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Abiotic resources provide multiple services to humans. The resource services provided to humans can be considered as the anthropocentric instrumental values of resources, which is defined as the Area of Protection (AoP) "Natural Resources" as per the consensual definition elaborated by the UNEP-SETAC Life Cycle Initiative[1]. Humans benefit from services provided by the resources, but so far no life cycle impact assessment method has been developed to assess the specific impact pathways leading to a deficit of resources services. This research work aims to fill-in this gap and assess impacts to human society from the deficit of resource services. Building upon the conceptual framework from Greffe et al. (2022)[2], CARSeD assesses the deficit of resources services for humans and then the impact to human society in term of adaptation cost. The deficit of services is assessed as the mismatch between the provision and the demand. The prospective demand of resources is evaluated by coupling a material flow analysis model with an integrated assessment model. The potential impact of the use of a given resource (through its life cycle encompassing extraction, dissipation and occupation) is calculated from the deficit of services between demand and provision. Degradation of resource is also evaluated as the difference of functionality between the flows of resource entering and leaving the product system. Finally, the damage is calculated as the cost to pay to recover the deficit. Preliminary characterization of intermediary and elementary flows of resources have been determined for aluminium and will probably be determined for iron, copper, nickel, indium and zinc. The elementary flows characterized are the extraction of resources from the ecosphere and the dissipative flows back to the ecosphere. The intermediary flows characterized are newly introduced occupation flows, that are distinguished by their potential to fulfill services. The comparison of functionality between resource flows enables the impact assessment of degradation or restoration. An exploratory operational impact assessment method is now available to assess resources services deficit and will soon be generalized to other resources.

[1] https://doi.org/10.1016/j.jclepro.2017.05.206

[2] Greffe, T., Margni, M., Bulle, C., 2022. A framework for assessing abiotic resources services deficit in life cycle impact assessment (under review). Int. J. Life Cycle Assess.

2.05 An Absolute Sustainability Approach for Holistic Planning of a Product Fabrication with Additive Manufacturing

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In the last decade, the concept of absolute sustainability, intended to represent the need to develop a prosperous society in respect of the Earth´s carrying capacity, has been widely investigated by academics and adopted by a few major European manufacturing industries. At the same time, companies and researchers recognized the potential of additive manufacturing (AM), both in terms of lean manufacturing, lightweight design, and increased product functionality optimization. Since the manufacturing sector constitues a high-carbon economy and contributes to about a quarter of the industrial carbon emissions worldwide alone, AM's potential for energy and carbon emissions savings during product life cycle should be investigated. To reduce the overall impact of the manufacturing sector, it is essential to develop a holistic framework that simultaneously mitigates its environmental impact and increases resource-use efficiency. This is the main aim of this paper. We developed a framework that combines Material Flow Analysis (MFA) and Life Cycle Assessment (LCA) for assessing the sustainability potential of additive manufacturing processes in terms of circular economy (CE) at the product level and applying an absolute sustainability perspective. LCA adopts an assessment that is based on existing products or systems in a retrospective manner. On the other hand, manufacturing process planning, and CE strategies need to be investigated and decided upon prior to a part fabrication. Thus, they are more prospective. To fill this gap, a scenario analysis was applied to a product produced with Wire Arc Additive Manufacturing (WAAM). The scenario assumptions were based on the likely design and application of the manufacturing process. Overall, combining (1) Life Cycle Assessment (LCA), (2) Material Flow Analysis (MFA), and (3) circular economy (CE) for scenario analysis of a specific component fabrication through additive manufacturing showed potential to aid decision-making for companies. In particular, the framework could be used as a support tool for holistic production planning by avoiding burden-shifting and highlighting trade-offs in choosing the best circular economy strategies.

2 Resource Efficiency in Production (Poster)

2.P.01 Environmental and Social Impact Assessment Focusing on Mineral Resources and Fossil Fuels for Multiple Vehicle Types (ICEV, HEV, EV)

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Transportation accounts for about 16% of global greenhouse gas emissions, with passenger cars emitting the largest amount of CO2 compared to others. As the need to reduce CO2 emissions from transportation increases and gasoline regulations in many countries progress, electric vehicles (EVs) are expected to spread rapidly. EVs require batteries, and the demand for the mineral resources needed to manufacture batteries is expected to increase even further. Currently, NCM (nickel, cobalt, and manganese) is the main battery component, with more than 50% of cobalt production coming from the Democratic Republic of Congo (DRC). 40,000 children are estimated to be involved in mining in the DRC, where child labor, low wages, and work hazards (dermatitis, breathing problems, etc.) are reported. diseases, etc.) have been reported. To achieve sustainable development, it is necessary to create products that take into account not only environmental but also social risks. In automotive LCA, many studies focus on the environmental aspect in particular, and the results vary depending on preconditions such as vehicle type and lifetime mileage. In terms of the social aspect, there are some papers on lithium-ion batteries using social databases, but there are no papers that evaluate the life cycle of automobiles, nor are there any papers that compare databases with each other.

The purpose of this study was to present the characteristics of both environmental and social impact assessments for three vehicle types (ICEV, HEV, and EV), and social impact assessments using the Social database. In the environmental impact assessment, the number of environmental emissions and resource consumption were calculated, and then the amount of environmental damage was estimated and converted into monetary values by performing a Life Cycle Impact Assessment