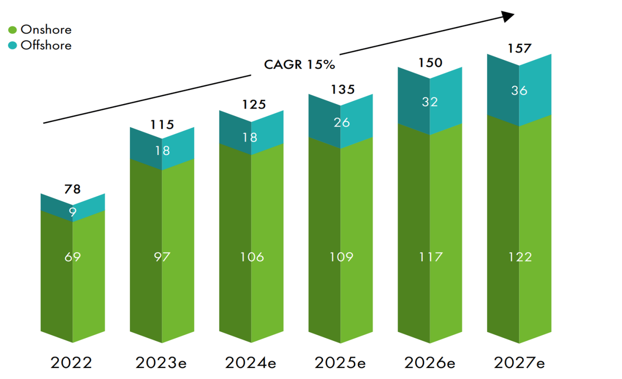
The problem: wind waste



Since the 80s, wind turbines (**WTs**) have been placed at an increasing pace all over the world to provide renewable energy. Since then, many have reached their service life, which is 25 years on average.

These wind turbine blades (**WTBs**) must be replaced after this period. WTBs have continued to increase in size, with future offshore turbine diameters reaching 250 meters. The amount of WTB waste produced anually by 2050 is projected to be 43 million tons.

WTBs are made from composite materials (**WTBM**), including glass fiber, carbon fiber, epoxy and balsa wood. WTBM is exceedingly difficult to recycle. Due to the huge waste output of WTBM, many countries choose to burn or landfill most of it, wasting potential value.

WTBM has excellent material properties which can be exploited for repurposing. Various structural applications using repurposed WTBM can be found, where its high bending stiffness excels. Not many application directions have been explored, which is the basis for this project.

Acoustic Applications

For repurposing wind turbine blade composite waste

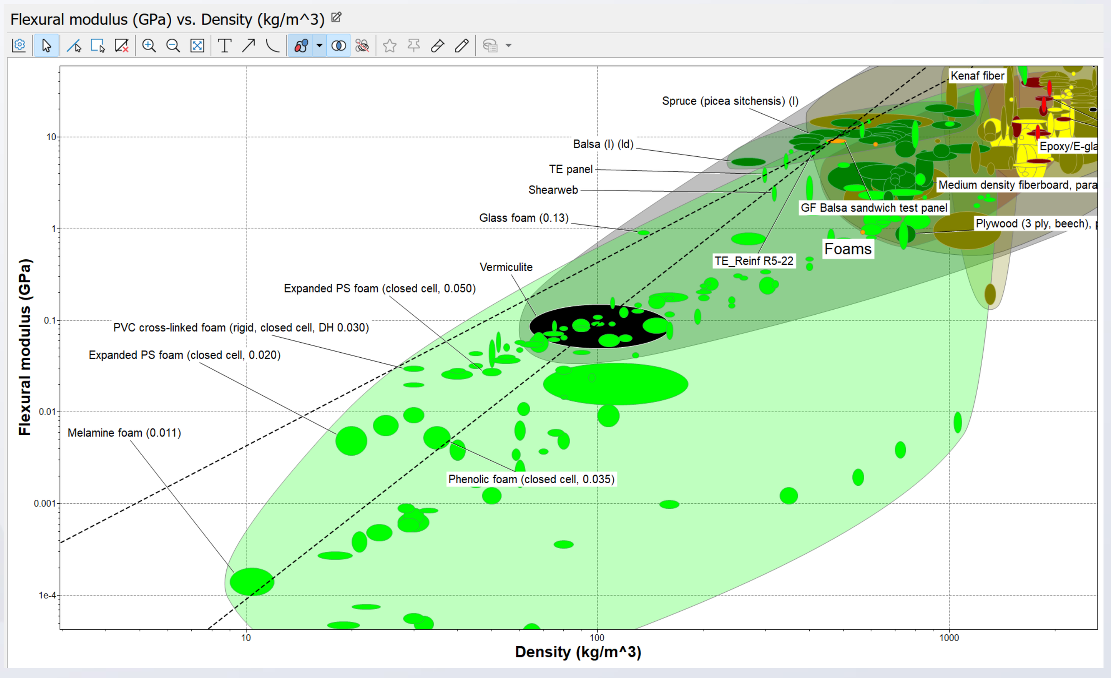
The prototype

The RAA is made from the panels connecting the leading edge to the aerodynamic shape of the WTB. They effectively form two distributed mode loudspeakers (DMLs) driven by exciters (a speaker without the cone component) bonded to the inner surfaces.

These exciters are driven by an amplifier to directly transfer digital or analog sound signal s to the WTBM panel. The shape and size of the RAA dictate its authentic tone and sound dispersion. The concept shown below was made into a functional prototype and evaluated with user testing.

Its perceived authenticity and sound dispersion were high, which established a firm belief in the potential of WTBM as a substitute for natural tone woods.

The method: CATSS



During this project, the method circular applications trough selection strategies (**CATSS**) was used. CATSS is based on material driven design and seeks to link material properties to existing applications. By examining WTBM properties, finding similar materials and then looking at currently known applications which these materials are used in, possible areas where WTBM can be substituted are identified.

Using Ansys Granta Edupack, bubble charts were constructed and overlayed with material indices based on relevant identified material properties. From there, similar materials were examined.

The solution: tone wood

From this comparison, WTBM was found to have similar acoustic properties to natural tone woods. Tone wood, such as Sitka Spruce, is used in tone boards for a variety of acoustic instruments. The tone board is principally responsible for amplifying the sound that vibrating strings make, coupling it to a resonating volume to produce a loud and rich sound.

To evaluate the performance of WTBM in the role of natural tone wood, a resonating acoustic amplifier (**RAA**) prototype was constructed. Thhe RAA is used to amplify digital and acoustic sound signals while providing an authentic and omnidirectional sound, equal to that of an acoustic instrument.

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Finding applications for end-of-life wind turbine blade materials based on their acoustic properties
26/08/2024
MSc Integrated Product Design

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