Final Report

Project acronym: *MARWEL*

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M-ERA.NET Call 2018

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Publishable project summary

The MARWEL Project aims at extending the service life of critical elements involved in rolling contacts as bearings in rotors/generators, gearbox components of Wind Turbines by the development of wear-corrosion resistant Innovative Graded Coatings and by optimization of the induction hardening process.
For competitiveness of wind power, reliability and the life of turbines need to be improved. A 20-year life wind turbine have a high relevance Operation and Maintenance (O&M) costs: a 750 kW turbines might account for about 25%-35% of the overall energy generation costs or 75%-95% of the investment cost. O&M costs for Onshore wind farms in major wind markets averages between 0.008 €/kWh and 0.021 €/kWh while for Offshore plants costs can be between 0.023 and 0.041 €/ kWh due to the difficulties of the offshore environment.
The 20-year design wind turbine gearbox life is far to be achieved due to unplanned downtime. For instance, on cylindrical roller bearings the manufacturers declare a failure rate from 40 to 70% after two years only. In the gearbox bearings are distributed by planet, high speed (HSS), intermediate and low speed shafts bearings. HSS suffer the highest rates of failure mainly caused by steel degradation WEA (White Etching Area) and WSF (White Structure Flaking) due to combination of harsh environment, lubricant, high shear rate, electrical currents, hydrogen diffusion, corrosion. Excessive external vibration generates a relative motion between rolling elements and raceway causing lack of lubricant film and enhancement of wear process. Modern vibration monitoring/ analysis due to the rolling surfaces degradation is probably the most widely used Predictive Maintenance technique and can be applied to the rotating equipment to identify bearing failures progression. Layered CerMet coatings deposited by Cold as Spray (CGS for bearings) technology and High Velocity Oxy Fuel (HVOF for shafts) are the composite candidate materials combining the metal matrix and ceramic particles unique properties.
The MARWEL Project intended to address:

- development of CerMet graded coatings for high speed shafts (HVOF) and bearings (CGS) able to mainly enhance resistance to wear-corrosion combined effect starting from modeling stresses induced in the component by mixed rolling-sliding contact between rollers and raceways, coatings composition, porosity and surface finishing as variables to be tuned;
- optimization of the induction hardening process in order to increase large bearings lifespan;
- data mining management of in-service materials related data (rotor, gearbox and generator) for the maintenance of wind assets;
- development of a lab-bench monitoring system for coated bearings during severe wear tests and processing of the acquired data for the detection of possible bearing faults. Correlation among laboratory and in-service data for advanced failure mode interpretation.

Concerning the Cold Gas Spray, for each powders a series of experiments, following a fraction factorial design, were carried out in order to evaluate the influence of particle temperature and particle velocity on the deposition efficiency, quality of the coating, porosity, hardness, adhesion, wear resistance etc. Deposition efficiency up to 40 % (high value considering the difficult to deposit cermet by CGS) and a porosity and crack free microstructure were obtained.
At the end of the MARWEL project, innovative solutions studied were developed and validated at TRL 6.