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PERIODIC REPORT (TECHNICAL PART) of project implementation Programme 'Applied Research'				
Report number [1]	1			
Reporting period	**from**	01.01.2021	**to**	31.12.2021

A. PROJECT INFORMATION				
Number of project contract	NOR/POLNOR/Hetman/0073/2019		**Acronym**	Hetman
Duration of project	**from**	01.04.2021	**to**	01.04.2024
Project title	Healthy society-towards optimal management of wind turbines' noise			
Keywords	noise,wind turbines,noise annoyance perception,noise guidelines,health outcomes			
Name of the call	POLNOR 2019 call			

ENTITIES				
Status in project	**Name of entity**	**Short name**	**Type of entity** [2]	**Country**
Project Promoter	Uniwersytet im. Adama Mickiewicza / Adam Mickiewicz University	UAM / AMU	Research unit/institution	Poland
Project Partner 1	Akustix Sp. z o. o. / Akustix Ltd.	Akustix	Micro-enterprise	Poland
Project Partner 2	Akademia Górniczo-Hutnicza im. Stanisława Staszica / AGH University of Science	Akademia Górniczo-Hutnicza im. Stanisława Staszica	Research unit/institution	Poland
Project Partner 3	Stifelsen SINTEF, P.O.	SINTEF	Research unit/institution	Norway
Project Partner 4	Instytut Ochrony Środowiska – Państwowy Instytut Badawczy / Institute of Environmental Protect	Instytut Ochrony Środowiska – Państwowy Instytut Badawczy	Research unit/institution	Poland
Project Partner 5	Główny Instytut Górnictwa / Central Mining Institute	Główny Instytut Górnictwa	Research unit/institution	Poland
Project Partner 6	Instytut Medycyny Pracy im. prof. Jerzego Nofera / Nofer Institute of Occupational Medicine	Instytut Medycyny Pracy im. prof. Jerzego Nofera	Research unit/institution	Poland

Project Partner 7	Polskie Stowarzyszenie Energetyki Wiatrowej / Polish Wind Energy Association	Polskie Stowarzyszenie Energetyki Wiatrowej	Micro-enterprise	Poland

B1. Principal Investigator	
First and last name, academic degree/title	Anna Preis, profesor zwyczajny
Place of employment	Uniwersytet im. Adama Mickiewicza w Poznaniu/Adam Mickiewicz University
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[1] The successive number of the project report - 1,2,3 etc.
[2] Choose one: research unit/institution, small /medium/ large enterprise, other

C. INFORMATION ON THE IMPLEMENTATION PROGRESS IN THE REPORTING PERIOD

C1-1. Work Package title and number [3]	Noise annoyance and limits - Nr zadania / WP No. 1			
Start date	planned [4]	01.04.2021	actual	01.04.2021
End date	planned	30.09.2023	actual [5]	in progress
Cost of WP (PLN)	planned	883 975.00	actual (value at the end of the reporting period)	111 904.42
Implementing entities	UAM / AMU, Akustix, SINTEF, Główny Instytut Górnictwa , Instytut Medycyny Pracy im. prof. Jerzego Nofera, Polskie Stowarzyszenie Energetyki Wiatrowej			

An explanation of the work carried out by the implementing entities (max. 2500 characters with spaces)

The specific task to be carried out in the reporting period was Task 1: Survey research + noise recordings. In particular: the questionnaire for the survey was to be created, we were to select wind farms for the survey, we were to perform preliminary research to identify the target group of participants for our surveys. Finally, in month 6 of the project, we should present Deliverable 1 i.e. Report about choosing the experimental group. Only one of these tasks has been completed. We have created a questionnaire that we intend to use in surveys at selected wind farms. The reason why we were not able to survey the people living near the farms was that the wind farm managers (a large wind farm in the Wielkopolska region) did not allow us to conduct both objective measurements and surveys. Currently, we have permission to conduct surveys and measurements at another wind farm and discussions are underway about the second farm.

An overview of the progress of work towards the objectives of the project, including achievements, milestones and deliverables identified in the project contract No more than 12 000 characters with spaces for each WP implemented in the reporting period: a description of the results achieved during the reporting period, activities carried out during this period.

During the reporting period, the task to be carried out was Task1: Survey research + noise recordings. As part of this task we had to: (1) design the questionnaire for the surveys (2) select the target farm (3) carry out preliminary research (4) select the target group for the study of noise nuisance generated by wind turbines During our weekly project meetings we managed to construct the questionnaire for the survey. This task was mainly handled by Jan Felcyn (AMU), Truls Gjestland (SINTEF), Małgorzata Pawlaczyk-Łuszczyńska (IMP), Maciej Buszkiewicz and Anna Pastusiak (AMU). We decided to include audio examples in the survey, which will be presented to residents around wind farms via headphones. These sound examples are 6 sounds with known annoyance ratings. This is a way of teaching people which numbers correspond to which noise annoyance ratings. In addition, each resident will have to judge for himself/herself, using a number, the annoyance caused to him/her by 3 pre-recorded sounds generated by wind turbines. Those ratings will be then compared with ratings given for the same stimuli by the respondents from the laboratory experiment. Originally, we did not plan this option in our research because we assumed that all the questionnaires would be done for the inhabitants of one large farm. However, as there is a problem with having all the needed permissions for the largest farms in Poland, we add this option to the experimental procedure to be more flexible. Unfortunately, it turned out that we were not allowed to conduct both noise measurements and surveys at this planned large farm. Currently, we have an agreement to make noise measurements at another farm. Unfortunately, the number of inhabitants around it is small – nevertheless, survey research will be conducted there. We conducted there preliminary noise measurements (July 13, 2021) and did a site visit to assess the number of potential survey participants. We are in the process of negotiating and signing a non-disclosure agreement (NDA) for two further wind farms with a larger number of inhabitants in the vicinity of them. Thus, we are still looking for at least two other wind farms where we will be able to conduct both noise measurements and surveys. We did not foresee such a situation when planning this project and therefore we have to adjust our plans regarding the selection of this target group based on the surveys. The analyses we wanted to carry out comparing noise annoyance ratings of wind turbines in different groups will be carried out post factum, i.e. after the selection of the target group for our main study. The differences will be found between the assessment of annoyance of people living close to wind turbines for a few years (1st group), people living near wind turbines at most six months (2nd group) people living at a greater distance from the wind turbines (3rd group) and people exposed to wind turbine noise for the first time (4th group). It will allow studying: – the impact of the non-acoustic factors (eg. negative attitude) on the assessment of wind turbine noise (higher annoyance rating observed for 1st group than for others); – if short exposure to unknown noise leads to a reliable assessment of the wind turbine noise? Is the annoyance assessment undertaken based on a momentary impression, or the transposition of a momentary impression on the long-term experience? (different annoyance rating observed for 4th group than for others) – preliminary assessment of an adaptation effect on wind turbine noise (lower annoyance rating observed for 2nd group than for others) Based on discussions with all the project partners we decided to select group 4 as the target group, i.e. to study the assessment of the annoyance of wind turbine noise among people who are exposed to this noise for the first time. This choice will allow us to invite to our laboratory (arranged as a living room) people (recruited for this project for a fee) who will evaluate the annoyance of previously recorded noise generated by wind turbines. The selection of the target group for our

research is described in detail in Deliverable 1. The completion of Deliverable 2 (12M) in WP1 is strongly related to the approvals for conducting surveys at two more wind farms. At the current stage of the project, we assume that all other tasks (Task 2 Laboratory experiment, Task 3 Choice of the noise indicator, Task 4 Limits of noise indicators) will be executed according to schedule.

Deliverables [6]
For deliverables that are not in writing (e.g. prototype), the PP must submit a short written description.

Deliverable name	Lead entity	Deliverable file (Maximum one file per deliverable, in case of several files, please create a zip and upload that zip)	Comment
Selection of the target group for main r	UAM / AMU	D1.1.docx	corrected file

Milestones [7]

Number	Description of milestone	Lead entity	Planned delivery date (according to project proposal)	Achieved (YES/NO)	Actual delivery date	Comment
1	Dose-Response function for wind turbine noise	UAM / AMU	31.03.2023	no	-	Dose-Response function for wind turbine noise will be obtained based on laboratory experiments. This work is in progress.

Description and justification of discrepancies and corrective actions for each WP
If during the reporting period there was a derogation from the contractual provisions (e.g. duration of WP), an explanation should be given: what type of derogation, reasons for the discrepancy, taken or planned corrective actions to determine impact on further implementation of the project and achievement of planned results of the project. (max. 1500 characters with spaces)

not applicable

C1-2. Work Package title and number [3]	Monitoring of environment - methodology of wind turbine noise measurement - Nr zadania / WP No. 2			
Start date	planned [4]	01.04.2021	actual	01.04.2021
End date	planned	30.11.2023	actual [5]	in progress
Cost of WP (PLN)	planned	1 126 187.50	actual (value at the end of the reporting period)	63 207.97
Implementing entities	UAM / AMU, Akustix, Akademia Górniczo-Hutnicza im. Stanisława Staszica, SINTEF, Główny Instytut Górnictwa , Polskie Stowarzyszenie Energetyki Wiatrowej			

An explanation of the work carried out by the implementing entities (max. 2500 characters with spaces)

The WP2 started with about 5 month delay due to the delay of the final arrangement signing. From 01.09.2021 to 31.12.2021 The following tass were realized: Task 1: Review of the existing methods of wind farm noise measurement This task is actually finished. A detailed review and analyses of the

latest literature (scientific journals as well as the conference papers) was conducted. We have also gathered and analysed actual national methodologies of wind turbine noise monitoring from all EU countries as well as from Norway, US, Canada, Australia, New Zealand and Japan. Now we are starting to work on Task 2 – Verification of methods from Task 1. We started sub-task 2.1 – Choice of methods to verify. At this early stage of the project it was crucial to build an equipment base for the rest of the project. The work on this topic was running in parallel with previously described tasks. We have chosen and bought a main equipment – two noise monitoring stations, and other crucial hardware components. In January 2022 we are finalizing the equipment purchase procedures. We had also adjust our existing equipment to extensive field measurements. We built mobile power supply system, microphone mounting systems, reflecting measurement disc for noise measurements on the ground etc. for over 10 simultaneous measurement points spread over the wind farm surrounding. We were solving time synchronization issues of such a spread measurement system. In order to perform field measurements for verification of existing methodologies a several meetings with wind farm representatives took place together with field visits in order to choose the best possible testing site. At the moment no final destination was found due to many formal problems (lack of permissions of wind farm management boards to perform measurements and provide necessary non-acoustical data crucial for further analyses and post-processing of measurement data, and other impediments due to COVID-19).

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The objective of WP2 is the development of the methodology of wind turbines' noise measurement regarding to specific issues of this source, especially high wind speeds and low values of signal to noise ratio. Most of existing measurement methodologies dedicated for other noise sources like communication noise, industrial noise may not be appropriate for measuring wind turbine noise. The main issue in wind turbine noise measurements is the wind itself. Wind flowing around the microphone body generates an extra noise mainly due to turbulences induced by microphone body and its wind screen. The wind generates also an extra noise induced by turbulences generated by other obstacles like trees, buildings, different constructions etc. Wind generates also an extra noise through inducing movement of leaves, plants, mechanical equipment on farms etc. In case of measurement of other noise sources (communication noise, industrial noise) a measurement methodology usually limits the wind speed to some value (in most cases to 5 m/s) – because noise generation process for these sources does not depend on the wind speed. Below this limit value of wind speed - the wind influence may be neglected. However this is not the case for the wind turbine noise – since this type of noise is only generated in windy conditions and is strongly related to wind speed. In many cases the maximal performance of the wind turbine is achieved for the wind speeds exceeding the limits for other types of noise sources. The other issue concerned with wind turbine noise measurements is the relatively low signal to noise ratio. It is the case since the absolute values of sound levels generated by wind turbines are relatively low and the background noise levels due to wind induced noise effects mentioned above and relatively high living noise in the rural areas (farms, animals etc.). Such a specific measurement conditions leads us to search methodology which will limit (and correct) the influence of a wind noise on the measurement, and limit the influence of a background noise. The method we are going to propose will be relatively simple so that it would be accessible to administrative bodies of environmental protection, installation managers and local communities and lets them to determine and control the actual impact of wind turbines' on the environment. The method will be ready to implement to state regulation on environmental noise monitoring. In order to achieve this objective at this stage of the project in Task 1 a systematic review of the already existing methods of wind turbines' noise measurement was made. Based on its results and our experience in the field (UAM, AX, AGH, SINTEF, GIG), now we are working on choosing the initial proposal of methodology of measurements at wind speeds greater than 5 m/s. The methodology will cover different aspects of the measurement conditions like compensation of the influence of wind shield and wind itself, localization and height of the measurement point, acceptable wind speed range etc. This initial proposal will be verified in Task 2. The set of field measurements will investigate all the above mentioned aspects of the measurements conditions. The activities of Task 1 and Task 2 in WP2, despite the some delays (caused e.g. by problems with the delay of the final arrangement signing) are being successively implemented and it's results will achieved according to schedule.

Deliverables [6]
For deliverables that are not in writing (e.g. prototype), the PP must submit a short written description.

Deliverable name	Lead entity	Deliverable file (Maximum one file per deliverable, in case of several files, please create a zip and upload that zip)	Comment
No record			

Milestones [7]

Number	Description of milestone	Lead entity	Planned delivery date (according to project proposal)	Achieved (YES/NO)	Actual delivery date	Comment
1	Description of a new methodology of measurement of the wind turbine noise, which will include specifics of this source. Thanks to that, this methodology will outperform already existing commonly used procedures.	Akustix	30.11.2023	no	-	Proposing a new research methodology requires an adequate amount of measurement data collected and verified. This is how the work accutally proceeds.

Description and justification of discrepancies and corrective actions for each WP If during the reporting period there was a derogation from the contractual provisions (e.g. duration of WP), an explanation should be given: what type of derogation, reasons for the discrepancy, taken or planned corrective actions to determine impact on further implementation of the project and achievement of planned results of the project. (max. 1500 characters with spaces)
not applicable

C1-3. Work Package title and number [3]	Managing infrasound wind turbine noise - Nr zadania / WP No. 3			
Start date	planned [4]	01.04.2021	actual	01.04.2021
End date	planned	31.12.2022	actual [5]	in progress
Cost of WP (PLN)	planned	557 606.25	actual (value at the end of the reporting period)	104 821.58
Implementing entities	Akademia Górniczo-Hutnicza im. Stanisława Staszica, Główny Instytut Górnictwa , Instytut Medycyny Pracy im. prof. Jerzego Nofera, Polskie Stowarzyszenie Energetyki Wiatrowej			

An explanation of the work carried out by the implementing entities (max. 2500 characters with spaces)

The assessment of infrasound noise from wind turbines is the subject of numerous works and still raises many doubts at all its stages, starting from measurement methods, indicators and prediction methods. Therefore, it was considered very important to review the latest research results in this field. The results of the literature review are included in the report (Deliverable) D3.1. AGH UST, GIG and IMP partners participated in this part. AGH UST contribution includes a review of solutions to reduce the impact of wind noise on the measurement result, the impact of infra and low frequency noise (ILFN) on the human body, and computational methods for infra noise. The contribution of IMP is the impact of infrasound noise on human body and indicators used in its assessment. The work of GIG focused on the analysis of infra noise measurement methods. This task was completed 6 months after the start of the project, i.e. on 30 September 2021. The results of the literature review in question were presented by the head of the AGH UST team, the leader of task WP3, T.Wszołek at a joint seminar of the Institute of Acoustics UAM in Poznań and the Committee on Acoustics of the Polish Academy of Sciences, on 14 December 2021. This work was also presented by T.Wszołek at the Open Seminar in Acoustics in (OSA 2021, Krakow) during the plenary paper on September 17, 2021. The remaining tasks are in progress, and the nearest one (D3.2) is planned to be completed on March 31, 2022. As part of this task, a team from AGH UST conducted field studies towards calibration of measurement systems in terms of eliminating the influence of wind interference. The effectiveness of different wind shields was tested with respect to the shielding according to ISO 61400-11:2013 at different wind speeds, including windless conditions. The study was carried out using a natural source of low-frequency noise - an outlet from a ventilation shaft and on a wind farm in Łęki Dukielskie. Two publications are planned in this area:(1) on experimental verification of wind shields and (2) proposal of measurement methodology useful in assessment of infrasound and low frequency noise. Such studies were also carried out by the GIG team using the ventilation system outlet as the noise source. The study focused on the use of the "inverted microphone" method on the plate, according to SINTEF.

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D3.1 Complete review of the existing methods and models of infrasounds' measurement and impact on human health A literature review was carried out with regard to noise sources in wind turbines (particularly regarding the generation of infrasound and low frequency noise), measurement and assessments of infrasound and low frequency, infrasounds' impact on human health, and modeling infrasound sources. Based on the literature description, sources of mechanical noise generated, which can be propagated to the environment through elements of the turbine structure such as: the nacelle, hub, rotor, and tower, were selected. Wind turbines also generate aerodynamic noise, one of whose components is low frequency noise. This noise is caused by rotating rotor blades in interaction with air gaps created by flow around the tower or by changes in wind speed. In order to accurately characterise the noise measured in the vicinity of wind farms, it is necessary to ensure that outdoor microphones are adequately protected from the wind. A standard 90 mm windshield is appropriate for measurements in light winds; however, as the wind speed increases, wind-induced pressure fluctuations erroneously contribute to the measured sound pressure level. The measurement of infrasound at low levels requires a specific methodology too, as it is readily affected by the wind on the microphone in low frequencies. Such a methodology has been tested (developed) in a few countries i.e. in Japan (by Hideki TACHIBANA), in Australia (by Turnbull CP and Turner JP; by Hansen K., Zajamšek B., Hansen C.; by Cooper S.), in Belgium (by D'Amico S. and Van Renterghem T. and Botteldooren D.), in USA (by Bruce Walker), in Denmark (Madsen K.D. and Pedersen T.H.). Because wind-induced microphone noise complicates infrasound measurements considerably, a wind-shielding for signal-to-noise ratio improvement of acoustic pressure infrasound frequencies was designed and tested independently by the listed researchers. The best results were achieved by using double spherical covers. Tachibana H. proposed a double-skin set consisting of a globular wind-screen of 20 cm diameter made of urethane foam and a newly designed dodecahedral second screen covered with a thin cloth (nylon 90% and polyurethane 10%; opening ratio: 60%) with high elasticity. Hansen K. and Zajamšek B. and Hansen C. tested three configurations based on outdoor microphones equipped with 90mm-diameter windshields and extra hemispherical windshield, box windshield and spherical windshield. D'Amico S., Van Ren a semi-spherical wind-shielding dome which aimed at maximizing the pressure averaging of large atmospheric turbulent eddies while keeping the structure reasonably compact. The dome allowed to clearly identify the infrasonic tonal components of wind turbines that were otherwise completely covered by the wind-induced microphone noise even at low mean wind speeds. This solution seems to be the best approach to measuring ILFN. Only two countries (Denmark, USA - Shawano County) consider ILFN in acoustic criteria for the environmental impact of wind turbines. A comprehensive review of the literature was also carried out on the impact of low frequencies, particularly infrasound, on mental health, brain morphology and other aspects of human well-being. The work (Ascone et. Al., 2021), which describes the clinical trials conducted to determine the effect of long-term human exposure to infrasound compared to placebo, can be considered particularly important scientific reports on this issue. The presented study proved that long-term exposure (1 month) of infrasound with an amplitude above the values observed in wind farms and with a frequency of 6 Hz does not affect human behavior, including many variables related to health and psyche. Still, at the same time, it was observed that exposure to infrasound binds with a decline in gray matter in areas of the brain. Also, some major studies were reviewed where the influence of infrasound on humans was examined indirectly, i.e. by observing areas exposed to infrasound due to the proximity of sources or industrial works (Bolin et. Al. 2011), (Persinger, 2014), (Leventhall, 2007). These reports usually highlight potential side effects such as nausea, malaise, fatigue, undefined pain, sleep disturbance, or irritability. However, there are also reports (Vahl et. At., 2021), (Yount et. Al., 2004) signaling the potential use of infrasound in oncological therapy as a supportive effect and bringing measurable positive effects supporting the treatment. After conducting a literature review about infrasounds models, it can be stated that the most frequently used methods for predicting infra and low frequency noise (LFN) generated by wind turbines are the methods generally used for predicting environmental noise, i.e. the method described in ISO 9613-2, the CNOSSOS method and the NORD2000 method. In the literature, one can find the use of more complicated techniques for LFN prediction, e.g. using parabolic equations, ray tracing, the Fast Field Program numerical model, and a model of wind turbine noise in the time domain, using the HAWC2 aeroelastic model and Formula 1A developed by Farassat. Models developed by Viterna and Amiet are also used to model LFN in the environment. D3.2 The proposal of methodology for infrasounds' measurements and recording Parallel to the literature review, systems were worked on to develop the proposed measurement and recording methodology. As the first multi-channel wireless measurement system allows synchronous measurement at measurement points far apart from each other. For each measurement point, it is possible to measure in 3 channels. Different configurations and ways of compensating the influence of wind on measurement signals will be tested. The system can record sound pressure signals at a sampling rate of 51.2 kHz. Recording the time courses of acoustic pressure allows any acoustic parameter to be determined with any time constant. This approach also enables the use of new signal processing methods. The second research was to evaluate and compare the influence of position of measurement points in relation to ground surface, as well as diagnose the possible influence of wind speed. The measurements were performed in adjacent area to a broad band noise source, namely outdoor ventilation system of a laboratory of radiometry. The measurement approach was to measure and record simultaneously noise signals with low frequency microphones, shielded using windscreens, localized at height of 0.0 m (a microphone in a vertical position mounted on a round disc), 1.5 m and 2.7 m. The measurements were performed using Brüel & Kjær PULSE measuring system. In measurement chain GRAS microphones type 40AN, and 40AZ were utilized. The results of these approaches were analyzed and compared. The measurements were repeated several times. The difference between recorded sound pressure level (broad band) at height 0.0 m and 1.5 m (approximate location of a human ear in standing position) ranged from 3 dB to 4 dB. Additionally the influence of wind fluctuations was observed and for the observation at height 2.7 m the difference for recorded sound pressure level (broad band) for different wind conditions (approximately from 0 m/s to 3 m/s) exceeded 7 dB. The conclusion for this preliminary phase of the research is that it seems to be possible to calibrate the measurement system for microphones positioned on the ground (disk), where influence of wind is very low, to obtain relevant results at height of 1.5 m (approximate location of a human ear for standing position). The measurement of a wind speed in the vicinity of a microphone is necessary. Third part of investigations was devoted to validation and estimation of the frequency range of Zoom handy recorders in low frequency range. The comparison was performed using Brüel & Kjær PULSE measuring system together with a GRAS microphone type 40AN. As a source for low frequency waves a vibration exciter with mounted round plate was utilized. The measurements were performed for 5 Hz, 10 Hz and 20 Hz and for different amplitudes of sound pressure level, starting from a

noise floor level. What may be generally concluded is that Zoom recorders are not suitable for low noise signal acquisition. D3.3 The proposal of infrasounds' indices used for rating their impact on people The first proposals of criteria for infrasound exposure were presented at Colloquium on Infrasound, in Paris, in 1973. These studies suggested that exposure to infrasound at sound pressure levels (SPL) above 180 dB posed a risk of death, and that a 2-minute exposure at levels in the 150□172 dB range is tolerated by healthy individuals, while many hours of exposure to levels of 120 ÷ 140 dB might induce fatigue and health disorders. In the late 1970s, the first criteria for assessing occupational exposure to infrasound were established in Scandinavian countries. Later, other countries, including Sweden, Russia, USA and Poland, introduced limit values for occupational exposure to infrasound. Over the years many different methods have been suggested for the assessment of LFN indoors. Exposure criteria are in use or are proposed in Germany, Sweden, Denmark, the Netherlands, Finland, the United Kingdom, Poland, Australia, Canada and Japan. Generally, majority of them are based on frequency analysis in 1/3-octave bands in various frequency ranges from 8 Hz to 250 Hz. In the majority of cases, measured sound pressure levels are compared with criterion curves, which are close to the hearing threshold levels. However, only a small number of jurisdictions, including the province of Alberta, Canada, Japan, and Australian States of South Australia and New South Wales have introduced outdoor LFN limits, so far. Several of these guidelines assumed that the difference between C- and A-weighted sound pressure levels ≥ 20 dB indicates LFN. For example, in Australian State of New South Wales, the LFN evaluation is based on the measurements the C-weighted sound pressure levels. A 5 dB should be applied to the measured noise level from the wind farm for the periods and meteorological conditions under which the LFN has been identified. The limit values of 65/60 dB(C) have been adopted. Parallel to the literature review, a design of the infrasound recording system for listening purposes was prepared. A prototype was setup and tested in two different locations. The system is based on a hybrid solution combining the recording of the acoustic field using the spherical harmonics (1st order ambisonics) and the ITD (Interaural Time Difference) sound source localization mechanism through the AB stereo technique. This combination allows the spatial characteristics of the acoustic field to be faithfully reproduced with a significantly extended frequency band (below 10 Hz) and at very low sound pressure levels (below 20 dBA). An algorithm was developed that distributes the recorded signals to the listening system in a perception-neutral manner. These signals were compared to the results of measurements using calibrated devices.

Deliverables [6]
For deliverables that are not in writing (e.g. prototype), the PP must submit a short written description.

Deliverable name	Lead entity	Deliverable file (Maximum one file per deliverable, in case of several files, please create a zip and upload that zip)	Comment
Complete review of the existing methods	Akademia Górniczo-Hutnicza im. Stanisława Staszica	D3.1.docx	corrected file

Milestones [7]

Number	Description of milestone	Lead entity	Planned delivery date (according to project proposal)	Achieved (YES/NO)	Actual delivery date	Comment
1	Methodology for infrasounds' measurements	Akademia Górniczo-Hutnicza im. Stanisława Staszica	31.03.2022	no	-	The manuscript is preapered to submit for publication.
2	Measure of infrasounds' impact on people	Akademia Górniczo-Hutnicza im. Stanisława Staszica	31.10.2022	no	-	Laboratory studies are currently being conducted on the effects of infrasound on the human body.

3	The possibly simple method of calculation infrasounds' noise indices	Akademia Górniczo-Hutnicza im. Stanisława Staszica	31.12.2022	no	-	Reaching this milestone will be possible after completion of laboratory testing

Description and justification of discrepancies and corrective actions for each WP
If during the reporting period there was a derogation from the contractual provisions (e.g. duration of WP), an explanation should be given: what type of derogation, reasons for the discrepancy, taken or planned corrective actions to determine impact on further implementation of the project and achievement of planned results of the project. (max. 1500 characters with spaces)

not applicable

C1-4. Work Package title and number [3]	Method of wind turbine noise prediction - Nr zadania / WP No. 4			
Start date	planned [4]	01.04.2021	actual	01.04.2021
End date	planned	30.09.2023	actual [5]	in progress
Cost of WP (PLN)	planned	483 475.00	actual (value at the end of the reporting period)	101 770.49
Implementing entities	Akustix, Akademia Górniczo-Hutnicza im. Stanisława Staszica, SINTEF, Polskie Stowarzyszenie Energetyki Wiatrowej			

An explanation of the work carried out by the implementing entities (max. 2500 characters with spaces)

Participation in discussions and planning of survey on annoyance, including wording of questionnaire, respondent selection and analysis of responses

An overview of the progress of work towards the objectives of the project, including achievements, milestones and deliverables identified in the project contract No more than 12 000 characters with spaces for each WP implemented in the reporting period: a description of the results achieved during the reporting period, activities carried out during this period.

SINTEF has participated in regular (weekly) discussions and planning of the progress of the project. Some highlights: A new questionnaire for the annoyance surveys has been developed. The questionnaire is based on previous experience and recommendations such as ISO TS 15666:2021. A memo discussing annoyance with regard to non-acoustic factors have been produced. Much of the work in WP1 is based on the assumption that differences in the annoyance response are caused by (small) differences in the noise signal. The memo sketches a procedure for a survey around a single wind farm that will eliminate the influence of many non-acoustic factors so that the effect of small differences in the noise signal can be more easily detected. The difference between the long-term annoyance response and momentarily annoyance has been discussed. Noise prediction models require a good characterization of the source. Noise data from the manufacturer need to be verified and supplemented. Different methods for measuring the noise emitted from a wind turbine have been discussed. Background wind-generated noise may be a problem, but certain techniques to avoid this will be implemented. Methods for calibrating noise measurements against a common reference situation has also been developed. Different prediction programs for wind turbine noise are commercially available. The difference between these is mainly due to the internal sound propagation models. Different propagation models have been assessed. These differences are mostly caused by meteorological parameters, and how these parameters are handled. It has been concluded that a prediction program based on the NORD2000 sound propagation algorithms can be well suited for the HETMAN project since this is the only propagation model that can use detailed meteorological data, and a NORD2000 program can calculate the noise for any given meteorological situation and given periods (and not only yearly average). A method for noise prediction calculations around Polish wind farms has been drafted. The method is based on a library of pre-calculated situations (>10,000) so that a user does not need to have access to the actual NORD2000-based program nor the necessary skill to operate such a program. The input is limited to a specification of the meteorological situation and information about generator types and their relative position. The method also includes a low-frequency module capable of handling frequencies down to 1 Hz.

Deliverables [6] For deliverables that are not in writing (e.g. prototype), the PP must submit a short written description.			
Deliverable name	**Lead entity**	**Deliverable file** (Maximum one file per deliverable, in case of several files, please create a zip and upload that zip)	**Comment**
No record			

Milestones [7]						
Number	**Description of milestone**	**Lead entity**	**Planned delivery date (according to project proposal)**	**Achieved (YES/NO)**	**Actual delivery date**	**Comment**
1	Description of a new method of noise prediction in the environment dedicated to wind turbines.	SINTEF	30.06.2023	no	-	All partners are included in discussions on choosing the best method to predict noise generated by wind turbines to the environment.

Description and justification of discrepancies and corrective actions for each WP If during the reporting period there was a derogation from the contractual provisions (e.g. duration of WP), an explanation should be given: what type of derogation, reasons for the discrepancy, taken or planned corrective actions to determine impact on further implementation of the project and achievement of planned results of the project. (max. 1500 characters with spaces)
not applicable

C1-5. Work Package title and number [3]	Reduction of wind turbines noise - Nr zadania / WP No. 5			
Start date	planned [4]	01.04.2021	actual	01.04.2021
End date	planned	31.03.2023	actual [5]	in progress
Cost of WP (PLN)	planned	334 943.75	actual (value at the end of the reporting period)	14 995.89
Implementing entities	UAM / AMU, Akustix, Akademia Górniczo-Hutnicza im. Stanisława Staszica, Główny Instytut Górnictwa , Polskie Stowarzyszenie Energetyki Wiatrowej			

An explanation of the work carried out by the implementing entities (max. 2500 characters with spaces)

Team working on Work Package 5 in the above period focused mainly on gathering information on wind turbine noise, developing new noise reduction solutions/assessing possibilities of implementing known ones, preparing experiment scenarios and environmental noise measurements. These undertakings were aimed at completing Task 1 consisting of the creation of a list of proposed wind turbine noise reduction methods, which at later stages of the project will be verified in in-situ and in laboratory conditions. The accumulation of knowledge on wind turbine noise consisted primarily of a literature review of issues such as current methods of reducing wind turbine noise, perception of amplitude-modulation in wind turbine noise signals, the effect of amplitude-modulated noise on annoyance ratings, the possibility of masking wind turbine noise with other signals (e.g., car

noise). For a better understanding of noise propagation from wind turbines, a site inspection was carried out on two farms (WF1 and WF2). During inspections, sound level measurements and audio recordings were derived. Local inspections were also used to select farms for conducting surveys and long-term measurements. All entities were involved in the realization of this task, without being limited to literature review but also by sharing experiences and knowledge from past scientific work (Akustix, GIG, AGH) and enabling contact with farm administrators (PSEW). Based on the literature findings and other data, work to develop wind turbine noise reduction methods was undertaken. The first proposal is masking the noise with naturally occurring sources in the vicinity of wind farms. The types of maskers that can be found in the vicinity of wind farm sites were identified and the weather conditions under which audio recordings and sound level measurements should be made were estimated. Further, preliminary recordings of traffic noise (near the A4 motorway) at various distances were conducted. On their basis with the use of recordings of wind turbine noise from local inspections preliminary preparations for psychoacoustic experiments on the effectiveness of the selected background noise/masker (traffic noise) have been made. In addition, the preparations for audio-visual experiments on the annoyance of wind turbines in virtual reality using a set of VR goggles, a 360-degree camera and software simulating the scenery of the occurrence of wind turbines has been done. This task was carried out by AMU.

An overview of the progress of work towards the objectives of the project, including achievements, milestones and deliverables identified in the project contract No more than 12 000 characters with spaces for each WP implemented in the reporting period: a description of the results achieved during the reporting period, activities carried out during this period.

Wind turbine noise is becoming a significant threat to the physical and mental health of the Polish public. This is due to the rotational movement of wind turbine propellers, which generate noise and contribute to the flicker effect that annoys people living in their vicinity. The scientific literature on this matter provides numerous reasons and effects of the negative impact of wind turbine noise on human health and well-being. Planned changes in the law to allow less than "10H" distance from homes will increase the number of wind energy projects and thus the number of people exposed to the negative impacts of wind farm noise. The declared result of Work Package 5 in the HETMAN Project is a catalog of noise abatement solutions for wind turbines, which are to be applied to single turbines, entire wind farms - both the existing ones and those at the planning stage. Moreover, the methods should be simple to implement, not cause excessive expense, and be effective. Many of the methods described in the literature involve intervening in the device itself or its elements in order to reduce the generated level; within Work Package 5 these solutions are called "hard methods". Examples are the use of feathered rotor blade ends with similar tabs or the use of direct shafts in generators instead of using a gear system. The effectiveness of such solutions can often only be determined by the type of turbine for which the solution was found. These solutions are also complex, costly and require implementation at the turbine design stage. Due to the complexity of the process and interference with wind turbine energy production, many investors and managers will not decide to introduce them in existing and planned wind power projects. The methods that have received most of attention in the course of Work Package 5 so far have been organizational solutions and "soft methods". Organizational methods are those, which most often affect the spatial distribution (location of wind farms, turbine deployment, distance of the noise source from protected areas) and operating mode of wind turbine. Noise reduction of wind turbines by spatial distribution is caused by sound absorption in the air and by changing the propagation path through terrain features. The current "10 x H" law is an example of an organizational noise reduction method. Such methods are effective provided they are applied at the investment planning stage. At the same time, however, their application may be an obstacle to the occurrence of future investments and cannot be applied on farms already in existence. Solutions based on operating mode of turbine can reduce noise with temporary shutdowns or by changing blades angle of attack. These methods however influence energy production thus are not welcome by farm managers. Organizational methods are considered as part of the work on Work Package 5 as methods of reducing sound levels which are simpler to implement than “hard methods” and less costly. Where it is possible it consists in moving the noise source away from the observation point as much as possible. Despite the use of organizational methods (e.g. in Poland), high annoyance related to wind turbine noise is still reported. To this end, "soft methods" of noise reduction are being developed. "Soft methods" of noise reduction serve to reduce the annoyance caused by wind turbine noise to residents of nearby areas. Considering wind turbine noise levels on average not being very high (~45 dBA) but causing significant annoyance is the reason why a major emphasis is put on annoyance reduction methods rather than noise levels. Dominant characteristic affecting annoyance caused wind turbine noise is amplitude modulation of wind turbine noise. Amplitude-modulated signal is better perceived thus easier draws attention to itself and distracts from activities and making life difficult. Wind turbine noise is, due to size of wind turbines and rotor blades, dominantly low frequency. For this reason it propagates over long distances and is almost impossible to suppress. The main focus in current state of WP5 work is put on developing masking methods involving sounds naturally existing in vicinity of wind turbine farms and rural households. Maskers sounds should be familiar to the subject, not cause annoyance by themselves, and preferably have a sound spectrum similar to that of wind turbine noise. Sounds of these characteristics are to be found on motorways and roads with constant traffic volume. Most people living nearby traffic noise sources are used to them and are not (overly) annoyed. The purpose of using maskers with characteristics similar to the noise of wind turbines is to reduce the perception of sounds generated by the wind turbines and, consequently, to reduce the annoyance rating. To date, an analysis of the use of road and highway noise to mask wind turbine noise has been conducted based on literature reports. Preliminary measurements and recordings of traffic noise near A2 highway at various distances from the noise source were carried out. These recordings, together with recordings made during local inspections at wind farms, will be used to prepare preliminary laboratory experiments on the effectiveness of this masker. Preliminary verification of the effectiveness of the method of reduction by masking is an important element of Task 1 in Work Package 5. At further stages of work, recordings of traffic noise will be made at other measurement points to take into account different types of roads (traffic intensity), distances, meteorological conditions and time of day. In addition, other maskers are considered: industrial noise, vegetation noise (forest, individual trees), and water noise (fountains, streams), for which measurement, implementation, and verification procedures will be implemented in the coming months. Visual aspect, which also plays significant role in annoyance ratings from wind turbines, will be tested in virtual reality setting. Appropriate equipment, consisting of VR goggles, 360-degree camera and ambisonic microphone, is part Work Package 5 inventory. Preliminary laboratory experiments are being prepared and will consist of audio and video signals presented in various scenarios. The activities of Task 1 in WP5, despite the some delays (caused e.g. by problems with the commencement of long-term noise measurements at a selected wind farm) are being successively implemented and it’s results will achieved according to schedule.

Deliverables [6] For deliverables that are not in writing (e.g. prototype), the PP must submit a short written description.			
Deliverable name	**Lead entity**	**Deliverable file** (Maximum one file per deliverable, in case of several files, please create a zip and upload that zip)	**Comment**
No record			

Milestones [7]						
Number	**Description of milestone**	**Lead entity**	**Planned delivery date (according to project proposal)**	**Achieved (YES/NO)**	**Actual delivery date**	**Comment**
1	Determination of the real effectiveness of each noise reduction method.	UAM / AMU	31.12.2022	no	-	Laboratory experiments are in preparation to determine the effectiveness of wind turbine noise masking by road traffic noise.
2	Procedures implementing complex noise reduction methods for controlling either emission (close to the source) or immission (at living areas)	UAM / AMU	31.03.2023	no	-	This procedure will be proposed after the results have been obtained in laboratory experiments.

Description and justification of discrepancies and corrective actions for each WP If during the reporting period there was a derogation from the contractual provisions (e.g. duration of WP), an explanation should be given: what type of derogation, reasons for the discrepancy, taken or planned corrective actions to determine impact on further implementation of the project and achievement of planned results of the project. (max. 1500 characters with spaces)
not applicable

C1-6. Work Package title and number [3]	Managing wind turbines noise - practical implementation of project's results - Nr zadania / WP No. 6			
Start date	planned [4]	01.04.2021	actual	01.04.2021
End date	planned	31.03.2024	actual [5]	in progress
Cost of WP (PLN)	planned	759 293.75	actual (value at the end of the reporting period)	22 921.10
Implementing entities	Akustix, Akademia Górniczo-Hutnicza im. Stanisława Staszica, Polskie Stowarzyszenie Energetyki Wiatrowej			

An explanation of the work carried out by the implementing entities (max. 2500 characters with spaces)

Within a reporting period the following task have been realized: Task 1: The concept of the hardware part of the noise control system have been introduced. Main functional modules are: noise gathering/processing/recording unit, bidirectional communication unit, general control unit, weather station, power supply unit. Different available solutions have been taken into account as well as genuine hardware platform based on own construction. We are now in the process of selecting the main electronic components of the mentioned functional modules as well as data gathering transducers. These components will be ordered and tested for theirs functionality, durability, cost, quality, etc. Although general purpose and expected functionality of the modules are well defined, several practical aspects are not clear. For example, the expected microphone sensitivity depends on expected signal to noise ratio, which in wind farms further depends mostly on wind conditions, presence of other sources of environmental noise (eg. industrial noise, traffic noise, etc.) and distance to wind turbine. At this stage we consider using different solutions depending on the signal to noise conditions at specific monitoring sites and the results of WP2. The transmission system will be based on commonly available GSM infrastructure with the aid of local data storage within monitoring units. It is also possible to integrate with the communication systems available at the wind farm sites. Due to expected diverse locations of monitoring stations, several power delivery schemes are possible including solar panels, energy banks and commonly available power lines where possible. At the moment no specific hardware platform was decided yet, which will be possible after preliminary testing of the selected constructions.

An overview of the progress of work towards the objectives of the project, including achievements, milestones and deliverables identified in the project contract No more than 12 000 characters with spaces for each WP implemented in the reporting period: a description of the results achieved during the reporting period, activities carried out during this period.

Within a reporting period the following task have been realized: Task 1: The concept of the hardware part of the noise control system have been introduced. Main functional modules are: noise gathering/processing/recording unit, bidirectional communication unit, general control unit, weather station, power supply unit. Different available solutions have been taken into account as well as genuine hardware platform based on own construction. We are now in the process of selecting the main electronic components of the mentioned functional modules as well as data gathering transducers. These components will be ordered and tested for theirs functionality, durability, cost, quality, etc. Although general purpose and expected functionality of the modules are well defined, several practical aspects are not clear. For example, the expected microphone sensitivity depends on expected signal to noise ratio, which in wind farms further depends mostly on wind conditions, presence of other sources of environmental noise (eg. industrial noise, traffic noise, etc.) and distance to wind turbine. At this stage we consider using different solutions depending on the signal to noise conditions at specific monitoring sites and the results of WP2. The transmission system will be based on commonly available GSM infrastructure with the aid of local data storage within monitoring units. It is also possible to integrate with the communication systems available at the wind farm sites. Due to expected diverse locations of monitoring stations, several power delivery schemes are possible including solar panels, energy banks and commonly available power lines where possible. At the moment no specific hardware platform was decided yet, which will be possible after preliminary testing of the selected constructions. An overview of the progress of work towards the objectives of the project, including achievements, milestones and deliverables identified in the project contract No more than 12 000 characters with spaces for each WP implemented in the reporting period: a description of the results achieved during the reporting period, activities carried out during this period. The two main objectives of the WP6 are 1) TASK 1: Prototype research in order to deliver the low-cost tool of ongoing control of wind farm noise level. General philosophy behind the control system is to provide solution affordable to everybody concerned about noise levels, as well as for local or control authorities, e.g. as a preliminary measurement before accurate but more expensive analysis. Here the term ‘control’ is used to distinguish form noise ‘monitoring’ which is meant to be compliant with legal regulations, including requirements for the sound level meter class. Similar solutions show the accuracy of about 2 dB what is enough to informative purposes, trend detection, etc. 2) TASK 2: Prototype research in order to deliver the tool (based on a mentioned above low-cost noise controlling system) for optimization of turbine’s performance involving instantaneous noise propagation conditions aimed to keep the noise level below limits at the selected areas. The concept of the whole system (SCADA module), by AkustiX, and prototype research (hardware and software), by AkustiX and AGH with support of PSEW, is aimed to the ongoing control of noise level around wind farm where noise limits should not be exceeded. The system will consist of a grid of low-cost devices (Task 1) installed near wind turbines (reference points, measurement of the emission level), in the living areas (immission points, where noise limit should not be exceeded) and between (to get information on propagation conditions feeding prediction model). Noise level at the immission point depends on the instantaneous conditions of propagation (ground effect, wind speed, its direction and wind shear, current background level etc.) and the emission level of single wind turbine and is influenced by the height of source and an observer. Making use of prediction method, delivered by WP4, instantaneous sound level at the immission point will be calculated taking into account e.g.: wind direction (directivity of radiated noise), wind speed (influencing turbine’s sound power level) etc. All these parameters are correlated, so it gives a chance to control sound level at an immission point through noise-related wind turbine’s operation optimization (e.g. blade angle of attack). Optimization criterion will be defined as the maximal wind turbine energy production effectiveness which will not lead to the exceedance of noise limit in the observed area. At the time – in accordance to the time schedule only the Task 1 is in the progress. At this early stage of this task a selection of the main electronic components of the mentioned functional modules as well as data gathering transducers is in progress. These components will be ordered and tested for theirs functionality, durability, cost, quality, etc. Although general purpose and expected functionality of the modules are well defined, several practical aspects are not clear. For example, the expected microphone sensitivity depends on expected signal to noise ratio, which in wind farms further depends mostly on wind conditions, presence of other sources of environmental noise (eg. industrial noise, traffic noise, etc.) and distance to wind turbine. At this stage we consider using different solutions depending on the signal to noise conditions at specific monitoring sites and the results of WP2. The activities of Task 1, despite the some delays (caused e.g. by problems with the delay of the final arrangement signing) are being successively implemented and it’s results will achieved according to schedule.

Deliverables [6] For deliverables that are not in writing (e.g. prototype), the PP must submit a short written description.			
Deliverable name	**Lead entity**	**Deliverable file** (Maximum one file per deliverable, in case of several files, please create a zip and upload that zip)	**Comment**
No record			

Milestones [7]						
Number	**Description of milestone**	**Lead entity**	**Planned delivery date (according to project proposal)**	**Achieved (YES/NO)**	**Actual delivery date**	**Comment**
1	Prototype research of the low-cost system of continuous and on-line wind farms noise control	Akustix	31.03.2023	no	-	The proposal of such a low-cost system for noise control at wind farms will be possible to propose as a result of the work of all partners in this project.
2	Prototype research of the SCADA module – support for the wind farm management taking into consideration the criterion of the acceptable noise emission and immission levels	Akustix	31.03.2024	no	-	A proposal for a sacad module for wind farm managers will be possible as a result of the work of all partners in this project.

Description and justification of discrepancies and corrective actions for each WP If during the reporting period there was a derogation from the contractual provisions (e.g. duration of WP), an explanation should be given: what type of derogation, reasons for the discrepancy, taken or planned corrective actions to determine impact on further implementation of the project and achievement of planned results of the project. (max. 1500 characters with spaces)
not applicable

C1-7. Work Package title and number [3]	New state regulations and guidance on wind turbines noise management - Nr zadania / WP No. 7			
Start date	planned [4]	01.08.2021	actual	01.04.2021
End date	planned	31.03.2024	actual [5]	in progress
Cost of WP (PLN)	planned	654 030.00	actual (value at the end of the reporting period)	5 415.42

Implementing entities	UAM / AMU, Akustix, Instytut Ochrony Środowiska – Państwowy Instytut Badawczy, Główny Instytut Górnictwa , Instytut Medycyny Pracy im. prof. Jerzego Nofera, Polskie Stowarzyszenie Energetyki Wiatrowej

An explanation of the work carried out by the implementing entities (max. 2500 characters with spaces)

Task 1 - A dedicated project's website addressed to the wide audience including administrative authorities, environmental consulting companies, wind farms managers, local communities, etc. The website will present ongoing results and milestones achieved during the whole project, starting with current state of knowledge (as a result of each Task 1 in WP1 - WP 5). Task 1 - updated during the project - task started.

An overview of the progress of work towards the objectives of the project, including achievements, milestones and deliverables identified in the project contract No more than 12 000 characters with spaces for each WP implemented in the reporting period: a description of the results achieved during the reporting period, activities carried out during this period.

D 7.1 Project's website as a widely available database of knowledge (M5) a website design was made, containing information about the project https://hetman-wind.ios.edu.pl/aktualnosci/.

Deliverables [6]
For deliverables that are not in writing (e.g. prototype), the PP must submit a short written description.

Deliverable name	Lead entity	Deliverable file (Maximum one file per deliverable, in case of several files, please create a zip and upload that zip)	Comment
Project's website as a widely available	Instytut Ochrony Środowiska – Państwowy Instytut Badawczy	D7.1-1.docx	Corrected deliverable file

Milestones [7]

Number	Description of milestone	Lead entity	Planned delivery date (according to project proposal)	Achieved (YES/NO)	Actual delivery date	Comment
1	Activation of the website devoted to the project	Instytut Ochrony Środowiska – Państwowy Instytut Badawczy	31.08.2021	yes	31.08.2021	Activation of the website devoted to the project. https://hetman-wind.ios.edu.pl
2	Presentation of the new state regulations on noise: limits, measurements and calculations	Instytut Ochrony Środowiska – Państwowy Instytut Badawczy	29.02.2024	no	-	The proposal of new regulations for wind turbine noise limits will be possible after all planned laboratory experiments and surveys are completed.

3	Publication of good practice guide on wind turbines noise management	Instytut Ochrony Środowiska – Państwowy Instytut Badawczy	31.03.2024	no	-	The publication of the good practice guide is planned as a final result of the work of the project.

Description and justification of discrepancies and corrective actions for each WP
If during the reporting period there was a derogation from the contractual provisions (e.g. duration of WP), an explanation should be given: what type of derogation, reasons for the discrepancy, taken or planned corrective actions to determine impact on further implementation of the project and achievement of planned results of the project. (max. 1500 characters with spaces)

not applicable

C2. A publishable summary of the progress of work
A short summary (max. 1500 characters with spaces) for all WPs of the total work performed on the project during the reporting period. The information provided here may be published by the PO on the website of the Programme or transferred to the Donors for publication therefore shall be of a suitable quality to enable direct publication without any additional editing.

During first months of the project, a website dedicated to it was made https://hetman-wind.ios.edu.pl. There were many activities ongoing in the background. All applicants analysed the literature and prepared the state-of-the-art report, including law regulations from EU countries and more (e.g. Norway or New Zealand). Thanks to the help of the Applicant 8 some agreements between wind farms' managers and the Project Promoter were signed. Based on the knowledge of Applicant 2, we have prepared the measurement procedure for the in situ noise measurements (held in 2022). In cooperation with Applicants 4 and 8 a survey questionnaire was prepared, used then in the in situ interviews with inhabitants. Applicant 3 revised in situ the method for calibration of the measuring system in the presence of strong wind. Based on experience of all applicants a method for modelling wind turbines noise was chosen. After analysis of methods aimed to lower noise emitted by wind turbines, some of them were investigated deeper and experiments to check out their performance were planned. The whole work was needed to conduct both laboratory and in situ experiments – held in 2022.

[3] Each launched WP in separate table
[4] Planned start date, end date and cost of WP according to the project contract or the last amendment to the project contract (if a project contract was amended).
[5] If WP was not completed during the reporting period, use the phrase "in progress"
[6] Please provide basic information about all deliverables produced during the reporting period as they were described in the project proposal (Annex 5 to project contract).
[7] Please provide basic information about all achieved milestones described in the project proposal (Annex 5 to project contract) including their numbers and names as given in Annex 5.

C3. INDICATORS OF THE PROGRAMME							
No.	**Indicator**		**Baseline value**	**Target value**	**Value reached in the reporting period**	**Value reached from the beginning of the project implementation**	**Progress (%)**
1	**Number of peer-reviewed scientific publications submitted** *(please include information about publications in part D1 of the report)*		0	4	0	0	0.00
2	**Number of joint, peer-reviewed scientific publications submitted** *(please include information about publications in part D1 of the report)*		0	3	0	0	0.00
3	**Number of new products/technologies developed**		0	2	0	0	0.00
4	**Number of registered applications for Intellectual Property Protection** *(please include information about applications in part D3 of the report)*		0	0	0	0	n/a
5	**Number of Polish researchers supported**	**all**	0	26	24	24	92.31
		female	0	8	8	8	100.00
6	**Number of Norwegian researchers supported**	**all**	0	2	1	1	50.00
		female	0	1	0	0	0.00
7	**Number of female researchers going abroad for research**	**female**	0	0	0	0	n/a
8	**Number of mentor-mentee relationships established for young researchers**		0	2	2	2	100.00
9	**Number of joint applications submitted for further funding** *(please include information about applications in part D4 of the report)*		0	1	0	0	0.00

Iceland Liechtenstein Norway grants

Norway grants

D. DISSEMINATION AND PROMOTION									
D1. PUBLICATIONS									
No.	**Title of publication**	**Authors (names and surnames of authors)**	**Joint publication** *publication that is authored by researchers from at least one Polish and one Norwegian entity* **(YES/NO)**	**Name of journal**	**IF**	**Date of submission for publication** year of publication	**Status of publication** (under preparation/ submitted/ published / rejected)	**Language**	**Open access publication** (YES/NO)

If the project currently doesn't have any scientific publication, please check the box.
☒ This project does not currently have any scientific publication

D2. CONFERENCES AND SEMINARS						
No.	**Title of presented work**	**Authors (names and surnames of authors)**	**Name of the conference / seminar**	**Date and place**	**Type (international / national)**	**Presentation / poster / other (specify)**
1	Towards optimal management of wind turbines' noise Hetman	Anna Preis, Truls Gjestland, Piotr Kokowski, Tadeusz Wszołek, Patrycja Chacińska, Janusz Kompała, Małgorzata Pawlaczyk- Łuszczyńska, Magdalena Klera -	1 st Conference on Sound Perception (CSP)	2021-09-03 Conference organized by Faculty of Physics A. Mickiewicz University in Poznań Due to the Covid-19 pandemic, the CSP was a virtual e-conference on-line	international	Oral presentation

Link to the presentation or conference / seminar agenda						
csp.amu.edu.pl						
2	Review of methods for predicting, measuring and assessing infra- and low-frequency noise from wind turbines.	Tadeusz Wszołek	Seminar organized by Department of Acoustics	2021-12-14 Department of Acoustics (on-line mode)	national	oral presentation
Link to the presentation or conference / seminar agenda						
ia.amu.edu.pl						
3	Corrections used in the assessment of the nuisance of noise sources	Tadeusz Wszołek	Open Seminar on Acoustics 2021	2021-09-14 National OSA2021 conference organized by Polish Acoustical Society, Krakow Division	national	oral presentation
Link to the presentation or conference / seminar agenda						
http://www.osa2021.ptakrakow.pl/						

D3. REGISTERED APPLICATIONS FOR INTELLECTUAL PROPERTY PROTECTION (IPR)							
No.	**Type of IP Rights (Patent/ Trademark/ Registered design/ Utility model/ Other)**	**Application reference/ number**	**Date of the application**	**Official title of the application**	**Applicant(s)**	**Has the IPR protection been awarded? (YES/NO)**	**If available, official publication number of award of protection**

If the project currently doesn't have any application for IPR, please check the box.
☒ This project does not currently have any application for IPR

D4. APPLICATIONS FOR FURTHER FUNDING						
No.	**Title of the project**	**Project partners**	**Joint application** *a continuation of existing collaboration supported within the project, including at least 1 researcher from the supported Norwegian partner and 1 researcher from the supported Polish partner.* **(YES/NO)**	**Source of financing, name of the programme**	**Status of the application (under preparation / submitted / funded / rejected)**	**Project budget (EUR)** [11]

If the project currently doesn't have any application for further funding, please check the box.
☒ This project does not currently have any application for further funding

[8] this is a unique string of characters allocated to a website, file, or other piece of digital information
[9] Link to to the Open Access repository or to any other repository where a copy of the published version or the author's accepted manuscript has been deposited, or to a page within that repository providing access to the deposited version (possible after the end of an embargo period, where applicable). This is not a link to the publication on the journal/publisher website, and itis NOT a link to a personal or institutional homepage where the publication may have been posted.
[10] The date that the Open Access repository has accepted the publication

D5. OTHER (not mentioned above e.g. promotional materials, training materials, educational materials, master thesis, PhD thesis, organization of workshops, conferences etc.)
2 master thesis

D6. RISK MANAGEMENT IN THE PROJECT
Foreseen risks Please, refer to the risks described in the Annex 2 to the Proposal Manual: PROJECT PROPOSAL FORM - Implementation and Management (annex to the submitted project proposal). Information about materialised risks and applied risk mitigation measures.
The key tool to control risks in the project is the weekly online meeting. In this meeting all WP leaders as well as their team members are present. We discuss current issues, including risks and delays in the project. The overall progress of the project is also controlled using the dedicated software which helps to track all changes in time. In the reporting period no severe delays were found; minor issues were solved rapidly. When planning the project we knew that much time would spend negotiations between us and wind farms' managers. We solved this with fast agreement with one manager. Thanks to that we can do initial measures in situ while we still negotiate with other possible partners.
Unforeseen risks Provide description of new risks identified in the project and information about planned risk mitigation measures. Please, include also information about unforeseen risks that have been already mitigated (during the reporting period).
The most obvious unforeseen risk is the spread of COVID-19. It influences us regarding possibilities of travelling to Norway and conducting possible laboratory experiments. The pandemic and war in Ukraine both influenced significantly European market and prices of many things, including equipment planned to buy. Thus, we had to limit amount of some devices and change our budget. However, we cooperate strictly with all partners, we share equipment between us and it let to conduct all measurements without problems. Another unforeseen risk is the lack of people willing to fill in a survey about noise. As we want to analyse noise annoyance evoked by wind turbines, we need to ask people around wind farms for their thoughts about that. However, there are not many houses around wind farms and not every manager want us to contact with the inhabitants. Moreover, people do not want to take part in the research and the response rate is very low. Thus, we have only few filled surveys now but hope to gather more in the nearest future.

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[11] In case of the application having budget in other currency than EUR, please use the exchange rate from the date of submission of proposal. For proposals under preparation, please use the current exchange date (date of prepating the periodic report).