University of Stuttgart
Stuttgart Wind Energy (SWE)
@ Institute of Aircraft Design

Towards Recommended Practices for Floating Lidar Systems

EERA DeepWind'2017

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SWE

WindForS
Windenergie
Forschungscluster

Introduction

Wind lidar technology…

onshore – accepted as (almost) standard tool

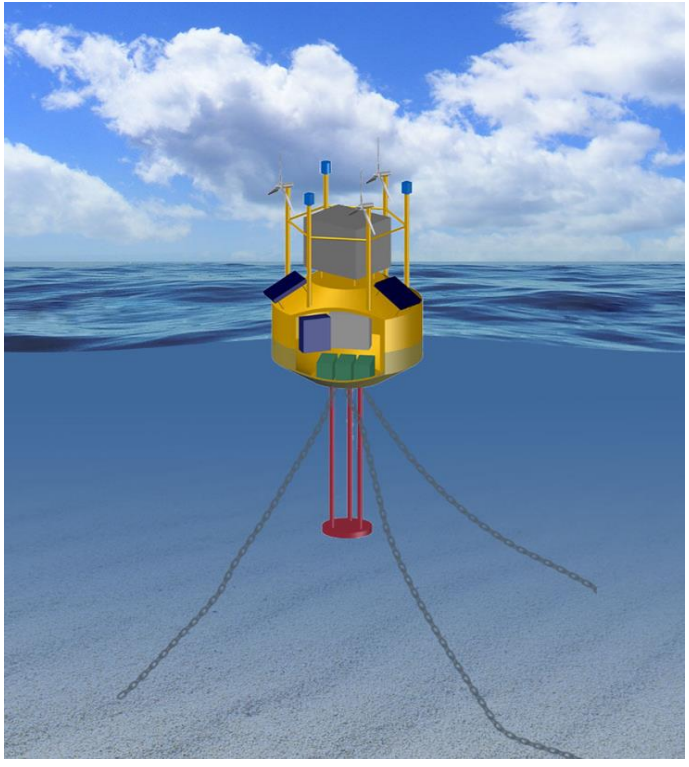
… for wind resource assessments

… power curve tests (in flat terrain)

→ cost-efficient, high data quality

Introduction

Wind lidar technology…



onshore – accepted as (almost) standard tool

… for wind resource assessments

… power curve tests (in flat terrain)

→ cost-efficient, high data quality

offshore – even larger cost benefits (!) –

with lidar devices integrated in / on top of

floating platforms or buoys, resp.

(→ *floating lidar systems*)

What is needed for a succesful operation of Floating Lidar Systems (FLS)?

Variety of concepts and designs available today
(→ picture gallery *and others*)

[Flidar, Fugro Seawatch, SeaZephIR]

Open Questions

- Recommended configuration, mandatory and optional features?
- Requirements of wind industry on systems?
- Maturity of technology
- Present technology gaps?

→ **Need for standards or recommend practices (RP)**

→ **IEA Wind Task 32 activities**

+ Carbon Trust OWA activities

Step 0: OWA Roadmap – commercial acceptance of floating lidar

→ *Carbon Trust Offshore Wind Accelerator roadmap for the commercial acceptance of floating lidar technology* (Nov. 2013) …

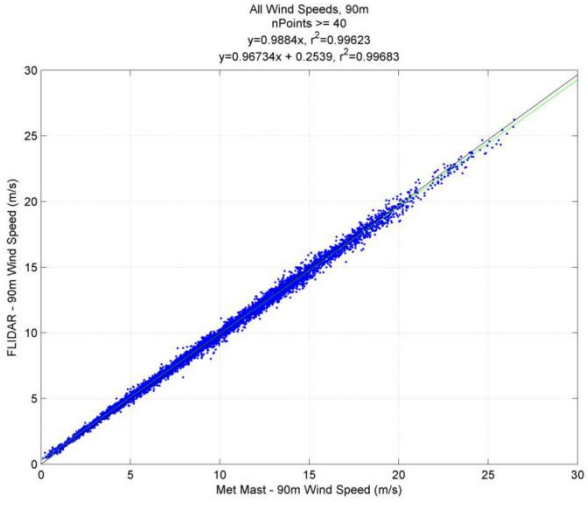
proposed three stages of maturity:
baseline – pre-commercial – commercial

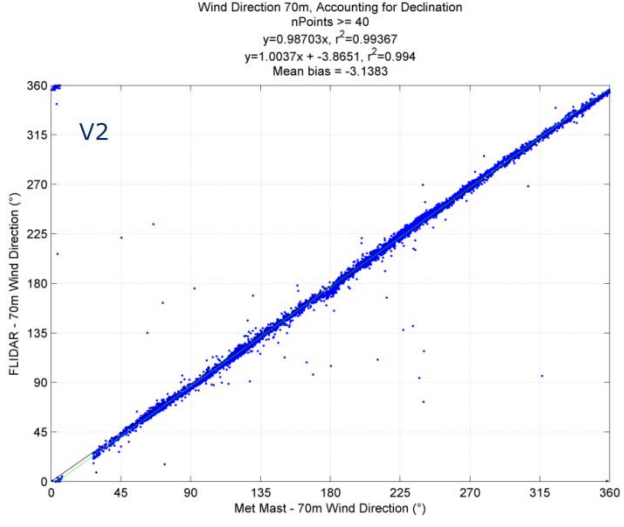
status linked to a successful (6-months) trial offshore:
meet KPIs for system availability and data accuracy

Step 0: OWA Roadmap - FLiDAR application example

→ *Carbon Trust Offshore Wind Accelerator roadmap for the commercial acceptance of floating lidar technology* (Nov. 2013) …

[Flidar]



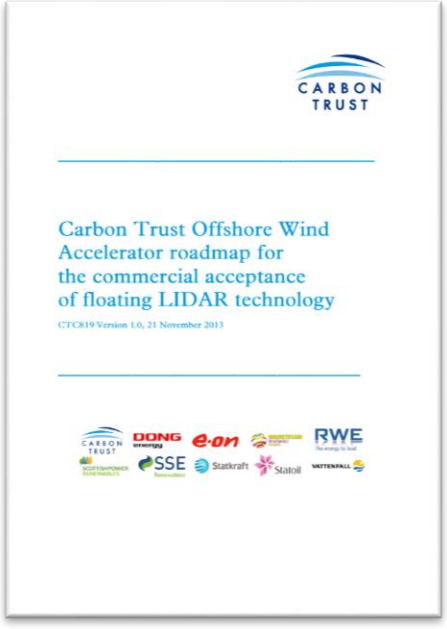


First (almost) pre-commercial floating-lidar system (FLS)

Results of 3-months trial at Gwynt y Mor [presented at EWEA Offshore 2013] show convincing agreement with met mast in wind speed and direction

Step 0: OWA Roadmap - Final document

→ *Carbon Trust Offshore Wind Accelerator roadmap for the commercial acceptance of floating lidar technology* (Nov. 2013) …



Today several FLS with status ‘pre-commercial‘ from different providers, a few more in the pipeline and some even on the way to commercial status

Status ‘commercial‘ gains in importance but is not yet fully defined.

[Axys, IWES, EOLOS]

Online available:
https://www.carbontrust.com/resources/reports/technology/owa-roadmap-for-commercial-acceptance-of-floating-lidar-technologies

Step 1: IEA Wind Task 32 Phase I WP 1.5 – first step towards Recommended Practices

- IEA Wind Task 32 Phase 1 WP 1.5 on Floating Lidars (initiated in Nov. 2012, 2nd General Meeting in Oldenburg)
- Two actions:
  - create **technology review** document
  - collect **recommended practices** (RP) and prepare document

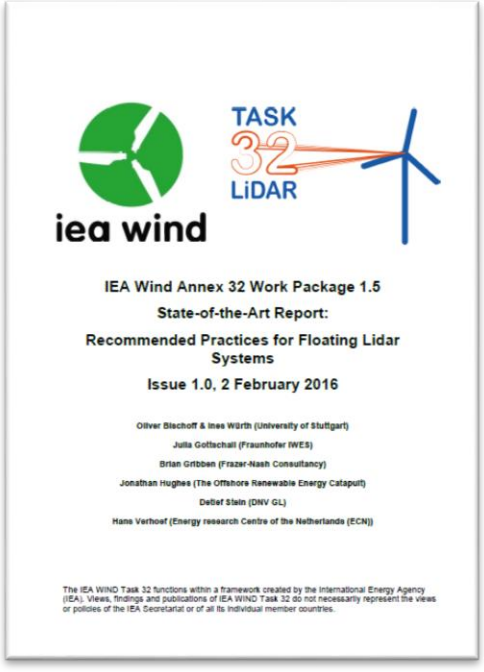
further discusssions in 2013, start of document production in 2014; formation of author and review groups, focus on RP document

Good progress by end of Phase 1
collected recommended Practices (RP) at this stage published as state-of-the-art report early 2016

Step 1: IEA Wind Task 32 Phase I WP 1.5 - State of the Art Report

State-of-the-Art Report: Recommended Practices for Floating Lidar Systems

(Issue 1.0, Feb. 2016)


IEA Wind Annex 32 Work Package 1.5

State-of-the-Art Report:

Recommended Practices for Floating Lidar Systems

Issue 1.0, 2 February 2016

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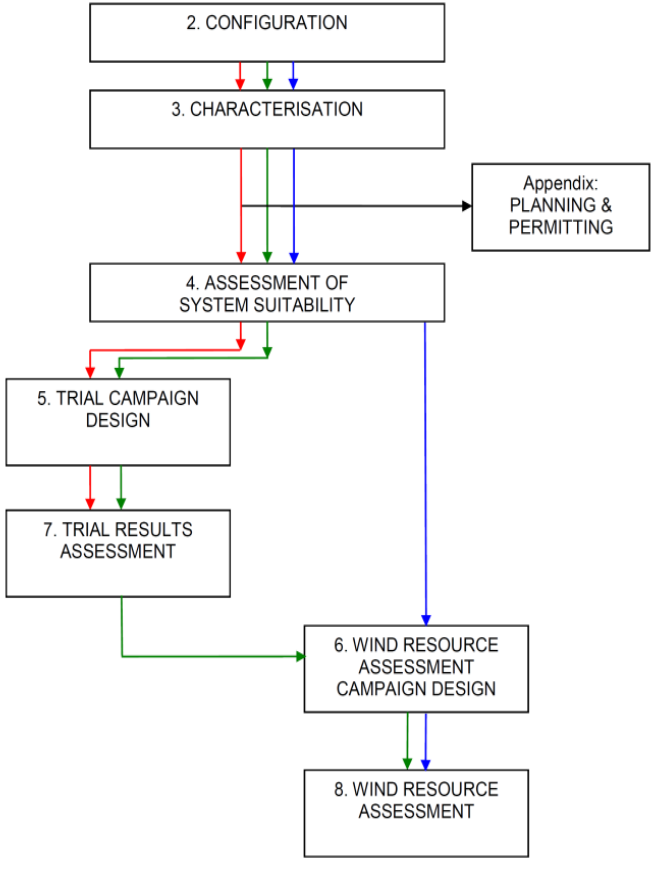
The IEA WIND Task 32 functions within a framework created by the International Energy Agency (IEA). Views, findings and publications of IEA WIND Task 32 do not necessarily represent the views or policies of the IEA Secretariat or of all its individual member countries.

in total 113 RPs
and a number of notes,
all with focus on
performing wind resource
assessment with FLS

High interest of OWA (Offshore Wind Accelerator) partners in already before publication of document

available online:
http://www.ieawindtask32.org/download/task32documents/



Step 2: OWA Carbon Trust project - Topics

Call for project aiming at further development of RP document, awarded to IEA Wind author team led by Frazer Nash Consulting (FNC)

→ worked on update of report between autumn 2015 and summer 2016

→ 2 workshops with stakeholders OEM‘s etc.

Topics priorized by workshop participants

- Developing a useable uncertainty framework.
- Guidance on mooring design and assessment
- Making the document more accessible and useful by improved use of drawings and schematics
- Standards for trusted reference system
- Pre-deployment verification - more detailed guidance on when and how much.
- Representativeness / comparisons of wave climates.
- Introduce wind shear as a KPI.

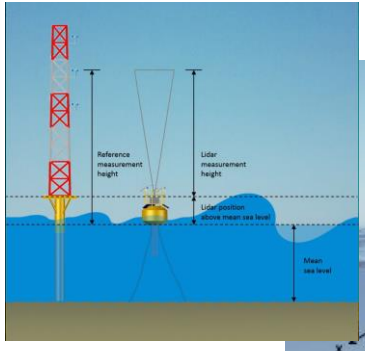
+

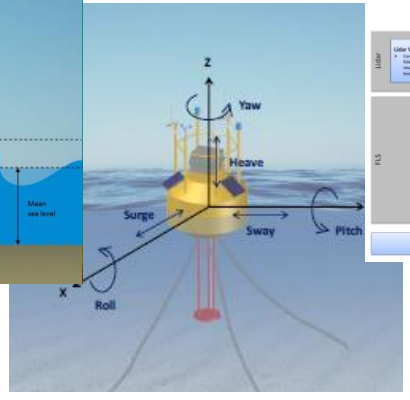
Extensive review process
- author team
- review team
- OWA stakeholders review

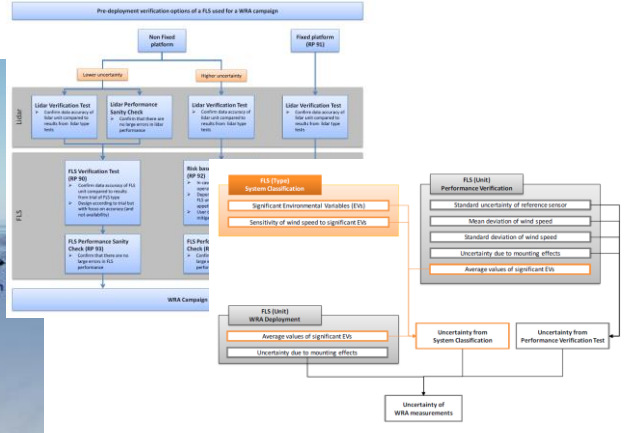
Step 2: OWA Carbon Trust Project – update of state of the art report

OWA Recommended Practices for Floating LiDAR Systems
Issue 1.0 25 October 2016

in total **120 RPs** and some more notes, all with focus on performing wind resource assessment with FLS
+ **figures**
+ uncertainty framework (!)







Online available:
https://www.carbontrust.com/resources/reports/technology/owa-floating-lidar-recommended-practice/

Step 3 IEA Wind Task 32 Phase II - Assessment of stakeholder acceptance

Pre-workshop survey:
answered by participants (incl. OEMs, Consultants, Project developers, Academics)

How would you rate the present level of maturity (in TRL 1-9) of floating-lidar technology in general?

Answer: between TRL 4 and 9 – average 6.9

How do you judge the current acceptance (0 = not at all, 10 = fully) of FLD data to be used quantitatively for finance-relevant wind resource assessments?

Answer: between 2 and 8 – average 5.8

How long will it take for the technology to reach full commercial acceptance?

Answer: 4 out of 18 ‘already reached‘, others between 2 and 10 years

Discussion of questions

→ *IEA Wind Task 32 Phase 2 Workshop on Floating Lidar Systems (23-24 Feb. 2016 at ORE Catapult, Blyth)*

Step 3: IEA Wind Task 32 Phase II - Identification of technology gaps

Outcome of workshop:

Gap 1: well defined uncertainty framework for FLS wind speed measurements

Gap 2: increase of investors‘ confidence (with appropriate further stakeholder activities)

Gap 3: re-defined validation framework (scope, reference, possibly adjusted to use case)

Gap 4: alternative approaches for validation (?)

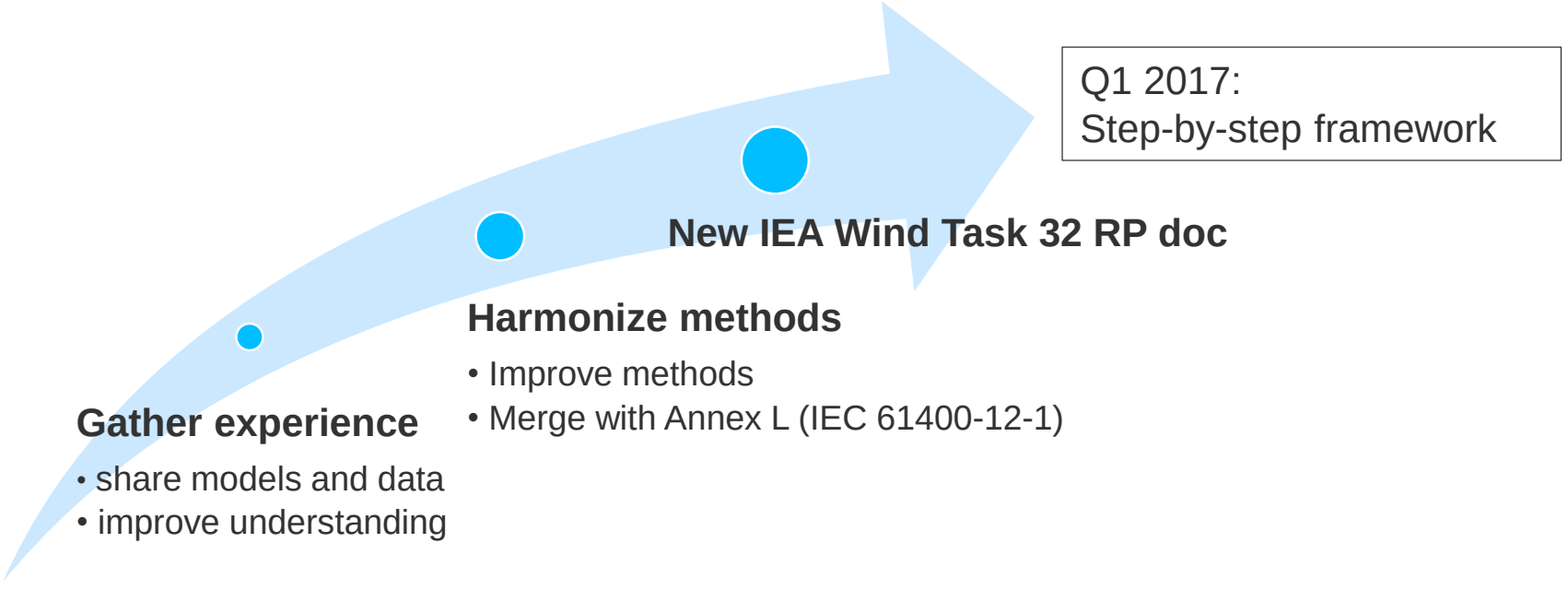
Gap 5: turbulence intensity (TI) measurements from FLS (transfer of existing knowledge from Lidar TI data, and further work)

→ **Definition of roadmaps to close the gaps**

Step 3: IEA Wind Task 32 Phase II - Example ‘uncertainty framework‘

‘Roadmaps‘ for gaps/requirements as result from group work

e.g. for Gap 1 – ‘uncertainty framework‘:

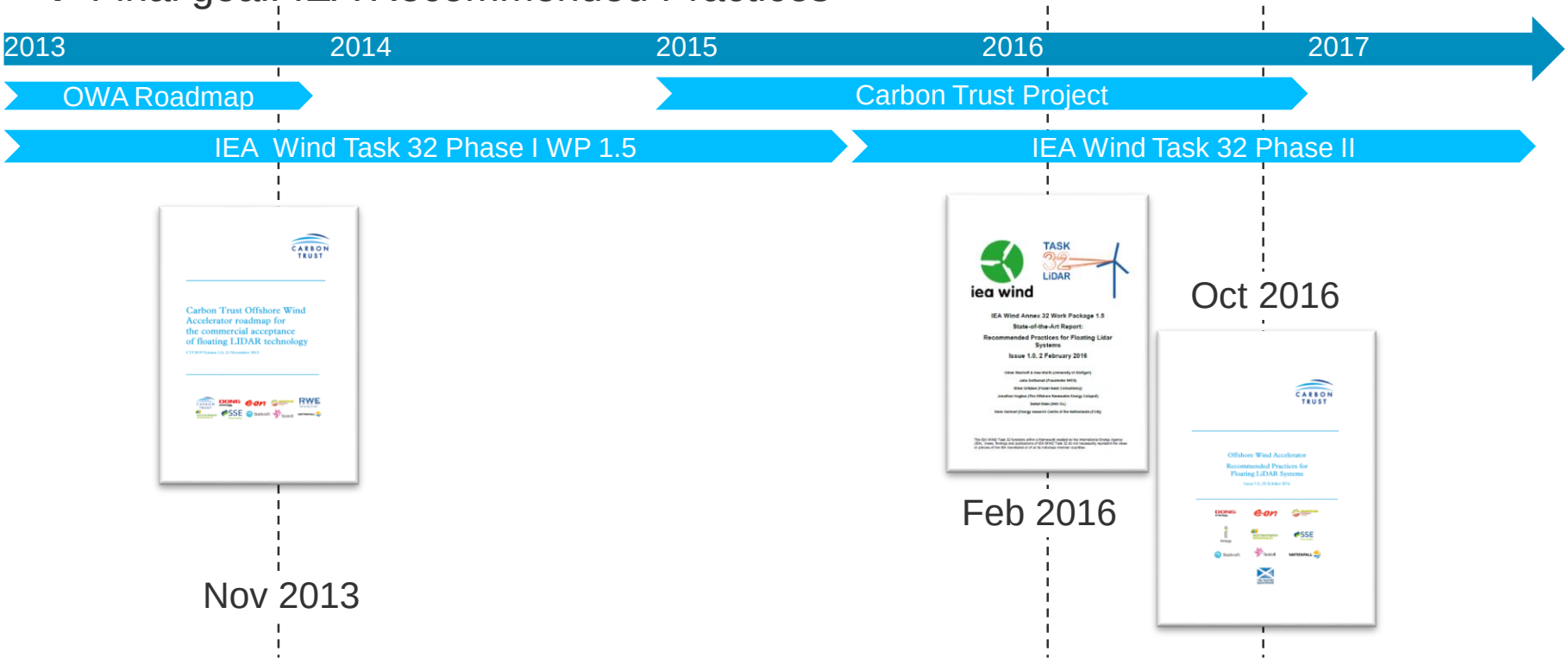


Overview about currently available documents

Different projects & work in the field of Floating Lidar Systems (FLS) since 2013

→ Outcome: 3 relevant documents regarding commercial use of FLS

→ Final goal: IEA Recommended Practices



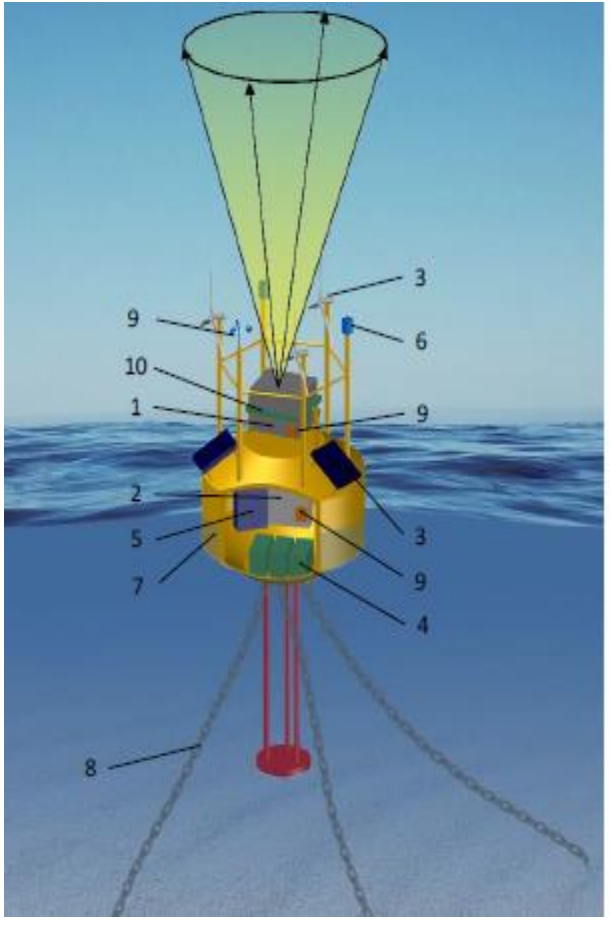
Summary & Conclusions

Objectives of this presentation

- Present available documents for application of floating lidar technology
- Elaborate on what is needed for the technology to reach full maturity
- Present activities on floating lidar within IEA Wind Task 32

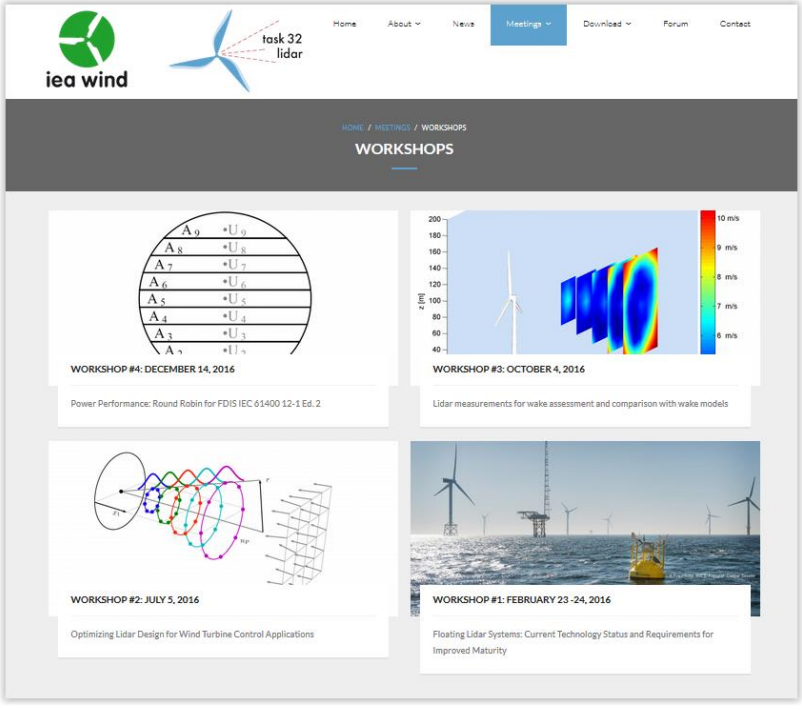
Current application status

- First commercial WRA campaigns based on FLS are being reported
- The market of FLS providers is still diverse & uncertainty of measurements with FLS requires more consideration



Next steps

- Research FLS for further application (beyond wind resource assessment) e.g
  - → assessment of turbine performance (incl. loads)
  - → use of TI data from FLS
  - → Power curve tests – higher demand on uncertainties and their estimation
- further workshops are planned in IEA Wind Task 32 to identify and to mitigate barriers to the use of the lidar technology in wind energy applications



http://www.ieawindtask32.org/meetings/workshops/

Final Step: Submission of updated RP document to IEA Wind ExCo for review and consideration as IEA Wind RP doc.

Acknowledgements

J. Gottschall (Fraunhofer IWES)
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Thank you!

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