
Design and Construction of Pedestrian Bridges from Decommissioned FRP Wind Turbine Blades

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Outline

- Introduction to FRP wind blade end-of-life (EOL)
- The Re-Wind Network and Catalog
- Cork BladeBridge
- Draperstown BladeBridge
- Atlanta BladeBridges (proposed)
- Conclusion

Wind Turbine Blade End-of-Life

- **Prevent:** Extend project or blade lifetime
- **Reuse:** Sell blades on secondhand market
- **Repurposing:** Remanufacturing for use in new products
- **Recycle Mechanically:** Shredding, grinding and milling for filler for FRP or concrete
- **Recover Materials:** Pyrolysis (~700 °C), thermolysis (~400 °C), solvolysis or hydrolysis (~100 °C) to recover composite material, fibers, or polymers.
- **Co-process in cement kilns:** chemical substitution at ~1500 °C
- **Incinerate** – with or without energy recovery, then landfill ash
- **Landfill**



<https://www.epa.gov/homeland-security-waste/waste-management-hierarchy-and-homeland-security-incidents>

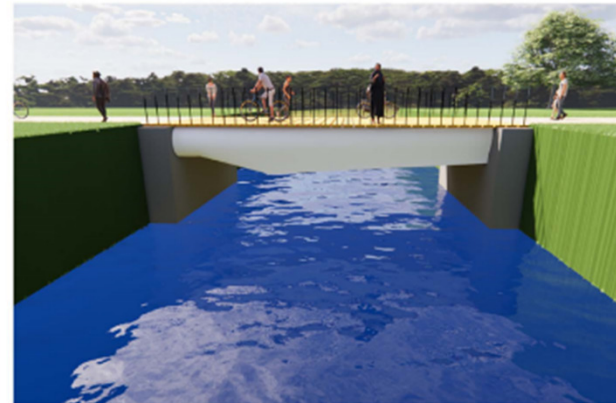
Re-Wind Network Catalog



12m length - 6m width

Symmetric Girders - 21m V44 blade

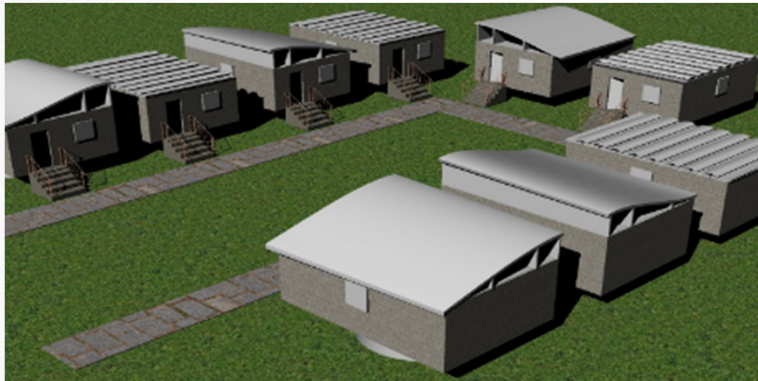
Root ends - 3 girders below deck level at 3m spacing



Three wind blades of the same type are used in the above BladeBridge to support a 6m wide pedestrian deck. The girders are mostly hidden from view in this configuration which may be desirable in certain locations. With the girders placed below the deck the pedestrians have a more expansive view of their surroundings.

<https://static1.squarespace.com/static/5b324c409772ae52fecb6698/t/636bd07125aeb5312a8e320e/1668010099748/Re-Wind+Design+Catalog+Fall+2022+Nov+9+2022+%28low+res%29.pdf>

Re-Wind Blade Repurposing Concepts



BladeHousing



BladeBridge

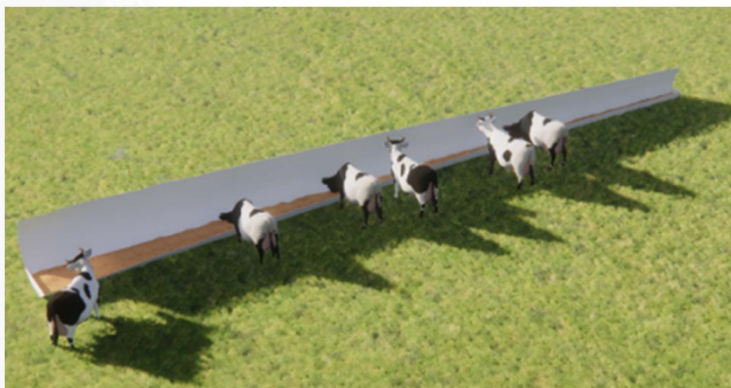


BladePole



BladeBarrier

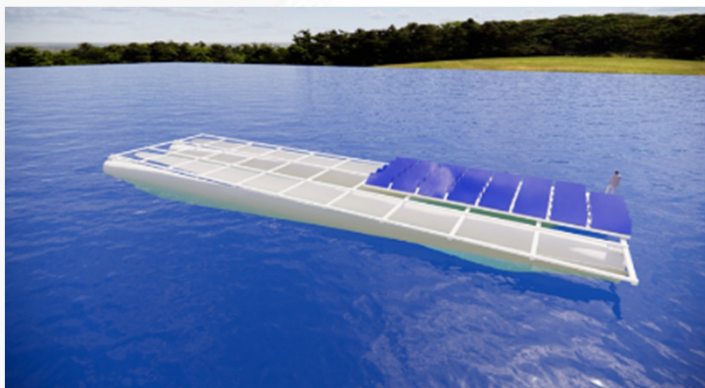
Re-Wind Blade Repurposing Concepts



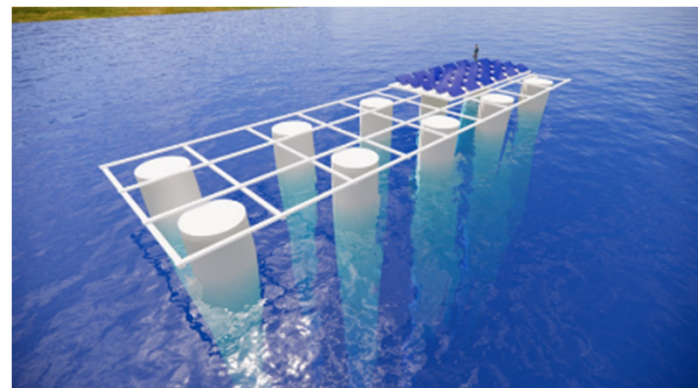
BladeFarm



BladeJetty



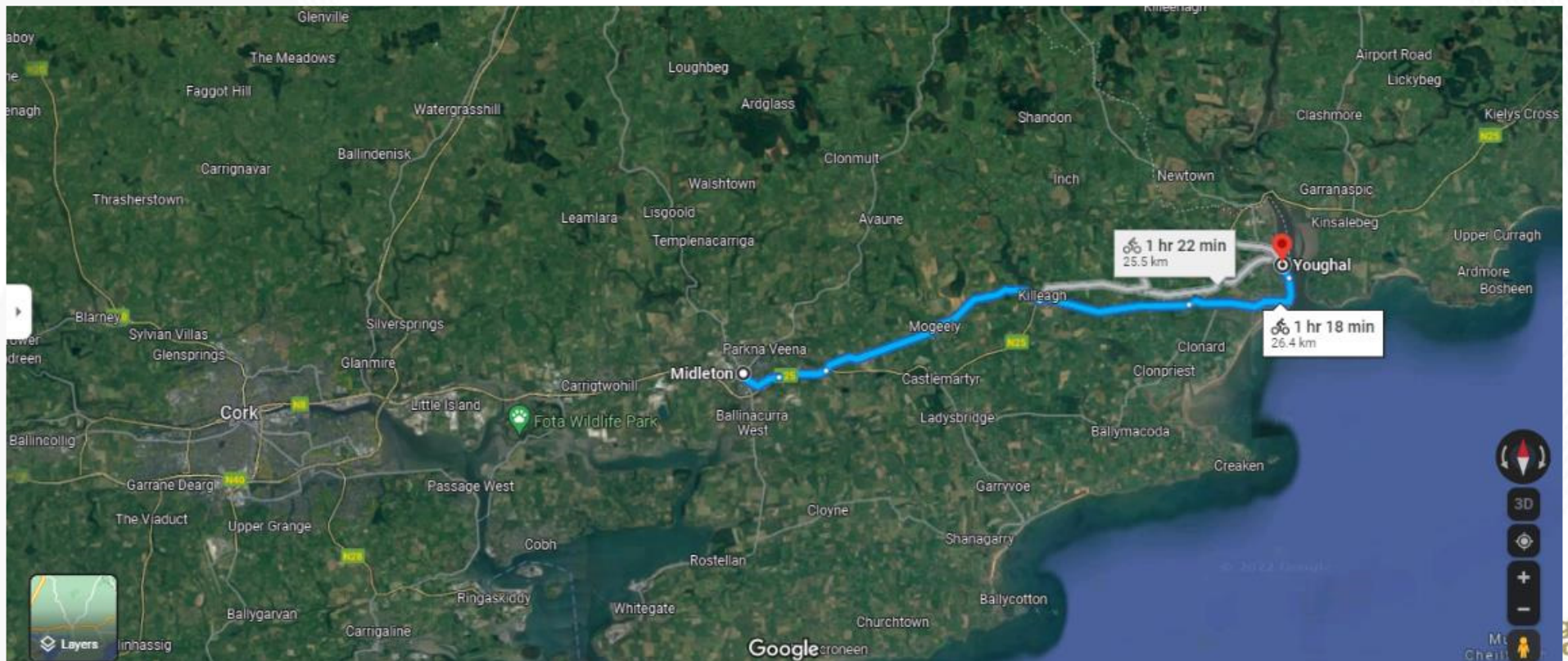
BladeSolar



BladePlatform

Cork BladeBridge

Midleton-Youghal Greenway, County Cork, Ireland
Completed January 2022

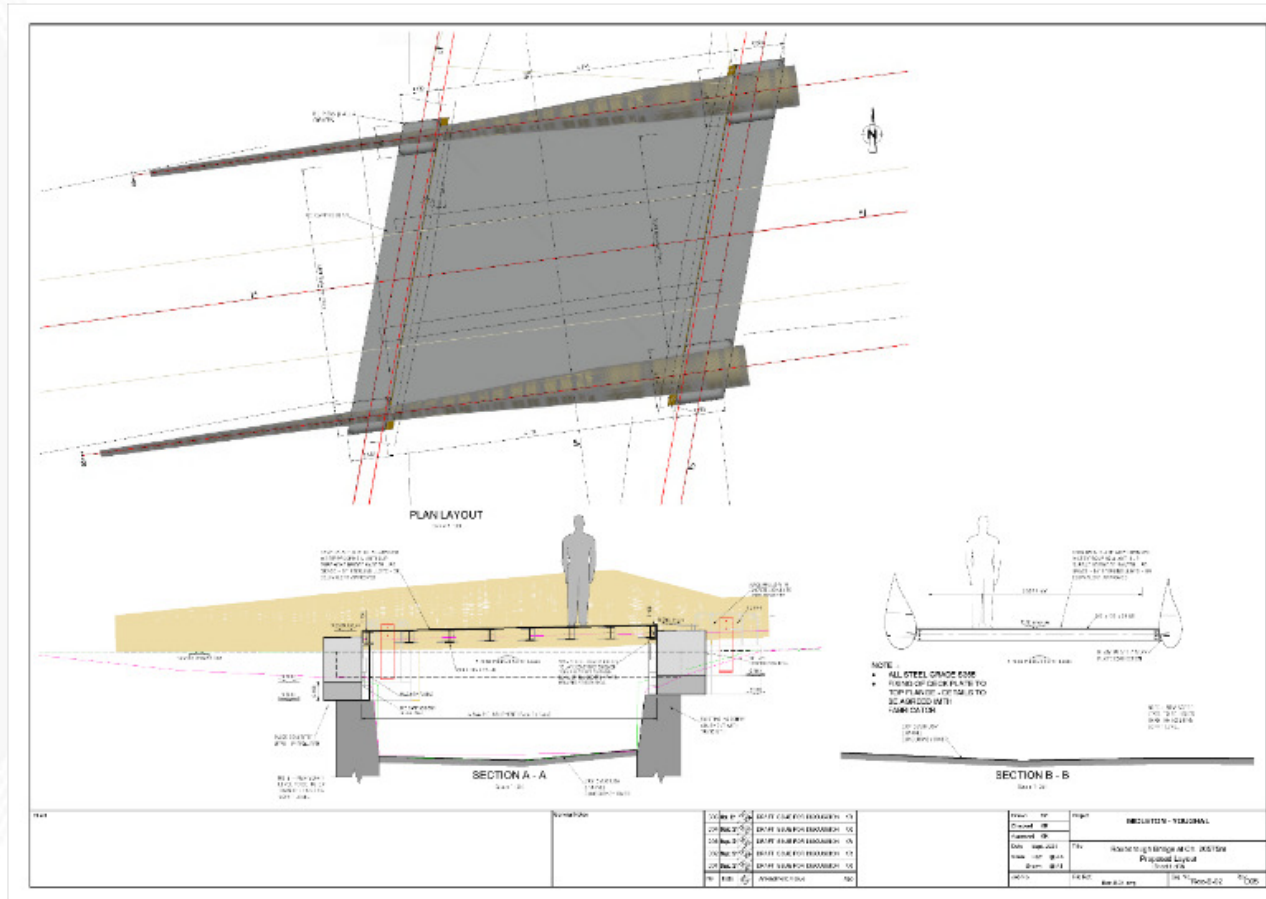


Cork Blade Bridge Testing (MTU)



Testing conducted at Munster Technological University, Cork, Ireland by Kieran Ruane, Zoe Zhang and staff
For more details see: "Material and Structural Characterization of a Wind Turbine Blade for Use as a Bridge Girder," <https://doi.org/10.1177%2F03611981221083619>

BladeBridge Detailed Design



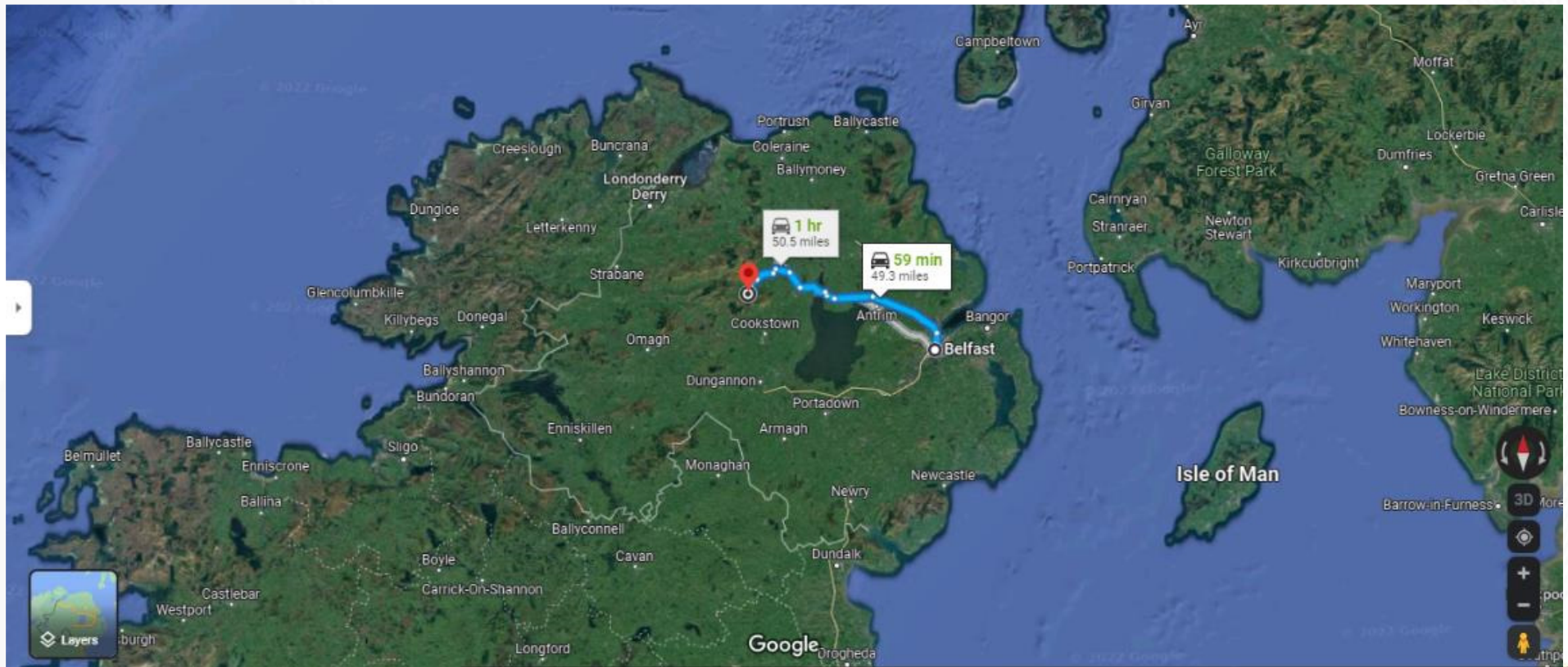
Design: Kieran Ruane, Munster Technological University

Cork Blade Bridge

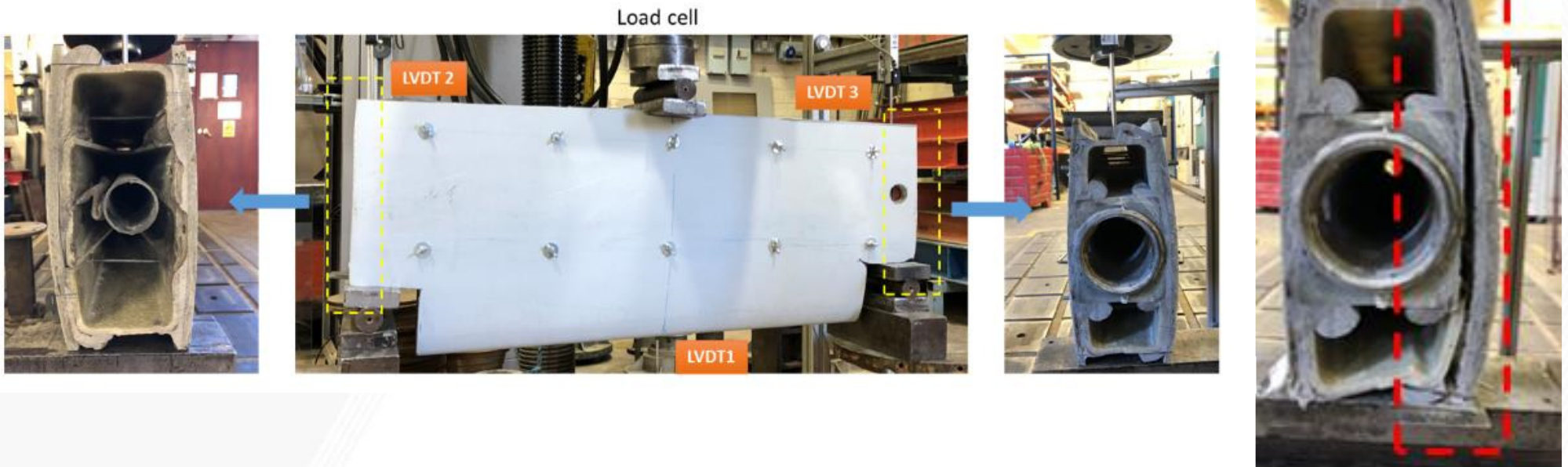


Draperstown BladeBridge

Draperstown Northern Ireland Competed May 2022



Draperstown BladeBridge Testing (QUB)



Draperstown BladeBridge

Draperstown Northern Ireland Competed May 2022



Design: An Huynh, Marios Soutsos; Construction: Kenny McDonald and QUB lab staff,
Queens University Belfast, Northern Ireland

BladeBridge Costs

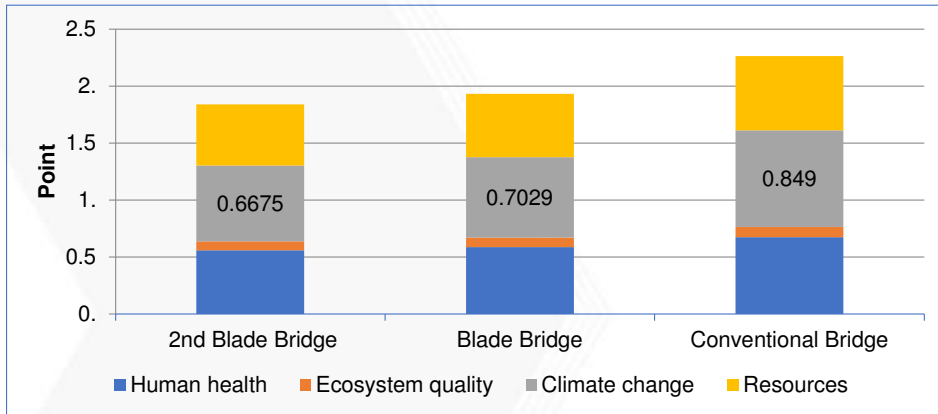
Table 1. Overview of material and labour costs for the Cork BladeBridge

Item	Description	BladeBridge cost
Surveying	External Surveyor	€1,800
Fasteners	Blind bolts	€1,250
Steel	Bespoke welded cleats, steel beams, deck plates	€5,775
Steel	Galvanization	€1,650
Sealants	Bolt hole sealant	€70
Labour	Fabricator Time	€7,425
FRP Layup	Root end cap FRP	€825
FRP Layup	Trailing edge treatment	€413
Reinforced Concrete	On-site reinforced concrete works	€2,800
Transportation and Crane	HiAb truck and driver	€1,200
Total	(without design or testing costs)	€23,208

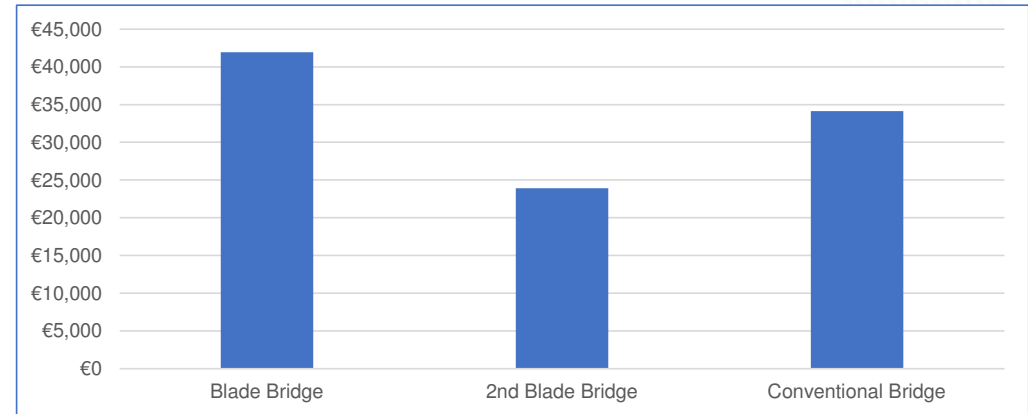
Table 2. Overview of material and labor costs for the Northern Ireland BladeBridge

Item	Supplier	BladeBridge cost
Film face plywood	IJK timber	£456.00
Steel	K&M	£593.00
Wood carcassing	IJK timber	£897.50
Screws	K&M	£150.00
Wood carcassing	IJK timber	£331.70
Bolts, washers, nuts	K&M	£432.00
Steel tubing	K&M	£50.00
Decking	eglantine timber	£723.00
Concrete	Quarry owner	£500.00
Technician hours	3 technicians, approx. 120 hours total	£6,675.00
Total	Without design or testing costs	£10,808.20

BladeBridge LCA and LCC



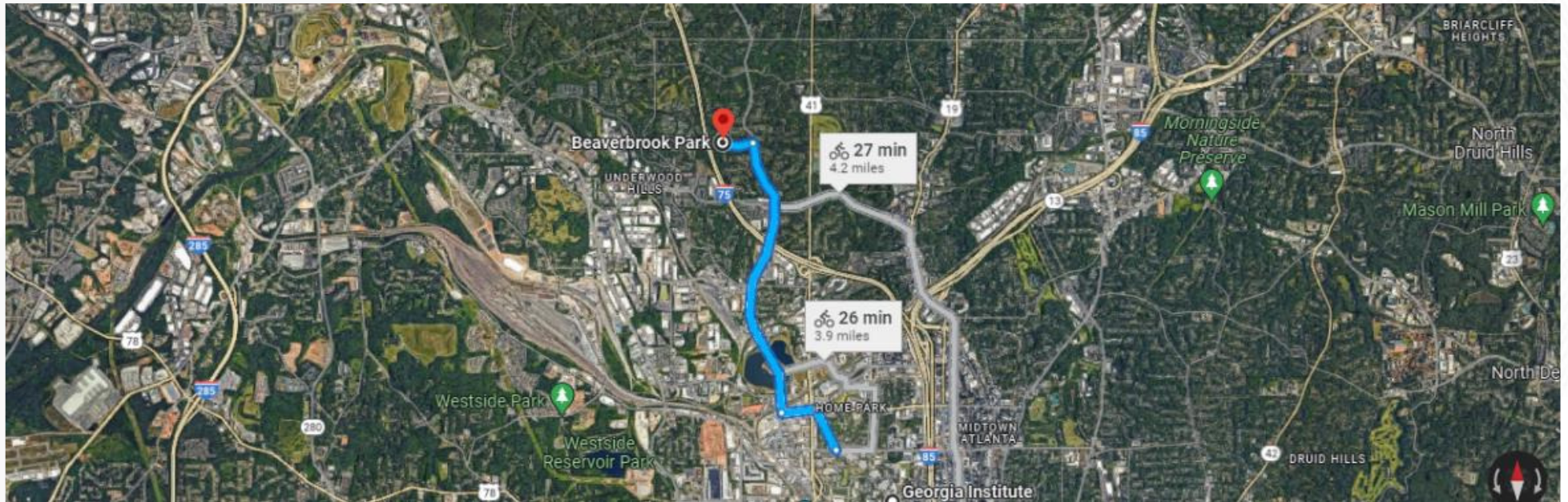
Single Score Comparison between blade-bridge and a conventional bridge



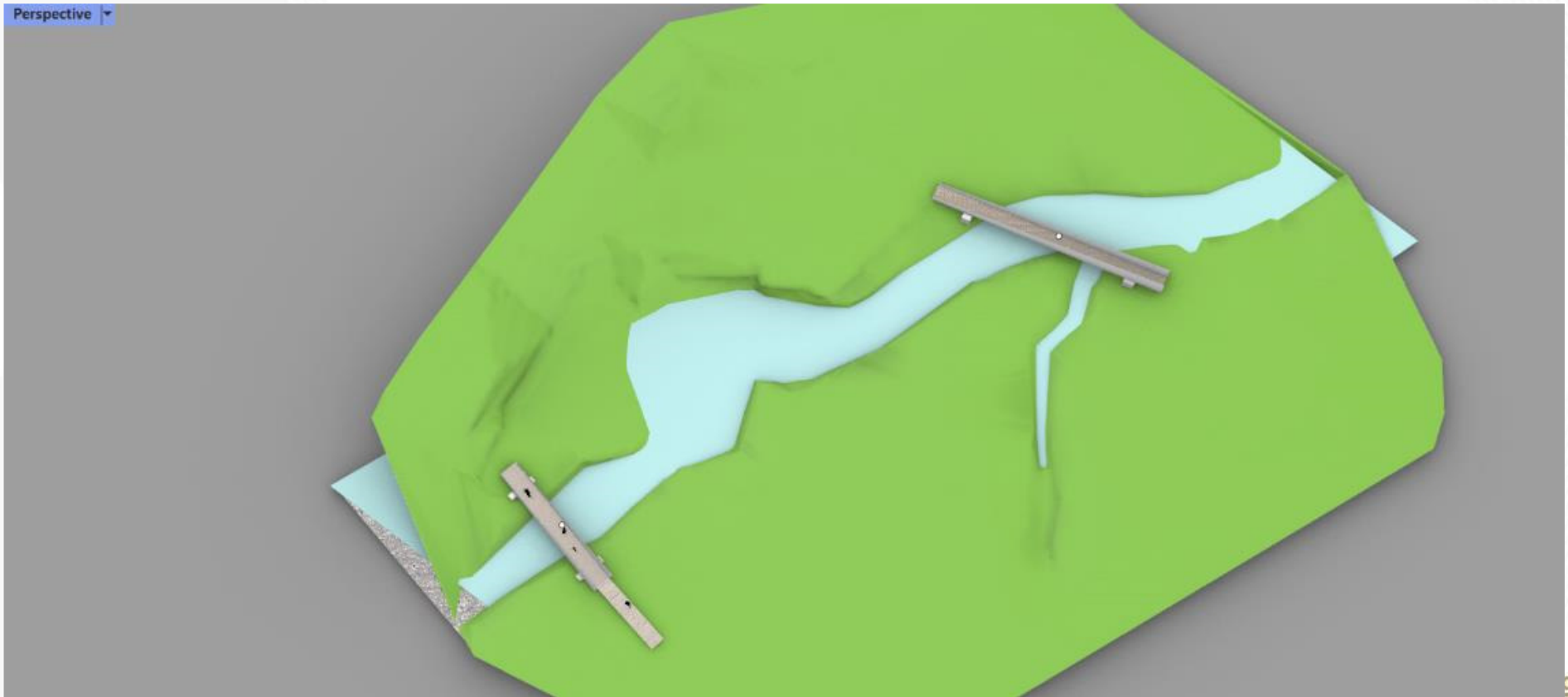
Lifetime cost comparison between BladeBridge, a second BladeBridge and a conventional bridge

“Sustainability Assessment of the Repurposing of Wind Turbine Blades,” Angela Nagle, Thesis submitted for the degree of Doctor of Philosophy, School of Engineering & Architecture, Environmental Research Institute University, College Cork.

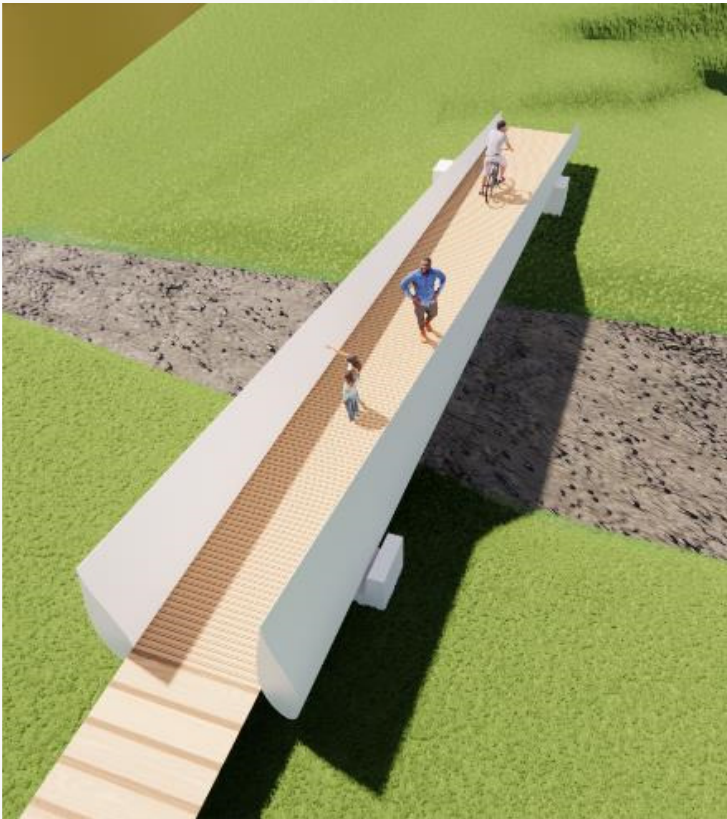
Atlanta BladeBridges (proposed) Beaverbrook Park, Atlanta, Georgia, USA



Atlanta BladeBridges (proposed)



Atlanta BladeBridges (proposed)



Atlanta BladeBridges (proposed)



Re-Wind Partners, Projects, Funding

Network University Members:

- Georgia Tech
- City University of New York
- University College Cork
- Queens University Belfast
- Munster Technological University

Affiliate Members:

- University of Bristol, UK

Funding (~\$3m 2014-current)

- NSF (CBET, PFI, I-CORPS), NYSERDA
- SFI, DfE, ENEL Green Power

Current Project Partners:

- Logisticus Group
- ENEL Green Power
- Siemens-Gamesa RE
- Vestas
- Cork County Council
- NYC Dept of Design and Construction (DDC)
- NREL Wind Manufacturing

Conclusions

- We have proved that BladeBridges can be analyzed, designed and constructed with FRP wind turbine blades.
- Precise geometries of the blades is a must-have condition for even conceptual design.
- Transportation and construction logistics (mainly length) must be considered as an integral part of the design scheme.
- Significant environmental benefits and cost benefits are obtained by using large sections of decommissioned blades.
- For more information and publications visit www.re-wind.info