Shape Analysis of Solar Panels

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INTRODUCTION

Solar panels are a promising source to CO_2 neutral and climate friendly energy. Today solar panels are often applied to the roofs of houses when they are not merely placed angled on a supporting structure on the ground constituting so called solar farms. However, solar panels are rarely used in modern cites, as the ordinary rectangular shape is not easily incorporated in the design of city skyscrapers. The vision behind this project was to help spread the use of solar panels to cities by analyzing a variety of alternative shapes of solar panels and developing tools to evaluate the energy efficiency of the panels.
The goal was to develop effective and easily applied methods for depicting the energy efficiency of solar panels of various geometric shapes. In ambitious and comprehensive construction projects, this framework would apply as an easy tool to consider energy optimization in the early stages of design planning. This is an important instrument for architectural offices as it could be used as a guideline for architectural planning.

METHODS

The general assumption of the project was that inward solar flux through any solar panel was proportional to the energy output of the solar panel. This assumption can be easily corrected by applying the actual efficiency of the solar panel.
The project developed a series of methods for modeling the energy output for solar panels based on depicting the sunlit and shadowed areas of the solar panels. It was found that the calculations rapidly became very demanding for even the simplest of shapes. For specific types of geometrically shaped solar panels a simpler method was derived and applied. However, the limitations of this method made it necessary to broaden the applicability of the model to a wider range of geometric shapes. This was achieved by applying Gauss's theorem to closed convex surfaces. The resulting method proved to be effective and much more general in applicability, as all convex surfaces could be modeled and computational time was reduced.

RESULTS

It was found that for closed convex surfaces the inward flux could be computed as the area of the shadow of the surface on a plane perpendicular to the sun.
The computational power and time required for this analysis of any solar panel, that is a closed convex surface, is very limited and thus very applicable.