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Life cycle assessment of a solar thermal collector

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Abstract

The renewable energy sources are often presented as 'clean' sources, not considering the environmental impacts related to their manufacture. The production of the renewable plants, like every production process, entails a consumption of energy and raw materials as well as the release of pollutants. Furthermore, the impacts related to some life cycle phases (as maintenance or installation) are sometimes neglected or not adequately investigated.

The energy and the environmental performances of one of the most common renewable technologies have been studied: the solar thermal collector for sanitary warm water demand. A life cycle assessment (LCA) has been performed following the international standards of series ISO 14040. The aim is to trace the product's eco-profile that synthesises the main energy and environmental impacts related to the whole product's life cycle. The following phases have been investigated: production and deliver of energy and raw materials, production process, installation, maintenance, disposal and transports occurring during each step. The analysis is carried out on the basis of data directly collected in an Italian factory.

Keywords: Life cycle assessment (LCA); Renewable energy; Solar thermal collector

1. Introduction

All goods and services have an environmental impact along their life cycle. On this concept the European countries have focused their attention, considering the improvement of

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the eco-performances of products/services as a key point of the European environmental programme [1]. In other words, global environmental problems can be met only if the use of the energy and the raw materials per product unit will be reduced, i.e. eco-efficiency increased.

The need to strengthen the 'green market' has been successively confirmed in another official document named 'the green paper on Integrated Product Policy (IPP)' [2]. Once a product is put on the market, there is relatively little that can be done to improve its environmental characteristics. The IPP approach seeks to reduce the environmental impacts occurring throughout the entire life cycle of the product since the early stages of product design and development. Furthermore, the diffusion of the 'green public procurement' should induce the producers to investigate the environmental impacts of their production and to disseminate the environmental information adopting scientific data format as the environmental product declaration (EPD) [3].

For IPP to be effective, life cycle thinking needs to become second nature for all those who come into contact with products [4]. The cognitive process is at the basis of the environmental performances improving. It is necessary to have detailed and reliable data on which to base assessments regarding each life cycle step. Life cycle assessment (LCA) represents an important support tool for IPP and the 'the best framework for assessing the potential environmental impacts of products currently available' [4]. To obtain reliable results, data should be collected and managed following standardised procedures. The international standards of series ISO 14040 represent a widespread accepted methodology [5–7]. The best way to demonstrate the advantage of the life cycle thinking concept is by demonstrating its practical application. The present paper focuses the attention upon one of the most common renewable technologies: the solar thermal collectors for warm sanitary water demand. Renewable energy sources are often presented as 'clean' energy, not considering the environmental impacts related to their manufacture. The production of the renewable plants, like every production process, entails a consumption of energy and natural resources as well as the release of pollutants [8].

Many authors have deeply investigated the benefits related to the employment of solar systems [9–13] including studies regarding LCA of solar collectors and comparative analyses of different collector's typologies [14–19]. However, the study's assumptions or data references are often not clearly shown. In addition, results are often presented as aggregated indexes [15–17] making difficult the comparison among different studies or the dominance analysis of each life cycle step are difficult. Furthermore, some life cycle steps (as, for example, installation or maintenance processes) are generally not investigated in detail or are simply neglected. Some studies, in fact, consider the full LCA of a solar collectors as too much expensive and time consuming [17] or suppose as significant only the impacts related to materials processing and collector's assembling [18,19].

On the other hand, the principles of eco-design suggest to employ disaggregated information to identify the steps with the greatest impacts and with the largest improvements potentials [20,21]. The aims of this paper are:

- to trace an eco-balance of an exemplary equipment, referring to a passive thermal. The research refers to a passive thermal solar collector produced in Italy
- to grant transparency of assumptions, system boundaries and data sources in order to allow comparability to other studies