Life Cycle Analysis

INFO Sheet A3

Description:	*Life cycle analysis for polymeric solar thermal collectors*
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Introduction

When developing new solar collectors with novel materials, the reduction of their environmental impact should be considered. In this context, several studies were published analyzing the environmental impact through polymeric materials and comparing them with conventional metal based collectors and systems by using life cycle analysis methodologies [1], [2].

Methodology

Life cycle analysis (LCA) is a method to evaluate the environmental impact of a product throughout its life cycle. The life cycle starts at the raw material extraction and runs throughout the production to the disposal of the product ("cradle to grave"). Different approaches, from the raw material extraction to the end of production ("cradle to gate") or just the production ("gate to gate"), are also possible. The analysis allows the description of potential environmental impacts caused by the consumption of raw materials, use of energy and the emission of pollutants. The principles and framework of life cycle analysis are defined in ISO 14040[3] and ISO 14044[4]. The methodology itself is flexible and can be adjusted according to the specific objectives. There are different models with different indicators (Ecoindicator 99, ReCiPe 2008, IPCC 2013, etc.) [5] that focus on different environmental aspects such as climatic change and cancerous risk.

Implementation

First the product system (Figure 1) should be defined with all life stages and steps throughout the stages of interest. In the next phase the inventory data for the description of the product system should be collected. The inventory data includes, for example, aspects such as the amount of materials used, energy demands, as well as the amount of emissions and waste. Basic data can be found in commercial databases like ECOINVENT® [6] or the European Reference Life-Cycle Database (ERPLCA) [7]. It should be noted that most available datasets are averaged for regions or materials. Therefore, they are not always in accordance with the objective of the individual research and should be adjusted accordingly. Depending on the required precision, additional inventory data needs to be collected, simulated or assumptions have to be made – especially when analyzing polymers with specific blends or additives. If assumptions are made, they have to be consistent until the end of the life cycle and must be considered in the disposal of the product due to the caused emissions. In an additional sensitivity study those assumptions can be evaluated.

Different software packages can be used, such as SimaPro® [8] or GaBi® [9] software for the evaluation and calculation. The software enables the construction of the life cycle, the integration of a database and calculation of the environmental impact and overall damage according to the selected indicator.

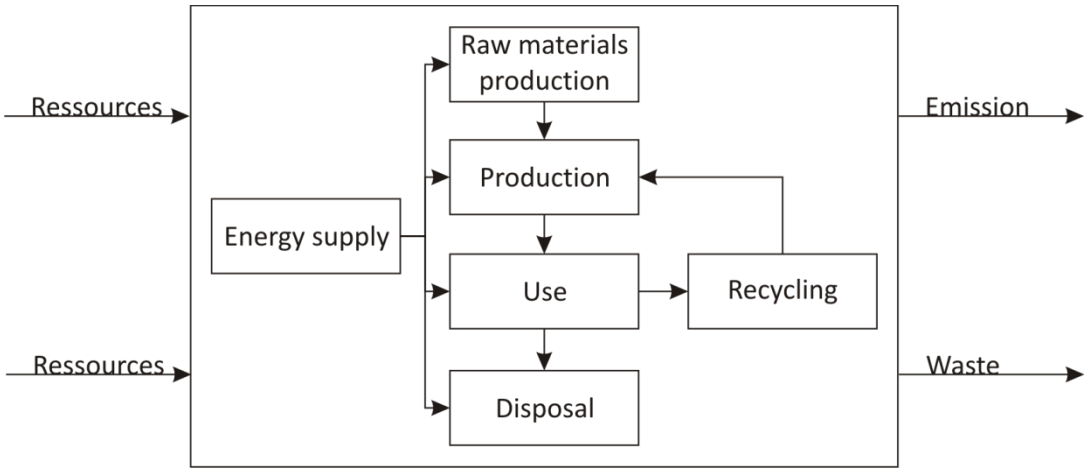

Figure 1: Scheme of a product system, which describes the life cycle of the product including all life stages and steps.

Attributes and Prospects

The studies conducted under the framework of IEA SHC Task 39 show a lower environmental impact for polymeric collectors compared to traditional collectors, such as flat plate collectors and evacuated tube collectors [1], [2]. The results indicate a high environmental impact in the production phase, especially for the production of raw materials. The environmental impact of plastics is significantly lower than the impact of metals. The impact from transportation is very low compared to the overall environmental impact.
In the implementation of life cycle analysis one must keep in mind that the results may vary depending on the particular objectives, indicators and assumptions.

References

[1] **B. Carlsson, H. Persson, M. Meir, J. Rekstad**, *A total cost perspective on use of polymeric materials in solar collectors – Importance of environmental performance on suitability*, Applied Energy, Volume 125, 2014, p. 10–20. (http://dx.doi.org/10.1016/j.apenergy.2014.03.027)
[2] **R. Weiß**, *Life Cycle Analysis von Polymermaterialien für neue Produktionsverfahren von thermischen Solarkollektoren,* Master Thesis, University of Ulm, 2014.
[3] **ISO 14040:2006**, *Environmental management - Life cycle assessment - Principles and framework*.
[4] **ISO 14044:2006**, *Environmental management - Life cycle assessment - Requirements and guidelines*.
[5] **ILCD Handbook**, *Analysis of existing Environmental Impact Assessment methodologies for use in Life Cycle Assessment*, First edition, European Commission Joint Research Centre Institute, 2010.
[6] http://ecoinvent.org/
[7] http://eplca.jrc.ec.europa.eu/ELCD3/
[8] http://www.pre-sustainability.com/simapro
[9] http://www.gabi-software.com/