Learning from the Experts Webinar Series

Strategies for Repurposing End-of-Life Offshore Wind Blades

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March 4, 2026

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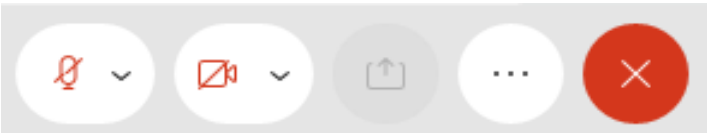

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Strategies for Repurposing End-of-Life Offshore Wind Blades

Speaker: Paul Leahy

School of Engineering & Architecture, University College Cork

Angela Nagle, Kieran Ruane, Lawrence Bank, Zoe Zhang, Emma Delaney, Ger Mullally, Niall Dunphy, Jennifer McKinley, Russell Gentry, An Huynh, Marios Soutsos

Re-Wind Network

University College Cork, Queens University Belfast, City University of New York, Georgia Institute of Technology, Munster Technological University

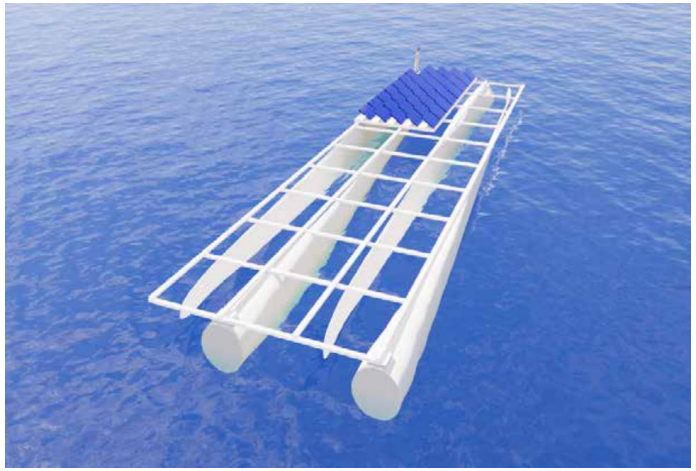
NYSERDA Learning With The Experts Series

4th March 2026

www.re-wind.info

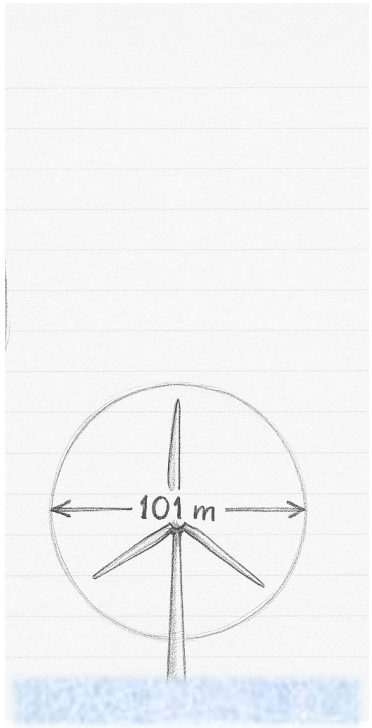
Webinar Overview

1. Background
   - Wind Turbine Blades:
   - Materials, Lifecycle and Value
2. End-of-Life Challenges
3. Repurposing
   - Technical, Environmental, Social and Economic Evidence Base
4. Case Study: Blade Bridges
   - Lessons Learned
   - Research Needs
   - Offshore: What's Different?
5. Removing Barriers: What can be done?

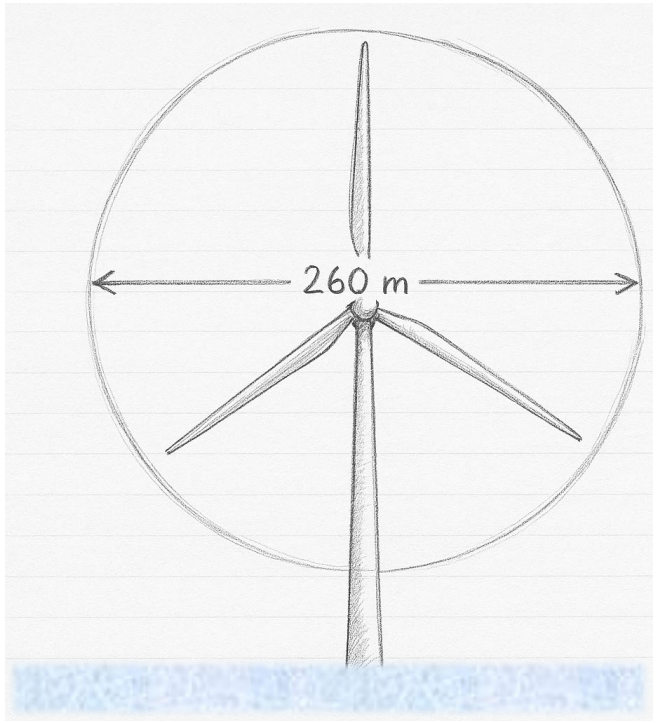


Re-Wind Catalog Modeling and Graphics: Asha McDonald, Chloe Kiernicki, Mehmet Bermek, Zoe Zhang, Alex Poff, Sakshi Kakkad, Emily Lau, Franco Arias, Russell Gentry.

Offshore Wind Turbine Evolution, 2004-2023



GE 3.6 MW
Arklow Bank, Ireland
Installed 2004



Mingyang MySE-260 16 MW
Fujian Strait, China
Installed 2023

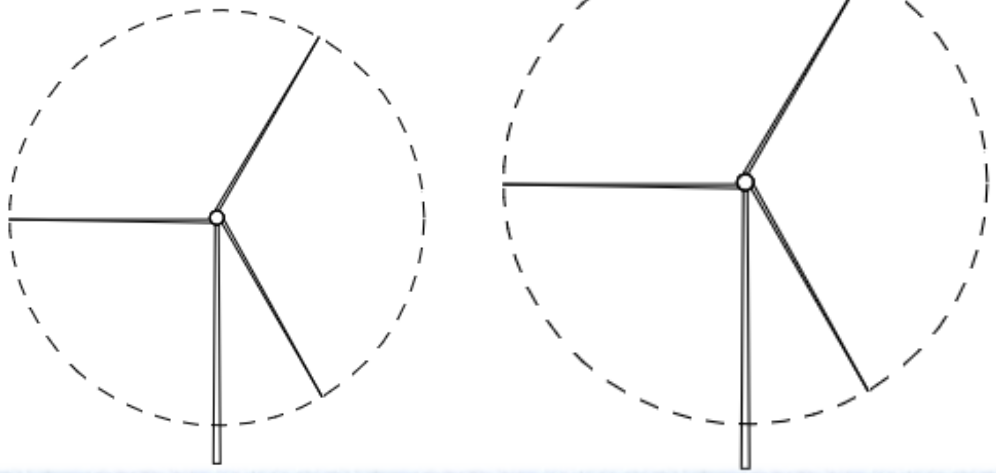
Turbine Dimensions, Measurement Units

RENEWABLE ENERGY

Plans for wind farm of '30 Eiffel Tower sized turbines' off Clare and Galway coasts withdrawn

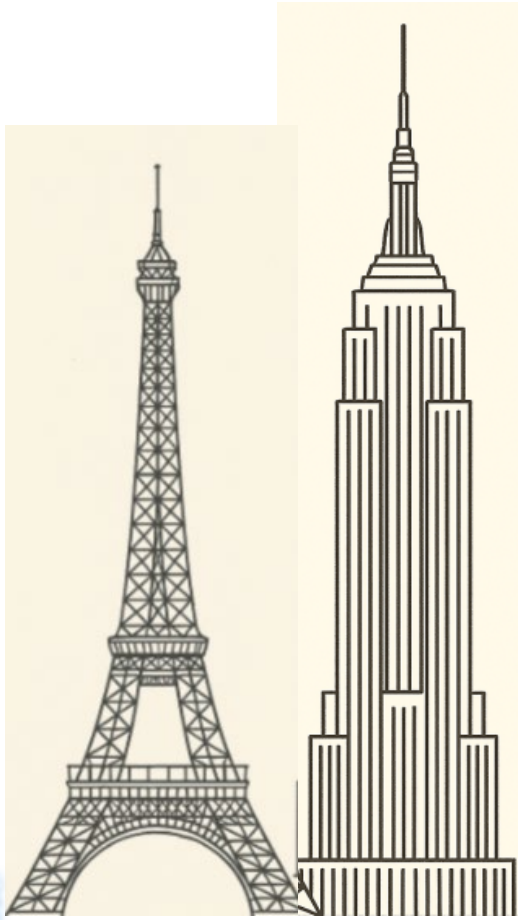
The firm behind the plans has forfeited the €35.4m performance security bond it lodged with the Dept of Climate,

4.50pm, 2 Jan 2026 ↗21.0k



Sunrise Wind
Siemens Gamesa SG11.0-200D
225 m

Empire Wind
Vestas V236-15MW
260 m



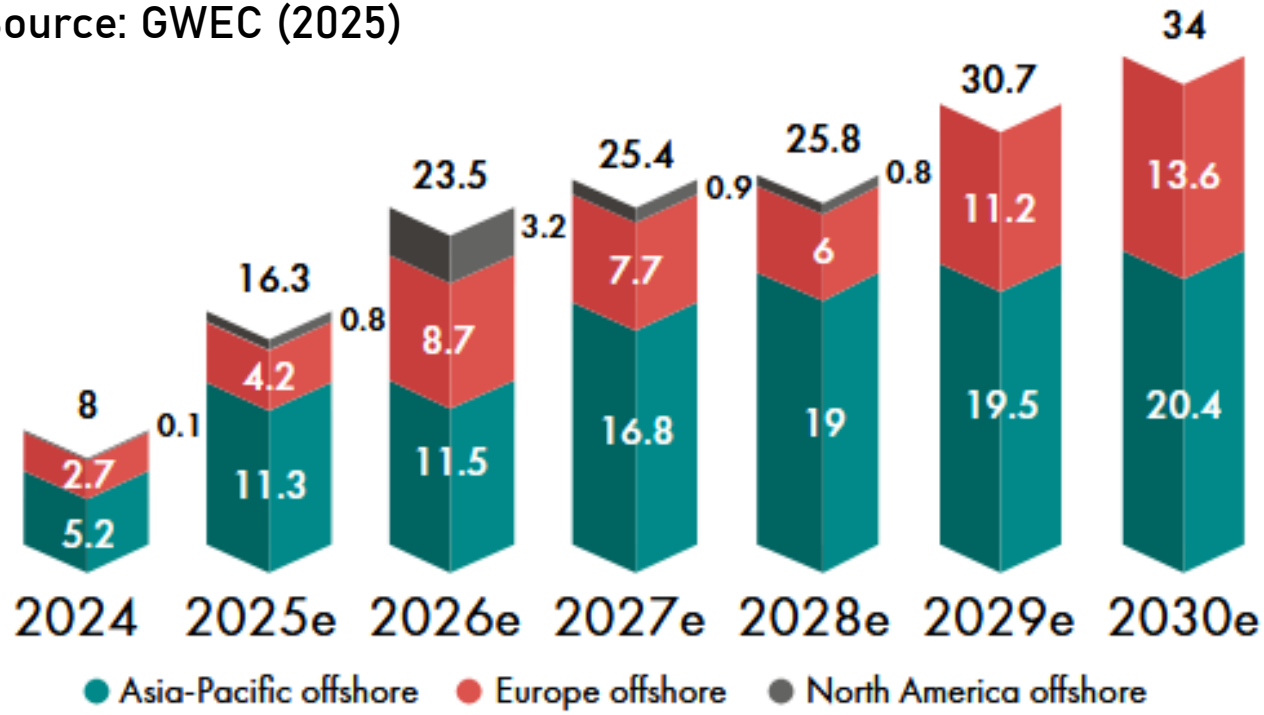
330 m

381 m

Offshore Wind: Installed Capacity & Projected Additions

Cumulative Installation (GW)

Source: GWEC (2025)



Wind Blade Decommissioning

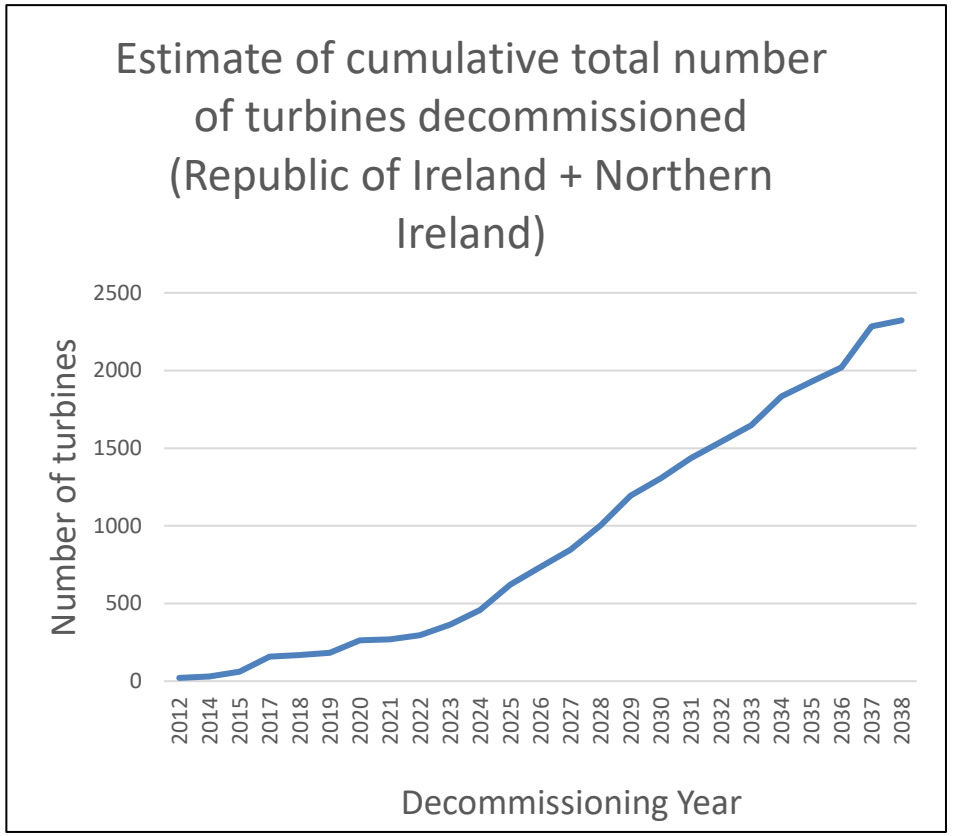
Turbine Lifetimes: 20+ years

Composite Material: Glass Fibre Reinforced Plastic (GFRP)

c. 5500 MW installed in Ireland (RoI + NI; mostly onshore)

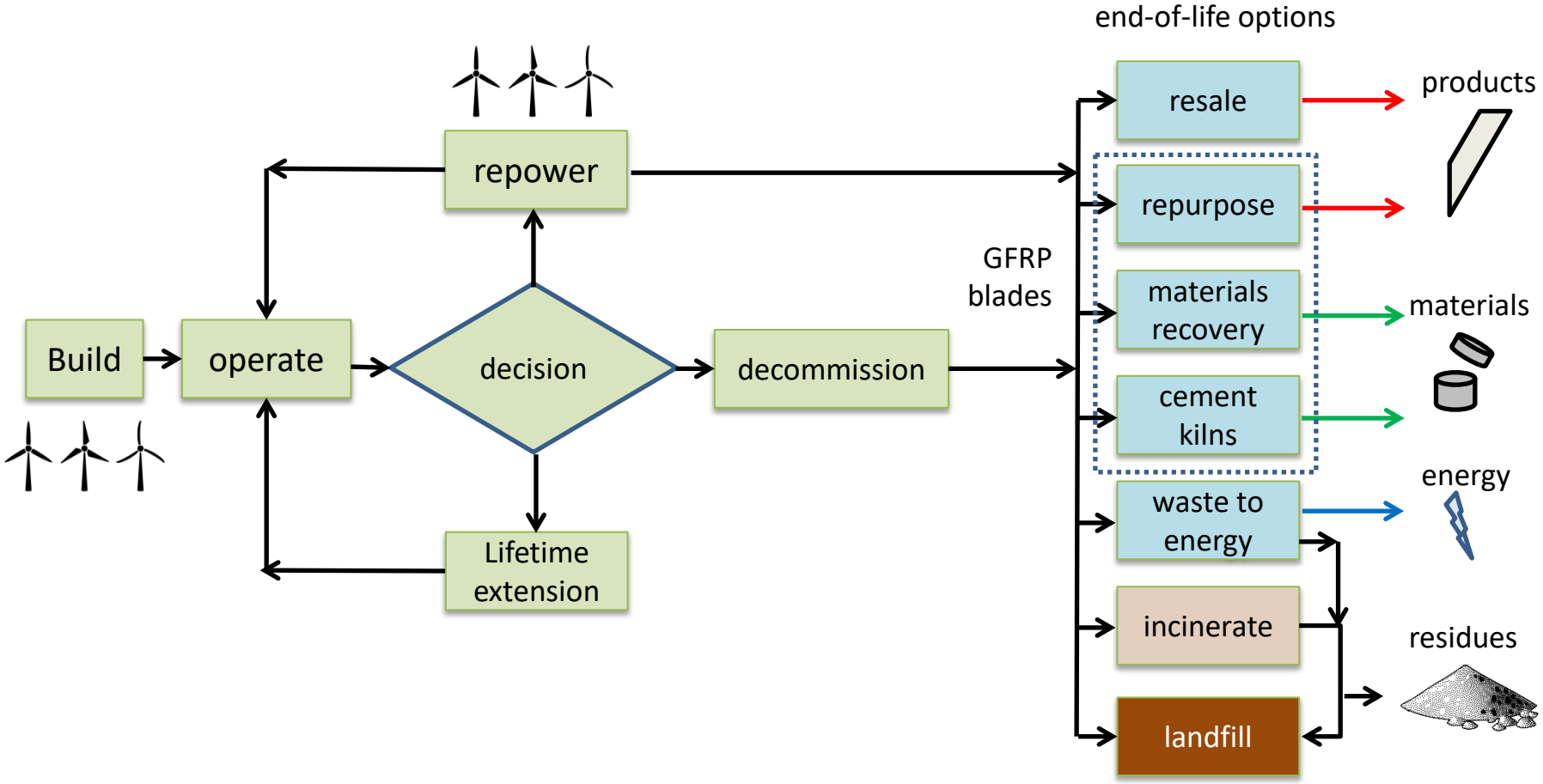
c. 10 tonnes of blade material per MW

Approximately 2,323 turbines to be decommissioned in Ireland by 2038



Emma Delaney, QUB

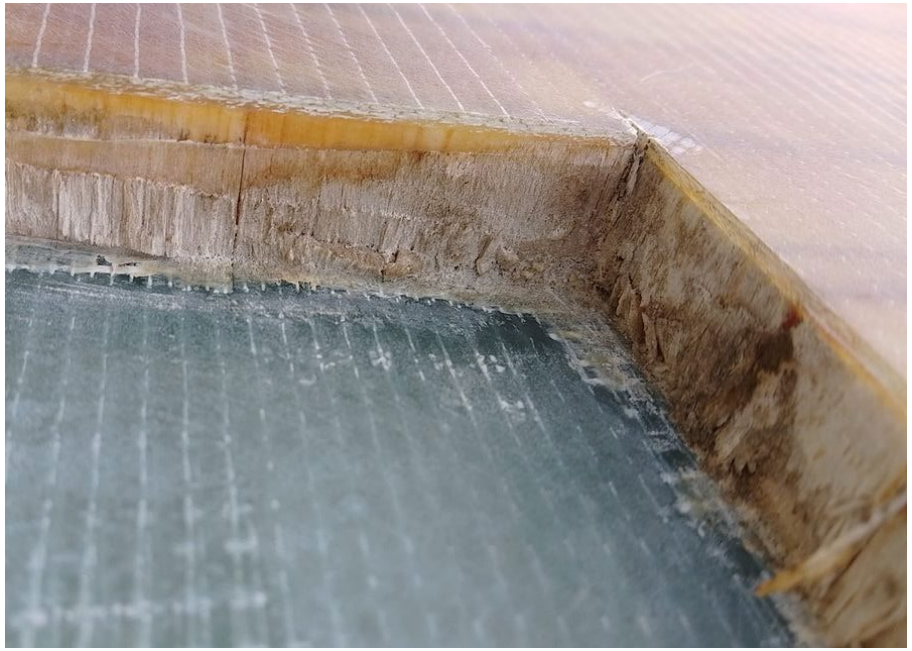
Wind farm lifecycle & blade end-of-life



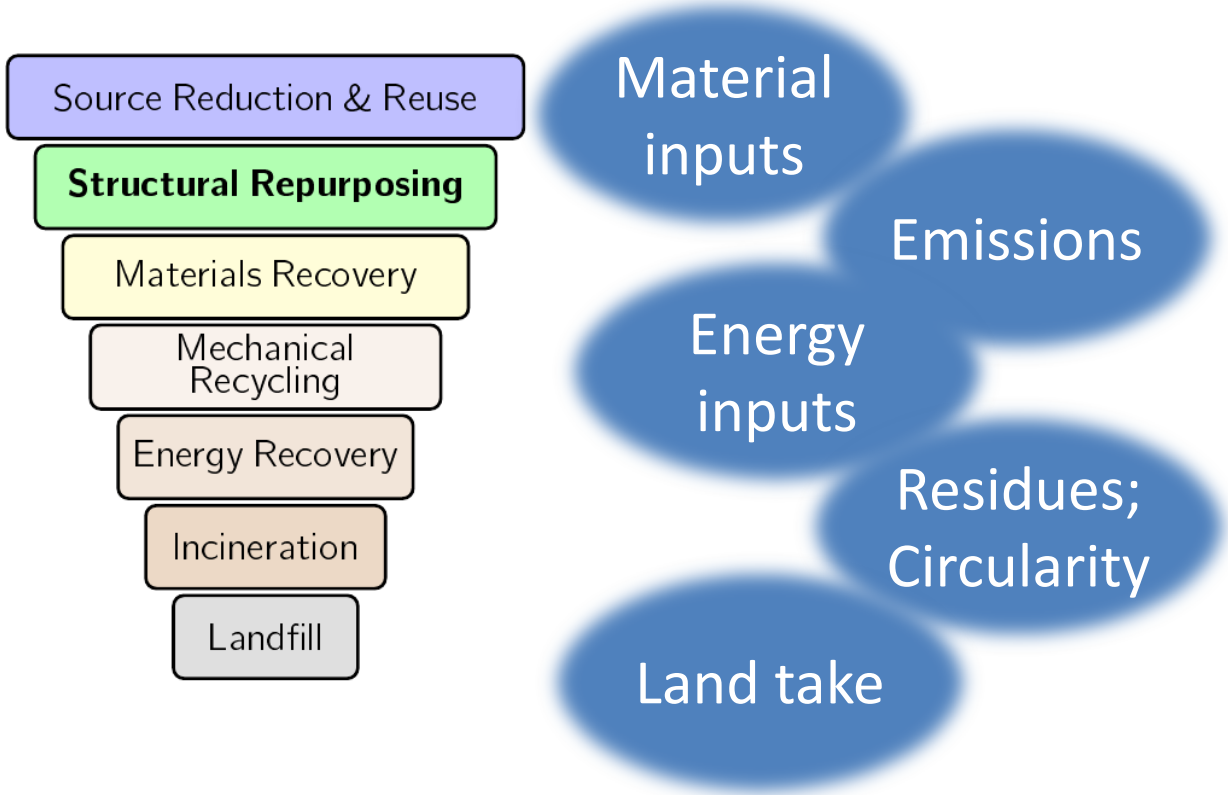
End of life wind turbine blades: a circular economy challenge

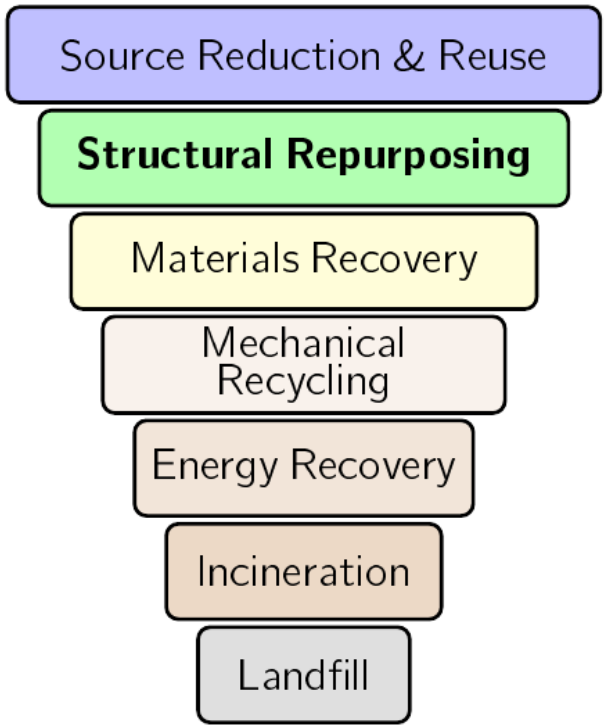
Photo: Benjamin Rasmussen

Composites:
Breaking up is never easy



The waste hierarchy & end-of-life treatments of composite blades





- Cumulative global blade waste is expected to reach 40 million tonnes by 2050
- Glass fibre reinforced polymer (GFRP) is a highly-engineered valuable material
- But its components are of relatively low value!
- Can technically, economically, environmentally & socially feasible repurposing options be found?

Cut GFRP composite waste Image:
BRIO project / Elhuyar Fundazioa

Blade Repurposing: Rationale & Hypothesis

- Rationale: preserve blades' engineered value
- Repurposing EoL GFRP blades sits near the top of the waste hierarchy
  - Technically feasible
  - Environmentally sustainable
  - Socially and economically sustainable
- We need evidence!
  - Sustainable Development Goals

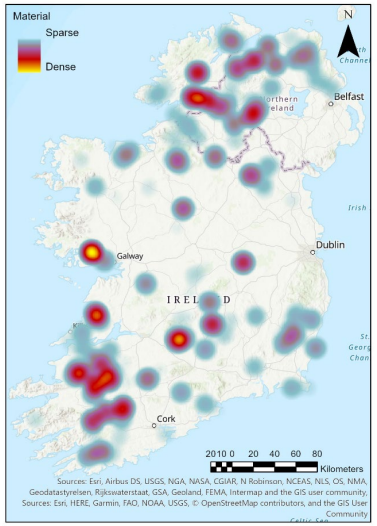
Decommissioned LM13.4 blade

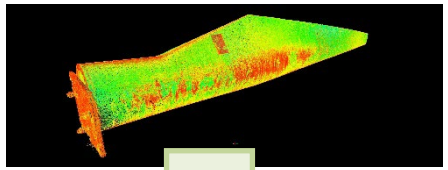
How do we go from this … to this?

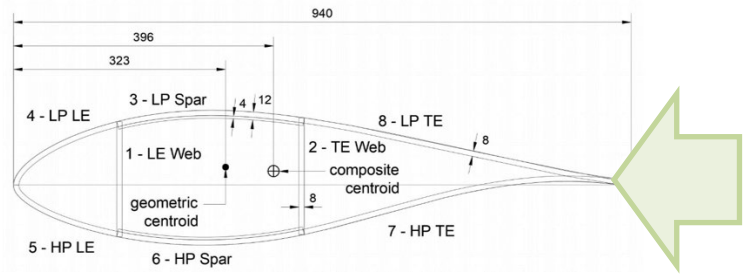
EOL blade at Everun Ltd, Northern Ireland

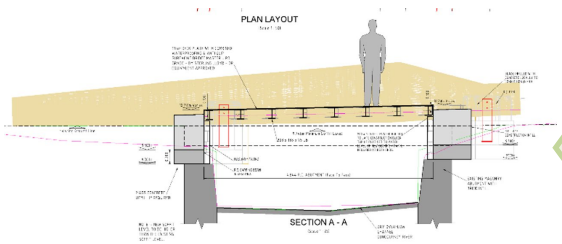
Midleton to Youghal Greenway, Ireland

Generating the evidence base: technical feasibility





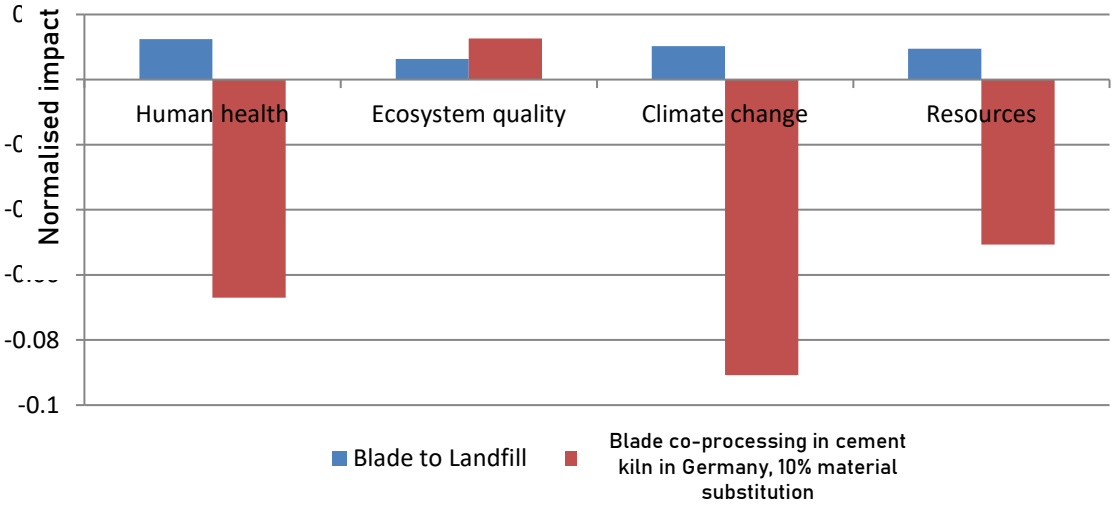


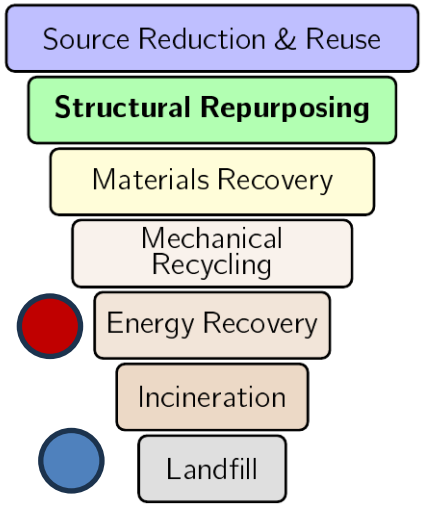


downcycling

Evidence base:
1. Environmental Impacts

- Baseline life cycle assessment carried out on two ‘conventional’ end-of-life options

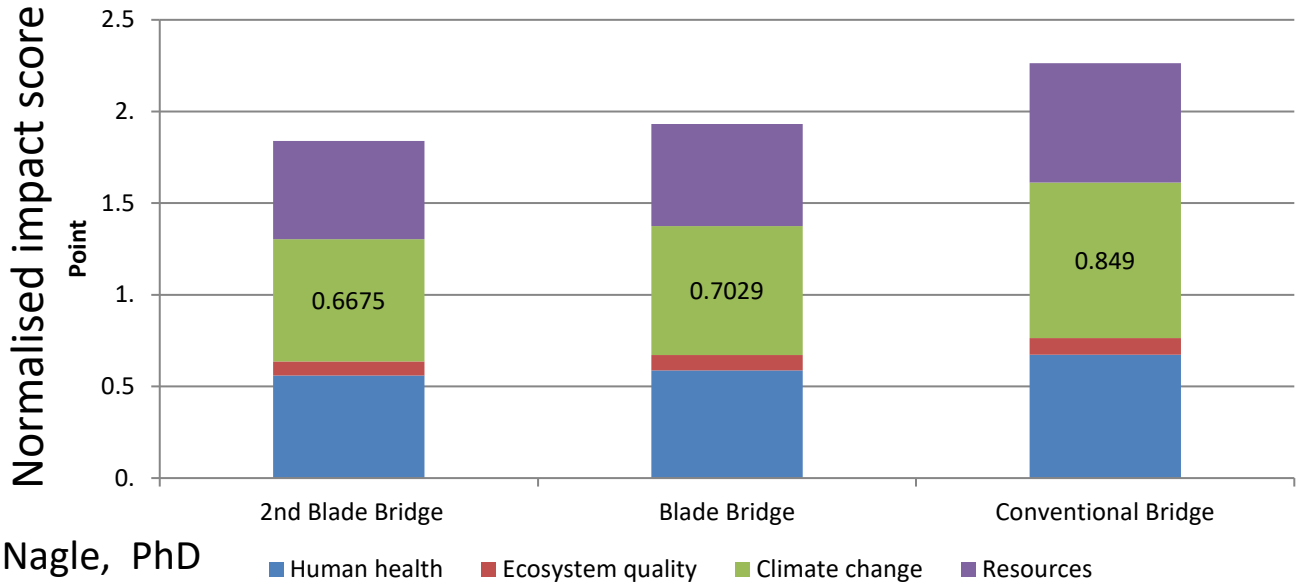




- Cement kiln co-processing has lower environmental impacts than landfill : “least worst” option

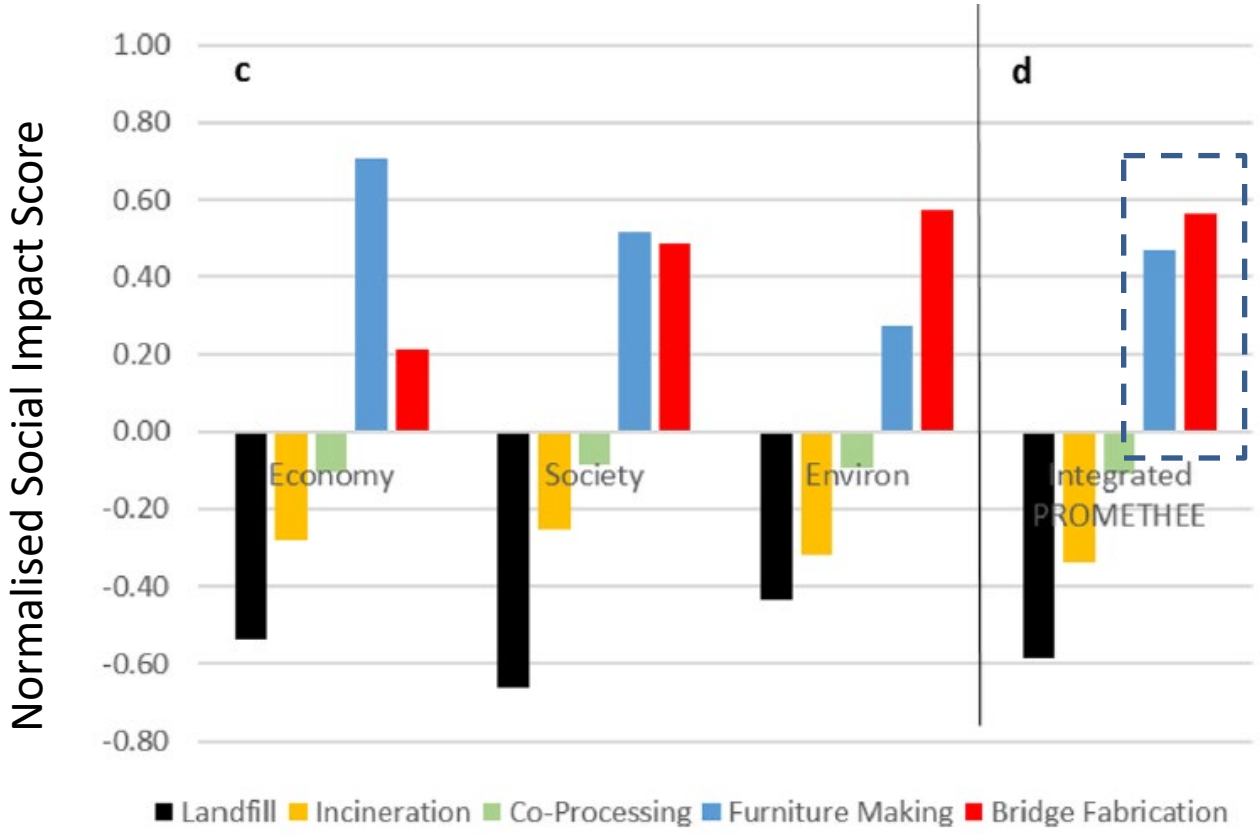
Evidence Base: Environmental Sustainability of Repurposing versus Alternatives

- EoL LCA: blade bridge environmentally preferable to alternative EoL treatments: co-processing or landfill (baseline, not shown)
- Product LCA: 14% reduction in overall environmental impact compared to a conventional steel bridge. Material substitution, transport.



Angie Nagle, PhD Thesis, UCC (2022)

Evidence Base: 2. Social Sustainability



Multicriteria decision analysis based on:

- Subset of UN SDG indicators,
- LCA outputs
- Delphi panels of experts

Benefits:

- Decarbonising transport;
- Healthy lifestyles;
- Sustainable rural development

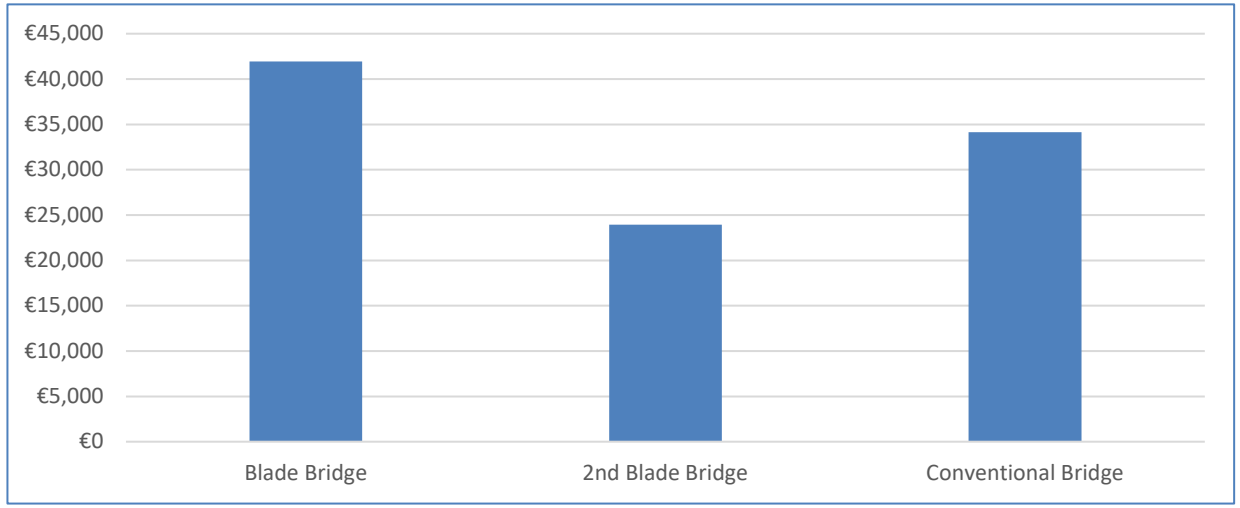
End-of-Life alternatives for wind turbine blades: Sustainability Indices based on the UN sustainable development goals

Peter Deeney [a,b,g,*], Angela J. Nagle [a,b], Fergal Gough [a,c], Heloisa Lemmertz [a,c], Emma L. Delaney [d], Jennifer M. McKinley [d], Conor Graham [d], Paul G. Leahy [a,b,g], Niall P. Dunphy [a,b,e,g], Gerard Mullally [a,c,e,f,g]

Resources, Conservation & Recycling 171 (2021) 105642

Evidence Base:
4. Economic Sustainability

Lifecycle Costing of BladeBridge vs Conventional Bridge



- Learning by Doing: costs decrease for 2nd and subsequent bridges.
  - Design streamlining; less reverse engineering;
  - Client confidence : less over-engineering

Angie Nagle, PhD Thesis, UCC (2022)

Evidence Base: Completed Projects

- Blade Bridge #2, Midleton, Rep. Ireland
- Blade Bridge #3, Draperstown, N. Ireland

Evidence Base: Completed Projects

- Blade Bridge #4,
- Atlanta, USA

- Blade Bridge #5,
- Co. Clare, Ireland.

Economic Sustainability: Commercialisation

- Repurposing has a two-sided business model:
  - accepting end-of-life blades
  - designing and building repurposed products
- Creating a **circular value chain** of interconnected enterprises focussed on recovery, repurposing, remanufacturing, recycling.

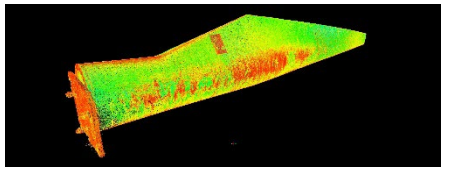
Achill Blade Shelter, Meenadreen Amenity Area. Images: BladeBridge Ltd. and Perch Design

BladeBridge


some lessons learned...

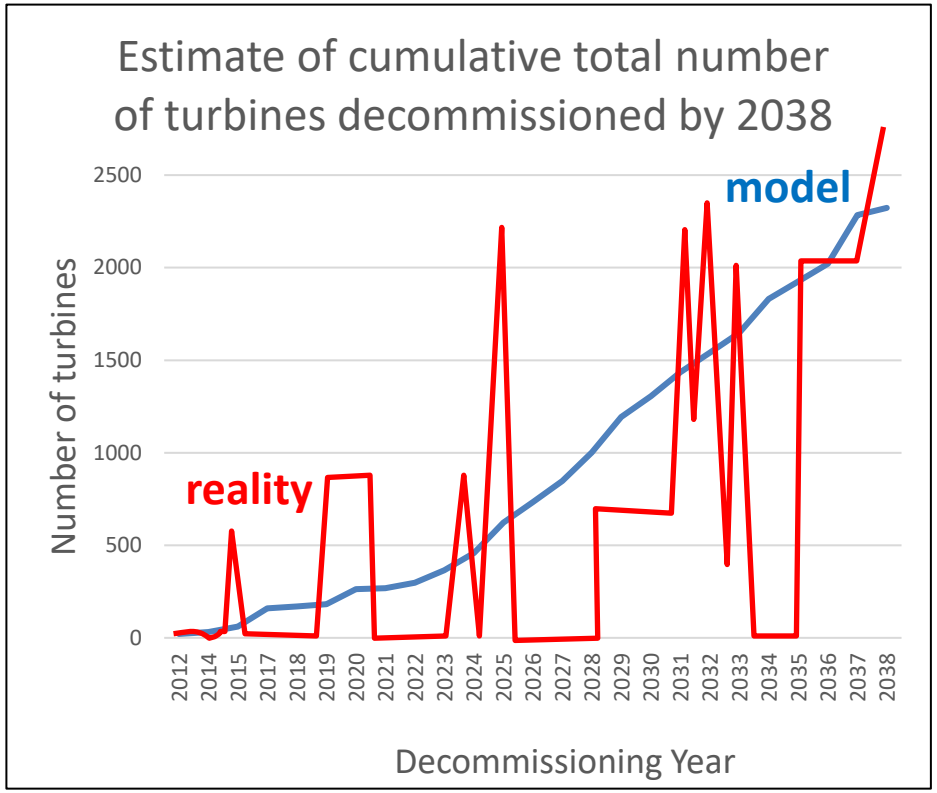
Lesson 1:
Data (re)discovery adds cost

- Locating and sourcing blades
- 3-D LiDAR scanning
- Geometry extraction
- Destructive and non-destructive testing
- Burnout tests
- Structural finite element modelling



Lesson 2: EoL blade supply and recovered product demand are “spiky”

- Blade repurposing (and pyrolysis, and solvolysis…) is a **two-sided business**
- Temporal mismatch in supply and demand
- Solutions
  - Blade Brokerage
  - Blade Storage



Projections for Ireland - Emma Delaney, QUB

Lesson 3:
Location, location, location

- Transport emissions are important for all EoL solutions
- Transport costs for large blade sections versus small cuts
- Local repurposing retains and adds local value (enterprise, jobs, public acceptance, environmental benefits)

Repurposing & Offshore Wind: What's Different?

- Larger Blades
  - Carbon fibers?
- Longer Lifetimes
- Avoid road transportation?
- Shoreside Facilities: High Costs
  - Fast processing
  - Cut and transport
  - Or repurpose offshore
- "Seafill" not an option

Arklow Bank 7 x GE3.6 MW (afloat.ie)

25-Year-Old Danish Offshore Wind Farm Gets Approval to Operate for 25 More Years

WIND FARM UPDATE

June 27, 2025, by Adrijana Buljan

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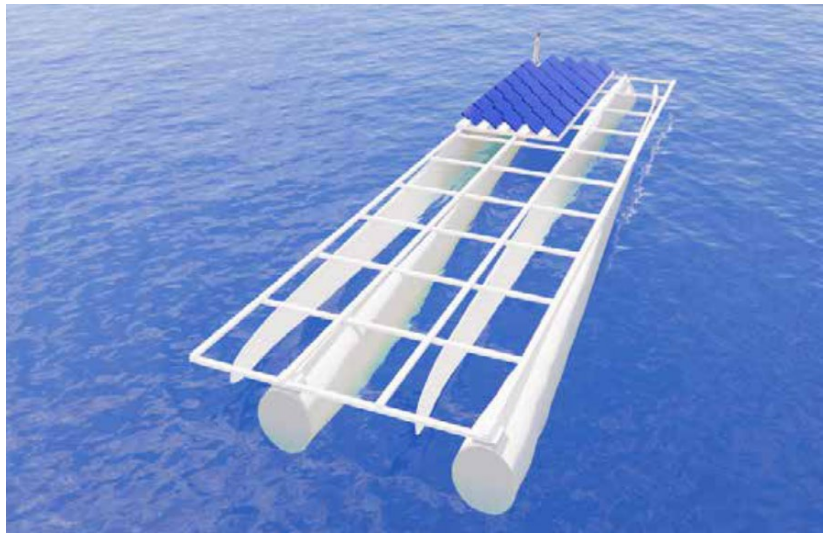
Re-Wind's Offshore Repurposed Wind Blade Concepts



37m x 10 m floating PV platform (GE37 blades)

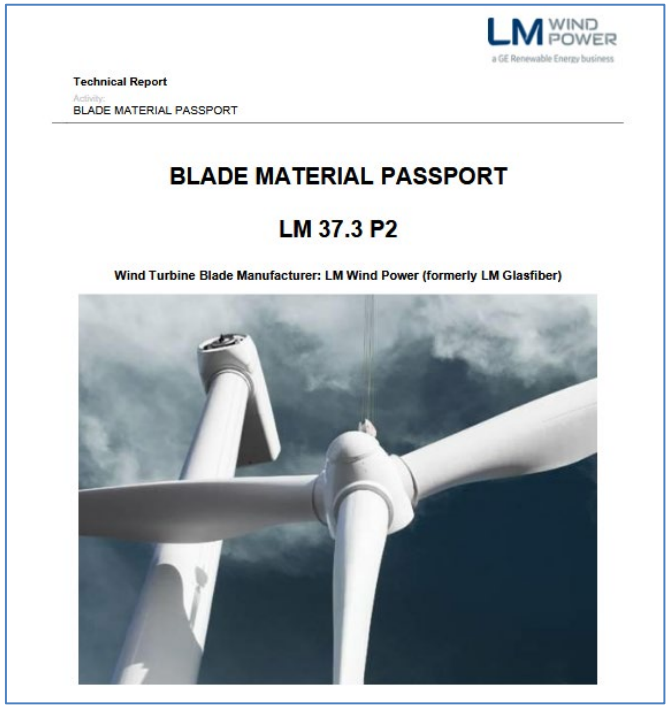
Bladebuoy

For further examples see: https://www.re-wind.info/s/Re-Wind-Design-Catalog-Fall-2022-Nov-9-2022-low-res.pdf


What can be done to facilitate blade repurposing?

How can turbine manufacturers facilitate blade repurposing?

- Share the data!
  - We need materials quantities, geometries, FRP layer specifications : **blade passports**
  - **Digital twins**
  - 3-D scanning, reverse engineering, FE modelling, certification, destructive and non-destructive testing, coupon tests, burnout tests...
    - all of these add costs!
  - Other EoL solutions also need this information
  - Legacy blade designs, no longer in production
  - Increase confidence in repurposed products


LM WIND POWER
a GE Renewable Energy business

Technical Report

Activity:
BLADE MATERIAL PASSPORT

BLADE MATERIAL PASSPORT

LM 37.3 P2

Wind Turbine Blade Manufacturer: LM Wind Power (formerly LM Glasfiber)

Blade passport,
LM WindPower
(decomblades.dk)

How can wind farm operators and decommissioners facilitate repurposing?

- Develop partnerships, sign MoUs with repurposers and EoL solution providers
  - Involve EoL solution providers **early** in the decommissioning process : site works planning, access, equipment.
  - Sustainability requirements in tenders
  - Win-win scenarios saving money and increasing sustainability
- Data sharing : blade history, work orders, SCADA data, digital twins

Photo: WindEurope

How can authorities facilitate repurposing?
1. Consenting and Waste Regulation

- Mandate decommissioning plans and waste handling
  - e.g. NYSERDA ORECRFP24-1 Solicitation
    - Focus on re-use / recycling
  - Ireland : maritime consent application includes decommissioning plan
    - Dublin Array (RWE) application references waste hierarchy
  - France : 55% rotor mass for reuse/recycling
- Regulation and taxes
  - Remove uncertainty around waste classification of EOL blades
  - Landfill bans in Austria, Finland, Germany, Netherlands*
  - Limited capacity and high surcharges (Ireland)
  - Key legislation : EU Circular Economy Act (2026)
    - Single Market for secondary raw materials
- Industry self-regulation
  - e.g. WindEurope self-mandated blade landfill ban (2026)

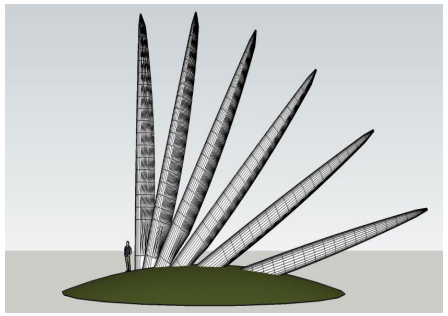
How can authorities facilitate repurposing? 2. Green Public Procurement

- Two-sided business model: blade supply and product demand
- Extremely competitive cost-driven markets even for high-value products such as bridges
  - Green & circular public procurement **mandates**
  - Certification, regulations and codes governing use of recycled/ repurposed materials

Streamlining Repurposing: EirBlade Toolbox

EirBlade
Rethink | Repurpose

- **Scalable, data-driven tools** to make repurposing easier
- All-Ireland wind turbine geodatabase for decommissioning projections
- In-field **condition rating** tool : blade readiness for repurposing
- Improves management of end-of-life structural materials
- **Decision support expert systems** with environmental benchmarks, scenario-based repurposing assistant & circularity metrics



Public realm sculpture proposal (image: Joseph Neeson);

E-mobility hub (image: ESB);

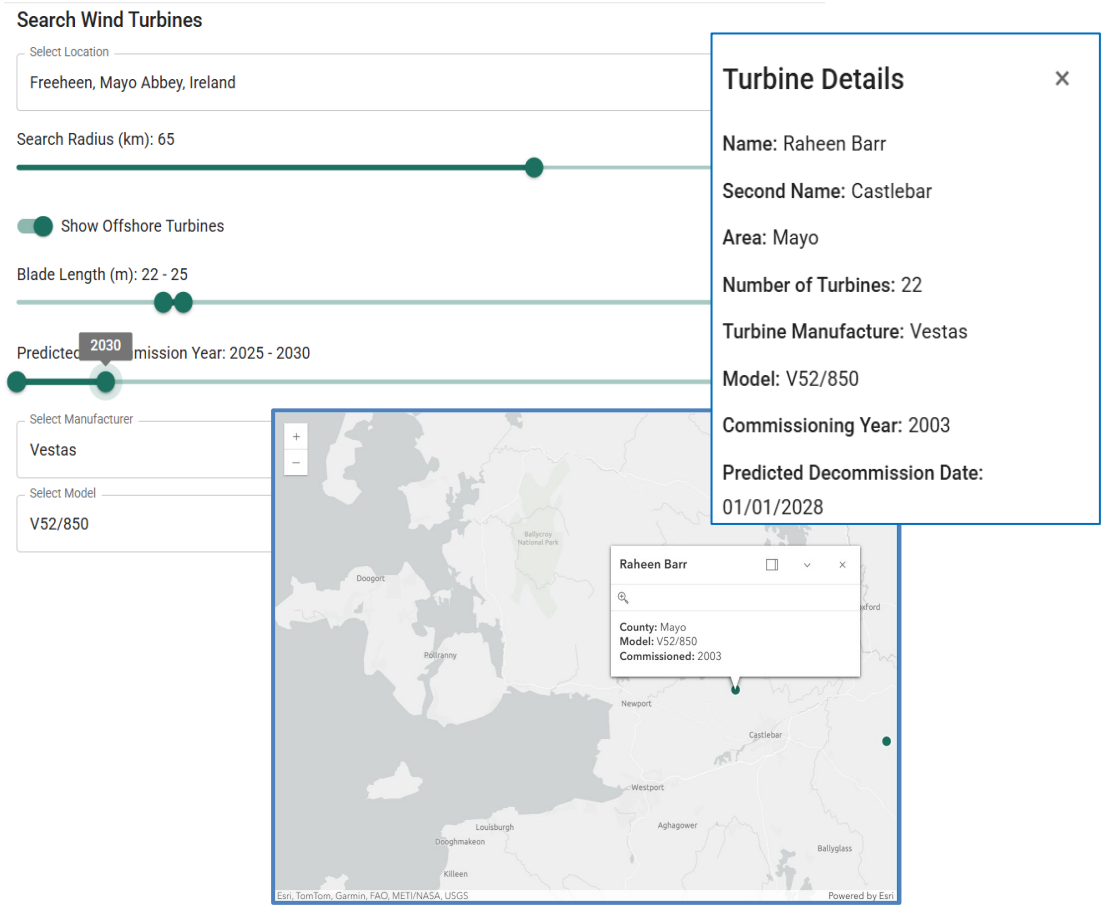
Meenadreen Windfarm Memorial [image: Enérgia]

EirBlade – Turbine Database

Finding the right blade for each application

Rich dataset including:

- Location
- Turbine make, model
- Blade dimensions
- Projected decommissioning dates
- Owner, operator



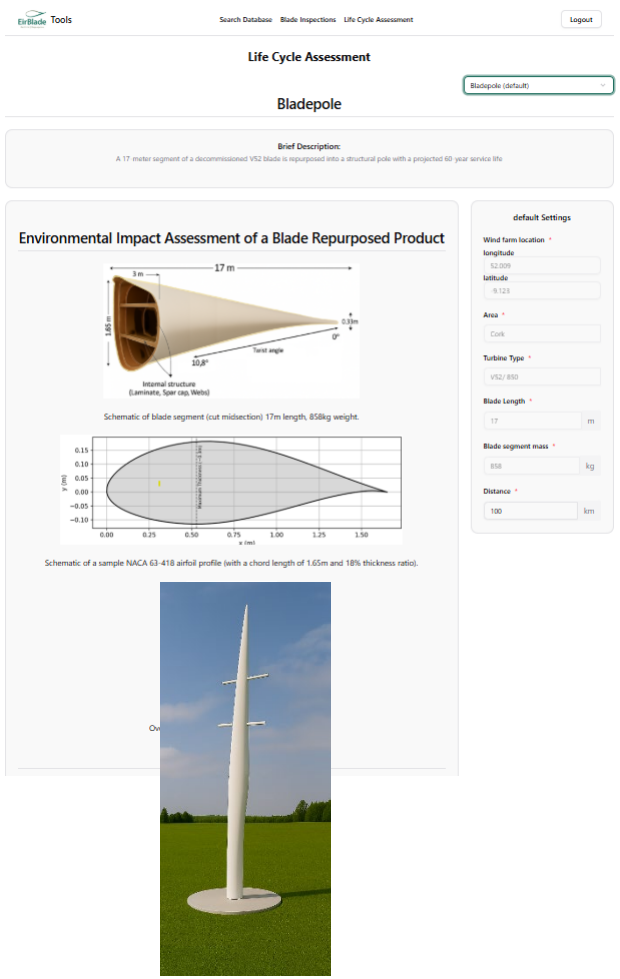
EirBlade – Life Cycle Assessment Tool

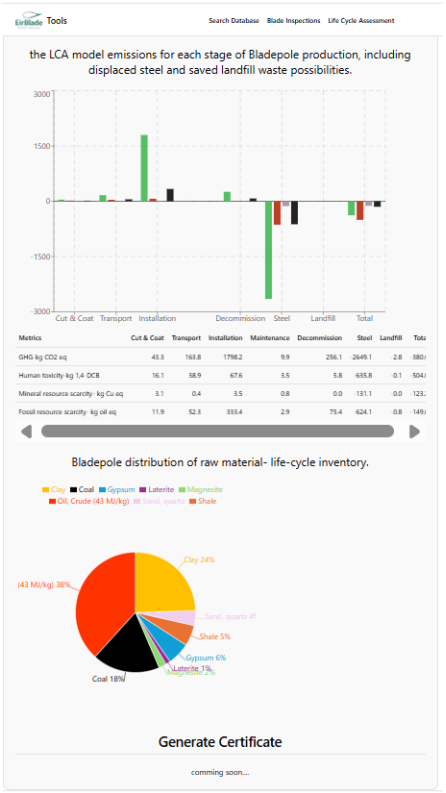
LCA Tool Objectives

- Tell you how much material you can substitute
- Calculate your avoided CO_2 emissions, transportation emissions and other environmental impacts
- Compare repurposing applications

Next Steps:

- Development of Environmental & Societal Impact Databank
- Creation of Blade Circularity Metrics Engine





Some conclusions

- Repurposing EoL blades is technically, economically, socially and environmentally feasible and is scalable
- However, barriers remain
- Co-operation and sharing information reduces costs and improve outcomes for all stakeholders
- Offshore: minimise blade movements; fast relocation
- Specific guidance on composites waste is needed
- “Green premium” on repurposed products : willingness to pay or mandates?
- Further research ongoing to eliminate barriers to creating a circular value chain for wind turbine blades: www.eirblade.ie

Acknowledgements

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Funders: Research Ireland; National Science Foundation of the USA; Department for the Economy, Northern Ireland, Sustainable Energy Authority of Ireland; National Challenge Fund (Ireland)

Questions?

Further information

www.re-wind.info

https://iea-wind.org/task45/

www.bladebridge.ie

https://www.eirblade.ie/

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Linkedin:
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EirBlade video:

Photo: Conor Graham, QUB / Re-Wind Network

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