Final report

1. Project details

Project title	OptiCore Platform
File no.	64022-1041
Name of the funding scheme	EUDP 2022-I
Project managing company / institution	Gurit Wind Systems A/S
CVR number (central business register)	34607109
Project partners	DTU Construct, DTU Wind, Nordex, Siemens Gamesa, Energy Cluster Denmark, Gurit UK
Submission date	29 August 2025

2. Summary

Describe the objectives of the project, the obtained results and how they will be utilized in the future, both in English and in Danish. The summary will be published on www.eudp.dk and www.energiforskning.dk.

Project summary:

The purpose of the project

- Development and prototype demonstration of a new digital design platform for wind turbine blades.
- Development of a design platform capable of optimizing the core kit design. Developed through software implementation and experimental work.
- Innovation lies in the digitalization of the core kit design process.

Results, conclusions and perspective

- Most important results of the project:
  - Development of a digital design platform capable of reading blade 3D models, design inputs and constraints and capable of optimizing the core kit design accordingly, automating the design process and estimating the quality of a specific design and its implications in terms of fit-to-mould, resin uptake, mechanical properties and infusion performance.
  - Creation of databases and analytical formulas through experimental work, used in the platform to estimate the fit, resin uptake, mechanical properties and infusion performance of a core kit design.
  - Full-scale validation of the created design and benefits together with OEMs.

- The results will be used in the future to design core kits for wind blade OEMs, leveraging the platform's design capabilities and to continuously improve the implemented techniques and methods.
- The effects expected to derive from the technology are faster lead time for core kit designs, lower resin uptake, better core fit and exploration of implications of a specific kit design on mechanical properties and resin flow.

Projektresumé:

Formålet med projektet

- Udvikling og prototypedemonstration af en ny digital designplatform til vindmøllevinger.
- Udvikling af en designplatform, der kan optimere core kit-designet, baseret på softwareimplementering og eksperimentelt arbejde.
- Innovationen ligger i digitaliseringen af designprocessen for core kits.

Resultater, konklusioner og perspektiv

- De vigtigste resultater af projektet:
  - Udvikling af en digital designplatform, der kan læse 3D-modeller af vinger, designinputs og begrænsninger og optimere core kit-designet tilsvarende, automatisere designprocessen samt estimere kvaliteten af et specifikt design og dets implikationer med hensyn til pasning til form (fit-to-modul), harpiksoptag (resin uptake), mekaniske egenskaber og infusionsperformance.
  - Etablering af databaser og analytiske formler via eksperimentelt arbejde, som anvendes i platformen til at estimere pasning, harpiksoptag (resin uptake), mekaniske egenskaber og infusionsperformance for et core kit-design.
  - Fuldskalavalidering af det udviklede design og dets gevinster i samarbejde med OEM'er.
- Resultaterne vil fremover blive brugt til at designe core kits for vindvinge-OEM'er ved at udnytte platformens designkapaciteter og til løbende at forbedre de implementerede teknikker og metoder.
- De forventede effekter er kortere gennemløbstid for core kit-designs, lavere harpiksoptag (resin uptake), bedre pasning af core samt mulighed for at undersøge, hvordan et specifikt kitdesign påvirker de mekaniske egenskaber og harpiksflow (resin flow).

3. Project objectives

- *What was the objective of the project?*

The development and prototype demonstration of a new digital design platform to design optimized core kits for wind turbine blades.

- *Which energy technology has been developed and demonstrated?*

The project has addressed some needs of the wind energy industry. We have demonstrated an optimized design on 6 blade trials for full-scale wind turbine blades. The results proved that there is potential for reducing blade mass via reduction of parasitic resin consumption and cost. The quality of fit was also validated and yielded further collaboration with an OEM towards a path to serial production.

4. Project implementation

- *How did the project evolve?*

The project evolved according to project plans with the completion of WP4 and the identification and implementation of the optimization methods and techniques to define and explore the solution space based on all the design parameters and constraints. In parallel the work carried out as per WP2 helped identifying the methodologies and key parameters affecting the infusion performance based on different core material kitting patterns and the validation of these through the experimental campaign and CFD modelling. In WP3 the experimental testing campaign was completed, and a mechanical properties database was release and then analytically implemented into the OptiCore platform. Finally, in WP5 the OptiCore platform was demonstrated on full-scale blades through a number of trials performed together with OEMs

- *Describe the risks associated with conducting the project.*

The risk of the projects where the following:

1. Being a rather conservative sector blade manufacturers will be reluctant to utilize tools
2. The proposed patterns don't ensure the right infusion performances required by wind turbine OEMs
3. The proposed patterns have detrimental influence on the mechanical properties of the final infused product

All three risks have been tackled through a number of mitigation measures to ensure the successful outcome of the project. Risk 1 was mitigated through continuously consulting OEMs, aligning on progress and hiring and involvement of blade design experts. Risk 2 was mitigated through the experimental work carried out by DTU as part of WP2 and Risk 3 through the analogous work carried out on testing mechanical properties as part of WP3. However, some of these risks persist depending on the risk appetite and design philosophy of the OEMs.

- *Did the project implementation develop as foreseen and according to milestones agreed upon?*

Yes, the project developed according to project plans with only a few milestones being slightly delayed and without this affecting the overall timeline and success of the project.

- *Did the project experience problems not expected?*

No.

5. Project results

- *Was the original objective of the project obtained? If not, explain which obstacles that caused it and which changes that were made to project plan to mitigate the obstacles.*

Yes the overall objective of developing and demonstrating a new digital design platform for optimized core kits for wind turbine blades was reached successfully and no significant obstacles were encountered.

- *Describe the obtained technological results. Did the project produce results not expected?*

The main technological result was the successful development of the OptiCore digital design platform and its full-scale demonstration on real wind turbine blades. The manufacture of the demonstrator blades was successful, without any significant infusion defects caused by the optimized core kits and yielding resin consumption savings.

- *Describe the obtained commercial results. Did the project produce results not expected?*

The main commercial results were the successful demonstration of the core kit designs created through the OptiCore platform. The benefits for OEMs were confirmed due to the lower blade weight and resin consumption in the trials, which would reduce the production costs. The OptiCore platform will be implemented on a further set of full-scale blades, and if successful, the core kit design will be taken to serial production. This would be a commercial win for both Gurit and the OEM.

- *Target group and added value for users: Who should the solutions/technologies be sold to (target group)? Describe for each solutions/technology if several.*

The target group for the OptiCore Platform is all wind turbine blade manufacturers as a Tier 1 and wind turbine operators as Tier 2. The added values can be grouped within

- Blade mass reduction
- Total Cost of Ownership reduction
- Resin uptake reduction

- *Where and how have the project results been disseminated? Specify which conferences, journals, etc. where the project has been disseminated.*

A number of conferences were attended, listed in the table below. Additionally, other dissemination activities were carried out through Linkedin posts and posting of videos showcasing the project progress and the OptiCore capabilities.

Event Titel	Date	Place	Type of event
Wind Energy Europe 2023	25-27 April 2023	Copenhagen, Denmark	Conference
43th Risø International Symposium on Materials Science	4-7 September 2023	Roskilde, Denmark	Conference (academic)
FLOW-3D World Users Conference 2024	10-12 June, 2024	Hamburg, Germany	Conference
21st European Conference on Composite Materials (ECCM21)	2-5 Jul, 2024	Nantes, France	Conference (academic)
21st European Conference on Composite Materials (ECCM21)	2-5 Jul, 2024	Nantes, France	Conference (academic)
China Composite Expo 2024	2-4 Sep, 2024	Shanghai, China	Expo
AMI Wind Turbine Blades	10-12 Dec, 2024	Dusseldorf, Germany	Conference (industrial)
45th Risø International Symposium on Materials Science	1-4 Sep, 2025	Roskilde, Denmark	Conference (academic)

- Conference contributions (presentations, posters, etc.):
    - Md Tusher Mollah, Maksim Larionov, Robert S Pierce, Jon Spangenberg, Computational Fluid Dynamics Modelling and Experimental Analysis of Resin Infusion Performance in Composite Sandwich Panels for Wind Turbine Blade Production, Flow-3D World Users Conference, Hamburg (Germany), Jun 10-12, 2024. Link

(Conference poster, DTU Construct and DTU Wind)

- M Larionov, MT Mollah, J Spangenberg, RS Pierce, Optimization of core groove geometry for the manufacture and operation of composite sandwich structures in wind turbine blades, 21st European Conference on Composite Materials (ECCM21), Nantes (France), Jul 2-5, 2024. Link

  (Conference paper and poster, DTU Wind and DTU Construct)

- Md Tusher Mollah, Maksim Larionov, Robert S Pierce, Jon Spangenberg, Computational fluid dynamics modelling of vacuum-assisted resin infusion in composite sandwich panels during wind turbine blade manufacturing, 21st European Conference on Composite Materials (ECCM21), Nantes (France), Jul 2-5, 2024. Link

  (Conference presentation and paper, DTU Construct and DTU Wind)

- Maksim Larionov, Agustin Canalis, Bo Madsen and Robert S. Pierce, Analysis of shape of resin flow in vacuum infusion of composite sandwich structures with core channels, 45th Risø International Symposium on Materials Science, Roskilde (Denmark), Sep 1-4, 2025.

  (Conference paper and poster, DTU Wind)

- Robert S. Pierce, Alessandro Murdaca, and Gregor Borstnar, Quantifying the flow behaviour through foam core materials for the optimisation of wind turbine blade kitting, NAFEMS: Simulation in Manufacturing conference, Hillerød (Denmark), Oct 21-22, 2025. **(Conference presentation and paper, DTU Wind and Gurit)**

- Number of published peer-reviewed articles:

  - Md Tusher Mollah, Maksim Larionov, Robert S Pierce, Berin Seta, Jon Spangenberg, Experimental and Numerical Investigation of Fluid Flow Behavior in Infusion Channels and Reinforcement Fabrics, Polymer Composites, 2025 (under review) **(Journal paper – under review, DTU Construct and DTU Wind)**

6. Utilisation of project results

- *Describe how the obtained technological results will be utilised in the future and by whom.*

  The technology will be used by Gurit to produce optimized core kit designs for wind turbine OEMs which can be also transferred to other core kitters for dual-source production requirements.

- *Describe how the obtained commercial results will be utilised in the future and by whom the results will be commercialised.*

  The commercial benefits of OptiCore will be shared between Gurit and wind turbine OEMs.

  - *Did the project so far lead to increased turnover, exports, employment and additional private investments? Do the project partners expect that the project results in increased turnover, exports, employment and additional private investments?*

Yes. The project has been critical to differentiate Gurit from the shift towards the commoditisation of the market, allowing Gurit to supply value add engineered product and ensuring maintaining of market share. The technology is fundamental to facilitating long-term agreements that are under negotiation. Gurit has additionally invested into developing and buying equipment in preparation for serial roll-out of the product and has applied to protect both software and hardware intellectual property.

- *Describe the competitive situation in the market you expect to enter.*
  - *Are there competing solutions on the market? Specify who the main competitors are and describe their solutions.*

There are no core material design solutions that have the same functionalities as the OptiCore Platform.

- *Describe entry or sales barriers and how these are expected to be overcome.*

The entry and sales barriers to the market are influenced by blade design and manufacturing process and risk appetite within wind turbine OEMs. The effect of the optimization to reduce mass leads to core kit patterns with fewer cuts, which reduce the flexibility of the core in areas that do not need o be flexible and in turn, reduce the resin uptake from the free-volume and exposed surface area. If an OEM is relying on a specific core pattern in that area for a secondary function, like resin infusion performance and/or to enhance the core materials mechanical properties, the ability for OptiCore to optimize the design is limited and can be interpreted as a barrier.

To overcome the infusion performance deficit, additional kit features like perforations and shallow channels can be added to compensate for the performance lost from the optimization. This approach has been validated on two core kit designs in full-scale trials, and further designs will reinforce the approach and support future OptiCore designs.

For the OEMs that rely on the infused mechanical properties, the solution is more complex. This stems from the inherent conflict of using cuts in the foam to boost mechanical performance, while the mass optimization wants to reduce the number of cuts in the optimized design. The proposed approach is to integrate OptiCore designs and the data rich outputs earlier into the design process, and in doing so, feed representative data about the core resin uptake and the local mechanical properties towards the OEMs to validate. This data integration represents a completely new endeavour and hence, project. Therefore, Gurit, together with a prominent OEM are embarking on a new EUDP project called ‘’OptiBlade’’, which will aim to address this barrier.

- *How does the project results contribute to realise energy policy objectives?*

Security of Supply
OptiCore reduces the LCoE with approximately 0.8% for turbines where the blade weight reduction is considered in the design of the blade and wind turbine
Fossil Fuel Independence
Once fully implemented, the annual global impact is expected to be + 500.000 MWH/year from turbines where the core kit is supplied by Gurit. As OptiCore designs can and will be supplied from other core kit manufactures this number is expected to be up to 3 times higher.
Climate and Environmental Considerations
When the increased energy production supresses fossil-based energy production, the additional 500.000 MWH/year would reduce CO2 emissions. The implementation of new turbine and blade models takes time. Estimated impact in 2025 is 4.000 tons CO2, but this will increase to a yearly saving of +170.000 tons CO2 by 2030. This is only for Gurit supplied kits, so global impact will be significantly

higher as Gurit's market share is around 25%, and GWS kit designs will be shared with other manufactures

- *If Ph.D.'s have been part of the project, it must be described how the results from the project are used in teaching and other dissemination activities.*

  No.

7. Project conclusion and perspective

- *State the conclusions made in the project.*

  During the course of the project the OptiCore software was successfully implemented including the geometrical algorithms to provide the best fit-to-mould of the core and the optimization algorithms enabling OptiCore to provide an optimal design based on the focus on different target parameters (fit, resin uptake, mechanical properties and resin performance). The findings of the experimental work of WP2 and WP3 have been implemented in the form of analytical formulas/databases to estimate these parameters for different kitting patterns. The full-scale testing campaign of WP5 have successfully demonstrated that the assigned geometrical patterns fit well in the mould and target the local curvature of the blade and allowed to validate and tune the resin uptake calculations and expected weight savings.

- *What are the next steps for the developed technology?*

  As mentioned in Section 6, the OptiCore platform is currently being applied to full-scale wind turbine blade core kit designs and has been validated in two separate trials. Commercially, the immediate next step is to validate the first 'serial' design in a set of trials and complete the Production Part Approval Process (PPAP) for serial production. This will represent the first OptiCore design to complete the process.

  Technically, the core kit designs generate a lot of usable data about the core kit that is currently utilized only in a post-processing manner. Gurit feels that its value is not fully realized in the blade design process, rather OEMs are only benefitting from a production standpoint by reducing the core resin uptake (blade mass) and associated materials costs. However, should designers know that the blade mass (and associated mass-moment) is reduced by a few hundred kilos from employing an optimized core kit, this could lead to a reduction in blade loads that may have a knock-on effect leading to further mass savings. Additionally, if designers are aware that the mechanical properties of the infused core kit are enhanced from the combination of the foam and stiffer resin, this could also lead to a more optimized laminate for the skins. Heren lies the basis of the future ''OptiBlade'' project as introduced in Section 6. This project will extend OptiCore and enable this data sharing towards OEMs to happen early in the design process, such that any benefits from the core kit properties and reduced parasitic mass are captured in the blade design loop.

- *Put into perspective how the project results may influence future development*

  WP3 generated a database of infused mechanical properties based on an initial set of parameters and tests that were requested and agreed with the OEM partners of the OptiCore project. The infused through-thickness hear stiffnesses yielded data that could be modelled in via an analytical relationship,

while the strength of the kitted foams was consistently improved for low PET foam densities and worsened for high PET densities. This indicated that understanding the infused strength was more complex than expected. Therefore, future testing will focus more on understanding the strength and the cross-over that was identified in the OptiCore project for high and low densities.

The WP3 results also enabled Gurit to approach (non OptiCore project-partner) OEMs and through these meetings, identified that the strength post-fatigue was also a critical parameter. This parameter would need to be tested and proven, in order to give the confidence in any mechanical properties that would be provided through OptiCore. Therefore, the approach for future testing will be ‘’changed’’ to test a more targeted set of configurations and to gather multiple properties rather than trying to develop a database covering a wider range of configurations with less detail.

The success of OptiCore has led to greater collaboration with one of the leading Danish OEMs, facilitating another joint EUDP application with them and another Danish university in order to take OptiCore to the next level of design integration and optimization via the ‘’OptiBlade’’ project.

8. Appendices

- *Add link to relevant documents, publications, home pages etc.*

  The publications link is available under Project Results.