

THE PROBLEM

WIND INDUSTRY MARKET
NEED FOR RECYCLING



Electric Power Research Institute
estimates on composite wind
turbine blade waste in the US:

~50,000 tons

of wind blade waste by 2023

~370,000 tons/year

by 2050



Fiberglass composite wind blades regularly being retired from wind farm repowering projects, site decommissioning, storm and lightning damage, etc.

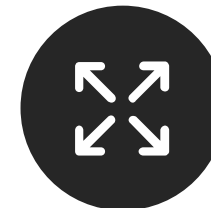


Wind energy represents only ~5% of glass fiber composites production in the US, meaning market penetration in wind can translate to significant growth in other industries like automotive, marine, construction, etc.



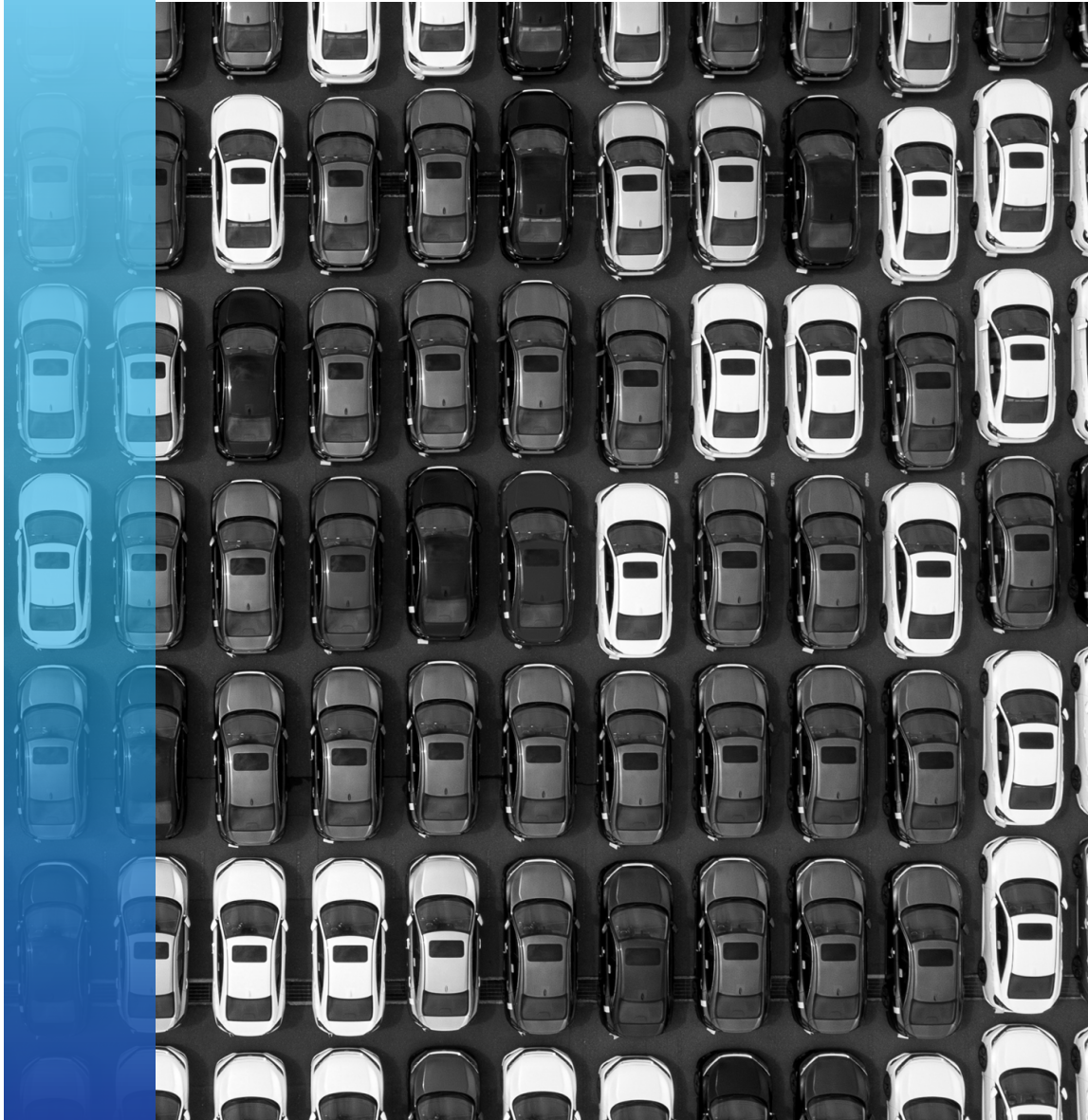
Recent media and government regulator attention has put enormous pressure on the wind industry to find a sustainable end of life solution for its fiberglass composite blades

- European Union has outlawed blade landfilling
- Multiple US states considering landfill banning legislation



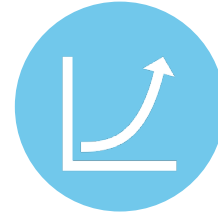
Both large OEMs and utility owner/operators actively seeking better options than currently available on the market





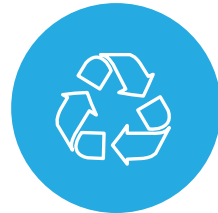
THE PROBLEM

AUTO INDUSTRY MARKET NEED FOR RECYCLING



Plastics and composites have rapidly gained traction in automotive manufacturing

- The average vehicle made today is ~12-15% plastics/composites (i.e., 330-440 lbs.)
- BloombergNEF projects use of lighter weight materials can also significantly reduce the cost of production for electric vehicles



Multinational automotive OEMs want to increase composites content but constrained by recyclability

- E.g., European Union End-of-Life Vehicle (ELV) Directive 2000/53/EC has a minimum 85% recycling target by an average weight per vehicle per year

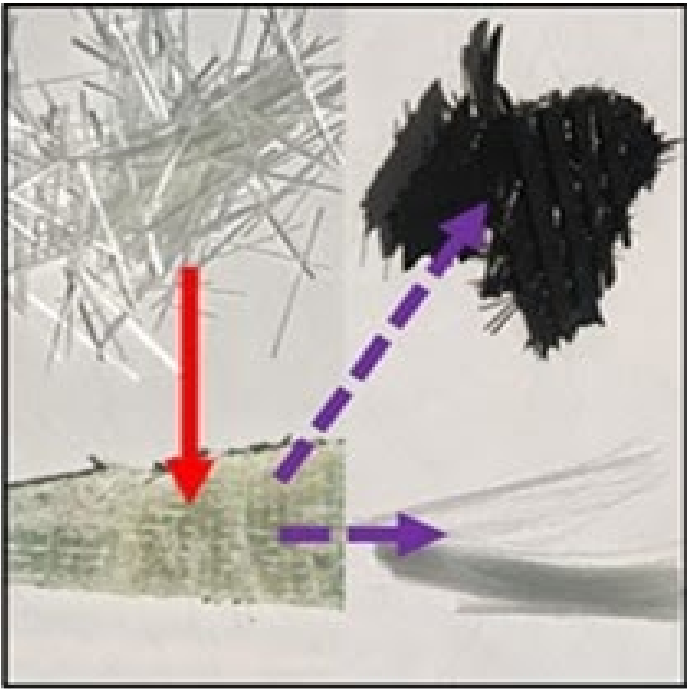


Composites recycling can also serve as low cost, reliable, domestic supply of materials to hedge against ongoing instability in today's global materials supply chain



THE SOLUTION

COMPOSITE RECYCLING SOLUTION



**TRADITIONAL
PYROLYSIS**

vs

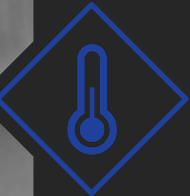
**MODIFIED
PROCESS**



Completely clean fiber surfaces for reapplication of sizing/coupling agents



Limits damage to tensile strength & preserves near virgin stiffness



And imparts additional thermal resistance useful for later compounding/molding



EXAMPLE FIBERGLASS RECOVERY FROM DECOMMISSIONED WIND TURBINE BLADES



01



INTAKE

02



CUTTING

03



SHREDDING

04



RECOVERED
FIBERGLASS



UPCYCLING OF RECOVERED FIBERGLASS INTO NEW, HIGH-VALUE COMPOSITE MATERIALS



- Recycled fiberglass reusable in new polymer composites: injection molding pellets, 3D printer filaments, nonwoven fabrics for infusion and hot processing
- Working to design materials for different composite consuming industries such as marine, automotive, sporting goods, etc.



**RECOVERED
FIBERGLASS**

**THERMOPLASTIC
PELLETS**



**NONWOVEN
FABRICS**

