IEA Wind Task 32 Meeting Minutes

2020 General Meeting

Task 32 has created a worldwide network of wind lidar researchers who meet regularly to identify opportunities for the use of wind lidar, and mitigate the barriers to its adoption.

The 2020 General Meeting took place online because of the COVID-19 pandemic. COVID-19 made networking and collaboration harder during 2020, and so the 2020 General Meeting was designed to let people mingle virtually with their colleagues through a mix of discussion, working groups, and networking sessions.

Contents

The meeting was moderated by Andy Clifton, Task 32 Operating Agent. The working group sessions were run by David Schlipf (Task 32 Operating Agent) and many members of the Task 32 Advisory Board. The minutes were written by Ines Würth and then converted into this document by Andrew Clifton.

1 Day 1: Tuesday 20 October

Time	Activity
14:00	Panel session on "Wind Lidar in 5 years" • Alex Woodward, ZX Lidars • Alexandra St. Pe, RWE • Rozenn Wagner, GE Offshore Wind • Reesa Dexter, DNV-GL
14:55	Break
15:00	Working groups: creative chaos to make progress on something
15:55	Break
16:00	Networking session
16:45	Close

1.1 Panel discussion: "Wind lidars in 5 years"

We started with presentations from all panelists with their view of where wind lidars will be in 5 years. 68 people joined us for this session.

1.1.1 Presentations

Alex Woodward:

- What if lidar manufacturers developed a really cheap lidar sensor? What would the community do with such a sensor?
- What if there were lidars that can be customized, e.g., with apps that community experts would develop? What would you do with a smart lidar?

Reesa Dexter

- Power performance with nacelle mounted lidar will be common
- Preference to used lidar over tall masts in simple terrain. R&D on lidar in complex terrain will continue
- Better FLS uncertainties
- "wind tunnel" equivalent calibration of lidar instead of mast verifications
- Ability to measure across the rotor for the tallest of turbines

Rozenn Wagner

- Nacelle lidar will be the standard for power curve testing
- Lidars will be standard for resource and site assessment. The main challenge to be solved are TI measurements

Alexandra St. Pé

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- Wind resource assessment
  - How does varying TI input impact wake models?
  - What's the impact of lidar speed and TI on P50 estimates?
- Site suitability
  - How does TI impact load models?
  - How does different load model output impact site suitability decisions?
- Power performance tests
  - How can power performance be more accurately and precisely be predicted using a lidar?
- Performance monitoring
  - How can we develop more integrated and intelligent wind farms?
  - How can lidars be used to optimize turbine performance?

1.1.2 Discussion

Many of the following questions and chat were taken verbatim from the video chat window. There have been some edits for spelling and clarity.

Alex: ZX lidar carry out factory acceptance tests and for certain customers an met mast validation is carried out. For ZX the factory tests are much more important, and the field validation is an add-on. What would be needed in order to remove the need for a mast validation?

- Rozenn: part of the answer is lying in the uncertainty estimation since the goal is to reduce the risk. And that is what is usually being looked for in a validation.
- Reesa: there needs to be an industry standard. It would be nice for the lidar manufacturer to have a standard way of coming up with an uncertainty quantification. There needs to be an industry acceptance.
- Alexandra: the question is why are we forcing the comparison to a cup. A cup free validation would be ideal. the lidar manufacturers

A researcher: a question to Reesa and Rozenn: How urgently does the industry really need TI measurements? (In other words: how much do you think industry would be willing to pay for it as an extra?)

- Reesa: there's been different stakeholders: OEM, developer, and academia. There was a lot of great but technical work from academia. Industry needs more practical solutions. The masts cannot keep up anymore with the high hub heights, so there is an economic incentive to resolve this question. It is a bottleneck to move away from the cup and towards only lidar. It is an important part of moving the technology forward.
- Alexandra: There has been a lot of work done. There is a gap in benchmarking all the methods. How do I know which method to use for a specific site and a specific lidar? I need something that is practical and does not cost much time. There is a CFARS site suitability subgroup that works with a lot of stakeholders and works on the questions how to get lidar TI accepted for site suitability. We need to go from TI measurements also to loads models. We are coming to an end of the line.
- Alex: the progress that CFARS and other groups are making is brilliant. The challenge as a lidar manufacturer is that we are not owning the data, but is owned by the turbine OEM. The different groups are pushing now independently and CFARS can bring the acceptance over the tipping point.

An industry engineer: how would a lidar sensor compare to a 3D Ultrasonic in terms of what we have learned from those measurements already? For example, if we were to estimate turbulent kinetic energy (TKE)?

- Reesa: the primary driver is the volume that is being measured in. Lidars measure over a big volume compared to a sonic. Comparing sonics to lidar measurements, the sonics are more similar than cups. Cups have also issues, e.g. with overspeeding.

A consultant: a question to Reesa/Rozenn: We already have quite some evidence for ground-based lidar (GBL) vs met mast TI measurements and the level of overestimation of GBL. Do you have some preliminary estimates on TI measurements when it comes to nacelle-mounted lidar? Do we expect it to be more conservative compared to the GBL case, considering today's technology?

- Rozenn: DTU have done a lot of analysis of this. Nacelle-mounted lidar would be less conservative than GBL. It is not the same bias because it is measured into the wind and is aligned to the yawing of the turbine. There is no simple correction to correct the TI, we still need to find a proper way to do that.

A lidar supplier: a question to Rozenn: you mentioned we need to measure wind profile for PPT for large wind turbines. Could you elaborate on this point? Would it be used to normalize the power curve or to determine if the shear value is within the range of the warranty power curve?

- Rozenn: for me the ideal method would be to fulfill the requirements for rotor equivalent measurements. That means measuring at least at three heights, and at 2.5 D upstream.
- Q: can you give details on the near measurements that you talked about?
- Rozenn: I am being conservative. I doubt we have completely overcome the 2.5 D challenge, so I think at least we need to measure the profile in that distance in 5 years...

1.2 Working session

Time	Activity
15:00	Working groups: creative chaos to make progress on something
15:55	Break

63 participants were split into 10 groups based on the preferences indicated before the meeting and in the

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break. The working groups were not minuted directly, but the outcomes are available in the minutes for Day 3.

1.3 Networking session

Time	Activity
16:00	Networking session
16:55	Close

Three rounds of random breakouts with 3 participants in each room were held to finish the day. The day closed at 16:55 CEST

2 Day 2: Wednesday 21 October

Time	Activity
14:00	Panel session on "Wind lidar - I wish we knew how to...": • Mads V. Sorensen, EMD • Peter Rosenbusch, Leosphere • Zachary Parker, Nordex • Julia Gottschall, Fraunhofer IWES
14:55	Break
15:00	Working groups
15:55	Break
16:00	Community news: • Update from the "wind lidar in cold climate" working group (Nicolas Jolin, Nergica) • Update from the "wind lidar in complex terrain" working group (Alexander Stökl, Energiewerkstatt) • A possible new round-robin on forward-looking lidar Ti (Jens Riechert, DNV-GL)
16:45	Close

2.1 Panel discussion: 'Wind lidar - I wish we knew how to...'

We started with presentations from all panelists with their views of where the entire wind energy and wind lidar community have work to do. 52 people joined us for this session.

2.1.1 Presentations

Mads V. Sorensen: I wish I knew how to get most value out of short (e.g. 3 months) measurement campaigns

- in terms of TI, seasonality, shear
- why should one use a lidar if it is the same cost for 12 months than a mast
- why not use the full advantage of the lidar

Peter Rosenbusch: I wish WE knew how to…

- Eliminate the cup anemometer from the uncertainty budget
- Augment acceptance of ground-based lidars in complex terrain
- Establish nacelle lidar for PPT in complex terrain
- Optimize offshore WRA by combining floating lidar and lidar from the shore
- Establish best practice for site suitability with ground based lidars

Zachary Parker: I wish we knew how to…

- determine load assessment bias and uncertainty given remote sensing measurements
- validate, correct and use remote sensing data for load assessment → TI, shear and wind speed
- provide guidance from the turbine OEM perspective on the use (or not) of remote sensing

Julia Gottschall: I wish we knew how to…

- Do the optimal measurements (most likely with lidar)... in terms of chosen technology, setup, duration, requirements on accuracy and availability → what should we really measure?
- There are two necessary steps: 1, to understand application as well as possible and 2. to consider all possible data sources

2.1.2 Discussions

Many of the following questions and chat were taken verbatim from the video chat window. There have been some edits for spelling and clarity.

Question from Julia: Should we put a scanning lidar on a buoy?

- Peter Rosenbusch: I have no objections to this. We are involved in a research project. The definition of a scanning lidar is a device which can point the measurement to any point. A benefit of a scanning lidar is to be able to put it on the shore, or on the transition piece of a turbine.

From an industry researcher to Julia: Should we 'measure' turbulence using TI as currently defined involving the standard deviation over 600 second intervals, or is there some other way to 'measure' turbulence that would give a better input to models? Would TKE be better to use in conjunction with models?

- Julia asks back: is it easier to work on the measurements or on the models? I personally don't know. We should not force a lidar to work as a cup because it cannot. We should understand the models and the measurements better. We also need to consider the bankability and the industry. My conclusion is we should try all of this, even a small impact will have a larger impact in the future. We should not be happy with using a lidar with a standard TI.
- Researcher: the measurement people stay with what they know and same for the load assessment people. Both groups should work together better. I think the load assessment process will be very difficult to change as it is based on many years of understanding of how to calibrate the load models. The new way of lidar measurement would require to throw away the existing experience. In the short term, you should adapt the measurements. In the long term, you should adapt the process.
- Peter: the calibration of the models to a point measurement seems less perfect in light of always grow-

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ing turbines.
- Zachary: we see if we just use the lidar as a point measurement, we just get higher loads. We really need to understand first how to use the additional information.
- David Schlipf: a lidar can give you a much better estimate over the whole rotor area than a cup anemometer could.

From an industry engineer to Mads and the group: Do we have a method to 'long-term' correct standard deviation / TI...from 3 months to 1 or multiple years? How to get the most out of your measurements?

- Answer: Not really!
- Andy: this ties in to the presentations yesterday, especially from Reesa. We need to develop new tools, but the need for simple tools is very clear. We cannot treat this just as an academic problem, we need simple solutions.

From a researcher to Zachary: in one of the plots, I observed TKE from the cup anemometers. As the TKE requires u,v and w components, how do you measure the TKE from cup?

- Zach: when there is a only cups involved, we use the TKE information from the lidar measurements

Andy wants to come back if we get the most value out of a lidar or could we do better?

- Peter: I think we could do better. We are trying to optimize e.g. the position of the lidar. Do you have simulation tools to help you decide whether to put that?
- Mads: there are flow models that can help, but they come at a cost. If you're not sure you only start measuring at one point. I would like to take the idea of the modeling: to get the most out of lidar measurements, the effort should be on the modeling. E.g. you could throw information from several different measurements positions into a flow model and get better results.
- Zachary: the lidar can give you information on the stability, and this is very important to get the modeling right.
- Julia: There are a lot of statistics of the wind fields involved, it is not just the modeling that is a challenge. So we should invest a lot of work in both. German guidelines will stick to 12 months for site assessment. I think it depends on the site.
- Zachary: There are a lot of statistics coming out of the lidar, we should also look more at the raw data.
- Andy: We have made some progress in the last few years on measurements and modeling, but there is still a lot of work to do.

Folks who leave the meeting should do this..

- Mads: consider the measurement period
- Julia: understand what your colleagues want to use the data for
- Zachary: study colocated lidar and sonic data with 1Hz
- Peter: brainstorm how to use the flexibility that a lidar provides

2.2 Working session

Time	Activity
15:00	Working groups: creative chaos to make progress on something
15:55	Break

47 participants were split into 10 groups based on the preferences indicated before the meeting and in the break. The working groups were not minuted directly, but the outcomes are available in the minutes for Day 3.

2.3 Community news

Time	Activity
16:00	Community news: • The "wind lidar in cold climate" working group (Nicolas Jolin, Nergica) • The "wind lidar in complex terrain" working group (Alexander Stökl, Energiewerkstatt) • A possible new round-robin on forward-looking lidar Ti (Jens Riechert, DNV-GL)
16:45	Close

50 participants joined us for an update on our ongoing activities.

2.3.1 Update from the "wind lidar in cold climate" working group (Nicolas Jolin, Nergica)

Nicolas presented an update on the "wind lidar in cold climate" working group. The presentation will be made available online.

An industry researcher: how do you estimate the liquid water content from the CNR and how sure are you on your temperature profile? This would be very interesting.

- Nicolas: we do not have a clear method yet. We need to find the correlation of the data with icing. One solution could also involve machine learning. We do not have a clear measure to extrapolate temperature profiles.

Andy: What would a good data set look like that you could use?

- Nicolas: 10 minute lidar data, the type of lidar does not matter. 1-2 months of temperature, altitude information.

An industry researcher: what can we get out of CNR or the spectra that would help us with the question of liquid water?

- Paul Mazoyer: we did not work on that ourselves but with an institute that worked on detecting icing. There are things possible, but we have not commercialised them.

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- Chris Slinger: the raw spectra is recorded and by eye you can tell if it is raining. There should be methods using this. At DTU Ana Maria Tilk is working on blade erosion.
- Hans Jorgenson: Mikkel Seijhorn is working on this topic as well.

2.3.2 Update from the "wind lidar in complex terrain" working group (Alexander Stökl, Energiewerkstatt)

An industry researcher: regarding the question of how to quantify terrain complexity: Have you considered the methodology described in Section 11.2 in IEC 61400-1:2019? (this describes a method for "Assessment of the topographical complexity")

- Alexander: yes they are a starting point, they give you a lower safe limit, but they do not tell you how far to go.

An industry wind lidar user: What is the reason for correcting the data for 'the effect of complexity'?

- Alexander: There are several methods used for lidar data correction on a regular basis. One point is to have a look at the suitability of the methods and how they compare to each other on these kinds of sites. It would have been nicer to have a broader range of sites to compare. We compare met mast data with lidar data. What we want to know is how good we get when applying the correction to the lidar data.
- Andy: wind lidar in complex terrain sometimes gives different estimates of wind speed and direction than a met mast. This is a result of the windfield reconstruction not capturing the true properties of the wind field (e.g. by incorrectly assuming flow homogeneity)
- The user: alright, so the goal is to establish transfer functions between met mast and lidar.

An academic researcher: Where do the highest uncertainties come from when assessing lidar data in complex terrain?

- Alexander: you do not have a steady and homogeneous flow. When you decompose the signal from the different beams, you make an error because usually you use the assumption of homogeneity. If you use a flow model you can correct for it using a correction model.
- The academic researcher: the wind field reconstruction is giving you the highest uncertainty.
- Alexander: it is a complex problem!

2.3.3 A possible new round-robin on turbulence intensity estimations from nacelle mounted lidar systems (Jens Riechert, DNV-GL)

Jens presented details of a proposed round-robin.

Participants were polled to ask if they would be interested in participating in the round robin:

- Yes, actively: 5
- Yes, as an observer: 14
- No: 9

A problem with the Zoom polling tool prevented some people from indicating that they would actively participate in the round robin. It is estimated that at least 5 "yes, actively" votes were not counted, giving a total of 10 "yes, actively" votes.

Q: What datasets are you looking for?

- Jens: the idea is to have both a pulsed and also a CW lidar exists. So we would like to have a data set with simultaneous measurements with the same conditions.

3 Day 3: Thursday 21 October

Time	Activity
14:00	Panel session on "Wind lidar - the next generation": • Clym Stock-Williams, TNO • Sandrine Aubrun, ECN • Marijn Floris van Dooren, ForWind, Oldenburg • Sarah Barber, OST
14:55	Break
15:00	Working groups
15:55	Break
16:00	Reporting & next steps
16:45	Close

3.1 Panel discussion: 'Wind lidar the next generation'

We started with presentations from all panelists with their views of where the entire wind energy and wind lidar community have work to do. 52 people joined us for this session.

3.1.1 Presentations

We started with presentations from all panelists with their view of how the wind lidar and wind energy community should be teaching and training the next generation of wind lidar users. 53 participants joined us for this session.

Clym Stock-Williams, TNO

- Scientist in industry must know the limitations and assumptions of their equipment, especially for lidar systems
- Regular training courses on lidar related technology are needed targeted at industry professionals
- Data scientists and statisticians are largely missing from wind energy industry

Sandrine Aubrun, ECN

- Do not set meteorology and engineering sciences as opposites or exclusives in education programs - both subjects are important but are taught in different courses
- Better transfer of knowledge from the research community to the industrial end-users

Marijm Floris van Dooren, ForWind

- Should lidar theory and wind energy application be

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an integral part of uni programs?
- Do we need a lidar course for non-academic audience?
- existing european/international networks such as the european wind energy master and the ITN project LIKE push the expertise and exploitation of lidar and enhance diversity in the field

Sarah Barber, OST

- Improving diversity in wind energy science
- Why do we need to improve diversity? The workforce does not represent our population's diversity which results from inequality
- Why should I care? Diverse teams are more productive
- What can I do? Increase awareness, get clued up, observe and report discreminations

3.1.2 Discussions

Many of the following questions and chat were taken verbatim from the video chat window. There have been some edits for spelling and clarity.

Sarah to Sandrine: How should we set up those programs?

- Sandrine: We have to actively facilitate transfer of knowledge. This could be a task for the LIKE project.
- Peter Rosenbusch: I am very grateful for the collaboration between academia and industry. A technology workshop is ongoing. We are offering webinars at Leosphere, and are happy to do more of those.
- Marijn: There are two industry workshops planned in LIKE where the goal is to transfer knowledge between the groups. One project might not be enough though.

Andy to Clym: are we reaching enough people, or is the lidar community too small?

- Clym: it is great to hear that industry if offering courses. But the question is, if those courses also teach knowledge from competitor's technology. Wind field reconstruction is a very important topic as well that needs to be taught. And each device needs to be treated differently.

Question from the chat: Why is knowledge of wind energy not so open and accessible in online platforms like Coursera or EDX, compared to solar energy? I know this is something irrelevant to current discussion but I would love to hear from current members?

- From Sarah Barber (via chat): Hi [...], this is a really good question and very relevant to the topic, in my opinion. We at OST are actually involved in trying to solve this problem by building a wind energy collaboration platform including data and workflow sharing. I can tell you more about it in private if you are interested. Zachary - I wonder if a collaboration with IEA Wind Task 43 Digitalisation might be interesting for this? Data sharing and collaboration is a part of this task.
- From Sandrine: I think this is a very good idea. This should be the objective of the EAWE (European Academy for Wind Energy) or other academic institutions. Such a course could be the goal to be constructed.
- Sarah: there are not many wind energy courses. So it is not surprising that there is nothing online so far. The question might also be, if we need more of those basic courses
- Marijn: I agree, there are not many programs. In Oldenburg there are good courses, but this is not part of a specialization. The european master program (EWEM is a collaboration between TU Delft, DTU, NTNU, and the University of Oldenburg) is a successful example of how knowledge can be combined within Europe. But more combined or shared programs would be good.
- Clym: There might be a difference between solar and wind because solar is more for domestic use. A wind energy master would be extremely useful for a university. In Delft there is also a course that has to be paid for. In my experience the students from master courses have a broad knowledge. A basic bachelor knowledge and a master in wind is often not enough knowledge to go into research. The specialization should take place on PhD level.
- Andy: for lidar we need to come up with material that sums up the state of the art.
- David: Master students are often looking for topics but cannot find some. The Task 32 could offer to be a platform for advertising master thesis topics in the newsletter
- Zachary responded: Like the one I recently posted on Linkedin!

Question from the chat: This seems to be a matter of managing interfaces. Research sometimes needs to be seperate from industry to encourage innovation without certain limits, and then it needs to exchange at a certain point to be used practically. How can we use IEA Task 32 to guide/frame the interface?

- Marijn: indeed this interface is missing. Often practicalities make it very hard to test things or implement ideas
- Andy: We need playgrounds where industry and academia can meet safely on a legal basis.
- Sarah: we need a way for industry and academia to work together with common data. I think it is possible to have a platform or set up where this is possible.
- Andy: we are starting to ask questions about digitalisation of lidar. We will be spinning this up over the next year.

Question from the chat: LiDAR technology for wind originally came from the atmospheric boundary layer research community. Today, the wind energy science community is somehow "separated" (maybe not the right term) from the ABL research world (with some exceptions like the collaboration with DWD for WIPAFF). Do you think it would make sense to "reconnect" with the ABL met folks, for instance through projects like the EU PROBE COST Action? They have wind lidars too, but also use lidars for other things, and have other

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interesting tech like radiometers for instance. How much overlap do you think with those groups?

- Sandrine: I think this is exactly the idea which I had for the educational program which is split between earth sciences and engineering. A lot of people in wind energy a lot of people come from physics or earth science - so the link exists already but is probably not used enough or established.
- Andy: Often we are most comfortable to talk to people who are doing something similar. The Task 32 OA is trying to get involved with PROBE but this may take some time. We encourage everyone to get involved with other activities where they see links and share knowledge from, or with, Task 32.

Andy: This brings us back to diversity. Sarah brought up the point, that if you don't have the whole society represented, you do not get what you need. Do you think we are wearing a white western hat?

- Sarah: Well, you are wearing a white male, western european heterosexual hat. And that is unconscious. Everybody should be conscious about it.
- Andy: as white male engineers - what might I be doing that stops different people from engaging?
- Sarah: Starts with language. A lot of people refer to engineers as he. You might write a job description which focuses more on male behaviours. I had a job description myself recently with only male applications. And so the topic might be not written in an interesting way to appeal to female people.

Andy to all participants: what was your experience with trying to get a diverse applicant pool into your projects?

- Marijn: All universities tried to take care of diversity, and the ITN LIKE project is relatively diverse.
- Sandrine: in FLOAWER we tried to increase the percentage of accepted women compared to how many applied. The key element of selection was not the gender but the knowledge. We still managed to improve the percentage. I got feedback from positive discremination by being too many women in my group. Sometimes we are being used as representatives. For my career this was a positive aspect.
- Ines agrees: It is important to start early, e.g. At University of Stuttgart girls from school are introduced to science at an early age through the Try Science program.
- Clym: how can we help as a lidar community? My feeling for outreach work is that lidar is a very physical subject. Everyone experiences the wind, the magic of lidar ist that you can feel it. And this is inspiring. There is an african society which is also trying to foster diversity - so we should really try to reach out of our own borders.

An engineer (via chat): Hiring practices need to be less intuition based - see e.g., "Thinking Fast and Slow" Chapter 21, by Daniel Kahnemann. What role could IEA Task 32 really play in encouraging this?

- Sarah Barber: The first step is even getting people to accept that under-representation *is* a problem. Many people do *not* believe that something has to be done, because encouraging under-represented groups is seen as "positive discrimination" or discriminating *against* the white male.

Andy: What would the panel members like to provide as a 'take away'?

- Marijn: We as a lidar community should make sure that we provide a safe environment for everybody
- Sarah: Increasing diversity is something we can do every day - let's get started.

Task 32 action: we'll be looking at our activities again from the perspective of diversity and inclusion to make sure that we encourage and enable everyone to take part in the Task. If any of our members have comments, questions, or critique, please contact the Operating Agents.

3.2 Working session

Time	Activity
15:00	Working groups: creative chaos to make progress on something
15:55	Break

47 participants split into 8 groups based on the preferences indicated before the meeting and in the break. The working groups were not minuted directly, but the outcomes are available in the next section.

List of Participants

The presence of a person's name or company name in this list should not be taken to imply that that person or company agrees with any of the opinions set out in these minutes.

Name	Affiliation
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Steven Clark	NRG Systems
Andy Clifton	SWE, U. Stuttgart
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Reesa Dexter	DNV GL
Rémi Gandoin	C2Wind
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Julia Gottschall	Fraunhofer IWES
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Alexander Stoekl	Energiewerkstatt
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The International Energy Agency is an autonomous organisation which works to ensure reliable, affordable and clean energy for its 30 member countries and beyond. The IEA Wind Technology Collaboration Programme supports the work of 38 independent, international groups of experts that enable governments and industries from around the world to lead programmes and projects on a wide range of energy technologies and related issues.

IEA Wind Task 32 exists to identify and mitigate the barriers to the deployment of wind lidar for wind energy applications.

For more information: See the Task 32 website. **Author team:** Andrew Clifton (Task 32 Operating Agent, University of Stuttgart, Germany), David Schlipf (Task 32 operating Agent, Flensburg University of Applied Sciences, Germany). **Images:** Banner, left to right: Alexandre Debiève on Unsplash, SWE U. Stuttgart, Markus