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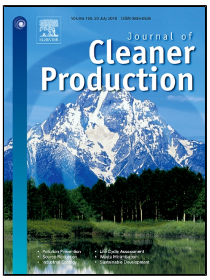

Life cycle analysis of external costs of a parabolic trough Concentrated Solar Power plant

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Life cycle analysis of external costs of a parabolic trough Concentrated Solar Power plant

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Abstract
A number of developing countries have undertaken measures to diversify into renewable electricity generation. Concentrated Solar Power (CSP) is one of the technologies, though despite the high capital costs have numerous technological capabilities. CSP however is a new technology in many developing countries, where the external costs have not been fully understood. Thus far, South Africa has not conducted any detailed externalities assessments for renewable electricity sources. The presented research aims to evaluate the external cost associated with a solar CSP plant using life cycle analysis. The analysis uses a parabolic trough CSP plant with 100MW capacity located in the Northern Cape region in South Africa.

The analysis evaluated external impacts and costs for climate change, human health, loss of biodiversity, local effects on crops, and damage to materials. The study found that climate change accounted for an estimated 32.2 g CO_2 eq/kWh of electricity generated. A number of non-greenhouse gas impacts were also analysed of which the effect on human health was the most significant category (0.214g/kWh). The damage cost quantified in the study for the solar CSP plant was in the range of 2.10-3.31 ZA c/kWh (1.4-2.2 €/MWh) with a central estimate of 2.83 ZA c/kWh (1.9 €/MWh). The results suggested that climate change and human health had a combined contribution of 91% to the central estimate of the external costs which was mostly attributed by the manufacturing life cycle phase. The analysis showed that manufacturing activities have a major contribution across all impact categories. A major policy understanding is that the overall damage costs can be reduced if manufacturing the main components can be localised, to reduce the emissions caused by the transport systems. This could bring added benefits for local communities and industries.

Keywords: Life Cycle Analysis, Concentrated Solar Power, Greenhouse gas, Human health, Damage cost

List of notations and abbreviations

c_{study}	Thermal capacity of power plant within study
c_{ref}	Thermal capacity of reference power plant
$m_{study(solar\ field\ or\ HTF)}$	Mass of the solar field or HTF components of the power plant within study
$m_{ref(solar\ field\ or\ HTF)}$	Mass of the solar field or HTF components of reference power plant
$m_{study(Power\ Plant)}$	Mass of power plant components within study
$m_{ref(Power\ Plant)}$	Mass of power plant components of reference power plant
$m_{study(TES)}$	Mass of the thermal storage components of power plant within study
$m_{ref(TES)}$	Mass of the thermal storage components of reference power plant
CSP	Concentrated Solar Power
HTF	Heat Transfer Fluid
IRP	Integrated Resource Plan
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
NMVOC	Non-Methane Volatile Organic Compounds
PPM	Primary Particulate Matter
REIPPP	Renewable Energy Independent Power Producer Procurement Programme
TES	Thermal Energy Storage