

OWA

Deployments of Floating LiDAR Systems

Offshore Wind Accelerator – Wakes and Wind Resource
UFLR – OWA Floating LiDAR Roadmap Update

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Contractor: DNV GL, Frazer-Nash Consultancy, Multiversum Consulting and Fraunhofer IWES
Email: EloiseBurnett@carbontrust.com, marie-anne.cowan@dnvgl.com, b.gribben@fnc.co.uk,
d.stein@multiversum.consulting, julia.gottschall@iwes.fraunhofer.de,
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AUTHORS

Name	Company
Jennifer Cocks	Frazer-Nash Consultancy
Brian Gribben	Frazer-Nash Consultancy
Marie-Anne Cowan	DNV GL
Detlef Stein	Multiversum Consulting
Julia Gottschall	Fraunhofer IWES

FOREWORD

Floating LiDAR technology has been identified as a potential replacement for conventional meteorological masts, which have been prevalent in use for wind resource assessments of proposed offshore wind farms to date. A floating LiDAR system (FLS) offers a significant cost reduction over an offshore meteorological mast and has the flexibility of being redeployed at different locations. As floating LiDAR is a maturing technology, it requires defined industry best practice validation procedures to improve industry confidence in the performance of this type of device before it can be used commercially. The Offshore Wind Accelerator (OWA) Floating LiDAR Systems Roadmap was originally published in 2013 to define different stages of maturity and establish the prerequisites for floating LiDAR systems to satisfy these defined stages of maturity. The Carbon Trust on behalf of the OWA has commissioned a combined project team from DNV GL, Frazer-Nash Consultancy, Fraunhofer IWES and Multiversum Consulting to update the existing Roadmap to reflect the latest status of floating LiDAR systems using input from stakeholders across the industry.

This document will support the OWA FLS Roadmap update project by providing a comprehensive list of FLS deployments and gathering associated operational experience. Following contributions from a number of parties (including Wind Farm developers, OEMs, Consultants and Research Institutes) it has been possible to compile a list of deployment campaigns to date, with details of the campaign and operational experience gained, including breakdowns by geography. The information available for each deployment varies. In some cases, a comprehensive set of deployment information and analysis data has been placed in the public domain, with independent review of outcomes also reported; in others, limited information is available due to commercial sensitivities. In all cases the information available is provided here including associated references.

At the time of writing, the number of known FLS deployments, including trials and WRA deployments, totals 84. These consist of 13 FLS types deployed at approximately 40 locations, mostly in northern Europe but also including North America and Taiwan. Stage 2 maturity ("Pre-Commercial") has been independently reported for 7 systems. The majority of deployments to date have taken place since the publication of the roadmap document, which in itself underlines to requirement to provide an update to the roadmap.

The information contained in this document, together with the outcomes of the associated industry workshop held in London on the 23rd January 2018, informs the requirements for the subsequent stages to the OWA FLS Roadmap project.

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1. ACRONYMS

EOWDC	European Offshore Wind Deployment Centre
FLS	Floating LiDAR System
GSOE	Garden State Offshore Energy
NAREC	National Renewable Energy Centre
OEM	Original Equipment Manufacturer
OWF	Offshore Wind Farm
PNNL	Pacific Northwest National Laboratory
WRA	Wind Resource Assessment

2. INTRODUCTION

2.1 BACKGROUND

The Offshore Wind Accelerator (OWA) was initiated in 2008 by the Carbon Trust with the support of nine offshore wind development companies. The aim of the OWA is to reduce costs and increase the efficiency of offshore wind farms and to develop best practice in the industry.

Floating LiDAR technology has been identified as a potential replacement for conventional meteorological masts which have been prevalent in use for wind resource assessments of proposed offshore wind farms to date. A floating LiDAR system (FLS) offers a significant cost reduction over an offshore meteorological mast and has the flexibility of being redeployed at different locations. As floating LiDAR is a maturing technology, it requires defined industry best practice validation procedures to improve industry confidence in the performance of this type of device before it can be used commercially. The OWA Floating LiDAR Systems Roadmap [R1] was originally published in 2013 to define different stages of maturity and establish the prerequisites for floating LiDAR systems to satisfy these defined stages of maturity. The Carbon Trust on behalf of the OWA has commissioned an update to the existing Roadmap to reflect the latest status of floating LiDAR systems using input from stakeholders across the industry.

2.2 OBJECTIVE

This document will support the OWA FLS Roadmap update by providing a comprehensive list of FLS deployments. Following contributions from a number of parties (including Wind Farm developers, OEMs, Consultants and Research Institutes) it has been possible to compile a list of deployment campaigns to date, with details of the campaign and operational experience gained, including breakdowns by geography.

It should be noted that the information presented is based on information available and shared by stakeholder parties at the time of writing, but it is not possible to guarantee that all FLS deployments have been listed.

2.3 DOCUMENT STRUCTURE

The document comprises 4 sections:

2. [Introduction](#)

3. [Deployments Overview](#)

This section presents a brief overview of the number of systems and deployments, and of reported maturity stages.

4. [Detailed Deployments List](#)

This section contains a detailed list of all FLS deployments sorted by FLS type. The entry for each deployment contains information including date, location, organisations involved and resources as well as an image and an account of user experiences during the campaign (where available). Each deployment is assigned a reference number (e.g. D1) which is referred to throughout the document.

5. [Deployments by Location](#)

Deployments are sorted geographically and shown on a map.

6. General Operational Experience Feedback

From the feedback received, a number of challenges were identified which are relevant to deployment of FLS in general and not specific to individual deployments. These are listed in this section.

3. DEPLOYMENTS OVERVIEW

At the time of writing, the number of known FLS deployments, including trials and WRA deployments, totals 84. These consist of 13 FLS types deployed at approximately 40 locations, mostly in northern Europe but also including North America and Taiwan. Stage 2 maturity (“Pre-Commercial”) has been independently reported for 7 systems.

The FLS types, their first deployment dates, and any independently reported maturity claims are summarised in Table 1 below. A detailed list of deployments by FLS type is included in Section 4. To convey the growth in the industry’s use of the technology, the number of FLS deployments at any one time is shown in Figure 1. A geographical view of the distribution of FLS deployments is provided by the map figures in Section 5.

System Name	First Deployment	LiDAR Used	Independently Reported Maturity Stage
AXYS FLiDAR WindSentinel	2009	ZephIR 300, Windcube v2	Stage 2
SeaZephir	2009	ZephIR 300	
AXYS FLiDAR 4M (FLiDAR)	2011	ZephIR 300, Windcube v2	Stage 2
EOLOS FLS200	2013	ZephIR 300	Stage 2
DeepCLiDAR	2013	Windcube v2	Stage 2 ¹
Fraunhofer IWES Wind LiDAR Buoy	2013	Windcube v2, ZephIR 300	Stage 2
Nass&Wind M3EA	2014	Windcube v2	
Fugro Oceanor SEAWATCH	2014	ZephIR 300	Stage 2
Babcock FORECAST	2014	ZephIR 300	Stage 2
SeaLiDAR	2015	ZephIR 300	
Eolfi Spar	2016	Diabrezza (Mitsubishi Electric) or other	
AKROCEAN WINDSEA	2017	Windcube v2, ZephIR 300	
DEWI with Leosphere	2017	Windcube v2	

1 Maturity stage independently reported following a 5 month trial duration only.

Table 1: Summary of Floating LiDAR System types by first deployment dates, with associated maturity stages.

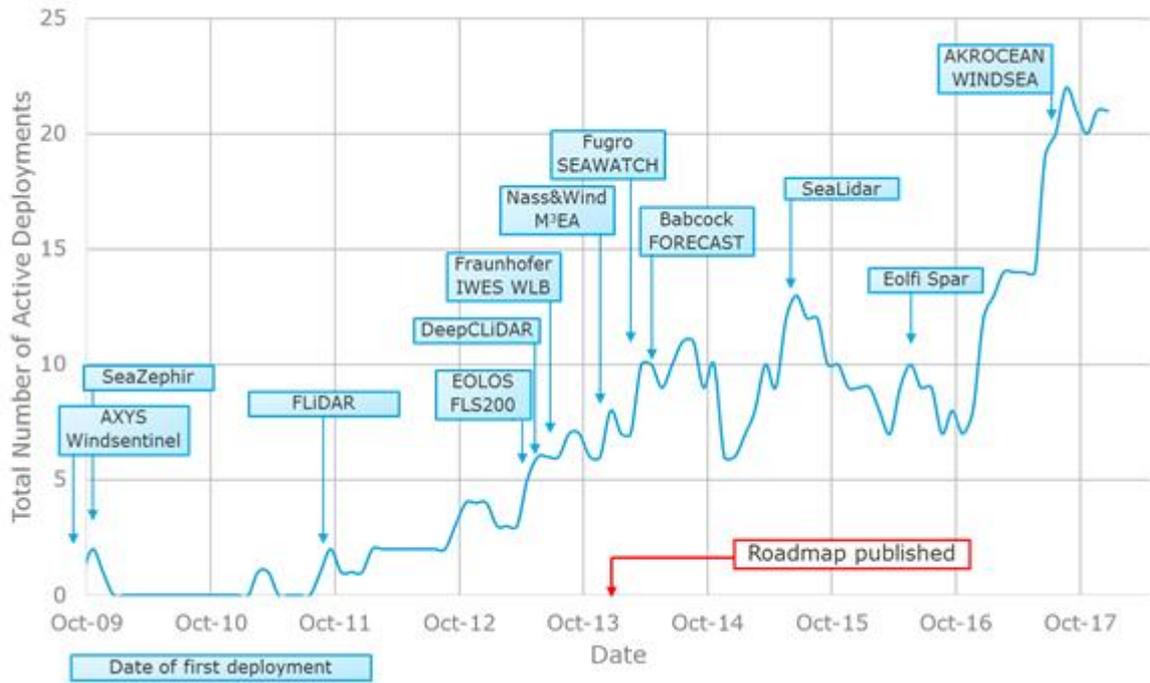


Figure 1: Indicative timeline showing number of deployed FLS systems. The date of the original OWA FLS Roadmap publication is shown in red.

4. DETAILED DEPLOYMENTS LIST

The following pages contain details of all known FLS deployments at the time of writing. It should be noted that the information presented is based on information available and shared by stakeholder parties at the time of writing, but it is not possible to guarantee that all FLS deployments have been listed.

Entries are sorted by FLS type, starting with the earliest initial deployment:

Index	FLS	Date of First Deployment	Number of deployments to date
4.1	AXYS FLiDAR WindSentinel	October 2009	24
4.2	SeaZepHIR	November 2009	3
4.3	AXYS FLiDAR 4M	September 2011	12
4.4	EOLOS FLS200	May 2013	5
4.5	DeepCLiDAR	June 2013	2
4.6	Fraunhofer IWES Wind LiDAR Buoy	August 2013	10
4.7	Nass&Wind M ³ EA	January 2014	2
4.8	Fugro OCEANOR SEAWATCH	April 2014	19
4.9	Babcock FORECAST	May 2014	2
4.10	seaLiDAR	July 2015	1
4.11	Eolfi Spar	May 2016	1
4.12	AKROCEAN WINDSEA	July 2017	2
4.13	DEWI with Leosphere	September 2017	1

4.1 AXYS FLIDAR WINDSENTINEL

FLS OEM: AXYS Technologies Inc.

LiDAR Type: The AXYS FLIDAR WindSentinel was previously known just as WindSentinel™ and carried a Vindicator® laser wind sensor. It was renamed in 2014 and now supports either a ZephIR 300M, WINDCUBE v2 Offshore LiDAR, or a combination of both.

Greyed-out rows indicate known deployments where further detail cannot be provided due to commercial sensitivity.

Ongoing deployments as of February 2018 are marked with an asterisk (*). The duration reported in these cases is the number of months from the deployment date to February 2018.

Deployments

Ref	Deployment Date	Duration (months)	Location	Campaign Type
D1	October 2009	1	Race Rocks, Strait of Juan de Fuca, Canada	Trial
D2	October 2011	18	Lake Michigan, USA	WRA
D3	February 2012	23	New Jersey, USA	WRA
D4	May 2013	12	Taiwan	WRA
D5	September 2013	36	California	WRA
D6	July 2014	12	Demowfloat, Portugal	WRA
D7	November 2014	12	Virginia Beach, Virginia, USA	WRA
D8	April 2015	1	National Renewable Energy Centre (NAREC), North Sea	Trial
D9	April 2015	1	National Renewable Energy Centre (NAREC), North Sea	Trial
	May 2015	33*	France	WRA
D10	June 2015	5	FINO1 Met. Mast, German Bight, North Sea	Trial
D11	September 2015	6	West of Duddon Sands wind farm zone, Irish Sea, UK	Trial
	October 2016	16*	Taiwan	WRA
D12	December 2016	14*	Bay of St Brieuc, France	WRA
	January 2017	1	USA	Trial
	July 2017	2	Taiwan	Trial
	July 2017	2	Taiwan	Trial
	July 2017	3	Taiwan	Trial
D13	July 2017	8*	East Coast USA	WRA
	August 2017	2	UK	Trial
D14	September 2017	5*	Taiwan	WRA
	October 2017	4*	Taiwan	WRA
	November 2017	3*	Taiwan	WRA
	April 2018	Not started	USA	WRA

D1. FLiDAR WindSentinel Trial, 2009

FLS OEM	AXYS Technologies Inc.	Other organisations	
Start/End Date	October – November, 2009	Length of campaign	1 month
Location	Race Rocks, Strait of Juan de Fuca, Canada		
Image	 <p>Image taken from WindSentinel Field Test Data Summary [R2]</p>		
FLS	FLiDAR WindSentinel™		
LiDAR Type	Vindicator® laser wind sensor		
Purpose of deployment	Trial		
Description	The AXYS WindSentinel™ performed a comparison test with a land mounted system approximately 700 meters away. The FLS was instrumented with meteorological sensors, motion sensors and a Vindicator® laser wind sensor. The land mounted system was also instrumented with standard meteorological instruments and an identical Vindicator® LiDAR.		
OWA Roadmap Maturity Claim	N/A (Pre-Roadmap)		
Operational experience	Average surface wind speeds of up to 17.7m/s and 200m height wind speeds of 22.78m/s were recorded. The WindSentinel™ platform saw maximum wave heights of over 4 meters, ocean currents over 6 knots.		
Resources	WindSentinel Field Test Data Summary [R2] Deployment details and experiences contributed by AXYS Technologies.		

D2. FLiDAR WindSentinel Great Lakes WRA 2011 –2013

FLS OEM	AXYS Technologies Inc.	Other organisations	Grand Valley State University Michigan Alternative and Renewable Energy Center (MAREC) University of Michigan Michigan Memorial Phoenix Energy Institute (MMPEI) Michigan Natural Features Inventory of the Michigan State University Extension
Start/End Date	October 2011 – April 2013	Length of campaign	18 months
Location	Lake Michigan, USA		
Image			Image taken from Great Lakes Offshore Wind Resource Assessment Project Case Study [R3].
FLS	FLiDAR WindSentinel™		
LiDAR Type	Vindicator® laser wind sensor		
Purpose of Deployment	WRA		
Description	The objective of the project was to field test FLS technology to improve understanding of offshore wind resources as well as other physical, biological and environmental conditions on the Great Lakes as precursor activity to the future development of offshore wind energy technology.		
OWA Roadmap Maturity Claim	N/A (Pre-Roadmap)		
Operational experience	This campaign included the first towed deployment of a commercial FLS and the first jack up barge deployment of a system. Winds of up to 26 m/s and gusts of 29.9 m/s, and peak waves of around 10 m were experienced.		
Resources	Great Lakes Wind Resource Assessment Project Case Study [R3] Grand Valley State University: Lake Michigan Offshore Wind Assessment Project [R4] Deployment details and experiences contributed by AXYS Technologies,		

D3. FLiDAR WindSentinel WRA, New Jersey, 2013

FLS OEM	AXYS Technologies Inc.	Other organisations	Fisherman’s Energy BOEM
Start/End Date	February 2012 – January 2014	Length of campaign	23 months
Location	New Jersey, USA		
Image	 <p>Image provided by AXYS Technologies</p>		
FLS	FLiDAR WindSentinel™		
LiDAR Type	Vindicator® laser wind sensor		
Purpose of Deployment	WRA		
Description	“With a year of preparations and near-shore testing, the buoy was relocated from a test site near Atlantic City to an offshore area leased from the U. S. Department of Interior’s Bureau of Ocean Energy Management (BOEM). Located eleven miles southeast of Atlantic, NJ, this site is within the Mid-Atlantic Wind Energy Area, in an area Fishermen’s Energy proposed to build a 350MW wind farm.” [R6]		
OWA Roadmap Maturity Claim	N/A (Pre-Roadmap)		
Operational experience	N/A		
Resources	OffshoreWIND.biz press release [R5] AXYS Technologies press release [R6]		

D4. FLiDAR WindSentinel WRA, Taiwan, 2013

FLS OEM	AXYS Technologies Inc.	Other organisations	National Cheng Kung University
Start/End Date	May 2013 – May 2014	Length of campaign	12 months
Location	Taiwan		
Image	 <p>Image provided by AXYS Technologies</p>		
FLS	FLiDAR WindSentinel™		
LiDAR Type	Vindicator® laser wind sensor		
Purpose of Deployment	WRA		
Description	The objective of the campaign was to support Taiwan’s planned development of 3 GW of offshore wind projects.		
OWA Roadmap Maturity Claim	N/A (pre-roadmap)		
Operational experience	N/A		
Resources	AXYS Technologies press release [R7] Deployment details contributed by AXYS.		

D5. FLiDAR WindSentinel WRA, California, 2013

FLS OEM	AXYS Technologies Inc.	Other organisations	Sound & Sea Technology US Navy DNV GL
Start/End Date	September 2013 – September 2016	Length of campaign	36 months
Location	California, USA		
Image	 <p>Image taken from AXYS news [R8]</p>		
FLS	FLiDAR WindSentinel™		
LiDAR Type	Vindicator® laser wind sensor		
Purpose of Deployment	WRA		
Description	N/A		
OWA Roadmap Maturity Claim	N/A (pre-roadmap)		
Operational experience	N/A		
Resources	AXYS Technologies press release [R8] Deployment details contributed by AXYS.		

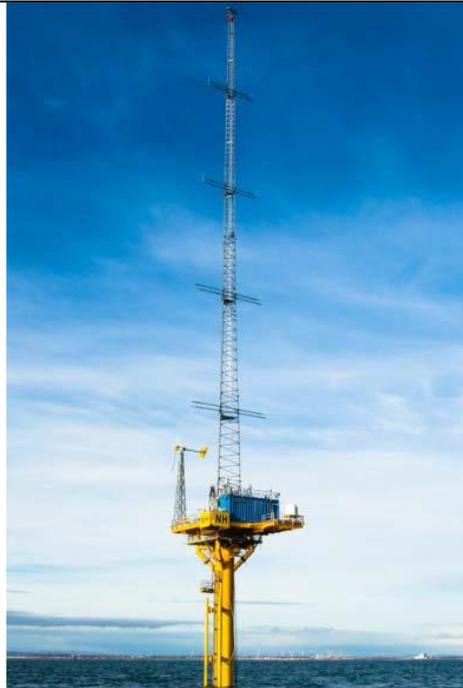
D6. FLiDAR WindSentinel WRA, Portugal, 2014

FLS OEM	AXYS Technologies Inc.	Other organisations	EDP Inovacao
Start/End Date	July 2014 – July 2015	Length of campaign	12 months
Location	Demowfloat, Portugal		
Image	 <p>Image provided by AXYS Technologies</p>		
FLS	FLiDAR WindSentinel™		
LiDAR Type	Vindicator® laser wind sensor		
Purpose of Deployment	WRA		
Description	The system was used by EDPr to test and monitor the performance of a prototype floating wind turbine, support the development of new methodologies for deep offshore resource assessments and to refine the wind estimate for this location.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	The system survived a major storm with gale force winds gusting 90km/hr and waves 10 metres high.		
Resources	<p>AXYS Technologies press release [R9]</p> <p>Deployment details and experiences contributed by AXYS Technologies.</p>		

D7. FLiDAR WindSentinel WRA, Virginia Beach, 2014-2016

FLS OEM	AXYS Technologies Inc.	Other organisations	PNNL
Start/End Date	November 2014 – November 2015	Length of campaign	12 months
Location	Virginia Beach, Virginia, USA		
Image	 <p>Image taken from PNNL Deployment Plan [R10]</p>		
FLS	FLiDAR WindSentinel™		
LiDAR Type	Vindicator® laser wind sensor		
Purpose of Deployment	WRA.		
Description	Deployments made to address the lack of publicly available long-term meteorological observations in US waters and to aid future development of offshore wind energy in the US. [R10]		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	PNNL Wind-Profiling LiDAR Buoy Deployment Plan [R10]		

D8. and D9. FLiDAR WindSentinel Trial, NAREC, 2015

FLS OEM	AXYS Technologies Inc.	Other organisations	DNV GL (Independent assessor) NAREC
Start/End Date	April 2015 – May 2015	Length of campaign	1 month
Location	National Renewable Energy Centre (NAREC), North Sea		
Image			NAREC Met. Mast. Image taken from Validation Assessment [R11].
FLS	AXYS FLiDAR WindSentinel™		
LiDAR Type	ZephIR 300 LiDAR and Vindicator MK-III		
Purpose of Deployment	Trial		
Description	<p>Two FLS deployed.</p> <p>“An evaluation of the AXYS WindSentinel Floating LiDAR system was completed by comparing its measurements against data of a Reference Met Mast at the British Narec NOAH offshore test site. Sufficient data in terms of WS data completeness and coverage were collected to allow an assessment of this pre-deployment validation in line with the Roadmap.” [R11]</p>		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported (in combination with [D10])		
Operational experience	N/A		
Resources	<p>DNV Validation Assessment NAREC [R11]</p> <p>DNV Validation Assessment FINO1 [R12]</p>		

D10. FLiDAR WindSentinel Trial, FINO1, 2015

FLS OEM	AXYS Technologies Inc.	Other organisations	DNV GL (Independent assessor) NORCOWE
Start/End Date	June 2015 – November 2015	Length of campaign	5 months
Location	FINO1 Met. Mast, German Bight, North Sea		
Image	 <p>Image taken from DNV GL Independent Assessment [R12]</p>		
FLS	AXYS FLiDAR WindSentinel™		
LiDAR Type	ZephIR 300M LiDAR (x2)		
Purpose of Deployment	Trial		
Description	AXYS Technologies Inc. (AXYS or the Client) commissioned GL Garrad Hassan Deutschland GmbH (“GHD”), part of the DNV GL group (“DNV GL”) to carry out an independent assessment of an AXYS FLiDAR Windsentinel offshore validation, executed over a 5 month period next to the FINO1 Offshore Research Platform in German North Sea waters.		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported (in combination with [D8])		
Operational experience	FLS unit experienced 10-minute average winds up to 26.4m/s, significant wave heights of 5.9m and maximum wave heights up to 10.7m.		
Resources	DNV Independent Assessment [R12] Deployment details and experiences contributed by AXYS Technologies.		

D11. FLiDAR WindSentinel Trial, West of Duddon Sands, 2015

FLS OEM	AXYS Technologies Inc.	Other organisations	Ørsted DNV GL (Independent assessor) Scottish Power (Iberdrola)
Start/End Date	September 2015 – March 2016	Length of campaign	6 months
Location	West of Duddon Sands wind farm zone, Irish Sea, UK		
Image	 <p>Image taken from DNV GL Validation Report [R13]</p>		
FLS	AXYS FLiDAR WindSentinel		
LiDAR Type	ZephIR 300M LiDAR and Vindicator MK-III		
Purpose of Deployment	Trial		
Description	“An independent evaluation of the AXYS FLiDAR 6M Buoy employing a ZephIR 300 type LiDAR (FLiDAR 6M single-ZephIR, formerly known as WindSentinel) was completed by DNV GL in assessing its reliability and comparing its wind measurements from the buoy mounted ZephIR LiDAR against data from the WoDS Reference Met Mast (WRMM) in the Irish Sea.” [R13]		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported		
Operational experience	FLS unit experienced 10-minute average winds up to 29.8 m/s, significant waves of Hs = 5.0m and max waves up to 9.4m		
Resources	Image taken from DNV GL Validation Report [R13] Deployment details and experiences contributed by AXYS Technologies.		

D12. AXYS FLiDAR 6M St Brieuc WRA, 2016-2018

FLS OEM	AXYS Technologies Inc.	Other organisations	Scottish Power Renewables (Iberdrola) RES Ailes Marines
Start/End Date	December 2016 – December 2018 (anticipated)	Length of campaign	14 months*
Location	St Brieuc, Brittany, France		
Image	 <p>Image provided by AXYS Technologies</p>		
FLS	AXYS FLiDAR WindSentinel™		
LiDAR Type	ZephIR 300M LiDAR		
Purpose of Deployment	WRA.		
Description	Part of the energy assessment for the Bay of Saint-Brieuc commercial offshore wind farm development managed by Ailes Marines.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	Favourable weather conditions meant installation was very quick.		
Resources	Deployment details and experiences contributed by Iberdrola (Scottish Power) and AXYS Technologies.		

* The duration reported is the number of months from the deployment date to February 2018.

D13. AXYS FLiDAR Windsentinel USA WRA, 2017-2019

FLS OEM	AXYS Technologies Inc.	Other organisations	Ørsted
Start/End Date	July 2017 – July 2019 (anticipated)	Length of campaign	8 months*
Location	East Coast USA		
Image	No image available		
FLS	FLiDAR WindSentinel™		
LiDAR Type	ZephIR 300 LiDAR		
Purpose of Deployment	WRA.		
Description	LiDAR units were validated onshore to capture the required data range and offshore trial undertaken against met mast. Validation continues to prove useful as extended SAT Internal Validation carried out by Ørsted.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<p>Successful deployment.</p> <p>Good co-operation from site team.</p> <p>Tech challenges overcome with relative efficiency.</p> <p>Supplier open to adaptations to Ørsted’s specifications.</p>		
Resources	Deployment details and experiences contributed by Ørsted.		

* The duration reported is the number of months from the deployment date to February 2018.

D14. FLiDAR WindSentinel WRA, Taiwan, 2017-2019

FLS OEM	AXYS Technologies Inc.	Other organisations	Ørsted (developer)
Start/End Date	September 2017 – September 2019 (anticipated)	Length of campaign	5 months*
Location	Taiwan		
Image	 <p>Image provided by AXYS Technologies</p>		
FLS	FLiDAR WindSentinel™		
LiDAR Type	ZephIR 300 LiDAR		
Purpose of Deployment	WRA.		
Description	LiDAR units were validated onshore to capture the required data range + offshore trial undertaken against met mast. Validation continues to prove useful as extended SAT Internal Validation carried out by Ørsted.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<p>Successful deployment.</p> <p>Good co-operation from site team.</p> <p>Tech challenges overcome with relative efficiency.</p> <p>Supplier open to adaptations to Ørsted's Specifications.</p>		
Resources	Deployment details and experiences contributed by Ørsted.		

4.2 SEAZEPHIR

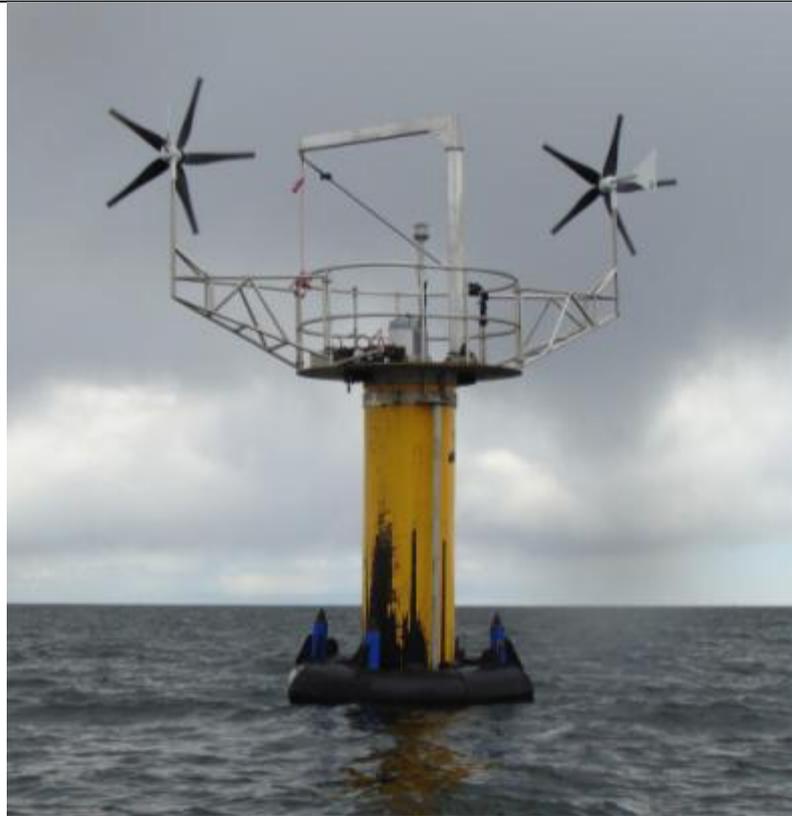
FLS OEM: SeaRoc

LiDAR Type: ZephIR 300 LiDAR

Deployments

Ref	Deployment Date	Duration (months)	Location	Campaign Type
D15	November 2009	1	S. Coast Norway	Proof of concept
D16	March 2011	1	Block Island, Rhode Island, USA	Trial
D17	November 2014	24	GSOE, Delaware, USA	WRA

D15. SeaZephIR Norway Concept Trial, 2009

FLS OEM	SeaRoc	Other organisations	Natural Power (validating party)
Start/End Date	November 2009 – unknown	Length of campaign	1 month (assumed)
Location	800m off the south coast of Norway		
Image	 <p>Image taken from Wind LiDAR Innovations presentation [R14]</p>		
FLS	SeaZephIR		
LiDAR Type	ZephIR 300 LiDAR		
Purpose of Deployment	Proof of concept		
Description	Concept trial: two ZephIR units deployed off coast of Norway, LandZephIR on small island and SeaZephIR buoy anchored out to sea. Separation 800m.		
OWA Roadmap Maturity Claim	N/A (pre-roadmap)		
Operational experience	Excellent correlation obtained between SeaZephIR and LandZephIR.		
Resources	Wind LiDAR Innovations presentation [R14]		

D16. SeaZephIR Block Island Trial, 2009

FLS OEM	SeaRoc	Other organisations	Deepwater Wind (developer)
Start/End Date	March 2011 – April 2011	Length of campaign	1 month
Location	Block Island, Rhode Island, USA		
Image	Image taken from the Block Island Times article [R16]		
FLS	SeaZephIR		
LiDAR Type	ZephIR 300 LiDAR		
Purpose of Deployment	Trial		
Description	The FLS was being trialled to use for wind farm development in the area. [R15]		
OWA Roadmap Maturity Claim	N/A (pre-roadmap)		
Operational experience	There was a structural failure three weeks in and the FLS tipped over [R16]		
Resources	Wind LiDAR Innovations presentation [R14]		

D17. SeaZephIR GSOE WRA, 2012

FLS OEM	SeaRoc	Other organisations	GSOE (developer)
Start/End Date	November 2012 – November 2014	Length of campaign	24 months
Location	Garden State Offshore Energy, Delaware, USA		
Image	No image available		
FLS	SeaZephIR		
LiDAR Type	ZephIR 300 LiDAR		
Purpose of Deployment	WRA		
Description	Following its previous deployment at Block Island, the SeaZephIR underwent several structural design changes and was re-deployed 23 miles off the coast of Atlantic City to support GSOE’s planned offshore wind farm. [R17]		
OWA Roadmap Maturity Claim	N/A (pre-roadmap)		
Operational experience	N/A		
Resources	North American Clean Energy Press release [R17]		

4.3 AXYS FLIDAR 4M

FLS OEM: AXYS Technologies Inc. FLiDAR was originally launched in November 2012 by 3E and OWA and was acquired by AXYS in 2015 [R18].

LiDAR Type: Supports both Leosphere WINDCUBE®v2 LiDAR and ZephIR 300 LiDAR.

Greyed-out rows indicate known deployments where further detail cannot be provided due to commercial sensitivity.

Ongoing deployments as of February 2018 are marked with an asterisk (*). The duration reported in these cases is the number of months from the deployment date to February 2018.

Deployments

Ref	Deployment Date	Duration (months)	Location	Campaign Type
D18	September 2011	1	North Sea, Belgium	Proof of concept
D19	October 2012	3	Gwynt-y-Môr wind farm zone, Irish Sea, UK	Trial
D20	June 2013	15	Burbo Bank Extension wind farm zone, Irish Sea, UK	WRA
D21	January 2014	3	NAREC, Blyth, UK	Pre-deployment Trial
D22	April 2014	10	Walney Extension, Irish Sea	WRA
D23	April 2014	12	Near na Gaoithe wind farm zone, North Sea, UK	WRA
	May 2015	2	Fécamp, France	Trial
	July 2015	14	Courseulles-sur-Mer, France	WRA
	July 2015	4	Fécamp, France	Trial
	October 2015	12	UK	WRA
	November 2016	3	Fécamp, France	Trial
	December 2017	2*	Provence Grand Large, France	WRA

D18. FLiDAR Proof of concept, North Sea, 2011

FLS OEM	FLiDAR	Other organisations	
Start/End Date	September – October, 2011	Length of campaign	1 month
Location	North Sea, Belgium		
Image	 <p>Image taken from press release [R19]</p>		
FLS	FLiDAR™ (prototype)		
LiDAR Type	WINDCUBE®v2 LiDAR from Leosphere		
Deployment purpose	Proof of concept		
Description	Early validation of FLiDAR prototype 15 km of the coast of Belgium. Data validated against fixed WINDCUBE LiDAR device on an offshore communication mast close to the test site.		
OWA Roadmap Maturity Claim	N/A (Pre-Roadmap)		
Operational experience	N/A		
Resources	offshoreWIND Press Release [R19] 3E News Press Release [R20]		

D19. FLiDAR Trial, Gwynt-y-Môr, 2012-2013

FLS OEM	FLiDAR	Other organisations	RWE OWA, Carbon Trust, Frazer-Nash Consultancy DNV GL
Start/End Date	October 2012 - January 2013	Length of campaign	3 months
Location	Gwynt-y-Môr wind farm zone, Irish Sea, UK		
Image	 <p>Image taken from OWA, Carbon Trust Results and Findings of a OWA Floating LIDAR Trial in the Irish Sea [R21]</p>		
FLS	FLiDAR™ (prototype)		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	Trial		
Description	Validation against Gwynt y Môr meteorological mast in the Irish Sea, which includes Measnet-calibrated cup anemometers at 90m and 50m above LAT and a wind vane at 70m. A Waverider buoy was also deployed during the trial.		
OWA Roadmap Maturity Claim	N/A (Pre-Roadmap)		
Operational experience	N/A		
Resources	OWA, Carbon Trust Results and Findings of an OWA Floating LIDAR Trial in the Irish Sea [R21]		

D20. FLiDAR 4M WRA, Burbo Bank, 2013-2014

FLS OEM	FLiDAR	Other organisations	Ørsted
Start/End Date	June 2013 – September 2014	Length of campaign	15 months
Location	Burbo Bank Extension wind farm zone, Irish Sea, UK		
Image	 <p>Image taken from OffshoreWIND press release [R22]</p>		
FLS	FLiDAR 4M		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	WRA with post-validation		
Description	“A FLiDAR buoy was the only device measuring the offshore wind resource on site from June 2013 to September 2014. It subsequently completed a final period of post validation against an offshore met mast.” [R22]		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	OffshoreWIND.biz press release [R22]		

D21. FLiDAR 4M Trial, NAREC, 2014

FLS OEM	FLiDAR	Other organisations	DNV GL (Validating party)
Start/End Date	January 2014 – April 2014	Length of campaign	3 months
Location	NAREC Met. Mast, Blyth, UK		
Image	 <p>Image taken from Carbon Trust press release [R23]</p>		
FLS	FLiDAR 4M		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	Trial		
Description	The FLS was validated by DNV GL before being used for a WRA for the Neart na Gaoithe wind farm zone [D23].		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported		
Operational experience	N/A		
Resources	Carbon Trust OWA press release [R23]		

D22. FLiDAR 4M WRA, Walney Extension, 2014-2015

FLS OEM	AXYS Technologies Inc.	Other organisations	Ørsted
Start/End Date	April 2014 – February 2015	Length of campaign	10 months
Location	Walney Extension wind farm zone, Irish Sea, UK		
Image	 <p>Image taken from NorCOWE press release [R25]</p>		
FLS	FLIDAR™ 4M		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	Wind resource assessment with post-validation		
Description	N/A		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	NorCOWE press release [R25].		

D23. FLiDAR 4M WRA, Neart na Gaoithe, 2014

FLS OEM	FLiDAR	Other organisations	Mainstream Renewable Power
Start/End Date	April 2014 – March 2015	Length of campaign	12 months
Location	Nearth na Gaoithe (NNG) wind farm zone, North Sea, UK (WRA)		
Image	 <p>Image taken from MAINSTREAM press release [R24]</p>		
FLS	FLiDAR 4M		
LiDAR Type	WINDCUBE®v2 LiDAR from Leosphere		
Purpose of Deployment	WRA		
Description	A WRA was undertaken at NNG following a pre-deployment validation at the NAREC Met. Mast off the coast of Blyth [D21].		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	MAINSTREAM press release [R24]		

4.4 EOLOS FLS200

FLS OEM: EOLOS

LiDAR Type: ZephIR 300 LIDAR

Ongoing deployments as of February 2018 are marked with an asterisk (*). The duration reported in these cases is the number of months from the deployment date to February 2018.

Deployments

Ref	Deployment Date	Duration (months)	Location	Campaign Type
D24	May 2013	3	Spain, Mediterranean Sea	Proof of concept
D25	March 2015	6	Ijmuiden wind farm zone, North Sea, Netherlands	Trial
D26	January 2017	13	St Brieuc, France	WRA
D27	October 2017	1	National Renewable Energy Centre (NAREC), North Sea	Trial
D28	January 2018	1*	Bàltica III, Poland (40km from shore)	WRA

D24. EOLOS FLS200 Neptune Project, 2013

FLS OEM	EOLOS	Other organisations	University of Stuttgart Gas Natural Fenosa Catalonia Institute of Energy Research Technical University of Catalonia
Start/End Date	May 2013 – July 2013	Length of campaign	3 months
Location	Spain (Mediterranean Sea), 250m from shore		
Image	 <p>Image taken from Neptune Brochure [R26]</p>		
FLS	FLS200		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Proof of concept		
Description	In May 2013, a full scale prototype of EOLOS buoy was deployed 250 meters off the coast of Barcelona, in north-eastern Spain, for an 8 week measurement and design-validation campaign. The buoy was anchored at a distance of 50 meters from a nearby pier, where an identical calibrated ZephIR 300 LiDAR was installed. This configuration allowed to take simultaneous measurements from the moving (LiDAR Buoy) and fixed LiDAR systems.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	Excellent correlation between the two LiDAR types.		
Resources	EOLOS Validation for CT Roadmap [R27] EOLOS Neptune Brochure [R26]		

D25. EOLOS FLS200 Ijmuiden Trial, 2015

FLS OEM	EOLOS	Other organisations	ECN (Validation party) RWE Innogy B.V (Client)
Start/End Date	March 2015 – October 2015	Length of campaign	6 months
Location	Ijmuiden wind farm zone, North Sea, Netherlands		
Image	 <p>Image taken from ECN press release [R28]</p>		
FLS	FLS200		
LiDAR Type	Zephir 300		
Purpose of Deployment	Trial		
Description	<p>“Last October 2015, the EOLOS FLS200 successfully completed a 6-month validation campaign next to the IEC-compliant Ijmuiden offshore meteorological mast in the North Sea. The campaign has been carried out in collaboration with RWE Innogy and under the framework of, and supported by, the OWA, Carbon Trust, as well as the Dutch R&D programme FLOW.” [R28]</p>		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported		
Operational experience	N/A		
Resources	<p>EOLOS Validation for CT Roadmap [R27] ECN press release [R28]</p>		

D26. EOLOS FLS200 St Brieuc WRA, 2017-2018

FLS OEM	EOLOS	Other organisations	Scottish Power Renewables
Start/End Date	January 2017 – February 2018	Length of campaign	13 months
Location	St Brieuc, France		
Image	 <p>Image provided by EOLOS.</p>		
FLS	FLS200		
LiDAR Type	Zephir 300		
Purpose of Deployment	WRA		
Description	Bound for Baltic Sea project for PGE after Blyth deployment. Pre-validation before commercial campaign in Baltic Sea.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	Deployment details contributed by Iberdrola.		

D27. EOLOS FLS200 NAREC Trial, 2017

FLS OEM	EOLOS	Other organisations	
Start/End Date	October 2017 – November 2017	Length of campaign	1 month
Location	NAREC, North Sea		
Image	 <p>Image provided by EOLOS.</p>		
FLS	FLS200		
LiDAR Type	Zephir 300		
Purpose of Deployment	Trial		
Description	Bound for Baltic Sea project for PGE after Blyth deployment. Pre-validation before commercial campaign in Baltic Sea.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	EOLOS Validation for CT Roadmap [R27]		

D28. EOLOS FLS200 Bàltica III WRA, 2017-2019

FLS OEM	EOLOS	Other organisations	
Start/End Date	January 2018 – 2019 (anticipated)	Length of campaign	1 month*
Location	Bàltica III, Poland (40km from shore)		
Image	 <p>Image provided by EOLOS.</p>		
FLS	FLS200		
LiDAR Type	Zephir 300		
Purpose of Deployment	WRA		
Description	N/A		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	EOLOS Validation for CT Roadmap [R27]		

* The duration reported is the number of months from the deployment date to February 2018.

4.5 DEEPCLIDAR

FLS OEM: University of Maine

LiDAR Type: WINDCUBE®v2 LIDAR from Leosphere

Deployments

Ref	Deployment Date	Duration (months)	Location	Campaign Type
D29	June 2013	18	Gulf of Maine, USA	Trial
D30	May 2016	5	Gulf of Maine, USA	Trial

D29. DeepCLiDAR Trial, Maine, 2013

FLS OEM	University of Maine	Other organisations	AWS Truepower (validating party) NRG Systems Inc.
Start/End Date	June 2013 – November 2014	Length of campaign	18 months
Location	Gulf of Maine, USA		
Image	No image available		
FLS	DeepCLiDAR		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	Trial		
Description	N/A		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	University of Maine News [R29]		

D30. DeepCLiDAR Trial, Maine, 2016

FLS OEM	University of Maine	Other organisations	AWS Truepower (validating party)
Start/End Date	May 2016 – October 2016	Length of campaign	5 months
Location	Gulf of Maine, USA		
Image	 <p>Image taken from University of Maine News [R30]</p>		
FLS	DeepCLiDAR		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	Trial		
Description	<p>“The recent 5-month test concluded a robust, three-phase validation program that sequentially vetted the DeepCLiDAR’s performance onshore, near-shore and offshore. The validation campaign was jointly developed by AWS Truepower and UMaine to characterize the floating LiDAR’s measurements in the absence of an offshore meteorological tower. The basis for the system’s evaluation and acceptance were the Key Performance Indicators and Acceptance Criteria defined by the OWA and Carbon Trust.</p>		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported		
Operational experience	N/A		
Resources	University of Maine News [R30]		

4.6 FRAUNHOFER IWES WIND LIDAR BUOY

FLS OEM: Fraunhofer IWES

LiDAR Type: Supports both Leosphere WINDCUBE®v2 and ZephIR 300 LiDAR.

Ongoing deployments as of February 2018 are marked with an asterisk (*). The duration reported in these cases is the number of months from the deployment date to February 2018.

Deployments

Ref.	Deployment Date	Duration (months)	Location	Campaign Type
D31	August 2013	2	FINO1 Met. Mast, North Sea, Germany	Trial
D32	August 2014	1	FINO1 Met. Mast, North Sea, Germany	Trial
D33	January 2015	3	FINO1 Met. Mast, North Sea, Germany	Trial
D34	June 2015	3	FINO1 Met. Mast, North Sea, Germany	Trial
D35	July 2015	2	FINO1 Met. Mast, North Sea, Germany	Trial
D36	November 2015	6	Danish West Coast, North Sea	WRA
D37	February 2016	6	FINO1 Met. Mast, North Sea, Germany	Trial
D38	November 2016	6	FINO3 Met. Mast, North Sea, Germany	Trial
D39	March 2017	11*	Scottish East coast, UK	WRA
D40	December 2017	2*	Kincardine OWF, Scotland	WRA

D31. Fraunhofer WINDCUBE v2 Trial, 2013

FLS OEM	Fraunhofer IWES	Other organisations	
Start/End Date	August 2013 – October 2013	Length of campaign	2 months
Location	FINO1 Met. Mast, German Bight, North Sea		
Image	 <p>Image taken from Fraunhofer IWES report [R31]</p>		
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	Trial		
Description	“Tested accuracy of wind measurements by Fraunhofer IWES Wind LiDAR Buoy in intended environment, 45 km offshore in 450 m distance to FINO1 met. mast (German Bight, North Sea)” [R31]		
OWA Roadmap Maturity Claim	N/A (Pre-Roadmap)		
Operational experience	N/A		
Resources	Offshore Wind Resource Assessment with Fraunhofer IWES Wind LiDAR Buoy [R31] Gottschal et al. (2014) [R32]		

D32. Fraunhofer ZephIR 300 Trial, 2014

FLS OEM	Fraunhofer IWES	Other organisations	ZephIR
Start/End Date	August 2014 – September 2014	Length of campaign	1 month
Start/End Date	August 2014 – September 2014		
Location	FINO1 Met. Mast, German Bight, North Sea		
Image	 <p>Image taken from ZephIR LiDAR press release [R33]</p>		
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Trial		
Description	<p>“An offshore verification test was performed for and with the Fraunhofer IWES Wind LiDAR Buoy now equipped with a ZephIR 300 LiDAR next to the FINO1 met mast, in the German North Sea about 45km north of the East Frisian island Borkum. Both the availability and the accuracy of the floating lidar system were assessed against the offshore test site which was set up as a lidar-mast comparison adhering to IEC 61400-12-1 ed.2 CD where wind measurements from the lidar and the mast are compared with each other for different corresponding height levels and reference conditions.” [R33]</p>		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	ZephIR LiDAR press release [R33]		

D33. Fraunhofer WINDCUBE v2 Trial, 2015

FLS OEM	Fraunhofer IWES	Other organisations	DNV GL (Reviewing party)
Start/End Date	January 2015 - April 2015	Length of campaign	3 months
Location	FINO1 Met. Mast, German Bight, North Sea		
Image			
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	Trial		
Description	“DNV GL was asked by IWES to carry out an independent review of data from IWES LiDAR Buoy Validations at FINO1 and to provide written acknowledgment on the wind speed and wind direction accuracy results gained within these Trials with regards to the corresponding OWA/CT Roadmap KPI Acceptance Criteria [1].” [R34]		
OWA Roadmap Maturity Claim	Accuracy requirements for Stage 2 independently confirmed by DNV GL.		
Operational experience	N/A		
Resources	DNV GL Technical Note [R34]		

D34. Fraunhofer with ZephIR 300 LiDAR FINO1 Trial, 2015

FLS OEM	Fraunhofer IWES	Other organisations	OBLEX-F1 partners (incl. NORCOWE consortium)
Start/End Date	June 2015 - September 2015	Length of campaign	3 months
Location	FINO1 Met. Mast, German Bight, North Sea		
Image	 <p>Image taken from Fraunhofer Results Presentation [R35]</p>		
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Trial		
Description	Two Fraunhofer FLS carrying different lidar types were measuring wind speed profiles up to 200 m as part of the met-ocean research campaign OBLEX-F1 campaign.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	Fraunhofer IWES Results presentation at OBLEX-F1 Workshop [R35]		

D35. Fraunhofer with WINDCUBE®v2 LiDAR FINO1 Trial, 2015

FLS OEM	Fraunhofer IWES	Other organisations	OBLEX-F1 partners (incl. NORCOWE consortium)
Start/End Date	July 2015 - September 2015	Length of campaign	2 months
Location	FINO1 Met. Mast, German Bight, North Sea		
Image	 <p>Image taken from Fraunhofer Results Presentation [R35]</p>		
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	WINDCUBE®v2 LiDAR from Leosphere		
Purpose of Deployment	Trial		
Description	Two Fraunhofer FLS carrying different lidar types were measuring wind speed profiles up to 200 m as part of the met-ocean research campaign OBLEX-F1 campaign.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	Fraunhofer IWES Results presentation at OBLEX-F1 Workshop [R35]		

D36. Fraunhofer RUNE Measuring Campaign, 2015

FLS OEM	Fraunhofer IWES	Other organisations	Technical University of Denmark (DTU) RUNE consortium
Start/End Date	November 2015 - April 2016	Length of campaign	6 months
Location	North Sea, Danish West Coast		
Image	 <p>Image taken from Fraunhofer press release [R36].</p>		
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	Measuring campaign		
Description	Used to support the RUNE research project (Reducing the Uncertainty of Near-shore wind resource estimate using onshore lidars) for DTU. Reference measurements of winds speed at heights of up to 250m were provided to support the project and to develop the use of floating LiDAR systems in a commercial environment.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	Survived storm Freja one week after installation, experiencing significant wave heights up to 4.5m.		
Resources	Fraunhofer press release [R36]		

D37. Fraunhofer FINO1 Trial, 2016

FLS OEM	Fraunhofer IWES	Other organisations	OWA, Carbon Trust ODSL for ORE Catapult (Validating party)
Start/End Date	February 2016 – August 2016	Length of campaign	6 months
Location	FINO1 Met. Mast, German Bight, North Sea		
Image	 <p>Image provided by Fraunhofer IWES</p>		
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Trial		
Description	<p>“ORE Catapult Development Services has carried out an independent verification of Fraunhofer IWES’ Floating LiDAR System Verification Trial in accordance with the new OWA Recommended Practices for Floating LiDAR Systems.</p> <p>The Fraunhofer IWES Floating LiDAR Buoy was found to meet the highest, “Best Practice”, criteria within the “OWA Roadmap for Floating LiDAR Systems” and the “OWA Recommended Practices for Floating LiDAR Systems” for all wind speed and direction metrics.” [R39]</p>		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported		
Operational experience	N/A		
Resources	ORE Catapult Floating LiDAR System Verification Report [R39]		

D38. Fraunhofer WINDCUBE®v2 Trial, 2016

FLS OEM	Fraunhofer IWES	Other organisations	DNV-GL (Validating party)
Start/End Date	November 2016 – June 2017	Length of campaign	6 months
Location	FINO3 Met. Mast, German Bight, North Sea		
Image	 <p>Image taken from DNV GL Independent Assessment Report [R40]</p>		
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	Trial		
Description	Dedicated 6-month trial for buoy with second LiDAR system.		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported		
Operational experience	N/A		
Resources	DNV GL Independent Assessment Report [R40]		

D39. Fraunhofer Firth of Forth WRA, 2017

FLS OEM	Fraunhofer IWES	Other organisations	Seagreen Wind Energy Ltd (developer)
Start/End Date	March 2017 – March 2019 (anticipated)	Length of campaign	11 months*
Location	Firth of Forth, Scotland		
Image	 <p>Image taken from Fraunhofer Press Release [R41]</p>		
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	ZephIR 300		
Purpose of Deployment	WRA		
Description	“The project from Seagreen Wind Energy Ltd encompasses a 12 to 24 month measuring campaign during which the LiDAR buoy will measure wind speeds at different heights of up to 650 feet using laser remote sensing.” [R41]		
OWA Roadmap Maturity Claim	N/A		
Operational experience	Smooth preparations and installation - see [R41]		
Resources	Fraunhofer IWES Press Release [R41]		

* The duration reported is the number of months from the deployment date to February 2018.

D40. Fraunhofer Kincardine WRA, 2017

FLS OEM	Fraunhofer IWES	Other organisations	
Start/End Date	December 2017 – December 2018 (anticipated)	Length of campaign	2 months*
Location	Kincardine OWF, Scotland		
Image	 <p>Image provided by Fraunhofer IWES</p>		
FLS	Fraunhofer IWES Wind LiDAR Buoy		
LiDAR Type	WINDCUBE®v2 LIDAR from Leosphere		
Purpose of Deployment	WRA		
Description	A wind resource assessment for the Kincardine OWF project.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	gov.scot Notice to Mariners [R42]		

* The duration reported is the number of months from the deployment date to February 2018.

4.7 NASS&WIND M3EA

FLS OEM: Nass&Wind Smart Services

LiDAR Type: Leosphere WINDCUBE®v2 OFFSHORE 8.66

Ongoing deployments as of February 2018 are marked with an asterisk (*). The duration reported in these cases is the number of months from the deployment date to February 2018.

Deployments

Ref.	Deployment Date	Duration (months)	Location	Campaign Type
D41	January 2014	11	Saint Marcouf Island, France	Trial
D42	May 2016	21*	Dunkirk, France	WRA

D41. Nass&Wind M³EA Trial, Saint Marcouf, 2014

FLS OEM	Nass&Wind Smart Services	Other organisations	DNV GL (Validating party)
Start/End Date	January 2014 – December 2014	Length of campaign	11 months
Location	Saint Marcouf Islands, Channel, North of France		
Image	 <p>Image courtesy of Nass&Wind Smart Services</p>		
FLS	M ³ EA		
LiDAR Type	WINDCUBE®v2 Offshore LiDAR from Leosphere		
Purpose of Deployment	Trial		
Description	WINDCUBE®v2 Offshore LiDAR used as a reference.		
OWA Roadmap Maturity Claim	Based on the results of this validation, DNV GL considers that the uncertainty associated with horizontal wind speed measurements undertaken by M3EA as a standalone source of wind data would be in the higher range of the indicative uncertainty of Stage 2: “Pre-commercial”. However, as an offshore LiDAR was used as a reference (as opposed to an offshore metmast as specified in the OWA Roadmap). The M3EA Floating LiDAR device type is not considered to be within Stage 2.		
Operational experience	<ul style="list-style-type: none"> • Broad validation envelope obtained (including wind speed, significant wave heights, current speed) • Two major outages occurred due to memory card issues, resulting in missing data. 		
Resources	<p>Nass&Wind Oceanology International presentation [R45]</p> <p>WINDPOWER OFFSHORE Press Release [R44]</p> <p>Nass&Wind with DNV GL EWEA Poster [R45]</p> <p>Details provided by Nass&Wind Smart Services.</p>		

D42. Nass&Wind M³EA WRA, Dunkirk, 2016

FLS OEM	Nass&Wind Smart Services	Other organisations	
Start/End Date	May 2016 - ongoing	Length of campaign	21 months*
Location	Dunkirk, France		
Image	 <p>Image taken from Offshore Wind Industry [R46]</p>		
FLS	M ³ EA		
LiDAR Type	WINDCUBE®v2 Offshore LIDAR from Leosphere		
Purpose of Deployment	WRA		
Description	Wind measurement campaign for the OWF project off Dunkirk		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	Offshore Wind Industry Press Release [R46] Deployment details and experiences contributed by Nass&Wind.		

* The duration reported is the number of months from the deployment date to February 2018.

4.8 FUGRO OCEANOR SEAWATCH

FLS OEM: Fugro Oceanor (Norway)

LiDAR Type: ZephIR 300 LiDAR (M or M equivalent)

Ongoing deployments as of February 2018 are marked with an asterisk (*). The duration reported in these cases is the number of months from the deployment date to February 2018.

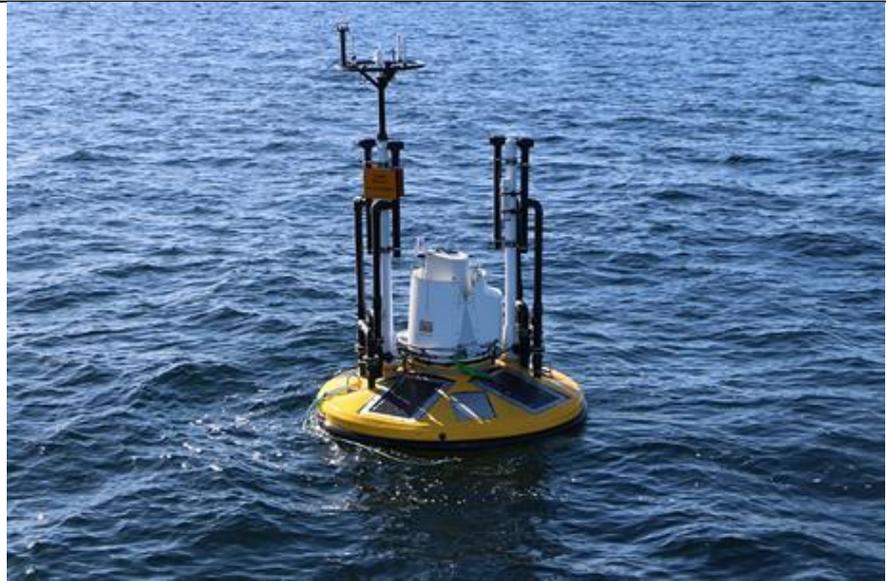
Deployments

Ref.	Deployment Date	Duration (months)	Location	Buoy ID	Campaign Type
D43	April 2014	7	Ijmuiden Met. Mast, North Sea, Netherlands	WS140	Trial
D44	February 2015	12	Navitus Bay offshore wind farm, UK	WS140	WRA
D45	March 2015	1	Titran, Frøya, Norway	WS149	Trial
D46	June 2015	3	Titran, Frøya, Norway	WS156	Trial
D47	June 2015	18	Borssele Lot 1, The Netherlands	WS149, WS156, WS157	WRA
D48	November 2015	7	East Anglia ONE Met. Mast, UK	WS155	Trial
D49	December 2015	1	Titran, Frøya, Norway	WS157	Trial
D50	February 2016	5	Borssele Lot 2, The Netherlands	WS156	WRA
D51	April 2016	1	Titran, Frøya, Norway	WS158	Trial
D52	May 2016	3	Titran, Frøya, Norway	WS140	Trial
D53	June 2016	20*	Hollandse Kust zuid, The Netherlands	WS140, WS155, WS158	WRA
D54	January 2017	1	Titran, Frøya, Norway	WS159	Trial
D55	January 2017	13*	Baltica 3, Poland	WS155, WS159	WRA
D56	March 2017	1	Titran, Frøya, Norway	WS170	Trial
D57	March 2017	1	Titran, Frøya, Norway	WS171	Trial
D58	April 2017	10*	Hollandse Kust noord, The Netherlands	WS149, WS155, WS170	WRA
D59	May 2017	9*	East Anglia THREE, UK	WS171	WRA
D60	July 2017	3	Hornsea Met. Mast, UK	WS172, WS173	Trial
D61	October 2017	4*	Hornsea, UK	WS172, WS173	WRA

D43. Fugro SEAWATCH WS140 Trial, 2014

FLS OEM	Fugro	Other organisations	Ecofys (Validating party) ECN (Reviewing party) DNV GL (Data analysis) ENECO, OWA, Carbon Trust
Start/End Date	April 2014 – November 2014	Length of campaign	7 months
Start/End Date	April 2014 – November 2014		
Location	Ijmuiden Met. Mast, North Sea, Netherlands		
Image	 <p>Image taken from Ecofys Uncertainty Assessment [R47]</p>		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS140)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Trial		
Description	The FLS was validated against the RWE Ijmuiden Offshore Met Mast, located 80km off the Dutch coast.		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported		
Operational experience	The campaign originally began in January 2014 but failed, and was re-deployed in April 2014.		
Resources	Ecofys Uncertainty Assessment [R47] DNV GL Assessment [R48]		

D44. Fugro SEAWATCH WS140 Navitus Bay WRA, 2015

FLS OEM	Fugro	Other organisations	EDF Energy (developer)
Start/End Date	February 2015 – January 2016	Length of campaign	12 months
Location	Navitus Bay offshore wind farm, English Channel, UK		
Image	 <p>Image taken from WINDPOWER Offshore press release [R49]</p>		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS140)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	WRA		
Description	<p>The project was stopped by a decision in the British Parliament 11 Sept 2015. Fugro Norway (OCEANOR) decided to keep the buoy in position as long as there was fuel left. This was until end of year 2015 and the buoy was recovered in early 2016.</p> <p>Pre-deployment validated [D43]</p>		
OWA Roadmap Maturity Claim	N/A		
Operational experience	Good availability		
Resources	<p>WINDPOWER Offshore press release [R49]</p> <p>Deployment details contributed by Fugro.</p>		

D45. Fugro SEAWATCH WS149 Pre-deployment Trial, 2015

FLS OEM	Fugro	Other organisations	DNV GL (Validating party)
Start/End Date	March 2015	Length of campaign	1 month
Location	Titran, Frøya, Norway		
Image	 <p>Image taken from DNV GL Assessment [R50]</p>		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS149)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Trial		
Description	Buoy WS149 completed a pre-deployment Trial before performing a WRA at Borssele Lot 1 [D47].		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	DNV GL Validation report [R50]		

D46. Fugro SEAWATCH WS156 Pre-deployment Trial, 2015

FLS OEM	Fugro	Other organisations	DNV GL (Validating party)
Start/End Date	June 2015 – September 2015	Length of campaign	3 months
Location	Titran, Frøya, Norway		
Image	 <p>Image taken from DNV GL Validation report [R51]</p>		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS156)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Trial		
Description	Buoy WS156 completed a pre-deployment Trial before performing a WRA at Borssele Lot 1 [D47].		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	DNV GL Validation report [R51]		

D47. Fugro SEAWATCH WRA, Borssele Lot 1, 2015 - 2017

FLS OEM	Fugro	Other organisations	Ørsted (developer)
Start/End Date	June 2015 – February 2017	Length of campaign	18 months
Location	Borssele Lot 1, The Netherlands		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS149) OCEANOR SEAWATCH Wind LiDAR buoy (WS156) OCEANOR SEAWATCH Wind LiDAR buoy (WS157)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	WRA		
Description	Pre-deployment validated (Buoys WS149, WS156 and WS157 validated by DNV GL [D45], [D46], [D49])		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<ul style="list-style-type: none"> • Excellent availability after February 2016 • Initially, LiDAR was not marinized and suffered a corrosion problem. 		
Resources	Deployment details and experiences contributed by Fugro.		

D48. Fugro SEAWATCH WS155 Trial, 2015-2016

FLS OEM	Fugro	Other organisations	Scottish Power Renewables (developer) Natural Power (Validating party) OWA, Carbon Trust
Start/End Date	November 2015 – June 2016	Length of campaign	7 months
Location	East Anglia ONE Met. Mast, UK		
Image	 <p>Image taken from offshoreWIND press release [R52]</p>		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS155)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Trial		
Description	Part of the Carbon Trust OWA LiDAR validation campaign [R37]. Good results for the KPI's both for wind speed and wind direction.		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported		
Operational experience	<ul style="list-style-type: none"> • Excellent availability in late stages • Smooth towing • Initial issue with corrosion of the communications cable causing a data loss of nearly 50%. 		
Resources	offshoreWIND press release [R52] 4c offshore press release [R53] Deployment details and experiences contributed by Fugro and Iberdrola.		

D49. Fugro SEAWATCH WS157 Pre-deployment Trial, 2015-2016

FLS OEM	Fugro	Other organisations	DNV GL (Validating party)
Start/End Date	December 2015 – January 2016	Length of campaign	1 month
Location	Titran, Frøya, Norway		
Image	 <p>Image taken from DNV GL Validation report [R54]</p>		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS157)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Trial		
Description	Buoy WS157 completed a pre-deployment Trial before performing a WRA at Borssele Lot 1 [D47]. WS157 was deployed at a later stage in the WRA than buoys WS149 and WS156.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	DNV GL Validation report [R54]		

D50. Fugro SEAWATCH WRA, Borssele Lot 2, 2016

FLS OEM	Fugro	Other organisations	Ørsted (developer)
Start/End Date	February 2016 – June 2016	Length of campaign	5 months
Location	Borssele Lot 2, The Netherlands		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS156)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	WRA		
Description	Pre-deployment validated [D46]		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<ul style="list-style-type: none"> • Excellent availability 		
Resources	Deployment details and experiences contributed by Fugro.		

D51. Fugro SEAWATCH WS158 Pre-deployment Trial, 2016

FLS OEM	Fugro	Other organisations	DNV GL (Validating party)
Start/End Date	April 2016 – May 2016	Length of campaign	1 month
Location	Titran, Frøya, Norway		
Image	 <p>Image taken from DNV GL Validation report [R56]</p>		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS158)		
LiDAR Type	ZepHIR 300		
Purpose of Deployment	Trial		
Description	Buoy WS158 completed a pre-deployment Trial before performing a WRA at Hollandse Kust zuid [D53].		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	DNV GL Validation report [R56]		

D52. Fugro SEAWATCH WS140 Pre-deployment Trial, 2016

FLS OEM	Fugro	Other organisations	DNV GL (Validating party)
Start/End Date	May 2016 – August 2016	Length of campaign	3 months
Location	Titran, Frøya, Norway		
Image	 <p>Image taken from DNV GL Validation report [R55]</p>		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS140)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	Trial		
Description	Buoy WS140 completed a pre-deployment Trial before performing a WRA Hollandse Kust zuid [D53]		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	DNV GL Validation report [R56]		

D53. Fugro SEAWATCH Hollandse Kust zuid WRA, 2016 - 2018

FLS OEM	Fugro	Other organisations	Ørsted (developer)
Start/End Date	June 2016 – June 2018 (anticipated)	Length of campaign	20 months*
Location	Hollandse Kust zuid, The Netherlands		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS140) OCEANOR SEAWATCH Wind LiDAR buoy (WS155) OCEANOR SEAWATCH Wind LiDAR buoy (WS158)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	WRA		
Description	Commercial WRA and met-ocean measurements. Pre-deployment validated		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<ul style="list-style-type: none"> • Good availability • Good data accuracy • One incident where a vessel cut the mooring. 		
Resources	Deployment details and experiences contributed by Fugro.		

* The duration reported is the number of months from the deployment date to February 2018.

D54. Fugro SEAWATCH WS159 Pre-deployment Trial, 2017

FLS OEM	Fugro	Other organisations	DNV GL (Validating party)
Start/End Date	January 2017 – February 2017	Length of campaign	1 month
Location	Titran, Frøya, Norway		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS159)		
LiDAR Type	ZephIR 300 LiDAR		
Purpose of Deployment	Trial		
Description	Buoy WS159 completed a pre-deployment Trial before performing a WRA at Baltica 3 [D55].		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	Deployment details and experiences contributed by Fugro.		

D55. Fugro SEAWATCH Baltica 3 WRA, 2017 - 2019

FLS OEM	Fugro	Other organisations	
Start/End Date	January 2017 – February 2019 (anticipated)	Length of campaign	13 months*
Location	Baltica 3, Poland		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS155) OCEANOR SEAWATCH Wind LiDAR buoy (WS159)		
LiDAR Type	ZephIR 300		
Purpose of Deployment	WRA		
Description	Commercial WRA and met-ocean measurements. Pre-deployment validated (WS155 [D48], WS159 [D54]).		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<ul style="list-style-type: none"> • Good availability 		
Resources	Deployment details and experiences contributed by Fugro.		

* The duration reported is the number of months from the deployment date to February 2018.

D56. Fugro SEAWATCH WS170 Pre-deployment Trial, 2017

FLS OEM	Fugro	Other organisations	DNV GL (Validating party)
Start/End Date	March 2017	Length of campaign	1 month
Location	Titran, Frøya, Norway		
Image	 <p>Image taken from DNV GL Validation Report [R57]</p>		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS170)		
LiDAR Type	ZephIR 300M		
Purpose of Deployment	Trial		
Description	Buoy WS170 completed a pre-deployment Trial before performing a WRA at Hollandse Kust Noord [D58]		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	DNV GL Validation Report [R57] Deployment details and experiences contributed by Fugro.		

D57. Fugro SEAWATCH WS171 Trial, 2017

FLS OEM	Fugro	Other organisations	DNV GL (Validating party)
Start/End Date	March 2017 – April 2017	Length of campaign	1 month
Location	Titran, Frøya, Norway		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS171)		
LiDAR Type	ZephIR 300M		
Purpose of Deployment	Trial		
Description	N/A		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	Deployment details and experiences contributed by Fugro.		

D58. Fugro SEAWATCH Hollandse Kust noord WRA, 2017 - 2018

FLS OEM	Fugro	Other organisations	
Start/End Date	April 2017 – April 2018	Length of campaign	10 months*
Location	Baltik III, Norway		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS149) OCEANOR SEAWATCH Wind LiDAR buoy (WS155) OCEANOR SEAWATCH Wind LiDAR buoy (WS170)		
LiDAR Type	ZephIR 300M or M equivalent		
Purpose of Deployment	WRA		
Description	Commercial WRA and met-ocean measurements. Buoys WS149, WS155 and WS170 pre-deployment validated by DNV GL ([D45], [D48], [D56] respectively)		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<ul style="list-style-type: none"> • Good availability • Good data accuracy 		
Resources	Deployment details and experiences contributed by Fugro.		

* The duration reported is the number of months from the deployment date to February 2018.

D59. Fugro SEAWATCH East Anglia THREE WRA, 2017 - 2018

FLS OEM	Fugro	Other organisations	Scottish Power Renewables (developer)
Start/End Date	May 2017 – May 2018 (anticipated)	Length of campaign	9 months*
Location	East Anglia THREE, UK		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS171)		
LiDAR Type	ZephIR 300M		
Purpose of Deployment	WRA		
Description	Commercial WRA and met-ocean measurements. Buoy was pre-deployment validated [D56]		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<ul style="list-style-type: none"> • Good availability 		
Resources	Deployment details and experiences contributed by Fugro.		

* The duration reported is the number of months from the deployment date to February 2018.

D60. Fugro SEAWATCH Hornsea Trial, 2017

FLS OEM	Fugro	Other organisations	Ørsted (developer)
Start/End Date	July 2017 – September 2017	Length of campaign	3 months
Location	Hornsea Met. Mast, UK		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS172) OCEANOR SEAWATCH Wind LiDAR buoy (WS173)		
LiDAR Type	ZephIR 300M		
Purpose of Deployment	Trial		
Description	LiDAR units were validated onshore to capture the required data range and offshore trial undertaken against met mast. This work was part of FLS contract. Internal Validation carried out by Ørsted.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<p>Successful deployment.</p> <p>Good co-operation from site team.</p> <p>Quick manufacture & delivery time.</p> <p>Using field engineers from multiple locations.</p> <p>Supplier open to adaptations of SWLB to Ørsted's Specifications.</p> <p>Some challenges with directional measurements - OWA KPI's achieved but with a degree of scatter remaining.</p>		
Resources	Details contributed by Ørsted.		

D61. Fugro SEAWATCH Hornsea WRA, 2018-2019

FLS OEM	Fugro	Other organisations	Ørsted (developer)
Start/End Date	October 2017 – October 2018 (anticipated)	Length of campaign	4 months*
Location	Hornsea, UK		
Image	No image available		
FLS	OCEANOR SEAWATCH Wind LiDAR buoy (WS172) OCEANOR SEAWATCH Wind LiDAR buoy (WS173)		
LiDAR Type	ZephIR 300M		
Purpose of Deployment	WRA		
Description	Commercial WRA and met-ocean measurements. Buoys were pre-deployment validated by DNV GL.		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A – Future deployment		
Resources	Details contributed by Fugro.		

* The duration reported is the number of months from the deployment date to February 2018.

4.9 BABCOCK FORECAST

FLS OEM: Babcock

LiDAR Type: Zephir 300 LiDAR

Deployments

Ref.	Deployment Date	Duration (months)	Location	Campaign Type
D62	May 2014	6	Gwynt-y-Môr wind farm zone, Irish Sea, UK	Trial
D63	October 2016	15	Aberdeen Offshore Wind Farm (EOWDC), Scotland	WRA

D62. Babcock FORECAST Trial, Gwynt-y-Môr, 2013-2015

FLS OEM	Babcock	Other organisations	RWE OWA, Carbon Trust, Frazer-Nash Consultancy DNV GL
Start/End Date	May 2014 – November 2014	Length of campaign	6 months
Location	Gwynt-y-Môr wind farm zone, Irish Sea, UK		
Image	 <p>Image taken from ZephIR LiDAR press release [R58]</p>		
FLS	FORECAST		
LiDAR Type	Zephir 300		
Purpose of Deployment	Trial		
Description	<p>The FLS was initially deployed in October 2013 for an initial development phase where individual systems were tested. The validation then began in August 2014 and was carried out over a period of 6 months [R58].</p> <p>Part of the Carbon Trust OWA LiDAR validation campaign [R37].</p>		
OWA Roadmap Maturity Claim	Stage 2 maturity independently reported		
Resources	<p>ZephIR LiDAR press release [R58]</p> <p>Carbon Trust OWA Floating LiDAR Campaign: Babcock trial at Gwynt Y Môr [R59]</p>		
Operational experience	N/A		

D63. Babcock FORECAST WRA, EOWDC 2016 - 2018

FLS OEM	Babcock	Other organisations	Vattenfall (Wind farm owner) Aberdeen Offshore Wind Farm Ltd
Start/End Date	October 2016 – January 2018	Length of campaign	15 months
Location	Aberdeen Offshore Wind Farm (EOWDC), Scotland		
Image	 <p>Image taken from offshoreWIND press release [R60]</p>		
FLS	FORECAST		
LiDAR Type	Zephir 300 LiDAR		
Purpose of Deployment	WRA		
Description	Previously validated at Gwynt-y-Môr [D62] as part of the Carbon Trust’s OWA LiDAR validation campaign [R37].		
OWA Roadmap Maturity Claim	N/A		
Operational experience	Installation went well and the power system and buoy performed well. Some problems reported with the data logger and memory issue on LiDAR.		
Resources	Offshore wind press release [R60] Deployment details and experiences contributed by Vattenfall.		

4.10 SEALIDAR

D64. seaLIDAR Trial, Greece, 2015

FLS OEM	seaLIDAR	Other organisations	
Start/End Date	July 2015	Length of campaign	Unknown
Location	Thermaikos Gulf, Greece		
Image	 <p>Image taken from Windpower Engineering & Development press release [R61]</p>		
FLS	seaLIDAR		
LiDAR Type	ZephIR 300 LIDAR		
Purpose of Deployment	Trial		
Description	N/A		
OWA Roadmap Maturity Claim	N/A		
Operational experience	N/A		
Resources	Windpower Engineering & Development press release [R61]		

4.11 ACCURASEA - EOLFI SPAR BUOY

D65. Eolfi Spar FLS, Le Planier Test campaign, 2016-2017

FLS OEM	Eolfi	Other organisations	NKE Instrumentation Ifremer, IRSEEM Wood Group
Start/End Date	May 2016 – September 2017	Length of campaign	17 months
Location	Le Planier, France		
Image	 <p>Deployment of the BLidar buoy at Le planier</p> <p>Image courtesy of Eolfi</p>		
FLS	Spar Floating LiDAR System		
LiDAR Type	Mitsubishi Diabrezza		
Purpose of Deployment	Test campaign, wind data collection		
Description	Part of the BLIDAR campaign. The new FLS system completed a 17 month test campaign and results will be certified by Wood Group, an independent third party. A second measurement campaign is planned to validate the FLS against the Roadmap. [R62]		
OWA Roadmap Maturity Claim	N/A		
Operational experience	Good overall system availability Installation/retrieval of the buoy went well Good buoy robustness and stability Good quality and availability of wind speed and direction measurements (In accordance with the Acceptance Criteria from the OWA Roadmap)		
Resources	OffshoreWIND Press Release [R62] Deployment details and experiences contributed by EOLFI.		

4.12 AKROCEAN WINDSEA

FLS OEM: AKROCEAN

LiDAR Type: Leosphere WINDCUBE®v2 LIDAR, Zephir 300

Ongoing deployments as of February 2018 are marked with an asterisk (*). The duration reported in these cases is the number of months from the deployment date to February 2018.

Deployments

Ref.	Deployment Date	Duration (months)	Location	Campaign Type
D66	July 2017	7*	Oléron Island, France	WRA
D67	March 2018	Not started	Fécamp Met. Mast	Trial

D66. AKROCEAN WINDSEA Oléron Island WRA, 2017-2018

FLS OEM	AKROCEAN	Other organisations	Meteo France (developer)
Start/End Date	July 2017 – September 2018 (anticipated)	Length of campaign	7 months*
Location	Oléron Island, France		
Image	 <p>Image provided by AKROCEAN.</p>		
FLS	WINDSEA		
LiDAR Type	Leosphere WINDCUBE®v2 LIDAR		
Purpose of Deployment	WRA		
Description	A one-year wind assessment campaign for Meteo France		
OWA Roadmap Maturity Claim	N/A		
Operational experience	<p>Pre-commissioning and installation went smoothly</p> <p>Good LiDAR measurements availability and quality (excellent correlation with METEO France wind models)</p> <p>Good collaboration with maintenance teams and supervision centre and good working conditions on-site</p> <p>Sea state complicated sinker deployment</p> <p>Effective response from secondary power systems following a failure of the main power allowed a quick recovery and re-deployment (system fully functional again after <30 hours)</p> <p>Minor problems with data reconstruction with 3D motion compensation algorithm while raw data were OK. Software update solved the problem.</p>		
Resources	<p>AKROCEAN presentation [R63]</p> <p>Deployment details and experiences contributed by AKROCEAN.</p>		

* The duration reported is the number of months from the deployment date to February 2018.

D67. AKROCEAN WINDSEA Trial, 2018

FLS OEM	AKROCEAN	Other organisations	DNV GL
Start/End Date	March 2018 – October 2018 (anticipated)	Length of campaign	Not yet started
Location	Northern Europe Onshore Met. Mast and Fécamp offshore Met. Mast		
Image	 <p>© Airbus Helicopters / Akrocean - All rights reserved.</p> <p>Image provided by AKROCEAN.</p>		
FLS	WINDSEA		
LiDAR Type	Leosphere WINDCUBE®v2 LIDAR + ZephIR 300 LiDAR		
Purpose of Deployment	Trial		
Description	Type 2 validation deployment with dual LIDAR Offshore trials reviewed by DNV GL		
OWA Roadmap Maturity Claim	N/A – Future deployment		
Operational experience	N/A – Future deployment		
Resources	AKROCEAN presentation [R63] Deployment details and experiences contributed by AKROCEAN.		

4.13 DEWI WITH LEOSPHERE

D68. DEWI Lightship based FLS, Trial 2017-2018

FLS OEM	DEWI by UL international	Other organisations	
Start/End Date	August 2017 – ongoing	Length of campaign	5 months*
Location	German Bight, North Sea		
Image	No image available		
FLS	Wind LiDAR on a lightship (moored) + AHRS/GPS sensors		
LiDAR Type	WINDCUBE V2		
Purpose of Deployment	Trial		
Description	Comparison with a wind LiDAR at Helgoland Island (WindCube WLS8-8)		
OWA Roadmap Maturity Claim	Unknown		
Operational experience	No problems reported		
Resources	Presented at DEWEK17 conference		

* The duration reported is the number of months from the deployment date to February 2018.

5.2 IRISH SEA, NORTH SEA

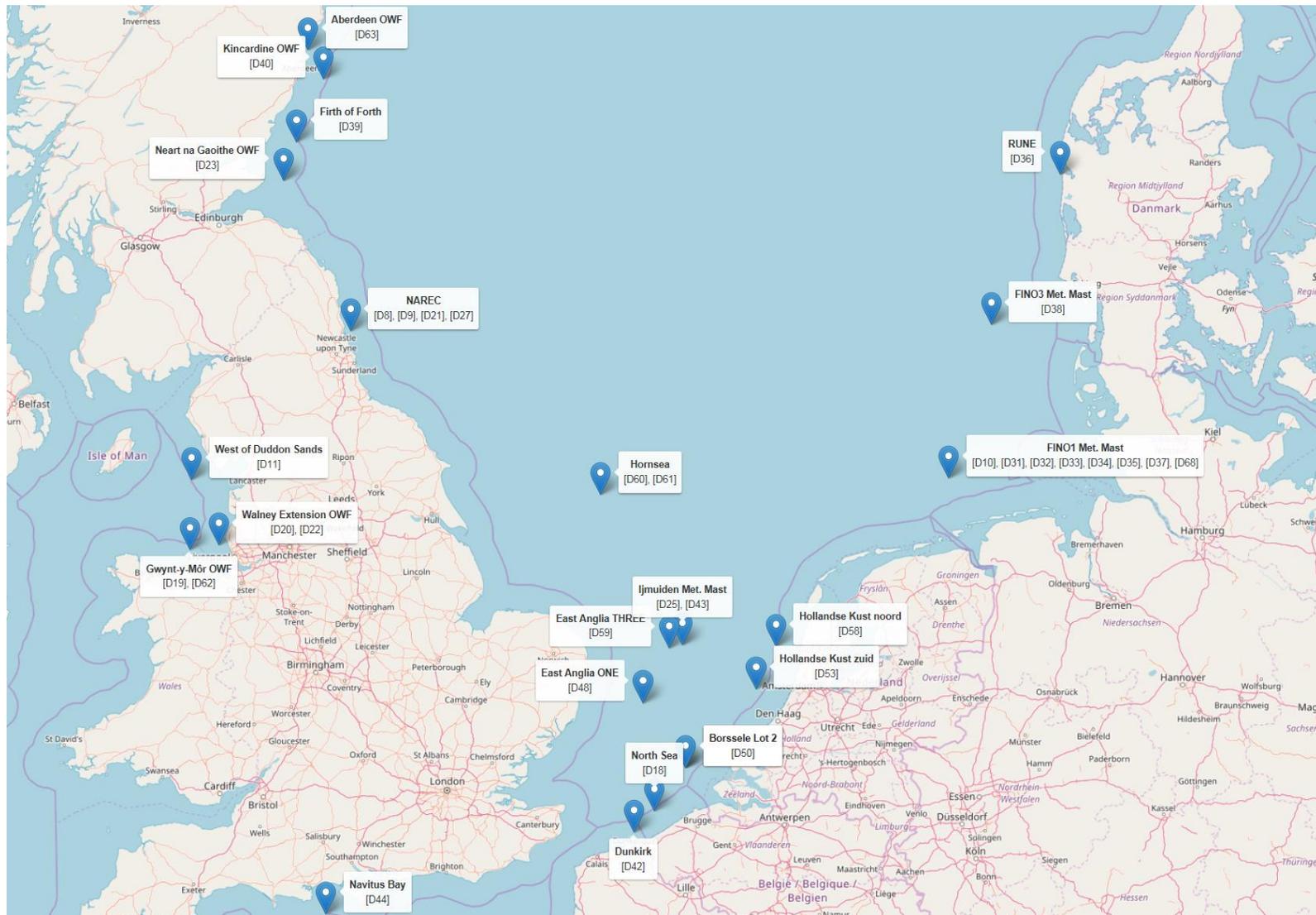


Figure 3: Locations of deployments in the Irish Sea and North Sea. Image produced using Leaflet © OpenStreetMap.

5.3 SOUTHWEST EUROPE



Figure 4: Locations of deployments off the coasts of France and Portugal and in the Mediterranean Sea. Image produced using Leaflet © OpenStreetMap.

5.4 USA

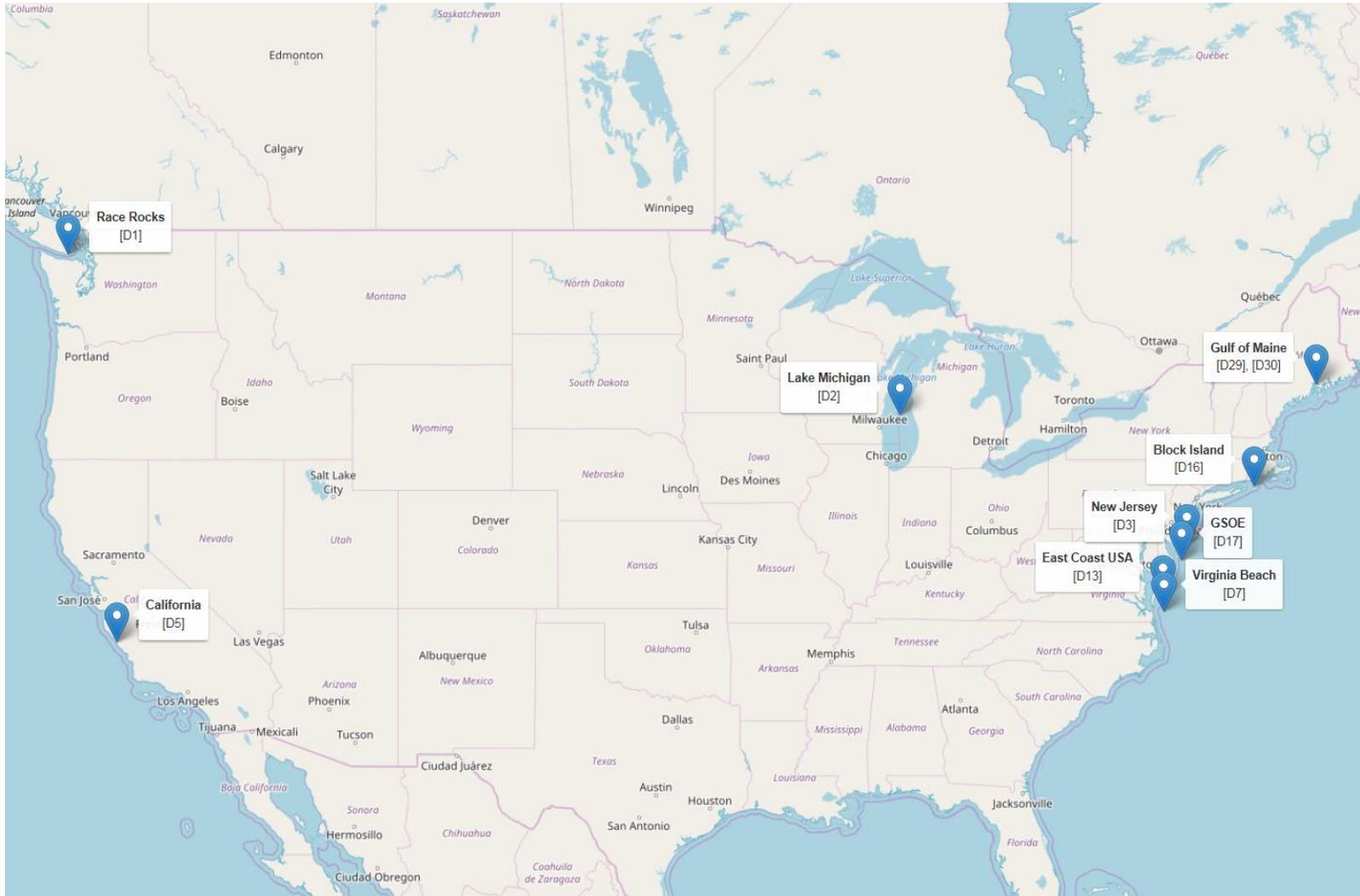


Figure 5: Locations of USA deployments. Image produced using Leaflet © OpenStreetMap.

5.5 BALTIC AND NORWEGIAN SEA

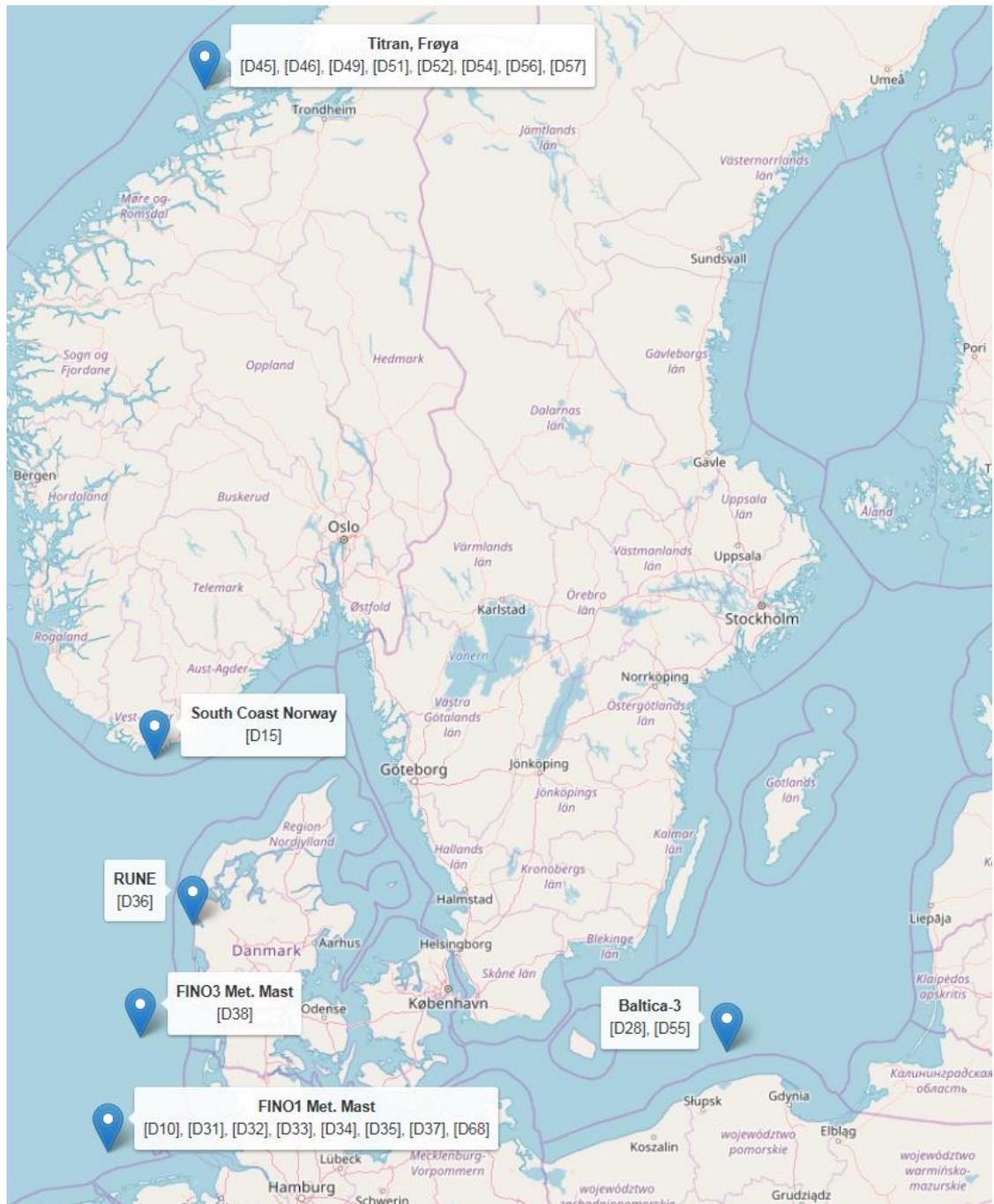


Figure 6: Locations of deployments in the Baltic and Norwegian Sea. Image produced using Leaflet © OpenStreetMap.

6. GENERAL OPERATIONAL EXPERIENCE FEEDBACK

As part of the research conducted to compile this document, the operational experiences and problems encountered by FLS users were obtained from a variety of sources. A number of items are included in the list of deployments (Section 4). In many cases stakeholders made more general statements or did not wish to attribute deployment issues to particular deployments due to commercial sensitivities. To aid future FLS developments and updates to the Roadmap these experiences are listed anonymously in this section. Entries have been edited for brevity.

- Hardware damage due to sea state, drifting debris or other vessels.
- Water ingress to electronics causing systems to malfunction and communication problems.
- On-board power generation being insufficient for offshore applications.
- Damage caused during deployment (dropping buoy on deck) or by equipment (e.g. collision with crane, entanglement of mooring and tow lines, failures in lines).
- Rusting and corrosion.
- Inoperative wind turbines, solar panels or other power supply components.
- Tangling and breakage of mooring lines, in some cases due to fishing activities.
- Vandalism to the FLS including theft.
- Failure of memory units.
- Failure of communication links and hardware.
- Availability of vessels complying with the health and safety standards of validating parties.

7. REFERENCES

- R1. Carbon Trust Offshore Wind Accelerator roadmap for the commercial acceptance of floating LiDAR technology (November, 2013). <https://www.carbontrust.com/media/422195/ctc819-owa-roadmap-commercial-acceptance-floating-lidar-technologies.pdf>
- R2. AXYS Technologies: WindSentinel Field Test Data Summary (March, 2010). <http://axystechnologies.com/wp-content/uploads/2013/12/Windsentinel-Race-Rocks-trial-report.pdf>
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