Chair of Energy Systems
TUM School of Engineering and Design
Technical University of Munich

Semester Thesis

(Theoretical)

Literature Review: End-of-Life Emissions in Energy System Modeling – Approaches and Implications with a Focus on the Chemical Industry

Description:

Energy system models form a central basis for decision-making when assessing transformation pathways toward climate neutrality. Conventional models predominantly account for the direct emissions from energy conversion, whereas emissions at the end of the product life cycle (end-of-life) – for instance from the incineration, landfilling, or recycling of biogenic and non-biogenic residual materials – often remain unaccounted for. Yet particularly in the chemical industry, where carbon is bound as a feedstock in long-lived products such as plastics, End-of-Life emissions are decisive for a complete carbon balance. Neglecting them can lead to a systematic underestimation of total emissions and thus to a distorted assessment of defossilization strategies such as Carbon Capture and Utilization (CCU), bio-based feedstocks, or the recycling of existing material streams. A consistent representation of end-of-life emissions is therefore becoming increasingly important.

The objective of this thesis is a structured literature review of approaches for accounting for end-of-life emissions in energy system modeling. Existing methodological approaches are to be systematized, their respective assumptions and system boundaries identified, and the effects of such an implementation on model results (e.g., emission balances, technology choice, CO_2 shadow prices) assessed. A particular focus is to be placed on the chemical industry.

Work packages:

- Familiarization with the fundamentals of energy system modeling and carbon accounting
- Systematic literature review of approaches for accounting for end-of-life emissions, with an emphasis on the chemical industry
- Categorization and comparison of the approaches with respect to modeling tool, system boundaries, assumptions, data requirements, and transferability
- Analysis of coupled approaches combining energy system modeling and LCA, as well as their methodological challenges
- Discussion and assessment of the effects on model results, and derivation of recommendations for modeling practice

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