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Energy and environmental performances of hybrid photovoltaic irrigation systems in Mediterranean intensive and super-intensive olive orchards

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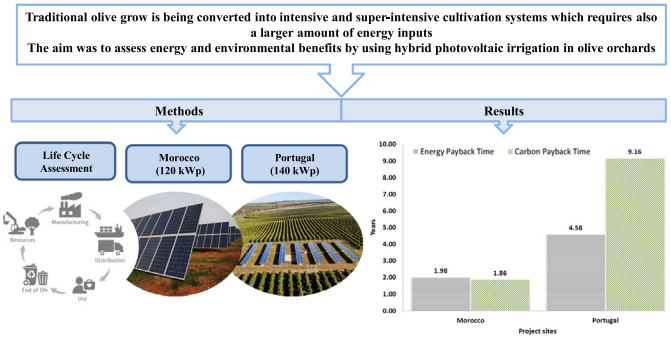
HIGHLIGHTS

- Life cycle assessment approach was used to evaluate hybrid PV irrigation systems.
- PV plants were exclusively devoted to supply energy to Mediterranean olive orchards.
- The HPVIS CO_2 emissions rates were 48 and 103 gCO_2e per kWh.
- The PV plants allowed to save among 41 and 67% of the energy previously consumed.

GRAPHICAL ABSTRACT



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ABSTRACT

Over the last decades, traditional olive production has been converted to intensive and super-intensive cultivation systems, characterized by high plant density and irrigation. Although this conversion improves product quality and quantity, it requires a larger amount of energy input. The new contributions in this paper are, first, an analysis of the energy and environmental performance of two commercial-scale high peak-power hybrid photovoltaic irrigation systems (HPVIS) installed at intensive and super-intensive Mediterranean olive orchards; second, an analysis of PV hybrid solutions, comparing PV hybridization with the electric power grid and with diesel generators; and finally, a comparison of the environmental benefits of HPVIS with conventional power sources. Energy and environmental performances were assessed through energy and carbon payback times (EPBT and CPBT). The results show EPBT of 1.98 and 4.58 years and CPBT of 1.86 and 9.16 years for HPVIS in Morocco and Portugal, respectively. Moreover, the HPVIS were able to achieve low emission rates, corresponding to 48 and 103 g CO_2e per kWh generated.
The EPBT and CPBT obtained in this study were directly linked with the irrigation schedules of the olive orchards; therefore, weather conditions and irrigation management may modify the energy and environmental performances of HPVIS.
The consumption of grid electricity and diesel fuel, before and after the implementation of HPVIS, was also analyzed. The results obtained show fossil energy savings of 67% for the Moroccan farm and 41% for the Portuguese

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