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Life Cycle Assessment of a Parabolic Solar Cooker

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Abstract : Cooking is a primary need for humans, several techniques being used around the globe based on different sources of energy: electricity, solid fuel (wood, coal...), fuel or liquefied petroleum gas. However, all of them leads to direct or indirect greenhouse gas emissions and sometimes health damage in household. Therefore, the solar concentrated power represent a great option to lower the damages because of a cleaner using phase. Nevertheless, the construction phase of the solar cooker still requires primary energy and materials, which leads to environmental impacts. The aims of this work is to analyse the ecological impacts of a commercialaluminium parabola and to compare it with other means of cooking, taking the boiling of 2 litres of water three times a day during 40 years as the functional unit. Life cycle assessment was performed using the software Umberto and the EcoInvent database. Calculations were realized over more than 13 criteria using two methods: the international panel on climate change method and the ReCiPe method. For the reflector itself, different aluminium provenances were compared, as well as the use of recycled aluminium. For the structure, aluminium was compared to iron (primary and recycled) and wood. Results show that climate impacts of the studied parabola was 0.0353 kgCO2eq/kWh when built with Chinese aluminium and can be reduced by 4 using aluminium from Canada. Assessment also showed that using 32% of recycled aluminium would reduce the impact by 1.33 and 1.43 compared to the use of primary Canadian aluminium and primary Chinese aluminium, respectively. The exclusive use of recycled aluminium lower the impact by 17. Besides, the use of iron (recycled or primary) or wood for the structure supporting the reflector significantly lowers the impact. The impact categories of the ReCiPe method show that the parabola made from Chinese aluminium has the heaviest impact - except for metal resource depletion - compared to aluminium from Canada, recycled aluminium or iron. Impact of solar cooking was then compared to gas stove and induction. The gas stove model was a cast iron tripod that supports the cooking pot, and the induction plate was as well a single spot plate. Results show the parabolic solar cooker has the lowest ecological impact over the 13 criteria of the ReCiPe method and over the global warming potential compared to the two other technologies. The climate impact of gas cooking is 0.628kgCO2/kWh when used with natural gas and 0.723 kgCO2/kWh when used with a bottle of gas. In each case, the main part of emissions came from gas burning. Induction cooking has a global warming potential of 0.12 kgCO2eq/kWh with the electricity mix of France, 96.3% of the impact being due to electricity production. Therefore, the electricity mix is a key factor for this impact: for instance, with the electricity mix of Germany and Poland, impacts are 0.81kgCO2eq/kWh and 1.39 kgCO2eq/kWh, respectively. Therefore, the parabolic solar cooker has a real ecological advantages compared to both gas stove and induction plate.

Keywords : life cycle assessement, solar concentration, cooking, sustainability
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