SUSTAINABILITY ASSESSMENT OF A HYBRID CONCENTRATED SOLAR POWER/BIOMASS MINI POWER PLANT

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INTRODUCTION

Novel renewable energy systems need a progressively development regarding the rising global energy demand and the consequently impacts of an energy mix mainly based on fossil fuel resources. Additionally, the impact assessment of these technologies should be analysed along the whole supply chain in the three sustainability pillars so that not only cost of energy is accounted for but also the involved environmental and socioeconomic impacts throughout the life cycle, such as job creation and CO_2 emission.

This work analyses the life cycle economic, socioeconomic and environmental impacts of a hybridized concentrated solar/biomass mini power plant in Tunisia. The expected sustainability results will be compared and contrast with available similar case studies analysed in the literature.

REELCOOP Project

REELCOOP project (*REnewable ELectricity COOPeration*) is an EU-FP7 funded project (www.reelcoop.com) which focuses on developing renewable electricity generation systems and promoting cooperation between different EU countries. Its scope covers five relevant renewable energy fields: photovoltaics (PV), concentrated solar power (CSP), solar thermal (ST), bioenergy and grid integration, by developing and testing three new prototype systems representatives of both micro-scale (distributed) and large-scale (centralised) approaches to electricity production.

One prototype is a mini 60 kW parabolic through plant hybridized with a biogas boiler to provide energy backup to the solar field and to enlarge operational time during the night, contributing to lower electricity production costs and avoiding large energy storage systems. This prototype is being installed at the National School of Engineering of Tunis (ENIT). The biomass resources consist on local organic food waste, therefore reducing local environmental and human health problems. Additionally, the CSP system based on direct steam generation avoid thermal fluids (e.g. oil), and includes an Organic Rankine Cycle (ORC) power system with a organic refrigerant as working fluid.

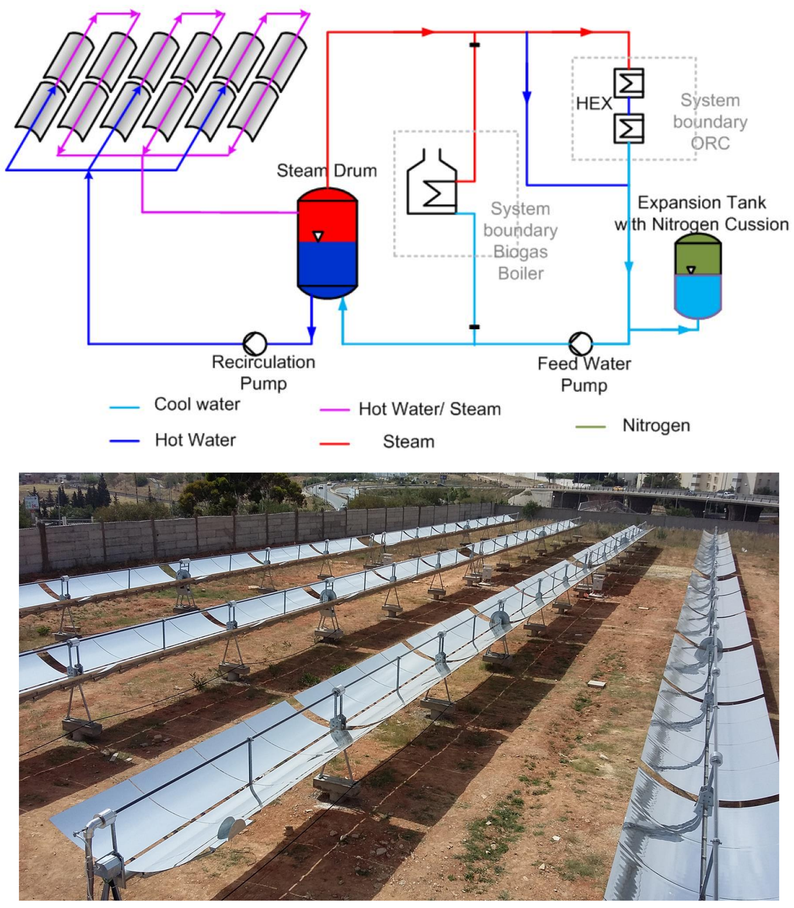

Figure 1. REELCCOP CSP/Biomass power plant prototype design (top) and parabolic through solar field installed in ENIT, Tunis (down).

MATERIALS & METHODS

The sustainability assessment focuses on capturing the economic, socioeconomic and environmental impacts involved along the supply chain of products and services. The framework is based on an Input output analysis (IO), which allows to estimate economic stimulation in a region or country as a result of the increase of goods and services generated by a given project.

Furthermore, the IO methodology is extended to the socioeconomic and environmental dimensions in order to account for the impacts associated to such economic demand: added value creation, employment, etc.

Finally, the outputs of the analysis allow the simultaneous representation of the results by displaying which effects (direct/indirect effects) or project phases have the largest contribution in each of the sustainability impacts.

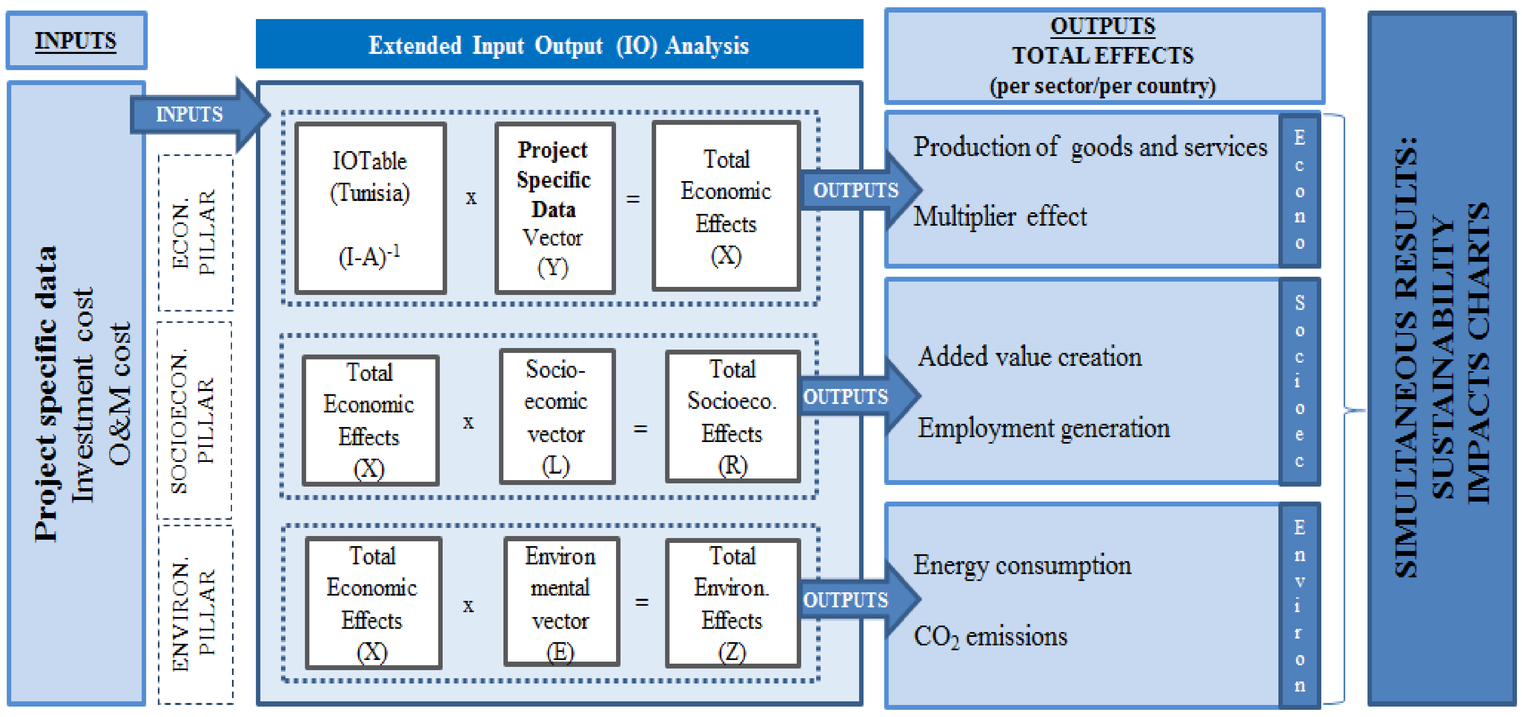

Figure 2. Extended Input Output analysis framework.

EXPECTED RESULTS & DISCUSSION

The expected results will show not only the direct economic stimulation of the products and services demanded by the project along the whole supply chain but also the indirect economic stimulation from trade relationships between economic sectors, as well as the associated multiplier effect, which represents how much the national economy will be stimulated per monetary unit invested directly in the project.

Additionally, results of the associated socioeconomic and environmental impacts will be equally assessed by extending the IO methodology, both direct and indirect impacts. There are few available similar case studies but they report that CSP/biomass power plants are technically and economically viable in other countries, *e.g.* Spain [1], Portugal [2] or India [3]; and impacts obtained in this work will be compared with available literature.

CONCLUSIONS & FUTURE DEVELOPMENTS

The expected results could contribute to support the progressively development of hybrid CSP/biomass power plants by assessing not only the economic but also the environmental and socioeconomic impacts along the supply chain, as well as accounting for indirect trade effects and impacts.

Moreover, the simultaneous representation of the results in the sustainability impact charts could support the decision making processes by identifying and fostering the positive effects while guiding to the setting of solutions to minimize the negative ones. This case study could also contribute to develop the Tunisia´s renewable energy portfolio. Future research analysis will be conducted to compare the results of the three REELCCOP prototypes.

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