Wind Blade Repurposing

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End-of-Life Issues for Onshore Wind Farms

Cork, Ireland

Friday 27th May 2022

WIND VALUE
An Opportunity for Climate Action and for Energy Communities

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RE-WIND NETWORK BLADE REPURPOSING SOLUTIONS WWW.RE-WIND.INFO

What does blade end of life (EOL) mean?

We define EOL as "**the *time* at which blades are no longer performing their intended and permitted function on their original turbine**." It may in fact mean any of the following "times":

End of (design) life - extending life by permit

End of (design) life - extending life by repair or retrofitting

End of (functional) life - removal due to in-service damage

End of (functional) life - removal due to repowering the wind farm

End of (location) life - removal and reselling

End of (location) life - removal and stockpiling

End of (location) life - abandoning

What does functional EoL mean in terms of blade mass reuse

We define functional EoL in the context of the circular economy as **reuse of the mass of the blade material in a new product**. The term may in fact be used for any of the following that have **different percentages** of material reuse

Blade disposal as waste: **0% re-use -** Landfilling or incineration - No fibers and no polymers are recycled. Currently the preferred methods due to lowest cost but highest environmental impacts.

Blade constituent material reuse: **40-50% re-use.** Partial reuse of the fiber or the polymer – Thermolysis, pyrolysis, solvolysis in which only the fiber is reclaimed (recovered). Monomer reclamation for reuse is experimental, This category includes co-processing in a cement kiln (i.e., thermolysis). Costs, markets and impacts unclear.

Blade composite material re-use: **70-80% reuse -** Partial reuse of the composite material by reduction (cutting, shredded, grinding) to micro-size particles) for reuse as filler new polymer composites or concrete.. Costs, markets and impacts unclear.

Blade structural re-use: **90-100% reuse**. Full reuse by repurposing of the entire wind blade or large parts of the blade for a second life in other infrastructure, building or architectural products. Costs and markets unclear.

US EPA Waste Hierarchy

Waste Hierarchy for wind blades

- **Prevent:** Extend project or blade lifetime
- **Reuse:** Sell blades on secondhand market
- **Repurposing**: Remanufacturing for use in new products
- **Mechanical Recycling**: Shredding, grinding and milling for filler for FRP or concrete
- **Materials Recovery**: Pyrolysis (700 °C), thermolysis (400 °C), solvolysis (acetone or ammonia) to recover composite material, fibers, or polymers.
- **Co-processing in cement kilns:** chemical substitution at 1500 °C
- **Incineration** – with or without energy recovery, then landfill ash
- **Landfilling**

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

Rebuying C&D Materials

https://www.epa.gov/smm/sustainable-management-construction-and-demolition-materials

Buying used C&D materials and recycled content products for use in new construction can:

- Lower construction and renovation costs while maintaining building function and performance.
- Ensure materials collected from reuse and recycling programs will be used again in the manufacture of new products and/or new construction, thereby fully realizing the benefits of reuse and recycling efforts;
- Boost the local economy as recovered materials are typically locally sourced.
- Preserve local architectural character and historic significance (in cases of preserved or restored buildings).

Blade Repurposing Concepts

2021

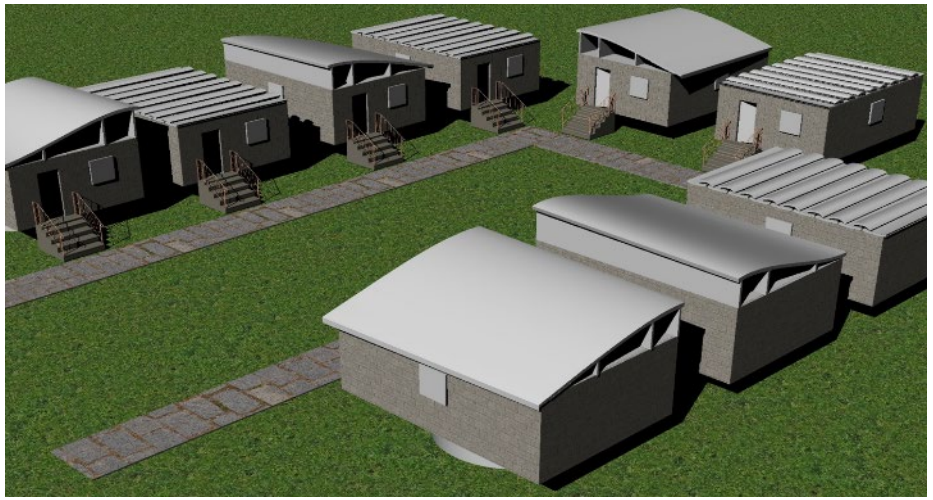
12m length – 6m width

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.

Re-Wind Blade Repurposing Concepts



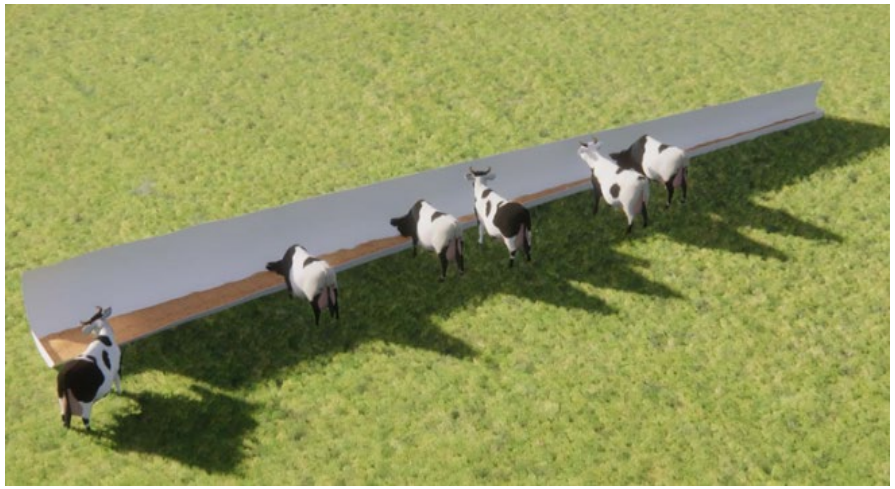
BladeHousing

BladeBridge

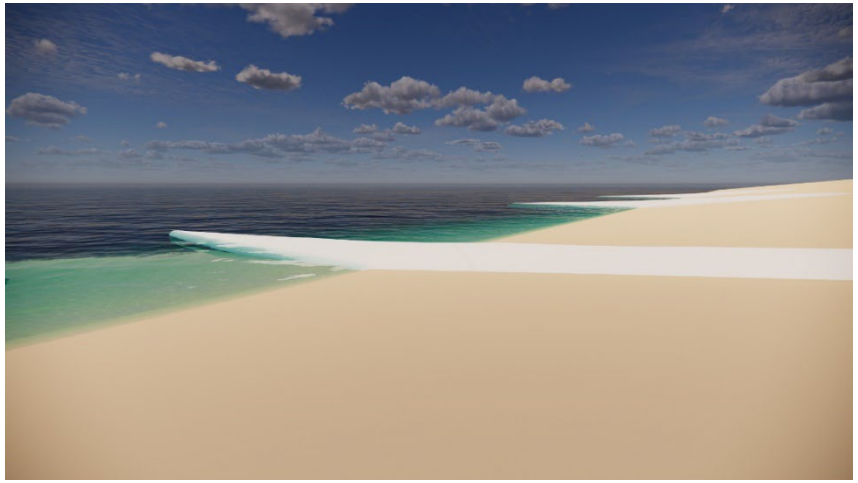
BladePole

BladeBarrier

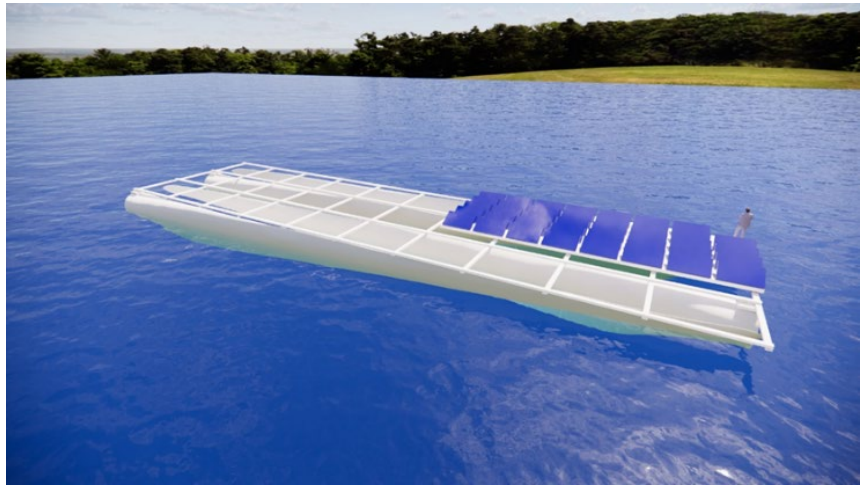
Re-Wind Blade Repurposing Concepts



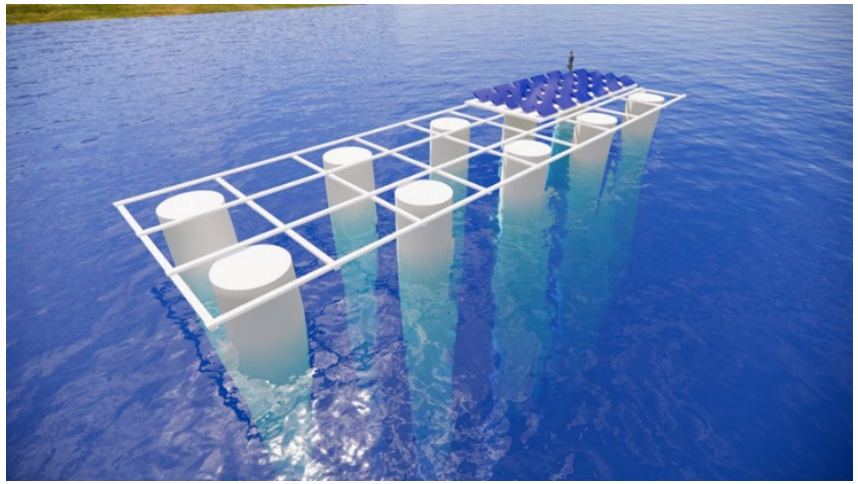
BladeFarm



BladeJetty



BladeSolar



BladeOffshore

BladeBridge

Cork, Ireland, January 2022

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BladeBridge

Video of construction on YouTube at
https://youtu.be/8bmWAX_6uAY

BladePole

BladePole

February 2022
Full-scale testing of braced line post assemblies for gravity and wind loads.

BladePole Phase 2 Installation at Smoky Hills, Kansas

ENEL Green Power
Smoky Hills Kansas

BladePole Phase 2 Installation at Smoky Hills, Kansas

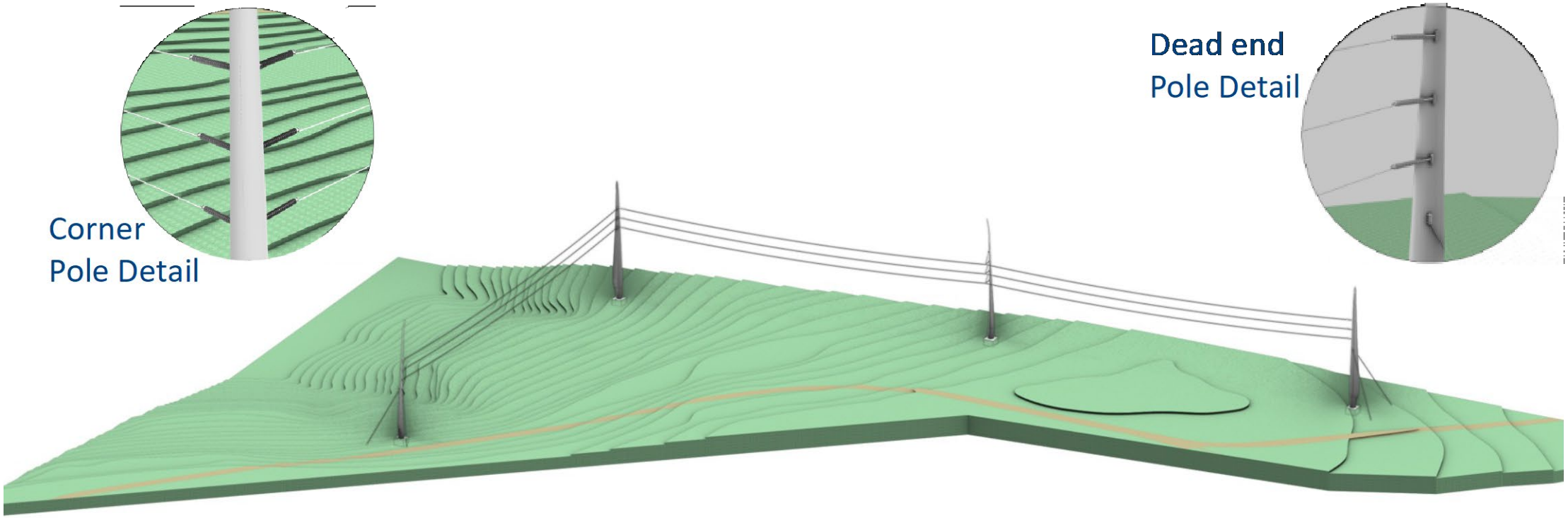

Figure 8: Four-pole configuration of deadend, corner and tangent BladePoles

Re-Wind Partners, Projects, Funding

Network University Members:

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

Funding (~$2m 2014-current)

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

Current Project Partners:

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

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Join with Re-Wind

1. Support responsible decommissioning of wind turbine blades.
2. Help us obtain timely information of the types and quantities of blades coming out of service in the coming months in your locations.
3. Help us develop cost-effective ways of characterizing EOFL blades for repurposing.
4. Help us develop better cost models for blade removal, cutting and transportation.
5. Help us demonstrate Re-Wind designs in your communities.

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