XROTOR

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

D1.2

Periodic Status Report #1

https://xrotor-project.eu

@XROTORProject

January 2021

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

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

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

WP1 Project Management
D1.2 Periodic Status Report

Lead Beneficiary: University of Strathclyde
Delivery date: 31st December 2021

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Acknowledgements/Contributions:		
Name	Organisation	Email
All Consortium Partners	UoStrath, UCC, TUDelft, NTNU, CENER, GE	

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 detailing the progress from each work package in Year 1 of 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: Based on input from all WP leaders a report detailing the XROTOR project progress in year 1 has been created. The report were presented to and signed off by the Project Coordinator. Based on the reasons outlined above, Deliverable 1.2 is successfully completed.

Contents

Contents

Introduction

The following report details the Year 1 progress of each work package from the XROTOR project. Next steps for each work package are also included. Section 10 provides the deliverable conclusion and a note from the project coordinator on the XROTOR project year 1 progress.

1. WP 1 Report (Project Management)

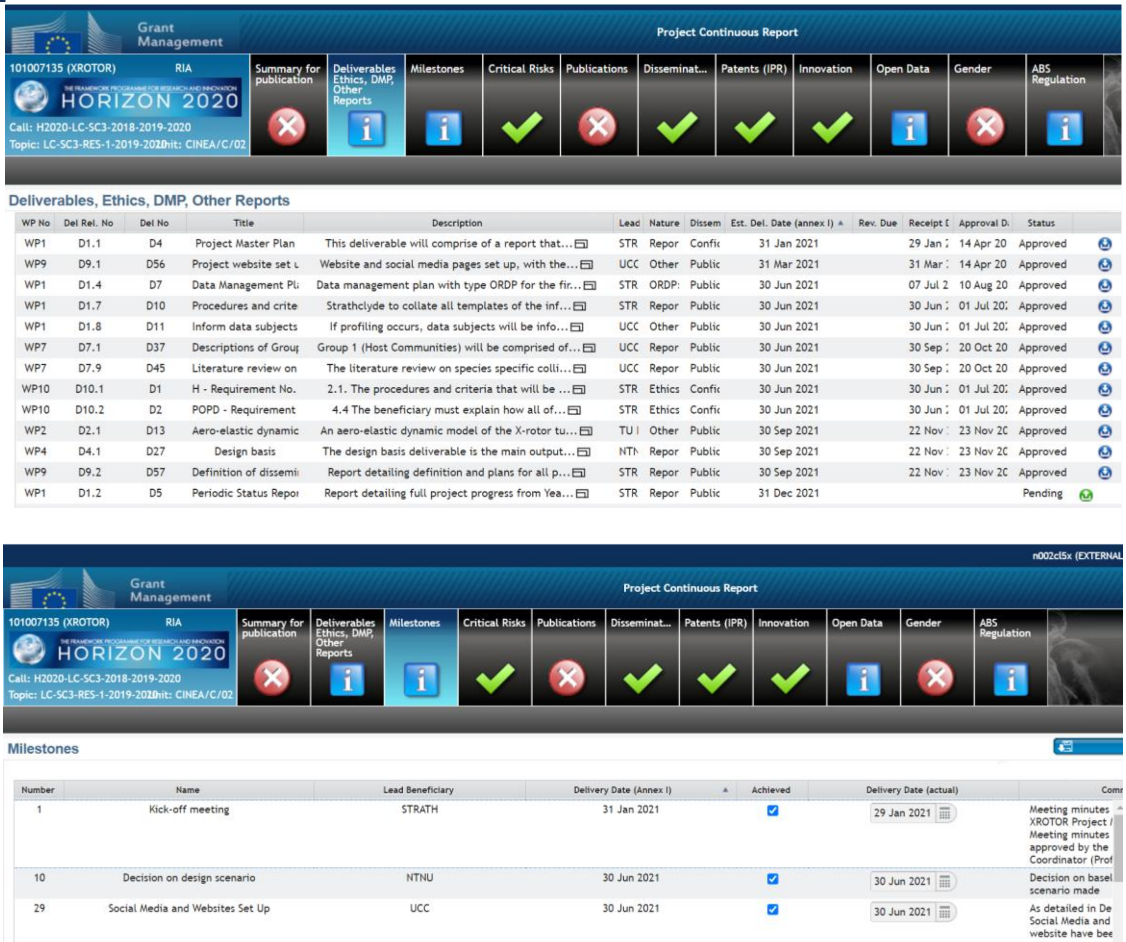
WP1 is currently being led by Dr James Carroll and Professor Bill Leithead. They have part time administration assistance from Shirley Kirk and Data management and infrastructure development assistance from Dr Adam Stock. A full time XROTOR administrator will be hired in Q1 2022. The advertisement is currently live for that role.

Table 1 outlines the work package 1 deliverables that were successfully uploaded to the EU project portal and approved to date in in WP1.

Deliverable Number[14]	**Deliverable Title**	**Lead beneficiary**	**Type[15]**	**Dissemination level[16]**	**Due Date (in months)[17]**
D1.1	Project Master Plan	1 - STRATH	Report	Confidential, only for members of the consortium (including the Commission Services)	1
D1.4	Data Management Plan 1	1 - STRATH	ORDP: Open Research Data Pilot	Public	6
D1.7	Procedures and criteria for identifying and recruiting research particpants	1 - STRATH	Report	Public	6
D1.8	Inform data subjects of the existence of profiling	3 - UCC	Other	Public	6

Table 1.1: WP 1 deliverables uploaded and approved

In year 1, the XROTOR project management team have engaged with 3 EU POs and have had excellent engagement with each. The project management team has updated the project portal on a monthly basis with milestone and project deliverable uploads. Figure 2 shows a snapshot of the project portal and confirms that all deliverables up to month 12 have been successfully uploaded and approved for the XROTOR project.

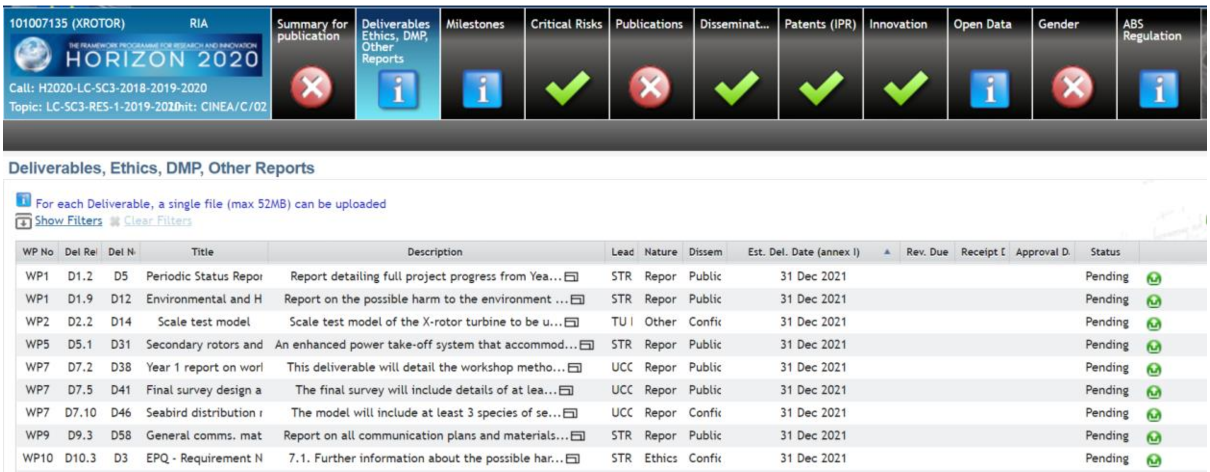


WP No	Del Rel. No	Del No	Title	Description	Lead	Nature	Dissem	Est. Del. Date (annex I)	Rev. Due	Receipt [	Approval D.	Status
WP1	D1.1	D4	Project Master Plan	This deliverable will comprise of a report that…	STR	Repor	Confic	31 Jan 2021		29 Jan :	14 Apr 20	Approved
WP9	D9.1	D56	Project website set u	Website and social media pages set up, with the…	UCC	Other	Public	31 Mar 2021		31 Mar :	14 Apr 20	Approved
WP1	D1.4	D7	Data Management Pl	Data management plan with type ORDP for the fir…	STR	ORDP:	Public	30 Jun 2021		07 Jul 2	10 Aug 20	Approved
WP1	D1.7	D10	Procedures and crite	Strathclyde to collate all templates of the inf…	STR	Repor	Public	30 Jun 2021		30 Jun :	01 Jul 20:	Approved
WP1	D1.8	D11	Inform data subjects	If profiling occurs, data subjects will be info…	UCC	Other	Public	30 Jun 2021		30 Jun :	01 Jul 20:	Approved
WP7	D7.1	D37	Descriptions of Grou	Group 1 (Host Communities) will be comprised of…	UCC	Repor	Public	30 Jun 2021		30 Sep :	20 Oct 20	Approved
WP7	D7.9	D45	Literature review on	The literature review on species specific colli…	UCC	Repor	Public	30 Jun 2021		30 Sep :	20 Oct 20	Approved
WP10	D10.1	D1	H - Requirement No.	2.1. The procedures and criteria that will be …	STR	Ethics	Confic	30 Jun 2021		30 Jun :	01 Jul 20:	Approved
WP10	D10.2	D2	POPD - Requirement	4.4 The beneficiary must explain how all of…	STR	Ethics	Confic	30 Jun 2021		30 Jun :	01 Jul 20:	Approved
WP2	D2.1	D13	Aero-elastic dynamic	An aero-elastic dynamic model of the X-rotor tu…	TU I	Other	Public	30 Sep 2021		22 Nov :	23 Nov 2C	Approved
WP4	D4.1	D27	Design basis	The design basis deliverable is the main output…	NTN	Repor	Public	30 Sep 2021		22 Nov :	23 Nov 2C	Approved
WP9	D9.2	D57	Definition of dissemi	Report detailing definition and plans for all p…	STR	Repor	Public	30 Sep 2021		22 Nov :	23 Nov 2C	Approved
WP1	D1.2	D5	Periodic Status Repoi	Report detailing full project progress from Yea…	STR	Repor	Public	31 Dec 2021				Pending

Number	Name	Lead Beneficiary	Delivery Date (Annex I)	Achieved	Delivery Date (actual)	Comr
1	Kick-off meeting	STRATH	31 Jan 2021	☑	29 Jan 2021	Meeting minutes XROTOR Project / Meeting minutes approved by the Coordinator (Prof
10	Decision on design scenario	NTNU	30 Jun 2021	☑	30 Jun 2021	Decision on basel scenario made
29	Social Media and Websites Set Up	UCC	30 Jun 2021	☑	30 Jun 2021	As detailed in De Social Media and website have bee

Figure 1.1: XROTOR deliverables and milestones to M12 uploaded and approved

Figure 2 shows the XROTOR milestones and deliverables that the project management team will upload by the end of Dec 2021. No issues in meeting the project management requirements from year 1 are expected.



WP No	Del Rel	Del N	Title	Description	Lead	Nature	Dissem	Est. Del. Date (annex I)	Rev. Due	Receipt [	Approval D.	Status
WP1	D1.2	D5	Periodic Status Repoi	Report detailing full project progress from Yea…	STR	Repor	Public	31 Dec 2021				Pending
WP1	D1.9	D12	Environmental and H	Report on the possible harm to the environment …	STR	Repor	Public	31 Dec 2021				Pending
WP2	D2.2	D14	Scale test model	Scale test model of the X-rotor turbine to be u…	TU I	Other	Confic	31 Dec 2021				Pending
WP5	D5.1	D31	Secondary rotors and	An enhanced power take-off system that accommod…	STR	Repor	Public	31 Dec 2021				Pending
WP7	D7.2	D38	Year 1 report on worl	This deliverable will detail the workshop metho…	UCC	Repor	Public	31 Dec 2021				Pending
WP7	D7.5	D41	Final survey design a	The final survey will include details of at lea…	UCC	Repor	Public	31 Dec 2021				Pending
WP7	D7.10	D46	Seabird distribution i	The model will include at least 3 species of se…	UCC	Repor	Confic	31 Dec 2021				Pending
WP9	D9.3	D58	General comms. mat	Report on all communication plans and materials…	STR	Repor	Public	31 Dec 2021				Pending
WP10	D10.3	D3	EPQ - Requirement N	7.1. Further information about the possible har…	STR	Ethics	Confic	31 Dec 2021				Pending

Figure 1.2: XROTOR deliverables and milestones to be uploaded by the end of M12

2. WP 2 Report (WP2: Aeroelastic Code Development and Performance)

In WP2 an aero-elastic model capable of capturing the dynamics of the X-Rotor concept will be created and validated. Performance loads and energy capture of the X-Rotor concept will be evaluated and aerodynamic noise analysis will be carried out.

For the first 12 months of the project, three tasks were started and developed:

- Task 2.1: Create Aero Elastic Dynamic Modelling tool (TUD)
- Task 2.2: Evaluate Performance, Loads and Energy Capture (TUD)
- Task 2.5: Aerodynamic Evaluation (CENER)

Additionally, two deliverables associated with Tasks 2.1 and 2.2 were developed, completed and submitted on time:

- D2.1: Aero-elastic dynamic model capable of modelling the X-Rotor (M9)
- D2.2: Scale test model (M12)

D2.1: Aero-elastic dynamic model capable of modelling the X-Rotor (M9) – Format: report

The current version of the Aero-Elastic Dynamic Modelling tool is able to (text from the description of Task 2.1 *in italic*):

- model the complex geometry of the X-Rotor (primary rotor)
- assess the deformations of the blades under unsteady loading and the effect of localised forces due to the small rotors.
- simulate the unsteady aerodynamics of the rotor.
- structurally model the rotor with linear beam elements.
- be coupled to an aerodynamic model for VAWTs: an actuator cylinder model, for fast load simulation.

The aeroelastic model has been validated using wind tunnel data from a VAWT.

The aerodynamic model was used to calculate the loads and performance of the X-Rotor's primary rotor as part of Task 2.2. The data is uploaded along with the report and distributed to project partners. This document also supports the shared simulation results database. The outcomes include normal operational conditions as well as extreme loads in stand-still situations.

The source code and simulation files will be made available upon request for the duration of the X-Rotor project, and made available in an open repository upon conclusion of the project.

The model can support the X-Rotor project's immediate planned activities. As described in Task 2.1, the model will be further developed in the project, both as part of Task 2.1 and in conjunction with other tasks.

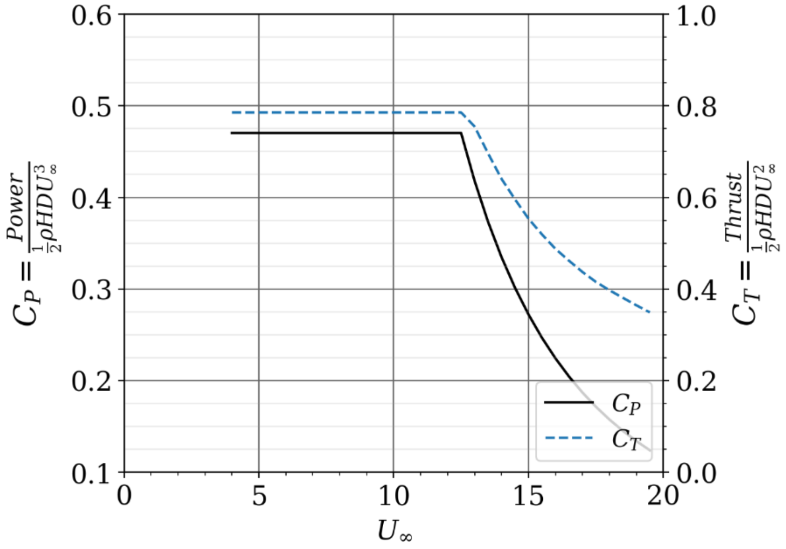


Figure 2.1: Aerodynamic Power (CP) and thrust (CT) coefficient as function of wind speed U_∞, with collective pitch control, accounting for tip losses, calculated in Task 2.2 and presented in deliverable 2.1.

D2.2: Scale test model (M12) – Format : other - report

D2.2: Scale test model (M12) is delivered as a report. It describes the development of the experimental X-Rotor model and first experimental campaign. Three design iterations of the X-Rotor have been identified, namely, Generation 1,2 and 3. These are defined as follows:

- Generation 1: An H-Type Darrieus vertical-axis wind turbine with actuator mesh disks as tip rotors.
- Generation 2: An X-Rotor turbine with actuator mesh disks as tip rotors.
- Generation 3: An X-Rotor turbine with lightweight horizontal-axis wind turbines as secondary rotors.

This report presents an experimental campaign which has been designed and completed at TU Delft around the Generation 1 turbine. This campaign focused on the impacts of actuator mesh disks on the aerodynamic loading and wingtip vortices of the blades. The respective data is in the process of being analyzed.

Furthermore, a current version of the numerical model of the Generation 2 turbine is described in this report. This model will serve as a baseline for the design and construction of a physical Generation 2 model to be tested in the wind tunnel, and includes the following functionality:

- model the complex geometry of the X-Rotor (primary rotor)
- structurally model the rotor with linear beam elements.

The source code and simulation files will be made available upon request for the duration of the X-Rotor project, and made available in an open repository upon conclusion of the project.

The model can support the X-Rotor project's immediate planned activities. As described in Task 2.1, the model will be further developed in the project, both as part of Task 2.1 and in conjunction with other tasks.

Progress in Task 2.5: Aerodynamic Evaluation (M21)

The team at CENER as developed the first complete simulations of the primary rotor, including performance curve. The progress means that the milestone M21 is feasible.

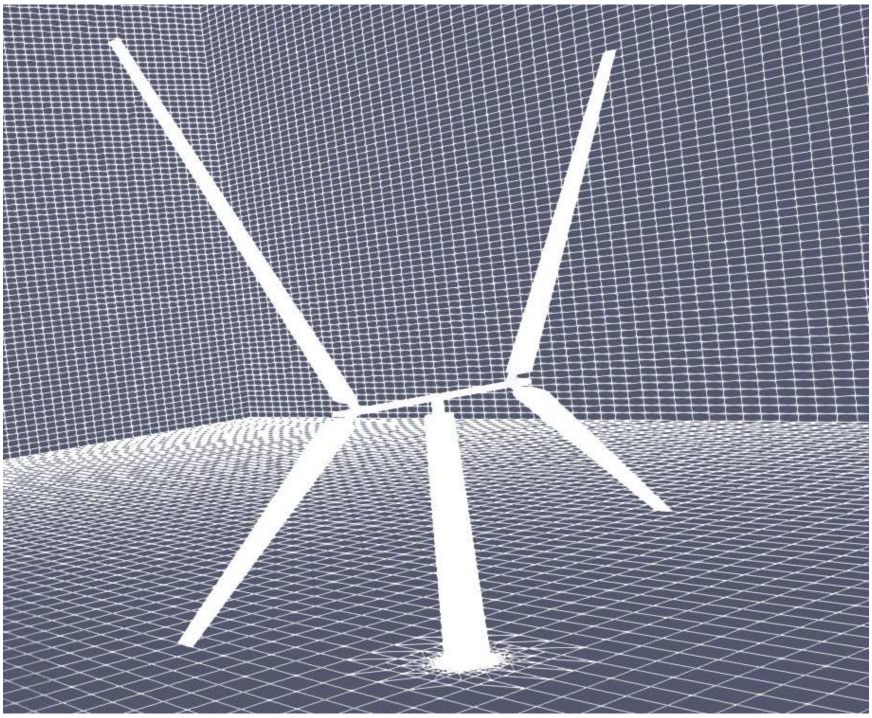


Figure 2.2- Representation of the mesh of the primary rotor in OpenFOAM, developed in Task 2.5 by CENER.

Next steps for the coming year

For the next 12 months, the activities will focus in the development and submission of the following deliverables:

Deliverable (number)	Deliverable name	Lead particip.	Type	Dissemination level	Delivery date
D2.3	Data from a scale model test	TU Delft	OTHER	CO	M18
D2.4	X-Rotor performance and loading evaluation report	TU Delft	R	PU	M20
D2.5	CFD of aerodynamic performance	CENER	OTHER	CO	M21
D2.6	Results of multibody analysis	CENER	R	PU	M21

Table 2.1- Next steps for the coming year.

3. WP 3 Report (Control and Operational Strategy)

Task 3.1. Specification of operational strategy

D3.1. Definition of operational strategy (M34)

Progress

In below rated conditions, the rotational speed of the secondary rotors is controlled through varying the frequency of their AC power connections. In this way, the operation of the secondary rotors, i.e. their torque/power and/or thrust, is directly regulated. Furthermore, the operation of the primary rotor, i.e. its power/torque, is indirectly regulated by the variation the secondary rotor thrust. Progress on specifying the below rated operational strategy is summarised below.

- The most appropriate secondary rotor output to be regulated is tip speed ratio; that is, the relationship $T_S = k\Omega_S^2$ is maintained but with k, the control variable, being adjusted to realise the required operational strategy.
- It has been that established that operational strategies realised as in the previous bullet point maximise energy capture. Furthermore, they are resilient; that is, they are stable and the impact of errors in the aerodynamic characteristics, being assumed by the controller, leads to only small modifications in the strategy.
- The options for which appropriate control laws have been determined include
  - C_{Pmax} tracking
  - Constant speed operation by either primary or secondary rotors in just below rated conditions
  - Anticipatory pitching of the primary rotor blades in just below rated conditions

In above rated conditions, the mean of the rotational speeds of the secondary rotors is controlled to be constant. In addition, the rotational speed of the primary rotor is controlled by pitching the blades. Progress on specifying the below rated operational strategy is summarised below.

- Initial investigation of the impact of fixed pitch offsets on C_P, thrust and range and rate of change of pitch requirements have been undertaken.
- Positive and negative pitching schedules with and without a fixed pitch offset have been determined.
- The options for transition between below rated and above rated conditions when using a fixed pitch offset have been considered.

The aerodynamic models of the primary rotor employed when exploring above rated operational strategies are those being developed in Task 3.2.

Next Steps

The next steps for Task 3.1 are as below.

1. Investigate the impact of a combination of fixed pitch offset plus sinusoidal varying pitch offset on offsets on C_P, thrust and range and rate of change of pitch requirements.
2. Determine options for full envelope operational strategies covering below rated, transition and above rated conditions. (Full evaluation is not possible over the next 6 months so a small number of strategies will be chosen for taking forward.)
3. Control laws will be defined for each of the options in 2

4. An internal technical report on operational strategy options will be prepared and circulated to the consortium.

Task 3.2. Construct control simulation model of X-rotor concept

D3.2. Control simulation model of X-rotor concept (M15)
M3.1 Control simulation model (M15)

Progress

A double multiple streamtube model of the primary rotor aerodynamics has been developed. Its development has been strongly guided by input from the higher fidelity modelling being undertaken in WP2 Aero-elastic code development and performance. The double multiple streamtube model has been validated by comparison to CFD simulations, see for example Figure 1.

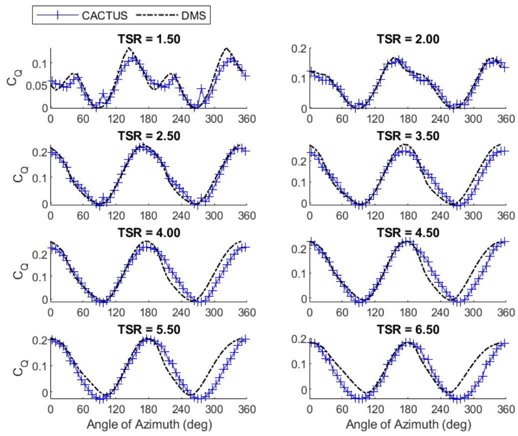


Figure 1: Aerodynamic model validation

An overview of the Control simulation model is proved by Figure 2 and progress is indicated in Figure 3, where green shading indicates complete and red shading indicates in progress.

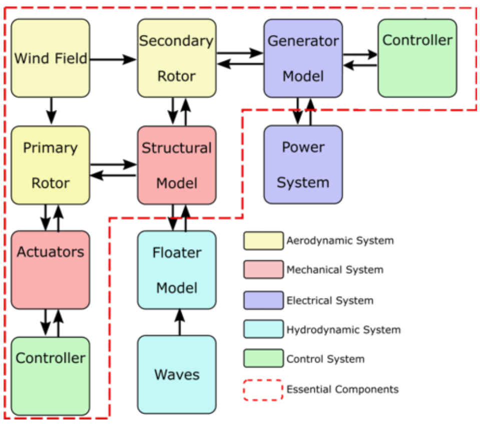


Figure 2: Overview of control simulation model

Module	Iteration 1	Iteration 2	Iteration 3
Wind Field	Homogenous wind speed	Sheared wind profile	Turbulent wind fiel
Primary Rotor	DMS look-up model outputting C_Q	DMS look-up model outputting structural loads	Vertically discretise DMS look-up mode
Secondary Rotor	Actuator disk model (direct C_T control)	BEM look-up model	Strath-turb rotor model
Generator Model	Efficiency term	Direct drive generator model	
Structural Model	Rigid body Primary rotor	Mechanical loads on primary rotor and support structure	
Actuators	'Perfect' actuator model	2nd order actuator model	

Figure 3: Control simulation model progress

Next Steps

The next steps for Task 3.2 are as below.

1. Develop effective wind speed model for primary rotor
2. Develop BEM model for secondary rotor
3. Complete control simulation model Version 1
4. Thoroughly test and assess Version 1
5. Complete Deliverable D3.2
6. Meet Milestone M3.1

4. WP 4 Report (Design of mechanical structure & Analysis)

The work in WP4 has so far centered on establishing a design basis (Deliverable D4.1). That deliverable describes the site conditions for which the structural design of the Xrotor turbine shall be performed and documents the decisions that were taken with respect to model fidelity and what assumptions shall be made for the design.

Regarding the environmental conditions, it was decided that a representative site should be similar to the conditions at the Doggerbank wind farm. However, as the relevant data is not publicly available, it was decided to instead use the North Sea Center conditions that were established during the MARINA EU project, and which should be very similar to conditions expected for Doggerbank, albeit with somewhat less details.

It was decided, with the Technical Management Team, that a sequential analysis (applying rotor loads obtained with a rigid support structure in the structural model) suffices for the basic design, and that this phase shall focus on designing the offshore jacket for the Xrotor turbine, keeping the blades and rotor configuration as during the feasibility study.

Assumptions regarding the weight and dimensions of the electrical equipment have been based on input from WP5. The loads from WP2 will be azimuth-dependent average loads obtained with constant pitch angle and zero turbulence.

A load model has been established in a flexible multibody solver (Fedem Version 7.2) and will be further improved. First tests have been performed and documented (Milestone MS4.2) regarding the necessary functionality. The software provides, among other things, linear wave forces, nonlinear soil modelling, control system integration, and the ability to work efficiently with finite element component models of varying fidelity using a substructuring approach (which is relevant here for certain structural details and the electrical equipment). The only issue that was identified where it is not straightforward to perform the desired analyses is the case of extreme wave loading, since Fedem only provides linear waves. There are various possibilities for still performing such a load analysis with the software - so this is not problematic - but it is currently somewhat unclear which one is the most effective. The load model will be presented during the international EERA DeepWind R&D Seminar 2022 in Trondheim.

For the jacket a first parametric model has been implemented in the Julia programming language that creates a jacket simulation model from a small number of input parameters (e.g. foot print, height and desired number of bays) for use in the multibody load simulation software, and similarly for the rotor (see figure for an impression)

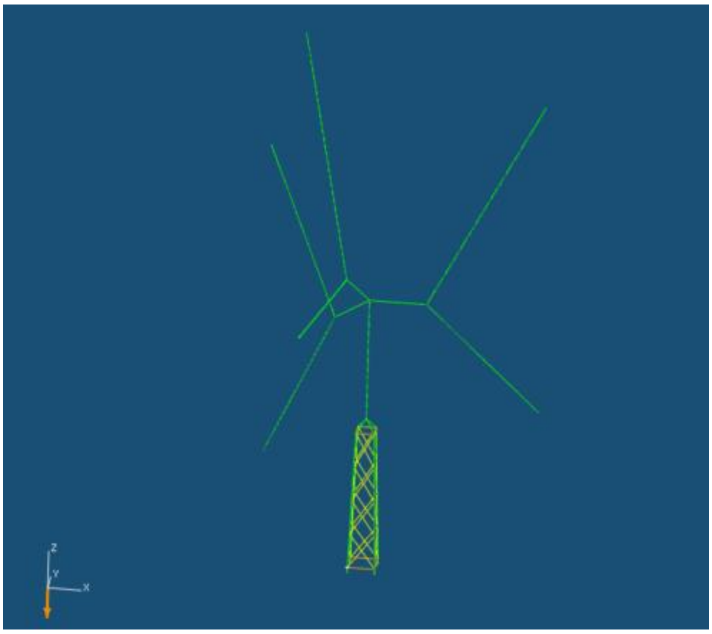


Figure 3.1 - XROTOR Structure

Next steps 2022

The next few months will be spent by exploring a few options for the design of the connection between the rotor and the offshore jacket. In particular it will be investigated how the horizontal hub, and the bearings should be designed and supported. The most straightforward option is to consider a vertical shaft with two bearings. However, the requirements for these bearings are quite different from what is usually used in horizontal axis wind turbines, so this merits careful study.

Load simulations will be performed for the cases defined in the Design Basis and analyzed. This necessitates modifying and extending scripts used for post-processing.

The current structural design of the blades will be checked and made more precise.

A numerical optimizer will be employed with the simulation code to perform an iterative optimization. The design that is obtained will be documented and published.

The rest of the year will be spent by improving the load model for use in the second design phase. The aerodynamic loads and the blade design will be revisited, and the model will be coupled with the controller developed in WP3 once it becomes available.

5. WP 5 Report (Power take off and conversion system design)

5.1. The progress made on WP5 to date

Deliverable 5.1:

The preparation of the first deliverable 5.1 (related to T5.1 and T5.2 Secondary rotor design and Generator and Power Converters) is underway and we should be able to complete and submit it by 20th December 2021.

In this deliverable, we review the aerodynamic design constraints in terms of tip speed, rotational speed, rated power, dimensions as well as operational strategies of the X-Rotor secondary rotors and provide a generator and power converter design strategy/framework to address the particular features of the secondary rotors from an electrical, electromagnetic and construction perspective.

This deliverable reviews the X-rotor operational strategy and identifies from it the requirements needed from the generators and power electronic control systems. Conventional type-IV wind turbines are compared against the secondary rotor requirements and a design strategy is proposed to modify standard type-IV designs within realistic design specifications, desired efficiencies, size and cost. Such design strategy implies the solution of a multi-parameter problem in which most of the design variables of permanent magnet synchronous machines are involved (p.e. volume, length, diameter, PM size, windings, air gap and many others). To obtain an optimal solution, metaheuristic algorithms using real-world design specifications and constraints are applied.

The solutions provided by the design strategy, are validated using an Electromagnetic field solver where the elements, dimensions and characteristics of the optimized generator are reproduced in 2-D and 3-D models. Here, the electrical, electromagnetic and thermal performances are corroborated using finite element analysis.

Finally, the electric features of the optimized generator design are used to create an electromagnetic simulation environment where the interaction of the generator and power electronics is revised. In this stage, the minimum requirements of power electronic converters are specified for the range of operating speeds of the secondary rotors.

Other progress:

Research is ongoing in the use of high-power wireless slip rings for power transfer: Initial Ansys Maxwell Models created to analyze the size, airgap length and electric features to increase efficiency (frequency, mutual inductance, efficiency).

Research on Rotary Transformers that control power transfer and rotation.

- At present, it is possible to control the high order harmonics of the air gap field in multi-phase machines
- The simultaneous control of the mechanical speed and the rotor power is achieved with acceptable efficiency

5.2. WP5 next steps for the coming year.

- Complete First deliverable December 20, 2021
- Recruit 2 new PDRAs in Q1 2022
- Continue of work for T5.3 and Start devising controller strategies for T5.4

6. WP 6 Report (Cost of Energy Reduction Analysis)

Work package 6 does not start until month 15 of the project. Consequently, no WP6 technical work has been completed to date. However, preparation for the future work is underway. As part of that preparation an experienced researcher has been hired to complete the early stage (O&M cost modelling) work for WP6. The researcher hired is Dr Alan Turnbull, his research interests are a direct match with WP6 objectives and include reliability and O&M cost modelling. He has industrial experience from working with RES, a globally leading wind turbine operator, and as a former Strathclyde PhD student he is aware of and interested in the X-Rotor concept. No issues are foreseen with the delivery of the first WP6 deliverable in project month 25.

7. WP 7 Report (Environmental and Socio-Economic Impact)

WP7 is concerned with understanding the environmental and socio-economic implications of the novel turbines under development within the project. The WP is led by University College Cork, with the support of the University of Strathclyde and TU Delft.

The first component of WP7, **Task 7.1** addresses the social dimension of the X-ROTOR concept. The aim of this task is two-fold: firstly, to promote the acceptability of the concept by ensuring that the technology takes account of the practices, values, and attitudes of the prospective host communities; and secondly, to ensure that key end user groups are receptive to the new turbine design. In this respect, the task comprises engagement with two stakeholder groups, which reflect these objectives and their respective focal groups.

- Group 1 consists of those with a stake in the areas that are prospective hosts for X-ROTOR (e.g., coastal communities, fisheries, environmental groups, shipping industry, oil and gas, tourism groups, policy makers, regulators etc.).
- Group 2 is made up of industry and end users (e.g., developers, academics, consultancies, standards bodies, operators, vessel companies, installation companies, O&M providers, OEMs etc.). A key aim is identifying the market requirements beyond lowest LCOE.

The initial work in this task was focused on the approach to be taken for the identification, recruitment and convening of the two stakeholder groups. This resulted in Deliverable 7.1, '*Methods to identify and convene stakeholder communities'*, submitted in September 2021. It began consideration of the composition of the stakeholder groups. It then explored the level of engagement being offered to both groups. Methods to recruit members to both groups were discussed, with particular care to avoid systematic omissions for coastal communities. It suggested that efforts for Group 1 should be focused on one principal host community in addition to several satellite host communities in a selection of different locations, this would ensure a wide representation. The report forwarded several techniques for recruitment and engagement (including surveys, physical meetings, online meetings, so-called asynchronous structured dialogues, *etc*.). Finally, a proposed approach and schedule for realising the engagement of the two groups was outlined.

The second output of T7.1 – D7.2, '*Year 1 Report on workshops design recommendations'*, was submitted in December 2021. It describes the initial engagement with the two groups 1 and 2. It provides some detail regarding the methodology used (which was asynchronous structured dialogue for this initial engagement) and the analytical tools to understand the input from the groups. The initial findings were that there is a stark contrast between the outlook of the two groups regarding the impact of offshore wind on the local community and on the fishing industry. Group 1 was concerned with the impact of wind turbines on the environment, local community, and fishing, while Group 2 were concerned with financial performance of the turbine's ability to survive extreme conditions.

Next steps: Continuation and intensification of engagement with both groups including: a face-to-face (or at least hybrid) workshop for group 1 focal community (coupled with satellite remote engagements), and an online workshop for industry and professional stakeholders. These engagements will be reported in D7.3 '*Year 2 report on workshops design recommendations'* in M24.

Task 7.2, the second part of the work package is concerned with analysing the economic impact of the prospective deployment of the X-ROTOR turbine, focusing on the regional economic impact of the X-ROTOR technology compared with conventional designs. Work over the first year was preparatory in nature and focus on research design and planning. There was one output from this task, namely: D7.5 '*Final survey design and methodology'* – this deliverable outlines the approach and methodology adopted for the survey of Group 2 on purchasing preferences. While new information will inform the precise content of the final survey, an indicative structure is presented.

Next steps: the survey will be finalised and realised on the 'potential purchasing decision influencing attributes of offshore wind turbines' which will be reported on in D7.5 in M24. In addition, work will commence on the regional economic analysis, which will continue on into year three

The third task**, T7.3** is focused on the environmental aspects of X-ROTOR. There are a number of elements to this task: (i) comparative life Cycle assessment of the turbine concept; (ii) understanding seabird behaviour and distribution; (iii) development of a noise propagation model for operation of X-ROTOR; (iv) assessing the impact on seabirds, marine mammals, and users of the marine environment of the deployment of X-ROTOR; (v) defining measures to mitigate the impact of the X-Rotor (including *e.g.,* selection of sites, turbine control strategies, *etc.*). In this initial year, work has focused on understanding the seabird aspects associated with the X-ROTOR design and deployment.

The first output from this task was a literature review on species specific collision risks for sea birds – Deliverable 7.9 'Review of species-specific collision risks for sea birds' was prepared and submitted in September 2021. This comprised a comprehensive literature review for 82 species, including breeding and migrating birds, focusing on flight height and three others collision risk factors. Within X-ROTOR, collision risk factors will be coupled with habitat use and conservation status into the Collision Vulnerability Index. This index will be applied to seabird distribution data to aid identification of suitable areas for the development of the X-ROTOR turbines. The second output from T7.3 was a seabird distribution model – Deliverable 7.10 'Seabird distribution and vulnerability to wind farms', which has just been completed and submitted in December 2021. In this report, Collision and Displacement Vulnerability Indices were calculated (using data on flight behaviour, sensitivity to disturbance and conservation status for 81 seabird species present in European waters). These indices were combined with distributions of 12 commonly occurring seabird, to generate vulnerability maps for breeding, wintering, and migration periods when risk is likely to vary.

Next steps: Conclusion and full write up of the field work on sea bird to be reported on in D7.11 'Field work data and methodology' due in M18. The coming year will also see the commencement of the life cycle assessment work.

8. WP 8 Report (Industry Ratification and Further Development Roadmap)

Task 8.1. Industry Ratification

Progress

The procedure for industry ratification has been established. The Technical Management Team meets on a monthly basis to ensure that GE is kept fully informed of WP progress. Depending on the status off each Work Package, a meeting is called between the Technical Management Team and the Work Package Lead, see WP8.3. (It may not be necessary to meet with each Work Package Lead every month, particularly during the first year of the project. Not all Work Packages are active during that time and those that are may be progressing sufficiently well.) The GE member of the Technical Management Team participates in all these meetings. Guidance on methodology, results and next steps is, thereby, fed back by GE to Work Package Lead.

The following meetings of the Technical Management Team with Work Package Leads have been held:

- WP2, 8th June 2021
- WP4, 23rd June 2021
- WP9, 24th June 2021
- WP5, 5th June 2021
- WP7, 8th July 2021
- WP4, 18th July 2021
- WP2, 10th November 2021
- WP4, 10th November 2021
- WP7, 23rd November 2021
- WP9, 23rd November 2021

No issues have arisen regarding the standard of methodology and results or their ratification during the first year.

A single monitoring form is used for both Task 8.1 and Task 8.3, see below.

Next Steps

Early next year, the Technical Management Team will hold an X-Rotor concept development workshop with GE engineers to present the year's progress on concept development and take questions and guidance from the GE turbine engineering team regarding methodology, results and next steps.

Task 8.3: Turbine Design Integration

Progress

The following consortium technical meetings with all Work Package Leads present have been held:

- Consortium Technical Meeting 1, 2nd February 2021
- Consortium Technical Meeting 2, 23rd March 2021
- Consortium Technical Meeting 3, 8th December 2021

In addition, the following technical meetings have been held:

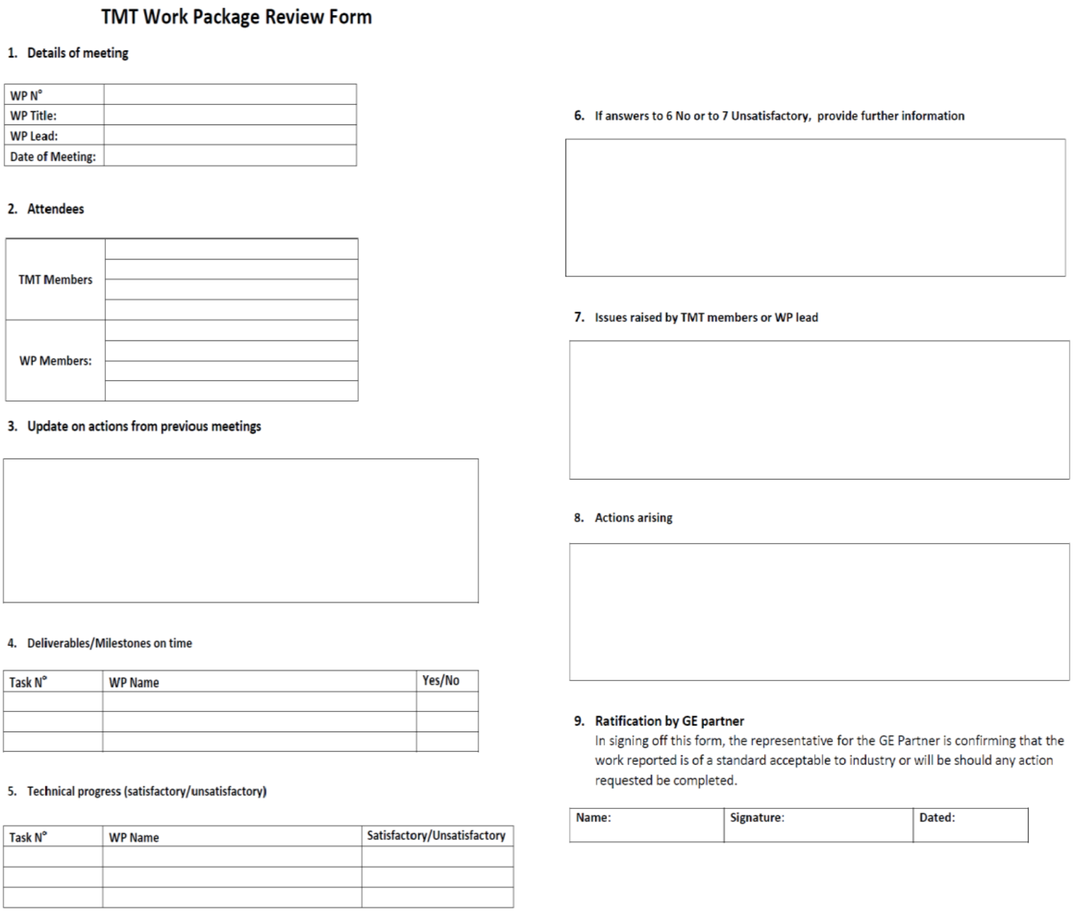
- WP9 technical meeting, 23rd February 2021
- WP2, WP3, WP4, WP5 technical meeting, 8th March 2021
- WP2, WP4 technical meeting, 23rd June 2021
- WP3, WP5 technical meeting, 16th October 2021
- WP3, WP5 technical meeting, 3rd November 2021
- WP3, WP5 technical meeting, 23rd November 2021
- WP2, WP3, WP4 technical meeting, 30th November 2021

Other informal discussions have taken place between researchers on the consortium.

The monitoring form used for both Task 8.1 and Task 8.3 is shown in the Figure below.

Next Steps

The core Work Packages 2, 3, 4 and 5 are closely connected. Accordingly, a timetable for regular meetings has been set up for 2022. These will occur at least every 3 months with other meetings, where not all Work Packages are involved, will occur whenever required. AT least 2 full consortium technical meetings will also be held.



TMT Work Package Review Form

1. **Details of meeting**

WP N°	
WP Title:	
WP Lead:	
Date of Meeting:	

2. **Attendees**

TMT Members	
WP Members:	

3. **Update on actions from previous meetings**

4. **Deliverables/Milestones on time**

Task N°	WP Name	Yes/No

5. **Technical progress (satisfactory/unsatisfactory)**

Task N°	WP Name	Satisfactory/Unsatisfactory

6. **If answers to 6 No or to 7 Unsatisfactory, provide further information**

7. **Issues raised by TMT members or WP lead**

8. **Actions arising**

9. **Ratification by GE partner**
In signing off this form, the representative for the GE Partner is confirming that the work reported is of a standard acceptable to industry or will be should any action requested be completed.

Name:	Signature:	Dated:

9. WP 9 Report (Communication and Dissemination)

WP9 deals with the procedures and techniques for the dissemination and communication of the project results, although other dissemination activities are included within WP8. The main objective is to effectively disseminate the results and increased understanding gained during the project.

The first part of the work package, **T9.1** concerns the corporate image of the project. The project corporate identity will be created in this task. The corporate identity aims to provide visual conceptualization of the project, and ease project recognition. This includes the project Logo (full colour and grayscale versions), project colours, and other visual designs, as well as the design of official communication templates to show cohesion across the corporate identity.

Next steps: A new project logo will be introduced in conjunction with the relaunch of the project website. Communication templates will be revised and updated to take account of the new design. Other visuals will be prepared as required for communication purposes.

The second task, **T9.2** involves the establishment and maintenance of a project website to serve as a communication and dissemination channel for the project's results as well as tools for involving and enlarging the stakeholder community. The X-ROTOR website went live on 31 March 2021 on the following URL: https://xrotor-project.eu. The website has the structure as outlined below.

- HOME (Landing page, brief introduction, social media feed, funding acknowledgement, policies)
- ABOUT (Information about the project, its objectives and activities, funding acknowledgement)
- PARTNERS (A brief description of each project partner with logo and link to their website)
- OUTPUTS (Project public deliverables, and other outputs of interest arising from the project)
- NEWS & EVENTS (All news and events both from the project, and those of interest to the project)
- CONTACT (A form to contact the X-ROTOR project)

This first iteration of the website – as outlined in D9.1 – was intended as a soft launch with an initial basic layout and design and relatively limited content. The intention is that additional content, including extra sections such as blog posts, would be added later in the project matures. A revision and redesign of the website has been underway over the last few months of this year; this (re)design and development is taking a "Mobile First" approach, the aim of which is the production of a (more) modern, visually appealing and engaging website. The new design will be responsive catering for all desktop, tablet and mobile devices, and will degrade gracefully in older browser versions.

Next steps: The redesign of the website will be finalised, and the site (re)launched in early 2022 (coupled with a social media mini-campaign). Over the remainder of the year, new content will be added to the website as results and outputs emerge from the project.

The next activity is **Task 9.3** Social media positioning. As described in D9.1, the X-ROTOR project's principal social media presence will be on the Twitter platform, on which an account – @XRotorProject – has been set up for the project.

<u>Next steps</u>: A mini-social media campaign publicising the project will be rolled out to coincide with the (re)launch of the project web site in early 2021. Over the rest of 2021, account will be used sparingly; Its principal use will be over the second half of the project once results start to emerge. The Use of the Twitter account will be complemented by partners' posts on the LinkedIn platform. As the research develops a project YouTube channel will be used to promote the X-ROTOR concept and publicise research outputs.

Task 9.4 is concerned with the preparation of communication and dissemination materials over the life of the project. This task also includes the preparation and release (following an IP review) of Peer reviewed journal articles. Two deliverables were produced in the context of this task during 2021, D9.2 '*Definition of dissemination activities'* in September and D9.3 '*General communication material development*' in December .

<u>Next steps</u>: A press release publicising the work of the project will be released in early 2022, in conjunction with the (re)launch of the project web site and the mini-social media campaign. The first issue of the electronic newsletter will be distributed in the first half of 2022. In addition, ixt is envisaged that the first prospective journal articles will be emerging during the latter part of 2022 / early 2023.

The next task **T9.5** relates to the organization of result exploitation events, meetings and workshops during the lifetime of the project. It is intended that the workshops will firstly, contribute to the dissemination of the project's work and secondly, inform specific stakeholder groups of the progress, achievements and opportunities derived from project results and its exploitation to other related communities. It has not been appropriate to hold such events at this early stage of the workshop.

<u>Next steps</u>: It is envisaged that the first of these events will take place in late 2022 depending on timing of results emerging from the project (and subject to the public health context).

The final element of that WP, **Task 9.6** is focused on communication through the participating universities (UoS, TUD, UCC, NTNU). Students (and other members of university communities) will be invited to attend lectures and special workshops based around the challenges arising with n the project's work packages.

<u>Next steps</u>: It is envisaged that the first of these special talks will be conducted in late 2022.

10. Note from Project Coordinator and Conclusion

All deliverables and milestones have been met in year 1 of the XROTOR project. The project coordinator would like to thank consortium members for their contribution to this report as well as for their work in year 1 of the XROTOR project. Additionally the project coordinator would like to thank the EU PO for facilitating the XROTOR project in year 1.

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

The deliverable description states: “Report detailing full project progress from Year 1. Successful once delivered to the project coordinator and/or the executive management group.”

Dissecting that description, a report detailing full project progress from Year 1 has been created and delivered to the Project Coordinator.

The year 1 progress report has been reviewed by the Project Coordinator and has been approved.

In conclusion, this deliverable has been successfully completed.