



Shaping the Future with Advanced Lightweight Materials in the Energy Sector



AS PART OF THE AMULET TECHNOLOGY ROADMAP



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➤ Introduction

The tremendous increase in anthropogenic CO₂ emissions arose after the Industrial Revolution until our days are bringing undesired climate changes at a rate steeper than predicted. Although still unpredictable, the effects of these changes will impose important stresses on Earth's ecosystems and measures to mitigate these effects are being put in place.


European Climate Law includes a set of measures targeting net greenhouse gas emissions reductions of at least 55% by 2030, compared to 1990 levels, aiming to make Europe climate neutral by 2050. These changes will involve the radical transformation of multiple value chains, from material development to the product's End-of-Life. In this context, advanced lightweight materials will play a critical role in providing solutions for many applications to drive the green and digital transition. In fact, lightweight materials have been identified as relevant enablers for nine selected Materials Innovation Markets representing the 'market pull' to address the societal needs and citizen challenges sustainably in the long term.

AMULET's technology roadmap aims to inform decision-makers about the drivers, challenges and innovations related to lightweight materials in four different industrial sectors: Automotive, Aerospace, Energy and Building. This information will provide relevant technological insights about the developments being made in these sectors, allowing the elaboration of better policies as well as providing recommendations on which developments are more suitable to be financed.

The information used for the elaboration of this technology roadmap comes from a series of four sectoral workshops (one per sector) which have involved relevant stakeholders with expertise in the different stages along the value chain. The information has been completed with a detailed bibliographic search.

►► The Energy sector

Energy is in the spotlight due to its key role in the transition to a zero CO₂ emission society. The electrification of industrial and transport sectors is increasing the demand by an average of 2.4% per year. This surge must be not only substantial within a generation but also as clean and environmentally friendly as possible. This concern extends beyond just considering CO₂ emissions and encompasses the materials that will be used for the transition.



Efficiency in energy generation and material utilisation is a pressing concern. A key aspect of this is optimising material trade, notably in wind turbine technology, where polymer-based composites (PBC) play a fundamental role. PBCs, constituting 16% of a wind turbine generator's weight,¹ have enabled the development of larger and more resilient blades, some reaching extraordinary lengths like the 107-meter-long blades on the GE Haliade X with a 12MW capacity. Nonetheless, the recycling and circularity of these composites present intricate challenges due to the complexities of separating fibres, matrix, and resin. Consequently, there's a growing trend towards the development of biodegradable or easily dissolvable bio-based materials, showing promise as a solution.

Efficiency cannot be developed in isolation; it must be accompanied by a clear cost reduction approach. Affordable lightweight materials are essential to challenge existing technologies and align with Sustainable Development Goal 7, focusing on "affordable and clean energy." Wind and solar energy have witnessed a remarkable nearly 60% price reduction over the last two decades, rendering them increasingly accessible and indispensable for developing nations.



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Cost and emissions reduction underscore the importance of a robust value chain. Unifying and strengthening this chain is essential. Streamlining manufacturing through local regulations and optimised transport networks in Europe is instrumental in addressing this challenge. Key to this effort is clustering and networking among industries.

Expanding beyond energy generation, the effective storage of surplus energy, a critical aspect in the era of renewable energies, is vital. Here, the use of tanks for hydrogen storage crafted from PBCs and the utilisation of CMCs for heat storage emerge as key enablers for these innovative technologies.

In conclusion, lightweight materials have played a pivotal role in advancing cleaner and sustainable energy solutions. To further this progress, they should be incorporated into a wider range of applications, and their design and manufacturing must align with circular principles. These steps are essential for propelling the energy industry toward a net-zero and responsible future.

AMULET's technology roadmap will provide insightful information on challenges and innovations related to the sectoral drivers. The full technology roadmap will be available in 2024.



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