Report 2022

# Task 49

**WindFloat Atlantic final hookup at Viana do Castelo, Northern Portugal**
*Photo: The Windfloat Atlantic project / Principle Power. Artist: DOCK90*

# Integrated Design of Floating Wind Arrays (IDeA)

**Authors** *Matthew Hall and Matt Shields, National Renewable Energy Laboratory (NREL), United States; Cian Desmond, Gavin & Doherty Geosolutions, Ireland; Pauline Bozonnet and Emmanuel Persent, IFP Energies Nouvelles, France; Konstanze Kölle, SINTEF Energy, Norway; Clément Mochet, BlueFloat Energy, France.*

**IEA Wind Task 49 aims to accelerate the sustainable commercialisation of floating wind arrays by developing open-access reference information and designs.**

As floating wind technology expands to larger scales and a wider range of site conditions, the industry faces unique challenges associated with having many large floating wind energy systems in an array. These challenges extend beyond individual turbines to instead encompass multidisciplinary considerations such as designing reliable and effective stationkeeping systems, optimising array layouts for specific site conditions, mitigating system-level risks, and coexisting with ocean users. A holistic approach to these challenges will help ensure the efficient and

responsible development of floating wind energy systems.

IEA Wind Task 49 is a four-year project initiated in December 2021 focused on the Integrated Design of Floating Wind Arrays. The Task brings together floating wind experts from around the world to develop datasets, methodologies, and insights which enable more holistic floating wind research and development. In its second year, the Task's work packages are in the process of developing reference site conditions, reference array designs, an array-level risk assessment framework, and a register of major research and planning questions faced by the industry. These resources will be combined into an open-access repository to help provide a standardised foundation for future innovation, development, and industrialisation of floating wind projects worldwide. Task participants include representatives from project developers, technology providers, universities, consultancies, regulatory agencies, and research institutions from 12 countries. By working together, this diverse group brings a comprehensive and global perspective to address key questions facing the floating wind industry.

## Introduction

IEA Wind Task 49 aims to accelerate the sustainable commercialisation of floating wind arrays by developing open-access reference information and designs. As floating wind technology expands to larger scales and a wider range of site conditions, the industry faces a set of unique challenges to scale from existing demonstration projects to commercial-scale floating arrays. These challenges are not constrained to individual turbine systems but instead encompass multidisciplinary considerations. These include the mooring, anchor, and cabling design, array layout optimization, installation and operational logistics, environmental and marine spatial planning impacts, and failure modes and analysis for utility-scale floating wind projects. The goal of Task 49 is to facilitate international collaborative research that helps address these challenges.
Task 49 has four work packages (Figure 1) targeted at different challenges. Their respective objectives are as follows:

- WP1: Curate a set of site conditions representative of the global floating wind pipeline.
- WP2: Develop reference array designs for typical site conditions and technology types.
- WP3: Catalogue array-level failure risks, consequences, and mitigation strategies.
- WP4: Identify critical innovation opportunities and marine spatial planning requirements.

The Task 49 membership includes 12 countries and 78 organisations, including a share of industry participants, some of whom have had a strong involvement in meetings and discussions. Table 1 lists the countries participating.

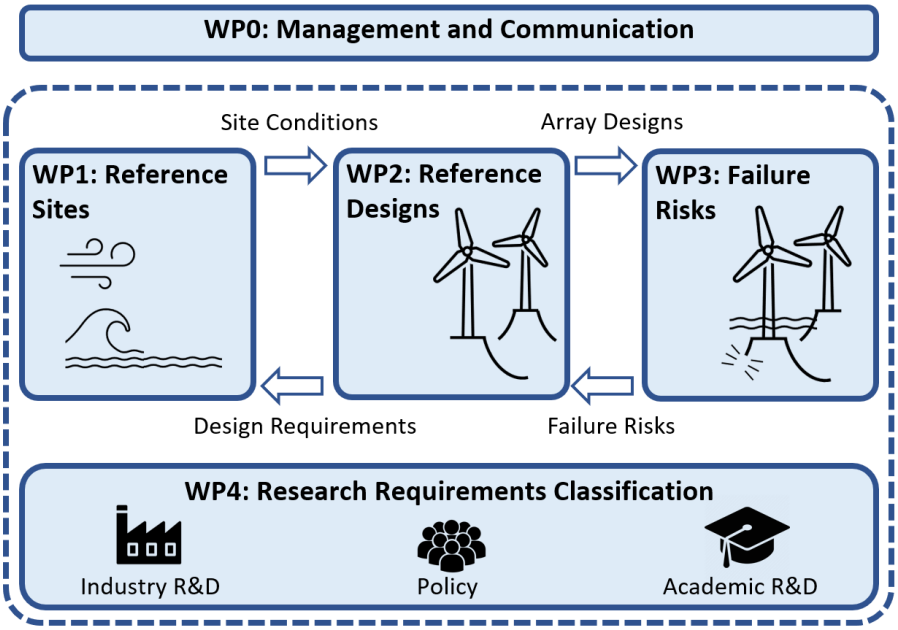


**Figure 1.** Task 49 work packages.

**Table 1. Countries Participating in the Task.**

| | COUNTRY/SPONSOR | INSTITUTION(S) |
|---|---|---|
| 1 | **China** | CWEA |
| 2 | **Denmark** | DTU, PeakWind, DHI |
| 3 | **France** | BlueFloat, BV, BW Ideol, FEE, France Energies Marines, IFPEN, RWE, Safier, SBM Offshore, Supergrid Institute, Valorem, Technip Energies |
| 4 | **Germany** | Fraunhofer, Uni Aachen, GICON, Ramboll, Sowento, TUHH, Uni Stuttgart, Woelfel |
| 5 | **Ireland** | GDG, Subsea Micropiles, TfI Marine, Trinity College Dublin, UCD, UCC |
| 6 | **Italy** | Politecnico di Tornio, RSE |
| 7 | **Japan** | Shimizu Corp, Ashikaga University |
| 8 | **Netherlands** | TU Delft, MARIN, Vryhof, TNO, Deltares |
| 9 | **Norway** | 4subsea, NGI, Norce, NTNU, Sintef Energy, Ui Agder, Ui Bergen, Ui Stavanger, IFE |
| 10 | **South Korea** | Institute for Advanced Engineering, KETEP, KIT Valley, U Ulsan |
| 11 | **UK** | University of Edinburgh, Acteon, DNV GL, Interocean, JDR Cables, Lloyds Register, ORE Catapult, QUB, U Aberdeen, U Bristol, U Strathclyde, First Energy Development |
| 12 | **USA** | ABS, BOEM, Delmar, Glosten, NREL, Ocergy, Principle Power, Ram Power, U Delaware, Triton Systems, UMaine, UMass, Woods Hole, DOE WETO |

## Progress and Achievements

Task 49 kicked off in December of 2021 and the work packages began at different times over the first year. Each work package has made progress as the Task proceeds through its second year.

WP1: Reference sites. For this WP, a framework has been developed for aggregating country-by-country site conditions into modular groups of conditions for reference sites. It is using this framework to develop a set of reference site conditions that can be used for various floating wind research applications. The process includes gathering metocean conditions for relevant floating wind sites and identifying the most prominent characteristics that should be captured in the reference site conditions. The social and environmental impact of floating wind arrays is also considered.

WP2: The Reference array designs WP has gathered a broad collective vision for developing reference floating wind array designs to serve the needs of the floating wind research field and industry. Through online information-gathering exercises and numerous meetings of five different working groups, WP2 created tables that represent a consensus perspective on the reference array design scope, features of interest, and designs to be developed. The group then collaboratively drafted a design basis to guide the reference design process and serve as a resource for future design efforts. The design basis is being finalised and will also incorporate site condition inputs from WP1.

WP3: The WP, Failure risks, has developed the scope and goals for a floating wind farm failure risks assessment framework. A core team of specialists was formed encompassing the following areas: Failure modes, effects, and criticality analysis (FMECA), monitoring systems, mooring systems, insurance, classification, project development, and technical advisory. The kick-off meeting was recently held on the 9th of March 2023. WP3 will compile information on floating wind farm failure modes and failure rates, which will be used to identify the greatest failure risks and inform the development of reference array designs.

WP4: The Innovations and marine spatial planning WP has formulated questionnaires to distribute to stakeholders in each participating country to understand major research and

deployment questions for floating wind in that country. It is conducting the initial round of engagement with the Marine Spatial Planning (MSP) community.

Several interviews have already been performed and are being synthesised. The results will be shared once all countries have been engaged and the results have been aggregated and processed.

## Highlight(s)

Task 49 developed a plan for creating reference floating wind array designs through a highly collaborative process involving input from over 50 international experts from research institutions, government agencies, and industry. WP2 formed five working groups on different aspects of the design problem and held numerous discussions to ensure that a broad range of viewpoints was incorporated. The resulting plan for reference designs involves three general designs for shallow-, intermediate-, and deep-water regions and different design variants in each category to incorporate different design features (Table 2).

At the Wind Energy Science Conference (WESC 2023) in Glasgow, Scotland, Task 49 is organising a mini symposium to present initial results from each work package, hear from other related projects, and facilitate discussion beyond the Task. A separate meeting will support further in-person Task planning and collaboration.

To understand the needs, approaches, and challenges for marine spatial planning (MSP) of floating wind projects, WP4 has been engaging with MSP experts from each participating country. The information from these discussions is being collated and will be used to develop deeper insights into MSP best practices and challenge areas.

Task 49 is collaborating with participants from IEA Wind Task 28 on the social impact of floating wind arrays, and with IEA Wind Task 37 on systems engineering and reference design best practices.

## Outcomes and Significance

As the floating wind field increasingly focuses on large-scale deployment, R&D projects require more realistic site condition inputs and a starting point for full floating wind farm designs. By looking at site conditions around the world and assembling representative datasets, WP1 will generate site condition information that can be used in future floating wind research and development efforts. Additionally, the reference array designs developed in WP2 will provide a much-needed baseline of design information to make it easier for researchers to study challenges at the scale of full floating wind farms.

Looking ahead as floating wind development expands, the risks of failures at the array scale are a key uncertainty and practices to manage multiple uses are a growing challenge. By categorising failure risks and their array-level implications, WP3 will provide insights that can inform industry decisions and focus mitigation efforts. Marine spatial planning challenges and best practices identified by WP4 from a broad set of countries will increase international awareness and facilitate the adoption of best practices for responsibly integrating floating wind development accounting for the surrounding environment and stakeholders.

## Next Steps

As Task 49 proceeds through its second year, each work package is advancing toward its objective:

- WP1 will finalise the site conditions framework and assemble the database of reference site conditions.

**Table 2. Proposed organisation of floating wind array reference designs.**

| DESIGN CATEGORY | SHALLOW WATER | INTERMEDIATE WATER | DEEP WATER |
|---|---|---|---|
| **Design aspects of focus** | Shallow water mooring/ cabling issues | Seabed irregularities, anchor innovations | Deep water mooring/ cabling issues |
| **Nominal water depth** | 80 m | 250 m | 800 m |
| **Initial platform type** | Semisubmersible | Semisubmersible / Spar | Semisubmersible / Spar |
| **Initial mooring type** | Semi-taut | Catenary chain | Taut rope |
| **Potential design variants (in order of priority)** | V1: Uniform seabed<br>V2: Sloped seabed<br>V3: Load reduction devices | V1: Uniform seabed<br>V2: Irregular seabed conditions/obstacles<br>V3: Shared anchors | V1: Uniform seabed<br>V2: Sloped seabed<br>V3: Shared mooring lines<br>V4: Tension-leg platforms |

- WP2 will complete the design basis, include site inputs from WP1, and then design the sub-systems that will be part of the reference array designs.

- WP3 will gather existing knowledge on failure modes, define a base case with WP1 and WP2, and subsequently develop a framework for floating wind failures.

- WP4 will complete its engagement with the MSP community, analyse the results and identify research priorities to inform the other work packages.

## Contacts

Matthew Hall,
National Renewable Energy Laboratory (NREL), United States.
Cian Desmond,
Gavin & Doherty Geosolutions (GDG), Ireland.
Pauline Bozonnet,
IFP Energies Nouvelles (IFPEN), France.

Emails:
matt.shields@nrel.gov
csdesmond@gdgeo.com
pauline.bozonnet@ifpen.fr

Website:
www.iea-wind.org/task49/