

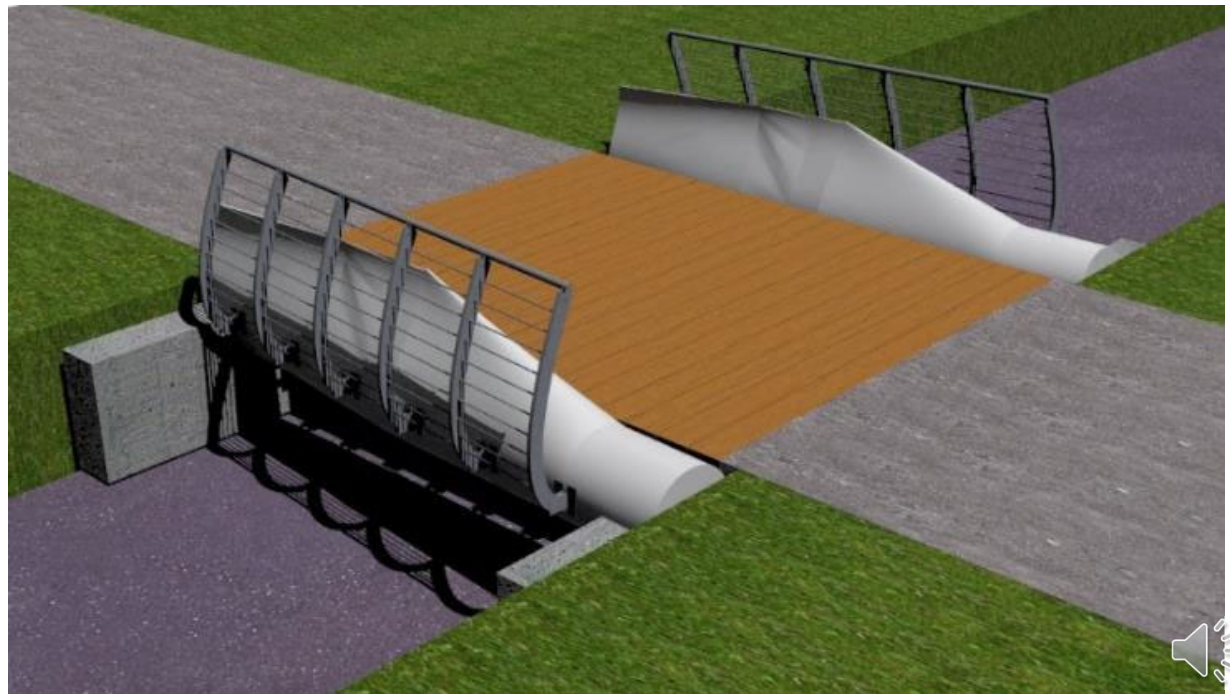
Life Cycle Assessment of the Use of Decommissioned Wind Blades in 2nd Life Applications

Angie Nagle

PhD Student

University College Cork
icRS Conference

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Re-Wind Network: Repurposing Concepts for Decommissioned Wind Turbine Blades



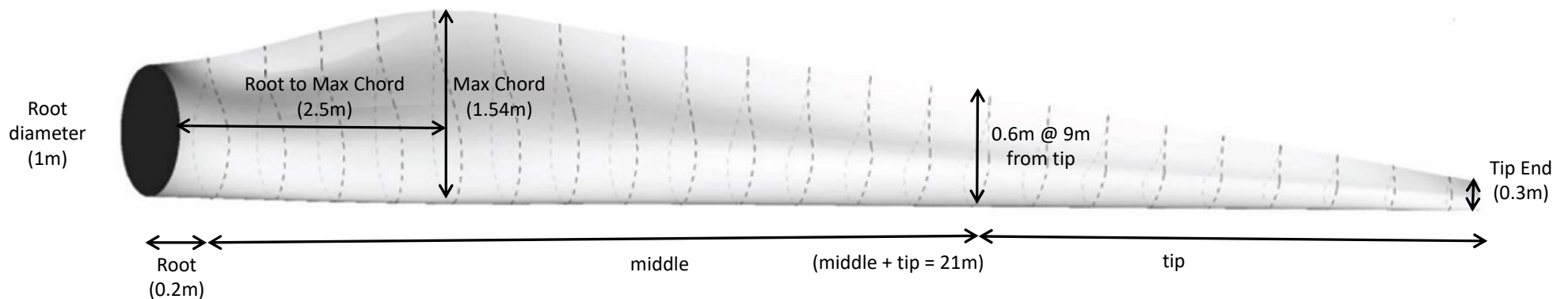
Research Questions

How can we best utilize the full blade length in repurposed applications?

Who needs repurposed products in Ireland?

What materials can we substitute to offer the most environmental gains?

Could I create an indicator of CO₂ abatement per tonne of blade material?



Green Public Procurement (GPP)

A Market Driver for Repurposing?

Ireland's public spending is 10-12% of GDP (DECC, 2021) , which is quite average

GPP focuses this purchasing power on the promotion of resource-efficient goods and services

GPP may encourage repurposing of materials in the public construction sector

County Councils WANT help with GPP

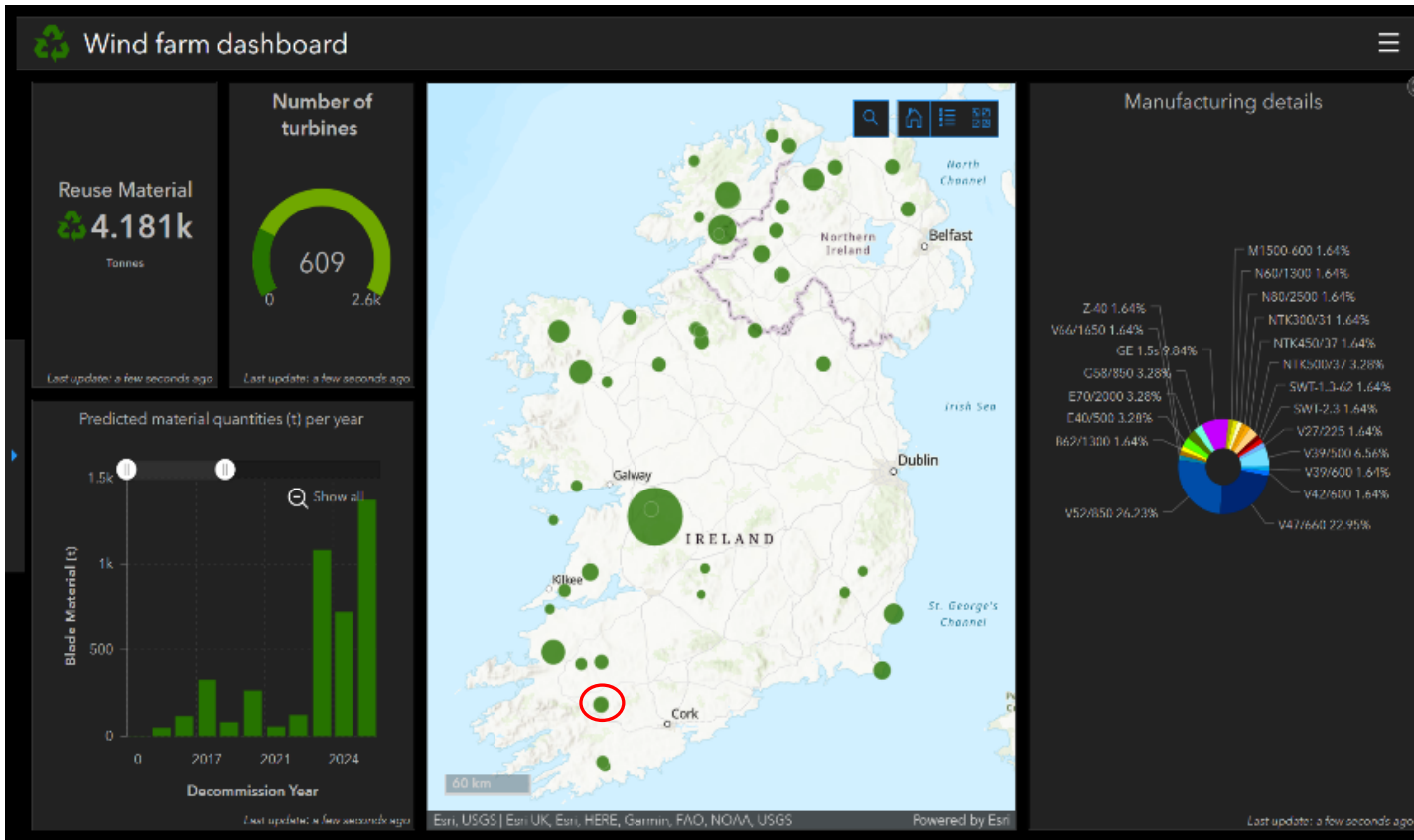


Design Atlas Assessment (subset)

Application	Initial Design, Testing & Fabrication	Material Substitution	Feasibility in Ireland, including amount of blades utilized and GPP potential	Blade Utilized (1=root, 2=mid, 3=top)	Discussion of Suitability	Overall Rank
Bridge	high	Steel	Public and private; High acceptance; high potential for blade utilization for greenway bridges	2	High interest; pilot project underway in 2021; med-high utilization of blade waste; GPP; steel substitution	4-high
Bus Shelters, bike racks	low	polycarbonate, steel	Public; good public acceptance; GPP	2	GPP; medium utilization; good acceptance; steel and polycarbonate substitution	3-med-high
Noise barriers	med	Cyclefoam, recycled PVC	Public and private; high utilization along motorways;	2,3	Medium amount engineering required in order to slot blades together to seal out noise, matching aesthetics, lots of blades used. However, from geo-coastal.ie website, sound barriers are made from 'Cyclefoam' which is recycled PVC. Therefore, the material substitution rates low.	2-med
Skate Park & Playground Equipment	med	concrete	Public, Low utilization	1	Low utilization, one off project. Legal aspects would make this difficult.	1-low



Hypothetical Irish Wind Farm & Location



Based on 20yr lifespan:

42 Wind Farms Due for Decomm by 2025

Avg: 10 turbines/farm

Blades 13-35m long

Hypothetical Farm: SW Ireland, 10 turbines with blades 21.2m each



Scenario 1—Rural County Councils & Farmers

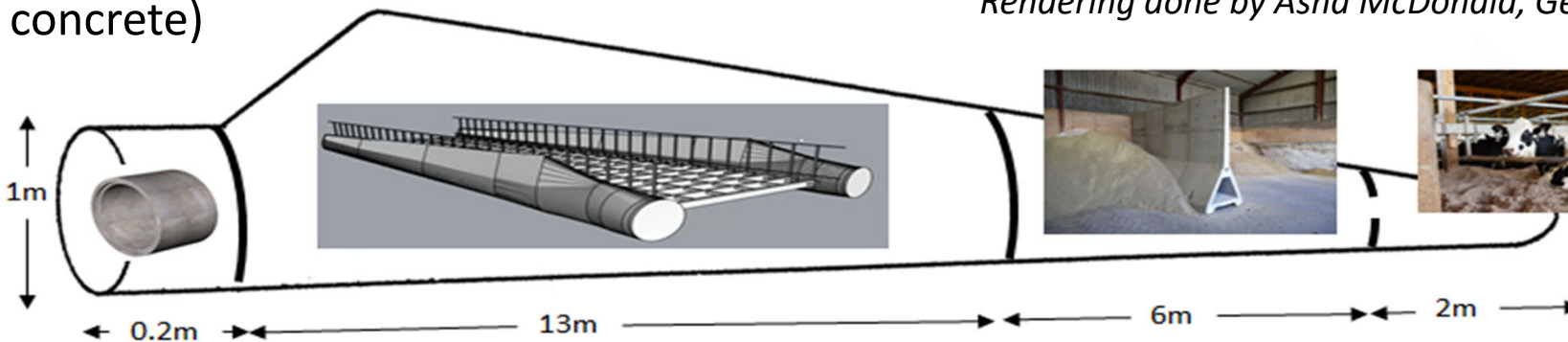
Root: Culverts or Manholes
(concrete)

Middle: Girders for Pedestrian
Bridges (steel)

Tip: Cattle partitions (steel pipe)
and grain partition walls (pre-cast
concrete)



Rendering done by Asha McDonald, Georgia Tech



Scenario 2 – Glamping DIY'ers

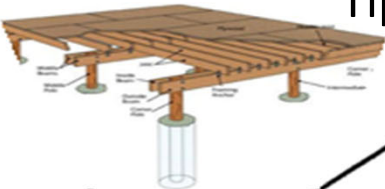
Root: Foundation footing for Tiny Homes/Glamping Pods (Concrete)

Middle: Roof for Glamping Pods (Wooden Beams/Sheet Roofing Steel)

Tip: Fencing (Wood)



Rendering done by Alex Poff, Georgia Tech



Scenario 3 – Urban County Council

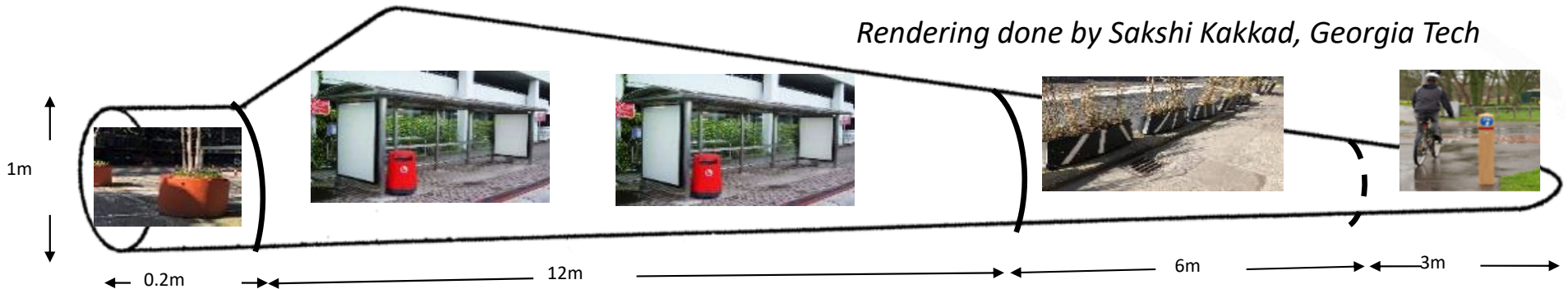
Root: Planters (concrete)

Middle: Bus or Bike shelters
(polycarbonate)

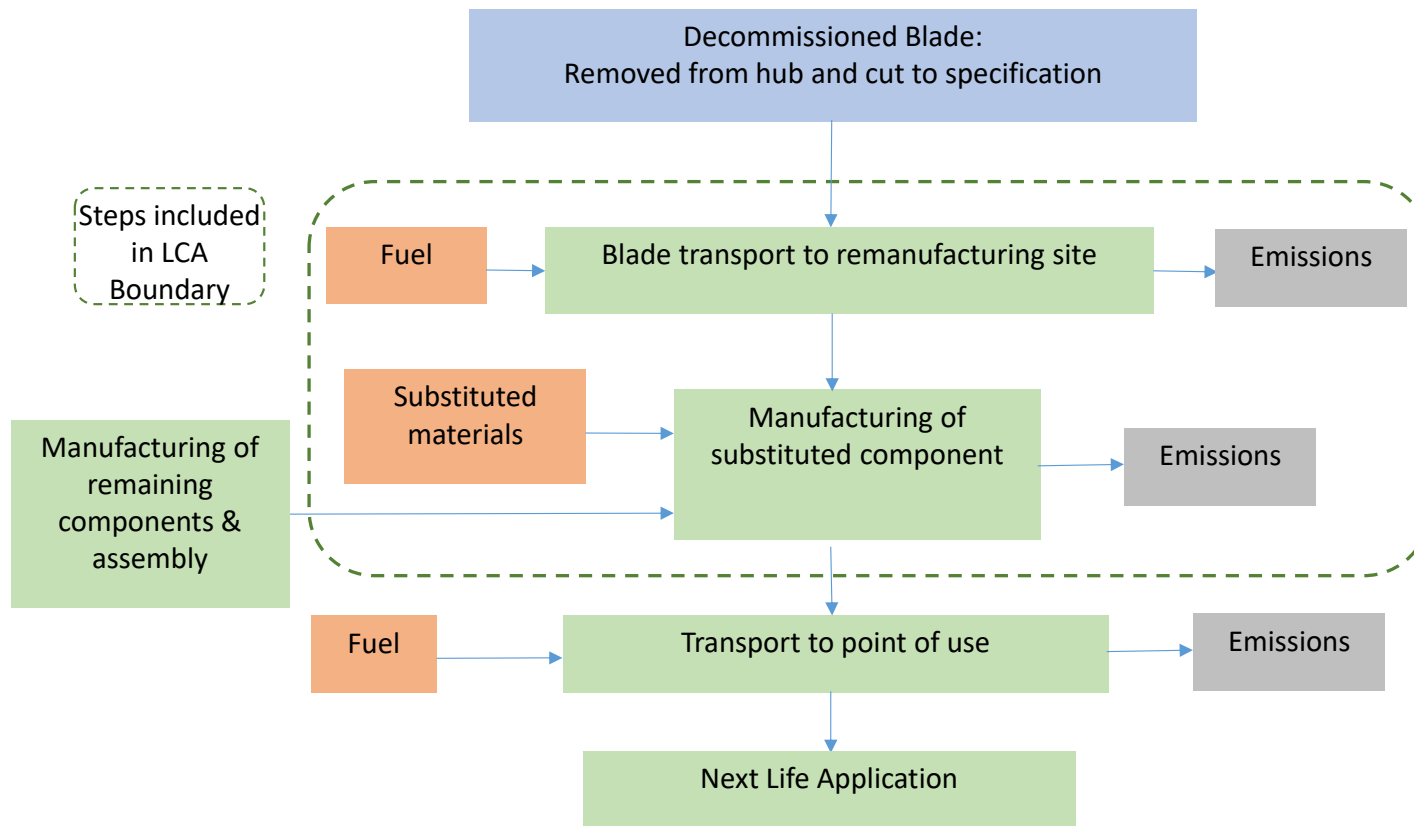
Tip: More Planters (concrete) and
Bollards (new GFRP)



Rendering done by Sakshi Kakkad, Georgia Tech



System Boundaries and Functional Unit

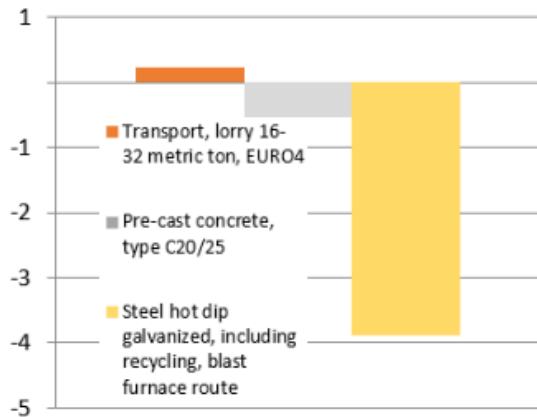


Functional unit:
*The utilization for
60 years of
30 x 22 meter
GFRP blades,
from a windfarm
in the Southwest
of Ireland.*

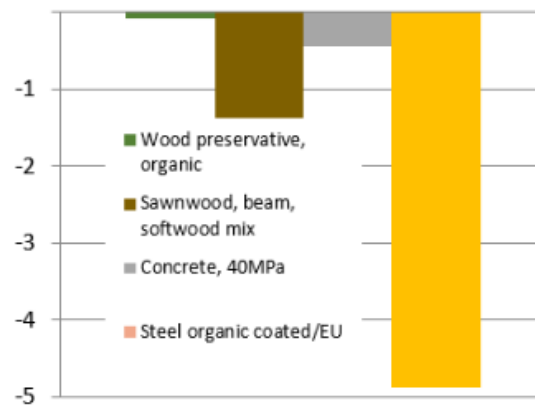


Life Cycle Assessment and Comparison

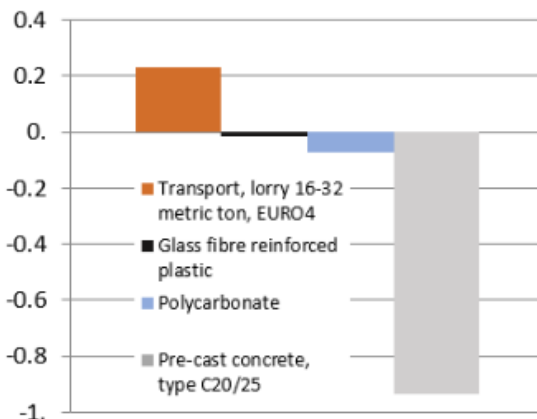
Scenario 1



Scenario 2



Scenario 3



LCA Input	Kg CO ₂ e
Transport, lorry 16-32 ton	397
Sawnwood, softwood, dried	-440
Concrete, 40MPa	-617
Pre-cast concrete type C20/25	-2826
Steel hot dip galvanized, w/recycle	-4685
Steel organic coated/EU	-6845
Polycarbonate & GFRP	-328
Total of all processes	-15,300
Total kg CO₂/Functional Unit	-342 kg CO₂/tonne

Steel substitution, particularly sheet steel for roofing, gave highest environmental benefits (partly due to requirement for replacement after 30 years).

Concrete replacement was 2nd most beneficial

Estimated reduction of 342 kg of CO₂/tonne of blade waste



Yeah, but really...

Application	Use of 1047 blades between 3 scenarios	Estimation of feasibility of application per year
Culverts	175m of culverts	Fully Feasible
Bridge	175 bridges	Would require 523 km of greenways to be built. 20% feasible
Commodity Item: Cattle Partitions	349 partitions	At 70 head of cattle per farm, this would outfit 5 farms. Fully feasible
Commodity Items: Grain partition walls	175 grain partition walls	20% feasible
Small Housing – Piling	87 pilings	Would require 21 tiny homes. Fully feasible
Small Housing – roofing	698 glamping roofs	10% feasible
Fencing & perimeter walls	3141 1 meter fence pieces	50% feasible
Commodity Items – Planters	349 one meter high planters	10% feasible
Bus Shelters, bike shelter	1047 bus or bike shelters	5% feasible
Commodity Items – Planters	2094 one meter high planters	5% feasible
Commodity Items – Signage	698 bollards	10% feasible

Estimating 1047 blades per year in Ireland between 2023-2030.

Here are the number of each application that would need to be built if the blades were divided between the three scenarios. **Repurposing of all blades is not feasible.**

However, 20% could be? **20%** annually is 210 blades per year:

315 tonnes of blade waste diverted from landfill

71,820 kg CO₂ e LESS emissions



Summary

- Substitution of materials with high embodied carbon & short design life in construction applications will help with CO₂ reduction.
- Stockpiling or legal 'aggregating' could help with material availability
- Use in low-risk & public settings is doubly beneficial
- EU Green Public Procurement (GPP) requirements are coming to Ireland. Awareness raising and educating procurement specialists will be key.

Next steps:

- Costing of diverted disposal, marginal costs of blade products, and value of waste cert
- Work with designers and engineers to develop more products, and assess acceptability
- Job creation implications with repurposing





Thanks & Questions!

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angelajanenagle@umail.ucc.ie

