



UNECE

**Genium Refresh – A concept to reduce the
environmental impact of wind blade waste**

25th November 2020

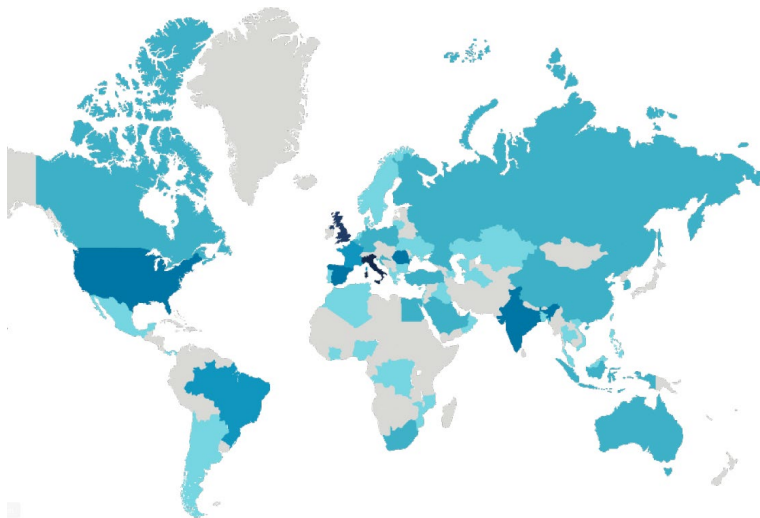
RINA – Energy Innovation & Digital - Who We Are?



3900
Colleagues

200+
Offices

70+
Countries



Energy

Get the best performance for your projects, taking into account their safety and environmental impact



Research & Development

Building a better future through R&D and open Innovation to quickly transfer new ideas to industrial practice



Transport & Infrastructure

Hit the road to the next generation of buildings and transport modes by ensuring their safety and efficiency



Certification

A set of solutions to support products, people, facilities and processes on their pathway to achieve excellence



Marine

Sail to the highest standard: rules, technologies and notations to handle shipping, offshore or yachting units



Industry

Connect the hubs of the 4.0 revolution: big data and AM, new synergies to make the quantum leap



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Innovation for
Energy – Digital
Projects

We deliver digital solution through
our digital platform Rina Cube.



Genium Refresh Concept



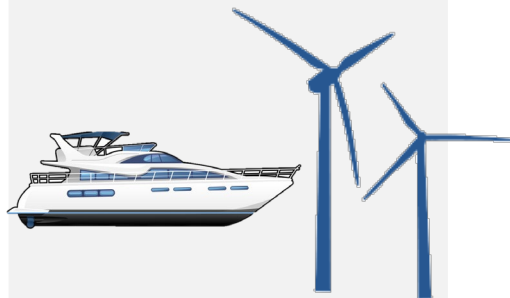
Genium – Refresh Concept Scope

At a Glance - The Concept aims at reducing the environmental impact of Wind Blades.



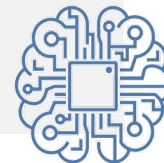
Refresh Concept

Refresh is a concept proposed to the EU commission as R&D project focused on developing an holistic approach for the recycling and re-manufacturing of Glass Fiber Reinforced Composites and multi-layer materials .



RINA Genium

Rina Genium is a digital solution developed by Rina which exploits the Artificial intelligence (Deep learning) to automatically categorize from an asset integrity point of view blades visual inspection pictures. This solution allows wind operators to timely identify and correct blade integrity threats, extending the blade operating life.



The market need



Composites Blade

Unfortunately, composite wind blades have proven to be the **blind spot** in these sustainable energy systems.

Re-Blading

Most EU western countries have started to **re-blade old (>15y) wind turbines or decommission** them to install new ones.

Blade Waste Amount

WindEurope estimates 14,000 blades could be decommissioned **by 2023**, equivalent to 40,000 and **60,000 tons of composite material**.

Year	Country	N° of >15y turbines
2016	Germany	3400
	Danmark	1250
	Spain	> 500
	UK	19

Country	% of >15y turbines
Germany	41%
Danmark	57%
Spain	44%
UK	10%

In 2020

The state-of-the-art solutions

Fiber – Epoxy Separation

In order to completely recycle the glass fiber composite, it is necessary to separate the polymeric matrix (eg Epoxy) from the fiber.

State of the art solutions

- Recirculation fluid bed @ 450°
- Pirolisis @600°
- Supercritical fluids, ionic fluids
- Mechanical Recycling

Drawbacks

- Cost
- Efficiency
- Environmental impact

Wind renewable lifecycle Blind Spot

- Composites are **landfilled**
- Composites are **burnt** to produce some energy



REFRESH concept



REFRESH

The target of Refresh concept is to develop a novel **holistic approach** for the recycling and re-manufacturing of Glass Fiber Reinforced Composites and multi-layer materials (i.e. hybrid epoxy/polyurethane binders) within two markets: **wind power** and yachting. The approach includes the entire reverse circular value chain: from End-of-Life (EoL) to a wide range of re-manufactured circular end-products



Full Traceability

- Eco-design approach
- Strategy for life extension
- Strategy for repurposing

Dismantling i.e. Constrictor

Mobile Automated Sorting

Mechanical Recycling

Thermal Cracking

Remanufacturing and Validation



TRACEABILITY

Build a tracking system of raw material and (semi)-finished products, based on **blockchain** technology;

RECYCLE

Recycle the basic components (fibres) and put them again in the value chains as secondary raw materials

SORTING

Make the sorting automated, cost-effective, precise and easier (e.g collection of large blades and hulls).

CIRCULAR

Apply Circular Design approaches for further and easier disassembly, sorting and recycle/reuse

Extend the components operating life

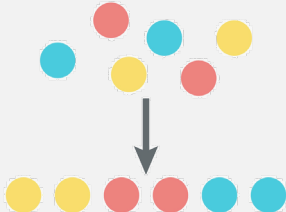
Define a strategy to Increase the lifetime of composite components

Refresh Concept Expected impact



Improved Sorting

- **33%** reduction of logistic costs
- **40%** lower environmental impact and no dust emission
- **100%** automated process
- **>90%** Separation/recovery rate and purity level



Improved recycling

- Up to 70% energy savings, up to 65% CO2 savings, zero VOC emissions
- Up to 35% of pre-consumer waste savings
- 25% saving process costs



Improved Ecodesign

- 10% increase lifespan of yacht hulls and wind blades
- At least 70% of savings in energy consumptions during manufacturing
- Up to 65% of CO2 savings during manufacturing



Wind Blade operating life



Zero Maintenance Approach – No Inspection

- Blade inspection campaigns are not performed;
- Blade integrity threats are identified only when they affect the turbine operability;
- If the defects are not early identified they usually can not be repaired and the blade has to be replaced.
- With this strategy the blade operating life is not exploited at its full potential



Human Visual Inspection

- Blade inspection campaign are performed periodically
- Blade integrity category is defined by a human operator who checks each single visual inspection picture
- This inspection process is costly and prone to human errors
- Blades integrity threats (when identified) are timely repaired and the Wind turbine life can be extended

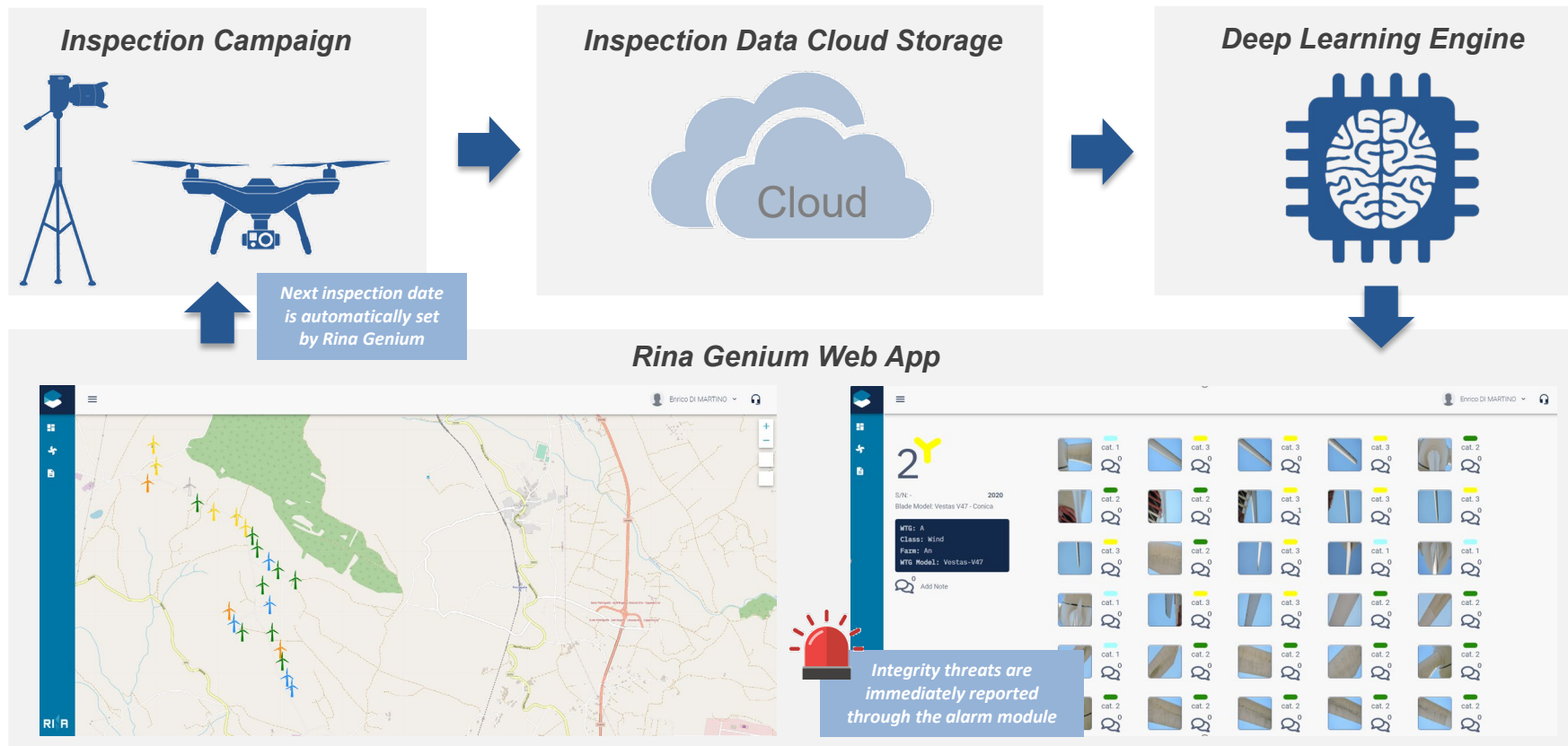


RINA Genium

- Blade inspection campaign are performed periodically within an optimized time frame automatically defined by Rina Genium;
- Blade integrity category is automatically assigned by the Rina Genium deep learning engine;
- Blade integrity threats are timely identified and corrected extending the operating life at its full potential



Rina Genium

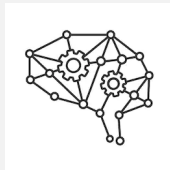


Rina Genium - Future Development



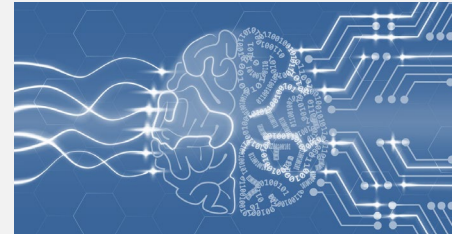
Deep Learning Performance Improvement

- First Deployment Phase: inspection pictures categorization is checked and eventually corrected by a human operator;
- The consolidated results are then exploited to perform a new training on the deep learning engine.
- Significantly improvement in the engine performance.



Automatic WTG Integrity categorization - ML

- Each inspection campaign collects around 100 picture per WTG (Wind Turbine Generator).
- Development of a Machine Learning algorithm which will have the target to analyze the entire WTG inspection results to automatically assign the right integrity category to the WTG.



Thank You for your attention

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