# XROTOR

X-shaped Radical Offshore Wind Turbine for Overall Cost of Energy Reduction

## D1.4

# Data management plan
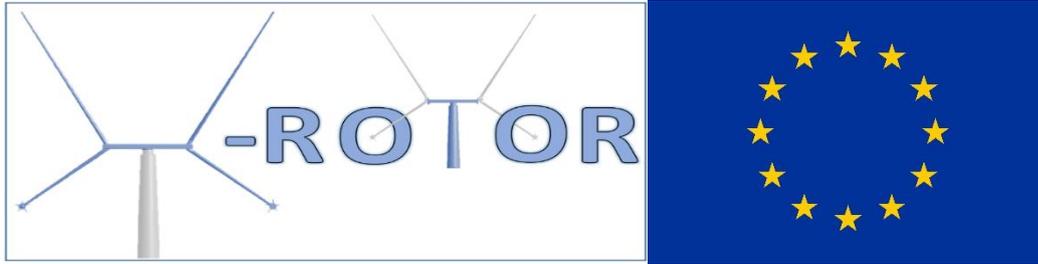
🌐 https://xrotor-project.eu

🐦 @XROTORProject

**June 2021**

# X-SHAPED RADICAL OFFSHORE WIND TURBINE FOR OVERALL COST OF ENERGY REDUCTION

Project acronym: **XROTOR**
Start date: 1st January 2021
Duration: 3 years

## WP1 Project management and coordination
## T1.3 - Project planning and execution
## D1.4 Data Management Plan

Lead Beneficiary: University of Strathclyde
Delivery date: 30th June 2021

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**Document Information**

| Version | Date | Description | Prepared by | Reviewed by | Approved by |
|---|---|---|---|---|---|
| 1 | 29/06/21 | Final version | Adam Stock (Project Data Manager) | James Carroll (Project Manager) | Bill Leithead (Project Coordinator) |

# Executive Summary

This deliverable will comprise an initial data management plan (DMP). The DMP includes information regarding:

- The handling of research data during & after the end of the project

- What data will be collected, processed and/or generated

- Which methodology & standards will be applied

- Whether data will be shared/made open access and

- How data will be curated & preserved (including after the end of the project).

An Initial Data Management Plan (DMP) that aligns with the Horizon 2020 data management plan guidance has been created. The DMP has been reviewed and signed off by the Project Coordinator. Additionally, the Initial DMP has been added as an agenda point to be presented to the Executive Management Group at their next meeting. Based on the reasons outlined above, Deliverable 1.4 is successfully completed.

# Table of Contents

# 1  Data Summary

*This section provides a summary of the data in tabulated form, addressing the several key issues. For each of the data items the purpose of the data collection/generation is listed along with an explanation of the data's relation to the project. The type and format, plus the expected size of the data is listed alongside a statement of whether the data is reused and its origin. Finally, an outline of the data utility, that is, to whom it will be useful is provided.*

The data to be used and or produced in the project are summarised in the table below:

| Description of Data | Purpose and Relation to Project Description | Collected or Generated? | New or re-used data | If re-used, what is the original source | Data type/format | Expected Size (MB, TB, etc.) | Are there any ethical considerations (e.g. GDPR) | Potential future users of the data | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **X-Rotor Dynamic Control Models** | Models of the X-rotor system used to design control systems | Generated | New | | MATLAB and Simulink models | Up to tens of GB | No | Control engineers designing advanced controllers for X-Rotor systems, X-rotor system modellers | |
| **X-rotor dynamic model performance data** | Outputs of the control model detailing the performance of the X-Rotor under different control strategies and different wind conditions | Generated | New | | MATLAB/Simulink outputs | Up to tens of GB | No | Control engineers designing advanced controllers for X-Rotor systems, X-rotor system modellers, O&M engineers | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Data management plan** | A plan on how the project data will be managed | Generated | New | | ORDP, Report and Spreadsheets | MB | No | All project members, EU | |
| **Industrial board workshop inputs** | Advice and feedback from Industrial board members to guide the project partners | Collected | New | | Report | MB | No | Project participants, future X-Rotor projects | |
| **Site metereological and metocean data** | Example site data as input to O&M modelling, used to infer realistic inputs for control models | Collected | Re-Used | FINO - open source North sea wind and wave data repository | csv | Up to tens of GB | No | Further projects looking to compare different wind energy converter designs | |
| **Latest Input Output economic accounts for UK, produced by Office for National Statistics** | Dataset for economic modelling in WP7 | Collected | Re-Used | ONS | xls/csv | MB | None | No new data created. | |
| **Economic accounts disaggregated by technology** | Dataset for economic modelling in EP7 | Generated | New | | xls/csv | MB | None | Analysts/modellers with interest in disaggregated economic accounts. | |

| Economic statistics on electricity sector | Dataset used in construction of disaggregated economic accounts | Collected | Re-Used | ONS | xls/csv | MB | None | No new data created. | |
|---|---|---|---|---|---|---|---|---|---|
| **O&M cost model inputs** | Data to model X-Rotor O&M costs for WP6 | Collected | Both | Past Publications | Excel | MB | No | Anyone carrying out O&M and/or cost modelling for the X-Rotor | |
| **O&M cost model outputs** | Modelled X-Rotor O&M costs for WP 6 | Generated | New | | Excel | MB | No | WP7& WP8 Anyone carrying out O&M and/or cost modelling for the X-Rotor | |
| **O&M cost model** | Matlab files from O&M cost model for WP 6 | Generated | New | | Matlab | MB | No | Anyone carrying out O&M and/or cost modelling for the X-Rotor | |
| **Background information on X-Rotor Design** | Information on the design and specification of the X-Rotor concept from previous projects | Generated | Re-Used | Prior X-Rotor projects | Reports and spreadsheets | MB | No | Anyone conducting future research in the area of X-Rotor design | **Read Only** |
| **Initial aerodynamic modelling data** | X-Rotor aerodynamic design information | Generated | Re-Used | Prior X-Rotor projects | Q-Blade files | Up to tens of GB | No | Anyone conducting future research in the area of X-Rotor | **Read Only** |

| | | | | | | | | aerodynamic design | |
|---|---|---|---|---|---|---|---|---|---|
| **Initial FE analysis of X-Rotor blades data** | Finite element analysis of the X-Rotor blades | Generated | Re-Used | Prior X-Rotor projects | Anysys files | up to tens of GB | No | Anyone conducting future research in the area of X-Rotor blade design | **Read Only** |
| **Electrical system models** | To model the electrical system of the X-Rotor and derive the best practical design for this system | Generated | New | | MATLAB/Simulink | MB | No | Electrical systems designers for novel wind energy converter designs | |
| **Magnetic models (FE models)** | | | New | | Ansys | MB | No | | |
| **Electrical design specification** | A specification of the electrical system to inform the final X-Rotor design | Generated | New | | Reports and spreadsheets | MB | No | Further X-Rotor projects, designers of electrical systems for other novel wind energy converters | |
| **X-Rotor Controller designs** | Details of the controllers, including switching mechanisms and design methods | Generated | New | | Reports and spreadsheets | MB | No | Further X-Rotor projects, designers of control systems for other novel | |

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|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | wind energy converters | |
| **X-Rotor Controller Code** | Controller code to be compiled for use alongside the X_Rotor dynamic control models | Generated | New | | MATLAB/C++/DLLs | MB | No | Further X-Rotor projects, designers of control systems for other novel wind energy converters | |
| **Design basis** | Description of the design scenario, load models and assumptions to be used for the design. | Generated | Both | X-Rotor pre-project | Report / PDF | MB | No | All project members. Researchers. Wind turbine designers. | |
| **Preliminary structural design** | Description of the structural design after preliminary design optimization. | Generated | New | | Text files, spreadsheet model | MB | No | All project members. Researchers. Wind turbine designers. | |
| **Load simulation model** | Performing structural analysis. Basis for structural optimization. | Generated | New | | Text files / sourcecode | MB | No | All project members. Researchers. Wind turbine designers. | |

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|---|---|---|---|---|---|---|---|---|---|
| **Preliminary structural performance data** | Analysis of the preliminary design. Documentation. | Generated | New | | Text files | Up to hundreds of GB | No | Internal | A summary will be compiled and published. The raw data itself seems to be of limited to others. |
| **Simplified analysis models** | Investigation of specific phenomena (e.g. aerodynamic damping). | Generated | New | | Text files / source code | MB | No | All project members. Researchers. Wind turbine designers. | |
| **Structural optimization code** | Optimization according to the criteria described in design basis. | Generated | New | | Text files / source code | MB | No | Follow-up research projects. Wind turbine designers. | |
| **Advanced structural design** | Description of the structural design after advanced design optimization. | Generated | New | | Text files, spreadsheet model | MB | No | All project members. Researchers. Wind turbine designers. | |

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|---|---|---|---|---|---|---|---|---|---|
| **Structural performance data** | Analysis of the advanced design. Documentation. | Generated | New | | Text files | Up to hundreds of GB | No | Internal | A summary will be compiled and published. The raw data itself seems to be of limited to others. |
| **Noise analysis inputs** | Simulations to obtain necessary information for subsequent noise analysis. | Generated | New | | Text files / HDF5 | Up to hundreds of GB | No | Internal | Input for WP2 |
| **Design drawings** | Detailed design. For visualization purposes and manufacturability check. | Generated | New | | Text files / proprietary formats (e.g. DWG) | MB | No | Internal | |
| **Aero-elastic model of X-Rotor** | To understand the aeroelastic behaviour of the X-Rotor | Generated | New | | tbd | Up to tens of GB | No | Designers of a future X-Rotor prototype who wish to model a range of scenarios | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **LBM/VLES model acoustic simulations of X-Rotor sub-components** | To understand the noise emissions from X-Rotor individual components | Generated | New | | .dat, .tiff, .snc, .fnc | Up to tens of TB | No | Designers of a future X-Rotor prototype wishing to understand potential noise emissions | Some of the data will be stored in the software property format, other extracted and stored as dat |
| **LBM/VLES model acoustic simulations of entire X-Rotor concept** | To understand the total noise emissions and interactions of the various components from the X-Rotor | Generated | New | | .dat, .snc., .fnc, .tiff | Up to tens of TB | No | Designers of a future X-Rotor prototype wishing to understand potential noise emissions | Some of the data will be stored in the software property format, other extracted and stored as dat |
| **Wind tunnel model X-Rotor aeroelastic** | To validate the aeroelastic model predictions | Generated | New | | tbd | Up to tens of GB | No | Designers of a future X-Rotor prototype | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **measurement data** | | | | | | | | requiring data for validation | |
| **Wind tunnel model X-Rotor aeroacoustic measurement data** | To validate the aeroacoustic model predictions | Generated | New | | .dat, .h5,.tiff | Up to hundreds of GB | No | Designers of a future X-Rotor prototype requiring data for validation | |
| **Wind tunnel model X-Rotor flow visualisation data** | To validate the aeroelastic model predictions and give insight into the X-Rotor wake characteristics | Generated | New | | tbd | Up to hundreds of GB | No | Designers of a future X-Rotor prototype who wish to understand it aerodynamic behaviour and potential wake interactions | |
| **Acoustic model of noise propagation from operating X-Rotor** | To predict the environmental noise emissions from a full-scale X-Rotor when operating at sea | Generated | New | | tbd | up to hundreds of GB | No | Planners who wish to understand the environmental impact due to noise propagation from the X-Rotor | |
| **Rotor aerodynamic model, design and performance** | To improve and predict the aerodynamic behaviour of the X-Rotor | Generated | New | | tbd | Up to tens of GB | No | Designers of a future X-Rotor prototype who wish to model a range of scenarios | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **XROTOR primary rotor CFD computations** | XROTOR primary rotor CFD computations to compare with experiments and with the aeroelastic code designed in WP2 | Generated | New | | txt files including forces and moments on the blades | MB | No | All project members, to compare with experiments and to be used as reference for structural part design. | |
| **XROTOR secondary rotor CFD computations** | XROTOR secondary rotor CFD computations to compare with experiments and with the aeroelastic code designed in WP2 | Generated | New | | txt files including forces and moments on the blades | MB | No | All project members, to compare with experiments and to be used as reference for structural part design. | |
| **XROTOR multibody analysis** | XROTOR multibody analysis to extract dynamic behaviour of the system | Generated | New | | xls/dac result files gathering dynamic loads on rotor components | MB | No | All project members to be used as input for the XROTOR structrual design | |

## 2 FAIR Data

*Effort is made to ensure that the data collected and generated in the project follows the "FAIR" principles – that it is findable, accessible, interoperable and re-usable. In this section, the methods and processes to ensure FAIR data are described.*

### 2.1 Making data findable, including provisions for metadata

All final data sets will be stored on University of Strathclyde servers through the PURE system, with an associated DOI to enable citation and long term location. The minimum number of metadata elements is consistent with the DataciteOpens mandatory metadata schema and the full Pure schema, in which the overall project collection will be recorded, is compliant with not only Datacite but also Dublin CoreOpens, GeminiOpens and CerifOpens standards for research data.

Where software or other code is being created, version control will be implemented using specialist software. Currently, both Mercurial and GIT are used to track code, however this will be standardised over the next few months such that just one system is used.

As data is stored in PURE, each data set will include a description covering the same information given in the table in section 1, as well as information regarding the software requirements to open the data files. The files themselves will be named in a manner suitable for the file type. The data itself will have relevant meta-data associated with it, which will be detailed within the data description in PURE allowing for key word search.

### 2.2 Making data openly accessible:

All data will be made openly available if possible. In cases where data is received from outside the project, it will be made as open as possible within the constraints of the IP owner. Data received from industrial partners will initially be considered closed data for Intellectual Property protection, however, the possibility of making the data open will always be discussed.

Final data for the project will be made available through the PURE system that will be linked on the project website. Data will be stored in non-proprietary formats where possible to minimise the requirement for additional software to view the data, though in some cases proprietary formats will be required. A full list of the expected data formats is available in section 1 of this document.

Final versions of the software developed through the project will be made available through the University of Strathclyde PURE system at the end of the project, including any software created during the project that is required to open data files. Software created during the project will be open-source, with the full source code available through PURE at the end of the project. As appropriate, software repositories of code under development will be made publicly available.

In the case of data restrictions, data will be made available from the lead institution (University of Strathclyde) via email request, unless the nature of the data means it must be stored at another institution, in which case the same process will be applied at that institution.

## 2.3 Making data interoperable

In general, the data to be produced will be in the form of the standard output formats of commonly used software. Whilst some software is not open (e.g. MATLAB, Ansys), the software is commonly used in the field and the data formats output are commonly recognised.

Critical simulation data outputs will be in ASCII format where possible to allow interoperability between software tools, however, it is expected that this will not be practical in all cases. A full list of the data expected from the project including file types is included in section 1 of this document.

## 2.4 Increase data re-use (through clarifying licenses):

The default option for data licensing will be for open access and open source, with copyright held by the creating party, though each data set will be considered on a case-by-case basis. All data will be reusable by default, with each institution's data champion for the project tasked with identifying data that requires alternative licensing. The exception to this is data received from partners that will be assumed to be closed and unavailable outside the project team as the default.

All relevant data will be made available for re-use at the end of the project at the latest, with a preference for availability as soon as is practical (this excludes data with IP issues and/or embargos).

Data will remain reusable for a minimum of 5 years, with data expected to remain available and reusable long after this date.

## 3 Allocation of Resources

*In this section the required resources for achieving the aims from section 2 are described. An estimate of the costs for making the data FAIR and a description of how these costs will be met is provided. The people responsible for data management at each of the partner institutions (data champions) are defined and the potential value of long-term preservation of the data is discussed.*

Each organisation in the project will have a defined data champion who is responsible for ensuring that their institution's data is FAIR. These champions will be overseen by the project data manager.

The data manager and data champions are given in the table below:

| Institution | Data Champion |
|---|---|
| University of Strathclyde | Adam Stock (also project data manager) |
| TU-Delft | Simon Watson |
| NTNU | Michael Muskulus |
| CENER | Beatriz Mendez Lopez |
| UCC | Niall Dunphy |

The data champions are responsible for ensuring that the relevant institution follows this data management plan correctly. This includes appropriate licensing of data, provision for long term storage of data created at the institution and ensuring data is stored in an interoperable manner.

The project has a significant budget for running costs (~EUR60,000). Whilst this budget must cover more than just data management it is expected that the costs of data management will be covered within this amount.

The X-Rotor project aims to develop the X-Rotor concept towards TRL level 3-4 and so it is critical that the data produced is stored in a FAIR manner to enable future projects to develop the concept further up the technology readiness levels. The potential value of long-term preservation is high, as without it, development of the concept will be stalled.

## 4  Data Security

*In this section issues around data security and data recovery are addressed. This includes secure transfer of sensitive data.*

All research data will be stored on either mapped institutional network drives, secure share points or institutionally approved cloud storage (e.g. Strathclyde's "Strathcloud"). The options are detailed below for the University of Strathclyde. Other institutions in the project have similar storage options in place that will be similarly utilised.

- Mapped Drives (H: and I: drives)

- Sharepoint

- Strathcloud

- One Drive

The use of version control and change management software during software development will help to minimise risks of data loss during software creation, whilst use of sharepoints, StrathCloud and one drive will all ensure that data can be easily shared between institutions whilst being backed up with a history of prior versions.

## 5  Ethical Aspects

*Any ethical aspects that require special consideration associated with the data to be collected and generated through the project are addressed here.*

Whilst there is no requirement for ethics consent for any of the data anticipated in the project, rules regarding GDPR may be applicable and will be followed at all times. To prevent IP leakage, any data received from industrial partners is treated by default as "closed" rather than open data, though the possibility of opening the data will be discussed in each case.

Further, the project will follow the ICO guidance on data minimisation. This applies to personal data, which is expected to be a minimal part of this project. Where applicable, we will ensure that any personal data is adequate, relevant, and limited to what is necessary. This requires

the data to be deleted if not of use to the project. Any personal data held will be reviewed every 12 months and any superfluous data will be deleted.

# 6  Other

*In this section, other national/funder/sectorial/departmental procedures for data management that will be used are listed.*

As the University of Strathclyde is the lead partner in this project, the project conforms to relevant Strathclyde/funder policies:

University Research Data Policy
University Research Data Deposit Policy
University Information Governance and Compliance
University Research Code of Practice
University Policy and Code of Practice for Post Graduate Research Programmes
University Information Security Policy