



Driemaandelijks overzicht van relevante literatuur over windenergie en gezondheid Q4-2023

Periode: Oktober t/m december 2023

Het Expertisepunt Windenergie en Gezondheid houdt voor haar kennisbasis de wetenschappelijke literatuur bij over windenergie en gezondheid. Elke drie maanden wordt een overzicht gemaakt van de nieuwgevonden wetenschappelijke en grijze literatuur.

In dit document vindt u het overzicht van de literatuur gevonden in de hierboven aangegeven periode.

Literatuuropbrengst

Hieronder wordt eerst een overzicht gegeven van de wetenschappelijke artikelen gevonden in diverse literatuurdatabanken. Daarna volgt een (niet-uitputtende) opsomming van overige relevante bronnen, zoals (Nederlandse) onderzoeksrapporten en conferentieverlagen, ook wel grijze literatuur genoemd.

Disclaimer

Deze selectie is tot stand gekomen met behulp van een zoekprofiel (zie bijlage Methode Zoekstrategie) en toepassing van inclusie en exclusiecriteria. Op deze documenten is geen dataextractie toegepast noch is er een algemeen kwaliteitsoordeel aan gegeven.

Literatuur gepubliceerd in wetenschappelijke tijdschriften

Tabel 1 Overzicht van het aantal gevonden studies

Fase	Oktober- December 2023
Aantal artikelen gevonden met zoekstrategieën voordat selectie heeft plaatsgevonden	158
Aanvullende referenties gevonden via andere bronnen (dit betreft niet de grijze literatuur)	0
Aantal referenties na verwijdering van duplicaten	133
Verwijderde referenties omdat ze niet relevant zijn (voldoen niet aan inclusie en exclusie criteria)	115
Aantal relevante artikelen geselecteerd door reviewers	18
Aantal artikelen waarover reviewer 1 en reviewer 2 hebben afgestemd (grensgevallen)	11
Totaal aantal relevante artikelen (na afstemmen)	9

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Overzicht van de relevante studies

1. Titel: A distance-to-sustainability-target approach for indicator aggregation and its application for the comparison of wind energy alternatives

Samenvatting (gekopieerd uit artikel): Sustainability impact assessments studies combine several indicators to cover environmental, economic and social impacts. These indicators describe different impact pathways and are expressed in different units, which makes comparing alternatives challenging. An aggregated metric is required to facilitate the presentation and communication of sustainability. The presented aggregation framework is based on the distance-to-target method NR-TOPSIS and adapted to a distance-to-sustainability-target approach. A procedure is given for aggregating 12 sustainability indicators into a single score sustainability indicator. Reference points for normalization of diverse impact indicators and weighting factors are investigated. The framework was applied to a wind energy case study comparing one offshore and two onshore alternatives. The case study results were compared using both a dashboard of 12 endpoint indicators and an aggregated sustainability indicator. The indicator was presented on a sustainability scale that indicated the distance of the investigated cases to an ideal (sustainable) solution. A sensitivity analysis of the weighting factors showed that the distribution of weights influenced the ranking of alternatives, especially when the alternatives are positioned close to each other on the sustainability scale, as it is the case for the wind energy scenarios. For most of the weighting scenarios, the onshore wind energy project using permanent magnet synchronous generators appeared to be the most sustainable solution. © 2023 Elsevier Ltd

Referentie: Buchmayr, A., Taelman, S. E., Thomassen, G., Verhofstadt, E., Van Ootegem, L. & Dewulf, J. (2023). A distance-to-sustainability-target approach for indicator aggregation and its application for the comparison of wind energy alternatives. *Renewable and Sustainable Energy Reviews*, 185.

Link naar bron: <https://doi.org/10.1016/j.rser.2023.113608>

2. Titel: Dynamics of social acceptance of renewable energy: An introduction to the concept

Samenvatting (gekopieerd uit artikel): A step change is needed in the deployment of renewable energy if the triple challenge of ensuring climate change mitigation, energy security, and energy affordability is to be met. Yet, social acceptance of infrastructure projects and policies remains a key concern. While there has been decades of fruitful research on the social acceptance of wind energy and other renewables, much of the extant research is cross-sectional in nature, failing to capture the important dynamic processes that can make or break renewable energy projects. This paper introduces a Special Issue of Energy Policy which focusses on the neglected topic of the dynamics of social acceptance of renewable energy, drawing on contributions made at an international research conference held in St. Gallen (Switzerland) in June 2022. In addition to introducing these papers and drawing out common themes, we also seek to offer some conceptual clarity on the issue of dynamics in social acceptance, taking into account the influence of time, power, and scale in shaping decision-making processes. We conclude by highlighting a number of avenues of potential future research. © 2023 Elsevier Ltd

Referentie: Ellis, G., Schneider, N. & Wüstenhagen, R. (2023). Dynamics of social acceptance of renewable energy: An introduction to the concept. *Energy Policy*, 181.

Link naar bron: <https://doi.org/10.1016/j.enpol.2023.113706>

3. Titel: Association between exposure to wind turbines and sleep disorders: A systematic review and meta-analysis

Samenvatting (gekopieerd uit artikel): To date, there is scarce evidence on the association between sleep disorders and noise generated by wind turbines. We searched six relevant electronic databases from the inception to May 2023 for relevant articles. The methodological quality of the included articles was evaluated using the US National Institutes of Health tool. Fifteen articles met the inclusion criteria. The overall prevalence of sleep disorders among residents close to wind turbines was 34% (95% Confidence Interval, 0.22-0.47). Univariate meta-regressions for distance and sound power level showed that at higher distance the prevalence of sleep disorders decreases ($p = 0.010$) and with a higher sound power level the prevalence increases ($p = 0.037$). Furthermore, this systematic review and meta-analysis highlighted that the overall quality of current research on this topic is poor, and the methods to measure the results are often based on subjective assessments and not validated questionnaires. In conclusion, our preliminary findings suggest that there may be a possible relation between exposure to wind turbines and sleep disorders, although no conclusions can be drawn in terms of causality due to the nature of the retrieved data and the poor quality of current evidence. Future studies should adopt a longitudinal design and focus on objective measurements, supported by validated subjective methods such as questionnaires.

Referentie: Godono, A., Ciocan, C., Clari, M., Mansour, I., Curoso, G., Franceschi, A., Carena, E., De Pasquale, V., Dimonte, V., Pira, E., Dallapiccola, B., Normanno, N. & Boffetta, P. (2023). Association between exposure to wind turbines and sleep disorders: A systematic review and meta-analysis. *International journal of hygiene and environmental health*, 254, 114273.

Link naar bron: <https://doi.org/10.1016/j.ijheh.2023.114273>

4. Titel: Wind turbines as new smokestacks: Preserving ruralness and restrictive land-use ordinances across U.S. counties

Samenvatting (gekopieerd uit artikel): Renewable energy (RE) facilities provide a global public good of climate mitigation but impose local costs such as landscape disruption and harming the rural character. Because of their land-intensive nature, utility-scale RE facilities tend to be located in rural areas with plentiful and cheap land. In the U.S., about every fourth county (729 of 3,143) has enacted ordinances restricting the siting of RE facilities. Drawing on a novel dataset of county-level restrictions on wind and solar RE facilities for the period 2010-2022, we explore whether, all else equal, levels of ruralness motivate the onset of such restrictions. As the policy literature on problem visibility suggests, we find support for this hypothesis for wind energy facilities only, probably because wind turbines due to their height tend to disrupt the rural landscape and are visible from long distances. We also find that counties are more likely to adopt restrictions for both wind and solar when adjacent counties have enacted them, thereby suggesting a contagion effect in the onset of restrictions. Contrary to the prevalent view on partisanship in climate policy, liberal counties are likely to restrict wind facilities. Our paper points to important sociological and quality-of-life factors that might be impeding the clean energy transition.

Referentie: Ko, I., Dolšak, N. & Prakash, A. (2023). Wind turbines as new smokestacks: Preserving ruralness and restrictive land-use ordinances across U.S. counties. *PLoS ONE*, 18(12 December).

Link naar bron: <https://doi.org/10.1371/journal.pone.0294563>

5. Titel: Contested renewable energy sites due to landscape and socio-ecological barriers: Comparison of wind and solar power installation cases in Japan

Samenvatting (gekopieerd uit artikel): There has been an increasing effort to promote renewable energies as climate change mitigation measures in Japan. Yet, the installation of wind turbines and solar photovoltaic (PV) power plants is being contested in several parts of the country. There is a need to understand these oppositions to reduce the number of delayed projects or overcome future barriers. Thus, in this study, we investigated cases of opposition movements and legal proceedings against wind and solar PV power development. Results indicated that landscape elements and socio-ecological factors motivate local oppositions. For instance, there were cases filed due to landscape view obstruction caused by wind turbines and solar panels. In terms of socio-ecological barriers, examples of cases scrutinized showed opposition caused by the potential impact on recreational activities such as climbing and hiking trails. Additionally, we observed that there were differences in the scope and scale of opposition movements and legal proceedings between wind and solar PV power projects. These differences were related to the scale (project size) and duration (construction to operation) of the project coupled with the renewable energy-related legal system changes in Japan. We observed that the overall legislative framework is frequently designed at the national level while challenges in project site selection are dealt with at the municipal- and prefectural-level. The findings of this study can help policymakers to revise and/or develop legal systems that minimize impacts on landscape and social elements while satisfying the demand for renewable energy transitions. © The Author(s) 2022.

Referentie: Kohsaka, R. & Kohyama, S. (2023). Contested renewable energy sites due to landscape and socio-ecological barriers: Comparison of wind and solar power installation cases in Japan. *Energy and Environment*, 34(7), 2619-2641.

Link naar bron: <https://doi.org/10.1177/0958305X221115070>

6. Titel: The State of Knowledge and Attitudes of the Inhabitants of the Polish Świętokrzyskie Province about Renewable Energy Sources

Samenvatting (gekopieerd uit artikel): One of the ways to achieve an energy transformation is to reduce environmental degradation through the use of, among other things, renewable energy sources (RES). The widespread use of RES depends not only on economic and technical aspects, but also on societal acceptance. The aim of this research was to find out the attitudes and the state of knowledge of residents of Świętokrzyskie province regarding RES. This aim was further specified through five research questions. The research used a diagnostic survey method, and respondents' opinions were gathered through an author's survey. This survey included open-ended questions on solar energy (solar panels and photovoltaic panels separately), wind power, hydropower, geothermal energy (ground source heat pump and other sources separately), biomass and biogas. The research sample was selected based on data availability. Econometric modeling was used to analyze the results. The freedom in responding allowed for the exploration of a wide range of respondents' opinions. The results confirmed the positive attitude of residents towards RES and the influence of education level on their self-assessment. Residents of Świętokrzyskie province, in comparison to residents of Poland, stand out for their high level of acceptance of the use of hydropower in their neighborhood. The opinions of the residents of Świętokrzyskie province on the impact of wind power and heat pumps on the environment did not align with the opinions of the residents of Poland. © 2023 by the authors.

Referentie: Latosińska, J. & Miłek, D. (2023). The State of Knowledge and Attitudes of the Inhabitants of the Polish Świętokrzyskie Province about Renewable Energy Sources. *Energies*, 16(21).

Link naar bron: <https://doi.org/10.3390/en16217445>**Opmerkingen:**

7. Titel: Are wind turbines integrated into landscape? an analysis of its social perception in a spanish mediterranean area

Samenvatting (gekopieerd uit artikel): Context: Renewable energy sources development has introduced wind farms as a regular landscape element. However, as human-made elements, wind farms influence on landscape's scenic beauty differently according to the socio-demographic characteristics of the beholder. Objectives: In this regard, the study analyses the population's visual perception of wind farms into Mediterranean landscapes with reference to three social variables: gender, age and education level. Method: People's preferences were assessed through two on-line surveys with several landscape photographs, with and without wind turbines. Subsequently, the score of each photograph was statistically analyzed regarding the landscapes showed and the respondents' socio-demographic variables. Results: The results demonstrate how vegetation had a positive effect in landscape' scenic beauty, especially forest, as well as people do not perceive negatively wind turbines presence. In fact, their implementation in deteriorated or low scored landscapes improves its scenic beauty. Lastly, despite the fact that gender, age and education do not influence on people's perception, there is a trend between these factors and wind turbines influence on landscape. Conclusions: In addition to reinforce the vegetation positive effects on landscape' scenic beauty, wind turbines have become a new landscape element that, in general, do not have a negative impact on its scenic beauty but, according to age, different consideration appeared. © 2023, The Author(s).

Referentie: López-Martínez, F. (2023). Are wind turbines integrated into landscape? an analysis of its social perception in a spanish mediterranean area. *Landscape Ecology*, 38(12), 3499-3515.

Link naar bron: <https://doi.org/10.1007/s10980-023-01698-8>

8. Titel: Prevalence and predictors of wind energy opposition in North America

Samenvatting (gekopieerd uit artikel): Addressing climate change requires societies to transition away from fossil fuels toward low-carbon energy, including renewables. Unfortunately, large wind projects have proven politically controversial, with groups opposing them across advanced economies. To date, there are few large-scale, systematic studies to identify the prevalence and predictors of opposition to wind energy projects. Here, we analyzed a dataset of wind energy projects across the United States and Canada between 2000 and 2016. We found that during this period, in the United States, 17% of wind projects faced significant opposition, and in Canada, 18% faced opposition, with rates in both countries growing over time. Opposition was concentrated regionally in the Northeastern United States and in Ontario, Canada. In both countries, larger projects with more turbines were more likely to be opposed. In the United States, opposition was more likely and more intense in areas with a higher proportion of White people, and a smaller proportion of Hispanic people. In Canada, opposition was more likely and more intense in wealthier communities. The most common tactics used to oppose wind energy were court cases, legislation, and physical protests. The number of people engaging in opposition to wind projects is likely small: Across articles that cited the number of individuals engaging in protests, the median number was 23 in the United States and 34 in Canada. When wealthier, Whiter communities oppose wind projects, this slows down the transition away from fossil fuel projects in poorer communities and

communities of color, an environmental injustice we call "energy privilege." (PsycInfo Database Record (c) 2023 APA, all rights reserved) Impact Statement Local opposition poses a significant barrier to rapid deployment of wind energy. Our study looks comprehensively at opposition to wind projects across the United States and Canada between 2000 to 2016. Larger projects were more likely to be opposed. In the United States, opposition was more likely and more intense in areas with a higher proportion of White people, and a lower proportion of Hispanic people; in Canada, the same pattern held for wealthier communities. The names in articles associated with US opposition were overwhelmingly likely to be White. This suggests an environmental justice challenge we term "energy privilege," wherein the delay and cancellation of clean energy in wealthier, Whiter communities leads to continued pollution in poorer communities, and communities of color. (PsycInfo Database Record (c) 2023 APA, all rights reserved)

Referentie: Stokes Leah, C., Franzblau, E., Lovering Jessica, R. & Miljanich, C. (2023). Prevalence and predictors of wind energy opposition in North America. *PNAS Proceedings of the National Academy of Sciences of the United States of America*, 120(40), 1-8.

Link naar bron: <https://dx.doi.org/10.1073/pnas.2302313120>

9. Titel: Infrasound from wind turbines

Samenvatting (gekopieerd uit artikel): Wind turbines are important for a sustainable energy supply. The health effects of infrasound are often the focus of public discussion during the construction and operation of these installations. Noise measurements and noise impact studies indicate that infrasound levels from wind turbines are well below the human perception threshold. According to the current state of research, there is no evidence that infrasound from wind turbines causes adverse health effects. However, so far only the results of cross-sectional studies and experimental investigations are available. Therefore, long-term epidemiological studies in the vicinity of wind turbines should be carried out to identify possible long-term effects not yet known. The German Environment Agency has awarded a preparatory research project for such an investigation in 2021.

Referentie: Wothge, J. & Myck, T. (2023). Infrasound from wind turbines. *Padiatrische Praxis*, 99(3).

Tabel 2 Indeling van de wetenschappelijke literatuur naar type en onderwerp.

	Hinder	Slaap	Gezondheid divers	Anders (bijv. co-determinanten)
Tekstmining (bijv. sentiment analyse van (sociale) media artikelen)				
Case study				
Observationeel (bijv. Cross-sectionele, cohort, of case control studies)				Buchmayr (2023); Ko (2023); Latosińska (2023); López-Martínez (2023); Stokes (2023);
Experimenteel				
Review	Godono (2023)		Worthge (2023)	

	Hinder	Slaap	Gezondheid divers	Anders (bijv. co-determinanten)
Anders (bijv. theoretisch model, opinie,...)				Kohsaka (2023); López-Martínez (2023); Ellis (2023)

Relevante Nederlandse onderzoeksrapporten en overige relevante grijze literatuur

Overzicht van relevante grijze literatuur

1. Titel: Gezondheidsverkenning windturbines: bevindingen op populatieniveau van een landelijke studie gebaseerd op gegevens van huisartsregistraties, over een tienjaarsperiode (2012-2021)

Beschrijving (gekopieerd): Gekopieerd uit rapport:

Kernpunten

1. Geen invloed van nabijheid windturbines op aan huisarts gepresenteerde gezondheidsproblemen: Er zijn geen consistente significante associaties gevonden tussen wonen in de buurt van windturbines en bijbehorende geluidniveaus en door huisarts gediagnostiseerde gezondheidsproblemen. Problemen die in de literatuur worden genoemd op basis van zelfrapportage van omwonenden (bijv. slaapverstoring) vinden we niet terug.
2. Een beperkt aantal symptomen en sociale problemen: Symptomen als spanningshoofdpijn en depressieve gevoelens worden in de latere jaren van de studie wat vaker gezien bij mensen dichterbij windturbines, ten opzichte van mensen die verderop wonen. Het gaat om kleine aantallen en om niet statistisch significante verschillen. Het omgekeerde, minder symptomen dichterbij windturbines, komt soms ook voor.
3. Nauwelijks meer problemen bij hogere geluidniveaus: Hogere geluidniveaus (gemiddeld boven 42 decibel) worden in de latere jaren van deze studie geassocieerd met een hoger risico op door de huisarts voorgeschreven pijnstillers. Dit wordt echter in eerdere jaren niet gevonden, ook niet nabij een windturbine.
4. Dat de resultaten voorzichtig geïnterpreteerd moeten worden: Dit onderzoek kan geen causale verbanden vaststellen. Het is een verkennende studie met als doel om mogelijke risico's voor de gezondheid te monitoren gebruik makend van het oordeel van de huisarts over de aangeboden gezondheidsproblemen.
5. Sterke punten en beperkingen: In dit landelijke onderzoek werd gebruik gemaakt van betrouwbare gezondheidsgegevens, van een grote steekproef en van een lange onderzoeksperiode. Naast deze sterke punten zijn er ook enkele belangrijke beperkingen. Met name de geringe statistische kracht omdat maar een klein percentage van de bevolking in de directe omgeving (<500m) van windturbines woont. Er kon ook maar beperkt gecorrigeerd worden voor versturende factoren. Toekomstig onderzoek dient deze beperkingen zoveel mogelijk aan te pakken (gebruik maken van volledige postcode, precieze blootstellingsdata, inclusief het meenemen van laagfrequent geluid, meer gegevens over de kenmerken van de turbines en de datum van oprichting en meer controle over versturende invloeden zoals overige bronnen van geluid in de omgeving).

Referentie: Baliatsas, C., IJzermans, J., Hooiveld, M., Kenens, R. & Dückers, M. (2023). *Gezondheidsverkenning windturbines: bevindingen op populatieniveau van een landelijke studie gebaseerd op gegevens van huisartsregistraties, over een tienjaarsperiode (2012-2021)* (ISBN: 978-94-6122-826-0). NIVEL.

Datum van publicatie: 21-12-2023

Link naar bron: <https://www.nivel.nl/nl/publicatie/gezondheidsverkenning-windturbines-bevindingen-op-populatieniveau-van-een-landelijke>**Opmerkingen:** In opdracht van het Ministerie van Economische Zaken en Klimaat

2. Titel: Monitor RES 2023. Een voortgangsanalyse van de Regionale Energie Strategieën

Samenvatting (gekopieerd): Wat biedt dit rapport?

Het rapport is een update van de Monitor RES 2022 (PBL 2022) en geeft de voortgang rond het halen van het nationale 2030-doel van 35 terawattuur en in hoeverre regio's het totaal van hun RES-biedingen (55 terawattuur) in 2030 kunnen bereiken. De resultaten en conclusies uit de Monitor RES 2022 vormen hierbij het startpunt waarbij zowel de kwantitatieve als kwalitatieve aspecten van recente ontwikkelingen aan bod komen.

- Dit rapport geeft de stand van zaken weer op basis van de RES 1.0

voortgangsrapportages die de regio's in 2023 hebben geleverd. Netbeheer Nederland heeft nieuwe analyses per regio gemaakt van de impact op het netwerk door de RES-plannen. Deze netimpactanalyses zijn meegenomen in de Monitor RES 2023.

- Dit rapport laat zien wat de bijdrage is van de RES aan de verduurzaming van de warmte-voorziening in de gebouwde omgeving. Dit doen we op basis van de Regionale Structuur Warmte, zoals die door de regio's is beschreven in hun RES 1.0

voortgangsrapportages. De resultaten en conclusies uit de Monitor RES 1.0 en een PBL-analyse van de gemeentelijke Transitievisies Warmte vormen hierbij het startpunt.

- Het rapport biedt ook een kwalitatieve reflectie op de thema's: Leefomgeving en Energie-systeem. Voor deze monitor richten we ons op het beschrijven van de veranderende context voor deze thema's.

o Leefomgeving: we kijken naar de ruimtelijke keuzes die regio's maken rond hernieuwbare energie in de leefomgeving. Keuzes die bijdragen aan ruimtelijke kwaliteit en waarbij oog is voor maatschappelijke betrokkenheid.

o Energiesysteem: we hebben de ontwikkelingen gevolgd die betrekking hebben op de transportschaarste op het elektriciteitsnet (netcongestie). Daar schetsen we een samenvattend beeld van en we geven aandachtspunten voor de RES-regio's en partners.

- Het rapport bevat geen analyse rond het RES-thema 'Bestuurlijk draagvlak' omdat er in 2030 een wisseling van de wacht was door de Provinciale Statenverkiezingen van 2023 en de Tweede Kamerverkiezing van 2023.

Referentie: Matthijsen, J., Chranioti, A., Heshusius, S., Scholte, S., van der Kooij, P. & Kool, M. (2023). *Monitor RES 2023. Een voortgangsanalyse van de Regionale Energie Strategieën*. Planbureau voor de Leefomgeving.

Datum van publicatie: 7-12-2023

Link naar bron: <https://www.pbl.nl/publicaties/monitor-res-2023>

3. Titel: Do Wind Turbines Have Adverse Health Impacts?

Beschrijving (gekopieerd): While wind power is considered key in the transition towards net zero, there are concerns about adverse health impacts on nearby residents. Based on precise geographical coordinates, we link a representative longitudinal household panel to all wind turbines in Germany and exploit their staggered rollout over two decades for identification. We do

not find evidence of negative effects on general, mental, or physical health in the 12-Item Short Form Survey (SF-12), nor on self-assessed health or doctor visits. We also do not find evidence for effects on suicides, an extreme measure of negative mental health outcomes, at the county level.

Referentie: Krekel, C., Rode, J. & Roth, A. (2023). *Do Wind Turbines Have Adverse Health Impacts?* (IZA DP No. 16505). IZA Institute of Labor Economics.

Datum van publicatie: October 2023

Link naar bron: <https://www.iza.org/publications/dp/16505>