

MODULAR SYSTEM FOR HOLOGRAPHIC SOLAR CONCENTRATION
INTEGRATED IN URBAN AND ROAD ELEMENTS

Technical sector

5 The invention is located in the technical sectors of renewable energies, specifically photovoltaic solar energy, energetic efficiency and integration of energy generation in the enveloping of buildings or urban or street elements (BIPV).

10 **Prior art**

 The majority of urban and street elements, such as for example street lamps, bus stops, parking meters, motorway toll booths, charging facilities, kiosks and advertising sites, amongst others, need electricity supply to feed the various electric and/or electronic devices thereof, such as lighting, chargers,
15 advertising or informative screens, etc.

 Although generally, said elements are connected to the network, it is increasingly more common for them to incorporate an electricity generation system, normally solar photovoltaic, and even a storage system which can allow autonomy. There are a multitude of examples of urban elements with
20 photovoltaic technology incorporated. One example of solar street lamps is provided by Chong and Kong in the patent, WO/2014/126453, Wang and Wang (patent CN 101009071 A), Hao et al. (patent CN 101781939 A), or Freitas et al. (patent US 2014/0080406 A1) can be named as an example of bus stops; solar kiosks are also found, such as for example that proposed by Hixson and
25 Creswell in the patent, US 2013/0033222 A1. Many of these can even be applied to assembly systems for solar modules, as Depaw proposes in the patent EP 2 369 266 A2.

 It is also usual for said systems to be able to incorporate intelligent management devices, as Freitas et al. propose in the patent already mentioned.

30 One element common to all these is the difficulty of combining the urban or street element with the photovoltaic solar module, both aesthetically and technically. Given that for the most part, standard, commercially available, photovoltaic modules are provided, the modules are an element external to the urban or street element. This involves orientations and inclinations which break
35 the aesthetic of the element, even sometimes not allowing the integration

thereof in accordance with the urban environments. Although there are architectonic integration solutions, these are generally energetically inefficient and also have a higher cost.

5 **Description of the invention**

The examination of the prior art reports that a significant improvement both in the performance as well as in the aesthetic of the urban and street elements, which generate energy, would be to achieve the architectonic integration of the solar module at low cost.

10 The present invention proposes to use the versatility of the holographic solar concentration (HSC) modules with the urban and street elements. The HSC modules have, amongst other elements, a hologram and solar cells, and the hologram always directs the light towards these solar cells, whatever the orientation of the module. There exist various versions of HSC modules
15 developed by the applicant, such as for example the 3rd generation in the patent US20080257400 from Mignon and Han, in which a flat HSC module is presented; the 4th generation with a tridimensional module with a concentration factor between 3 and 10x in the patent ESP 201331199 from Calo et al.; or the document “Modular system for solar concentration without tracking by means of
20 combining conventional optics and holographic optical elements (HOES)” from Rodríguez et al. and pending patenting, which presents the 5th generation, a flat HSC module capable of reaching concentration factors from 10x and which separates the optics from the generation part. All these HSC modules can act independently or architectonically integrated, and at a lower cost than that of the
25 conventional flat solar modules, which can even reach 0.25 euros per watt peak.

The versatility of these HSC modules is translated into the form and orientation which they can adopt, since the hologram which they integrate, allows the light from the sun to be captured at a multitude of orientations,
30 without tracking, with high efficiency. Thus, they can be adapted to various forms (straight, curved, round, etc.) and orientations (horizontal, vertical, north, south, east and/or west).

Therefore, the HSC modules can substitute the support of a solar street lamp, as is shown in figure 1, which uses a 4th generation solar module in
35 circular form. One embodiment of the invention for this application is explained

further on in the corresponding section. The covers of the toll booths or bus stops can also be substituted, as is observed in figures 2 and 3, or can be included in advertising sites, being able to form part of the stops of the same. One example of this last application is observed in figure 4.

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Description of the drawings

Figure 1. Holographic solar concentration (HSC) module (1) substituting the support of a street lamp or any other urban element (3) which requires a post.

10 Figure 2. Holographic solar concentration (HSC) module (1) substituting the cover of a toll booth (3).

Figure 3. Holographic solar concentration (HSC) module (1) substituting the cover of a bus stop (3).

15 Figure 4. Holographic solar concentration (HSC) module (1) integrated into an advertising site (3).

Embodiments of the invention

In a preferred, but not exclusive, configuration, the invention is applied to supports of solar street lamps, or any other urban or street element, which requires a post. As is observed in figure 1, the HSC modules in this case are of the 4th generation and form a circle. Each row of solar cells is placed vertically and in different orientations of north to south and east to west. Therefore, the electric interconnection of the HSC module can be made with the different rows in parallel. The street lamp can have one or various sections with a diameter variable in height. With an initial diameter of 300 mm and a height of 9 meters, the potential can be sufficiently covered in order to supply LED lights of 100 watts for 10 hours.

Another non-exclusive configuration relates to substituting the covers of toll booths or bus stops for HSC modules, as can be observed in figures 2 and 3, respectively. In these, the HSC module can be 4th generation and be adapted to the curve of the cover, or 3rd generation, if it is desired flat. The 5th generation modules can be coupled in covers of toll booths which are sufficiently large. In the case of the 4th and 5th generation modules, the solar collection is increased. The 3rd generation can be used if it is desired to transmit visible light below the cover. The hologram is designed according to the final form of the urban or

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street element, such that whatever the orientation thereof, it directs the light towards the solar cell. The interconnections of the solar cells depend in each case on the different orientations which are presented. Rows of cells are connected in series with similar orientation, and in turn, in parallel with rows of cells in different orientations.

In the case of advertising sites, as is shown in an example in figure 4, the HSC modules are adapted to the form of the support, whether it be vertical, horizontal or inclined. The module most adaptable to these types of urban elements, although not exclusive, is the 4th generation.

HSC modules can be coupled in practically all types of urban and street elements. Other examples are charging facilities, motorway and road signposts, kiosks, etc.

CLAIMS

1. A modular system for holographic solar concentration which has, amongst other things, holograms and solar cells, **characterized by** being
5 architectonically integrated into urban or street elements, forming part of the structure thereof and being adapted to the forms of the same and the hologram thereof is designed such it captures the solar light in all the positions in which it is integrated into the element and directs it towards the solar cells.
- 10 2. The modular system for holographic solar concentration integrated into urban or street elements according to claim 1, **characterized in that** said elements can be street lamps with the module in the support thereof or any other type of element which requires a post, as well as toll booths, kiosks, advertising sites, road or motorway signposts and bus stops and any other type
15 of urban or street amenity.
3. The modular system for holographic solar concentration integrated into urban or street elements according to claims 1 and 2, **characterized in that** the electricity generation can be autonomous, in the case of which the urban or
20 street element is equipped with accumulators or similar such that it can supply electricity in a constant manner.
4. The modular system for holographic solar concentration integrated into urban or street elements according to claims 1 and 2, **characterized in that** the
25 electricity generation can be connected to the network, in the case of which the urban or street element is equipped with current inverters for injecting alternating current to the network.
5. The modular system for holographic solar concentration integrated into
30 urban or street elements according to claims 1, 2 and 4, **characterized in that** the element can incorporate management systems for the electricity production and demand in order to be coupled to intelligent networks.