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Orienting a photovoltaic panel to make the most of the sun's energy

Nowadays the interest in renewable energy sources is growing. Solar energy is definitely an endless resource and photovoltaic panels can transform it into electricity. However, correct orientation is essential to ensure the maximum efficiency of these panels. This work aims at developing an application to calculate the best orientation angle of a photovoltaic panel, based on the apparent motion of the sun relative to a fixed point on the Earth.

The sun rises and sets at slightly different times every day of the year and consequently describes different trajectories every day. For every given day, time and place, the exact position of the sun is defined by two angles: the angle of elevation and the azimuth. The application is based on a simple physical model that describes the apparent motion of the sun across the sky, and provides its exact location - the two angles - depending on the entered parameters. The area of interest - the point on the Earth where we want to carry out the analysis - is defined by its geographic coordinates and by a digital model of the surface that duplicates the natural and artificial structures on it. As a function of the position of the sun, the structures on the surface will produce different shadows: the change in the pattern of the shadows affects both the amount of energy potentially exploitable by a photovoltaic panel and the definition the optimal orientation of the panel itself.

From these physical and geographical backgrounds, the application was developed using the Python programming language. The model developed processes and displays the results in a GIS environment (Quantum GIS). 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 helps better understanding the behaviour of the solar radiation and the best orientation angles for photovoltaic panels in the area.

The model was tested on a portion of the Lund municipality making the simulation for the year 2015. The results allowed us to understand the annual evolution of shadows, highlighting the areas that benefit the most from solar radiation. The most useful result for this study's purposes is the identification of the best angle of orientation of a photovoltaic system. One of the graphical outputs suggests how areas not hampered by shadows require an orientation angle of 180 degrees (facing directly South). In addition, another series of outputs suggest the best orientation angle for those areas where, according to the shadow pattern, 180 degrees is not the best orientation.

The proposed application is based on a simple physical model, it is developed with non-proprietary software and provides results within a reasonable time. However, a model, as such, can always be improved and during the implementation process some aspects that encourage further development of the model have already been identified.

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