

"PHOTOVOLTAIC WINDOW MODULE AND BUILDING COMPRISING AT
LEAST ONE SUCH PHOTOVOLTAIC WINDOW MODULE"

Cross-Reference To Related Applications

5 This Patent Application claims priority from Italian
Patent Application No. 102023000010083 filed on May 18,
2023, the entire disclosure of which is incorporated herein
by reference.

Technical field

10 The reference technical field of the present invention
relates to a photovoltaic window module configured to be
installed in a building and to generate electrical current
spontaneously due to its exposure to the sun. In particular,
the present invention refers to a mobile photovoltaic window
15 module which can be moved around at least one hinge so that
it can assume different configurations relative to the
building. In this context, the present invention will offer
a solution, which on the one hand maximizes the production
of current, and on the other hand addresses the problem of
20 how to reconcile the movement of the module with the safe
transfer of current from the module itself to the users
located in the building.

State of the art

25 Today, panels made of photovoltaic glass, for example
amorphous silicon, are known to be used in buildings for
their dual function, i.e., that of an element insulating the
building from the external environment while allowing light
to enter the building, and that of exploiting their exposure
to the sun to generate electric current.

30 Usually, the panels described above are integrated into
windows that are fixed in relation to the building because
their movement makes the safe transport of the current
produced by the module to the building more complex.

35 Moreover, the panels known today are not capable of
producing large amounts of current because the transparency

of the glass must still be safeguarded and not excessively restricted.

Description of the invention

Based on this prior art, the object of the present
5 invention is therefore to provide a photovoltaic window module, which is movable in relation to the building, which produces current in significant quantities, and in which current transport from the module to the building occurs safely in all possible configurations of the module.

10 This object is achieved by providing a photovoltaic window module configured to be installed in a building and to be moved around at least one hinge to assume different configurations with respect to the building; wherein the photovoltaic window module comprises:

- 15 - a first panel, or outer panel, made of photovoltaic glass, preferably amorphous silicon, and comprising a first face configured to be exposed to sunlight and a second face opposite to the first; the panels can have any type of shape;
- a second panel, or inner panel, made of glass and
20 comprising a first face facing the second face of the first panel; the shape of the second panel is obviously the same as the first panel to create a double-glazed window;
- an intermediate photovoltaic device arranged in a gap between the first and the second panel;
- 25 - a perimeter window frame to hold the panels and the intermediate photovoltaic device in place and to insulate the gap;
- at least one hinge bushing coupled to the window frame and configured to be coupled to a hinge pin attached to a fixed
30 perimeter frame of the building;
- an electrical transfer system for transferring to the building the current generated by the first panel and the intermediate photovoltaic device.

Preferably, the intermediate photovoltaic device is of
35 the type that can be selectively switched between two

configurations, wherein in a first configuration it is a sunshade-type element between the panels suitable for at least partially intercepting sunlight passing the outer panel, and in a second configuration it is compacted at one side of the frame to allow sunlight passing the panel to reach the inner panel and possibly penetrate the building. For example, the intermediate photovoltaic device may be a Venetian blind (as shown in the figures) comprising a plurality of slats, wherein at least some of the slats of the Venetian blind are covered with monocrystalline silicon photovoltaic cells. In this case, the slats can all be selectively lifted and packed at the top edge of the module to clear the window completely of the sunshades.

Alternatively, the intermediate photovoltaic device can be a flexible thin-film photovoltaic panel. In this case, the flexible thin-film photovoltaic panel can selectively be rolled up at one edge of the frame.

As clearly described above, the starting point of the present invention is a double-glazed window inside which the intermediate photovoltaic device, such as a Venetian blind, is housed. This module, in terms of structure, is well known to the person skilled in the art and therefore no further construction details are necessary for the understanding of the present invention. An innovative aspect of the present invention is that the module has been optimized, not only by providing the outer panel as a power-generating element, but also by providing an intermediate photovoltaic device, for example the Venetian blind. This example is very advantageous in terms of power generation because the silicon applied on the slats does not have the problem of being transparent and because the slats can be, as is well known, oriented in space so as to always offer optimal exposure configurations as the position of the sun varies.

Preferably, the electrical connection system is integrated into the window frame and into the hinge bushing

so that the photovoltaic window module is of the type ready for installation and use. Even more preferably, the electric current transfer system comprises:

- an electrical junction box housed in the window frame and in contact with one edge of the panels (generally electrically connected to the panels and the intermediate photovoltaic device);
- electrical transfer cables running in the window frame from a first end coupled to the electrical junction box to a second end coupled to the hinge bushing;
- electrical transfer connectors housed in the hinge bushing on one side coupled to the second end of the transfer cables and on the opposite side being configured to be in contact with connectors housed in the hinge pin attached to the fixed frame of the building.

In one embodiment of the invention, the second panel can also be made of amorphous silicon photovoltaic glass.

The present invention also extends to the building for private or public use in which the module is installed, in the which building innovative aspects are expected to collaborate with the module. In particular, this building comprises:

- a photovoltaic window module as described;
- a fixed building frame configured to house the photovoltaic window module;
- at least one hinge pin coupled to the frame of the building and configured to be housed in the hinge bushing of the photovoltaic window module;
- an electrical distribution system for transferring the power generated by the first panel, the blind, and possibly the second panel into the building;

In this example, the electrical distribution system comprises:

- electrical connectors embedded in the hinge pin and coupled to the electrical connectors housed in the bushing;

- electrical distribution cables running in the building from a first end coupled to the hinge pin to a second end coupled to an inverter device;

- electrical power cables running in the building from a first end coupled to the inverter device to a second end coupled to at least one electrical device housed in the building.

Preferably, the Venetian blind is an electric blind powered by an electric power cable output from the inverter device.

Preferably, at least one electrical power cable output from the inverter device is connected to an electric socket, which is accessible inside the building and can be connected by the user to a personal electrical device.

List of Figures

Further features and advantages of the present invention will be apparent from the following description of a non-limiting embodiment thereof, with reference to the figures of the accompanying drawings, wherein:

- Figure 1 is a schematic view of a window structure according to the present invention;
- Figure 2 is a schematic view of an example of how a window of the present invention is integrated into the relevant building;
- Figure 3 is an enlarged view of the detail indicated with the reference III in Figure 2;
- Figure 4 is a detailed view of the Venetian blind component of the photovoltaic window module of the present invention, and of an example of an electrical connection for its integration into the relevant building.

Description of one Embodiment of the Invention

One embodiment of the present invention is shown with reference to the attached figures. In particular, Figure 1 shows three elements of a photovoltaic window module 1 of the present invention, namely - a first panel 4 comprising

a first face 5 configured to be exposed to sunlight and a second face 6 opposite to the first face 5;

- a second panel 7 comprising a first face 8 facing the second face 6 of the first panel 4;

5 - a Venetian blind 9 arranged in a gap between the first 4 and the second panel 7 and comprising a plurality of slats 10. This blind is an embodiment of an intermediate photovoltaic device generally envisaged by the present invention. As an alternative example (not shown), a flexible
10 thin-film photovoltaic panel of the roll-up type may be provided instead of the blind 9.

In this example, both the first 4 and the second panel 7 are made of amorphous silicon photovoltaic glass whereas at least some of the slats 10 of the Venetian blind 9 are covered
15 with monocrystalline silicon photovoltaic cells. As shown in Figure 2, the module 1 is configured to be installed in a building 2 and to be moved around side hinges 3 to assume different configurations relative to the building 2. Obviously, the position and number of the hinges can vary
20 from the embodiment in Figure 2. In addition to the components in Figure 1, the module 1 comprises:

- a perimeter window frame 11 to hold the panels 4, 7 and the blind 9 in place and to insulate the gap;
- an electrical transfer system for transferring to the
25 building 2 the current generated by the first panel 4 and the blind 9.

In this example, the electrical connection system is integrated into the window frame 11 and into a bushing 12 of a hinge 3 so that the photovoltaic window module 1 is of the
30 type ready for installation and use. In particular, as also shown in Figure 3 or Figure 4, the electrical transfer system comprises:

- an electrical junction box 14 housed in the window frame 11 and in contact with one edge of the panels 4, 7;
- 35 - electrical transfer cables 15 running in the window frame

11 from a first end coupled to the electrical junction box
14 to a second end coupled to the bushing 12 of the hinge 3;
- electrical transfer connectors 16 housed in the hinge
bushing 12, on one side coupled to the second end of the
5 transfer cables 15 and on the opposite side in contact with
connectors 17 housed in the pin 13 of the hinge 3 attached
to the fixed frame 24 of the building 2.

To transfer the current from the hinge 3 inside the
building 2, an electrical distribution system is provided,
10 comprising:

- the aforementioned electrical connectors 17 embedded in
the hinge pin 13 and coupled to the electrical connectors 16
housed in the bushing 12;
- electrical distribution cables 18 running in the building
15 2 from a first end coupled to the hinge pin 13 to a second
end coupled to an inverter device 19;
- electrical power cables 20 running in the building 2 from
a first end coupled to the inverter device 19 to a second
end coupled to at least one electrical device 21 housed in
20 the building.

The electrical device 21 can be of the user-controllable
type, in which case at least one electrical power cable 20
output from the inverter device 19 is connected to a user-
accessible electric socket 22, or it can be a stand-alone
25 electrical device 21. For example, it is possible to power
the blind 9 itself which produced part of the power
transferred to the building 2. For example, the electrical
device 21 can be an electrical distribution board already
present in the building and/or a bidirectional meter of the
30 local energy operator. In this last way, any excess current
produced by the window module of the present invention and
not consumed by the building can be transferred or sold to
the local energy operator.

Figure 4 shows the Venetian blind 9 in detail and how
35 it is connected to the electrical junction box 14 and from

there to the rest of the building. As can be seen, and as already described above, the Venetian blind 9 is placed between the two panels 4 and 7 and comprises, as is known, a plurality of sunshade slats 10, wherein each slat 10 can rotate around a horizontal central axis thereof to vary its tilt as desired. Reference 26 in Figure 5 schematizes the rotation pin of the slats 10. Furthermore, the slats 10 can all be lifted and packed at the top edge of the module 1 to clear the window completely of the sunshades 10. Reference 25 in Figure 5 schematizes the mechanism for adjusting the tilt of the slats 10 and for packing them. Arrows R and A also indicate these movements. As described, each slat has at least one face (preferably both) covered with silicon cells for photovoltaic current generation. In particular, as visible in the example in Figure 4, the silicon cells cover the entire length of the slats 10 up to the side rotation pins 26 (made of conductive material) at which there are dedicated vertical cables 27, which act as collectors for the current generated by the individual slats 10 and transfer the current to the electrical junction box 14. As can therefore be seen, the electrical junction box 14 receives, as input, the cables 27 connected to the slats 10 and the cables indicated with the reference 28, which carry the current produced by the photovoltaic glasses 4 and 7 to the box 14. As already described with reference to the figures above, the cables 15 then depart from the box 14 directed towards the photovoltaic hinge 12.

It is clear that modifications and variations may be made to the example shown in the figures of the invention described herein.

CLAIMS

1. A photovoltaic window module (1) configured to be installed in a building (2) and to be moved around at least one hinge (3) to assume different configurations with respect to the building (2); wherein the photovoltaic window module (1) comprises:
- a first panel (4) made of photovoltaic glass, preferably amorphous silicon, and comprising a first face (5) configured to be exposed to sunlight and a second face (6) opposite to the first (5);
 - a second panel (7) made of glass and comprising a first face (8) facing the second face (6) of the first panel (4);
 - an intermediate photovoltaic device in a gap between the first (4) and the second panel (7);
 - a perimeter window frame (11) to hold the panels (4, 7) and the intermediate photovoltaic device in place and to insulate the gap;
 - at least one hinge bushing (12) coupled to the window frame (11) and configured to be coupled to a hinge pin (13) attached to a fixed perimeter frame (24) of the building (2);
 - an electrical transfer system for transferring to the building (2) the current generated by the first panel (4) and the intermediate photovoltaic device.
2. The photovoltaic window module according to claim 1, wherein the intermediate photovoltaic device is of the type that can be selectively switched between two configurations, wherein in a first configuration it is a sunshade-type element between the panels suitable for at least partially intercepting sunlight passing the first panel (4), and in a second configuration it is compacted at one side of the perimeter frame (11) to allow sunlight passing the first panel (4) to reach the second panel and possibly penetrate the building (2).
3. The photovoltaic window module according to claim

2, wherein the intermediate photovoltaic device comprises a Venetian blind (9) comprising a plurality of slats (10), wherein at least some of the slats (10) of the Venetian blind (9) are covered with monocrystalline silicon photovoltaic cells.

4. The photovoltaic window module according to claim 2, wherein the intermediate photovoltaic device comprises a flexible thin-film photovoltaic panel of the roll-up type so that it can selectively be rolled up at an edge of the perimeter frame (11).

5. The photovoltaic window module according to any of the foregoing claims, wherein the electrical transfer system is integrated into the window frame (11) and into the hinge bushing (12) so that the photovoltaic window module (1) is of the type ready for installation and use.

6. The photovoltaic window module according to claim 5, wherein the electrical transfer system comprises:

- an electrical junction box (14) housed in the window frame (11) and in electrical contact with the panels (4, 7) and with the intermediate photovoltaic device;
- electrical transfer cables (15) running in the window frame (11) from a first end coupled to the electrical junction box (14) to a second end coupled to the hinge bushing (12);
- electrical transfer connectors (16) housed in the hinge bushing (12) on one side coupled to the second end of the transfer cables (15) and on the opposite side being configured to be in contact with connectors (17) housed in the hinge pin (13) attached to the fixed frame (24) of the building (2).

7. The photovoltaic window module as claimed in any of the previous claims, wherein the second panel (7) is also made of amorphous silicon photovoltaic glass.

8. The photovoltaic window module as claimed in claim 6 or 7, wherein vertical cables (27) are provided running along the sides of the intermediate photovoltaic device and

configured to receive the current produced by the intermediate photovoltaic device and to carry it to the electrical junction box (14).

9. The photovoltaic window module as claimed in claim 5 8 and claim 3, wherein each slat (10) comprises side pins (26) for tilt adjustment; at least one face of each slat (10) being fully covered by the silicon cells to carry the produced current up to the side pins (26); the vertical cables (27) passing along the vertical row of side pins (26).

10 10. A building (2) for private or public use comprising:

- a photovoltaic window module (1) as claimed in claim 2 or in claim 3 when dependent on claim 2;
- a fixed frame (24) of the building (2), the former being 15 configured to house the photovoltaic window module (1);
- at least one hinge pin (13) coupled to the frame (24) of the building (2) and configured to be housed in the hinge bushing (12) of the photovoltaic window module (1);
- an electrical distribution system for transferring the 20 power generated by the first panel (4), the intermediate photovoltaic device and possibly the second panel (7) into the building (2);

wherein the electrical distribution system comprises:

- electrical connectors (17) embedded in the hinge pin (13) 25 and coupled to the electrical connectors (16) housed in the bushing (12);
- electrical distribution cables (18) running in the building (2) from a first end coupled to the hinge pin (13) to a second end coupled to an inverter device (19);
- 30 - electrical power cables (20) running in the building (2) from a first end coupled to the inverter device (19) to a second end coupled to at least one electrical device (21) housed in the building.

11. The building according to claim 10, wherein the 35 Venetian blind is an electric blind powered by an electric

power cable (20) output from the inverter device (19).

12. The building according to claim 10 or 11, wherein
at least one electrical power cable (20) output from the
inverter device (19) is connected to an electric socket (22)
5 accessible inside the building (2).