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Multi-criteria decision methods applied to the assessment of photovoltaic technologies

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Extended abstract

The aim of this paper is the study and analysis of the decision criteria when searching for the best technology for manufacturing photovoltaic modules, considering both technical criteria such as economic and environmental factors and non technical criteria such as social and environmental factors. For that, multi-criteria decision making (MCDM) methods will be used for the modelling of the selection problem of the best technology for manufacturing photovoltaic cells. Combining these techniques with the use of fuzzy sets will mean that linguistic labels can be used to value the criteria used.

The technologies for manufacturing photovoltaic cells are divided as follows:

- A_1: Manufacturing technology with crystalline silicon (mono-crystalline and poly-crystalline)
- A_2: Manufacturing technology with inorganic thin layer (amorphous silicon)
- A_3: Manufacturing technology with inorganic thin layer (CdTe and CIGS)
- A_4: Manufacturing technology with advanced III-V thin layer with tracking systems for solar concentration (based in alloys of III-V elements)
- A_5: Manufacturing technology with advanced, low cost, thin layers (Organic and hybrid cells)

After analysing the technologies that will be identified as alternatives to study, the criteria with highest impact in their manufacturing processes will be defined. The criteria considered for the assessment of the decision problem are the following:

- C1: Manufacturing cost: it will constitute a criterion to minimize, it will be characterized in a quantitative way in the following terms: euros for watt peak that each cell produces (€/Wp)
- C2: Efficiency in energy conversion: it will constitute a criterion to maximize; it will be characterized in a qualitative way in terms of per cent (%)
- C3: Market share: it will constitute a criterion to maximize; it will be characterized in a qualitative way through linguistic assessment labels.
- C4: Emissions of greenhouse gases (that are generated in the manufacturing): it will constitute a criterion to minimize; it will be equally characterized in a qualitative way through linguistic assessment labels.
- C5: Energy pay-back time: Time that the system takes to generate the consumed energy in manufacturing. It will constitute a criterion to minimize; it will be equally characterized in a qualitative way through linguistic assessment labels.

The second part of the paper will consist in modelling the problem, using the multi-criteria decision making methods.

The weight of the criteria will be evaluated through the use of methodology: fuzzy Analytic Hierarchy Process (fuzzy AHP). The alternatives will be set out (photovoltaic manufacturing technology) through the use of the TOPSIS Method combined with fuzzy logic (TOPSIS Fuzzy Method). Its use will be fundamental for the modelling of the problem since the ratings used are vague or uncertain, with linguistic labels being used for the assessment.

Through the application of these methods a series of results will be obtained. They will be analysed to provide the solution of the decision problem set out. Finally, we will outline the most important conclusions and future research lines.