. Questions of energy justice, burdens and benefits and redistribution of these, the recognition of individuals and groups in the process, the use of local knowledge, process transparency and representation through institutions – all are of crucial significance (Jenkins et al., 2016). These issues are strongly influenced by practices of weighing the municipality's stand. Although justice has not been much addressed in licensing (Bailey and Darkal, 2017; Saglie et al., 2020), this becomes increasingly complex (and important). In particular, how costs and benefits are distributed between different sub-municipal actors and procedurally in informal interactions with the windpower developer and in the formalized licensing process.

6. Conclusions

This study has asked: *To what degree do environmental impact and local authorities influence windpower licensing decisions in Norway?* All cases of finalized licensing processes with accessible data from 2000 until 2019 were included in the analysis, yielding a population of cases of 102. Using manually coded data from the EIAs, as well as official host municipality stances for each windpower project, we established a new dataset that enabled statistical analysis. In addition to our key variables on environmental impact and local authorities' stance, we investigated whether cumulative effects influenced the licensing outcome, and controlled for both the timing and the size (economy) of the projects.

Our findings show that a high environmental impact substantially reduces the likelihood of a project being granted a licence. While this might not be surprising in and of itself, the influence of impact assessments has been subject to much discussion in relation to renewables projects. This is, to our knowledge, the first time their impact has been systematically and statistically investigated.

The stance taken by the municipality was found to have a significant and strong effect on the licensing outcome. The host municipality thus has a substantial say on whether a licence will be granted, even if the formal licensing authority in Norway is at the national level. However, the local authorities' influence differs, depending on their position. If a municipality is clearly opposed to a windpower project, the licence will very likely not be granted. In practice, the municipality holds an informal veto on the licensing decision. For positive municipalities there is also a clear effect, but not as strong. Having a host municipality that supports a windpower project is close to a necessary *but not sufficient* factor for a licence being granted. This also supports findings in the broader acceptance literature, where 'the degree of planning acceptance that is achieved is largely a function of the degree of local acceptance' (Toke et al., 2008, p. 1142).

This study represents only the first few steps towards a more robust testing of which factors actually influence windpower licensing decisions. Although we have used all the cases possible in Norway, our dataset with its 102 cases allowed only for limited quantitative testing of the causal relationships. For example, we have focused only on the 'nature environment' aspect of the EIAs. How this impact fares when compared to the other factors included in the EIAs remains an area in need of further examination.

Moreover, we have chosen to focus solely on the role of the municipality, because in most jurisdictions, local democracy and self-determination (whether or not it is the licensing authority) are important. However, there are certainly other relevant actors as well: other state, regional, or local planning and environmental offices could also have been investigated. How the municipal stance weighs in when compared with other relevant stakeholders is another area for investigation, although our findings strongly support previous qualitative studies showing the particular importance of the municipality.

To our knowledge, the research design implemented here represents a first investigation of the systematic influence of EIA aspects and key stakeholders on licensing outcomes for renewable energy. The approach can be replicated elsewhere, further developed, and expanded: it offers a way of comparing different licensing processes across jurisdictions and investigating differences related to issues like energy democracy (Szulecki, 2018), Environmental Policy Integration (EPI) (Persson et al., 2018), and energy justice and fairness (Jenkins, 2018; Jenkins et al., 2016). How different countries organize their licensing processes and the weight accorded to different project values and impacts within these systems, matters greatly for how nature is affected, who gets a real say, and to what extent, where and how such renewable energy projects are developed. These are hardly trivial issues.

Our findings provide a sound basis for further research along several dimensions. Particularly important is to follow up how EIAs are weighed in licensing and planning processes in *other* jurisdictions – for renewable energy and beyond. The framework here provides an initial approach for statistically measuring the impact of key variables on licensing decisions. As Norway was defined a critical case, similar analyses of 'less likely' cases, or more recent democracies (perhaps with a more centralized state system) can contribute to our understanding of how institutions and practices develop and to what degree this influences the integration of local environmental considerations. Possible cases might include, for example, Argentina, Chile, South Korea or other younger or less wealthy democracies in which local interests and environmental concerns could be expected to have a weaker standing. Such ventures are likely to generate valuable insights into boundary conditions of the patterns detected here.

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