AN ANALYSIS OF THE COST-EFFECTIVENESS OF SOLAR-POWERED IRRIGATION SYSTEMS IN GBANDOKAHA, CÔTE D'IVOIRE

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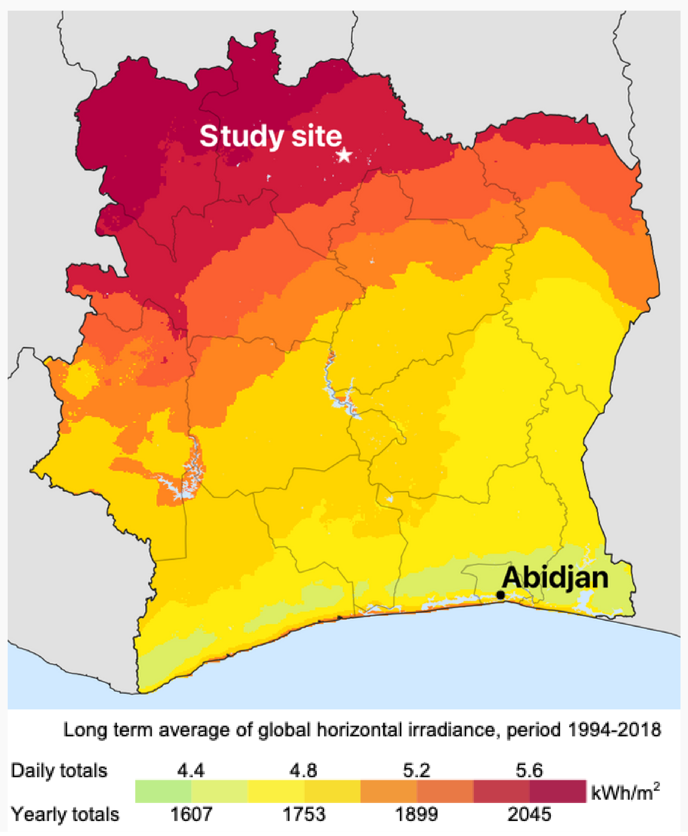
Introduction

- Expanding irrigation is vital for bolstering agricultural productivity and food security in Côte d'Ivoire, requiring access to both water and energy resources.
- Solar-powered irrigation systems (SPIS) have gained global recognition as mature and clean energy solutions (Fig. 1).
- The viability of solar irrigation in Côte d'Ivoire hinges, in part, on comparative costs with conventional fossil fuel-powered systems.
- **This study assessed the cost-effectiveness of a small-scale SPIS versus a comparable diesel-powered irrigation system (DPIS) for a single case located in Gbandokaha, Côte d'Ivoire (Fig. 2).**

Fig. 1 Exemplary Solar-Powered Irrigation System

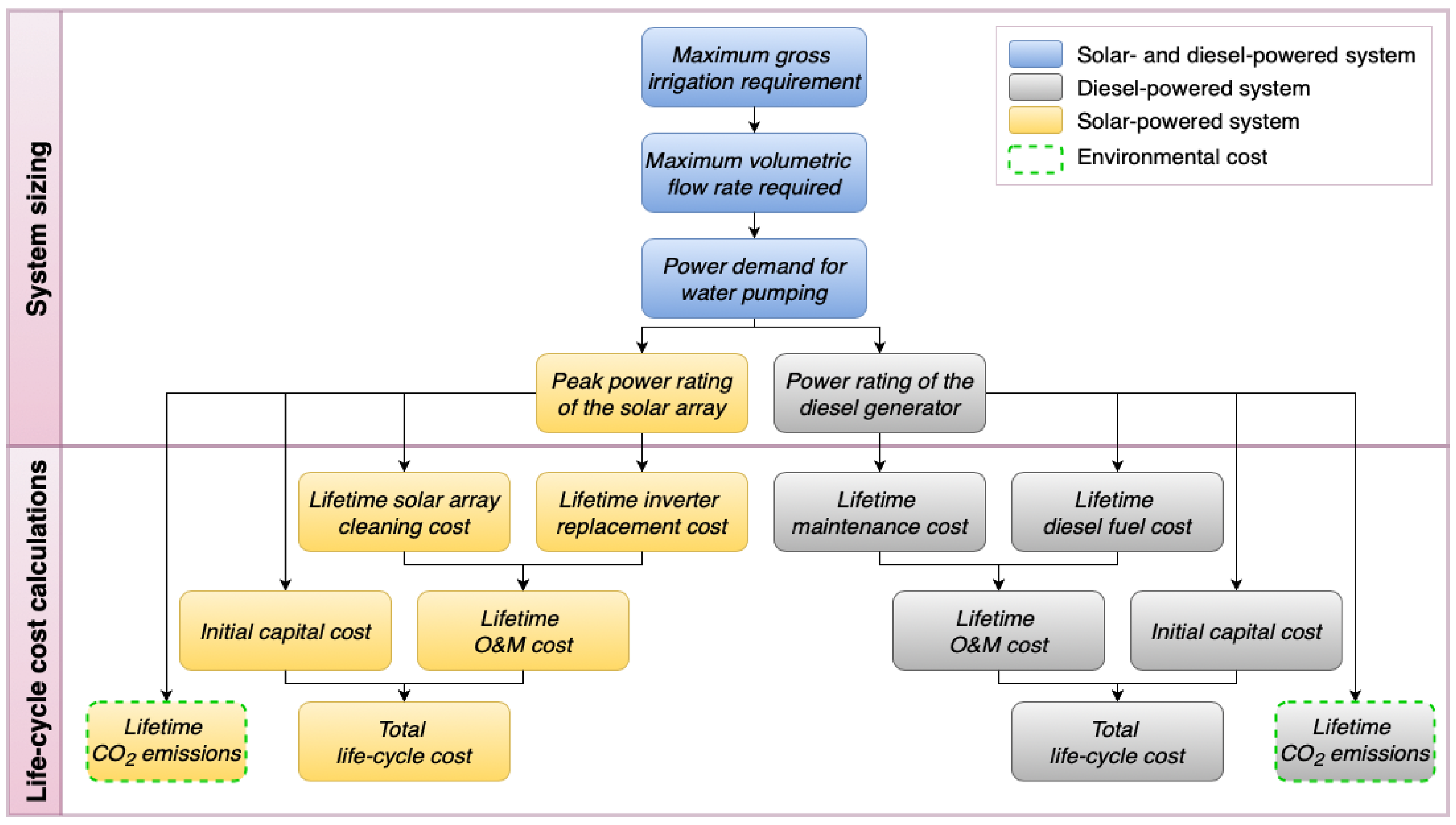
Fig. 2 Study Site and PV Power Potential



Methods

- Cost-effectiveness was assessed using secondary data and a life-cycle cost (LCC) model (Fig. 3), specifically for groundwater irrigation of a representative crop (eggplant) on a 1ha field under Gbandokaha's semi-arid conditions.
- The analysis included only anticipated cost disparities between the SPIS and the DPIS (Fig. 3), encompassing financial and environmental (CO_2 emissions) LCCs over a 25-year period, with varying diesel price escalation rates (0%, 2%, 4%), and a 4.38% discount rate.
- The LCC estimation procedure involved sizing the power units (i.e., the solar array and the diesel generator) for water pumping to meet peak energy demands to fulfill the maximum gross irrigation requirements (Fig. 3).

Fig. 3 Life-Cycle Cost Estimation Procedure Overview



Results

- The initial capital cost of the DPIS is only 54.8% of that of the SPIS. However, lifetime maintenance and operation costs, and total LCCs for the SPIS are significantly lower, at 1.4–2.1% and 13.2–19.1% respectively (Fig. 4).
- The primary cost component for the SPIS is the initial capital cost (89.8%), whereas for the DPIS, it is the lifetime diesel fuel cost (84.9–89.6%; Fig. 4).
- The time required for the SPIS alternative to achieve the same cumulative LCCs as those of the DPIS is estimated to be 1.4 years (see red dotted line Fig. 5).
- The SPIS emits 99% less CO_2 over its lifetime, resulting in a 33,286.9 kg CO_2-eq reduction, equivalent to the carbon offset of planting 61.2 mature trees.

Fig. 4 Estimated Financial Life-Cycle Costs of the SPIS and the DPIS

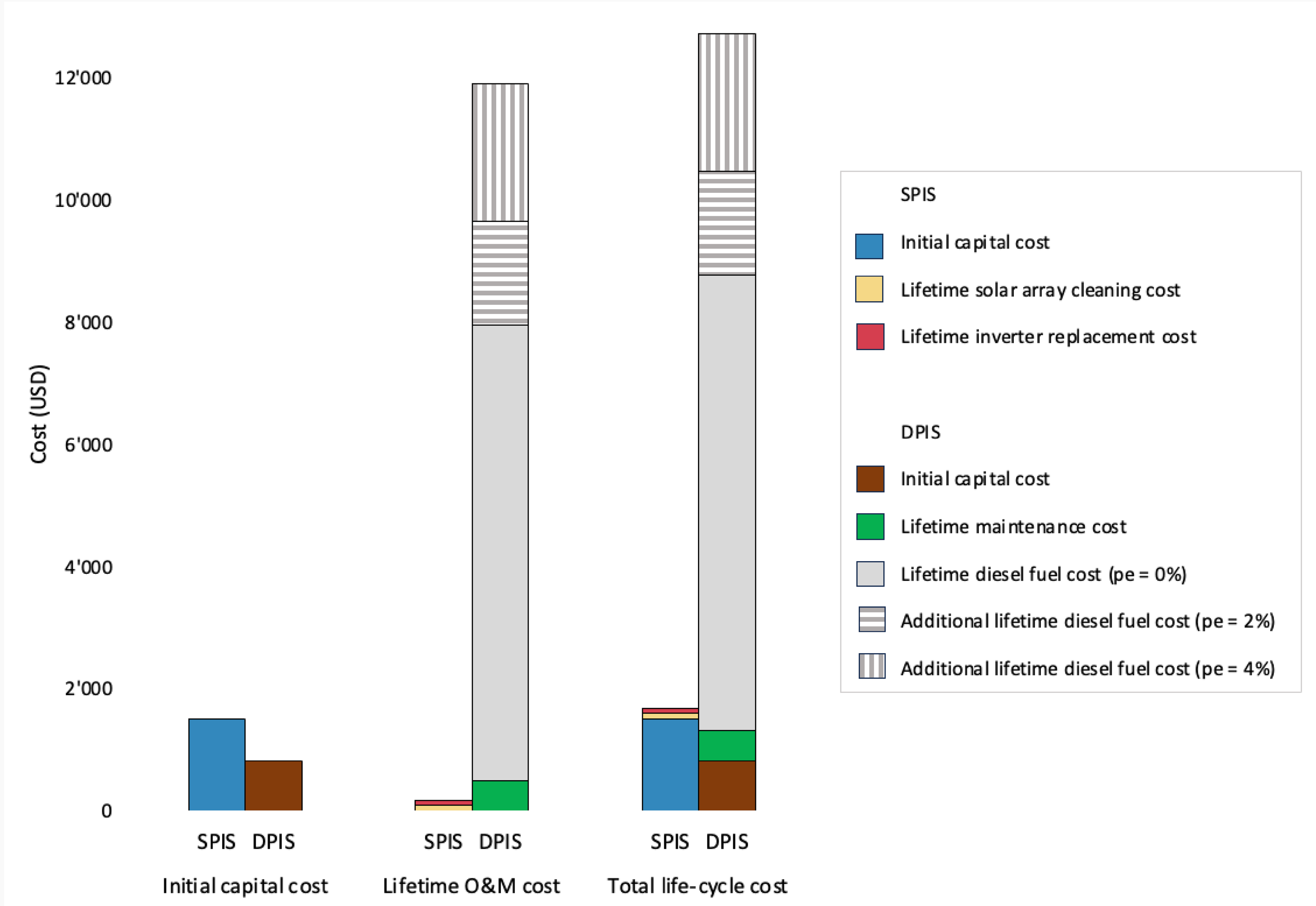
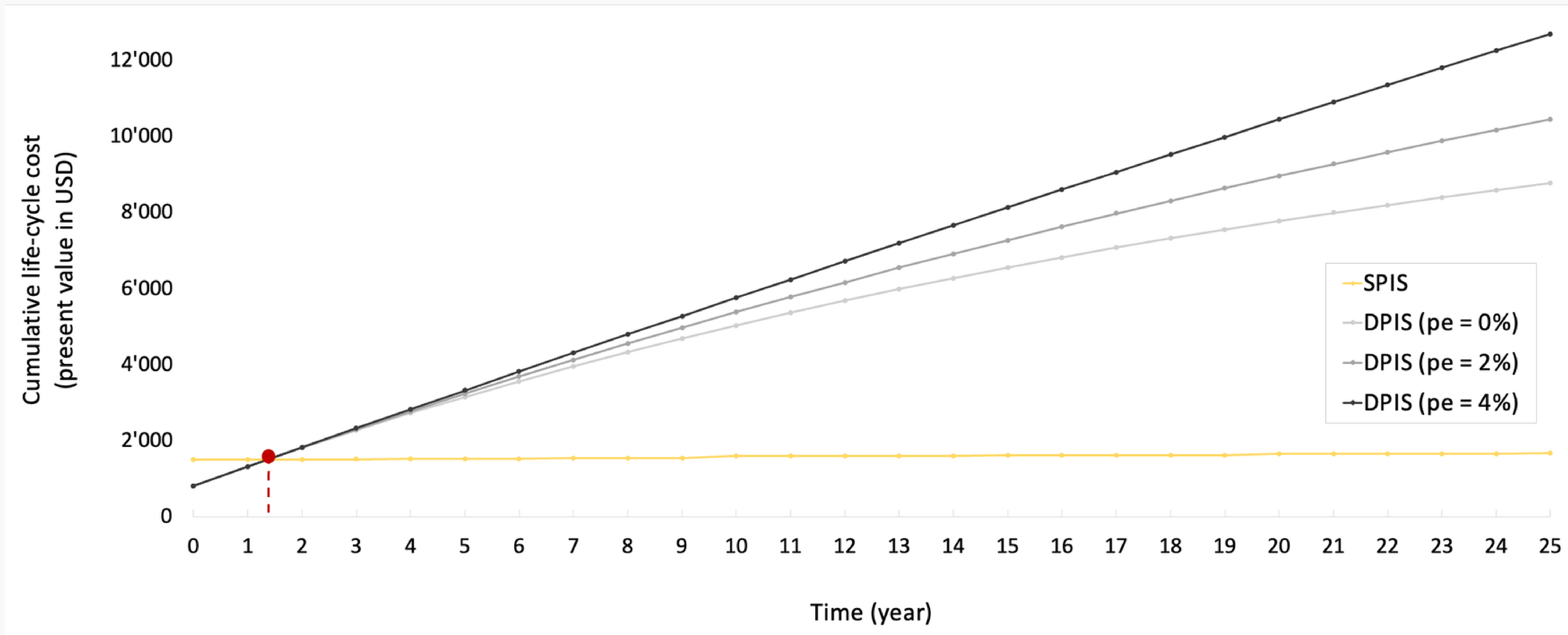


Fig. 5 Estimated Cumulative Financial Life-Cycle Costs of the SPIS and the DPIS



Conclusions

- In our analysis of the Gbandokaha case, solar-powered irrigation proves more cost-effective than diesel-powered irrigation over the system's life-cycle.
- However, the higher initial capital outlay for a SPIS, as opposed to a DPIS, underscores the importance of innovative financing for smallholder adoption.
- As diesel prices rise, the SPIS becomes increasingly cost-effective, highlighting its potential to hedge smallholders against diesel price fluctuations.
- **Further assessments are needed to determine SPIS cost-effectiveness in different Ivorian contexts, and additional factors (e.g., potential revenue) must be considered for a comprehensive viability evaluation of the technology.**

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