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Solar system for exploitation of the whole collected energy

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Abstract

An innovative architecture for the exploitation of the whole collected solar energy is described. A sun pointing optical concentrator focuses the received energy, containing the part of the required solar spectrum, in a low loss optical fibre transmission line. The optical panel is small in size and able to follow the sun in order to collect the maximum of its energy. The support is flat, 5 mm thick and includes four optical concentrators. The efficiency of the optical system depends on the optical configuration and on the material utilised for the optical components. Single commercial connector to the fixed fibres connects the fibre optics' four free ends. The energy is therefore properly transported to any user's end with an easy installation. The system was experimented for lightening, during the day, dissipated in a dark load in order to produce heat in some equipment and for photovoltaic applications. The total efficiency of the system was between 68% and 72%. Once the solar energy reaches the end of the transmission line, it can be addressed to the required utilisation by means of an optical switch, which redirects the sunlight towards the desired applicator. This procedure allows utilising the 100% of the sun-collected energy. Since the size of the panel was small, it can be placed, on the roof, on the garden, on the window-sill, on the field and on all sides exposed to sunlight.

Keywords: Solar energy; Sun pointing; Optical concentrator; Efficiency

1. Introduction

Solar energy has been used by mankind even before the use of fire as an energy capable of drying or cock and later as a means to remove water from material such

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as salt or bricks. Until animal and human power and more recently, fuel or mineral energy were available in such quantity to fulfil mankind's necessity, solar energy was ignored as an alternative or substitute for other types of power generation such as that derived from fuel, fossil, hydroelectric and atomic.

Among the most used system today, the following items can be mentioned:

- photovoltaic generators and
- thermal generators.

Some of the above mentioned items have been more successful and have generated major industries in several countries.

The presented system carries sunlight power from an optical collector, placed in a favourable location, down to a user's device by means of a low loss optical fibre. The small dimension of fibre diameter will favour the installation even in a very complicate environment such as a tall building, using existing cabling facilities. At the end of the bundle fibres an optical switch is provided in order to share the collected sun power among different conversion modules making time sharing possible and utilising the 100% of the available energy.

The objectives of this work were both the development and investigation of a wide range of optical solutions to be integrated into a demonstrator, from which appropriate performances and cost requirements could be carried out, as well as practical applications of a prototype that is able to exploit the totality of the collected energy.

The architecture of the system involves the following parts:

(a) Several elementary movable panels, each of them incorporates four optical collectors, each of which is coupled to an optical fibre. The fibres coming from the lower part of all the optical panels are assembled in a unique bundle.
(b) A sun tracking system that enables to settle the position of the collecting panel perpendicular to the sun direction during all day.
(c) Optical fibre line with low losses and opportune numerical aperture and diameter for transmitting the sunlight [1] from the output of the optical concentrator to the optical switch.
(d) The optical switch connected with the output of the glass fibre ribbon. The switch is suited to use the radiation efficiently in order to exploit the 100% of the collected energy.
(e) The final applicators designed in the function of the required utilisation.

The size of the optical fibre, even if covered by a protective shield is of such a dimension so as to be easily inserted, for example, into a TV cable already present almost in every house, which connects the roof of the house practically to every flat in the building.

2. The solar panels

The single solar panel consists of a square flat platform, incorporated in the rack of Fig. 1, to allow an effective support for the optical collectors. The platform has