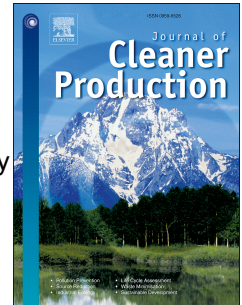


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Technical Product-Service Systems: Analysis and Reduction of the Cumulative Energy Demand

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Abbreviation

CED:	Cumulative Energy Demand
CEC:	Cumulative Energy Consumption
CND:	Cumulative non-Energy Demand
CED _E :	Cumulative Energy Demand of End-of-Life
CED _P :	Cumulative Energy Demand of Production of technical Product
CED _{PSS} :	Cumulative Energy Demand of technical Product-Service Systems
CED _{SD} :	Cumulative Energy Demand of Service Delivery
CED _{SR} :	Cumulative Energy Demand of Service Resource Provision
CED _U :	Cumulative Energy Demand of Usage of technical Product
CH:	Combine Harvester
E.IOA:	Energy Input-Output Analysis
EXWP:	Ex-works Price
LCA:	Life Cycle Assessment
LHV:	Lower heat value
MBA:	Material Balance Analysis
PCA:	Process Chain Analysis
PSS:	Product-Service Systems

Abstract: Technical Product-Service Systems (PSS) consist of technical products that are enhanced by life cycle-oriented services. PSS enable companies to fulfill individual customer requirements and to build long-term customer relationships. Besides their economic advantages, PSS are attributed to positive effects on ecological sustainability. However, the complex structure of PSS challenges the quantification of their impact on all aspects of ecological sustainability. This leads to the demand for quantification methods with increased practical applicability compared to methods that encompass all aspects of ecological sustainability like the Life Cycle Assessment (LCA). In this context, the Cumulative Energy Demand (CED) is an elaborated method that enables the comparison of different products or services regarding their primary energy demand. Since many aspects of ecological sustainability correlate to the primary energy demand, CED is seen as a suitable estimate of the results of an LCA with reduced efforts and complexity. In consequence, the adaption of the CED method to PSS is a promising research task that could support the design and operation of PSS with increased ecological sustainability. Therefore, this paper presents an approach to systematically analyze and reduce the CED of a PSS (CED_{PSS}). In order to validate the feasibility of the approach, a use case from agriculture machinery is carried out. The results indicate that the technical product is responsible for a large percentage of CED_{PSS}, while services have a relatively low impact. Despite their low primary energy demand, specifically designed services can reduce CED_{PSS}. This can be described as an energetic leverage effect of services in PSS.

Keywords: Technical Product-Service Systems, Cumulative Energy Demand, Sustainability

1 Introduction

In the late 1990s, the term of Product-Service Systems (PSS) was proposed with regards to sustainability, enabling the disconnection of economic growth from environmental burden (Goedkoop et al., 1999; Mont, 2004). Meanwhile, from a business perspective, a shift from product-based to functionality-based business models took place (Tukker and Tischner, 2006). Until today, many companies in the capital

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