Energy Policy 163 (2022) 112847

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Local residents' attitudes about wind farms and associated noise annoyance in South Korea

Jaehong Ki [a], Sun-Jin Yun [b,*], Woo-Chang Kim [b], Subin Oh [b], Jihun Ha [b], Eunyoung Hwangbo [b], Hyoeun Lee [b], Sumin Shin [b], Seulki Yoon [b], Hyewon Youn [b]

[a] Environmental Planning Institute, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul, 08826, South Korea
[b] Graduate School of Environmental Studies, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul, 08826, South Korea

ARTICLE INFO

Keywords:
Wind energy
Community acceptance
Wind turbine noise
Noise annoyance

ABSTRACT

Although the deployment of wind energy has gradually increased in South Korea, local opposition to the development of wind projects has frequently been reported; this could retard the deployment of wind power in South Korea. Noise from the operation of wind turbines is claimed to be the major reason for opposition. This study explored factors related to local residents' attitudes toward adjacent wind farms and the noise annoyance associated with them. Multivariate linear regression models were adopted to analyze a survey conducted in three counties in South Korea. In the analysis of attitudes, the perceived fairness of the development process was the most influential independent variable, followed by visual evaluation of wind farms and thoughts on whether more wind energy should be installed within the country. In the analysis of noise annoyance, current attitude toward existing wind farms was the most influential factor, followed by factors related to the visibility of wind farms and visual evaluation of them. These findings suggest that planning processes that engage local residents from the start of project development and empower them to influence wind farm layout designs are effective in securing community acceptance and even in alleviating the perceived annoyance of wind turbine noise.

1. Introduction

Promoting renewable energy is a key component of efforts to mitigate the climate change. While the share of renewables within the South Korean primary energy supply increased from 0.40% in 2000 to 2.36% in 2019, this is the lowest proportion among OECD members (OECD, 2021). Recognizing the lagging deployment of renewable energy in the nation, the Moon Jae–in government initiated the Renewable Energy 3020 Implementation Plan in late 2017. The plan sets a target to increase the share of electricity from renewable sources to 20% by 2030, with 48.7 GW of renewable energy capacity installed between 2018 and 2030 (The Blue House, 2018). This mostly comes from solar and wind energy, amounting to 30.8 GW and 16.5 GW, respectively. Considering that the installed capacity of wind energy in 2019 was only around 1.5 GW and its share of supply among renewables was 8.1% (Korea Energy Agency, 2020), the goal of that plan for South Korea's wind energy provision seems ambitious—and despite the plan, very few wind power projects have been installed.

In order to promote wind energy so rapidly, it is essential to consider societal acceptance of the technology. Although it is reported that almost 70% of the general public think more wind energy should be developed in South Korea (Korea Energy Economics Institute, 2018), the development of individual wind farm projects suffers from opposition by local residents who live close to project sites (Kim et al., 2016; Kim and Chung, 2019). Recognition of negative impacts from the development and operation of wind farm is one reason that motivates local residents' opposition. Noise produced from the operation of wind turbines is claimed to be an essential negative impact of wind energy. Wind turbine noise, and annoyance induced by it, can bring about negative experiences in local communities and reduced acceptance of wind energy (Rand and Hoen, 2017); this, in turn, can retard the deployment of wind energy in the country.

Studies have revealed factors influencing or related to acceptance of wind energy, largely from the early 2000s and mostly in European and North American countries where wind energy is extensively deployed (Fast, 2013; Rand and Hoen, 2017). Furthermore, with Pedersen and Persson Waye (2004) as one of the first efforts (Haac et al., 2019), studies to find factors related to wind turbine noise annoyance have

* Corresponding author.
E-mail address: ecodemo@snu.ac.kr (S.-J. Yun).

https://doi.org/10.1016/j.enpol.2022.112847
Received 30 May 2021; Received in revised form 4 February 2022; Accepted 6 February 2022
Available online 12 February 2022

been carried out. Yet, to the authors' knowledge, research on these subjects is lacking in South Korea. Therefore, this study aims to estimate factors that are related to attitudes toward wind farms and associated noise annoyance through a survey targeted to residents who live near wind farms in South Korea. Although studies on these subjects have been conducted, efforts are needed to examine whether findings from other studies are applicable in the South Korean context. Findings from this study could help not only South Korean policy makers but also scholars who are trying to establish solid knowledge about societal aspects of wind energy deployment by providing empirical evidence derived from South Korean cases.

2. Related literature

While studies on the acceptance of wind turbines and associated noise annoyance have been published in the past couple of decades, the findings of most studies were drawn from one or a few cases (Hoen et al., 2019). Among them, studies based on a 2016 survey in the U.S. (i.e., Firestone et al., 2018; Haac et al., 2019; Hoen et al., 2019; Hübner et al., 2019) are considered to provide more general results because they rely on nationwide samples that adopted random sampling and weighting methods; thus, they can control for case–specific issues that affect the results of analyses. Therefore, we selected variables for analysis that were comparable to the ones used in those studies so we could compare their findings to those of the cases we studied.

2.1. Community acceptance of wind energy

Wüstenhagen et al. (2007) distinguished three dimensions of societal acceptance of renewable energy development: Sociopolitical acceptance, market acceptance, and community acceptance. While we recognize this distinction, in this study "acceptance" refers to community acceptance, which focuses on local residents living close to wind farms. However, the term "acceptance" may not be appropriate because it includes responses such as tolerance, resignation, uncertainty, and ignorance (Batel et al., 2013; Firestone et al., 2018). Accordingly, related studies more typically use "support/opposition" for future or hypothetical projects and "positive/negative attitude" for existing projects (Firestone et al., 2018). In this study, we use the term "attitude" in survey questions and variable names because this survey has targeted those who live near existing wind farms.

Distance between wind farms and nearby residents is likely to be one determinant of acceptance. For example, in the study conducted by Hoen et al. (2019), in which distance was considered as a stratification variable, the attitudes of people living within 1.6 km of the closest wind farm were 0.17–0.19 more positive on their measurement scale than those of people living beyond 1.6 km when other variables were controlled. However, some studies report the opposite relationship between distance and attitude (Firestone and Kempton, 2007; Swofford and Slattery., 2010)—increased distance from wind turbines correlates with positive attitudes—or no significant relationship (Olson–Hazboun et al., 2016). It is unclear how distance is associated with attitudes toward wind farms.

The visual aspect of wind farms is reported to be associated with local residents' attitudes (Bishop, 2002; Gonzalez and Estevez, 2005; Jobert et al., 2007; Ladenburg, 2009; Sibille et al., 2009; Westerberg et al., 2013; Wolsink, 2007). Visual aspects of wind farms that have been related to the level of acceptance include both the visibility itself and evaluation of wind farms' aesthetic features (Bush and Hoagland, 2016). Wind turbines are high–rise structures, accompanied by rotational motion of blades and lights to which some people are sensitive during daytime and nighttime, respectively. Direct visibility, shadow flicker, and blinking lights can annoy neighboring residents and have been reported to be associated with an increased risk of sleep disorders (Freiberg et al., 2019). In Hoen et al. (2019), visibility of wind turbines did not correlate with attitudes, but the degree to which respondents liked the look of wind farms and thought wind farms fit the landscape had the largest standardized coefficient among their independent variables (0.38). Further, people's visual preferences regarding wind turbines are reported to be different depending on the aesthetic quality of the landscape (Molnarova et al., 2012).

Whether local residents think their opinions are respected during the process of communication with business operators or relevant authorities is also regarded as an important factor determining community acceptance (Firestone et al., 2012; Hall et al., 2013). Firestone et al. (2018) reported that the sum of the standardized coefficients for variables measuring perceptions of the process was 0.342, which was greater than that of general attitudes toward wind power. When members of hosting communities feel they could influence the project outcome and developers were communicated in an open and transparent manner, they are likely to have positive attitudes toward wind farms (Firestone et al., 2018).

Perceptions of economic benefits or losses from wind farms and their relationship with attitudes were also discussed in previous studies (Firestone et al., 2009; Groth and Vogt, 2014; Kim et al., 2014; Slattery et al., 2012). Property value is one such economic impact. Studies estimated property values around wind farms report inconsistent results. Some studies report no significant effect on property values by wind farms (Hoen et al., 2015; Hoen and Atkinson–Palombo, 2016), while others report reduced house prices at certain distance ranges (Dröes and Koster, 2016; Gibbons, 2015). Regardless of the real impacts on property values, the perception of wind farms' impact on property values correlates with attitudes (Rand and Hoen, 2017). Sometimes compensation is paid to the local community during the process of wind farm development. However, compensation may not offset perceptions of the negative impacts of wind farms (Jørgensen et al., 2020). In the regression model analyzed by Hoen et al. (2019), the standardized coefficient for property value perception had a value (0.17) comparable to general attitudes toward wind development, while the standardized coefficient for compensation was not significant.

In terms of environmental impacts, wind energy provides benefits at the global or regional level, such as climate change mitigation. On the other hand, the development of wind farms could have an impact on local ecology. Perceptions about such environmental concerns have been investigated, but their association with attitudes toward wind farms is reported to be weak or negligible (Baxter et al., 2013; Hoen et al., 2019; Olson–Hazboun et al., 2016).

2.2. Noise annoyance

One South Korean study showed that noise impact was the most frequently selected reason (60.5% for the general public and 51.6% for residents living close to existing wind farms) for opposition to a hypothetical new wind farm (Lee et al., 2020). Annoyance induced by wind turbine noise has been consistently reported to be associated with negative attitudes toward wind energy (Baxter et al., 2013; Fast et al., 2016; Firestone et al., 2015; Haac et al., 2019; Hübner et al., 2019; Langer et al., 2018; Pawlaczyk–Łuszczyńska et al., 2014; Pedersen and Persson Waye, 2007; Pohl et al., 2018). Results of a multivariate regression model conducted by Hübner et al. (2019) showed that attitudes toward existing wind farms were the strongest predictor of noise annoyance in American (beta: −0.459) and European (beta: −0.432) samples. In Haac et al. (2019), the odds of being annoyed by wind turbine noise was reported to decrease by 55% for a person who had a positive prior attitude compared to one who had a neutral or negative prior attitude.

Studies also report that the level of wind turbine noise is neither the only nor the most dominant predictor of wind turbine noise annoyance (Haac et al., 2019; Hübner et al., 2019; McCunney et al., 2014; Pawlaczyk–Łuszczyńska et al., 2014; Pohl et al., 2018; Radun et al., 2019). Even in studies where the measured or modeled sound level had a significant coefficient in the regression analysis, the impact of the variable was less than variables representing attitudes or subjective perceptions (Haac et al., 2019; Pawlaczyk–Łuszczyńska et al., 2014). In the same vein, the distance to the closest wind turbine was reported to have a negligible effect on noise annoyance when other variables were controlled for (Hübner et al., 2019; Pawlaczyk–Łuszczyńska et al., 2014; Pohl et al., 2018). Such findings indicate that other moderating variables should be considered in efforts to understand noise annoyance induced by wind turbines.

Given that noise annoyance correlates weakly with sound level or distance and strongly and negatively correlates with attitudes, non–acoustic factors that affect attitudes have been reported to be associated with noise annoyance, but the relationships take opposite directions. Some studies show that a resident who can see a wind turbine from their property tends to be more annoyed by wind turbine sound (Kuwano et al., 2014; Pedersen and Persson Waye, 2007; Pohl et al., 2018), but other studies show visibility has a negligible effect (Haac et al., 2019; Hübner et al., 2019). As with attitudes, not visibility itself but rather evaluation of the visual aspect of wind farms could be the factor significantly related to noise annoyance (Haac et al., 2019; Pawlaczyk–Łuszczyńska et al., 2014; Pedersen et al., 2009). A regression analysis by Haac et al. (2019) indicated that visibility had negligible influence on noise annoyance, but a person who did not like the look of wind farms was 11 times more likely to be annoyed by wind turbine noise. Economic benefits such as compensation seem to have an impact on alleviating noise annoyance, but the magnitude of the impact was less than that of visibility (Pedersen et al., 2009) or visual evaluation (Haac et al., 2019). People who experienced annoyance during the development of wind farms or who perceived the development process as unfair tended to be more annoyed by wind turbine noise (Hübner et al., 2019; Pohl et al., 2018). Some studies also show that self–reported sensitivity to noise correlates with noise annoyance (Haac et al., 2019; Hübner et al., 2019; Pawlaczyk–Łuszczyńska et al., 2014).

3. Methodology

In this study, three cases where wind farms are in operation were selected and a questionnaire survey was conducted among residents living in the vicinity of the wind farms. The questionnaire measured each factor in a quantitative manner, and multivariate regression was adopted for the analysis.

3.1. Survey area

The survey was conducted in Shinan, Yeonggwang, and Yeongyang in South Korea. The first two counties are located in the southwestern part of South Korea, and the latter is in the southeastern part. In Shinan, three wind farms are located near the survey area. The capacity of the wind farms is 24 MW (3 MW × 8), 18 MW (3 MW × 6), and 20.7 MW (3.45 MW × 6). Yeonggwang also has three wind farms near the survey area, with capacities of 20 MW (2 MW × 10), 40 MW (2 MW × 20), and 79.6 MW (2 MW × 3 + 2.3 MW × 33). In Yeongyang, there are two wind farms in the vicinity of the survey area, with capacities of 59.4 MW (3.3 MW × 18) and 75.9 MW (3.45 MW × 22). All three areas have typical rural villages and have multiple wind farms that were developed in phases (Shinan: 2016–2018, Yeonggwang: 2014–2019, Yeongyang: 2015–2019). However, the geographical features where wind farms are located are distinct among the cases. The Shinan survey area consists of villages on an island where wind farms are installed along the coastline. In Yeonggwang, wind farms are installed on plains near the coast, and most of the turbines are located on private farmland. Yeongyang is an inland mountainous region; all wind farms in this region are located along mountain ridges.

3.2. Sampling

Before conducting the survey, the research team developed a list of villages adjacent to wind farms. In August 2020, the leader of each village was contacted to discuss the survey. Because the survey period was in the middle of the COVID–19 pandemic, only villages that allowed the research team to visit were included in the survey. In October 2020, face–to–face surveys were conducted by research team members. Because a high proportion of residents in survey areas were elderly, there were no viable options other than a face–to–face survey for guaranteeing the quality of responses. Research team members recruited village residents for survey by door-to-door visit. A total of 206 participants answered the questionnaire; 161 samples were used for regression analysis because of missing responses. Based on the registered population of the villages included in the survey areas, about 16–19% of residents participated in the survey (Shinan: 16.4%, Yeonggwang: 18.9%, Yeongyang: 16.5%). Table 1 shows the sample composition in terms of gender, age, and education level.

3.3. Questionnaire

The questionnaire consisted of items measuring factors used for the analysis. Table 2 shows the questions and how answers for each question were coded. Variables were derived either from a single question or multiple questions, depending on semantic similarity and statistical reliability (Cronbach's alpha presented in Table 2 where applicable). When multiple questions were used to form a single variable, the mean value of answers for each question was used. In the multivariate linear regression model, demographic and socioeconomic variables (except for age) and variables with binary coding (i.e., visibility, audibility, and compensation) were included as dummy variables.

4. Results

4.1. Attitude toward wind farms

Table 3 presents mean values for each continuous variable and the proportion of respondents who answered "Yes" for each categorical variable. The variable attitude had a mean value of 2.19. This variable was coded in values ranging from 1 (Very negative) to 5 (Very positive), so it can be said that the sample recruited for this study represents

Table 1
Sample characteristics.

Category		County			Total
		Shinan	Yeonggwang	Yeongyang	
Sample size (persons)		83	43	35	161
Gender	Male	48 (58%)	19 (44%)	21 (60%)	88 (55%)
	Female	35 (42%)	24 (56%)	14 (40%)	73 (45%)
Age	Under 50	3 (4%)	7 (16%)	7 (20%)	17 (11%)
	50–59	7 (8%)	3 (7%)	10 (29%)	20 (12%)
	60–69	16 (19%)	8 (18%)	8 (23%)	32 (20%)
	70–79	24 (29%)	22 (51%)	5 (14%)	51 (31%)
	Over 80	33 (40%)	3 (7%)	5 (14%)	41 (25%)
Education	Less than middle school	58 (70%)	26 (60%)	10 (29%)	94 (58%)
	Middle school	7 (8%)	6 (14%)	3 (9%)	16 (10%)
	High school	14 (16%)	8 (19%)	16 (46%)	38 (24%)
	University and more	4 (5%)	3 (7%)	6 (17%)	13 (8%)

Note: Values (proportion) in each category may not sum to total sample size (100%) because of missing values.

Table 2
Variables and questions.

Variable	Questions	Coding	Alpha
Attitude	What is your attitude toward the existing wind farms in your village?	1 Very negative 2 Somewhat negative 3 Neutral 4 Somewhat positive 5 Very positive	–
Noise annoyance	To what extent do you feel annoyed by the noise from local wind farms?	1 Not at all 2 Slightly 3 Somewhat 4 Very	–
Visibility	Can you see any wind turbines from your house?	1 Yes 2 No	–
Audibility	Can you hear the sound of wind turbines inside your house?		–
Compensation	Was any compensation paid to you or your family from wind farm projects?		–
Landscape change	To what extent do you think the change to the landscape around your village affects your daily life?	1 Not at all 2 Slightly 3 Moderately 4 Somewhat 5 Very	–
Landscape appeal	I like the landscape of my village with wind farms.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree	–
Process fairness	The development process for wind farms in our village was fair. The wind project developer acted openly and transparently throughout the process. The community was able to influence the outcome of the wind project, for example the location or number of turbines. During the development process for wind farms, the interests of residents were considered.		0.85
Wind energy effective	I consider wind energy to have a positive effect on mitigating climate change.		–
Concern about climate change	I am concerned about climate change.		–
More wind energy required	I think more wind turbines should be installed within my country.		–
Property value perception	Wind farms have positive impacts on local property values.		–
Adverse ecological impact	Wind farms have negative impacts on the local ecology and environment.		–
Adverse health impact	Wind farms have negative impacts on the health of local residents.		–
Other noise annoyance	To what extent do you feel annoyed by traffic noise? To what extent do you feel annoyed by the noise of agricultural machinery? To what extent do you feel annoyed by the noise of livestock?	1 Not at all 2 Slightly 3 Somewhat 4 Very	0.74
Noise sensitivity	Overall, I am sensitive to noise.	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree	–
Background noise perception	The area where I am living was originally quiet.		–

Table 3
Descriptive statistics of variables and comparison across cases.

Variable	Total	Shinan	Younggwang	Yeongyang	p–value (ANOVA)
Attitude	2.19 (1.23)	2.08 (1.12)	1.81 (1.07)	2.91 (1.38)	0.000
Noise annoyance	2.61 (1.09)	2.58 (1.16)	2.86 (1.03)	2.40 (0.98)	0.174
Distance (m)	1165.8 (497.8)	1149.3 (517.8)	1407.0 (469.7)	908.3 (323.2)	0.000
Visibility (% Yes)	79.5%	62.7%	97.7%	97.1%	0.000
Audibility (% Yes)	69.6%	61.5%	74.4%	82.9%	0.050
Compensation (% Yes)	70.2%	65.1%	62.8%	91.4%	0.008
Landscape change	3.50 (1.29)	3.72 (1.24)	3.53 (1.33)	2.94 (1.23)	0.011
Landscape appeal	2.24 (1.25)	2.22 (1.19)	1.60 (0.90)	3.09 (1.31)	0.000
Process fairness	2.11 (0.91)	2.06 (0.85)	1.92 (0.92)	2.46 (0.98)	0.024
Wind energy effective	2.64 (1.26)	2.43 (1.06)	2.44 (1.52)	3.37 (1.09)	0.000
Concern about climate change	3.50 (1.29)	3.19 (1.33)	3.95 (1.38)	3.69 (0.87)	0.004
More wind energy required	2.66 (1.28)	2.60 (1.21)	2.28 (1.39)	3.29 (1.13)	0.002
Property value perception	2.06 (1.21)	1.80 (1.12)	1.93 (1.03)	2.86 (1.29)	0.000
Adverse ecological impact	3.19 (1.32)	3.20 (1.32)	3.53 (1.22)	2.71 (1.32)	0.023
Adverse health impact	3.30 (1.36)	3.11 (1.39)	3.91 (1.23)	3.00 (1.26)	0.002
Other noise annoyance	1.78 (0.71)	1.58 (0.62)	2.24 (0.75)	1.70 (0.61)	0.000
Noise sensitivity	3.49 (1.13)	3.27 (1.19)	3.95 (0.95)	3.46 (1.07)	0.005
Background noise perception	4.36 (0.82)	4.43 (0.74)	4.35 (0.90)	4.21 (0.93)	0.449

Note 1: Values presented in columns 2 through 5 are mean (standard deviation) for continuous variables and proportion for categorical variables.
Note 2: Values presented in column 6 are p–value of ANOVA test.

residents who generally had a negative attitude toward nearby wind farms. The level of attitude differed across the three survey areas, as did other variables. For example, the value of mean distance from the nearest wind turbine to respondent's home was the smallest in Yeongyang, while attitudes in this region were the least negative. On the other hand, the values of variables such as landscape appeal, process fairness, wind energy effective, more wind energy required, and property value perception in this region were relatively high compared to other regions. From such differences in variable values aggregated across each survey region, we can anticipate relationships between attitude and independent variables. The results of the multivariate linear regressions that are presented in this section provide more detailed information on such relationships, as the unit of analysis is at the individual level and the influences of other variables are controlled for when analyzing the impact of each variable.

In the linear regression analyses, independent variables categorized as demographic and socioeconomic, situational, and personal were successively included in models; the results for each model are presented in Table 4. In Model 1, where only demographic and socioeconomic variables were included as independent variables (i.e., county, gender, age, education (level, categorized), and income (level, categorized)), it is notable that the level of attitude in one survey region (Yeongyang) was statistically different (relatively higher) from the other two. The coefficient of this dummy variable remained statistically significant

Table 4
Linear regression with attitude as a dependent variable.

Dependent variable: Attitude		Model 1			Model 2			Model 3		
		Coef.	p–value	Std. Coef.	Coef.	p–value	Std. Coef.	Coef.	p–value	Std. Coef.
County	Shinan (base)									
	Younggwang	–.260	0.247	–.094	–.193	0.447	–.070	–.013	0.955	–.005
	Yeongyang	**.896**	**0.003**	**.302**	**.887**	**0.003**	**.299**	.004	0.988	.001
Gender	Base: Male	.146	0.465	.059	.105	0.589	.043	.214	0.205	.087
Age		.006	0.509	.071	.005	0.560	.055	.009	0.213	.106
Education	Less than middle school (base)									
	Middle school	–.218	0.424	–.053	–.158	0.558	–.039	–.025	0.925	–.006
	High school	.217	0.534	.075	.027	0.940	.009	.208	0.413	.072
	University and more	.005	0.991	.001	–.194	0.665	–.043	.102	0.788	.022
Income (Million won/year)	Less than 10 (base)									
	10 or more and less than 20	.307	0.341	.086	.192	0.551	.053	.478	0.068	.131
	20 or more and less than 30	.067	0.844	.016	–.032	0.932	–.008	.263	0.336	.063
	30 or more and less than 40	–.052	0.882	–.013	–.051	0.890	–.013	.153	0.589	.037
	40 or more and less than 50	–.030	0.933	–.007	.103	0.801	.023	.225	0.491	.050
	50 or more	.248	0.555	.060	.125	0.794	.030	.228	0.554	.054
Distance (100 m)					–.022	0.274	–.090	–.006	0.744	–.024
Visibility (base: Yes)					–.304	0.261	–.100	–.324	0.147	–.107
Audibility (base: Yes)					**.927**	**0.000**	**.349**	**.369**	**0.050**	**.139**
Compensation (base: Yes)					–.256	0.293	–.096	–.265	0.231	–.099
Landscape change								–.068	0.350	–.072
Landscape appeal								**.181**	**0.012**	**.186**
Process fairness								**.350**	**0.002**	**.260**
Wind energy effective								.080	0.268	.082
Concern about climate change								–.106	0.144	–.111
More wind energy required								**.176**	**0.029**	**.184**
Property value perception								**.148**	**0.042**	**.146**
Adverse ecological impact								–.110	0.076	–.118
Adverse health impact								–.047	0.505	–.052
Constant		1.539	0.044	–	1.77	0.014	–	.340	0.714	–
N R^2	Adj. R^2	161	0.127	0.056	161	0.227	0.141	161	0.530	0.442

Note: In the analysis, the unit of Distance variable were set to 100 m. This conversion of unit has been done to prevent values of coefficients becoming too small to present. For example, the value of 1600 in meters becomes 16 after conversion.

Table 5
Linear regression with noise annoyance as a dependent variable.

Dependent variable: Noise annoyance		Model 4			Model 5		
		Coef.	p–value	Std. Coef.	Coef.	p–value	Std. Coef.
County	Shinan (base)						
	Younggwang	–.318	0.162	–.130	–.319	0.144	–.130
	Yeongyang	.132	0.541	.050	.179	0.377	.068
Gender	Base: Male	.212	0.203	.097	.300	0.056	.138
Age		–.004	0.647	–.047	–.001	0.869	–.017
Education	Less than middle school (base)						
	Middle school	–.023	0.931	–.007	–.091	0.701	–.026
	High school	–.123	0.605	–.047	–.091	0.711	–.035
	University and more	**–.820**	**0.013**	**–.210**	**–.807**	**0.018**	**–.206**
Income (Million won/year)	Less than 10 (base)						
	10 or more and less than 20	–.094	0.700	–.030	.044	0.858	.014
	20 or more and less than 30	–.309	0.169	–.084	–.213	0.364	–.058
	30 or more and less than 40	–.080	0.776	–.023	–.065	0.810	–.018
	40 or more and less than 50	.510	0.058	.121	.406	0.089	.096
	50 or more	–.008	0.979	–.002	.020	0.944	.006
Distance (100 m)		.006	0.757	.026	.002	0.907	.009
Visibility (base: Yes)		**–.511**	**0.038**	**–.191**	**–.570**	**0.013**	**–.213**
Compensation (base: Yes)		–.179	0.353	–.076	–.238	0.163	–.100
Landscape appeal		**–.224**	**0.005**	**–.257**	**–.163**	**0.033**	**–.187**
Process fairness		–.115	0.313	–.096	–.009	0.935	–.007
More wind energy required		**–.224**	**0.001**	**–.265**	**–.128**	**0.049**	**–.152**
Other noise annoyance		.0217	0.852	.014	.013	0.902	.009
Noise sensitivity		**.168**	**0.022**	**.172**	.114	0.107	.117
Background noise perception		–.064	0.495	–.049	–.100	0.250	–.076
Attitude					**–.324**	**0.000**	**–.351**
Constant		4.023	0.000	.	4.298	0.000	.
N; R^2; Adj. R^2		155	0.386	0.289	155	0.451	0.360

Note: In the analysis, the unit of Distance variable were set to 100 m. This conversion of unit has been done to prevent values of coefficients becoming too small to present. For example, the value of 1600 in meters becomes 16 after conversion.

when situational factors—distance, visibility, and compensation—were included in the model (Model 2). Wind farms are sited along mountain ridges in Yeongyang, while the other two areas have their wind farms in a flat geographic setting. While Ek and Persson (2014) reported that wind farms on flat land were preferred over those in mountainous areas in a Swedish survey, this has not been the case in recent South Korean studies (Kim et al., 2020). Therefore, further investigation is required to evaluate whether the location of wind farms has a significant relationship with the level of acceptance. In Model 3, where personal factors were added to the model, the coefficient for Yeongyang became no more significant ($p = .988$). This result implies that personal, subjective factors are more influential in determining attitude level than geographic conditions, which are fixed and not controllable by developers. Attitude levels can be improved by taking proper measures to guide personal factors in a positive direction.

With the inclusion of personal factors (Model 3), the explanatory power of the model was greatly improved, as interpreted from the value of adjusted R^2. Among the variables, audibility, landscape appeal, process fairness, more wind energy required, and property value perception had coefficients that were statistically significant at the $p < .05$ level. The more a person likes landscapes having wind farms, perceives the siting and developing of wind farms as fair, thinks more wind farms should be developed in the nation, and thinks wind farms positively impact local property values, the more likely the person to have a relatively positive attitude toward wind farms. In addition, one who can hear the sound of wind turbines is likely to have a more negative attitude than one who cannot. All these relationships are generally in line with the previous studies described in Section 2.

4.2. Noise annoyance

Table 5 presents the results of multivariate linear regression models in which the dependent variable is noise annoyance. In Model 4, demographic and socioeconomic, situational, and personal variables were included as independent variables.[1] In Model 5, present attitude toward nearby wind farms, the dependent variable in the models in section 4.1, was added. Hübner et al. (2019) argued that measuring annoyance level alone might not be a sufficient impact indicator for wind turbine noise but rather should be compared to the general attitude. By adding attitude as independent variable in the model (Model 5), we tried to estimate how closely the level of noise annoyance and attitude are related and whether other factors remain statistically significant after controlling for the impact of attitude.

In Model 4, it is notable that distance was not a significant predictor of noise annoyance. Although sound level was not directly measured in this study, distance is a strong determinant of objective sound level because the sound level from a particular source is attenuated as distance increases. Therefore, this finding can be regarded as evidence of the relatively limited power of objective sound level in explaining noise annoyance.

Factors related to visual aspects were found to be significantly related to noise annoyance. Respondents who could see wind turbines from their property tended to be more annoyed by wind turbine noise than respondents who could not. This finding is in line with previous studies (Kuwano et al., 2014; Pedersen et al., 2009; Pedersen and Persson Waye, 2007). And, as found in Haac et al. (2019), someone who liked the landscape with wind farms was likely to feel less annoyed by the sound from a wind turbine. The perception that more wind turbines should be installed in the nation was negatively associated with the level of noise annoyance. People who had a university education or more were less annoyed by wind turbine noise than other groups. Noise sensitivity was the only acoustic factor found to have a statistically significant coefficient. Meanwhile, the extent to which respondents felt other sources of noise were annoying (other noise annoyance) did not significantly correlate with wind turbine noise annoyance.

In Model 5, attitude had a statistically significant and negative coefficient. Based on the value of the standardized coefficient, this variable was the most influential of all independent variables in determining the level to which people felt annoyed by wind turbine noise. The coefficients of other variables, excluding noise sensitivity, that were statistically significant in Model 4 remained significant at $p < .05$ level in Model 5.

5. Discussion

This study was conducted to estimate factors associated with attitudes toward wind farms and wind turbine noise annoyance through surveys targeted to residents living in the vicinity of existing wind farms in South Korea. This section discusses the major findings.

In regard to attitudes toward existing wind farms, the respondents in this study reported a relatively negative attitude, on average. The proportion of respondents having very negative, somewhat negative, neutral, somewhat positive, and very positive attitudes toward existing wind farm were approximately 38%, 27%, 21%, 7%, and 7%, respectively. The resulting ratio of positive to negative attitudes is approximately 1:4.6. This result is almost the opposite of the findings of Hoen et al. (2019), which reported the ratio as almost 7:1 in an American national survey sample. Not surprisingly, considering the negative relationship between attitude and noise annoyance found in this study as well as in previous studies (Hübner et al., 2019; Pawlaczyk–Łuszczyńska et al., 2014; Pohl et al., 2018), respondents recruited for this study tended to be more annoyed by wind turbines (mean value of 2.61 on a 1–4 scale) than the samples in Hübner et al. (2019) (American samples: mean value of 1.44 on a 0–4 scale; European samples: mean value of 1.46 on a 0–4 scale). This difference may be the consequence of differences in the distance of respondents from turbines—the mean distance to the nearest turbine in the samples in this study was 1.17 km, while it was 4.78 km in Hoen et al. (2019) and 2.72 km for American samples and 1.74 km for European samples in Hübner et al. (2019)—or differences in the cultural context where studies were conducted. Whichever is the case, it can be said that survey samples in this study represent residents who have generally negative attitudes and feel annoyed by wind turbine noise to some degree. Therefore, these results can be used to examine whether the findings of previous studies, especially ones with more general samples (e.g. Firestone et al., 2018; Haac et al., 2019; Hoen et al., 2019; Hübner et al., 2019), are applicable to samples with these more negative characteristics.

5.1. Attitude

In the regression models that had attitude as the dependent variable, perception of the fairness of the development process was the most influential factor in explaining attitudes toward local wind farms, based on the magnitude of the standardized coefficient. How positively one perceived a landscape with wind turbines was the second most influential factor. Previous studies also found such factors to be strongly associated with attitudes (Firestone et al., 2018; Hoen et al., 2019). As argued in previous studies, results from this study also emphasize the importance of procedural aspects of development for determining local residents' perceptions of wind farms. Local residents who are given information about development in an open and transparent manner and empowered to influence the outcome of the project are more likely to perceive that the process is fair (Firestone et al., 2018). During such inclusive procedures, the location and layout of wind farms could be adjusted in ways that local residents regard as a better fit to the

[1] As in analysis presented in a previous subsection (4.1.), we successively included variables categorized as demographic and socioeconomic, situational, and personal in models. But there were no changes found in the statistical significance (at $p < .05$ level) or signs of independent variables. Therefore, we only present the result of the last model in Table 5.

landscape or as aesthetically superior.

In regard to audibility and visibility, the results of the regression analyses are in line with the findings of Hoen et al. (2019). The coefficient of audibility was statistically significant, which indicates that one who can hear the sound of wind turbines is likely to have a negative attitude, but the coefficient of visibility was not. As pointed out by Hoen et al. (2019), it could be said that personal evaluation of the fitness of wind turbines to the surrounding landscape is a more influential factor on attitude formation than visibility itself.

In terms of economic aspects, the effect of perception of wind turbines' impact on local property values was significant, while receipt of compensation was not. This result implies that wind farms should be developed in ways that local residents think would benefit the local economy. Engaging local residents at the earliest stage of wind farm development can increase the chance that such perceptions could be formed.

5.2. Noise annoyance

In the noise annoyance models, one notable finding of this study is that the level to which respondents were annoyed by wind turbine noise was not determined by the distance to the nearest wind turbine. In this analysis, distance was used as proxy variable for actual sound level. Hübner et al. (2019) reported that the modeled sound level of wind farms had a negligible impact on the noise annoyance stress scale that they applied. In the similar vein, Haac et al. (2019) reported that the modeled sound level had a statistically significant relationship with wind turbine noise annoyance level, but was not as dominant a predictor as subjective variables such as attitude, noise sensitivity, and estimation of visual impression. The result of this study, that attitude toward nearby wind farms is the strongest predictor of annoyance with wind turbine noise, should be understood while acknowledging the subjective nature of noise annoyance.

In the model where the variable attitude was included, there still were factors whose coefficients were significant at the $p < .05$ level. Two such factors were relevant to the visual aspects of wind farms. Although seeing wind turbines can increase the likelihood of feeling annoyed by wind turbine sound, this could be alleviated if one perceives the wind farm as fitting the surrounding landscape. Consulting local residents during the process of designing the layout of wind farms could be emphasized as a way to alleviate noise annoyance as well.

6. Conclusions and policy implications

South Korea plans to expand wind energy deployment in coming years. However, several individual wind farm projects currently suffer from local opposition. From 2016 to 2020, 152 wind farm projects have been granted permission in South Korea, but only four projects have initiated operation during that period (Lee, 2020). Noise has been raised as one of the major reasons for opposition to wind farm development. This study was conducted to provide empirical evidence to help understand attitudes about wind farms in South Korea and associated noise annoyance. Overall, the cases analyzed in this study show a negative attitude toward wind farms, and respondents reported that they were annoyed by wind turbine sound to some degree. The results of regression models that have attitude and noise annoyance as dependent variables generally support the findings of previous studies.

Perceptions of process fairness was the most influential factor in determining attitude. From this result, it can be said that engaging local residents in the development process is the key component to leading neighboring communities to have positive attitudes toward wind farms. Considering that visual evaluation of wind farms is the second most influential factor on attitude, the importance of process should be emphasized. Although development of wind farms inevitably induces landscape changes, developers can seek wind farm layouts that minimize local residents' negative perceptions about the visual presentation of wind farms. This goal could be achieved by allowing local residents to engage in the planning process from the early stages. In that sense, the July 2020 amendments to the Electricity Business Act, which require renewable energy developers to consult with local residents before applying for permission, are expected to help mitigate future disputes during the development and operation of wind farms.

In terms of noise annoyance, the findings of this study suggest that noise issues arising from the operation of wind turbines are closely related to subjective perceptions of the wind farms (i.e., attitude toward and visual evaluations of existing wind farms), not the actual sound level. In the absence of this empirical evidence, measures to counteract wind turbine noise annoyance might be sought in technology, such as by funding research agencies to develop turbines that produce lower noise or by defining a setback distance between wind farms and dwellings. Although such technological measures are also important, the results of this study suggest that the noise issue can be effectively managed by a social process during the planning of wind farms and by policy measures encouraging the engagement of locals in the planning process.

Additionally, positive attitudes about the need for more wind farms in general is positively related to attitudes about nearby wind farms. This factor was among the significant determinants of noise annoyance as well. This implies that policy measures to increase awareness of the necessity of wind energy deployment should be consistently implemented to create more favorable ground for deployment of the technology. Campaigns targeted to local communities that have a high potential for wind energy development should be considered.

Because South Korean wind energy deployment is still in an immature stage and a large expansion is proposed in upcoming decades, more studies into societal interactions in the development of wind energy are required. Although this study is the first to quantitatively estimate determinants of attitudes toward local wind farms and associated noise annoyance and provides evidence that findings from previous research are applicable when people have negative attitudes about local wind farms, limitations exist. First, the results of this study are drawn from limited cases. Accordingly, it is not certain whether the generally negative attitudes found in this study are the result of a biased sample or are common across South Korea. Therefore, future studies with systematic recruitment of survey samples targeted across the nation could provide more general findings. Second, this study measured noise annoyance with a single scale. As argued by Hübner et al. (2019), measures incorporating both annoyance and stress reactions could provide more reliable information about how problematic noise from wind turbines is to nearby residents. Studies adopting such scales could help better explain the problems associated with wind turbine noise in South Korea. Finally, although distance can be regarded as a good proxy variable for the level of sound, attenuation of sound is not only determined by distance. Therefore, studies adopting measured or modeled sound level could provide more accurate estimates of its impact on noise annoyance.

Funding

This work was supported by Korea Institute of Energy Technology Evaluation and Planning (KETEP) grant funded by the Korean government (MOTIE) (20193010025820, Development of Design and Planning Technology for Noiseless Eco Friend Windfarm).

CRediT authorship contribution statement

Jaehong Ki: Conceptualization, Formal analysis, Investigation, Methodology, Software, Writing – original draft. **Woo-Chang Kim:** Conceptualization, Data curation, Project administration, Investigation, Writing – original draft. **Su-bin Oh:** Data curation, Formal analysis, Methodology, Writing – original draft. **Jihun Ha:** Data curation, Writing – original draft. **Eunyoung Hwangbo:** Data curation, Writing – original draft. **Hyoeun Lee:** Data curation, Writing – original draft. **Sumin Shin:**

Data curation, Writing – original draft. **Seulki Yoon:** Funding acquisition, Methodology, Resources, Supervision, Validation, Writing – review & editing, Data curation, Writing – original draft. **Hyewon Youn:** Data curation, Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Batel, S., Devine–Wright, P., Tangeland, T., 2013. Social acceptance of low carbon energy and associated infrastructures: a critical discussion. Energy Pol. 58, 1–5. https://doi.org/10.1016/j.enpol.2013.03.018.

Baxter, J., Morzaria, R., Hirsch, R., 2013. A case–control study of support/opposition to wind turbines: perceptions of health risk, economic benefits, and community conflict. Energy Pol. 61, 931–943. https://doi.org/10.1016/j.enpol.2013.06.050.

Bishop, I.D., 2002. Determination of thresholds of visual impact: the case of wind turbines. Environ. Plann. Plann. Des. 29 (5), 707–718. https://doi.org/10.1068/b12854.

Bush, D., Hoagland, P., 2016. Public opinion and the environmental, economic and aesthetic impacts of offshore wind. Ocean Coast Manag. 120, 70–79. https://doi.org/10.1016/j.ocecoaman.2015.11.018.

Dröes, M.I., Koster, H.R., 2016. Renewable energy and negative externalities: the effect of wind turbines on house prices. J. Urban Econ. 96, 121–141. https://doi.org/10.1016/j.jue.2016.09.001.

Ek, K., Persson, L., 2014. Wind farms—where and how to place them? A choice experiment approach to measure consumer preferences for characteristics of wind farm establishments in Sweden. Ecol. Econ. 105, 193–203. https://doi.org/10.1016/j.ecolecon.2014.06.001.

Fast, S., 2013. Social acceptance of renewable energy: trends, concepts, and geographies. Geography Compass 7 (12), 853–866. https://doi.org/10.1111/gec3.12086.

Fast, S., Mabee, W., Baxter, J., Christidis, T., Driver, L., Hill, S., McMurtry, J., Tomkow, M., 2016. Lessons learned from Ontario wind energy disputes. Nat. Energy 1 (2), 1–7. https://doi.org/10.1038/nenergy.2015.28.

Firestone, J., Kempton, W., 2007. Public opinion about large offshore wind power: underlying factors. Energy Pol. 35 (3), 1584–1598. https://doi.org/10.1016/j.enpol.2006.04.010.

Firestone, J., Kempton, W., Krueger, A., 2009. Public acceptance of offshore wind power projects in the USA. Wind Energy: An International Journal for Progress and Applications in Wind Power Conversion Technology 12 (2), 183–202. https://doi.org/10.1002/we.316.

Firestone, J., Kempton, W., Lilley, M.B., Samoteskul, K., 2012. Public acceptance of offshore wind power: does perceived fairness of process matter? J. Environ. Plann. Manag. 55 (10), 1387–1402. https://doi.org/10.1080/09640568.2012.688658.

Firestone, J., Bates, A., Knapp, L.A., 2015. See me, Feel me, Touch me, Heal me: wind turbines, culture, landscapes, and sound impressions. Land Use Pol. 46, 241–249. https://doi.org/10.1016/j.landusepol.2015.02.015.

Firestone, J., Hoen, B., Rand, J., Elliott, D., Hübner, G., Pohl, J., 2018. Reconsidering barriers to wind power projects: community engagement, developer transparency and place. J. Environ. Pol. Plann. 20 (3), 370–386. https://doi.org/10.1080/1523908X.2017.1418656.

Freiberg, A., Schefter, C., Hegewald, J., Seidler, A., 2019. The influence of wind turbine visibility on the health of local residents: a systematic review. Int. Arch. Occup. Environ. Health 92, 609–628. https://doi.org/10.1007/s00420–019–01403–w.

Gibbons, S., 2015. Gone with the wind: valuing the visual impacts of wind turbines through house prices. J. Environ. Econ. Manag. 72, 177–196. https://doi.org/10.1016/j.jeem.2015.04.006.

Gonzalez, M.I., Estevez, B., 2005. Participation, communication and negotiation in environmental conflicts: offshore wind energy in the Trafalgar Sea area. Arbor–Ciencia Pensamiento y Cultura 181, 377–392. https://arbor.revistas.csic.es/index.php/arbor/article/view/419/420.

Groth, T.M., Vogt, C., 2014. Residents' perceptions of wind turbines: an analysis of two townships in Michigan. Energy Pol. 65, 251–260. https://doi.org/10.1016/j.enpol.2013.10.055.

Haac, T.R., Kaliski, K., Landis, M., Hoen, B., Rand, J., Firestone, J., Elliott, D., Hübner, G., Pohl, J., 2019. Wind turbine audibility and noise annoyance in a national US survey: individual perception and influencing factors. J. Acoust. Soc. Am. 146 (2), 1124–1141. https://doi.org/10.1121/1.5121309.

Hall, N., Ashworth, P., Devine–Wright, P., 2013. Societal acceptance of wind farms: analysis of four common themes across Australian case studies. Energy Pol. 58, 200–208. https://doi.org/10.1016/j.enpol.2013.03.009.

Hoen, B., Atkinson–Palombo, C., 2016. Wind turbines, amenities and disamenitites: astudy of home value impacts in densely populated Massachusetts. J. R. Estate Res. 38 (4), 473–504. https://doi.org/10.1080/10835547.2016.12091454.

Hoen, B., Brown, J.P., Jackson, T., Thayer, M.A., Wiser, R., Cappers, P., 2015. Spatial hedonic analysis of the effects of US wind energy facilities on surrounding property values. J. R. Estate Finance Econ. 51 (1), 22–51. https://doi.org/10.1007/s11146–014–9477–9.

Hoen, B., Firestone, J., Rand, J., Elliot, D., Hübner, G., Pohl, J., Wiser, R., Lants, E., Haac, R., Kaliski, K., 2019. Attitudes of US wind turbine neighbors: analysis of a nationwide survey. Energy Pol. 134, 110981. https://doi.org/10.1016/j.enpol.2019.110981.

Hübner, G., Pohl, J., Hoen, B., Firestone, J., Rand, J., Elliott, D., Haac, R., 2019. Monitoring annoyance and stress effects of wind turbines on nearby residents: a comparison of US and European samples. Environ. Int. 132, 105090. https://doi.org/10.1016/j.envint.2019.105090.

Jobert, A., Laborgne, P., Mimler, S., 2007. Local acceptance of wind energy: factors of success identified in French and German case studies. Energy Pol. 35 (5), 2751–2760. https://doi.org/10.1016/j.enpol.2006.12.005.

Jørgensen, M.L., Anker, H.T., Lassen, J., 2020. Distributive fairness and local acceptance of wind turbines: the role of compensation schemes. Energy Pol. 138, 111294. https://doi.org/10.1016/j.enpol.2020.111294.

Kim, E.S., Chung, J.B., 2019. The memory of place disruption, senses, and local opposition to Korean wind farms. Energy Pol. 131, 43–52. https://doi.org/10.1016/j.enpol.2019.04.011.

Kim, H.S., Kim, M.Y., Hwang, S.W., Park, J.P., 2014. A preliminary study on local residents acceptance in southwest coast offshore wind energy complex –focused on survey results of local residents recognition. The Journal of Korean Island 26 (2), 101–129.

Kim, T.Y., Park, J.I., Maeng, J.H., 2016. Offshore wind farm site selection study around Jeju Island, South Korea. Renew. Energy 94, 619–628. https://doi.org/10.1016/j.renene.2016.03.083.

Kim, K.J., Lee, H., Koo, Y., 2020. Research on local acceptance cost of renewable energy in South Korea: a case study of photovoltaic and wind power projects. Energy Pol. 144, 111684. https://doi.org/10.1016/j.enpol.2020.111684.

Korea Energy Agency, 2020. Statistics of New and Renewable Energy in 2019.

Korea Energy Economics Institute, 2018. Survey on Public Opinion for Korean Energy Transition Policy.

Kuwano, S., Yano, T., Kageyama, T., Sueoka, S., Tachibana, H., 2014. Social survey on wind turbine noise in Japan. Noise Control Eng. J. 62 (6), 503–520. https://doi.org/10.3397/1/376246.

Ladenburg, J., 2009. Visual impact assessment of offshore wind farms and prior experience. Appl. Energy 86 (3), 380–387. https://doi.org/10.1016/j.apenergy.2008.05.005.

Langer, K., Decker, T., Roosen, J., Menrad, K., 2018. Factors influencing citizens' acceptance and non–acceptance of wind energy in Germany. J. Clean. Prod. 175, 133–144. https://doi.org/10.1016/j.jclepro.2017.11.221.

Lee, S., 2020. Only 5.8% of permitted solar & wind projects are initiated, Newsis. https://newsis.com/view/?id=NISX20201022_0001206513&cID=10401&pID=10400.

Lee, H., Huh, S., Woo, J., Lee, C., 2020. A comparative study on acceptance of public and local residents for renewable energy projects – focused on solar, wind, and biomass. Innovation Studies 15 (1), 29–61. http://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE09311125.

McCunney, R.J., Mundt, K.A., Colby, W.D., Dobie, R., Kaliski, K., Blais, M., 2014. Wind turbines and health: a critical review of the scientific literature. J. Occup. Environ. Med. 56 (11), e108–e130. https://doi.org/10.1097/JOM.0000000000000313.

Molnarova, K., Sklenicka, P., Stiborek, J., Svobodova, K., Salek, M., 2012. Visual preferences for wind turbines: location, numbers and respondent characteristics. Appl. Energy 92, 269–278. https://doi.org/10.1016/j.apenergy.2011.11.001.

OECD, 2021. Renewable energy (indicator). https://doi.org/10.1787/aac7c3f1–en. (Accessed 6 May 2021).

Olson–Hazboun, S.K., Krannich, R.S., Robertson, P.G., 2016. Public views on renewable energy in the Rocky Mountain region of the United States: distinct attitudes, exposure, and other key predictors of wind energy. Energy Res. Social Sci. 21, 167–179. https://doi.org/10.1016/j.erss.2016.07.002.

Pawlaczyk–Łuszczyńska, M., Dudarewicz, A., Zaborowski, K., Zamojska–Daniszewska, M., Waszkowska, M., 2014. Evaluation of annoyance from the wind turbine noise: a pilot study. Int. J. Occup. Med. Environ. Health 27 (3), 364–388. https://doi.org/10.2478/s13382–014–0252–1.

Pedersen, E., Persson Waye, K., 2004. Perception and annoyance due to wind turbine noise—a dose–response relationship. J. Acoust. Soc. Am. 116 (6), 3460–3470. https://doi.org/10.1121/1.1815091.

Pedersen, E., Persson Waye, K., 2007. Wind turbine noise, annoyance and self–reported health and well–being in different living environments. Occup. Environ. Med. 64 (7), 480–486. https://doi.org/10.1136/oem.2006.031039.

Pedersen, E., Van Den Berg, F., Bakker, R., Bouma, J., 2009. Response to noise from modern wind farms in The Netherlands. J. Acoust. Soc. Am. 126 (2), 634–643. https://doi.org/10.1121/1.3160293.

Pohl, J., Gabriel, J., Hübner, G., 2018. Understanding stress effects of wind turbine noise–the integrated approach. Energy Pol. 112, 119–128. https://doi.org/10.1016/j.enpol.2017.10.007.

Radun, J., Hongisto, V., Suokas, M., 2019. Variables associated with wind turbine noise annoyance and sleep disturbance. Build. Environ. 150, 339–348. https://doi.org/10.1016/j.buildenv.2018.12.039.

Rand, J., Hoen, B., 2017. Thirty years of North American wind energy acceptance research: what have we learned? Energy Res. Social Sci. 29, 135–148. https://doi.org/10.1016/j.erss.2017.05.019.

Sibille, A.D.C.T., Cloquell–Ballester, V.A., Cloquell–Ballester, V.A., Darton, R., 2009. Development and validation of a multi criteria indicator for the assessment of objective aesthetic impact of wind farms. Renew. Sustain. Energy Rev. 13 (1), 40–66. https://doi.org/10.1016/j.rser.2007.05.002.

Slattery, M.C., Johnson, B.L., Swofford, J.A., Pasqualetti, M.J., 2012. The predominance of economic development in the support for large–scale wind farms in the US Great

Plains. Renew. Sustain. Energy Rev. 16 (6), 3690–3701. https://doi.org/10.1016/j.rser.2012.03.016.
Swofford, J., Slattery, M., 2010. Public attitudes of wind energy in Texas: local communities in close proximity to wind farms and their effect on decision–making. Energy Pol. 38 (5), 2508–2519. https://doi.org/10.1016/j.enpol.2009.12.046.
The Blue House, 2018. Remarks by president Moon Jae–in at saemanguem renewable energy vision declaration ceremony. https://english1.president.go.kr/briefingspeeches/speeches/89. (Accessed 1 November 2021).
Westerberg, V., Jacobsen, J.B., Lifran, R., 2013. The case for offshore wind farms, artificial reefs and sustainable tourism in the French Mediterranean. Tourism Manag. 34, 172–183. https://doi.org/10.1016/j.tourman.2012.04.008.
Wolsink, M., 2007. Planning of renewables schemes: deliberative and fair decision–making on landscape issues instead of reproachful accusations of non–cooperation. Energy Pol. 35 (5), 2692–2704. https://doi.org/10.1016/j.enpol.2006.12.002.
Wüstenhagen, R., Wolsink, M., Bürer, M.J., 2007. Social acceptance of renewable energy innovation: an introduction to the concept. Energy Pol. 35 (5), 2683–2691. https://doi.org/10.1016/j.enpol.2006.12.001.