FLOATECH

D1.3. Training Manual, Project Partner Workshop and Public Dissemination

DATE OF DELIVERY - 30/06/2022

AUTHOR(S) – JOSEPH SAVERIN, DAVID MARTEN, SEBASTIAN PEREZ-BECKER, ROBERT BEHRENS DE LUNA
TECHNISCHE UNIVERSITÄT BERLIN

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007142

FLOATECH
THE FUTURE OF FLOATING WIND TURBINES

Document track details

Project acronym	FLOATECH
Project title	Optimization of floating wind turbines using innovative control techniques and fully coupled open-source engineering tool
Starting date	01.01.2021
Duration	36 months
Programme	H2020-EU.3.3.2. - Low-cost, low-carbon energy supply
Call identifier	H2020-LC-SC3-2020-RES-RIA
Grant Agreement No	101007142

Deliverable Information	
Deliverable number	1.3
Work package number	1
Deliverable title	Training Manual, Project Partner Workshop and Public Dissemination
Lead beneficiary	Technische Universität Berlin
Author	Joseph Saverin
Due date	30.06.2022
Actual submission date	30.06.2022
Type of deliverable	Report
Dissemination level	Public

Version management

Document history and validation			
Version	**Name**	**Date**	**Comment**
V 0.1	J. Saverin, TU Berlin	29/06/2022	First draft. Reviewed by R. Behrens de Luna.
V 0.2	J. Saverin, TU Berlin	30/06/2022	Updated draft internally reviewed

Background: about the FLOATECH project

The FLOATECH project is a Research and Innovation Action funded by the European Union's H2020 programme aiming to increase the technical maturity and the cost competitiveness of floating offshore wind (FOW) energy. This is particularly important because, due to the limitations of available installation sites onshore, offshore wind is becoming crucial to ensure the further growth of the wind energy sector.

The project is implemented by a European consortium of 5 public research institutions with relevant skills in the field of offshore floating wind energy and 3 industrial partners, two of which have been involved in the most recent developments of floating wind systems.

The approach of FLOATECH can be broken down into three actions:

- The development, implementation and validation of a user-friendly and efficient design engineering tool (named QBlade-Ocean) performing simulations of floating offshore wind turbines with an unseen combination of aerodynamic and hydrodynamic fidelity. The advanced modelling theories will lead to a reduction of the uncertainties in the design process and an increase of turbine efficiency.
- The development of two innovative control techniques (i.e. Active Wave-based feed-forward Control and the Active Wake Mixing) for Floating Wind Turbines and floaters, combining wave prediction and anticipation of induced platform motions. This is expected to improve the performance of each machine and to minimize wake effects in floating wind farms, leading to a net increase in the annual energy production of the farm.
- The economic analysis of these concepts to demonstrate qualitatively and quantitatively the impact of the developed technologies on the Levelized Cost of Energy (LCOE) of FOW technology.

In addition to the technological and economic impacts, the project is expected to have several impacts at societal, environmental and political levels, such as: public acceptance, due to no noise and visibility issues of FOWT; very low impact on biodiversity and wildlife habitat because no piles are needed be to installed into the seabed; the use of less material and space thanks to an environmentally friendly design; the promotion of the installation of FOW in transitional water depths (30-50 meters), as the costs for FOW at those locations will become more competitive compared to the fixed bottom foundations.

Table of contents

EXECUTIVE SUMMARY 5

1. TRAINING MANUAL 6
   1.1. THEORY GUIDE 6
   1.2. USER'S GUIDE 7
   1.3. VALIDATION CASES AND EXAMPLES 7
   1.4. LICENSE INFO 7

2. PROJECT PARTNER WORKSHOP 8
   2.1. WORKSHOP FORMAT 8
   2.2. PARTICIPANTS 9

3. PUBLIC DISSEMINATION 10

4. REFERENCES 10

EXECUTIVE SUMMARY

This document is a deliverable of the FLOATECH project, funded under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007142.

The aim of this document is to present a report detailing the work carried out relevant to the main tasks of Deliverable 1.3 of work package 1 of the project. The main task of this work package is the development of the open-source wind turbine simulation software suite QBlade to enable the simulation of offshore wind turbine platforms. Deliverable 1.3 revolves around the preparation of the software package and corresponding training material to facilitate uptake of the code and general public use. This is composed of three separate subtasks:

- **Training Manual:** This has been prepared as an online manual to provide the user with all the necessary information to correctly operate the software. This has been prepared with two sections: The theory manual gives a detailed description of the physical models applied in the implementation of QBlade. The user guide gives a detailed overview of generating simulations and specifying inputs to the various modelling tools available in the software.

- **Project Partner Workshop:** In order to ensure that the project partners of FLOATECH have the material and experience necessary to generate simulations within QBlade, a project partner workshop was held from Wed. 22nd to Friday 24th June 2022. A combination of presentation material and practical exercises was used to provide the users with practical experience applying the software.

- **Public Dissemination:** The QBlade website has been prepared to ensure that the public has easy access to the source code and the compiled binaries on a range of platforms. In addition, the QBlade website will serve as a platform for communications regarding the user manual, past and upcoming events and publications relevant to the use of QBlade.

These three tasks constitute the dissemination of the QBlade software along with the necessary material for members of the public and industry to easily apply the software and hence represent the final deliverable of work package 1 of the FLOATECH project. In the following, each of the above-mentioned tasks is described in greater detail.

1. TRAINING MANUAL

A comprehensive set of online documentation sources have been prepared to enable users to access all information relevant to the preparation and execution of a simulation in QBlade. This is accesible online via the QBlade ReadTheDocs page, hosted over the open-source documentation platform ReadtheDocs [2], linked through the QBlade website [1]. The source for the generation of the page has been prepared with the document generation package Sphinx [3]. A visualisation of the QBlade documentation is shown in Figure 1.

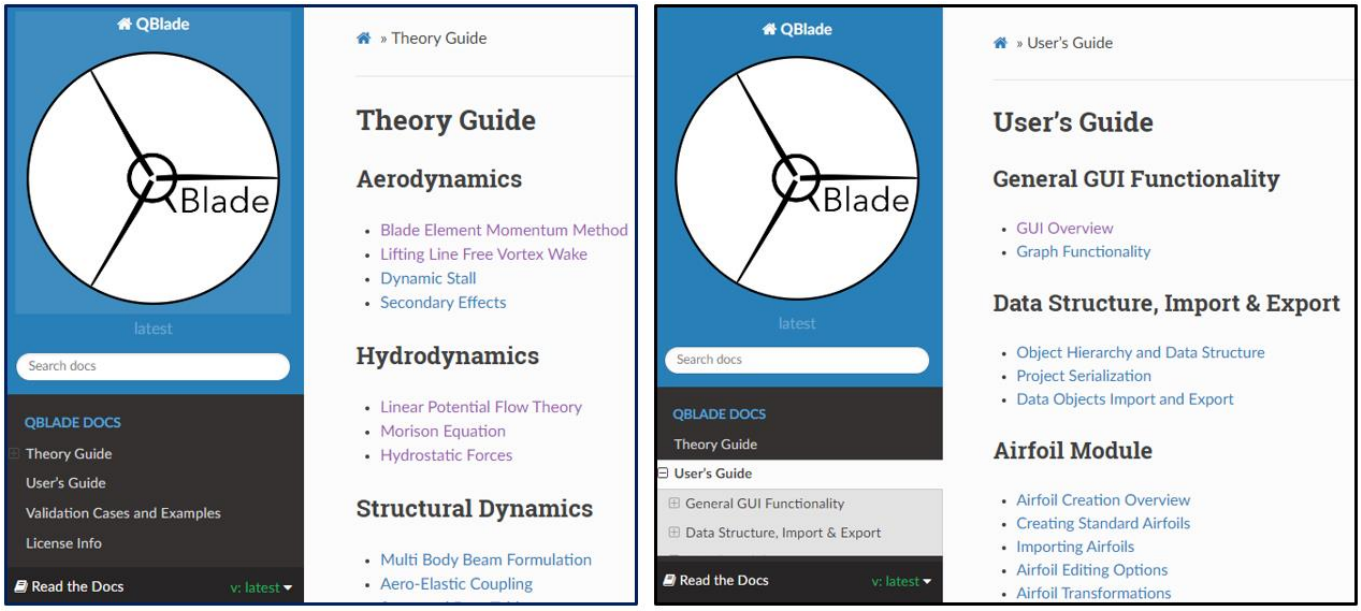

Figure 1: QBlade online documentation. Left: Theory Guide, Right: User's Guide.

The online documentation has been broken up into four sections to enable the user the simplest access to the necessary information. These are described in the following sections.

1.1. THEORY GUIDE

The algorithms which have been implemented in QBlade are based on a numerous physical models. These have been broke down into the following sections:

- Aerodynamics
- Hydrodynamics
- Structural dynamics
- Environmental conditions

Each section contains a range of appropriate subsections based on the model being described. Relevant physical models, equations and equation parameters are presented in order to facilitate a physical understanding of the applied model. The level of detail has been optimised to assist in analysis of results, however in cases where further detail may be required, appropriate references are provided. These pages are commonly linked to in the user's guide pages when necessary for the description of an applied model.

1.2. USER'S GUIDE

For the user wishing to set up a simulation or modify simulation parameters within QBlade, a number of steps need to be carried out in order to specify a turbine or simulation definition. The process of a turbine definition contains a range of setup steps and these are described in detail in the following modules:

- General GUI Functionality
- Data Structure, Import & Export
- Airfoil Module
- Airfoil Analysis Module
- Polar Extrapolation Module
- Blade Design Module
- BEM Analysis Module
- Turbine Definition Module
- Simulation Definition Module
- Windfield Generation Module
- Wave Generator Module

Each section contains a range of sub-modules and appropriate references to the underlying theory.

1.3. VALIDATION CASES AND EXAMPLES

In order to demonstrate the efficacy and accuracy of the solver, a range of verification cases have been carried out with QBlade by comparing the code to other available software packages. In addition, validation cases are carried out by comparing to experimental results. The data is presented in a clear way which allows comparison between different models and their effects on results. The following sections are specified:

- Aerodynamic Validation Tests
- Structural Validation Tests
- Hydrodynamics Validation Tests

It is planned to extend these as more validation tests are carried out in order to provide the user with the greatest range of comparison cases.

1.4. LICENSE INFO

QBlade is distributed under the academic public license (QBlade CE License v1.0). The documentation is made available under a CC BY-NC.ND 4.0 license. This license is provided for reference.

2. PROJECT PARTNER WORKSHOP

In order to facilitate dissemination of the QBlade software, the TU Berlin team hosted a project partner training session from Wed. 22nd to Friday 24th June 2022. In order to reduce the carbon footprint of the project and to improve the general workflow of the event, this event was held online over the conference application Zoom [3]. This allowed for the event to be administered easily amongst multiple participants. The workshop was conducted by the research team at the TU Berlin:

- Joseph Saverin (Host)
- David Marten (Co-Host)
- Robert Behrens de Luna
- Sebastian Perez-Becker

Prior to the workshop, a range of material including presentation slides, project files and project data were distributed to the workshop participants over a private folder on the FLOATECH tubCloud repository. A photo of the Zoom interface on the second day of the workshop is shown in Figure 2.

Figure 2: Project Partner Workshop: Screenshot of day two (23.06.2022).

The format of the workshop and the statistics collected are described in the following sections.

2.1. WORKSHOP FORMAT

The project was conducted with the conference application Zoom [3]. The workshop ran for 6 hours each day from 10AM to 4PM including a 45 minute lunch break. The relevant knowledge for the setup and execution of a simulation within QBlade was progressively developed with the participants over the course of the three days with the following modules (listed chronologically):

<u>Day 1 (22.06.2022):</u>

- QBlade User Interface

- Airfoils and Polars
- Blade Design
- Steady BEM Simulations
- Aerodynamic Turbine Definition

Day 2 (23.06.2022):

- Aerodynamic Simulations
- Turbulent Wind/IEC Wind Model
- Structural Turbine Definition
- Aero-servo-elastic Simulations

Day 3 (24.06.2022):

- Hydrodynamic Modelling
- Aero-hydro-elastic Simulations
- Wave Generation
- Offshore DLC Simulations

For each of these modules a presentation would be held by one of the TU Berlin team with appropriate slides- such as is shown in Figure 3, followed by a brief live demonstration of the software. Subsequently, the group would be broken up into four "breakout" rooms with 8-10 members for between 10 and 40 minutes. Each group would work through a set of exercises corresponding to the presented material. In each room a member of the TU Berlin development team was present to enable assistance and to provide necessary feedback and material for the given tasks. At the completion of the exercise session, the entire group would return to the main room and discuss the aforementioned tasks and encountered difficulties.

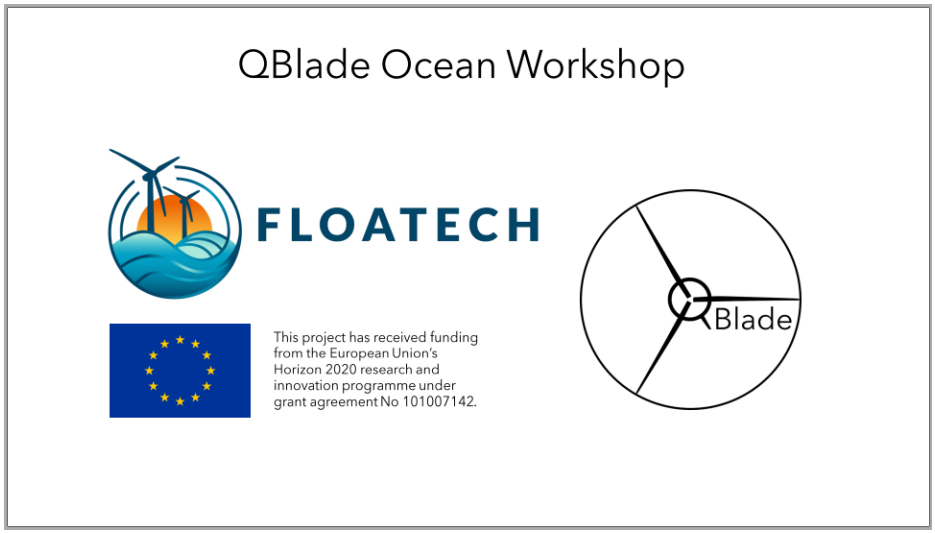

Figure 3: Introductory slide for the Project Partner Workshop.

2.2. PARTICIPANTS

Through advertisement efforts using social media platforms a significant interest in attendance at the project partner workshop was noted. It was decided that, due to the available resources of the QBlade

development team, the size should be limited to 30 participants. This was assessed after the training to indeed be a suitable limit. In addition to participants from within the FLOATECH project, the remaining spaces were also offered to individuals active within industry in order to improve the uptake of the software. This is a key objective of the project as described in the grant agreement. A range of statistics have been collected to summarise the constituency of the attendees and are summarized in Table 1.

Table 1: Statistics of Attendance

Day	No. Participants	Academia	Industry
Wednesday (22.06.2022)	26	46%	54%
Thursday (23.06.2022)	28	46%	54%
Friday (24.06.2022)	28	46%	54%

In addition to the academic participants from the FLOATECH project, multiple academic early stage researchers (ESR) were present from the parallel research project FLOAWER. This was described within Section 2.2.2 of the exploitation actions of the FLOATECH grant agreement.

Feedback has been collected from the participants who predominantly found the partner training format, timeline and material to be excellent. In general, the event was concluded to be successful and further events, for both academic and industrial users, are planned in the near future in order to further expand QBlade's public distribution and application.

3. PUBLIC DISSEMINATION

The dissemination of the QBlade software package source code and precompiled binaries are being made available through the QBlade website [1]. In addition to this, the theory manual, the user guide, the validation cases and license information are available on the QBlade ReadTheDocs page, also linked through the QBlade website. A range of publications are planned for the remainder of the project in order to improve dissemination amongst academia. It is furthermore planned to begin hosting QBlade workshops for industrial users in order to expand distribution.

4. REFERENCES

1. QBlade. *https://qblade.org/*
2. Read the Docs. *https://readthedocs.org/*
3. Brandl, G. (2021). Sphinx documentation. *URL* *https://www.sphinx-doc.org/en/master/*
4. Zoom. *https://zoom.us/*