

# Modular Root development and validation for Wind Turbine Blades

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## Publieke samenvatting / Public summary

### Aanleiding

Larger blades are required for the cost-effective growth of wind turbine power capacity. Larger blades lower LCOE and environmental impact but require stronger root connections. Reducing defects in the root is critical to match increasing life expectation demand of up to 40 years. With larger blades, manufacturing complexity and number of defects increase exponentially. To tackle this our solution is the segmentation of the blades and assembly from pre-cured, quality assured, smaller modules. Key to this is a defect-free root that has a secure connection to the hub. The root, because of its shape, size, and thickness, is subject to a lot of manufacturing defects in the current process. The new modular root concept is built up by 6-12 modules which can be produced separately with a higher quality and put together (assembled) in the mould. Automation can be applied more easily and cost-effectively to these smaller modules. Future blade production could be transformed into an assembly model like automotive and aerospace production. Future blade factories assemble parts which have been made, then distributed, from dedicated root module manufacturing cells.

### Doelstelling

The development and validation of a modular wind turbine root concept is crucial to meeting global CO2 reduction targets. The project addresses several challenges to demonstrate the feasibility and advantages of the modular wind turbine blade root concept. The first challenge is to understand

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#### Algemene informatie / General information

**Penvoerder / Secretariat**  
GE Renewable Holding B.V.

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the mechanical challenges of a modular wind turbine concept in terms of design, component production and assembly. This requires a combination of numerical modelling and tests at various scales. Secondly, one of the main advantages of modular concept is to reduce waste and increase production quality. This will help to reduce costs and improve the durability of large wind turbines. By evaluating opportunities for automation, we can further reduce costs, increase quality, and increase manufacturing capacity. In conclusion, the development and validation of a modular wind turbine root concept is a critical project that will help to reduce costs, increase production quality, and increase manufacturing capacity. By leveraging automation and optimizing manufacturing flow and layout, we can meet the growing demand for renewable energy while also reducing global CO2 emissions.

### **Korte omschrijving**

WP1 Component Design Detailing the modular root concept including joints to the remainder of the blade. WP2 Joint Analysis Tools Development of numerical models validated through material and component testing. WP3 Shape Prediction & Measurement Development of prediction tools and measurement methods to compensate for the shrinkage and thermal cure distortions of the parts. WP4 Component Verification Design validated by tests on sub-component and component scale. Results from WP2 serve as input to the tests. Adding new testing capability. WP 5 Automation Options for automated production of the different segments of the root will be investigated. WP 6 Blade Validation Validation of the final concept by manufacturing at full scale and performing static / fatigue blade tests. WP 7: Design Improvement Using the lessons learnt and validation data to improve the new concept. WP 8 Factory and Mould Optimisation Optimisation of use of factory equipment and moulds. Refining the business case for a modular root including onsite and offsite logistics. WP 9 Dissemination and Exploitation

### **Resultaat**

The main results of the project are:

- A modular root will be designed, integrated in a blade, and validated through testing.
- New design guidelines, testing equipment, and testing methods will be developed to standardise the approach to design and verify modular root sections for future wind turbine blades.
- Design and analysis tools will be developed to design, manufacture, validate, and inspect structural joints.
- Material and subcomponent mechanical properties will be measured to understand the load carrying capability of the root section and bushing elements to allow the modular root to become a standardised wind turbine component.
- New testing capability and capacity; both equipment and know-how will be developed to verify wind turbine root subcomponents.
- Automated production of components will be investigated to identify the most cost-effective level of automation to produce and inspect modular components.
- Factory manufacturing flow and layout simulations combined with supply chain logistic modelling will be completed to assess the most cost-effective manufacturing route to produce larger wind turbine blades.

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.

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