A Fast and Effective Approach to Modelling Solar Energy Potential in Complex Environments

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Overview

The deployment of rooftop photovoltaic (PV) systems has seen rapid expansion in recent years, vastly exceeding predictions. Almost all of these systems are grid connected, supplying generated electricity to the national grid when not consuming it on site. There is no definable pattern to the geographic distribution of these installations and information on the vast majority of these systems is not documented, yet alone accessible. In built up areas especially, optimisation of the deployment of PV is a non-trivial task. Shading can have a depredatory effect on system performance and the person time involved in the assessment of optimum installation conditions by surveying is often prohibitively expensive, particularly for large scale applications.

This work presents and describes a model, **solarscene.xyz**, developed at CREST that is capable of generating high resolution maps of solar energy potential for existing or proposed (building plans) locations. These calculated solar energy potential maps are inclusive of global and localised shading effects and are time resolved, allowing for the specific investigation of time sensitive shading scenarios, rather than limiting the results to averaged values. Diffuse and beam irradiance components are specifically considered. The model can be extended to include spectral effects.

The tool can be a powerful resource in solving many PV deployment problems, such as optimisation of self-use scenarios. Key to this is the dynamic assignment of value to electricity. The model is well optimised for the specific calculations performed meaning that large areas can be analysed at high spatial and temporal resolution in little time on an average specification PC.

solarscene.xyz is planned to be made freely available to the public by an html interface in 2016. In the full paper the model is explained in detail and assumptions within the model as well as user-defined settings and options are discussed. Test cases are presented showing the effects of the resolution of input data on model outputs. Dynamic electricity value optimisation problems and solutions are also explored.

Example Net Annual Irradiation Maps

Two examples are presented to the right. The top figure shows the net annual solar irradiation available to a 1 km^2 region in Manchester at a pixel resolution of 1 m^2. The meteorological input data for this specific example was interpolated from 2014 Met Office data at an hourly temporal resolution and the 3D environment gathered data from LiDAR records. Due to the optimised calculation procedure employed in **solarscene.xyz**, this simulation took less than 1 minute to run on a standard specification modern PC.

The bottom figure is a close up of a specific area within the top figure example. Clearly defined roof orientations can be seen alongside annually aggregated shadows cast within the environment by, for example, chimneys and trees. The resolution of the simulation output is a direct function of the input data. LiDAR exists to a 0.125 m^2 pixel resolution for some regions of the UK and future building project drawings are available to very high resolutions, making solar scene an exciting tool in assessment and development of building applied (BA) or building integrated (BI) PV.