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RAST: RoundAbout Solar Tracking

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Abstract

Roundabouts became popular worldwide as a tool to reduce the number of car accidents and the EU encourages and promotes this technology as a solution to the problems of urban and extra-urban traffic. RAST (Roundabout Solar Tracking) systems are designed to exploit the available space in roundabouts, which are already equipped and monitored, in order to produce electricity with a photovoltaic single axis tracking system. The energy produced can be used directly by the surrounding facilities or stored and consumed later or channelled to nearby car charge points. The amount of energy that can be produced on a single roundabout is limited by the land size and is normally in the range 100-400 kWp, but the number of suitable roundabouts in cities is high. Therefore, RAST could make an important contribution to the energy production.

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1. Introduction

The installed Photovoltaic (PV) capacity has increased rapidly in the last few years and in 2015 the PV market experienced a further worldwide expansion with an installed capacity of over 230 GW while the main development moved from Europe to Asia (China, Japan, India) and USA [1]. In particular, the strong exponential increase is driven by a reduction of PV system costs which for a utility scale system was about 1.8 \$/Wp and it was estimated to range from 1.5 to 1.7 \$/Wp in 2016 [2], [3]. The PV modules are emerging as a strong source of energy,

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which is efficient and distributed. The costs are decreasing and this justifies the effort to improve its use and to study the possibility of building large systems.

Two restrictions are still evident: the first is due to the availability of spaces for PV fields, the second is the cost of tracking systems, which would allow full use of the potential of the PV modulus, but have a higher cost and a more wide surface occupancy especially if we consider the double axis type (Fig.1 (a)). Therefore single, horizontal, North–South-oriented axis structures associated with flat-plate modules represent the most widely used tracking solution in current PV plants. Because of their inherent lack of shadowing in the North–South direction, single tracking devices can drive large surfaces and, owing to the horizontal axis position, associated wind loads tend to be relatively low. The structure involves a particularly simple and robust mechanical construction, which is the main advantage of this type of tracking.

However, the horizontal axis position limits the energy collected by the tracking surface. This depends on the solar climate and latitude of the site and can be compared with the energy collected by an ideal two-axis tracking, which represents the largest solar radiation potential for a particular location.

The major motivation for the development of other one-axis tracking alternatives is to overcome this limitation, while keeping the mechanics fairly simple. This type of single-axis tracker rotates around its vertical axis, in such a way that the azimuth of the receiver surface is always the same as the Sun's azimuth, while its tilt angle remains constant. Progress has been made in systems with an axis, and RW Energy has proposed a solution for solar farms based on a rotating mono-block platform on the ground (Fig. 1(b)). Some results in [4] show that azimuth tracking represents an increase of about 10% in energy collection, in comparison with horizontal axis tracking. It can also be seen that the advantages of tracking energy increase for both latitude and clearness index. In [4] and [5] the theoretical aspects of the mutual shading among trackers is analyzed, by relating the collection of energy to the relevant design parameters, namely, the tilt angle and the aspect relation (length/width) of the single tracked surfaces, and the spacing between adjacent trackers in North–South and East–West directions respectively. The lower the spacing between adjacent trackers, the lower the gross land occupation (to this purpose the so called Ground Cover Ratio, GCR, can be defined as the ratio between PV array area and total ground area) and, therefore, the lower the land-area-related costs (land, civil works, wiring, etc.). On the other hand, the larger the impact of shadowing, the greater the detrimental effect is on the electricity generation of the PV plant. If the vertical axis tracking is applied to a PV array made of many rows, a tracking solution, named carousel, is realized. This solution can be applied for installation on a building roof, where solar trackers are needed of a size to fit on the roof with no roof penetration and with low profiles for low wind resistance.

This solution can be extended and adapted to a specific solution that we have analysed and patented: RAST.

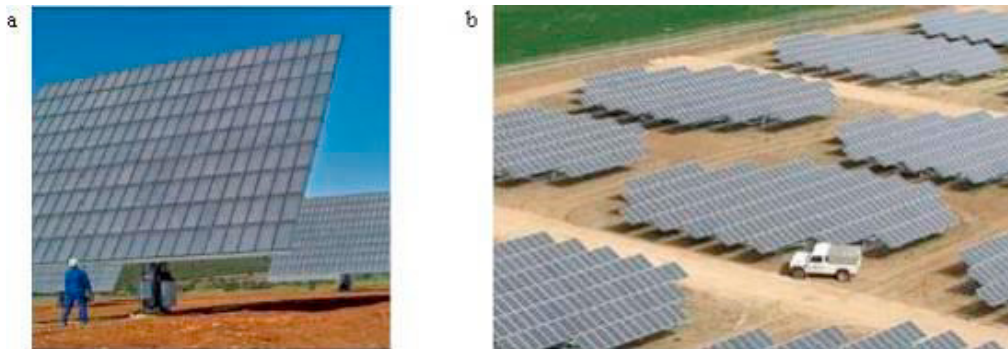


Figure 1 (a) Two axis tracking: Ammonix; (b) Vertical axis tracking: RW-Energy.

2. 1. The RAST System

RAST stands for Round About Solar Tracking and it aims to exploit available space, or at least already equipped and monitored locations, for producing electricity with vertical axis tracking PV systems.

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