

MOORING OF FLOATING PHOTOVOLTAIC POWER PLANTS

FIELD

The present disclosure relates to mooring systems for floating photovoltaic (solar)
5 power plants and arrangements for mooring an array of floating solar panel
arrangements in a body of water.

BACKGROUND

Floating photovoltaic (solar) power plants (FPV) have gained increasing interest
10 over the recent years, and such technology is being developed by a number of
companies. Mooring systems for surface floating structures in such plants have,
however, not been studied in detail, but such mooring is important to ensure reliable
installation and operation. For example, in many parts of the world, such plants may
periodically be exposed to strong winds (e.g., typhoons), waves and/or sea currents.

15 Documents which may be useful for understanding the field of technology include
WO 2017/209625 A1, WO 2020/040643 A9, CN 110304210 A and KR
20120073789 A.

When deploying a large number of floating structures in dense layouts (e.g. for the
purpose of space utilization / space saving), it may be difficult to access a floating
20 structure or floating structures located towards the centre of existing mooring
systems, particularly as the floating structures may be interconnected, and access
may be limited. For a large system with many floating structures, vessel accessibility
to all floating structures may be of necessity for regular maintenance. At the same
time, a structurally adequate mooring is required, having low risk of failure, also in
25 challenging weather conditions. Because of the inherent problems with the related
arts, there is a need for a new and improved mooring system for multi-structure
mooring systems allowing accessibility (e.g. by a maintenance vessel) to an FPV
unit over extended periods of operating time and in varying weather conditions.

SUMMARY

It is an object of the present disclosure to mitigate, alleviate or eliminate one or more of the above-identified deficiencies and disadvantages in the prior art, or at least to provide useful alternatives to the state of the art.

- 5 In an embodiment, there is provided a mooring system for securing an array of solar panel arrangements in a body of water, the system comprising a floating structure comprising a plurality of solar panel arrangements, each comprising a floating collar and a plurality of photovoltaic panels arranged inside and supported by the floating collar via a mat on which the plurality of photovoltaic panels are arranged, the mat
10 being fixed to the floating collar, and wherein the floating structure comprises a polygonal, horizontally arranged peripheral frame to which the plurality of solar panel arrangements are fixed via the floating collar, the plurality of solar panel arrangements are arranged inside the peripheral frame, and the peripheral frame is fixed to a plurality of anchors via mooring lines.
- 15 Further inventive aspects and embodiments according to the present disclosure are outlined in the detailed description below and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

- Figures 1A to 1D illustrate a first example of a mooring system for solar panel
20 arrangements anchored by mooring lines.

Figure 1E illustrates a solar panel arrangement suitable for use with or as part of mooring systems of the present disclosure.

Figures 2A to 2E illustrate a second example of a mooring system partially anchored by mooring lines.

- 25 Figures 3A to 3J illustrate a third example of a mooring system, partially anchored by mooring lines.

Figure 4 illustrates a further example of a floating structure with a mooring system.

Figures 5A to 5E illustrate a mooring system with interconnecting lines.

- Figures 6A and 6B illustrate a further example of a mooring system including
30 additional access elements.

Figures 7A and 7B illustrate a further example of a mooring system.

Figure 8 illustrates a further example of a mooring system anchored by mooring lines.

DETAILED DESCRIPTION OF THE DRAWINGS

- 5 The following description may use terms such as “horizontal”, “vertical”, “lateral”, “back and forth”, “up and down”, “upper”, “lower”, “inner”, “outer”, “forward”, “rear”, etc. These terms generally refer to the views and orientations as shown in the drawings and that are associated with a normal use of the invention. The terms are used for the reader’s convenience only and shall not be limiting.
- 10 Illustrated in Figure 1A is a mooring system 15. The mooring system 15 comprises a first and a second floating structure 20, 22.

In this example, the first and the second floating structures are substantially identical and comprise a plurality of solar panel arrangements 5. In some examples, the first and second floating structures 20, 22 may be a mirror image of one another. Each of the solar panel arrangements 5 may be configured to float on the surface of a body of water (not shown), and each of the solar panel arrangements 5 may comprise one solar panel, or a plurality of solar panels thereon, and in some examples a material such as a mat, net, sheet, cover or the like on which at least one solar panel is supported. Each solar panel arrangement 5 may comprise a frame or border material 6, which may comprise a connector and assist in the connection of the solar panel arrangements 5, and may assist to fortify the solar panel arrangements 5, for example against collision with another object. Although not illustrated in this example, it should be understood that there is no requirement for each of the floating structures 20, 22 to be identical. For example, one of the floating structures 20, 22 may comprise more or fewer solar panel arrangements 5 as part thereof, and/or may comprise the solar panel arrangements having a different arrangement. In Figure 1A, the solar panels arrangements 5 are arranged in a trapezoidal form (in particular, the solar panel arrangements 5 are arranged in the form of a parallelogram), however the solar panel arrangements 5 may be arranged in a different form, as will be described with reference to the following figures.

Each of the solar panel arrangements 5 may be connected (e.g. tethered) together, for example by a tie, such as a rope, cable, rigid connector, bar or the like. As such, the solar panel arrangements 5 may be able to maintain their configuration when floating in a body of water. In some examples, the floating structures 20, 22 may

comprise alternative or additional means to enable maintaining the form of the solar panel arrangements 5, such as by having a peripheral frame 4 (e.g. the solar panel arrangements 5 being contained within a peripheral frame 4), which may additionally define the boundary of the floating structures 20, 22. By holding the solar panel
5 arrangements 5 together in a desired configuration, access to the solar panels may be facilitated, for example for maintenance or cleaning operations.

In this example, each of the floating structures 20, 22 comprises a rectangular shaped frame 4, which defines the perimeter of the floating structure 20, 22, and which may assist to hold each of the solar panel arrangements 5 in place. Here,
10 mooring lines 2 are used to anchor the floating structures 20, 22 to anchor points 1 in the body of water. The anchor point 1 may be, for example, a location on the seabed or ocean floor, may be a lakebed, or may be a subsea or underwater structure to which a mooring line 2 may be attached. In this example, the mooring lines 2 connect to the peripheral frame 4. The mooring lines 2 may connect to the
15 solar panel arrangements 5 via the peripheral frame 4. In other examples, such as where the peripheral frame 4 is absent from the floating structure 20, 22 the mooring lines 2 may connect directly to a solar panel arrangement 5, or to a plurality of solar panel arrangements 5.

As illustrated, the floating structures 20, 22 may be held in place by multiple mooring
20 lines 2. Here, a mooring line 2 is connected to each corner of the rectangular frame 4 of the floating structures 20, 22. Mooring lines 2 may also be connected to the mid-section of the length of the peripheral frame 4 (in this case at two points along the length). Alternatively and as is shown in Figure 1A, the mooring lines 2 (e.g. at least one of a plurality thereof) may be attached to the solar panel arrangements 5
25 themselves, for example attached to the part of the solar panel arrangement 5 at the point of contact with the peripheral frame 4. In the examples of Figure 1A and Figure 1B, the mooring lines 2 are attached to the point of contact between the solar panel arrangement 5 and the peripheral frame 4 at a mid-section of an edge of the peripheral frame. In Figures 1C and 1D, which illustrate an elevation view of the
30 floating structures 20, 22 and mooring system arranged at a surface 29a and in a body of water 29. The mooring lines 2 can be seen hanging in a catenary style from the peripheral frame 4 to the anchor point 1 on the ocean floor.

In the centre of Figure 1A, it can be seen that, in order to anchor the floating structures 20, 22 in place, mooring lines 2 from each of the floating structures 20, 22
35 extend an/or be at least partially located underneath (e.g. directly vertically

underneath) the adjacent floating structure 20, 22, as is best seen in Figure 1C. In doing so, each floating structure 20, 22 can be securely anchored in place in close proximity to an adjacent floating structure 20, 22. For example, each floating structure 20, 22 may comprise a mooring line for restricting motion thereof in all
5 surface dimensions (e.g. restricted motion along the X- and Y-axes of motion in the horizontal plane).

The catenary form of the mooring lines 2 may provide some slack in the mooring lines such that relatively small movements of the floating structures 20, 22 caused by the wind, waves, etc. are possible without producing excessive tension in the
10 mooring lines 2.

As illustrated in Figure 1A, the configuration of the mooring lines 2, and the shape of the floating structures 20, 22, are such that the first floating structure 20 is able to be positioned and anchored on the body of water adjacent to the second floating structure 22. An access channel 7 is formed between the first floating structure 20
15 and the second floating structure 22. The access channel may permit a vessel 8 (see Figure 1D) access to solar panel arrangements 5 that are located along adjacent edges of the floating structures 20, 22, for example along the edge of the peripheral frame 4 of one floating structure 20 that is located adjacent an edge of a peripheral frame 4 of a second of the floating structures 22. In providing an access
20 channel 7, a user is able to easily access solar panel arrangements 5 on all sides of each of the floating structures 20, 22, and no access is blocked as a result of the array arrangement of the floating structures 20, 22, thereby resulting in a space-efficient and easily accessible layout of floating structures.

The access channel 7 may be dimensioned so as to be relatively narrow compared
25 to the dimensions of the floating structures 20, 22 (e.g. less than half the width of a floating structure, less than a quarter of the width, or the like). The access channel 7 may be dimensioned so as to permit access to a vessel such as a maintenance vessel, or a vessel for installation or retrieval of components, e.g. for providing access to a service vessel. This is illustrated most clearly in Figure 1D. Also visible
30 is the catenary configuration of the mooring lines 2.

Here, it is shown that the mooring lines extend below each of the floating structures 20, 22, downwards through the body of water. This may have the effect of preventing interference between the vessel 8 and the mooring lines 2, while simultaneously permitting the floating structures 20, 22 to be positioned in close
35 proximity. A vessel 8 may therefore enter the access channel 7, and may be able to

access either or both of the floating structures 20, 22, for example so as to repair, maintain, or replace any parts of the solar panel arrangements 5.

In Figure 1B, the mooring system 15 of Figure 1A is illustrated reconfigured. In the illustration of Figure 1B, the solar panel arrangements 5 are arranged in the form of a rectangle (e.g. a rectangular array) as opposed to having a trapezoidal form as in Figure 1A. As such, the width of the floating structures 20, 22 of Figure 1B may be greater than in Figure 1A, although the length may be smaller. The floating structures 20, 22 may have similar shapes. The floating structures may have tessellate shapes, for example the same or different tessellate shapes. The floating structures may be shaped so as to have at least one flat edge. The flat edge of one floating structure may be adjacent the flat edge of another floating structure. In some example, a floating structure or the floating structures may comprise at least one flat edge and at least one curved edge. There may be many reasons for desiring either the configuration of Figure 1A or Figure 1B, for example due to the space available, due to connection requirements of the solar panel arrangements 5, or the like.

Although the configuration of solar panel arrangements 5 is different between Figures 1A and 1B, there are many similarities. For example, in both Figures, the floating structures 20, 22 are surrounded by a frame 4, and both structures are positioned and anchored in place by similar configurations of mooring lines. In both Figures, the mooring lines are connected to the corners of the peripheral frame 4, as well as to the solar panel arrangements 5 along the mid-length of the floating structures 20, 22 at the point of contact between the solar panel arrangement 5 and the peripheral frame 4.

In both examples, each of the floating structures 20, 22 comprises twelve solar panel arrangements 5, although it should be noted that other examples where each floating structure 20, 22 comprises more or fewer floating structures are also possible.

Additionally illustrated in Figures 1A and 1B are a plurality of mooring buoys 3, located at the corners of each of the floating structures 20. The mooring buoys 3 may be located at corners of the peripheral frame(s) 4. The mooring buoys 3 may assist to provide the floating structures 20, 22 with buoyancy, and may also assist to counteract the weight or other downforce of any mooring line 2 on the floating structure 20, 22. A mooring line 2 may be attached to a buoy 3 as well as, or instead of, being attached to the peripheral frame 4 and/or solar panel arrangement 5 of the floating structures 5.

Fig. 1E illustrates an example of a solar panel arrangement 5 suitable for use with examples and embodiments of the present disclosure. The solar panel arrangement 5 may comprise frame in the form of a floating collar 30, for example a circular or substantially circular floating collar 30, with a plurality of photovoltaic panels 31 arranged inside and supported by the floating collar 30. The photovoltaic panels 31 can be supported by the floating collar 30 via a mat 32 on which the photovoltaic panels 31 are arranged, where the mat 32 is fixed to the floating collar 30. The solar panel arrangements 5 can be fixed to the peripheral frame 4 via the floating collar 30.

10 Illustrated in Figures 2A to 2E is a second example of a mooring system 115. As the example of Figures 2A to 2E bears some similarities to that of Figures 1A to 1D, for the sake of succinctness alike features will not be described again. Reference is made to the description above.

As with the previous example, and as can be best seen in Figures 2A, 2B and 2C, the floating structures 20, 22 are positioned and anchored so as to provide an access channel 7 therebetween. In this example, the floating structures 20, 22 are partially held in place by mooring lines 2. In the example of Figures 2A to 2E, the rectangular or trapezoidal floating structures 20, 22 are held in place by mooring lines 2 on three of four sides, and in this case on three of four sides of the peripheral frame 4. Here, the side of the floating structure located nearest (and in this example parallel to) the adjacent floating structure is positioned and anchored by a vertical column, or in this example by a plurality of vertical columns 9.

The vertical columns are located along the side of the floating structure 20, 22 that is nearest the adjacent floating structure 20, 22, and the vertical columns 9 may be considered to be located inside the access channel 7.

Similar to the previous example, the vertical columns 9 are connected to the floating structure 20, 22 at the point of contact between the peripheral frame 4 and the solar panel arrangement 5 (e.g. a midpoint of an edge of the peripheral frame 4), and provide an anchor for the floating structures 20, 22 on the seabed, ocean floor, subsea structure, or the like.

Figure 2E illustrates the connection between the floating structure 20, 22 and the vertical column 9. Here, the floating structure, which may be connected by the peripheral frame 4 or the solar panel arrangement 5, is connected to the vertical column 9 via a connection member 10. The connection member 10 may be or comprise a tie or cable. In this example, the connection member 10 comprises a

mooring buoy 3, which may additionally provide buoyancy to the floating structure. The connection member 10 additionally comprises a connection to the vertical column 9, which may be in the form of a bracket, a loop, a clamp, a tie, or the like (an example of which can be seen in Figure 2E).

- 5 The example of Figures 2A to 2E may permit a vessel to traverse the access channel 7 without having mooring lines positioned underneath the vessel. Therefore, the example of Figures 2A to 2E may provide additional safety to vessels, and to the mooring system, as it reduces the likelihood of a collision between the vessel 8 and a mooring line 2.

- 10 Figures 3A to 3J illustrate a further example of a mooring system 215. This example has many features in common with the previous examples, and once again for the sake of succinctness, these features will not be described again.

- As with the previous example, and as can be best seen in Figures 3A, 3C, 3D and 3F, the floating structures 20, 22 are positioned and anchored so as to provide an access channel 7 therebetween. In this example, the floating structures 20, 22 are partially held in place by mooring lines 2. In the example of Figures 3A to 3J, the rectangular or trapezoidal floating structures 20, 22 are held in place by mooring lines 2 on three of four sides, and in this case on three of four sides of the peripheral frame 4. Here, the side of the floating structure located nearest (and in this example parallel to) the adjacent floating structure is anchored in position relative to the adjacent floating structure 20, 22 by a connector, or by a plurality of connectors 11.

The connector or plurality of connectors 11 may be in the form of a rigid bar or elongate member, a flexible tie, a telescopic member, or the like. The connectors 11 may be in the form of bridle lines, as described in relation to e.g. Figs 5A-5E below.

- 25 In this example the connectors 11 attach to the floating structures 20, 22 at the point of contact between the peripheral frame 4 and the solar panel arrangement 5, and may attach to either or both of the solar panel arrangement and/or the peripheral frame 4. As is illustrated in Figure 3A, two connectors 11 may extend from a single connection point on one of the floating structures 20, and connect to two separate points on the adjacent floating structure 22, in a triangular configuration, which may provide additional strength benefits to prevent external forces from urging the floating structures 20, 22 together. The connectors 11 may extend between the floating structures 20, 22 at an oblique angle, as is shown in this example. Figure 3B shows the triangular configuration in greater detail, and the connection of each of the connectors 11 at the point of contact between the solar panel arrangements 5

and the peripheral frame 4. In some examples, the connectors 11 may connect to only the peripheral frame 4 and in cases where there is no peripheral frame 4, then the connectors 11 may connect only to the solar panel arrangements 5.

5 The connection between the connectors 11 and the floating structures 20, 22 may be fixed so as to prevent translational movement of the connector 11 relative to the floating structures 20, 22. In some examples, the connectors 11 may permit some degree of rotational movement between the floating structures 20, 22 and the connector 11, and may permit small movements or rotations of one floating structure relative to the other.

- 10 Although not illustrated, a similar configuration may be possible whereby the connectors 11 extend from the floating structures 20, 22 obliquely, but in the same direction (in contrast to extending obliquely in opposite directions, as illustrated in Figures 3A and 3B), and in some examples may extend obliquely in the same direction, so as to be parallel.
- 15 In Figure 3C, a further example of a mooring system 215 is illustrated, wherein the floating structures 20, 22 are connected by a plurality of connectors 11. In this example, the connectors 11 extend from the floating structures 11 parallel to one another, and in the case where the floating structures 20, 22 have a peripheral frame, the connectors 11 may extend perpendicular to the peripheral frame. The
- 20 connectors may be rigid or flexible. The connectors may be made from a connection bar or rod, a cable, cord, rope or the like.

- Additionally illustrated in Figure 3C is the connectors 11 connecting each of the floating structures 20, 22 at their width, rather than their length, as is illustrated in the previous Figures. As in previous examples, the access channel 7 is formed
- 25 between the adjacent sides of the floating structures 20, 22, and the access channel 7 is shorter in this example, since the adjacent sides of the floating structures 20, 22 is a width, rather than a length. As can be seen in Figure 3C, each floating structure 20, 22, is still partially positioned and anchored in place by mooring lines 2, which are able to be appropriately configured depending on the sides of each of the
- 30 floating structures 20, 22 that are adjacent. As in the previous examples, a mooring line 2 is connected to each of the corners of the floating structures 20, 22. Since, in this case, the length of the floating structures 20, 22 is significantly greater than the width, additional sets of mooring lines 2 are connected along the length of the floating structures 20, 22. In this case, the length is not the adjacent side of one
- 35 floating structure 20, 22 to another floating structure 20, 22.

An additional example of parallel connectors 11 is illustrated in Figure 3D, where the parallel connectors 11 connect two floating structures 20, 22 along their length. Although only two parallel connectors are illustrated in Figure 3D, it should be understood that in some examples, more parallel connectors 11 may be used.

5 Further detail of the parallel connectors 11 is illustrated in Figure 3E. From this figure, it can be seen that the connector 11 extends perpendicularly to the peripheral frame 4, and from the point of contact between the solar panel arrangement 5 and the peripheral frame 4. Here the connector 11 is oriented so as to be aligned with the centre point of the solar panel arrangement 5.

10 It is made clear from the comparison between the Figures 3C and 3F that it is possible to connect a first floating structure 20 to a second floating structure 22 along their width with the solar panel arrangements 5 having different configurations – in this example a rectangular and a trapezoidal configuration are shown. As illustrated, in the trapezoidal configuration, the connectors 11 may be lengthened in
15 order to connect one solar panel arrangement 5 to another of the adjacent floating structure 20, 22. Also, it is clear in the example of Figure 3C that the connector 11 connects only to the solar panel arrangement.

Figures 3G, 3H and 3J illustrate the connection between the adjacent floating structures 20, 22. As can be seen, and as is the case in previous examples, the
20 floating structures 20, 22 comprise mooring buoys 3 around their periphery. Additionally visible is that the connectors 11 extend through the access channel 7 between the floating structures, and along the surface of the body of water. As such, the connectors 11 may be buoyant, or may comprise buoyancy members, to ensure that they remain on the surface of the body of water.

25 Similar to previous examples, the access channel 7 is sufficiently wide so as to allow passage of a vessel therethrough. It may be possible for a vessel to disconnect individual connectors temporarily, thereby granting the vessel passage through the access channel. The connectors may be manually releasable, or their disconnection may be powered by a motor and optionally may be automatic (e.g. a sensor may be
30 used to detect the presence of a nearby vessel and disconnect the nearest connector 11).

Illustrated in Figure 4 is a further example of a mooring system 315 comprising a floating structure 20. In this example the floating structure 20 comprises a rhombus shape, and comprises four solar panel arrangements 5, each of the solar panel
35 arrangements being in contact with the peripheral frame 4 at two points of contact.

The solar panel arrangements in this example have a two-by-two arrangement, although it should be noted that other arrangements may also be possible, for example a four-by-four, three-by-four, five-by-three or the like. In such arrangements, there may be no requirement for each of the solar panel

5 arrangements 5 to have two points of contact with the peripheral frame 4, and some may have one or no contact points therewith.

Although only one floating structure 20 is illustrated, further floating structures may be moored adjacent, and may have the same shape as that of Figure 4, or a different shape, such as that illustrated in Figures 1A to 3J. Where a floating

10 structure is moored adjacent, an access channel 7 may be provided in a way to that previously described.

In this example, each corner 12 of the floating structure 20 comprises two mooring lines 2 connected thereto, although in some examples one or all of the corners may have just one mooring line attached thereto, or more than one.

15 Figures 5A to 5E illustrate a further example of a mooring system 415 comprising a floating structure 20. In this example the floating structure 20 has a rectangular shape and comprises six solar panel arrangements 5. Additional connecting devices 13 comprising for example ropes, attach the solar panel arrangements 5 to the peripheral frame 4. The connecting devices 13 are in this example bridle lines, i.e.

20 lines having two or more line parts with distributed connection points at the solar panel arrangement 5. In Figs 5A and 5B, there is shown twelve connection points for each solar panel arrangement 5. The connecting devices 13 may be attached directly or indirectly (for example, via buoyancy elements 3) to the peripheral frame 4, or optionally directly to mooring lines 2 or to additional buoyancy elements 3.

25 The solar panel arrangements 5 may be positioned in a rectangular or square grid, and may be connected directly adjacent to each other or with a clearance. The solar panel arrangements 5 may further be connected directly to each other by connectors 11 (see Fig. 3E) or connecting devices 13. In Figs 5A and 5B, the solar panel arrangements 5 are connected to each other by bridle lines.

30 Illustrated in Fig. 5A, the mooring system may comprise one or more connection hubs 25 located within the peripheral frame 4, and to which connecting devices 13, such as bridle lines, from several solar panel arrangements 5 are connected. The connection hubs 25 may be spaced from each solar panel arrangement 5, for example located with approximately the same distance to each solar panel

35 arrangement 5 to which the respective connection hub 25 connects. This may be

beneficial for load distribution, for example in order to permit a suitable spread of the bridle lines.

The connecting devices 13 may decouple the vertical motion of adjacent solar panel arrangements 5 in waves to enhance robustness of the floating structure 20 in
5 severe environmental conditions.

The peripheral frame 4 may be located on the water surface or submerged below the water surface, exemplified in Fig 5C. In case the peripheral frame 4 is submerged below the water surface, access for vessels can be permitted above the submerged peripheral frame 4.

10 Multiple adjacent floating structures 20 may be in close proximity, where bottom attachments may be located under a neighbouring floating structure 20. The structure may be extended in one or more directions, comprising additional solar panel arrangements 5.

The floating structure 20, the peripheral frame 4 and the solar panel arrangements 5
15 may be moored by means of catenary style mooring lines 2, exemplified in Fig. 5D. The system may alternatively be moored by taut style mooring lines 2, exemplified in Fig 5E. The taut mooring lines can be flexible or rigid and may comprise additional elastic elements 14 providing elasticity to the mooring lines 2. Alternatively, the system may be moored by a combination of the two mooring line arrangements, by
20 a combination of different style mooring lines or by each individual mooring line exhibiting properties of both above mentioned mooring line types.

Figures 6A and 6B illustrate a mooring system 515 for a floating structure 20 with the inclusion of additional buoyant elements 17, serving as attachment points for each individual solar panel arrangement 5. The buoyant elements 17 may be
25 walkable (i.e., arranged such that a person can walk on the buoyant element 17) and provide access to each individual solar panel arrangement 5. The solar panel arrangements 5 may be connected to the additional buoyant elements 17 and to adjacent solar panel arrangements 5 by means of one or more connectors 11. The connector or plurality of connectors 11 may be in the form of a rigid bar or elongate
30 member, a flexible tie, a telescopic member, or the like.

The floating structure 20 may be moored by means of mooring lines 2, which may comprise catenary style or taut style mooring lines, or a combination of mooring lines styles. Further, station keeping of the floating structure 20 may be achieved by bank anchoring or land anchors, or a combination of bottom attachment points and

bank anchoring. The connections to mooring lines 2 may be directly to one or more solar panel arrangements 5, directly to the buoyant element 17, or a combination. Optionally, the mooring system 515 may further comprise a peripheral frame 4, to which the solar panel arrangements 5 and/or the buoyant elements 17 are
5 connected.

The buoyant elements 17 may be flexible or rigid and may comprise one or several parts. The elements 17 may be constructed to allow transport of people and/or equipment thereon, by means of walking or vehicles, such as trolleys.

Illustrated in figure 7A is a mooring system 615 for a floating structure 20, with three
10 solar panel arrangements 5 connected within a peripheral frame 4. Figure 7B illustrate the same arrangement in a repeated pattern, and the pattern may be further repeated/extended to create larger floating arrays. The peripheral frame 4 may be supported by three or more mooring lines 2, exemplified with six mooring lines 2 in figure 7A. Each solar panel arrangements 5 is attached to the peripheral
15 frame 4 and to at least one other solar panel arrangement 5.

Figure 8 illustrate a further example of a mooring system 915 comprising a floating structure 20. In this example the floating structure 20 comprises seven floating solar arrangements 5, where the solar panel arrangements 5 have a polygonal, in this example a hexagonal, shape. One or more edges of a solar panel arrangement 5 is
20 positioned adjacent and parallel to edge(s) of a neighbouring solar panel arrangement 5. Connectors 11 as described above may be used for interconnecting the solar panel arrangements 5 for this purpose. Such interconnection may be arranged between corners of the solar panel arrangements 5, and/or between edges of the solar panel arrangements 5. The floating structure 20 is connected to mooring
25 lines 2.

Further inventive aspects and embodiments according to the present disclosure are outlined in the following numbered clauses.

A1. A mooring system for securing an array of floating structures in a body of water, comprising:

30 a first and a second floating structure, configurable to be positioned and anchored in a body of water via a respective first and second anchor arrangement, so as to form an array of adjacently located floating structures;

the first floating structure being positioned and anchored relative to the second floating structure so as to provide an access channel

therebetween, the access channel permitting access to at least one of the first and second floating structures in the array.

- 5 A2. The mooring system of any preceding clause, wherein the first and second floating structures each comprise a plurality of connected solar panel arrangements.
- A3. The mooring system of any preceding clause, wherein each of the plurality of solar panel arrangement comprises a plurality of solar panels.
- 10 A4. The mooring system of any preceding clause, wherein the plurality of solar panel arrangements are connected by a frame around the periphery of each of the first and second floating structures.
- A5. The mooring system of any preceding clause, wherein the plurality of solar panel arrangements are connected in one of a rectangular configuration; a trapezoidal configuration and a rhombus configuration.
- 15 A6. The mooring system of any preceding clause, wherein the access channel permits access to both the first and second floating structures in the array.
- A7. The mooring system of any preceding clause, comprising a third floating structure positioned adjacent to at least one of the first and second floating structures so as to provide an access channel between each adjacently positioned floating structure.
- 20 A8. The mooring system of any preceding clause, wherein each of the first and second anchor arrangement comprises a plurality of mooring lines, at least one mooring line from the first anchor arrangement extending in a catenary configuration under the second floating structure, and at least one mooring line from the second anchor arrangement extending in a catenary
- 25 configuration under the first floating structure.
- A9. The mooring system of any preceding clause, wherein each of the first and second anchor arrangement comprises at least one vertical column positioned in the access channel and extending from the respective first and second floating structure to an anchor point.
- 30 A10. The mooring system of any preceding clause, comprising removable connection members connecting the first and second floating structures and at least partially located in the access channel, for maintaining the relative positioning of the first and second floating structure.
- 35 A11. A method for mooring an array of floating structures in a body of water, the method comprising:

positioning and anchoring a first floating structure in a body of water;

- positioning and anchoring a second floating structure adjacent the first floating structure in a body of water, the first floating structure being positioned and anchored relative to the second floating structure so as to form an array of adjacently located floating structures and providing an access channel between the first and second floating structures;
- accessing at least one of the first and the second floating structure via the access channel.

Yet further inventive aspects and embodiments according to the present disclosure are outlined in the following numbered clauses.

- B1. A mooring system for securing an array of solar panel arrangements in a body of water (29), the system comprising:
a floating structure (20,22) comprising a plurality of solar panel arrangements (5).
- B2. The mooring system of any preceding clause, wherein the floating structure (20,22) comprises a peripheral frame (4) inside which and to which the plurality of solar panel arrangements (5) are fixed.
- B3. The mooring system of any preceding clause, wherein the peripheral frame (4) is submerged in the body of water, for example wherein the peripheral frame (4) is submerged to a depth of 1-3 m in the body of water.
- B4. The mooring system of any preceding clause, wherein the peripheral frame (4) comprises mooring buoys (3) fixed thereto.
- B5. The mooring system of any preceding clause, wherein the peripheral frame (4) is polygonal in a horizontal plane.
- B6. The mooring system of any preceding clause, wherein the peripheral frame (4) is polygonal and the mooring buoys (3) are arranged at corners of the peripheral frame (4).
- B7. The mooring system of any preceding clause, wherein the peripheral frame (4) is fixed to a plurality of anchors (1) via mooring lines (2).
- B8. The mooring system of any preceding clause, wherein the peripheral frame (4) is made of a pliable rope or wire, and the pliable rope or wire is held in tension by means of the fixation to the anchors (1) via the mooring lines (2).
- B9. The mooring system of any preceding clause, wherein the peripheral frame (4) and all connectors or connection devices (11,13) between solar panel arrangements (5) and between solar panel arrangements (5) and the

peripheral frame (4) are held in tension by means of the fixation to the anchors (1) via the mooring lines (2).

- 5 B10. The mooring system of any preceding clause, wherein the peripheral frame (4) is arranged substantially horizontally or horizontally.
- B11. The mooring system of any preceding clause, wherein each of the plurality of solar panel arrangements (5) faces, such as being positioned directly adjacent or in contact with, the peripheral frame (4) such as to be accessible from outside the floating structure (20,22) at or above the peripheral frame (4).
- 10 B12. The mooring system of any preceding clause, wherein each of the plurality of solar panel arrangements (5) is fixed to the peripheral frame (4) and to at least one other of the plurality of solar panel arrangements (5).
- B13. The mooring system of any preceding clause, comprising at least one connection hub (25) located within the peripheral frame (4) and to which
15 connecting devices (13) from several of the plurality of solar panel arrangements (5) are connected.
- B14. The mooring system of any preceding clause, wherein each of the plurality of solar panel arrangements (5) comprises a floating collar (30), for example a circular or substantially circular floating collar (30), and a plurality
20 of photovoltaic panels (31) arranged inside and supported by the floating collar (30).
- B15. The mooring system of any preceding clause, wherein the plurality of photovoltaic panels (31) are supported by the floating collar (30) via a mat (31) on which the plurality of photovoltaic panels (31) are arranged, the mat
25 (31) being fixed to the floating collar (30).
- B16. The mooring system of any preceding clause, wherein the solar panel arrangements (5) are fixed to the peripheral frame (4) via the floating collar (30).
- 30 B17. The mooring system of any preceding clause, wherein each of the plurality of solar panel arrangements (5) is fixed to the peripheral frame (4) via bridle lines (13).
- B18. The mooring system of any preceding clause, wherein each of the plurality of solar panel arrangements (5) is fixed to at least one other of the plurality of solar panel arrangements (5) via bridle lines (13).
- 35 B19. The mooring system of any preceding clause, wherein each of the plurality of solar panel arrangements (5) is connected to at least eight bridle lines (13), or to at least 12 bridle lines (13).

- B20. The mooring system of any preceding clause, wherein the bridle lines (13) are fixed to the floating collar (30).
- B21. The mooring system of any preceding clause, wherein the bridle lines (13) are fixed to the floating collar (30) at spaced attachment locations distributed about the floating collar (30).
- B22. The mooring system of any preceding clause comprising two floating structures (20,22), each of the two floating structures (20,22) having a peripheral frame (4) according to any preceding clause.
- B23. The mooring system of any preceding clause, wherein the two floating structures (20,22) are arranged adjacent each other and with an access channel (7) therebetween.
- B24. The mooring system of any preceding clause, wherein at least one mooring line (2) fixing a peripheral frame (4) of a first of the two floating structures (20,22) to an anchor (1) extends below a second of the two floating structures (20,22), and at least one mooring line (2) fixing a peripheral frame (4) of a second of the two floating structures (20,22) to another anchor (1) extends below the first of the two floating structures (20,22).
- B25. The mooring system of any preceding clause, wherein the floating structure (20,22) or the floating structures (20,22) is/are connected to a vertical column (9), for example a vertical column (9) fixed to a sea floor or ground below the body of water.
- B26. The mooring system of any preceding clause, wherein the vertical column(s) (9) is/are positioned in the access channel (7).
- B27. The mooring system of any preceding clause comprising at least one walkable buoyant element (17), wherein each of the plurality of solar panel arrangements (5) faces, such as being positioned directly adjacent or in contact with, the walkable buoyant element (17) such as to be accessible via the walkable buoyant element (17).
- B28. The mooring system of any preceding clause, wherein the solar panel arrangements (5) have a polygonal, for example a hexagonal, shape, and one or more edges of each solar panel arrangement (5) is positioned adjacent and parallel to one or more edge(s) of a neighbouring solar panel arrangement (5).
- B29. The mooring system of any of clause A1-A10 further having features as set out in any of clause B1-B28.

As will be appreciated when reading the disclosure herein, advantages of the methods described may be realised individually and by the use of only some of the method steps described above. The invention is not limited by the embodiments described above; reference should be had to the appended claims.

CLAIMS

1. A mooring system for securing an array of solar panel arrangements in a body of water (29), the system comprising a floating structure (20,22) comprising a plurality of solar panel arrangements (5),
5 wherein each of the plurality of solar panel arrangements (5) comprises a floating collar (30) and a plurality of photovoltaic panels (31) arranged inside and supported by the floating collar (30) via a mat (31) on which the plurality of photovoltaic panels (31) are arranged, the mat (31) being fixed to the floating collar (30),
10 and wherein the floating structure (20,22) comprises a polygonal, horizontally arranged peripheral frame (4) to which the plurality of solar panel arrangements (5) are fixed via the floating collar (30), the plurality of solar panel arrangements (5) are arranged inside the peripheral frame (4), and the peripheral frame (4) is fixed to a plurality of anchors (1) via mooring lines (2).
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2. The mooring system of claim 1, wherein the peripheral frame (4) is submerged in the body of water.
3. The mooring system of any preceding claim, wherein the peripheral frame
20 (4) comprises mooring buoys (3) fixed thereto.
4. The mooring system of the preceding claim, wherein the mooring buoys (3) are arranged at corners of the peripheral frame (4).
- 25 5. The mooring system of any preceding claim, wherein the peripheral frame (4) is made of a pliable rope or wire, and the pliable rope or wire is held in tension by the mooring lines (2).
- 30 6. The mooring system of any preceding claim, wherein each of the plurality of solar panel arrangements (5) faces the peripheral frame (4) such as to be accessible from outside the floating structure (20,22) at or above the peripheral frame (4).
- 35 7. The mooring system of any preceding claim, wherein each of the plurality of solar panel arrangements (5) is fixed to the peripheral frame (4) and to at least one other of the plurality of solar panel arrangements (5).

8. The mooring system of any preceding claim, comprising at least one connection hub (25) located within the peripheral frame (4) and to which connecting devices (13) from several of the plurality of solar panel arrangements (5) are connected.
- 5 9. The mooring system of any preceding claim, wherein each of the plurality of solar panel arrangements (5) is fixed to the peripheral frame (4) via bridle lines (13) connected to the floating collar (30).
- 10 10. The mooring system of any preceding claim, wherein each of the plurality of solar panel arrangements (5) is fixed to at least one other of the plurality of solar panel arrangements (5) via bridle lines (13).
- 15 11. The mooring system of any preceding claim comprising two floating structures (20,22), each of the two floating structures (20,22) having a peripheral frame (4).
- 20 12. The mooring system of the preceding claim, wherein the two floating structures (20,22) are arranged adjacent each other and with an access channel (7) therebetween.
- 25 13. The mooring system of any preceding claim, wherein
at least one mooring line (2) fixing a peripheral frame (4) of a first of the two floating structures (20,22) to an anchor (1) extends below a second of the two floating structures (20,22), and
at least one mooring line (2) fixing a peripheral frame (4) of a second of the two floating structures (20,22) to another anchor (1) extends below the first of the two floating structures (20,22).
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