

22 December 2016

## Minutes of the IEA Wind Task 32

### General Meeting 2016

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Date: December 15-16 2016

Venue: University of Strathclyde, Glasgow, UK

Minutes by Ines Würth, Florian Haizmann, David Schlipf

#### Agenda

##### Day 1

- 8:30 Arrival with coffee
- 9:00 Welcome/Introduction to IEA Wind Task 32 Phase 2 (David Schlipf) + Introduction Round
- 9:30 **What was the outcome of Phase 1?**
  - General review of Phase 1 (Davide Trabucchi)
  - Technical report: [Remote Sensing of Complex Flows by Doppler Wind Lidar: Issues and Preliminary Recommendations](#) (Andrew Clifton)
  - Expert report: [Estimating Turbulence Statistics and Parameters from Ground- and Nacelle-Based Lidar Measurements](#) (Ameya Sathe)
  - State-of-the-Art report: [Recommended Practices for Floating Lidar Systems](#) (Julia Gottschall)
- 10:30 Coffee break
- 11:00 **Identifying and mitigating barriers in 2016**
  - Results from Workshop #1 (Julia Gottschall)
  - Results from Workshop #2 (Eric Simley)
- 12:00 Lunch break
- 13:00
  - Results from Workshop #3 (Davide Trabucchi)
  - Results from Workshop #4 (Luke Simmons)
- 14:00 **What's new in the world of wind lidar?**

Results of recent research projects

  - UniTTe (Rozenn Wagner)
  - Scanning Lidar: Dublin Bay experiments (Michael Stephenson)
  - US Lidar Activities (Andrew Clifton)
  - News from the Anwind Project (David Schlipf and Florian Haizmann)
- 15:00 Coffee break
- 15:15 OpenLidar
  - Concept (Ines Würth)
  - Moderated discussion (Andrew Clifton)
- 16:00 **Let's talk!**

Poster Session with beer reception (details below)
- 17:30 End of Day 1
- 19:30 Joint Dinner

## Day 2

- 9:00 **What's new in the world of wind lidar?**  
Results of recent advances in lidar technology
- TI measurements (Paul Mazoyer)
  - Verification Protocol (Peter Clive)
  - Turning the tables: use of lidar to troubleshoot masts (Michael Harris)
  - A compact Doppler lidar for controlling the operation of wind turbines (Rainer Reuter)
- 10:00 Coffee break
- 10:15 **Identifying and mitigating barriers in 2017**
- Review and discussion of workshop strategy (David Schlipf)
  - Presentation on suggested workshop concepts (details below)
- World Cafe: group discussions for the four different application areas: do the suggested topics address the relevant barriers or do we need others?
- 12:30 Lunch break
- 13:30
- Presentation of results of World Café (Moderators)
  - Voting for new workshop topics
- 14:45 Next steps
- 15:00 End of General Meeting

## Minutes – Day 1

<b>9:00</b>	<b>Welcome/Introduction to IEA Wind Task 32 Phase 2 (David Schlipf) + Introduction Round</b>
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- David welcomes the participants and gives an introduction to Task 32
- Participants introduce themselves

<b>9:30</b>	<b>What was the outcome of Phase 1?</b>
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- General review of Phase 1 (Davide Trabucchi)
- Technical report: [Remote Sensing of Complex Flows by Doppler Wind Lidar: Issues and Preliminary Recommendations](#) (Andrew Clifton)
  - Goal was to establish ways to document the use of lidar in complex flow, and compare experience across groups
  - Complex flow is defined using a range of quantitative indicators
  - Once complex flow is expected or suspected, users should check that they are using lidar appropriately
  - A range of use cases were presented
- Expert report: [Estimating Turbulence Statistics and Parameters from Ground- and Nacelle-Based Lidar Measurements](#) (Ameya Sathe)
  - Conclusions from TI Study show that statistical parameters from lidar measurements are not directly comparable to sonic reference
  - Converging beam method is a method to improve TI measurements, however the probe length is still there. CW lidars are preferable here
  - There is no update or extension of the document planned so far.
  - The route forward for TI:
    - As developer nacelle lidars for TI statistics are interesting. Also coherence measurements would be interesting.
    - Estimating TI from floating lidars should be researched.
    - Recommended practice document, i.e guidelines for IEC and industry
- State-of-the-Art Report: [Recommended Practices for Floating Lidar Systems](#) (Julia Gottschall)

<b>11:00</b>	<b>Identifying and mitigating barriers in 2016</b>
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- Results from Workshop #1 (Julia Gottschall)
  - Bankability from banks was not checked in the survey as they have not been part of the stakeholder group.
  - TI assessment is important for the design of wind turbines. However, TI of FLS issue still has to be solved -but FLS show very good results in terms of average wind speed.
  - FLS are planned to be used for power performance tests and there are ongoing studies. Costs will finally play a major factor when deciding if FLS measurements are used for that application.
- Results from Workshop #2 (Eric Simley)
  - Questions?
- Results from Workshop #3 (Davide Trabucchi)
  - Sandia will make lidar data available, met tower data and some turbine data available. DOE has made sharing data a priority. See <https://a2e.energy.gov> and <https://a2e.energy.gov/data>.
  - The future of lidar wake measurements is both, in the planning or operational side of wind farms. Ideas for measurements and lidar application:
    - Wake redirection check with long range lidar scanner (Operation)
    - Low cost lidar to track the wake (Operation)
  - Wake models are not developed in Task 32 but in Task 31. Each participating institute has its own wake model. For control you need a simplified wake model, which can be detected with a low cost wake model.
- Results from Workshop #4 (Luke Simmons)
  - There are various explanations for the significantly higher uncertainty of the REWS but it is clear that it is the outcome when the standard is followed. One reason is the high calibration uncertainty of the lidar. However, REWS is still the most interesting for commercial application.

<b>14:00</b>	<b>What's new in the world of wind lidar?</b>
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Results of recent research projects

- UniTTe (Rozenn Wagner)
  - The difference between the two lidars for the relative AEP difference to IEC mast cannot be explained very well yet.
- Scanning Lidar: Dublin Bay experiments (Michael Stephenson)
- US Lidar Activities (Andrew Clifton)
- News from the Anwind Project (Florian Haizmann, Holger Fürst, and David Schlipf)

<b>15:15</b>	<b>OpenLidar</b>
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- See presentation at [www.ieawindtask32.org](http://www.ieawindtask32.org).
- See also [www.openlidar.net](http://www.openlidar.net) for more details.
- Questions
  - What about eye-safeness? What about safety? (Theodore Holtom)
  - What have you done so far? Have you involved any people with optics knowledge? (Julia Gottschall)
  - How would it work? Would you propose e.g. 10 systems one could then obtain? (Sarah Koller)
  - I really like the cooperative work. But what is the benefit for manufacturers to get them involved? (Detlef Stein)
  - What's your assessment on how to handle IPR? (Benny?)
  - A lot of lidar evolvement has come from this community. So let's do some fun things together! (Matt Smith)

- Analogy from automotive industry: all cars are basically different ways of packaging and presenting the same underlying components. Makes sense to compete there, rather than setting up competing supply chains. (Paddy)
- Presentation of Starter Kit
- Kahoot.it
  - What's your favorite Measurement Device? 17 – 2 – 1 – 6
  - Would you buy one?
    - Yes:13
    - No: 9
    - No, I'd buy 3: 4
  - What is the starter kit worth to you? (€)
    - <10,000: 15
    - 10,000-20,000: 7
    - 20,000-50,000: 4
    - > 50,000: 1
- Andy: What is it that reduced the value of this for you?
  - The way the question was asked, starting from low price. (Matt Smith, Eva Schmitt)
  - We as IWES are kind of satisfied with what we get from industry. (Julia Gottschall)
  - What you be willing to pay 20 000 – 50 000? (Matt Smith) -> about 10 hands

## Minutes – Day 2

<b>9:00</b>	<b>What's new in the world of wind lidar?</b> Results of recent advances in lidar technology)
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- TI measurements (Paul Mazoyer)
  - Question: Is it possibly that Lidars actually measure the TI better than Cups compared to what the Turbine experiences (both sample a volume)? (Paddy)
    - > Seems to be an interesting way of thinking of it. From wind turbine control we see something similar: It is the change in the rotor-effective/rotor-equivalent that drives the loads and it is the same for a rotor-effective/equivalent TI. But it is unclear if and how this could be measured and whether industry would accept it instead of the cup TI.
- Verification Protocol (Peter Clive)
  - Comment: It's very good and very nice. A lot is about black and white boxes. It seems you have a choice between the white and the black box, but often you don't have the choice in reality. So does it make sense to go to the white box all the time? (Julia Gottschall)
  - Question: Isn't the important thing that the reference is a white box? (Theodore Holtom)
    - > No, because ... (Andy Clifton)
- Turning the tables: use of lidar to troubleshoot masts (Michael Harris)
  - Comment: We are involved in several mast troubleshooting projects. (Peter Clive)
  - Comment: We as an offshore developer see this development very promising. (Ameya Sathe)
  - Question: How do we cope with the availability issues of lidars (especially offshore)? (Ameya Sathe)
    - > Current availability is pretty high at the moment.
  - Question: What ways of monitoring do you have to ensure lidar availability?
    - > A lot – as long as communication to the lidar is possible.

- How can we show that lidars are more accurate than cups? How can we close the gap and convince people that lidars are inherently more accurate than cups? We have an ongoing project with Carbon Trust to work on this issue. (Detlef Stein)
  - > The uncertainties of a staring system are extremely well understood, so 3 staring lidars (slide 7) could be a possible path. Wind tunnels are probably much more expensive than 3 lidars.
- Is there a way to coordinate between those who have the products and those who have planned activities around these questions? (Julia Gottschall)
- A compact Doppler lidar for controlling the operation of wind turbines (Rainer Reuter)
  - Question: How did you know the exact speed of the belt? (?)
    - > Conventional measurements with photoelectric barrier
  - Comment: The SWE scanner shows the same behavior of favoring the discrete bin of the FFT. Probably this has been improved in later versions of the WindCube. (David Schlipf)
    - > Yes. (Paul Mazoyer)

#### 10:15 Identifying and mitigating barriers in 2017)

- Review and discussion of workshop strategy (David Schlipf)
  - Comment: If we as a group want something else, we need to come up with a different concept. (Andy Clifton)
  - Comment: ...(Davide Trabucchi)
  - There were different ideas. (Julia Gottschall)
  - DS: Do we want to have these big events or more focused workshops with less people?
  - IW: I think it works out, it is fine. The group discussions worked out quite well.
  - Ameya: But have there been concrete conclusions and outcomes from the group discussions?
- Presentation on suggested workshop concepts (various)

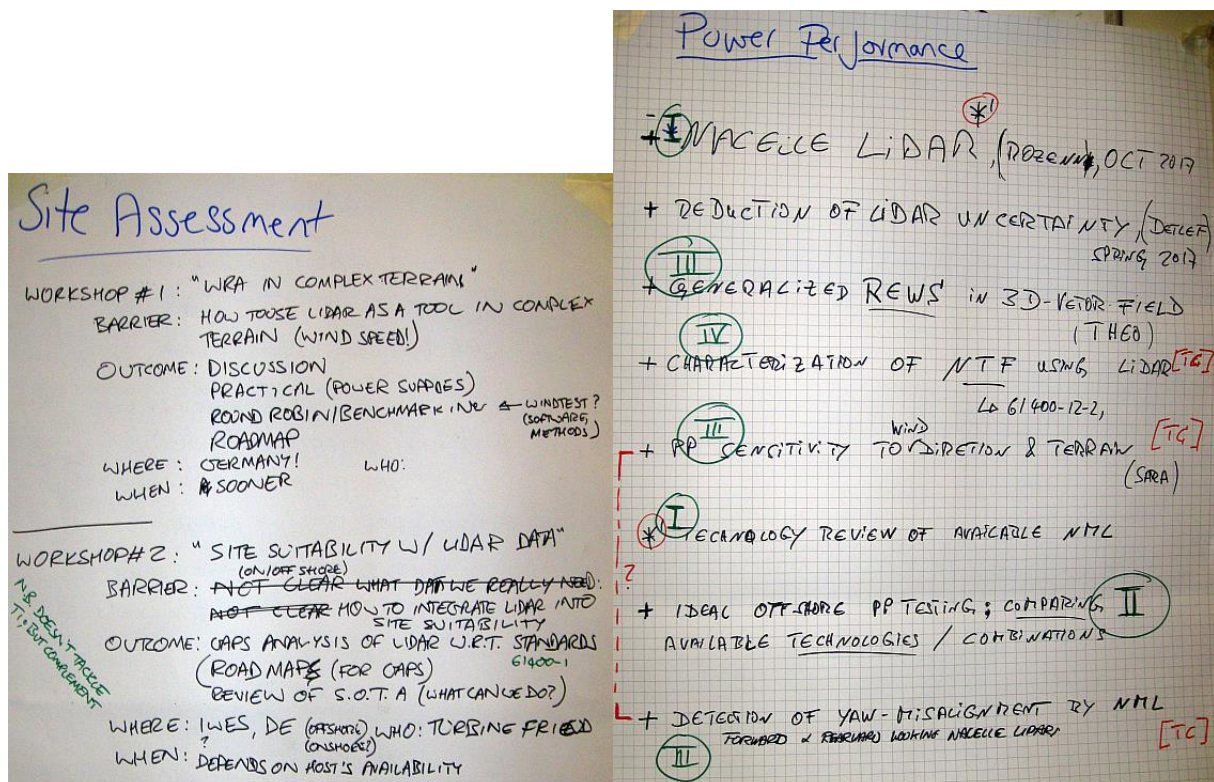


Figure 1: Workshop topics Site Assessment and Power Performance.



## Loads and Control

1. Load Verification using Lidar <sup>second</sup>
2. Best Practices for Certification with LAC <sup>first</sup>
3. Correcting LAC to LCOE <sup>second</sup>
4. Estimating Turbulence with Lidar <sup>first</sup>

④ Steps: - Wait for JIP outcome  
- Dong → DTU

③ Steps: - Wait for T37 to set up  
- Baseline Case (T3 only)  
- Download + add Lidar + DTU  
- V&S: Discuss results

General: - We still don't know, which Point WFC are important  
- Improve traditional / turbulence parameters / definitions to measure

① Steps: - Complete WS TI  
- Commit to T30

② Steps: - Commitment from Catia (ask)  
- Working for 2016 - WLS Time for

General: - We need someone in the Orga Point: - Teams understanding Loads

General: - We need a certifier in WS Orga Point: - Model for Reliability / Availability

General: - twisted WS?  
- Outcome: Project Proposal  
- KPI for WS might be helpful

## Complex Flow

- ① SOPHISTICATED & RARE WIND FIELD RECONSTRUCTION INTEGRATING MODELS & MEASUREMENT SEAMLESSLY FOR HIGH FREQ DATA  
- BARRIER - ?
- ② CONTINUITY OF COMPLEX WIND ASSESSMENTS WITH SIMPLE ESTABLISHED STANDARDS & PROCEDURES - E.G. STAND-1 VARIOUS COMPLEX FLOW (INC. HIGH FREQ. DATA?)  
- BARRIER - LACK OF ADOPTION BECAUSE UNCLEAR HOW MEASUREMENTS RELATE TO STANDARDS
- ③ LIDAR ASSESSMENTS OF EXTREME EVENTS & COMPLEX SHEAR (THIS COULD ALSO INFORM ②), I.E. EWM MODIFICATION IN LIGHT OF LIDAR DATA  
- BARRIER - SAME AS ② - MAKING LIDAR RELEVANT TO EXISTING STANDARDS (EWM BOTH WAYS)
- ④ SCANNING LIDAR IN COMPLEX TERRAIN / INS. MULTILIDAR, THIS CAN  
- LLJ's / MODEL VALIDATION & VIOLATION (E.G. FLOW SEPS)  
- ELABORATION OF USE CASES, GAP  
- TIES IN WITH ANALYSIS  
- VERIFY PROTOCOL  
- BARRIER - DEVELOPING EXTENDED, SPECIFIC DETAILED USE CASES FOR PARTICULAR PROBLEMS TO "UNLOCK VALUE OF LIDAR"
- ⑤ COMPLEX FLOW COMPENSATION - INC. FCF, MULTILIDAR, CFD OR ALGEBRAIC APPROXIMATIONS  
- BARRIER - USE IN COMPLEX TERRAIN
- ⑥ DYNAMIC WAKE MEASURING WITH LIDAR  
- BARRIER - WHAT IS THE WAKE? DEFINE WAKE  
- CAPTURING SMALL SCALE STRUCTURES  
- DEVELOP SYSTEM THAT WORKS UNDER DIFFERENT ATMOS STAB. CONDYS

Figure 2: Workshop topics Loads and Control and Complex Flow.

## Out-of-the-Box

- Fitting Lidar Data
  - Gathering different methods (Statistical Analysis, CNR Based)
  - Definition of fitting criteria for different application and relation to methods
  - Concept: Round Robin with common data set
  - Outcome: Exchange of experience, review of methods
  - Report
- Lidar Verification (?) Protocol
  - Increase of trust in measurements by following a protocol
  - Precise the document and discuss a step-by-step approach for simple and complex use case (wake measurements)
  - Concept: Gather approaches beforehand and consider them on workshop
  - Discuss especially for complex use case
- Long-term & some measurements for short-term power predictions (730m)
  - Close the gap between NWP
  - Grid operators need that knowledge
  - Correction to ICA Task 36
- OpenLidar
  - Application Areas of OpenLidar and to define "Specification"
  - Look into similar projects on a basis
  - Discuss applications and opportunities of a status list
- Uncertainty Reduction
  - Simulating the Lidar measurement accurately
  - Definition of the wind energy for the application for wind energy have to be changed?
  - Come up with a Road map (how are the measurements used (loads, design, control) & how can the standard be changed therefore)
  - Discuss with other ICA Tasks!
  - Outcome: Research project? (e.g. comparison of actual load measurements with different models with different wind speed models (new model needed))

Figure 3: Workshop topics Out-of-the-Box.

- A world café discussion takes place to discuss workshop topics for 2017.
- Presentation of results of World Café (Moderators) & Voting for new workshop topics

- Voting results from the present participants are given in () following each workshop proposal.
  - 1) Site Assessment
    - a. WRA in complex terrain (14)
    - b. Site suitability with lidar data (7)
  - 2) Power Performance
    - a. Nacelle lidar (9)
    - b. Ideal offshore power performance testing (6)
    - c. Characterization of nacelle transfer functions (NTF) using lidars (4)
    - d. More realistic definition of REWS (2)
  - 3) Loads and Control
    - a. Load verification using lidar (7)
    - b. Estimating turbulence with lidar (6)
    - c. Best practices for certification with Lidar-Assisted Control (3)
    - d. Connecting LAC to LCOE (3)
  - 4) Complex Flow
    - a. Integration of wind models & measurements (discussion forum) (7)
    - b. Elaboration of use cases (5)
    - c. Verification of dynamic wake meandering with lidar (4)
    - d. Application of lidar measurements in accordance with standards (2)
  - 5) Out of the box
    - a. Lidar uncertainty reduction (7)
    - b. Lidar data filtering (6)
    - c. OpenLidar (5)
    - d. Lidar verification protocol (2)
- General Feedback to the voting tool:
  - Several people say yes.
  - It was totally confusing and for really choosing a topic out of that lot of information it needs more time.
  - Very useful tool to get a first impression from all, instead of just letting the usual suspects decide.
  - It might be useful to add an option like “I don’t care”.
  - It might be useful to have a doodle, where people can change their mind according to majority.

<b>14:45</b>	<b>Next steps</b>
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- The advisory board will discuss about the workshops for 2017 and consider the discussions from the GM
- Please have a look at the website. You find a lot of stuff there (minutes from the advisory board, IEA Docs, task relevant publication list). And if you have any interesting news or relevant publications please let the OA know and that can be set up in the websites news section.
- The slides and minutes and photos will be uploaded to the task’s website (password protected: BeamMeUp)
- The website also features a forum, where general questions can be posted and answered.
- Thanks for coming! Thanks for contributing! Thanks for all support in the organization of the GM! Have safe travels back home.

## Participation List

Name	Country	Institution
Adrian How	UK	SSE
Ameya Sathe	Denmark	DONG Energy
Andrew Clifton	USA	NREL
Bruno Declercq	Belgium	Engie Lab
Cédric Arbez	Canada	TechnoCentre Éolien
Cristoph Tiefgraber	Austria	energiwerkstatt
David McCracken	UK	SSE
David Schlipf	Germany	SWE University Stuttgart
Davide Trabucchi	Germany	ForWind - Univeristy of Oldenburg
Detlef Stein	Germany	DNV GL
Ellie Weyer	USA	AWS Truepower
Eric Simley	USA	Envision Energy
Eva Schmitt	Germany	windtest grevenbroich
Fabrice Guillemin	France	IFP Energie Nouvelles
Florian Haizmann	Germany	SWE University Stuttgart
Fotis Kokkalidis	Greece	CRES
Frank Scheurich	Denmark	Siemens
Gibson Kersting	USA	E.ON
Gordon Barr	UK	SSE
Holger Fürst	Germany	SWE University Stuttgart
Hu Wei	China	Goldwind
Ines Würth	Germany	SWE University Stuttgart
Inhaeng Kim	South Korea	Jeju Energy Corporation
Ioannis Antoniou	Denmark	Siemens
Jochem Vermeir	Belgium	Tractebel Engie
Jonathan Hughes	UK	ORE Catapult
Julia Gottschall	Germany	Fraunhofer IWES
Kyungham Ko	South Korea	Jeju University
Lee Cameron	UK	RES
Luke Simmons	USA	DNV GL
Matt Smith	UK	ZephIR Lidar
Michael Harris	UK	ZephIR Lidar
Michael Stephenson	UK	Carbon Trust
Minsang Kang	South Korea	Jeju Energy Corporation
Patrick Jones	UK	NEL
Paul Kühn	Germany	Fraunhofer IWES
Paul Mazoyer	France	Leosphere
Peter Clive	UK	SgurrEnergy Ltd
Reiner Reuter	Germany	ForWind - Univeristy of Oldenburg
Ross Tyler	USA	Business Network for Offshore Wind
Rozenn Wagner	Denmark	DTU
Sara Koller	Switzerland	Meteotest
Seán Hayes	Ireland	Mainstream Renewable Power
Simon Toft Sorensen	UK	Fraunhofer Centre for Applied Photonics
Stefan Goossens	Netherlands	Vattenfall
Theodore Holtom	UK	Wind Farm Analytics
Wang Haibin	China	Goldwind
Wei Yufeng	China	MingYang