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

D1.5

Updated Data Management Plan

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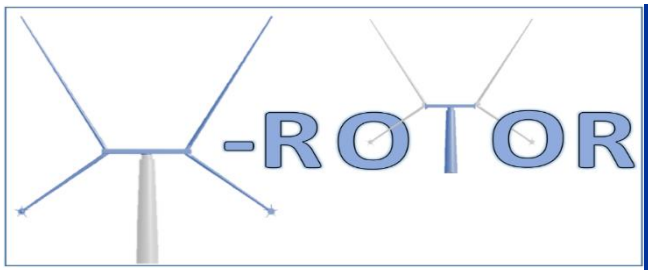
September 2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007135



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

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

WP1 Project management and coordination
T1.3 - Project planning and execution
D1.5 Updated Data Management Plan

Lead Beneficiary: University of Strathclyde
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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 the initial data management plan (DMP) for the project duration (D1.4) reviewed and updated to ensure it is applicable for the second half of the XROTOR project. 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 updated 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 updated DMP has been added as an agenda point to be presented to the Executive Management Group at their next meeting. The updated plan has been created via a review of the initial data management plan with no major changes suggested by any project partners. Only minor changes to the plan were required, which are discussed in an additional section at the end of the document. Based on the reasons outlined above, Deliverable 1.5 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	

								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.	

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.	

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.

Where practical, all data associated with publications resulting from the X-Rotor project will be given a Digital Object Identification (DOI) number and made available through a referenced link in the publication. This will allow readers to easily access the data and to re-use it for their own research. Note that IP sensitive information will be an exception to this.

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

7 Updates to the DMP

It is further clarified that data created at institutions other than the lead partner may be stored on their servers rather than on University of Strathclyde servers. Non-lead institutions will store the data via systems that are similar in scope regarding FAIR data to those of the University of Strathclyde

Further, an addition has been made to the DMP to ensure that when publications are produced from the work in the project, Digital Object Identifiers (DOIs) will be created for the data used in the publication, providing a link to the relevant data for readers. Note that in the case of industrially sensitive information this will not be done as an exception.

Lastly the data list in Section 1 has been reviewed and no project partners suggested further changes.