

## ASSEMBLY AND OPERATION OF A SOLAR PANEL INSTALLATION

### **Field of the Invention**

- 5     The invention relates to the generation of power from photovoltaic (PV) panels. In particular, the invention relates to flexibility in the installation of said PV panels.

### **Background**

- 10    Conventional solar PV structures are complicated to install. Those of substantial power generation capacity are intended for permanent placement, subject to the life of the panel itself. There has been no consideration for reassembly and/or relocation. Once installed, they become a fixture for the land for 25 years.
- 15    For domestic use, PV panels are secured to the roof structure using mounting brackets, and are subject to the same building code requirements as the actual structure. These include the ability of the panel, and the corresponding mounting, to resist applied live loads, to ensure the panel does not become wind borne debris.
- 20    For industrial and commercial use for ground based panels, the panels are also permanently fixed, through connection to below ground footings.

In either application, the ability to relocate or re-position the panel is not possible without a considerable amount of labour and capital cost.

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### **Summary of Invention**

- In a first aspect, the invention provides a PV panel module comprising: a frame
- 30    arranged to support a photovoltaic panel; the frame including an assembly of articulated members arranged to fold from an extended position to a retracted position.

In a second aspect, the invention provides a method of installing a PV panel module, said module comprising a PV panel mounted to a frame, the method comprising the steps of: placing said frame on a suitable surface; extending an arrangement of legs of  
5 said frame so as to raise said frame from a retracted position to an extended position; fitting a selectively releasable base to said frame so as to fix said frame to said surface.

In a third aspect, the invention provides a method of installing solar panels, dismantling and re-installing to a site, the method comprising the steps of : connecting a solar panel  
10 to a frame so as to form a PV panel module; transporting the PV panel module to the site; installing from a retracted position to an extended position the frame; engaging the ground with a releasable base on said frame; subsequently, on re-deploying the system to the site; removing the releasable base; folding the panel from extended position to retracted position; transporting the solar panel connected to the frame to another site.

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Therefore, the ability of the frame to fold reduces the space required for the module, and consequently, permits the module to be more easily transported and installed.

In one embodiment, the frame and panel may be integrally connected such that the  
20 frame and panel are arranged to be transportable as a single unit. The integral connection may be achieved by being bolted, glued, clamped or welded to the panel, or alternatively forming part of the peripheral frame of the panel itself forming a unitary assembly.

25 The frame may have four holes corresponding to the four holes in the commercial solar panels, such that the frame can be easily fixed to the solar panel using screws.

The photovoltaic panel may be fixed to the frame in the factory before being transported to the site. The photovoltaic panel connected with the frame can be more easily installed on site.

- 5 In a further embodiment, the frame may be arranged to form a plane shape in the retracted position. Further, the planar frame is arranged to nest into the panel in the retracted position.

- 10 The frame according to any one of the previous statements, wherein the frame includes selectively releasable base. Further, the selectively releasable base may include one or a combination of: weights mountable to said frame, ground engaging members, engagement devices for engaging a surface or selectively fillable weight containers arranged to receive sand, soil or liquid on site.

- 15 The weights may be concrete blocks, steel plates or other high-density material shaped to conveniently engage the frame. The ground engaging members may be useful where the panel is used on natural ground, and may include ground anchors. The engagement devices may be bolts, base plates boltable to the surface, such as a concrete slab.

- 20 Alternatively, the weights may be water containers which remain empty during transport and initial installation, but then filled so as to secure the install PV panel module. The water containers may be existing containers including jerry cans and traffic barriers which include connectors to mounting the containers to the module.

- 25 In a further alternative, the water containers may be purpose built, such as to include recesses into which ground engaging portions of the frame fit. Such custom built water

containers may be substantially elongate or planar, so as to provide, not just sufficient weight to secure the module, but also having sufficient dimensions to mitigate overturning. An advantage of using water containers may include easy transportation as the empty water container may be very light, particularly compared with concrete.

- 5 When installing solar panels, it is easy to place the light water containers at designated location, then pour water in to achieve the designed weight. To remove the modules, the water can be poured out and transport the light weight containers to another location.

- The base may be adjustable according to wind speed. For example, heavier weights may be used in stronger wind; the ground engaging members may include a locking element used in stronger wind. In a further embodiment, the weights may be interconnectable to form a base, such that the weighted base is assembled first, with the PV panel module assembled on the weighted base. This may be particularly useful if an array of modules is installed, and so a cumulative weighted base may be more efficient than providing
- 10 weights for individual modules that are subsequently connected.

- The frame may be one of: a scissor frame, a parallelogram pivot frame, a plurality of discrete legs pivotally connected to the frame or a telescopic frame. Further, the frame may include various forms of bracing, with each type having distinct bracing types, or
- 20 additional structural support.

- In a further embodiment, the frame may include an actuator to move the frame between the extended position and the retracted position. Further, the actuator may include a bi-axial pivoting actuator, so that when the frame is put in place, the PV panel may be
- 25 rotated and pivoted.

This has the advantage of positioning the installed frame for a more efficient position to receive solar input. This may avoid having to re-position the weighted base of the frame; instead, the frame can be fixed in a convenient orientation, and then the panel could be positioned to maximise solar input. Further still, the frame may include a control system, with the control system arranged to control a solar tracker used to operate the bi-axial actuator so as to optimally position the panel.

In a first step, the bi-axial actuator may be manually operated to give a coarse positioning and then, in a second step, control of the bi-axial actuator may be placed with a solar tracker to optimise the solar input to the panel whilst the arrangement is in position.

In a further embodiment, the modules may be mounted to pontoons so as to be installed floating on water, including reservoirs, lakes and protected coastal regions. To this end, the frame may be replaced by a floating structure, having fixed or adjustable inclination. Alternatively, the frame may be mountable to a pontoon, so as to have the flexibility of adapting land based modules for use on water. Given the greater exposure to wind by having the modules project upwards, the pontoons may have additional anchors to secure them.

For application of floating modules, access to water *insitu*, and also a means of draining the containers once used is readily available. To this end, the containers may include valves for easy draining. The containers may also include attachable, or unitary water pumps to speed the draining rate of the containers. Further, the containers may be shaped to include a sump at or near the base, to facilitate pump driven emptying.

**Brief Description of Drawings**

It will be convenient to further describe the present invention with respect to the accompanying drawings that illustrate possible arrangements of the invention. Other  
5 arrangements of the invention are possible and consequently, the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

Figures 1A to 1C are various isometric views of a PV panel module according to one  
10 embodiment of the present invention;

Figures 2A to 2D are various isometric views of a PV panel module according to a further embodiment of the present invention;

15 Figure 3A is an isometric view of a PV panel module according to a further embodiment of the present invention;

Figure 3B is an isometric view of a PV panel module according to a further embodiment of the present invention;  
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Figures 4A to 4D are various isometric views of a PV panel module according to a still further embodiment of the present invention, and.

Figures 5A to 5C are various views of a PV array according to one embodiment of the  
25 present invention.

**Detailed Description**

30 The invention seeks to provide a more straightforward installation process, as well as disassembly for relocation or re-positioning.

In its simplest form, the invention includes a frame arranged to support a photovoltaic panel, including articulated members suitable to fold from an extended position to a retracted position.

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Figures 1A to 1C show one embodiment of the present invention, whereby a PV panel 10 is mounted to a folding frame 15A,B. Together they form a PV panel module 5 that may be placed on site, and then optimally positioned based upon the location to receive sun light.

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The frame comprises an assembly of articulated members, in this case, two parts 15A,B which are pivotally connected by a hinge 17, with one end of each frame part arranged to engage the ground, and opposed ends mounted to the PV panel 10 sliding engagement. As each frame slides 11, 13 towards each other, relative the PV panel 10, the frame parts pivot about the hinge 17, and so moving 19 from a retracted position (as shown in Figure 1C) to an extended position (as shown in Figure 1A).

In a further embodiment, the placement of the hinge is not at a mid-point of the two frame parts 15A,B, but asymmetrically. This asymmetric position allows for the PV panel to be inclined to the horizontal once the frame is extended, and so arranged to expose the PV panel to an optimal level of sun light.

It will be appreciated that the extended position may include several extended positions, depending upon the degree of inclination desired. For instance, the frame parts may be marked so as to indicate the degree of extension required to provide for a desired inclination if the PV panel module is placed on flat ground.

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To secure the frame in the desired extended position, the frame parts may be locked relative to each other. Alternatively, one or both of the frame parts may be locked to the PV panel to prevent further relative sliding. Such a lock may be through the insertion of a pin (not shown) at discrete points, or a friction grip to allow for positioning at any point along the slide to which the frame parts are mounted.

Once the PV panel module is optimally placed, it may be secured to the ground using one of several methods. Figures 1A to 1C show one embodiment whereby the frame parts receive concrete blocks 20 moulded to fit over the frame. In so doing, the weight of the concrete secures the module against shifting due to wind or other external applied load. The concrete blocks may be selectively releasable from the frame, and in particular the base of the frame.

Figures 2A to 2D show an alternative arrangement, whereby a frame 32 comprises two frame parts 35, 40 as the assembly of articulated members. The frame parts are connected to a mount 55, with the mount 55 fixed to the panel 10. The frame parts 35, 40, are arranged to extend and retract separately. Each frame part 35, 40 is pivotally connected 37, 47 to the mount 55, with at least one of said frame parts in sliding engagement. Where one frame part is in sliding engagement, the other is translationally fixed. Alternatively, as shown in the embodiment of Figures 2A to 2D, both frame parts are slidingly engaged to the mount. The process of moving from the retracted position (shown in Figure 2C) to the extended position (shown in Figure 2B) involves rotating the frame part outwards, which is then locked into place by the respective brace 60, 61. The braces 60, 61 are pivotally connected to both the mount and the respective frame part 35, 40 and arranged to cooperatively rotate as the respective frame part is rotated. Once in the desired extended position, the brace forms a triangulation with the frame to lock the frame part into place. In an alternative arrangement, the brace may be manually

It will be noted the frame parts 35, 40 are not identical. By having one frame part 40 shorter than the other 35, the panel 10 is in an inclined position once the frame parts 35, 40 are extended and the module 30 placed on flat ground.

- 5    Once again, the module 30 according to the embodiment of Figures 2A to 2D is secured to the ground using concrete blocks 50 which secure the frame to ground through a ground engaging portion 45 of the frame part. Other ground securing methods may also be used for this and other embodiments, separately or together with the concrete block. These other methods may include ground anchors or stakes which penetrate the ground.
- 10   Said ground anchors or stakes may also be connected to the concrete blocks, so as to secure the concrete blocks directly, and the module indirectly.

- Figure 3A shows a further embodiment, which is shown in relation to the embodiment of Figures 2A to 2D, but may be equally applicable to other embodiments. Here the
- 15   frame part 35 is strengthened by providing a horizontal brace 62. This has the effect of shortening the unreinforced length of the frame part leg by fixing the brace from one leg to the corresponding second leg. An alternative embodiment of the brace may include a diagonal member, or two diagonal cross bracing members, so as to triangulate the frame part, adding to its rigidity.

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- Figure 3B shows a further embodiment of the bracing system for the PV panel module. Here the brace is manually placed by the installer after the frame legs have been extended. To this end, the frame includes a cooperatively placed lug 39, such as a pre-fixed bolt, on the frame leg 43 to which a recess 41 on the brace 36 engages. In
- 25   alternative embodiments, the frame leg may have a plurality of lugs spaced along the length, such that on engagement by the recess, the frame leg may be secured at a range of different inclinations. Similarly, the brace may a plurality of recesses arranged to engage a single lug, for similarly securing the frame leg at a range of inclinations.

Figures 4A to 4D show a further embodiment of the present invention. As with Figures 2A to 2D, the module 65 includes a mount 55, however it will be appreciated that the frame parts 75 may connect directly to the panel 70. In this alternative, the panel may  
5 include a recess into which the frame parts 75 fold so as to be in the retracted position.

Figures 5A to 5C show a still further embodiment. Here is shown a PV array 87, comprising four separate modules 85A to 85D. Each module includes a frame 90A to 90D, with each frame movable between a retracted position (not shown) and an  
10 extended position shown in Figure 5A. It will be appreciated that the modules shown in Figures 5A to 5C may be replaced by any of the modules previously described. With reference to Figure 5B it can be seen the modules according to this embodiment include a feature which may also be used with other modules, whereby a fixture 95 connects and binds adjacent modules together. Thus, by erecting the four (or any desired number  
15 of modules), they may then be bound together using the binding fixture 95 to form an erected array of PV panel modules.

Figure 5C shows a further embodiment, whereby the fixture 95 includes nestable brackets 92 for cooperatively coupling each module. The nestable brackets 92 nest  
20 together to ensure a secure a rigid connection between the modules. The brackets are then locked using a lock, such as a locking pin 100. Once all the modules are fixed together, they operate structurally as a single PV array, which may be of any desired size. Thus, the rapid installation provided by the present invention, through use of this embodiment, avoids any limitation on the power generating capacity of the invention.  
25 Instead, arrays of considerable size may be constructed using a plurality of modules, which are then mechanically locked. Electrical connection then becomes a straightforward process.

**CLAIMS**

1. A PV panel module comprising:  
a frame arranged to support a photovoltaic panel;  
5 the frame including an assembly of articulated members arranged to fold from an extended position to a retracted position.
2. The PV panel module according to claim 1, wherein said frame is integrally connected to the photovoltaic panel, such that the frame and panel are arranged  
10 to be transportable as a single unit.
3. The PV panel module according to claim 1 or 2, wherein the frame is connected to the panel through one frame part in a translationally fixed manner at a first end of the panel, and;  
15 slidingly engaged by a second frame part, such that in folding from the extended position to the retracted position, the second member is arranged slide relative to the panel.
4. The PV panel module according to any one of claims 1 to 3, wherein the frame  
20 is arranged to form a plane shape in the retracted position.
5. The PV panel module according to claim 4 wherein the planar frame is arranged to nest into the panel in the retracted position.

6. The PV panel module according to any one of claims 1 to 5, wherein the frame includes a selectively releasable base.
7. The PV panel module according to claim 6, wherein the selectively releasable  
5 base includes one or a combination of: weights mountable to said frame, ground engaging members, engagement devices for engaging a surface or selectively fillable weight containers arranged to receive sand, soil or liquid on site.
8. The PV panel module according to any one of claims 1 to 7, wherein the frame  
10 includes one of: a scissor frame, a parallelogram pivot frame, a plurality of discrete legs pivotally connected to the frame or a telescopic frame.
9. The PV panel module according to any one of claims 1 to 8, wherein the frame  
15 includes an actuator to move the frame between the extended position and the retracted position.
10. The PV panel module according to claim 9, wherein the actuator includes a bi-  
axial pivoting actuator, such that when the frame is placed the PV panel is  
arranged to be rotated and/or pivoted.  
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11. The PV panel module according to claim 10, further including a control system,  
said control system arranged to control a solar tracker used to operate the bi-  
axial actuator.
12. The PV panel module according to any one of claims 1 to 11, further including  
25 binding fixtures, said binding fixtures arranged to cooperatively engage a

binding fixture on an adjacent PV panel module so as to couple said modules together.

- 5        13. The PV panel module according to claim 12, wherein said binding fixture including a nestable bracket for the cooperative engagement of the modules, and a lock arranged to securely lock said nested brackets.

- 10       14. The PV panel module according to any one of claims 3 to 5, further including a brace connected to the frame, said brace arranged to move from a retracted position to a locked position on the frame moving from the retracted position to the expanded position, said brace in the extended position forming a triangulation with the frame.

- 15       15. A method of installing a PV panel module, said module comprising a PV panel mounted to a frame, the method comprising the steps of:

placing said frame on a suitable surface;

extending an arrangement of legs of said frame so as to raise said frame from a retracted position to an extended position;

- 20       fitting a selectively releasable base to said frame so as to fix said frame to said surface.

16. A method of installing solar panels, dismantling and re-installing to a site, the method comprising the steps of :

connecting a solar panel to a frame so as to form a PV panel module;

- 25       transporting the PV panel module to the site;

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installing from a retracted position to an extended position the frame;

engaging the ground with a releasable base on said frame;

subsequently, on re-deploying the system to the site

removing the releasable base;

5       folding the panel from extended position to retracted position;

transporting the solar panel connected to the frame to another site.

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