Future sustainable recycling processes for wind turbine blades – where are we today?

Wind power research in focus 2022

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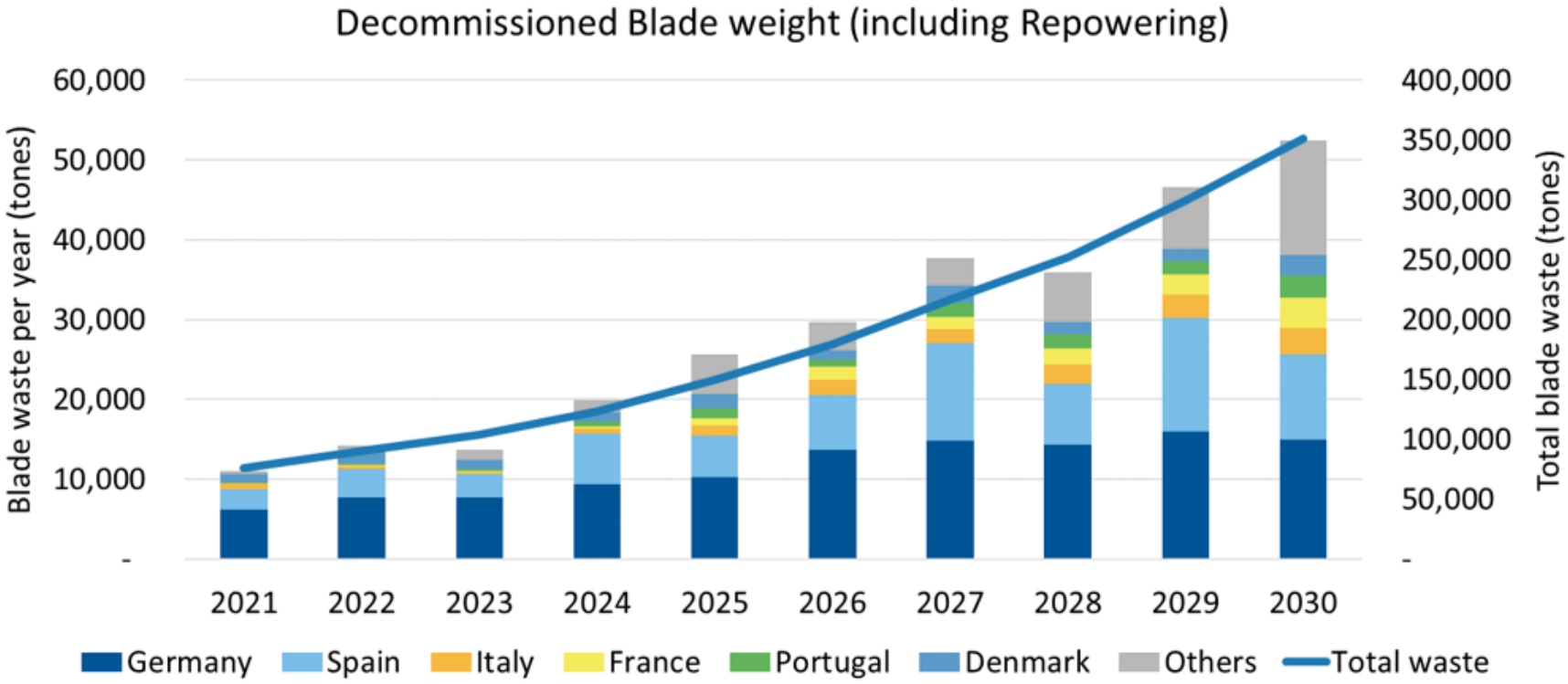
Do we have any sustainable recycling solutions for EOL wind turbine blades?
How are today's wind turbine blades recycled?
What is the cost of recycling for wind turbine blades?
RI.
SE



Source: WindEurope

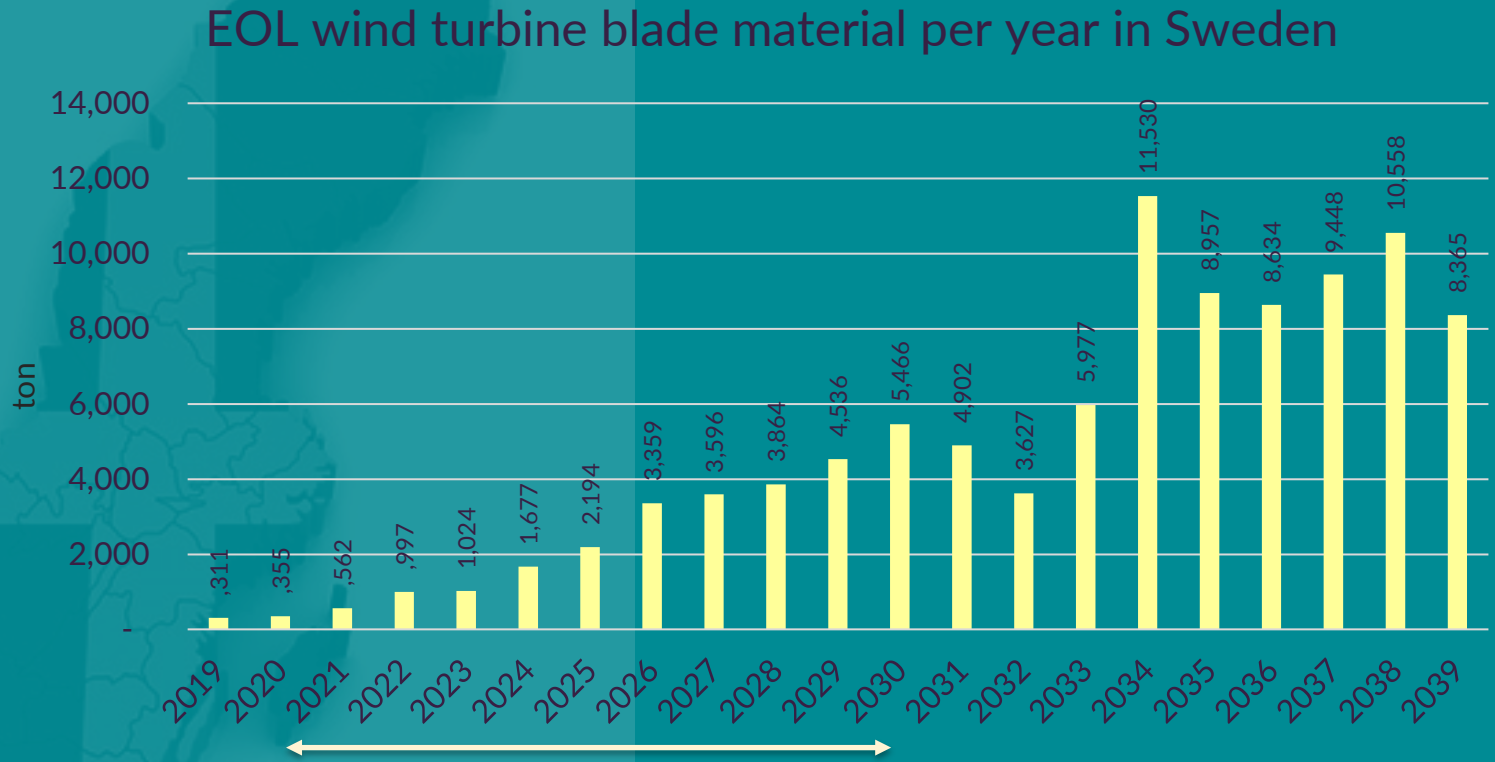
Within 9 year

50 000 blades*

350 000 tons

*2 MW, 7-ton blade

SWEDEN – What are the numbers?



Within 9 year

3900 blades*

27000 tons

*2 MW, 7-ton blade


Glass fiber composite (GFRP) = Glass fiber + thermoset

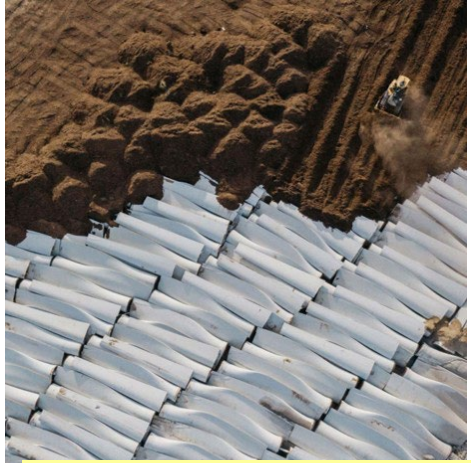
GFRP waste streams in Sweden -today

Regulations

Non-hazardous organic waste

- The **landfill directive** forbids landfilling of organic waste over 10% organic content
- GFRPs directed to incineration and energy recovery
- No reporting obligation for this group of waste

- **EOL Wind blades:** Reparation and re-use, transport as “repair parts” to other country for EOL handling, incineration in Sweden, landfill with dispensation in Sweden?
- **EOL Boat and building and constructions :** Fragmentation in car recycling or incineration
- **Vehicles:** Fragmentation in car recycling
- **Manufacturing waste:** Incineration (fully polymerized)

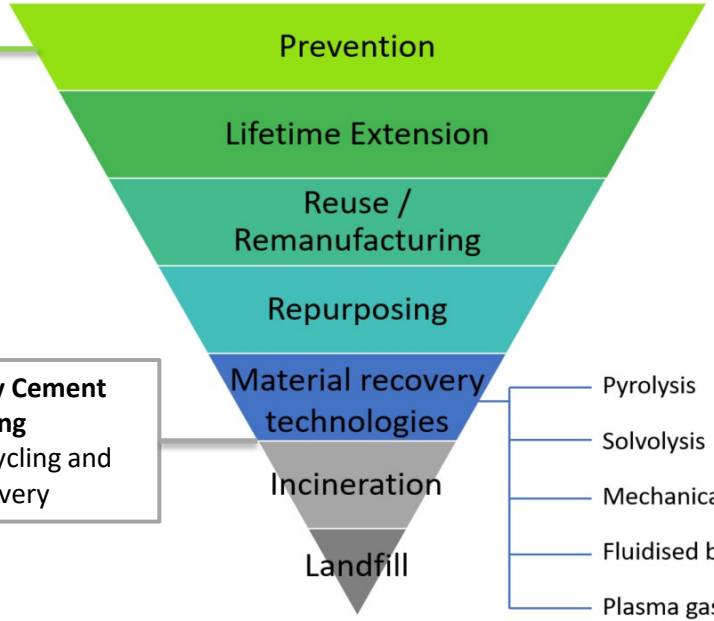


Fragmentation of GFRPs end up in residual fractions (SLF/Fines) which is incinerated or landfilled.

EPA, Mapping plastic flows in Sweden 2020 https://www.naturvardsverket.se/om-oss/publikationer/7000/978-91-620-7038-0/

Future recovery and recycling technology solutions for blades

New circular design of blades
releasable thermosets and thermoplastics

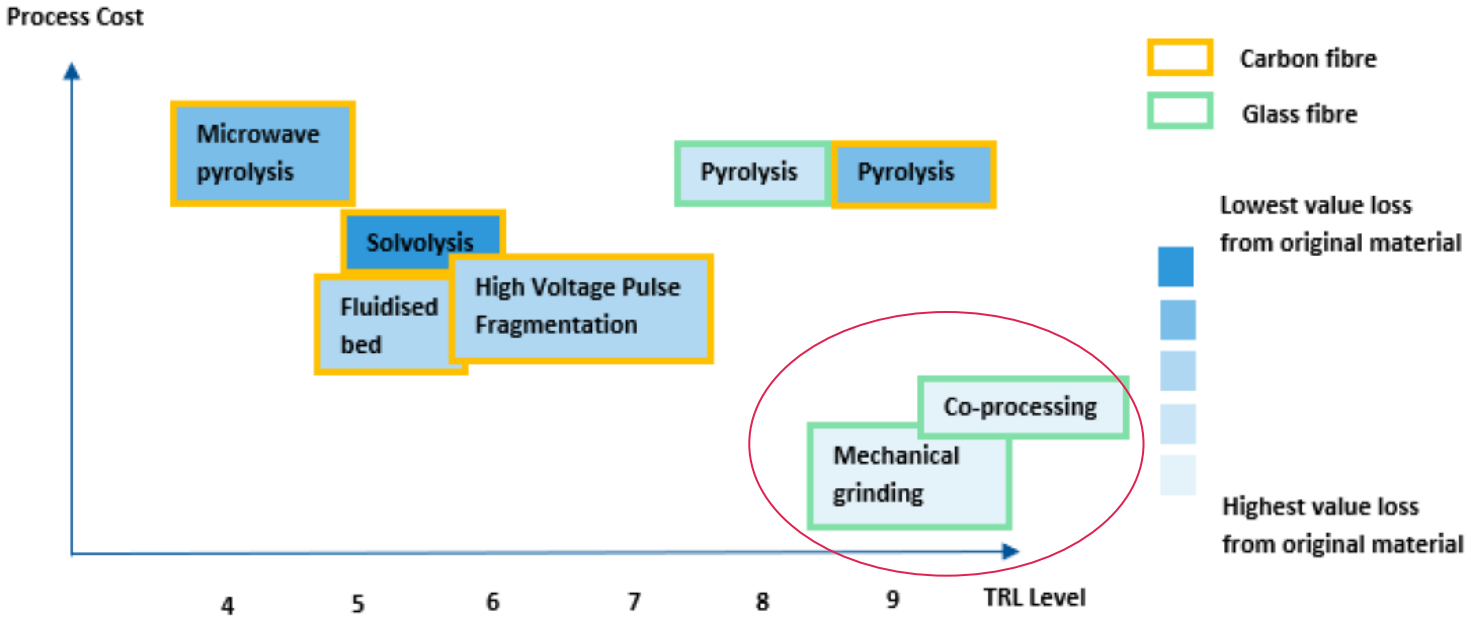


Recovery by Cement Co-processing
Mineral recycling and energy recovery

Repurposing as construction material

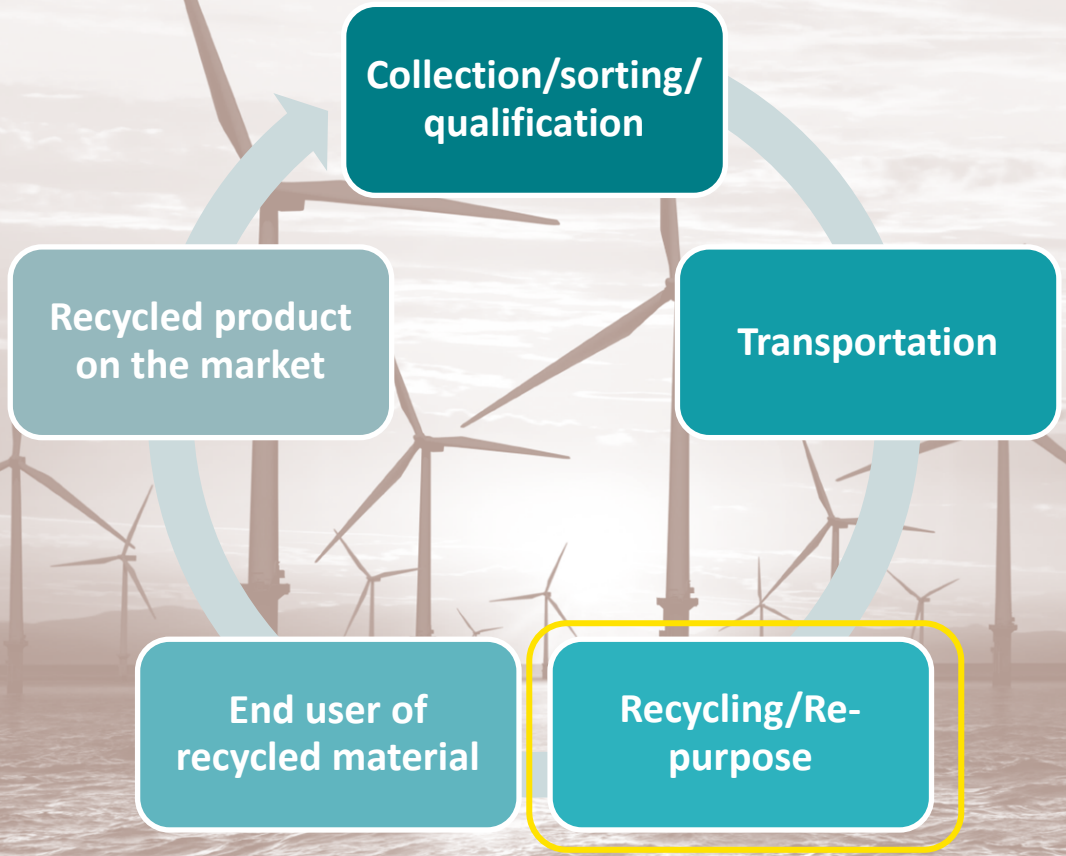
Mechanical recycling
Use of grinded blade fiber/fillers in new products

Recycling focus on solutions near in time: Co-processing in cement industry and mechanical grinding



https://windeurope.org/newsroom/press-releases/wind-industry-calls-for-europe-wide-ban-on-landfilling-turbine-blades/

Value chain GFRPs recycling - Need for development of new waste valorization system

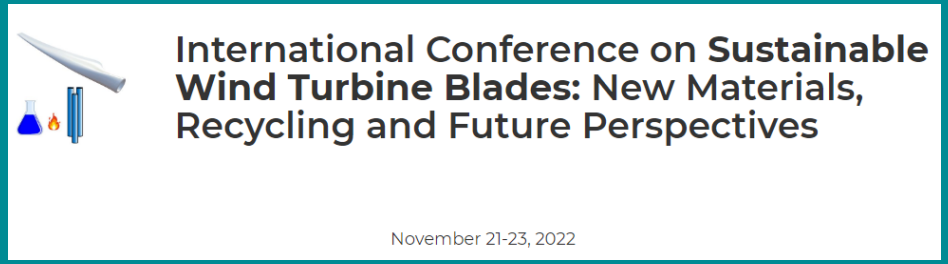


RI. SE

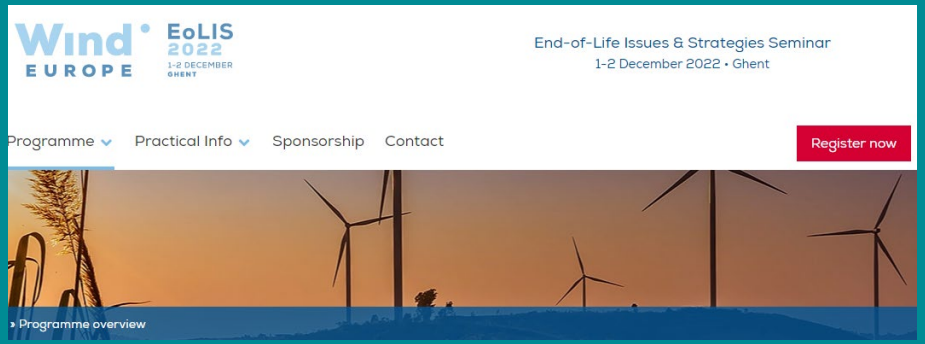
Need of:

- Digitalization of information
- End use products for recycled GF
- Policys and laws against landfill (and incineration?)
- Economical feasible business models

Upcoming conferences



https://www.conferencemanager.dk/recyc/conference



https://windeurope.org/eolis2022/programme/

Thank you for your attention

Rekovind
Chemical recycling of glass fiber composite from wind turbine blades

ReComp
Creating circular streams from GFRP composite waste

Rekovind2
Digitzation of wind blade streams before reuse and recyling

RECINA
REuse of Composite parts for Infrastructure Applications

Swedish Energy Agency

VINDFORSK

VINNOVA
Sweden's Innovation Agency

Partners Recomp: RISE, Nimbus boats, MTC, LTU, SMTF, Volvo Cars, Renova, PodComp, BladeSolutions, Librixer, Skene skog ÅVC
Partners RECINA: RISE, Chalmers, Composite Design, Marstrom Composite, Eventhotell , ABB
Blade samples: Enercon (Germany), Anmet (Polen)

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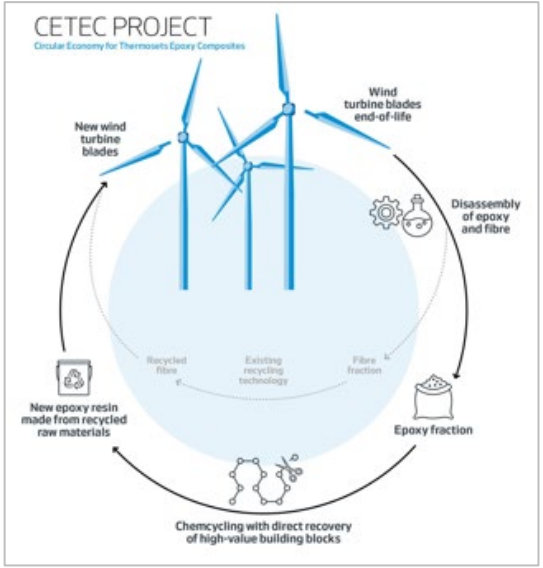
New circular design of blades

- **Siemens Gamesa – RecyclableBlade:** First six 81-meter-long RecyclableBlades already produced (Sept 2021) and **installed at RWE's Kaskasi project in Germany** in July 2022

- **CETEC** (Circular Economy for Thermosets Epoxy Composites) **Vestas, Aarhus University, Olin**, 3-year project started in **May 2021**. **New realesable thermosets based on epoxy will be used.**

- **Zebra** (Zero wastE Blade ReseArch) project, driven by French research center **IRT Jules Verne**, **LM Wind Power, CANOE, ENGIE, Owens Corning, SUEZ, Arkema**, started **September 2020**. Elium®, a recyclable thermoplastic resin will be used.

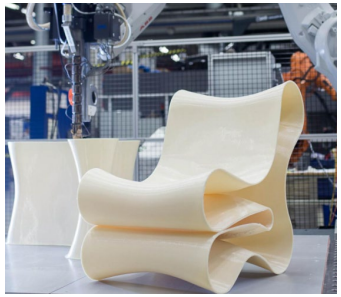


https://www.siemensgamesa.com/newsroom/2021/09/launch-world-first-recyclable-wind-turbine-blade; https://www.siemensgamesa.com/en-int/newsroom/2022/09/092222-siemens-gamesa-press-release-onshore-recyclable-blade
https://www.vestas.com/en/media/company-news/2021/new-coalition-of-industry-and-academia-to-commercialise-c3347473; https://www.lmwindpower.com/en/stories-and-press/stories/news-from-lm-places/zebra-project-launched

ReComp project– Mechanical recycling case studies

Thermoplastics

- Injection molding
- 3D-printing
- Short fibers



Cement

- Long fibers

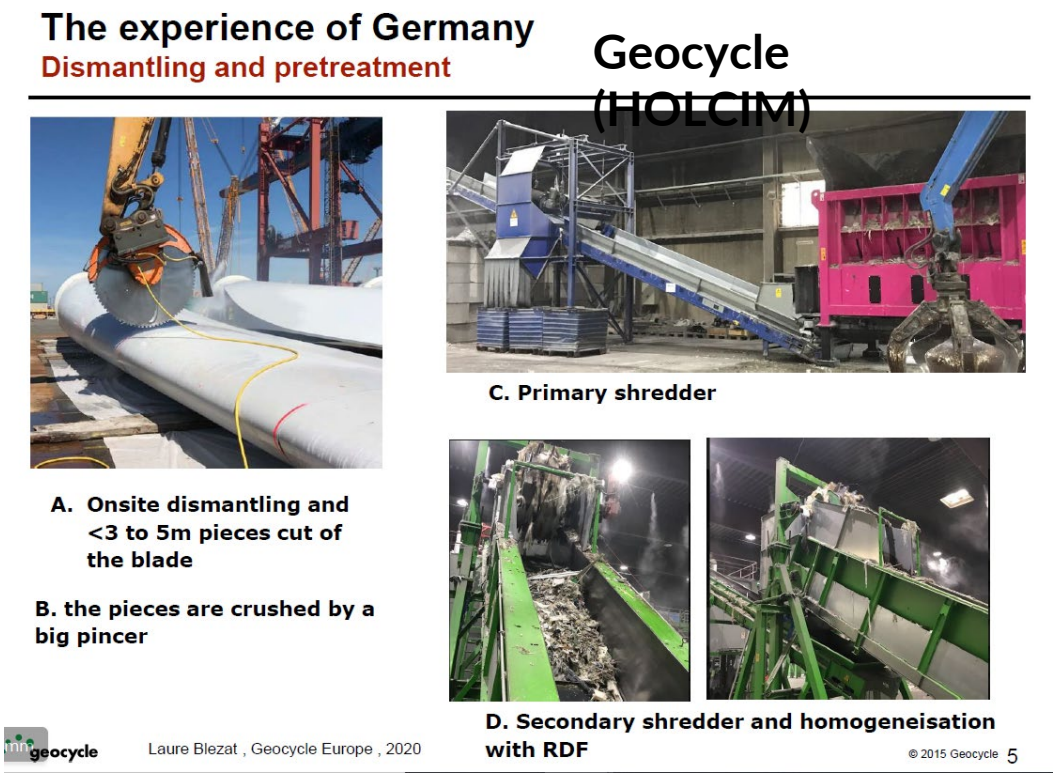
Thermosets

- Construction material
- Boat with 20% recycled fibers built in 1990

https://www.ri.se/sv/vad-vi-gor/projekt/recomp-cirkulara-strommar-fran-glasfiberkomposit

Co-incineration in cement industry

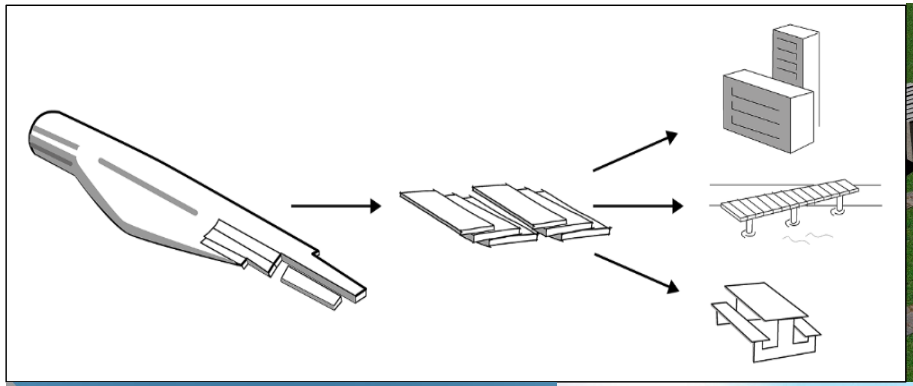
- Fiberglass contributes to silica in cement (22%)
- Toxic chemicals and plastics become energy
- Advantage: Saves CO2 emissions and energy, reduces use of fossil fuels
- No landfill residue - only cement

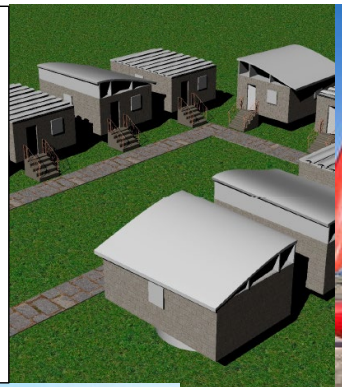


https://www.geocycle.com/

Repurposing of blades as construction material

Projects RISE:
- ReComp
- RECINA
- Rekovind2
- CIRCUBLADE





André et al 2020

© Césare Peeren, Superuse Studios - Blade bridge in Aalborg

© Césare Peeren, Superuse Studios – Wikado, Rotterdam 2009

First and second - pedestrian and bicycle bridges ”BladeBridge”

Anmet (Szprotawa, Poland, oct. 2021)

- **First bridge** of its kind in the word
- 24 m long
- One of the main challenge was to **get approval from authorities**.

Re-Wind Network (Cork, Ireland, feb. 2022)

- **Second bridge** of its kind in the word
- 5 m long and 3 m wide
- One challenge to know where and when the blades are decommissioned