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Abstract:

In the first decades of the 21st century increasing concerns regarding the environmental issues caused by anthropogenic global warming have spurred a rethinking of the generation and consumption of energy, and the management of local resources. In part as a consequence of this trend, it is expected that solar PhotoVoltaic (PV) panels will lead future renewable electricity capacity growth in the next decade [1]. Another societal change is the worldwide rise in urbanization, with the expectation that two thirds of the global population will live in urban areas by 2050. As a result, the consideration of Building-Integrated PhotoVoltaic systems (BIPV) and their widespread adoption is of crucial importance.

This work is part of the "G2Solaire" project, a Franco-Swiss project developing a solar cadastre (also called solar map) of the Genève agglomeration. The cadastre to be developed will take the form of a collaborative platform with objectives that are respectively related to:

- the intensification of the use of solar energy;
- the economic development of solar-related activities;
- and *in fine* to the energy transition goals in a context of urban densification.

The solar cadastre of a city comprises a representation of the solar energy that could be collected on each roof. Hence, one of the goals of the project is to develop an improved cadastre, considering façades, with more accurate predictions (considering local operating conditions, radiation reflexion, inter-buildings effects...). Performance Measurement Systems will then be defined in order to assess the suitability of a particular roof for PV integration.

The final decision problem addressed here consists in choosing the more adequate building roof for the installation of a solar PV system considering a wide range of technical, economical, societal and environmental criteria.

For this particular problem, decision-makers are the owners of the building, who can have divergent objectives and different set of criteria. However, other stakeholders must be considered such as the end-users, the city planners and environmentally aware citizens, who may give greater consideration to the environmental factors or prioritize economical aspects. Taking into account these different points of view leads us to the handling of a Group Decision Problem.

As a preliminary steps, all the shaded roofs, the area receiving only a low amount of solar energy as well as World heritage and other classified building for which PV integration needs specific studies, are excluded from the analysis because not eligible to the integration of PV systems.

Once this step finished, the suitability of the building for the integration of a solar PV system is assessed. To that aim, it is necessary to have a comprehensive knowledge of the influential choice criteria, which will be determined on the basis of:

- the previously established criteria regarding the implementation of PV modules [2]–[4];
- the environmental and societal impact of the integration of renewable energies in urban areas [5], [6].

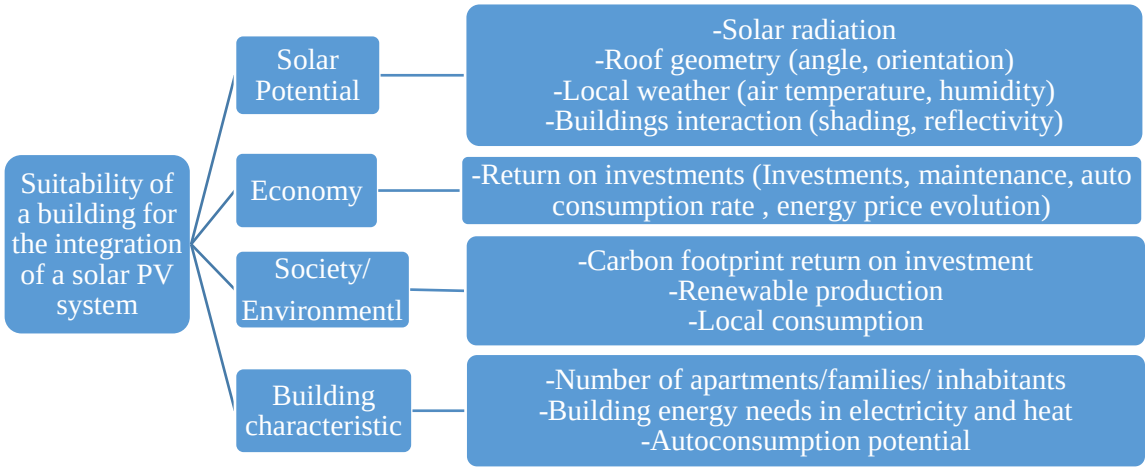

Figure 1 Hierarchical structure of the selection criteria

Let us mention that the self-consumption criterion is a new aspect in this type of analysis and has to be carefully handled. The selection criteria include four main sub-criteria which are respectively: the solar potential, the economical and

socio-environmental factors, and the building characteristics which play a crucial role in the evaluation of the self-consumption potential [7]. They have been represented following a hierarchical structure in Figure 1.

The analysis of the problem highly relies on the available data. In the framework of this project, many partners are implied from which different type of data are required. The evaluation of the solar potential rely on the 3D-Geographical Information System (GIS) models developed at Hepia and based on three-dimensional urban geometry data and solar radiation models [8]. On the economical aspect, a design and pedagogic software, CALSOL +, designed at the Institut National de l'Energie Solaire (INES), provides the economical as well as environmental outputs. The building characteristics are obtained based on available database, local consumption information and literature studies. The analyses will be carried on following an iterative and constructive process, starting from generic solutions (PV technologies, available surface, batteries), and progressively refining the alternatives during the decision process.

Once the problem fully described, a GIS-based model will be used concomitantly with a Multi-Criteria Decision Analysis (MCDA) method such as UTA, ELECTRE or MACBETH. GIS is able to handle large quantities of spatial data supporting the evaluation of the local solar potential while MCDA methods allows decision-makers to provide a finer analysis, as it has been shown in [4] including a wide range of criteria beyond geographical aspects.

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