Life Cycle Sustainability Assessment of a Pedestrian Bridge made from Discarded Wind Blades

Angie Nagle, Kieran Ruane, Paul Leahy, Ger Mullally, Niall Dunphy, Zoe Zhang, Russell Gentry, Lawrence Bank
Re-Wind Network/ University College Cork/ Munster Technical University/ Georgia Tech

Challenge / Research Question

Could decommissioned GFRP blades be repurposed into second life applications in such a way as to contribute to the improvement of Irish performance against the SDGs?

Few sustainable and acceptable End of Life options exist for discarded GFRP blade material

Separately, the Public Sector is being asked to place more focus on sustainable procurement & SDG 12

An opportunity exists in Ireland to repurpose blades into publicly procured cycleway bridges

The Irish program for government pledged to spend €1 million euros/day on cycling and walking infrastructure, and to develop an integrated national network of greenways across the country (DTTAS, 2018). Between the availability of decommissioned blade material (Delaney et al., 2021), the need to improve on SDG12 through circular material use, and the push to build cycling infrastructure across the country, a business opportunity exists in Ireland to repurpose decommissioned blades in the construction of bridges on public cycle ways.

Methods

Life Cycle Sustainability Assessment framework was used to assess environmental impacts, social benefits, and business viability of the BladeBridge. The 'Embedded Systems' Model, which reflects the reality that the economy exists only within society, which exists within the environment, was used to form a stage-gate assessment process.

1. First LCA compared impacts of Blade Bridge (BB) to a conventional bridge (CB), & co-processing of blades

2. Shortfalls in socially aligned SDGs were used to develop s-LCA indicators.

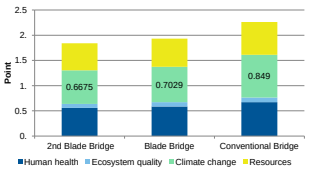
3. LCC compared costs. The NSF I-Corps customer discovery process was used to explore business models & economic value creation

Two **Functional Units** were used for the LCSA based on customer segments:

Customer Segment A: Public Procurers of cycleway bridges
Functional Unit B: A 22m^2 pedestrian bridge with emergency vehicle load capacity of 12 tonnes, over 60 years

Customer Segment B: Wind farm owners with unwanted GFRP blade material
Functional Unit A: Disposal of 3 x 0.75 tonne blade material for 60 years

Results



Step 1: Environmental LCA

1A. BB showed 14% lower overall impact than CB, and 17% lower CO_2 due to steel material substitution and reduced maintenance.

1B. BB 46% lower CO_2 than co-process

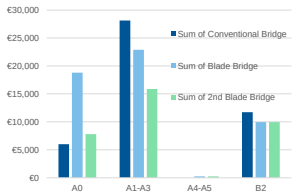
Overall, BladeBridge offer environmental improvements

Step 2: Social LCA

2A & 2B. Blade bridge scored 'Beyond Compliance' for SDG 12, & 'Ideal Performance' for SDG 17

Overall, Blade Bridge offers social improvements

Step 3: Economic & Business Viability Assessment



3A. Lifetime costs of BladeBridge was **12% more expensive** than conventional bridge due to reverse engineering costs (A0 in graph). However, the lifetime costs of a second bridge made from the same blade type are expected to be **35% less** than a conventional bridge due to steel substitution and reduced maintenance.

3B. From a cost of disposal perspective, both BladeBridge and co-processing require transport of the blade. Co-processing requires shredding & a gate fee for further processing, which makes **co-processing 300% more expensive**

Impact / Conclusions

The BladeBridge product appears superior to both a conventional pedestrian bridge, and to the current end of life disposal method of co-processing of blade material. A stage-gate process following the LCSA framework was used, whereby environmental improvements are first established, then social improvements, before the economic viability is assessed. This approach to early product planning can help develop products that contribute to 'Purpose Driven Businesses.'

This research could benefit both the wind sector and the public sector. By 2025, the wind sector will need to find a non-landfill solution to blade waste. The more circular and 'positive' this end of life solution is, the more it will benefit the wind sector from a publicity standpoint. Meanwhile, the public sector will be increasingly asked to source 'green' products. Creating visible public structures, such as cycleway bridges, will showcase their circular efforts. While the optics of these repurposing options look good for both sectors, this research offers quantified environmental, social and cost impacts to support the claims.

GDG GAVIN & DOHERTY GEOSOLUTIONS

WIND ENERGY IRELAND

Annual Conference 2022

Scan this QR code to go to a QR code generator.

You can delete this QR code and put in your own QR code to link to a video / paper / your CV / your research center. Basically, what ever you like!

Delete this text when you are done.