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Sun position and PV panels: a model to determine the best orientation

The correct positioning of photovoltaic panels is essential to ensure the maximum production of electrical energy. Two parameters are involved in this: the tilt angle and the angle of orientation. In the literature, though, the orientation angle receives little attention. In this work, I present an application I developed using the Python programming language in a GIS environment that can help finding the best orientation for photovoltaic panels to make the most from the solar radiation.

The developed model required both physical and geographical data. The first type of data was about the solar radiation, and it required information related to the apparent motion of the sun relative to a terrestrial observer and data about the amount of solar energy that hits the ground surface, which was provided by the Swedish Meteorological and Hydrological Institute. The geographical aspect of the project required the creation of a digital surface model from data acquired by LiDAR technology.

The GIS environment, where the model has been programmed, was Quantum GIS, which is a Free and Open-Source Software. The application is composed by a main python file and several auxiliary functions that provide interim results. Starting with a list of user-defined information about the area of interest, the application provides a range of both graphical and textual results that help better understanding the features of the solar radiation in the area and therefore provide some useful information for a more efficient use of solar energy.

The completed model was tested on a portion of Lund municipality, characterized by a non-built area in the immediate proximity of buildings. The results allowed a better understanding of the annual evolution of shadows, highlighting areas that benefit most from solar radiation and consequently how the shadows affect the average amount of solar energy (kWh/m^2) that reaches the ground. The most useful result for the purpose of this study was the identification of the best angle of orientation of a photovoltaic system. The last annual output suggests how areas not hampered by shadows require an orientation angle of 180 degrees. Instead, the monthly outputs suggest the best orientation angle for those areas where 180 degrees is not the optimal value.

The proposed application is based on a simple physical model, it is developed with non-proprietary software and uses data that are becoming more and more available on the net and finally provides results within a reasonable time. Nonetheless, a model, as such, can always be reconsidered starting from its foundation and, therefore, can always be improved. Some aspects that are open to further development have already been identified during the implementation process.