Report 2023

Task 39

A 3.9/4.1MW SGRE turbine in Denmark. *Photo credit: Andrea Vignaroli.*

Quiet Wind Turbine Technology

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Wind turbine noise is recognised as a key factor influencing the social acceptance of wind energy. The goal of Task 39 is to accelerate the development and deployment of quiet wind turbine technology.

Additionally, to consolidate the understanding of wind turbine sound emission, propagation, and ultimately its perception by residents as well as their attitude towards noise. Technical experts convene to investigate two key factors of wind turbine noise; the engineering aspects (noise generation and noise propagation), and socio-psychological aspects (assessment of the effects of noise on humans, and perception of noise related to other factors than noise itself). These activities are distributed between four work packages (WPs). Concerning the engineering aspects, a number of comparison benchmarks have been undertaken in order to identify the predictive capabilities of modern simulation tools. In parallel, the effects of noise perception,

annoyance, and its impact on wellbeing and health continues to be investigated. Furthermore, documents, including fact sheets on specific topics, are being drafted and should provide valuable and up-to-date technical information in an easily accessible format to a larger audience.

Introduction

Societal acceptance of new technologies is key to their successful adoption. In some jurisdictions, there is concern about the potential impact of wind turbine noise. Therefore, the mission of Task 39 is to research and assemble knowledge concerning wind turbine sound emission and propagation. Furthermore, its perception by residents in terms of noise impact and annoyance, as well as its psychological perception and acceptance. All with the goal of promoting the development and deployment of quiet wind turbine technology. The Task convenes an international expert panel to identify best practices in the prediction, measurement, and assessment of noise, as well as investigate regulatory aspects.

The first objective is to ensure that the best available information on quiet noise technology is available to consultants, regulators, and developers to contribute to relevant international standards and government regulations. The second objective is to promote collaboration between researchers across countries and disciplines for selected topics concerning wind turbine noise-related technologies. The collaboration is carried out in a series of focused WPs. The first one pertains dissemination. Two WPs investigate engineering aspects, namely noise emission at the turbine level, and noise propagation from the turbine to the dwellings across the atmospheric medium. Two additional WPs investigate the human aspects related to wind turbine noise. One addresses the psycho-acoustical aspects and physical perception of noise, as well as methods to quantify objective annoyance, and means to regulate noise emissions from wind farms, e.g. through penalty schemes. The last WP aims to characterise the external influences which are unrelated to noise, that may influence noise perception and yield additional annoyance, which hinders social acceptance of wind energy.

There has been significant participation in Task meetings, involving experts in a variety of disciplines in industry, consultancy, and research. Remote participation and presentations in meetings, facilitated through web conferencing, have extended participation to a wider group of experts. In addition, there has been in-kind contributions, in terms of active participation in sub-Tasks from the Task work programme, from several of the countries involved (as formal Task members or observers, see below) in the Task activities. However, three countries have officially committed to participate in the Task with agreement from their relevant governmental organisations that grant participation in IEA Wind TCP activities (see Table 1).

Progress and Achievements

The first work package focuses on interdisciplinary education and guidance. Several fact sheets and technical documents are already available on the Task 39 webpage. Additional documents are currently being drafted and reviewed by international experts in respective fields. A catalogue of International Wind Turbine Noise Limits and Regulations has been recently published online as an OSF (Open Science Foundation) webpage (see Highlights below).

The second and third WPs involve various ongoing activities regarding

Table 1. Countries Participating in Task.

COUNTRY/SPONSOR	INSTITUTION(S)
Denmark	DTU; FORCE Technology; SGRE; Vestas
Ireland	NUIGalway; ULimerick; RPS Consulting
Germany	DLR; IAG & IFB Stuttgart; General Electric; Enercon, 3DS; MSH Hamburg; UHannover; IWES Franhaufer; TUMunchen; RWE; RWTH-Aachen; PTB; MesH Engineering
The Netherlands	TNO; TUDelft; UTwente; UHanze; Lagerwey
Sweden	KTH; Uppsala University

In addition to the countries listed, a number of nations have expressed their interest in participating in Task 39 and/or have joined Task meetings but are not yet fully committed. These countries and organisations are (non-exhaustively): Canada (HGC Engineering, Aercoustics), China (Goldwind, CGC), Finland (Poyry), Switzerland (Prona SA), UK (ION Acoustics, Hayes McKenzie, Hoare Lea), USA (NREL, CH2M UCDavis).

the physical and technical aspects of wind turbine noise emission and sound propagation. WP2 concentrates on noise sources. Several wind Turbine noise prediction codes have been benchmarked on a reference turbine (in collaboration with Task 47 for the aerodynamic part of the comparisons). This has led to a better understanding of the impact of the models' fidelity on noise level predictions [1]. Active collaboration is taking place for acoustic wind tunnel testing, where various teams are comparing their facilities in an effort to standardise procedures. An outcome of this effort has been the creation of a database for serrated airfoil noise data, with measurement campaigns conducted in five acoustic wind tunnel facilities. In WP3, noise propagation models of different fidelities are compared for different configurations. This has led to several publications disseminating the efforts of various Task participants [2, 3].

The fourth and fifth work packages investigate the psycho-acoustic aspects of wind turbine noise. Both groups include experts from the fields of engineering and psychology. It was highlighted earlier that the group needed to develop an efficient knowledge exchange programme to promote efficient communications between participants from different backgrounds. For example, annoyance is an important concept in both engineering and social-psychological fields, but depending on one's background, the discussions on annoyance might deviate into one of these fields. To address this issue, a seminar featuring presentations from experts in both engineering and psychology was held and followed by an open discussion forum. This seminar is available for all Task Members to view. Through a shared working document hosted on the Open Science Framework [5], this knowledge exchange will enable effective collaboration and universal definitions of technical concepts. The aim of this working document is to form a state-of-the-art report on best practices in wind farm annoyance.

Highlight(s)

A recent highlight is the launch of the OSF Wind Turbine Regulations website. It is designed as an interactive, live platform where experts in the field can provide relevant and up-to-date information to the public. The project collates copies of the regulations governing wind turbine noise in different jurisdictions along with related publications. The intention is that this will serve as a resource for anyone working in the wind turbine industry, and would like to compare wind turbine policy across jurisdictions. The database will be updated continuously as more documents are made available (Figure 1).

The platform hosts both 'regulations' and 'related publications', where the term 'regulations' refers to legislation and guidelines regulating wind turbine noise, i.e. in some jurisdictions the regulations are binding legal requirements, whereas in others the guidelines are subject to interpretation on a case-by-case basis by planning/permitting authorities and the courts. In addition, the platform presents links to related publications which compare wind turbine noise regulations, i.e. publications in which

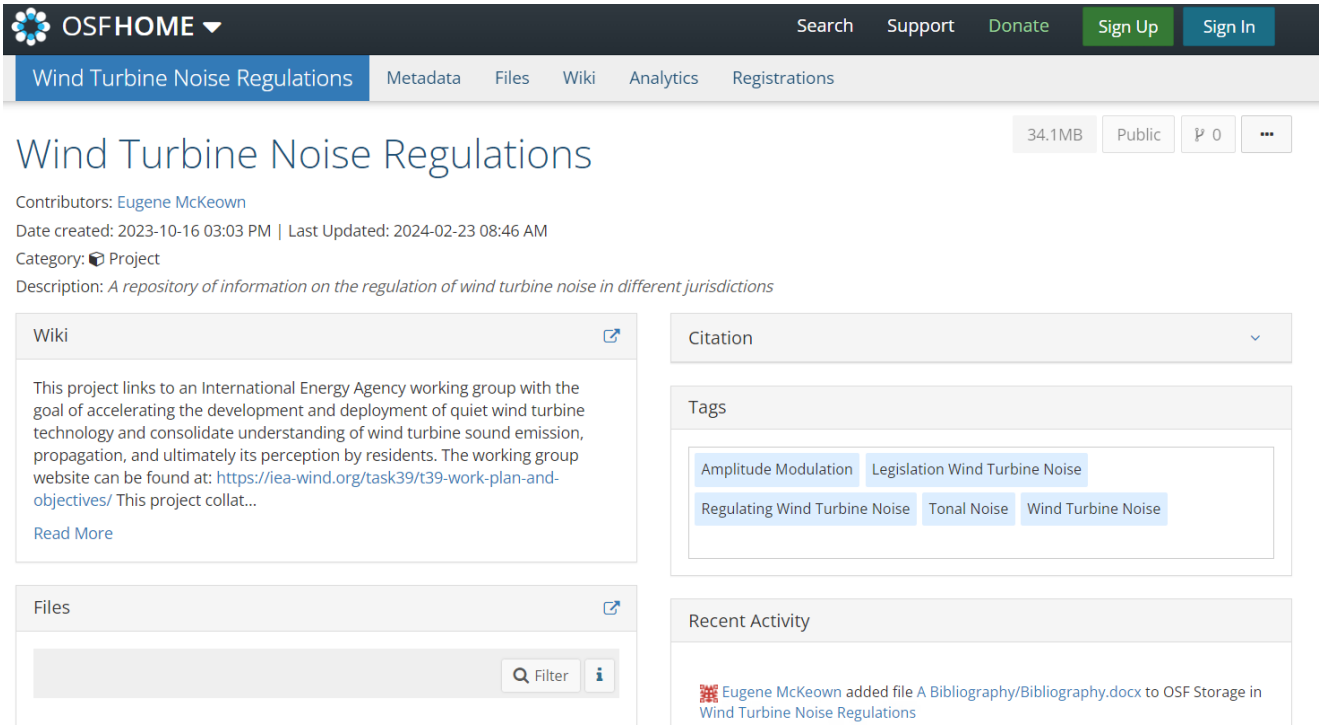

Figure 1. A snapshot of the OSF webpage.

the authors compare regulatory schemes and criteria. It is notable that no single approach has been adopted; examples of differences include the use of different criteria (e.g., L_{Aeq}, L_{AF90}, etc.), the use of controls for audible characteristics such as tones, and different limits for daytime and nighttime.

Outcomes and Significance

From a general point of view, developing noise mitigation technologies and recommending best practices for regulation and siting processes is regarded as an important step toward public acceptance. This should eventually facilitate the continued deployment of wind energy. The activities related to the psychology of noise will support the study of acceptance of wind energy in the public. Accordingly, the Task group prepared and presented a conference paper outlining the ongoing work across different member countries related to the social-psychological effects of wind turbine noise [4].

The work of Task 39 has led to successful research funding at national levels. One example is the WindSense Project, funded by the Irish Research Council [6, 7]. The principal investigators of this project are Task 39 Members whose purpose is to investigate the use of sound quality metrics in the assessment of noise from wind turbines. The work is ongoing and includes both an engineering assessment of the correlation between various psycho-acoustic metrics, as well as listening experiments.

On the engineering side, benchmarking and comparisons of models between research institutes and industry aim to improve the design tools for quiet wind turbine design and their siting. This should furthermore help in developing best practices on how to use these tools. Additionally, the OSF Wind Turbine Noise Regulations webpage will provide a valuable overview for policymakers, especially in countries in the early stages of wind energy deployment.

Next Steps

Task 39 continues its ongoing benchmarking activities. Several unknowns have been uncovered, but new questions have also risen. Wind tunnel benchmarking and the set-up of a publicly available database (e.g. for code validation) is underway. With regard to the socio-psychological effects of wind turbine noise, research is ongoing and supported by the identification of future needs highlighted throughout this Task. This will support national and international research programs, as well as the development of guidelines and policy documents.

References

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