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

D9.2

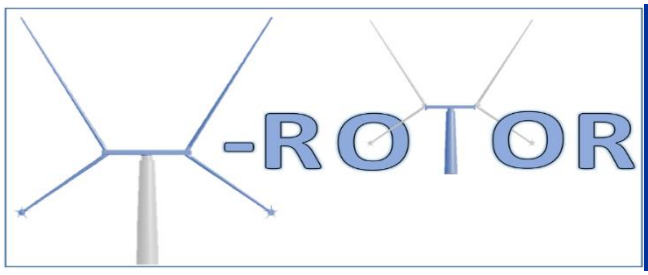
Definition of dissemination activities

https://xrotor-project.eu

@XROTORProject

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

Project acronym: **XROTOR**
Grant agreement number: 101007135

WP9 Communication and Dissemination
T9.4 – Communication and Dissemination Materials
D9.2 Definition of Dissemination Activities

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

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Document Information

Version	Date	Description	Prepared by	Reviewed by	Approved by
1	31/01/2021	Final version	James Carroll (Project Manager)	W. Leithead	W. Leithead (Project Coordinator)

The XROTOR Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101007135. For more information on the project, its partners, and contributors please see https://XROTOR-project.eu.

Executive Summary

Deliverable Description: This deliverable will comprise of a report on the dissemination activity that is planned for the XROTOR project. The deliverable will be considered successful once delivered to the project coordinator and/or the executive management group.

Responsible: University of Strathclyde

Outcome Summary: A report detailing the project dissemination activity has been created. The activity plan and this report were presented to and signed off by the Project Coordinator. Based on the reasons outlined above, Deliverable 9.2 is successfully completed.

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1 Introduction

1.1 Context

Dissemination is a key activity in research projects. XROTOR has a dedicated work package (WP9) focused on communication and dissemination. The objective of this work package is to maximise the impact of the project, by achieving the maximum awareness of the project and its results among stakeholders.

1.2 Background – the XROTOR Project

As the effects of climate change are becoming ever more visible[1], the European Union has decided to raise its target for the amount of energy it consumes from renewable sources from the previous goal of 27% to 32% by 2030. This move aims to consolidate Europe's position at the forefront of the global energy transformation and sets a positive pathway for the decarbonisation of the economy[2] in line with its commitments under the Paris Agreement.

X-ROTOR:

New concept for offshore wind turbine that will

- reduce LCOE by 20% to 25% through
  - 25% to 50% reduction in OPEX
  - 5% to 25% reduction in CAPEX
- improve H&S for service technicians
- reduce use of rare earth metals
- lower centre of thrust for floating turbines

Wind energy can play a key role in achieving the EU target and contribute to the 40% reduction in CO2 emissions. In 2017, wind overtook hard coal generation for the first time with a massive 19% increase from 306 to 364 Terawatt hours (due to huge investments into onshore and offshore wind plants) increasing to 426 Terawatt hours in 2019. If the EU is to meet its Climate and Energy objectives, WindEurope envisages a central scenario with 70GW of offshore wind in Europe's energy mix by 2030, which could meet 9.7% of electricity consumption. However, to exploit this offshore potential by 2030, it is essential to develop larger offshore wind turbines, e.g. 10-20MW, and lower the levelised cost of energy (LCOE).

As part of the INNWind.EU[3] project, several innovative offshore wind turbine concepts, both fixed and floating, were developed with the objective of reducing the LCOE in 10MW-20MW turbines. However, scalability was identified as a 'show-stopper' as, although most wind turbine components can be up-scaled, it is unlikely economic designs would be achieved. Other challenges, including large CAPEX (Capital Expenditure) on main structural components, load mitigation and installation issues (lack of economic installation and maintenance vessels), were identified. Hence, innovations in components and system design are necessary to further reduce the cost of energy. Major wind turbine manufacturers, are now searching for a step change in technology to achieve a large cost of energy reduction.

In this context, **XROTOR will develop a highly innovative wind turbine design** to directly target cost of energy reduction and scalability of wind turbines.

[1] IPPC Report SR15, *Global Warming of 1.5 ºC*, 2018

[2] A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy COM(2015) 80 final

[3] INNWIND.EU, http://www.innwind.eu/publications/deliverable-reports.

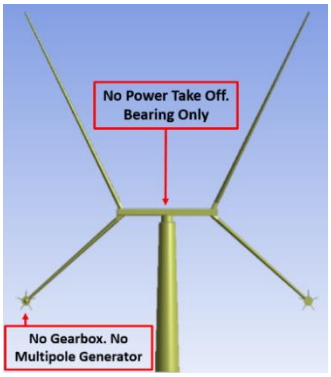


Figure 1: Representative figures of XROTOR concept

The “X-Rotor offshore wind turbine” is a Vertical Axis Wind Turbine (VAWT)/Horizontal Axis Wind Turbine (HAWT) hybrid, see Figure 1 (These images are provided to give a rough idea of how the concept will look. They are not design drawings.) The X-rotor concept directly targets cost of energy reduction and addresses scalability of wind turbines through combining the following key innovations:

1) Large reductions in the cost of drive-trains through an easily scalable approach to power take-off that does not require a gearbox or a multi-pole generator whilst achieving comparable efficiency levels in power conversion.
2) Large reductions in Operation and Maintenance (O&M) costs through no heavy components or machinery being situated at a great height above sea-water and through general simplification of the turbine.

Having a low centre of mass with no heavy machinery at height, may make it particularly well-suited to floating offshore usage; particularly when reconfigured to have 3 blades rather than 2. The opportunity, thus, exists to contribute, also, towards the targets for floating offshore wind set by the SET-Plan of 9ct€/kWh by 2030[4].

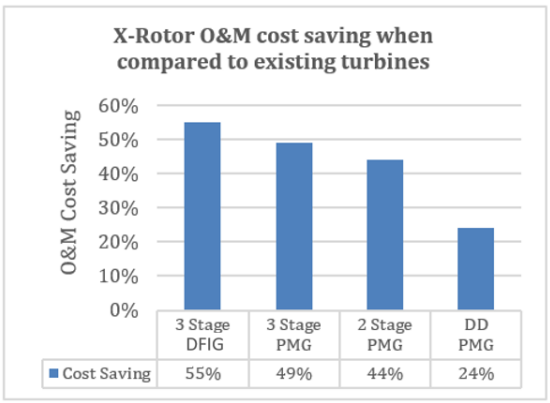
On a very early stage design and feasibility study, taking the concept no higher than TRL1, initial estimates[5] for the reduction in costs in comparison to 3-stage Double Fed Induction Generator (DFIG), 3-stage Permanent Magnet Generator (PMG), 2-stage PMG and direct drive PMG based technologies as in existing wind turbine types is indicated by Figure 2. The combined reduction in the estimated cost of energy ranges from 22% to 26%. This study received peer reviewed funding from both the UK RAE, in the form of a monetary prize and technical expertise[6], and from the UK EPSRC, in the form of a research Grant[7]. The OPEX savings[5] stem from the X-Rotor’s reduced requirement for costly heavy lift vessels for maintenance and from the removal of failure modes around the gearbox, multi-pole generator and yaw system. The CAPEX savings[5] stem from the X-Rotor’s greatly reduced drive train costs driven by the removal of the costly gearbox and/or multi-pole generator, whilst the rotor costs are not dissimilar to existing turbines.

[4] https://setis.ec.europa.eu/towards-an-integrated-SET-Plan

[5] Leithead et al., *The X-Rotor Offshore Wind Turbine*, Journal of Physics, October 2019

[6] Royal Academy of Engineering, ERA RU Award and support package from RAEng Fellows (2016-2020)

[7] EPSRC EP/R001472/1, X-Rotor Offshore Wind Turbine - Feasibility Studies in Energy Research (2017-2018)



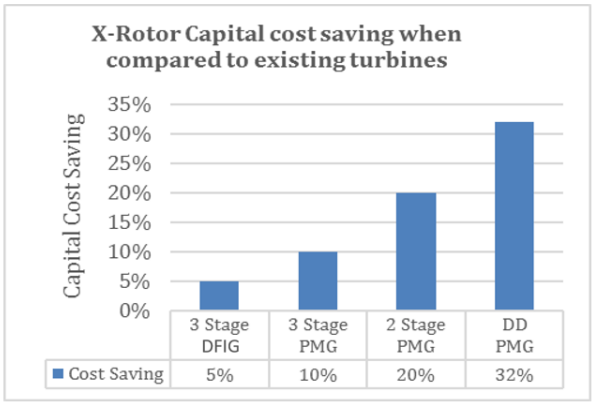


Figure 2 Comparison of O&M and capital costs[5]

X-ROTOR will advance the X-rotor concept design to TRL3 and provide improved cost of energy estimates. Given that almost all aspects, whether the rotors, mechanical structure, power systems and control, are radically different from conventional turbines, enabling design tools will be developed that will have wider applicability.

2 Objectives and Key Messages

2.1 Objectives

The objective of this strategy is to disseminate the results and outcomes of the project's activities, in an effective manner. The overall goal of the XROTOR project is to take the X-Rotor concept from its current TRL 1 position to TRL 3. The following section presents a synopsis of the project vision, objectives and discusses the plan for key message dissemination from the XROTOR project.

Project Vision
The XROTOR project will work to determine the X-Rotor concept's economic, social and environmental impacts and confirm the potential for a LCOE reduction of 20-30%.

Key project objectives to be considered in dissemination plan
O1: To determine the performance of the X-Rotor concept by designing the mechanical structure, operational strategy, and carrying out a performance assessment. Three tasks contribute to meeting this objective. Tasks are chosen instead of three separate objectives because of the high degree of interdependency between the tasks.

a) *Numerical design and performance assessment tool:* A new aero-elastic tool, that is capable of modelling the X-Rotor's hybrid vertical and horizontal axis design and is faster and less computationally heavy than CFD, will be created and validated using CFD. An assessment of the performance and loads on the X-Rotor turbine will then be provided. (WP2)

b) *Controller and operational strategy design:* New control design, analysis and modelling tools required for designing the controller of the X-Rotor turbine will be created. The design for the controller and operational strategy for the X-rotor turbine, that maximises energy capture and minimises loads, will be provided. (WP3)

c) *Turbine mechanical structure design:* The design for the mechanical structure of the X-rotor turbine, that is most economical whilst taking into account manufacturability constraints and safety requirements will be completed. The dimensions and mass of the major components will be provided. (WP4)

O2: To design the Power take-off and conversion system. This objective involves the design for the power take-off and conversion system for the X-Rotor turbine, that delivers power, initially extracted by

the secondary rotors as mechanical power, to the local power network connection point. A key design input will be enabling the controller to realise the choice of turbine operating strategy. (WP5)

O3: To estimate the reduction in levelised cost of energy (LCOE). Refined estimates for the reduction in the LCOE for the X-rotor concept, which arises from the replacement of heavy power-train components at height by secondary rotor based power take-off, will be provided. It will include both Capital Expenditure (CapEx) and Operating Expenditure (OpEx) elements. (WP6)

O4: To complete Socio-economic and environmental analyses. Based on a combination of field work, research and interviews, an assessment of the social, economic and environmental impact of the X-rotor concept and recommendations to mitigate them will be provided. Because of the disparate nature of the three aspects this objective is sub-divided into three tasks. (WP7)

a) *Social.*

b) *Economic.*

c) *Environmental.*

O5 To ratify all X-Rotor proof of concept work. Ratification that all proof of concept work meets the standard sufficient to ensure acceptance onto the first steps of an OEMs stage gate development process, in order to facilitate progression towards higher TRLs and beyond to commercialisation after this project is complete. (WP8)

O6: To create of a further development roadmap. A roadmap for further development of the X-rotor concept to higher TRLs and beyond to commercialisation will be delivered in consultation with the key stakeholder groups. (WP8)

2.2 Key messages

A key strategy toward achieving optimum dissemination for the XROTOR project has been the systematic identification of the key messages related to results from each project objective outlined in Section 2.1. A regular review of dissemination activities will be carried out by the consortium. Dissemination and communication activities are and will be based on a careful assessment of target audiences and the dissemination opportunities that can most effectively reach them. For each objective of the project, the target audiences for whom they are most relevant have been mapped. This in turn enabled the identification of dissemination channels outlined in Section 3 of this report.

3 Dissemination Plan

3.1 Dissemination plan overview

This section describes the project dissemination plan. It outlines the strategy to develop effective dissemination of results and knowledge gained during the project. One of the main goals is to maximize the impact of the project to maximise benefits for end users and consumers. Dissemination activities will be led by University of Strathclyde (UOS), who are prominent within the ORE (Offshore Renewable Energy) sector and are an established facilitator of both their own internal research programme and wider R&D activities. As mentioned at the end of Section 2, a tailored approach based on the project objectives will be used by XROTOR to ensure that the correct stakeholders are targeted, the outputs are successfully disseminated and that impact is maximised.

In relation to the project outputs, dissemination activities have two overarching goals:

1. To promote the outputs of XROTOR to ensure that stakeholders central to the next phase of technology development are targeted and that the path to commercialisation is, thereby,

accelerated. These stakeholders have been identified as those being involved in ORE, OEMs, developers, standards bodies, procurers and investors.

2. To demonstrate the potential and relevance of the technology developed in XROTOR, and promote its uptake at a pan European and International level.

3.2 Dissemination audiences and routes

The most appropriate communication route for each target audience has been identified and are summarised in Table 1 and Table 2. Dissemination activities can be described in brief as follows:

1. Packaging knowledge for an effective take up, i.e. presenting project results in formats and messages that are suited and accessible to the various targeted stakeholders
2. Preparing the effective exploitation of the project results with relevant key players.

Table 1 Targeted audience and Dissemination Activity

<table>
<tr><th>Target Audience / Measure</th><th>OEM</th><th>Research Intensive Organisations</th><th>Financiers</th><th>Standard Developers</th><th>Host communities</th></tr>
<tr><td>Demonstrating Innovation Potential</td><td colspan="2">Journal Papers (KPI: min 15)

Annual technical workshop (WP8)</td><td colspan="3">One Page Briefings communicating project developments & progress</td></tr>
<tr><td>Alignment with Industry Standards</td><td>Monthly teleconferences, monthly industry recommendations (Defined within WP8 activity)</td><td colspan="4">Advisory Board meetings (defined within management section 3.2.1.1)

Recommendations for Standards Development (KPI: min 1 on project website)</td></tr>
<tr><td>Further Development Roadmap</td><td colspan="4">Wider Stakeholder workshops (KPI: min 3)</td><td>WP7 workshop (KPI: 3)</td></tr>
</table>

An overview of the main target groups and communication activities under consideration is provided in Table 2. These activities are selected to best achieve both the desired audience and comply with the dissemination and communication needs of XROTOR project.

Table 2 Mapping of communication channels

Target Audience / Measure	Academia/ Institutions	Research Intensive Organisations/Experts in ORE Sector	Associations/Networks	Public/ Cross Sector
Scientific and Technical Discussion	4 Conference Papers per year (KPI: min 12) Journal papers (KPI: min 15) Trade fair (KPI: min 3)			
Wider Engagement to Maximise Impact	Project website, press releases for significant project milestones, social networks/channels (updated at least quarterly), leaflets/newsletters			
Training & Education	Webinars/Videos associated with special talks at partner Institutions and COP 26 (KPI: min 2)			

All project partners, especially the Work Package Leaders, will contribute to the implementation of all dissemination and communications related activities. Such activities aim at generating an effective flow of information and publicity about the objectives targeted, the results obtained during project progress, the contributions made to European knowledge and scientific excellence, as well as the value of collaboration on a Europe-wide scale, and the benefits to EU citizens in general.

3.3 Dissemination and expected project impacts

The following table outlines the dissemination and exploitation measures and their alignment with the expected project impact. Target audience and participants are also included. The exploitation media are the events, workshops and meetings outlined in the following pages The table provides examples of each heading and should not be taken as an exhaustive list of participants or exploitation measures. In the expected impacts column of the table: **1** = Accelerate and reduce cost of next gen renewable technology. **2** = Advance the knowledge and scientific proofs of the technological feasibility of its concept. **3** = Environmental, social and economic benefits. **4** = Establishing a solid European innovation base and building a sustainable renewable energy system.

Table 2 Exploitation measures, Impact and Participants

Target Audience	***Identified Participants***	***Exploitation Measures.***	***Expected Impact Alignment***
Research Organisations	e.g. Sintef, ORE Catapult	Provide open source aero-elastic and control models for novel wind turbine concepts for 3rd party use and validation.	Impact 1, 2, & 4

Standards providers	e.g. DNV GL	Engage with standards providers to investigate the requirement of standard adjustments for radical concepts.	Impact 1, 2, & 4
Operators/ Developers/ O&M providers	e.g. Orsted, SSE, SPR	Present and discuss X-Rotor benefits that will appeal to operators, developers and maintenance providers. Incorporate feedback in future development of the X-Rotor	Impact 1, 2, & 4
OEMs	e.g. GE, Vestas, Siemens Gamesa	Inform OEMs of X-Rotor benefits, such as capital cost and O&M cost savings. Discussion on further development partnerships and/or technology development.	Impact 1, 2, & 4
Financiers /Investors	e.g. ROC, Dunelm Energy	Present X-Rotor further development roadmap and partners to secure development funding.	Impact 1
Public, potential employees and environmental organisations.	e.g. Host communities, wind energy professionals Linkedin groups	Present and discuss socio-economic and environmental analyses from WP 7 and incorporate feedback in future development of the X-Rotor. Identified participants to include: host communities, wind energy professionals Linkedin groups, marine environmental organisations.	Impact 3

3.4 Specific dissemination activities

Scientific Journal publication:

Dissemination of scientific findings will be an important part of the project. Scientific publications and presentations will be targeted in relevant journals. Typical journals for scientific publications may include:

- Wiley Wind Energy

- Elsevier Renewable Energy

- IEEE Transactions on Sustainable Energy

- IEEE Transactions on Energy Conversio

- IEEE Transactions on Power Systems

- IET Renewable Power Generation Journal

- Wind Energy Science

- Journal of Energy and Power Engineering

XROTOR partners will aim to achieve high quality publications, publication index of at least an average of three journal articles/partner by the end of XROTOR. The purpose of this action is to increase awareness of the technology innovation potential to engage more end users keen to drive the technology through its next commercialisation stage.

End User Technical Workshops

This will be a platform for the project team to present the project's annual results and take recommendations & guidance from industry on project methodology, results and next steps. This activity is to ensure that the XROTOR concept is aligned with industry standards and will provide a wider industrial view supplementing the regular industry engagement and ratification work done in this area throughout the project with GE, as detailed in WP8.

Wider stakeholder Engagement Workshops

Joint workshops with other related and cross-sector ongoing projects are foreseen in order to disseminate experiences, knowledge and results. Some will focus on academic interests and others on business and industrial stakeholders.

Participation in Events

Links to relevant industry associations and technology platforms will be used for dissemination, these will be links to associations such as EERA JP WIND, EAWE, and IEA) and Technology Transfer Institutions such as SINTEF, OREC etc.

Final Project Event

The coordinator will organise a final dissemination event, presenting the key project results at the European level. All project stakeholders will be invited to this event with an emphasis being placed on stakeholders necessary for further and accelerated development of the X-Rotor, specifically existing wind turbine OEM's and investors.

Website

The XROTOR project website is the main communication and dissemination tool for the project, where all the dissemination materials will be timely published. A prompt and continuous flow/exchange of information between the participants of the project and key players and target groups is one of the most important conditions for the functioning of the network with its several national and international components. It will feature Newsletter functionalities and promotion of XROTOR results. The website will continue to be continually updated post project completion to communicate project next steps and impact.

During the project all beneficiaries will use their own communication portals and tools to point out relevant public project results and to announce upcoming events (e.g. conferences) where the XROTOR project will be represented.

Targeted Conferences

XROTOR project outputs will be disseminated at international events (conferences and fairs) as well as covered in international publications. The aim is to widen the environment in which the proposed solutions are conceived, developed and promoted during the project and beyond, increasing the outreach potential of project results to ultimately increase the rapid commercialisation of the technology. Considered events include:

- WindEurope Annual Event Conference & Exhibition. Leading onshore and offshore wind conference for the wind energy industry.

- European Academy of Wind Energy (EAWE) Wind energy Science Conference (WESC). Leading scientific conference for wind energy research.

- EAWE Torque. Leading scientific conference for wind energy drive train research.

- American Wind Energy Association (AWEA) annual conference. Leading onshore and offshore conference in the USA.

- Institution of Engineering and Technology (IET) Renewable Power Generation (RPG) annual conference. Leading Wind Energy Conference in EU and China.

- RenewableUK Offshore Wind Energy. Focus on UK offshore wind the world's largest market.

- AllEnergy. Focus on UK renewable energy.

Presentations prior to 30th September 2021

Leithead, W. E., *XROTOR*, EERA JP Wind-SP4 Workshop FALCON 30/50, 25th February 2021

Leithead, W. E., ***XROTOR:*** *X-shaped Radical Offshore wind Turbine for Overall cost of energy Reduction*, Session: Low-TRL Renewable Energy Technologies, Sustainable Places 2021, Rome Italy, 29th September, 2021

COP 26

COP 26 will be held in Glasgow in in November 2021. As consortium lead the University of Strathclyde will apply for floor space in the Green Zone of COP to communicate and disseminate information on the XROTOR project. Space will be requested for a screen, poster space and a table for leaflets.

Social Media Channel

XROTOR information will be shared through two Social Media Channels namely, LinkedIn and Twitter. Newsletter information will be shared through the Social Media Channels as well in accordance with a well-defined social media strategy involving all project partners. The project will use the partners' already existing social media accounts. In this way a large dissemination impact can be achieved from the very beginning of the project. Communication and dissemination activities will be supported by the XROTOR project website, and social media accounts through the partners' existing communities.

3.5 Uptake of disseminated results

The project exploitation and dissemination delivered by the consortium and its value chain are structured in such a way as to align the project within a strategic innovation context and to make the project outcomes scalable and replicable. The exploitation activities focus on several critical aspects:

- Context characterization and interactions involving strong in-depth market and stakeholder analysis, engagement of stakeholder community and end-users and standardization activities;
- Creating a further development roadmap to avoid R&D death-valley
- Identifying the beneficiaries of each result with associated responsibilities, protecting IPR;
- Entering the market strongly supported by solid exploitation plan enhanced by end-users' engagement through multi -channel dissemination activities.
- Ratification of findings by existing OEM so findings from this work can be entered into an existing OEM turbine stage gate development process.

3.6 Open access

As outlined in the previously delivered XROTOR Data Management Plan, the XROTOR consortium is committed to following Responsible Research & Innovation (RRI) principles and will endeavour were

possible to ensure that all research outputs and new knowledge generated is disseminated to the wider stakeholder community to maximise societal benefit.

XROTOR is fully committed to pursuing Open Access publications:

1) Through "*gold*" open access publications,
2) Existing available online data repositories as (OPENAIRE, UPCommons, ARXIV, RESEARCHGATE, among others) predominantly relying on the Green Open Access strategy (self-archiving) for maximum return on investment for project and funder, and actively linked to underlying data objects, in support of the EC Open Data Pilot.

4 Conclusion

To determine if this deliverable has been successfully completed, the deliverable description must be examined.

The deliverable description states: "This deliverable will comprise of a report detailing definition and plans for all project dissemination activities. Successful once delivered by Strathclyde and UCC to the project coordinator and/or the executive management group."

Dissecting that description, a report detailing the project dissemination plans has been created and delivered to the Project Coordinator.

This Dissemination Plan has been reviewed by the Project Coordinator and has been approved.

In conclusion, this deliverable has been successfully completed.