LIFE CYCLE ASSESSMENT OF GEOTHERMAL POWER GENERATION TECHNOLOGIES: A CRITICAL REVIEW

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Abstract
An environmental assessment of electricity production requires the identification and quantification of environmental impacts from a life cycle perspective, in this regard the implementation of life cycle assessment (LCA) as an evaluation tool has been widely accepted. Although a considerable effort has been made by some LCA studies for geothermal-based electricity production, especially in Europe and the U.S., information for other geothermal energy producers is still scarce. This study aims to present a comprehensively summary of published LCA results for the geothermal power generation sector. It is also intended to analyze the implementation of LCA to geothermal electricity production in emerging economies, where the development of this fundamental knowledge is still at a preliminary stage.

The analysis of the literature review shows that life cycle environmental impacts are mainly affected by five factors: (i) characteristics of the reservoir and (ii) the geothermal fluid cycle, (iii) power generation technology; (iv) type of emissions considered in the life cycle inventory (direct, indirect, or natural); (v) data sources and availability. Furthermore, it was found that most of the LCA studies carried out are based on a carbon footprint perspective. The results are presented based on three power generating technologies used for the exploitation of convective hydrothermal systems: (a) single and double flash (HF); (b) binary cycle (HB), and (c) dry steam (HD) power plants, as well as the enhanced geothermal systems (EGS) have also been analyzed. Thus, considering the global warming potential as a reference environmental impact, it was found that for HF power plants, their values range from 380 to 1045 kg CO₂equivalent.
eq/kWh, whereas for HB a value amounting to 5.8 kg CO₂ eq/kWh has been reported. In addition, greenhouse gas emission values for HD and EGS were encountered as 25-125 g CO₂ eq/kWh and 50-60 g CO₂ eq/kWh, respectively. Results for other environmental impacts from geothermal electricity production are also discussed.