Project proposal

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<tr>
<th>Company name</th>
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Project title or topic

"Scenario modelling of the carbon fiber industry in the transition to NetZero2050"

Context and background

This project, ideally as group project with several students, aims to promote systemic change and continued but sustainable market growth in the carbon fiber composites industry as an enabling technology towards 1.5°C socio-economic pathways and NetZero 2050 scenarios. It will take a trans-disciplinary approach to develop a review document and presentation examining avenues to improve the sustainability of carbon precursor and fiber manufacturing and increase the circularity of this industry.

As market adoption in aerospace, automotive, wind, and hydrogen storage potentially increases towards the objective of NetZero 2050, it is critical to reduce the embodied energy of the constituent materials, for example with bio-mass derived precursors. It is also important to reduce manufacturing scrap via automation and to prolong product life times via embedded sensors and increased product durability, with design for recycling to enable carbon fiber recovery at end of life to increase the degree of circularity.

Project description

This project will review and model how the carbon fiber industry can transition towards NetZero2050 taking a PESTLE (Political, Economic, Social, Technological, Legal, Environmental) macro level approach. Key enablers and barriers to be addressed will be identified. A multi-criteria comparative analysis will be made using Monti-Carlo based modelling (existing Python script, to be upgraded to include scope 1, 2, and 3 emissions) with 10-50-90 level assumptions of i) technological enablers (precursors, carbonization, automation, electric power-mix, fiber recovery infrastructure, blockchain, ...), ii) market growth by sector and how these interact with iii) alternate socio-economic pathways (1.5, 2.1, 2.7°C).
Project design, concepts, and data

The model will output mass flows (MFA), embodied energy (kg CO₂e/kg CF), the industry Gt CO₂e footprint (by scope 1, 2, and 3 emissions), and the $ investment required in new CAPEX until 2050 versus revenue and CF COM. This will build on existing resources including a literature review with synthesis of data including life cycle analyses, material/mass flow analyses, market trends and needs, supplier press releases, patents, papers, together with stakeholder interviews. Carbon fiber supplier and OEM user sustainability press releases will be built into the model assumptions. The projected market demand to 2050 will be mapped versus the announced carbon fiber supply and how commercial availability and CAPEX investment in enabling carbon fiber technologies could increase market adoption and reduce embodied energy in composite applications. Legislation related to carbon fiber recycling will be reviewed and enabling approaches projected forward in time. Statistical analysis will be made of the model output to quantify the contribution of each main effect on the key outputs of CO₂e footprint and investment. This will be pressure tested via stakeholder interviews.

Expected outcomes

A roadmap of SMART initiatives for the carbon fiber industry versus time across the PESTLE space will be generated including innovations in technology, supply chains, legislation, government funding, and business models (e.g. coalitions) with estimates of the investment needed and the corresponding effect on the cumulative CO₂e emissions of the industry. The developed results will be pressure tested with industry through stakeholder interviews.

- Deliverable 1: Model updated to include scope 1, 2, 3 emissions
- Deliverable 2: Sustainability position and initiative mapping of carbon fiber suppliers
- Deliverable 3: Summary of stakeholder interviews
- Deliverable 4: Road maps developed considering PESTLE drivers for the industry
- Deliverable 5: Report and presentation
- Deliverable 6: Use of project results in papers and presentations