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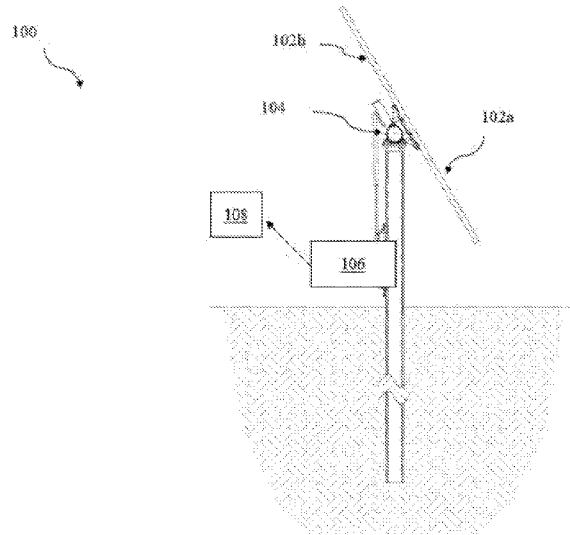


Fig. 1

(57) Abstract: The present invention discloses a system and method for determining optimal tracking trajectory of bifacial photo voltaic panels. The system (100) comprises at least one bifacial photo voltaic panel (102), at least one rotator (104), at least one tracker (106) and a processing unit (108). The tracker is operatively coupled to the bifacial solar panels to rotate by tracking the direction of the sun. The at least one rotator operatively coupled to the bifacial solar panels to rotate along with the direction of sun. The at least one tracker operatively coupled to the at least one bifacial photo voltaic panel to track a movement of the sun, wherein the at least one tracker having a processing unit that is configured to analyze one or more data inputs and determine optimal trajectory for the at least one bifacial photo voltaic panel to harness maximum sunlight and increase energy generation.



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- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
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Description

Title of Invention: A system and method for determining optimal tracking trajectory of bifacial photo voltaic panels

Technical Field

[0001] The present invention relates to bifacial solar panels. More specifically, it relates to a system and method for determining optimal tracking trajectory of bifacial photo voltaic panels.

Background Art

[0002] Solar energy refers to the radiant energy emitted by the Sun, which has the potential to generate heat, initiate chemical reactions, and produce electricity. By utilizing solar panels, this energy can be captured and converted into usable electrical power. A solar panel, also known as a solar cell panel, solar electric panel, or photo-voltaic (PV) module, is an arrangement of photo-voltaic cells mounted within a framework for installation. These panels harness sunlight as an energy source to generate direct current electricity. A grouping of PV modules is referred to as a PV panel, while an assemblage of PV panels is called an array. Photovoltaic systems consist of arrays that supply solar-generated electricity to electrical devices.

[0003] Bifacial solar panels, which are made with high-efficiency solar cells on both sides of the panel and generate electricity simultaneously, are the most recent technology. They can absorb light from both the front and rear sides, allowing for diffused light to be used. Solar panels for bifacial use are high-watt modules as well as high-efficiency panels for cell development and solar panels. The solar bifacial module is made of thin layers of silicon solar cells that are located on the front and back sides of the module. The solar cells on the front generate electricity from sunlight, while the solar cells on the back collect sunlight that has been reflected off the ground and other objects. This allows the solar cells to collect more photons, which leads to higher power output.

[0004] The existing solar tracking systems are devices that keep solar panels pointing at the sun while it moves across the sky. A solar tracking system adjusts the face of the solar panel or reflective surfaces to align with the sun. To maximize the efficiency of solar panels, they must be pointed at the Sun. There are many types of solar tracking systems. The most popular type is the single-axis tracker. This tracker tracks the sun along one axis, usually from east to west. A dual-axis solar tracker is another type. This tracker can track the sun with greater precision than a single-axis one as it has two axes.

[0005] For the longest part, the energy efficiency was calculated using only the front side of the bifacial solar panels and not the rear side of the bifacial solar panels. However,

with increasing technology, a few existing systems consider irradiance captured by the rear side of the bifacial solar panels. However, they fail to consider other factors such as bifacial module properties, diffusion, diffusion reflection, ground irradiance, shadow of the tracker parts, and sun's beam reflection among others.

[0006] As discussed above, the existing systems fail to harness maximum sunlight from solar energy.

[0007] Thus, in order to overcome the shortcomings of the existing technologies, it is implied that there is a need for a bifacial solar panel tracker that harnesses maximum solar energy by using various factors to consider while calculating the solar efficiency while offering a cost-effective solution, which is reliable and does not suffer from the problems discussed above.

Object of Invention

[0008] The principal object of this invention is to provide a system and method for determining optimal tracking trajectory of bifacial photo voltaic panels.

[0009] A further object of the invention is to provide a tracker operatively coupled to the bifacial solar panels to rotate by tracking the direction of the sun.

[0010] A further object of the invention is to provide a computational method/ an algorithm via a processing unit considering both the top and bottom faces of the bifacial solar panel and their corresponding parameters.

Brief Description of Drawings

[0011] This invention is illustrated in the accompanying drawings, throughout which, like reference letters indicate corresponding parts in the various figures.

[0012] The embodiments herein will be better understood from the following description with reference to the drawings, in which:

Fig. 1

[0013] [Fig.1] depicts a schematic diagram of a system for determining optimal tracking trajectory of bifacial photo voltaic panels, in accordance with an embodiment of the present disclosure; and

Fig. 2

[0014] [Fig.2] illustrates a method for determining optimal tracking trajectory of bifacial photo voltaic panels, in accordance with an embodiment of the present disclosure.

Statement of Invention

[0015] The present invention discloses a system and method for determining optimal tracking trajectory of bifacial photo voltaic panels. The system comprises at least one bifacial photo voltaic panel that comprises a front side and a rear side solar panel.

[0016] Further, the system comprises at least one rotator that is operatively connected to the at least one bifacial photo voltaic panel configured to rotate the at least one bifacial photo voltaic panel along with a direction of sun.

[0017] Subsequently, the system comprises at least one tracker operatively coupled to the at least one bifacial photo voltaic panel to track a movement of the sun, wherein the at least one tracker having a processing unit that is configured to analyze one or more data inputs and determine optimal trajectory for the at least one bifacial photo voltaic panel to harness maximum sunlight and increase energy generation.

Description of Embodiments

[0018] The embodiments herein and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments that are illustrated in the accompanying drawings and/or detailed in the following description. Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments herein may be practiced and to further enable those of skill in the art to practice the embodiments herein. Accordingly, the examples should not be construed as limiting the scope of the embodiments herein.

[0019] The present invention discloses a system and method for determining optimal tracking trajectory of bifacial photo voltaic panels. The invention aims to overcome the limitations of existing platforms by offering a rotation mechanism to the solar panels, thereby harnessing maximum sunlight.

[0020] [Fig.1] depicts a schematic diagram of a system for determining optimal tracking trajectory of bifacial photo voltaic panels, in accordance with an embodiment of the present disclosure.

[0021] The bifacial solar panels may be defined as “any photovoltaic solar cell/ module that can produce electrical energy when illuminated on both its surfaces, front or rear”. Herein the bifacial photo voltaic panels are also referred to as the bifacial solar panels or at least one bifacial solar panel.

[0022] In an embodiment, the system 100 comprises at least one solar panel 102, at least one rotator 104, at least one tracker 106 and a processing unit 108. In an alternate embodiment, the system 100 may comprise one or more solar panels 102.

[0023] In an embodiment, [Fig.1] discloses a front side 102a and a rear side 102b of the at least one bifacial solar panel 102.

[0024] The solar panel is configured to be a bifacial solar panel 102. The at least one bifacial solar panel 102 are supported on a tracker structure/ tracker 106, wherein the tracker structure is of a predetermined height from the ground. The at least one bifacial solar

panel 102 may comprise a bifacial solar panel 1, a bifacial solar panel 2, ..., a bifacial solar panel n.

[0025] In an embodiment, the at least one rotator 104 is operatively connected to the tracker structure 106. In an embodiment, the at least one bifacial solar panel 102 are placed adjacently on the tracker structure 106. In an embodiment, the at least one rotator 104 is placed in between the at least one bifacial solar panel 102.

[0026] In an embodiment, the at least one tracker 106 is operatively coupled to the at least one bifacial solar panel 102.

[0027] In an embodiment, with respect to [Fig.1], the at least one tracker 106 is configured to track the direction of the sun and enable the movement of the at least one bifacial solar panel 102 via the at least one rotator 104. In an embodiment, the at least one tracker 106 is implemented to track the movement of the sun to enable movement of the at least one bifacial solar panel 102 to capture more solar irradiance for better energy generation. The position of the at least one tracker 106 at any given time of the year depends on the sun's position all around the year and the one or more real time cloud data inputs of the location.

[0028] In an embodiment, the at least one tracker 106 tracks the movement of the sun, thereby enabling movement of the at least one bifacial solar panel 102. The front side 102a of the bifacial solar panel 102 is exposed to direct sunlight, whereas the rear side 102b of the bifacial solar panel 102 is exposed to indirect sunlight. Indirect sunlight may be considered as including but not limited to, the sunlight reflecting off the ground, or diffused sunlight emitting from clouds. However, as the at least one bifacial solar panel 102 rotate according to the sun's movement, the front side 102a of the at least one bifacial solar panel 102 capture more sunlight compared to static solar panels or bifacial solar panels thereby further enabling the rear side 102b of the bifacial solar panel 102 to capture more indirect sunlight, thereby capturing maximum sunlight using the rotating bifacial solar panels 102.

[0029] In an alternate embodiment, the at least one tracker 106 may be operatively coupled to the at least one bifacial solar panel 102, wherein the at least one tracker 106 is configured to the at least one rotator 104 such that each photovoltaic module may be rotated according to requirements.

[0030] With the advent of bifacial solar photovoltaic modules, the at least one tracker 106 and the at least one bifacial solar panel 102 are not sufficient to identify the optimum position of tracker angle. Hence to determine the optimal tracking trajectory angle of solar bifacial tracker 106, function of factors as indicated below shall be adopted. In an embodiment, an algorithm embedded in the processing unit 108 is implemented to find the maximum generation of sunlight at a particular location by combining the generation of both front side 102a and rear side 102b generation.

- [0031] Front side generation, $F1=f(\text{Sun's position, angle of tracker, cloud cover})$
- [0032] Rear side generation, $F2=f(\text{Sun's position, angle of tracker, ground albedo, tracker height})$
- [0033] Optimum Tracking Trajectory angle, $F_{\max}=f(F1, F2)$
- [0034] In an embodiment, the processing unit 108 is configured to find the optimal tracking trajectory angle at a particular location by combining the generation of both front side (F1) 102a and rear side (F2) 102b generation of the at least one bifacial photo voltaic panel 102, wherein the F1 and F2 comprises:
- [0035] Front side generation, $F1= f(\text{Data input 1,Data input 2,Data input 3})$
- [0036] Rear side generation, $F2= f(\text{Data input 1,Data input 4,Data input 5})$
- [0037] Optimum Tracking Trajectory angle, $F_{\max}=f(F1, F2)$
- [0038] In addition, any of the inputs may be incorporated in the formulae to provide additional value in optimization of the rear side generation and can be considered in some algorithms. In an embodiment, the inputs comprise module properties, diffusion, diffusion reflection, ground irradiance, shadow of the at least one tracker 106 parts, sun's beam reflection. Each of these factors play a significant role in calculating solar efficiency of the rear side of the bifacial solar panel, thereby increasing overall efficiency. With the at least one bifacial solar panel 102 moving along the sun's direction, it is important to consider the above-mentioned factors as the sun's angle changes, and changing weather conditions throughout a day, as the above-mentioned factors keep changing when trying to calculate the overall solar efficiency of the bifacial solar panel.
- [0039] In an embodiment, the processing unit 108 is communicatively connected to the bifacial solar panel 102 to enable the intelligent tracking and optimization of the bifacial solar panels, contributing to the system's ability to harness maximum sunlight and increase energy generation. The processing unit is positioned within the at least one tracker 106. The processing unit 108 analyzes various data inputs, such as solar irradiance, panel orientation, tilt angle, weather conditions, and historical data, to determine the optimal trajectory for the bifacial solar panels. It may process this information to calculate the most efficient position for the panels to maximize sunlight exposure and energy generation.
- [0040] Furthermore, the processing unit 108 may control the movement of the at least one rotator mechanism responsible for adjusting the position of the solar panels. It can receive one or more real-time data inputs from sensors or other sources and use algorithms or mathematical models to calculate and adjust the tracking trajectory of the panels accordingly. Furthermore, based on the analyzed data and algorithms, the processing unit 108 can make informed decisions regarding the rotation angles, speed, and timing of the panels to optimize energy generation. It may consider factors such as

the position of the sun, shading effects, and the electrical output of the panels to make these decisions.

[0041] The processing unit 108 may also facilitate communication between various components of the system. It could exchange information with the solar panels, tracker 106 units, and other monitoring devices to coordinate the tracking trajectory and ensure efficient operation of the bifacial PV panel system.

[0042] [Fig.2] illustrates a method for determining optimal tracking trajectory of bifacial photo voltaic panels, in accordance with an embodiment of the present disclosure.

[0043] The method 200 begins with providing at least one bifacial photo voltaic panel 102 that comprises a front side and a rear side solar panel, as depicted at step 202. Subsequently, the method 200 discloses rotating the at least one bifacial photo voltaic panel 102 along with a direction of sun by a at least one rotator 104 operatively connected to the at least one bifacial photo voltaic panel 102, as depicted at step 204.

[0044] Thereafter, the method 200 discloses tracking a movement of the sun by at least one tracker 106 operatively coupled to the at least one bifacial photo voltaic panel 102, the at least one tracker 106 having a processing unit for analyzing one or more data inputs and determining optimal trajectory for the at least one bifacial photo voltaic panel 102 to harness maximum sunlight and increase energy generation, as depicted at step 206.

[0045] The advantage of the current invention comprises harnessing maximum solar energy using the tracker to rotate the bifacial solar panels.

[0046] The system provides a user-friendly and cost-effective solution to capture maximum sunlight.

[0047] The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modification within the scope of the embodiments as described here.

Claims

- [Claim 1] A system (100) for determining optimal tracking trajectory of bifacial photo voltaic panels, the system comprising:
at least one bifacial photo voltaic panel (102) that comprises a front side and a rear side solar panel;
at least one rotator (104) operatively connected to the at least one bifacial photo voltaic panel (102) configured to rotate the at least one bifacial photo voltaic panel (102) along with a direction of sun; and
at least one tracker (106) operatively coupled to the at least one bifacial photo voltaic panel (102) to track a movement of the sun, wherein the at least one tracker having a processing unit that is configured to analyze one or more data inputs and determine optimal trajectory for the at least one bifacial photo voltaic panel (102) to harness maximum sunlight and increase energy generation.
- [Claim 2] The system (100) as claimed in claim 1, wherein a tracker structure of a predetermined height from the ground is provided to support the at least one bifacial photo voltaic panel (102).
- [Claim 3] The system (100) as claimed in claim 1, wherein the at least one tracker (106) is configured to adjust a position of the at least one bifacial photo voltaic panel (102) based on one or more real-time cloud data inputs and the sun's position throughout a year.
- [Claim 4] The system (100) as claimed in claim 1, wherein the at least one bifacial photo voltaic panel (102) is placed adjacently on the tracker structure, and wherein the at least one rotator (104) is placed to rotate the at least one bifacial photo voltaic panel (102).
- [Claim 5] The system (100) as claimed in claim 1, wherein the one or more data inputs, comprising at least one of solar irradiance, panel orientation, tilt angle, weather condition, module properties, diffusion, diffusion reflection, ground irradiance, shadow of the at least one tracker parts, sun's beam reflection, and historical data, to calculate the optimal trajectory for the at least one bifacial photo voltaic panel (102).
- [Claim 6] The system (100) as claimed in claim 1, wherein the processing unit (108) is configured to find the optimal tracking trajectory angle at a particular location by combining the generation of both

front side (F1) (102a) and rear side (F2) (102b) generation of the at least one bifacial photo voltaic panel (102), wherein the F1 and F2 comprises:

Front side generation, $F1=f(\text{Data input 1, Data input 2, Data input 3})$

Rear side generation, $F2=f(\text{Data input 1, Data input 4, Data input 5})$

Optimum Tracking Trajectory angle, $F_{\max}=f(F1, F2)$

[Claim 7]

A method (200) for determining optimal tracking trajectory of bifacial photo voltaic panel, the method comprising:

providing at least one bifacial photo voltaic panel (102) that comprises a front side and a rear side solar panel;

rotating the at least one bifacial photo voltaic panel (102) along with a direction of sun by at least one rotator (104) operatively connected to the at least one bifacial photo voltaic panel (102);

tracking a movement of the sun by at least one tracker (106)

operatively coupled to the at least one bifacial photo voltaic

panel (102), the at least one tracker having a processing unit

for analyzing one or more data inputs and determining optimal

trajectory for the at least one bifacial photo voltaic panel (102) to harness maximum sunlight and increase energy generation.

[Claim 8]

The method (200) as claimed in claim 7, comprising providing a tracker structure of a predetermined height from the ground to support the at least one bifacial photo voltaic panel (102).

[Claim 9]

The method (200) as claimed in claim 7, comprising adjusting a position of the at least one bifacial photo voltaic panel (102) by the at least one tracker (106) based on one or more real-time cloud data inputs and the sun's position throughout a year.

[Claim 10]

The method (200) as claimed in claim 7, comprising adjacently placing the at least one bifacial photo voltaic panel (102) on the tracker structure, and placing the at least one rotator (104) to rotate the at least one bifacial photo voltaic panel (102).

[Claim 11]

The method (200) as claimed in claim 7, comprising the one or more data inputs, comprises at least one of solar irradiance, panel orientation, tilt angle, weather condition, module properties, diffusion, diffusion reflection, ground irradiance, shadow of the at least one tracker parts, sun's beam reflection, and historical data, to calculate the optimal trajectory for the at least one bifacial photo voltaic panel (102).

[Claim 12]

The method (200) as claimed in claim 7, comprising finding the optimal tracking trajectory angle at a particular location by combining the generation of both front side (F1) (102a) and rear side (F2) (102b) generation of the at least one bifacial photo voltaic panel (102),

wherein the F1 and F2 comprises:

Front side generation, $F1=f(\text{Data input 1, Data input 2, Data input 3})$

Rear side generation, $F2=f(\text{Data input 1, Data input 4, Data input 5})$

Optimum Tracking Trajectory angle, $F_{\max}=f(F1, F2)$

[Fig. 1]

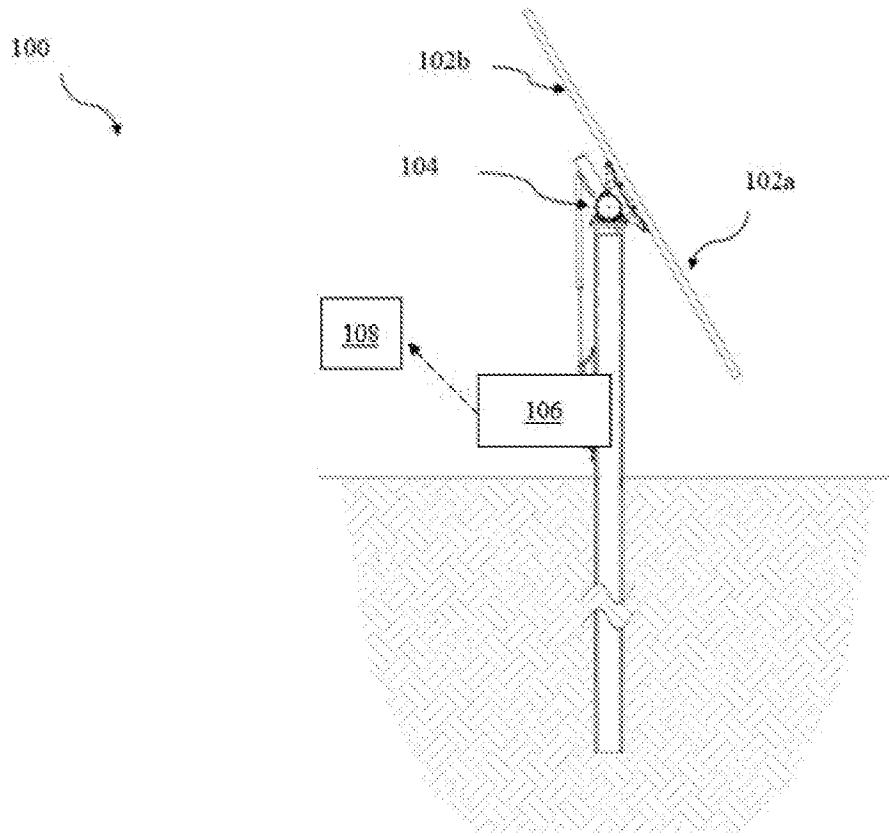


Fig. 1

[Fig. 2]

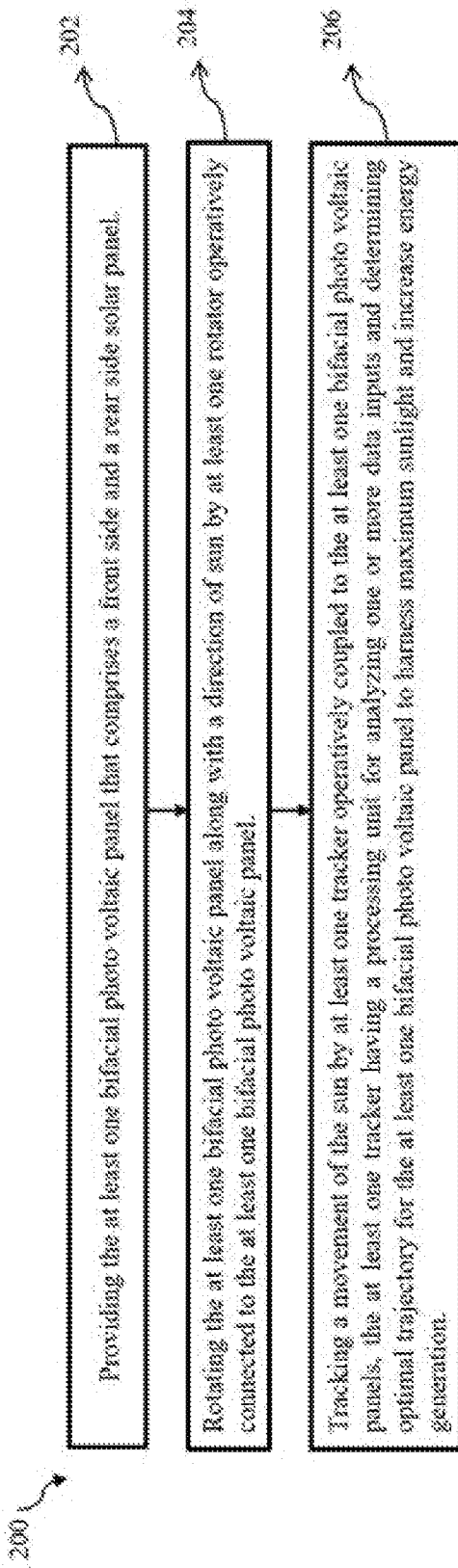


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2024/050695

A. CLASSIFICATION OF SUBJECT MATTER G05D3/12, H02S20/32, F24S50/20, F24S30/40 Version=2024.01		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) G05D, H02S, F24S		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic database consulted during the international search (name of database and, where practicable, search terms used) PatSeer, IPO Internal Database		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP3913795A1 (SOLTEC INNOVATIONS SL) 24 November, 2021 (24-11-2021) Abstract, Paragraph [0003, 0011, 0024, 0025, 0027]	1-12
Y	CN213717907U (GUANGZHOU ZHONGXU NEW ENERGY CO LTD) (English translation from Google Patents) 16 July, 2021 (16-07-2021) Abstract, Figure 1 & 3	1-12
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
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