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SOLPART

High Temperature Solar-Heated Reactors for Industrial Production of Reactive Particulates

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Deliverable 6.1

WP6 – Environmental life cycle assessment

Deliverable 6.1 Report on environmental impacts of the solar cement system

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1. Introduction and objectives

The main objectives of this report are to present the results of life cycle assessment (LCA) of the components designed as part of the SOLPART project, to propose eco-design options and to provide the methodological framework for scaling up of LCA results for laboratory and pilot plants to a commercial scale.

LCA is a standardized method to quantify the environmental impacts of products or services and is often used to estimate the potential impacts of both market-scale and emerging technologies (Cucurachi et al. 2018, Lacirignola et al. 2017). Therefore, in this report, LCA is used to determine the environmental impacts of the components designed for the SOLPART project according to a cradle-to-grave basis. These components include: fluidized bed reactor (laboratory scale); rotary kiln (laboratory scale); fluidized bed reactor (pilot scale); heliostat (commercial scale); and receiver tower (commercial scale).

Eco-design allows developers to identify hotspots in the manufacturing of products and technologies and, thus, to select alternative material or processes in order to reduce the environmental impacts (ISO 2011, Poudelet et al. 2012). In this report, the principles of eco-design are applied to laboratory and pilot scale components in order to identify the environmentally sustainable material for construction of different components. These finding will then help in selecting the appropriate materials while designing commercial facilities.

To further facilitate the application of eco-design principles in the design of commercial scale facilities, it is important to have a framework to scale-up the LCA results obtained for laboratory and pilot testing. This report describes an LCA scaling up framework designed to estimate the materials and energy necessary for the construction and operation of commercial scale solar reactors. This framework will be applied to determine the potential impacts of the SOLPART system integrated in Alicante’s cement production plant.

2. Conclusions

As part of this report, the life cycle environmental impacts of five components developed for the SOLPART system were assessed. These included: fluidized bed reactor (laboratory scale); rotary kiln (laboratory scale); fluidized bed reactor (pilot scale); heliostat (commercial scale); and receiver tower (commercial scale). This analysis allowed identifying the hotspots for each component and, potentially, it will allow the design engineer to determine where it would be necessary to intervene to reduce the overall environmental impact. For example, it was observed that reducing the use of water and diesel used for cleaning could reduce significantly the impact of the heliostats' operation, while dematerialization, where possible, would help decreasing the impact of both the tower and the solar field. Regarding the impact of the three reactors considered the main contributors were the alloy used to manufacture the body of the reactor and the storage.

Eco-design analyses were conducted to identify the alternative materials for the solar reactors. The analysis showed that the use steel 304L instead of other steel alloys would significantly reduce the environmental impacts associated with construction of the reactors.

The scaling up methodology has been developed which would be used to estimate the LCA impacts of commercial scale components (such as the solar reactor and tower) using the LCA results for laboratory and pilot scale studies. . This methodology has been designed specifically for the SOLPART project, but it is general enough to be applied to any project.

The integration of the SOLPART system in cement production plant as well as validation of the scaling up methodology by comparing results achieved with the commercial scale components will be discussed in D6.2.

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