Recycling Composite Wind Turbine Blade for High-Performance Composite Manufacturing

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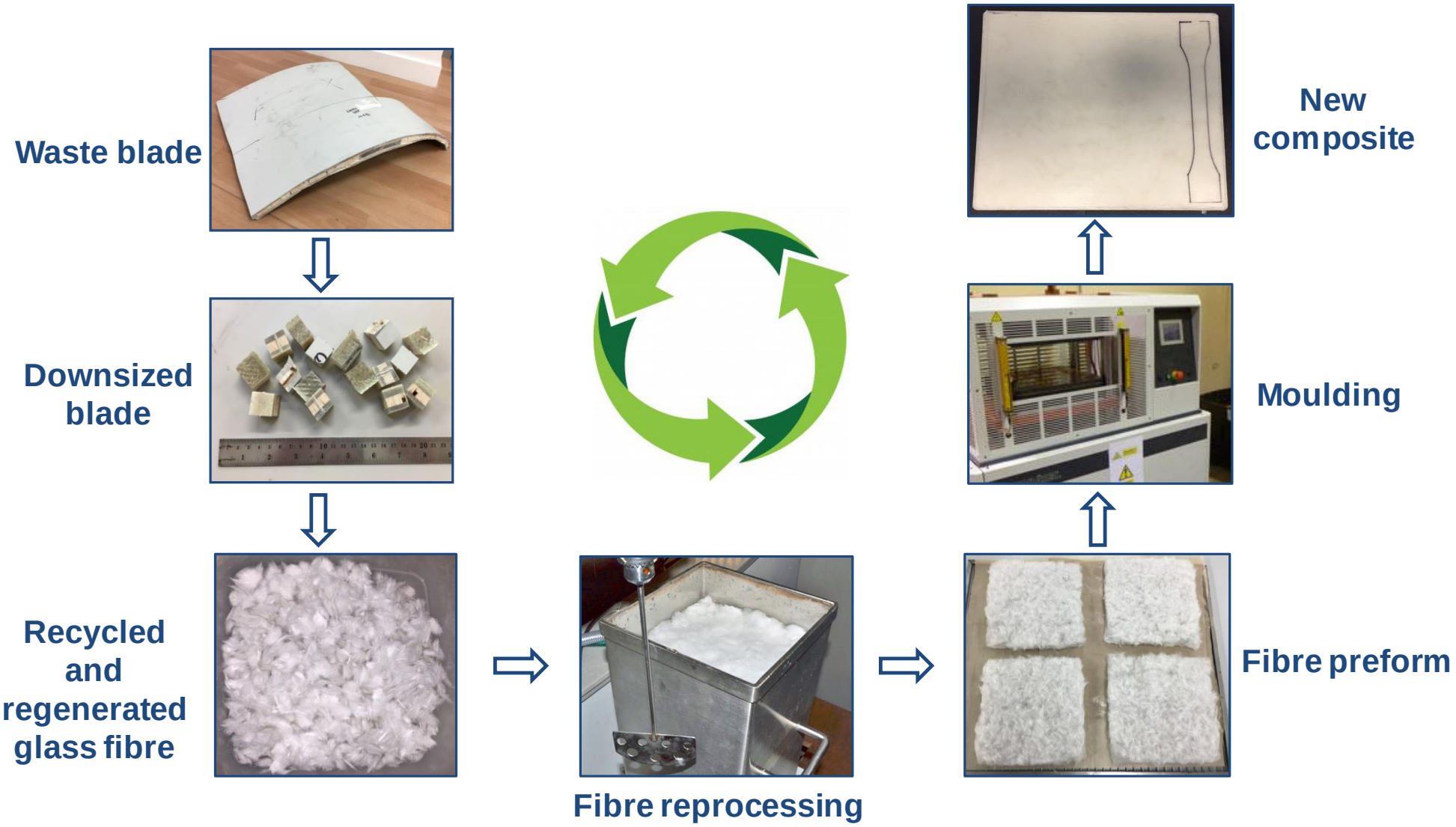
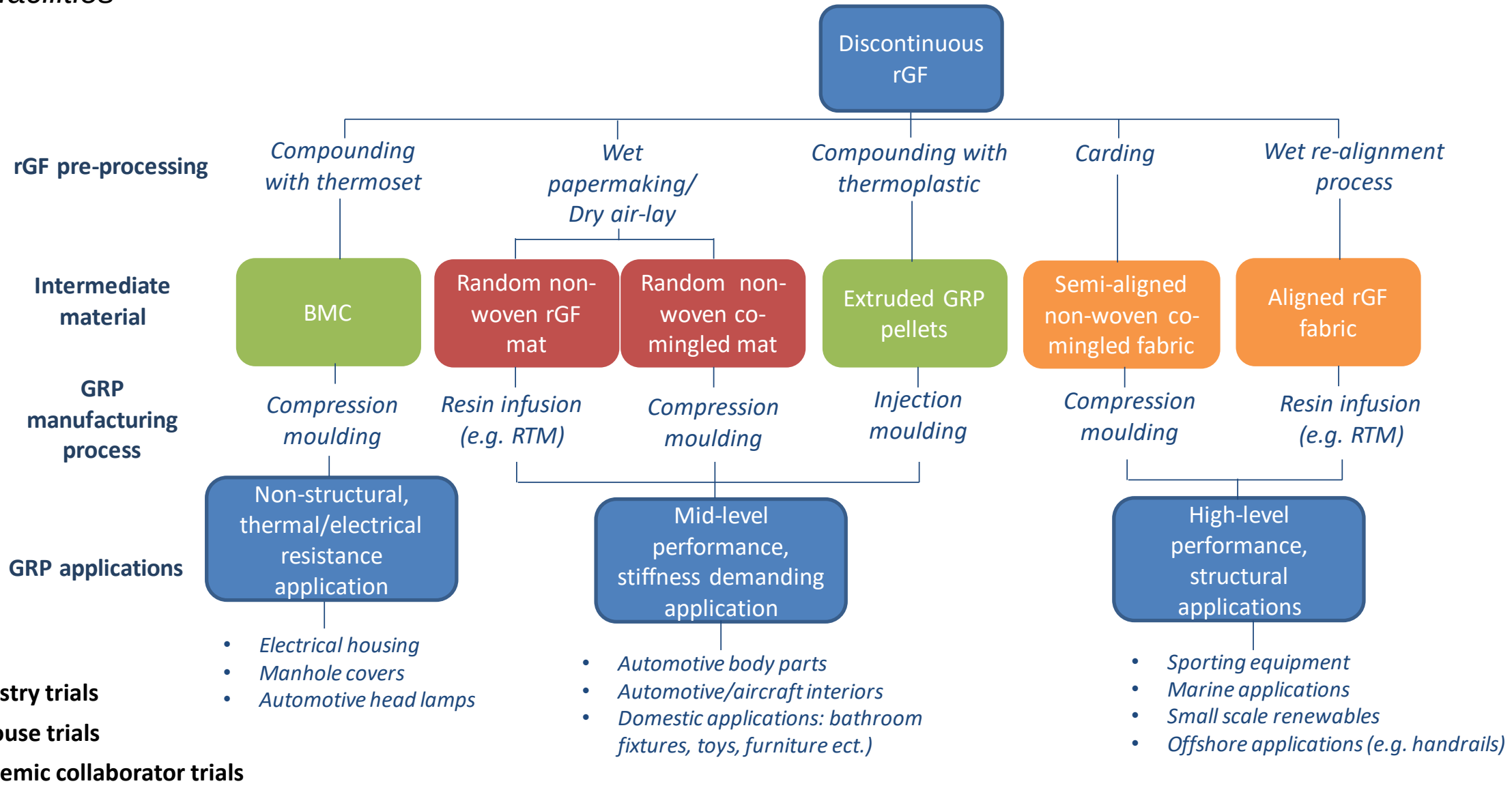
Example of wind turbine blade circularity

Recycling GRP and reprocessing recycled glass fibres has multiple steps, each with technological challenges. This schematic illustrates the concept of GRP circularity promoted by the Advanced Composites Group in this work.



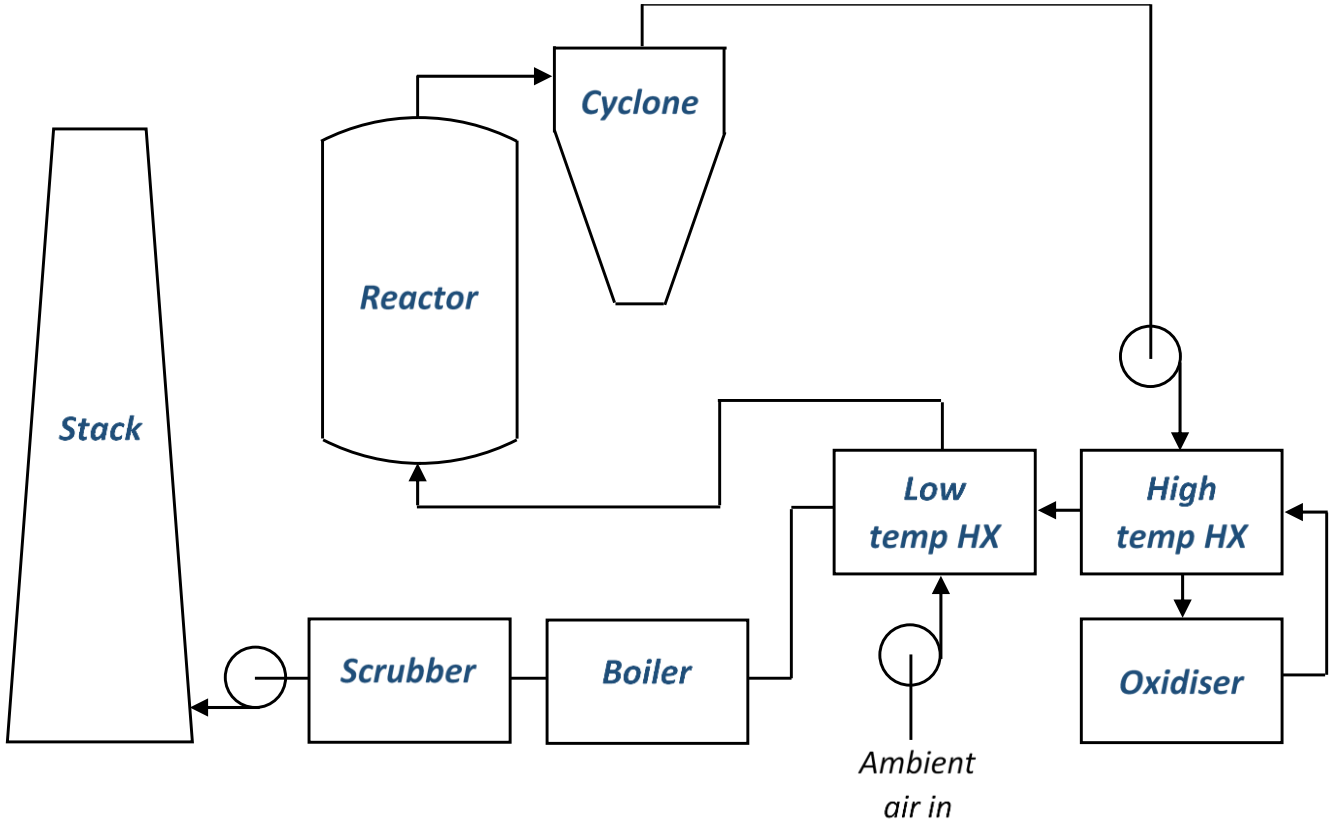
Recycled GF re-processing trials

Finding routes to market for recycled glass fibre is key to commercialization of GRP recycling. In this work multiple applications for recycled fibres were identified with processing trials underway/on the way in both industry and academic facilities



GRP recycling energy model

An energy model of a commercial GRP recycling plant was developed to asses environmental and economic implications of GRP recycling



Schematic of recycling process used in model

Operating conditions

- Set **reactor temperature** – based on matrix polymer
- Set **oxidiser temperature** – temp required to fully oxidise production gases
- Set **flow rate through reactor** – dependant on fluidisation dynamics
- Set **flow rate in piping** – avoid rGF clogging

Heat inputs

- Resin oxidation in reactor
- Natural gas oxidation in oxidiser

Fan electricity input

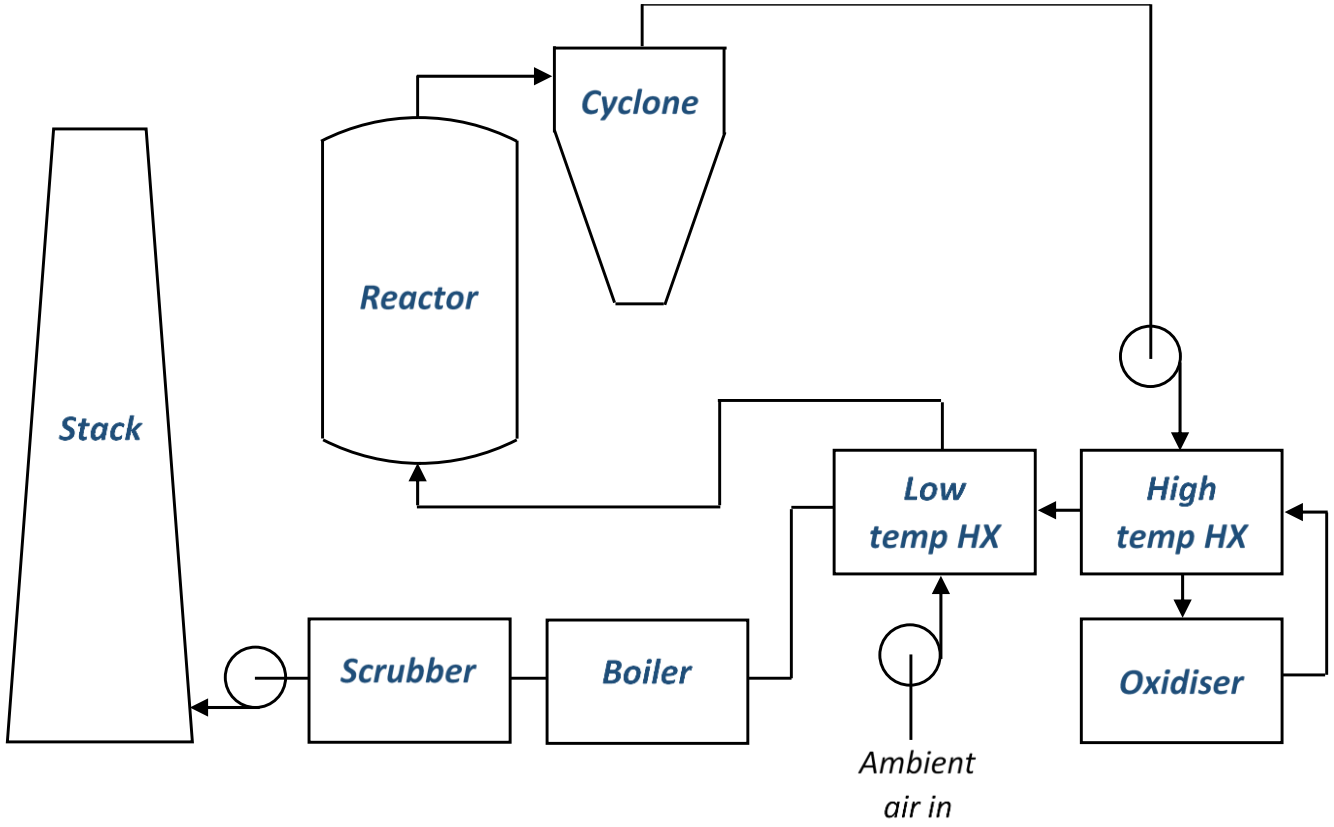
- Combined power from process fans

Heat losses

- Insulation losses through all components
- Stack losses

GRP recycling energy model

Techno-economic analysis was carried out to investigate economic outlook for GRP recycling



Schematic of recycling process used in model

Revenue

- Gate fee
- Process steam
- Filler (e.g. CaCO3)
- Recycled fibre

Indirect operational

- Plant overheads
- Insurance
- Administration
- Distribution
- Research and development
- Waste transportation

Direct operational

- Electricity
- Natural gas
- Materials
- Labour/supervision
- Laboratory costs
- Scrubber operation
- GRP downsizing

Key findings

- Energy demand of the recycling process would be significantly lower than is required to produce new glass fibres.

- It was concluded that manufactures selecting to use recycled glass fibres would have a net negative energy attributed to these materials which is commercially attractive given the social pressure to adopt green products/technologies.

- With appropriate pre-processing of waste GRP through mechanical downsizing and recyclate classification prior to thermal recycling in the fluidised bed, emissions associated with GRP recycling approaches net zero CO2 emissions.

- Recycled glass fibres could be cost competitive against virgin materials; with plant capacity and feedrate being the key determinants of the net cost for recovering recycled glass fibres.

- High fibre fraction waste streams, like wind turbine blades could be processed at break-even with a recycled glass fibres re-sale price just 50% of virgin fibres

Moving forward

- Advance ACG recycling technology by upscaling to pilot plant
- Continue developing routes to market for recycled glass fibre
- Create a range of demonstrator products using recycled glass fibres
- Integrate recycled glass fibres in commercial GRP manufacturing processes
- Create consortium of vested interests including OEMs, EoL asset owners, waste management and GRP manufacturers