

The faculty of Engineering of the Vrije Universiteit Brussel and the faculty of Bioscience Engineering of the KU Leuven invite you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES (VUB)
DOCTOR OF BIOSCIENCE ENGINEERING (KUL)

of **Anne Van Den Oever**

The public defense will take place on **Monday 8th September 2025 at 4 pm** in room **D.2.01** (Building D, VUB Main Campus)

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ENVIRONMENTAL LIFE CYCLE ASSESSMENT FOR DECISION-SUPPORT IN THE DEVELOPMENT OF ADVANCED BIOFUELS

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Abstract of the PhD research

The transport sector accounts for approximately one quarter of Europe's greenhouse gas emissions. While the electrification of passenger vehicles is advancing, sectors such as heavy-duty transport, aviation, and maritime shipping remain difficult to decarbonize through electrification alone. In these areas, renewable fuels, particularly advanced biofuels, are expected to play a role in achieving climate goals. Unlike first-generation biofuels, which are produced from food crops and have raised environmental concerns, advanced biofuels are derived from non-edible feedstocks such as forestry residues and agricultural waste. Although promising, the technologies required for their large-scale production are still in development. As a result, strategic decisions must be made about how and where to invest in these fuels. This dissertation assesses the environmental sustainability of advanced biofuels in the medium term (2030) and long term (2050), focusing on their potential climate benefits, wider environmental impacts, and energy efficiency. Using prospective life cycle assessment and energy system modelling, the research evaluates how these fuels could perform in different future scenarios, two with strong climate policies and one without. The findings suggest that while advanced biofuels can meet the European Union's greenhouse gas reduction targets, they often require significant energy inputs and may lead to increased pressure on other environmental resources such as water and land. Their use should therefore be limited to applications where they offer the greatest benefit compared to available alternatives. In the longer term, as electrification becomes more widespread, the role of advanced biofuels in Europe is likely to decline. This research advances the development and application of prospective life cycle assessment and contributes to a deeper understanding of the opportunities and trade-offs associated with advanced biofuels.