

DescriptionSolar module system with support structure

5 [0001] The invention relates to a solar module system having a support structure and at least one solar module element or reflector element which can be arranged on the support structure. Solar module systems such as these are used as photovoltaic systems and
10 thermal solar collector systems in widely different embodiments. For simplicity, in the present case, the expression solar module covers both photovoltaic modules and thermal solar collector modules.

15 [0002] Laid-open specification DE 100 41 271 A1 discloses a roof cover or wall cladding composed of self-supporting sheet-metal panels, to the outside of which a photovoltaic module which is protected by an outer covering layer composed of a translucent plastic
20 is applied. A system with controlled heat dissipation and/or heat supply is kept in thermally conductive contact with the sheet-metal panels, on the underneath. The photovoltaic module may be applied to the respective sheet-metal panel as a flexible composite
25 film over the entire area. Similar photovoltaic module laminates for mounting flat on a support layer by pressing or adhesive bonding, or in a self-adhesive embodiment, are described respectively in laid-open specification WO 01/67523 A1 and patent specification
30 US 6,553,729 B1.

[0003] Laid-open specification GB 2 340 993 A describes a photovoltaic structure in which a module mount is formed comprising a lower, flat steel plate, a
35 steel plate arranged at a distance from it with the interposition of an insulating material and profiled in a corrugated shape forming a duct, and an upper flat steel plate placed thereon, and a photovoltaic flat

module is applied to the upper steel plate. The hollow ducts which are formed between the profiled steel plate forming the duct and the upper steel plate act as cooling ducts.

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[0004] As is known, apart from non-concentrating flat-module systems, concentrating solar module systems are also in commercial use, for example of the so-called V-trough type, see for example both US
10 laid-open specification 2003/0201007 A1, and of the parabolic concentrator type, see for example patent specification US 5,344,496 and the Conference Proceedings Articles by C. K. Weatherby et al., Further Development and Field Test Results of Two
15 Low-Material-Cost Parabolic-Trough PV Concentrators, 2nd World Conference and Exhibition on Photovoltaic Solar Energy Conversion, July 6 to 10, 1998, Vienna, Austria, page 2189 and F. Dobon et. al., Controlled Atmosphere PV Concentrator (CAC), 17th European Photovoltaic Solar
20 Energy Conference, October 22 to 26, 2001, Munich, Germany, page 668.

[0005] Utility model specification DE 20 2004 005 198 U1 discloses a solar module system in which solar
25 modules are mounted directly on a mounting rack composed of metal with a heat dissipation profile on the rear face.

[0006] The invention is based on the technical problem
30 of providing a solar module system of the type mentioned initially which can be produced with comparatively little manufacturing effort and is also suitable for relatively large major power station installations, in the open air, and for building
35 integration on roofs and facades.

[0007] The invention solves this problem by providing a solar module system having the features of claim 1.

In this solar module system, the support structure contains at least one self-supporting rib longitudinal profile and/or hollow longitudinal profile as a support profile with a solar module functional area and/or reflector functional area. Support profiles such as these can be produced with comparatively little effort and offer a self-supporting capability for the support structure, reducing the complexity for the required substructures. The expression "self-supporting" in this case means, as a relevant person skilled in the art in this field would be aware, a configuration of the support profile which is chosen such that the support profile supports itself with the element or elements fitted thereto over a certain span width of typically up to several meters in the present applications of solar module systems, for example of between 2m and 10m, without any need to provide a close-mesh substructure, to be precise including the support loads to be calculated in during operation, in this case in particular resulting from wind and snow loads. The self-supporting support profile with this meaning and the self-supporting support structure with this meaning in consequence do not require any substructure longitudinal supports and, for the lengths which are typically used in this application, generally require only one central or two end supports, which in the latter case can typically be drawn in somewhat, that is to say they run with a short separation, which is very much less than the support profile length, from the respective support profile end.

[0008] Specifically, furthermore, the support profile according to the invention has a plug-in profile on the longitudinal side in order to attach a further support profile or a connecting profile or a terminating profile, and/or has a heat dissipation structure. The first of these allows a plurality of solar module-support profile and/or reflector-supporting profile to

be joined together at the side to produce relatively large support areas, in which case, depending on the system design, the support profiles may be plugged directly to one another or may be plugged onto an
5 intermediate connecting profile. The terminating profile can be used to achieve a respectively desired side edge termination. In embodiments with the heat dissipation structure provided on the support profile, the heat dissipation structure contributes to the
10 cooling required for the solar module functional area and/or the reflector functional area.

[0009] Plugging individual support profiles together at the side in order to achieve relatively large area
15 support structures is useful not only for non-concentrating flat module systems but also, for example, for concentrator systems of the so-called V-trough type. In a corresponding refinement of the invention as claimed in claim 2, the connecting profile
20 is in the form of a hollow-chamber longitudinal profile with a reflector functional area on the front face, that is to say the relevant area itself acts as a reflector or acts as a reflector contact surface, to which a separate reflector element can be fitted, for
25 example in the form of a reflector sheet, thus resulting in a reflective V-trough wall.

[0010] Furthermore, the invention can also advantageously be used, for example, for systems of the
30 parabolic concentrator type. In a corresponding development for this purpose as claimed in claim 3, the respective support profile has a parabolic reflector functional area, which is associated with a solar module element which is arranged or formed on a front
35 face of a connecting profile or terminating profile which is attached to the support profile at the side. This results in the radiation being reflected at the side from the reflector of the support profile forward

onto the solar module element arranged there, in a concentrating form. For example, the solar module element may be formed integrally on the connecting or terminating profile, or may be attached to it.

5 Depending on the application, this may be, for example, a conventional thermal solar collector tube or a suitably designed photovoltaic element.

[0011] In a further refinement of the invention as

10 claimed in claim 4, one or more hollow chambers is or are formed on the support profile and/or on the connecting profile, and/or the plug connection of the plug-in profile and/or the terminating profile are/is in the form of a hollow chamber or chambers, which can

15 contribute to the support structure being more robust. Furthermore, if required, the hollow chambers can be used to pass through a liquid or gaseous cooling medium, for better cooling or, if necessary, for heating the system, and/or as line/cable ducts.

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[0012] In one advantageous refinement of the invention as claimed in claim 5, the connection of the connecting profile to the support profile is designed to be thermally conductive so that, if required, the

25 connecting profile can also act as a heat dissipation body.

[0013] In a further refinement of the invention as claimed in claim 6, the plug-in profile on the

30 longitudinal side is designed such that a respective support profile can be fitted between two stationary connecting profiles and can be removed. In consequence, each of the support profiles can be removed individually from an assembled solar module system

35 without likewise having to remove adjacent connecting or support profiles for this purpose, thus making it very simple to replace one support profile.

[0014] In a further refinement of the invention as claimed in claim 7, pairs of terminating profiles are provided, by means of which prefabricated units provided with terminating profiles at the sides can be
5 connected to one another in a rainproof manner to form relatively large units, by the terminating profiles being designed such that two mutually adjacent terminating profiles in each case engage in one another, in a rainproof manner, in the form of an
10 overlapping roof-tile connection or labyrinth seal.

[0015] In one development of the invention which is advantageous from the manufacturing point of view, as claimed in claim 8, the support profiles are in the
15 form of extruded profiles, strand-drawn profiles or roll-formed profiles.

[0016] Advantageous materials for the support profiles are specified in claim 9.
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[0017] In a development of the invention as claimed in claim 10, the plug-in profile and/or the connecting profile are/is designed to connect in each case two support profiles with an aligned useful face, forming a
25 continuous solar module/reflector useful surface. This makes it possible to produce solar module and/or reflector useful surfaces which are extended in the width direction over a plurality of support profiles, without any significant lateral interruption and
30 without steps.

[0018] Advantageous embodiments of the invention will be described in the following text and are illustrated in the drawings, in which:
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[0019] Figure 1 shows a cross section through a support profile with a module contact surface on the front face

and with a thermally conductive rib structure on the rear face,

5 [0020] Figures 2 and 3 show cross-sectional views of variants of the support profile shown in Figure 1,

10 [0021] Figure 4 shows a cross section through a support profile variant with a side plug-in profile for direct coupling on further support profiles,

15 [0022] Figures 5 and 6 show cross sections through in each case one terminating profile for side termination of the support profile shown in Figure 4,

20 [0023] Figure 7 shows a cross section through the support profile shown in Figure 4, with terminating profiles as shown in Figures 5 and 6 plugged on,

25 [0024] Figure 8 shows a cross section through a support structure with three support profiles coupled to one another, as shown in Figure 4, and with side terminating profiles as shown in Figures 5 and 6,

30 [0025] Figure 9 shows a cross section through a variant of the support profile from Figure 4 with a greater profile depth in the plug-in profile area,

35 [0026] Figures 10 and 11 show a cross section of in each case one terminating profile for the side plug-in profiles of

the support profile shown in Figure 9,

5 [0027] Figure 12 shows a cross section through the support profile shown in Figure 9, with plugged-on terminating profiles as shown in Figures 10 and 11,

10 [0028] Figure 13 shows a cross section through a support structure comprising four support profiles as shown in Figure 9 plugged onto one another, and the side terminating profiles as shown
15 in Figures 10 and 11,

[0029] Figures 14 and 14A each show a cross sectional view of a further variant of the support profile shown in Figure 4,
20 respectively without and with hollow chambers and with an individually fitted solar module, with Figure 14 showing an associated terminating profile on
25 the left, and an associated connecting profile on the right, in the form of an exploded view,

[0030] Figures 15 and 15A each show a cross-sectional view through a part of a support structure with support profiles as shown in Figure 14 plugged onto one another, and, respectively, a
30 variant with a hollow chamber on the rear face,
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[0031] Figures 16 to 23 show cross-sections through modified embodiments of the

connecting profile shown in Figure 14, with different reinforcing profile shapes and profile depths,

5 [0032] Figure 24 shows a cross-sectional view through two support profiles, as shown in Figure 14, which have been plugged together by means of the connecting profile shown in Figure 22,

10 [0033] Figure 25 shows a cross section through a solar module support profile for a photovoltaic system of the V-trough concentrator type,

15 [0034] Figure 26 shows a cross section through a connecting profile with a reflector functional area for coupling support profiles as shown in Figure 25 to one another,

20 [0035] Figure 27 shows a cross section through a detail of a support structure for a photovoltaic system of the V-trough concentrator type with the support profiles as shown in Figure 25 and the connecting profiles as shown in Figure 26,

25 [0036] Figures 28 and 28A each show a cross section through a variant of the support profile shown in Figure 25 for a further photovoltaic system of the V-trough concentrator type, respectively without and with hollow chambers,

- [0037] Figure 29 shows a cross section through a connecting profile for the support profile shown in Figure 28,
- 5 [0038] Figure 30 shows a cross-sectional view corresponding to Figure 27 for the system variant with the support profiles as shown in Figure 28 and the connecting profiles as shown in
10 Figure 29,
- [0039] Figure 31 shows a plan view of a photovoltaic system of the V-trough concentrator type based on the system variant shown in Figure 30 with five solar
15 module support profiles which are plugged to one another via the connecting profiles with a reflector function,
- 20 [0040] Figure 32 shows a cross-sectional view along the line I-I in Figure 31,
- [0041] Figures 33 and 34 show cross sections through in each case one of two pairs of
25 terminating profiles, which are designed for rainproof connection,
- [0042] Figure 35 shows a cross section through a rainproof connection produced by
30 the two terminating profiles shown in Figures 33 and 34,
- [0043] Figure 36 shows a cross section through two
35 adjacent support profiles of the type shown in Figure 9, which are joined to one another at the side in a rainproof manner by two pairs

of terminating profiles similar to those shown in Figures 33 and 34,

5 [0044] Figure 37 shows a cross section through a support profile with parabolic reflector areas,

10 [0045] Figure 38 shows a cross section through a connecting profile with a solar module element integrally formed on the front face, and

15 [0046] Figure 39 shows a cross section through a detail of a support structure for a solar module system of the parabolic concentrator type with the support profiles shown in Figure 37 and the connecting profiles shown in Figure 38.

20 [0047] Various exemplary embodiments of the invention will be explained in more detail in the following text with reference to the drawings, and identical or functionally equivalent components are provided with the same reference symbol in each of the drawings, for the sake of clarity.

30 [0048] Figures 1 to 3 illustrate support profiles which are suitable, for example, for photovoltaic systems integrated in shade laminate installations. On the front face, a support profile 1 as shown in Figure 1 has a module contact surface 2 on which a conventional photovoltaic module, which is not illustrated, can be mounted. On the rear face, the support profile 1 has a heat dissipation structure, directly opposite the module contact surface 2, in the form of longitudinally running thermally conductive ribs 3 which are each provided with grooves or are

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profiled in the form of corrugated lines in order to increase the surface area on their side surfaces. On the longitudinal side, the support profile 1 is terminated by edge profiling 4 which in each case has an opening 5 for the introduction of self-tapping screws, in order to fix the support profile 1, in a manner which is not shown, in its end area, for example to a moving laminate holder, when the support profile 1 is used as a shade laminate with an integrated photovoltaic function.

[0049] A support profile 6 illustrated in Figure 2 corresponds to the support profile 1 illustrated in Figure 1 with the exception of a modified side edge profiling 4a, as shown, which is likewise provided with openings 5a for the introduction of self-tapping screws. A support profile variant 7, as illustrated in Figure 3, corresponds to the support profile 1 illustrated in Figure 1 with the exception of modified side edge profiling 4b, as shown, and hollow-duct profiling 8, which is provided laterally centrally and has an associated hollow duct 8a. The laterally central hollow-duct profiling 8 contributes to increased longitudinal stiffness of the support profile 7, and the hollow duct 8a can optionally be used, for example, for electrical lines or a cooling flow medium to pass through it.

[0050] As shown in Figures 1 to 3, the support profiles 1, 6, 7 can be produced by low-cost large-scale production methods such as extrusion, strand drawing or roll forming from a thermally conductive material such as aluminum, magnesium, stainless steel, galvanized steel, thermally conductive plastic, etc. The thermally conductive rib structure 3 which is integrated in the longitudinal support profile directly opposite the module contact surface 2, and in conjunction with the choice of a suitably thermally

conductive material for the support profile, allows effective heat dissipation from the solar module fitted thereto, during operation of the photovoltaic system.

5 [0051] Figures 4 to 8 illustrate a system variant which allows a modular support structure design of various widths, by plugging a plurality of support profiles together at the side. Figure 4 shows a single support profile 9 of this system variant, which
10 corresponds to that shown in Figure 1 with the exception that edge profiling 4c is provided on the longitudinal side and ends on the outside in plug-in profiles 10a, 10b which fit one another, that is to say the plug-in profiles 10a, 10b are designed such that
15 one plug-in profile on one support profile can be plugged to the other plug-in profile of a further support profile, which is to be plugged onto it at the side, forming a flush upper surface. For this purpose, in this example, the plug-in profiles 10a, 10b each
20 have two flexible latching tongues which project outwards at a distance from one another, with the first plug-in profiles, the left-hand plug-in profiles 10a in Figure 4, being provided as shown with an end latching tab, and with the other plug-in profiles, the
25 right-hand plug-in profiles 10b in Figure 4, being provided as shown with a latching groove corresponding to this. Apart from this, the edge profiling 4c on the longitudinal side once again has openings 5c for the introduction of self-tapping screws.

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[0052] Figures 5 and 6 respectively show a terminating profile 11, 12, by means of which the respective plug-in profile 10a, 10b on the longitudinal side of the support profile 9 as shown in Figure 4 can be
35 terminated when it is not intended to plug any other support profile thereto. For this purpose, the terminating profiles 11, 12 have the cross-sectional shapes shown in Figures 5 and 6, with the terminating

profile 11 in Figure 5 being used for plugging to the plug-in profile 10a, shown on the left in Figure 4, of the support profile 9 and for this purpose having latching tongues whose configuration corresponds to
5 that of the plug-in profile 10b, shown on the right in Figure 4, of the support profile 9. The terminating profile 12 in Figure 6 analogously has latching tongues, corresponding to the configuration of the left-hand plug-in profile 10a in Figure 4, for plugging
10 to the plug-in profile 10b shown on the right in Figure 4.

[0053] Figure 7 shows, in the form of a cross section, a completely plugged-together support structure with a
15 single support profile 9 as shown in Figure 4 and terminating profiles 11, 12 plugged onto the longitudinal sides, as shown in Figure 5 and 6 respectively. As can be seen from Figure 7 in conjunction with Figures 5 and 6, one terminating
20 profile 11 has a projecting step 13 on the front face, and the other terminating profile 12 has a projecting latching tongue 14 which, when the support structure is completely plugged together, in each case form a side boundary for the module contact area 2 produced on the
25 front face by the support profile 9.

[0054] Figure 8 shows a support structure using this system variant and comprising three plugged-together support profiles 9 as shown in Figure 4 and the side
30 terminating profiles 11, 12 shown in Figures 5 and 6, respectively. As can be seen from Figure 8, the support profiles 9 merge on the side plug-connecting areas such that they are flush and aligned with one another on the front faces, by means of the configuration mentioned
35 above of the interacting plug-in profiles 10a, 10b, thus resulting overall in a broader flat module contact surface 2 which is bounded at the side only by the edge steps 13, 14 of the terminating profiles 11, 12 and is

in general available as a solar module useful area. In the plug-connecting area, the interacting plug-in profiles 10a, 10b, as can likewise be seen in Figure 8, form a hollow-chamber structure 15 which contributes to the longitudinal stiffness of the plugged-together support structure. The hollow ducts 15 formed by the plug connections can also be used as required for carrying lines or for carrying a coolant.

[0055] Figures 9 to 13 show a modification of the system variant shown in Figures 4 to 8, which differs from that variant by having deeper hollow ducts in the plug connecting area, providing greater longitudinal stiffness. For this purpose, a support profile 16 as shown in the form of a cross section in Figure 9 is provided with deeper side plug-in profiles 10c, 10d, that is to say that the modified side plug-in profiles 10c, 10d extend rearward to a greater depth than those in the system variant in Figures 4 to 8, and in consequence with a correspondingly greater distance between their two latching tongues which project outwards. In a corresponding manner to this, Figures 10 and 11 show modified terminating profiles 11a, 12a for plugging, by latching and forming side terminations, onto the plug-in profiles 10c, 10d respectively shown on the left and right in Figure 9. Figure 12 shows the support profile from Figure 9 with the terminating profiles 11a, 12a plugged on.

[0056] Figure 13 shows a cross section through a support structure comprising four support profiles 16 as shown in Figure 9, plugged onto one another, and the terminating profiles 11a, 12a plugged on at the sides. As can be seen from Figure 13, the interacting plug-in profiles 10c, 10d form hollow-duct structures 15a of correspondingly great depth and with a correspondingly large cross section, and therefore contribute to achieving high strength and in particular longitudinal

stiffness of the plugged-together support structure. Stiffening hollow ducts 15b are also formed there by plugging on the terminating profiles 11a, 12a. The stiffening hollow-duct structures 15a, 15b can
5 optionally in turn be used, for example, to carry electrical lines or a cooling fluid. A useful area which is continuous in a flush and aligned form over the entire width is produced on the front face.

10 [0057] While the exemplary embodiments shown in Figures 8 and 13 show support structures in which the support profiles 9, 16 are typically plugged together before fitting a solar module, in order to produce a correspondingly broad module contact surface 2 on which
15 the solar module is then fitted, Figures 14 and 15 show a system variant in which individual support profiles, fitted with solar modules in advance, are typically plugged together using connecting profiles to form relatively large, that is to say broader, units. For
20 this purpose, this exemplary embodiment includes a support profile 17, a cross section through which is shown in Figure 14, similar to the support profile 9 shown in Figure 4, but with plug-in profiles 10e on the longitudinal sides which have been modified in the
25 illustrated manner and in this case are provided on both sides of the support profile 17 with the same cross-sectional shape and with latching tongues which project outward, are at a distance from one another and are provided with latching tabs at the ends.

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[0058] An associated solar module 18 is fitted in advance on the front-face module contact surface 2 of this support profile 17, for example by adhesive bonding, lamination etc. Figure 14A shows a variant of
35 the example in Figure 14 with additional hollow chambers 8b or hollow ducts which, for example, can be used as cooling ducts and/or cable ducts and also contribute to the mechanical robustness of the support

profiles. It is self-evident that any desired number of such hollow chambers or hollow ducts such as these can be provided in a corresponding manner, distributed in any desired manner, for all the other illustrated support profiles, as well.

[0059] A plurality of such support profiles 17 are plugged onto one another at the side using a suitably designed connecting profile 19, as is shown individually in the cross section in Figure 14 on the right, but not yet plugged together. The connecting profile 19 is provided on both sides with a respective plug-in profile 20 of the same shape, such that the respective plug-in profile 20 of the connecting profile 19 can be latched to the corresponding plug-in profile 10e on the support profile 17, by plugging them together. Figure 15 shows two support profiles 17 which have been plugged together in this way using the intermediate connecting profile 19, and which each have a solar module 18 fitted to them.

[0060] A suitably designed terminating profile 21, as is illustrated in the form of a cross section in Figure 14 but not yet plugged in, once again ensures a closed side termination for the support profile 17. The terminating profile 21 is provided on one side with a plug-in profile which is suitable for this purpose, that is to say with the plug-in profile 20 as provided on both sides of the connecting profile 19.

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[0061] As can also be seen from Figure 15, the described process of plugging this support structure together results in the formation of longitudinally stiffening hollow-chamber structures 22 both in the area of the respective connecting profile 19 and in the edge termination area on the longitudinal side, and the hollow ducts formed in this way can optionally be used

for a second purpose, for example for carrying electrical lines or a cooling fluid.

[0062] Figure 15A shows a variant of the support
5 profile from Figure 15 in which the support profile is
closed by a rear-face profile wall 17a, thus forming a
hollow chamber 17b which extends over the entire
support profile width, through which a liquid or
10 gaseous heating or cooling medium can be passed via
support profile openings 17c at the end, and in which
the thermally conductive rib structure is also located,
thus allowing the support profile 17 to be heated or
cooled very effectively. Furthermore, in this case as
well, the hollow chamber 17b that is formed provides
15 mechanical robustness and/or can be used for carrying
lines. In corresponding embodiment variants, a separate
wall, for example a membrane, can also be fitted to the
profile rear face in order to form a hollow chamber,
instead of the profile rear wall.

20 [0063] System variants with solar modules mounted on
the support profiles in advance, as illustrated in the
present case using the example of the system variant in
Figures 14, 14A and 15 are also particularly suitable
25 for do-it-yourself construction applications since the
support profiles that have already been fitted with the
solar modules can be offered or marketed individually,
and can be plugged together as required to form larger,
finally complete units.

30 [0064] Figures 16 to 23 show advantageous variants
relating to the cross-sectional configuration for the
connecting profile 19 of the system variant in
Figures 14, 14A, 15 and 15A. Instead of the central web
35 of the connecting profile 19 in Figures 14 and 15, a
connecting profile 19A as shown in Figure 16 has a
rectangular hollow profile which is open on the rear
face and provides additional longitudinal stiffening,

with plug-in profiles 20 projecting from its corner areas. In comparison to the connecting profile 19 shown in Figures 14, 14A, 15 and 15A, a connecting profile 19b as shown in Figure 17 has an additional rearward opening profile with an opening 23 for introduction of a self-tapping holding screw, which is not illustrated. A connecting profile 19c as shown in Figure 18 combines the formation of a holding screw opening 23 such as this with a rectangular profile 24, which is adjacent thereto at the rear, is open at the rear and additionally has a longitudinal stiffening effect. A connecting profile 19d as shown in Figure 19 corresponds to the connecting profile 19 shown in Figures 14, 14A, 15 and 15A with an additional rear rectangular profile 25, which is open at the rear.

[0065] The connecting profile variants shown in Figures 20 to 23 are suitable for situations in which more longitudinal stiffness is required, and for this purpose they have hollow profiles which are correspondingly deeper at the rear. A connecting profile 19e as shown in Figure 20 therefore corresponds to the connecting profile 19c shown in Figure 18 with a rectangular profile 24a drawn deeper on the rear face and with an additional holding screw opening 23a on a connecting web 26. A connecting profile 19f as shown in Figure 21 corresponds to that shown in Figure 20, but with two openings 23b being provided, instead of the opening 23a in the center of the web, adjacent to the two corner areas of the intermediate web 26. A connecting profile 19g as shown in Figure 22 corresponds essentially to that shown in Figure 21, but is considerably broader than it and is provided with additional rear-face profiling 27 on the rear face. A connecting profile 19h as shown in Figure 23 is modified from that shown in Figure 22 in that the longitudinally stiffening hollow-chamber profile part has a triangular cross section rather than a

rectangular cross section. It is self-evident that the connecting profile shapes shown in Figures 16 to 23 can be chosen depending on the desired stiffness characteristics of the plugged-together support structure.

[0066] By way of example and as a representative of the use of the other connecting profile variants, Figure 24 shows two support profiles 17 as shown in Figure 14 with solar modules 18 fitted thereto, which are plugged onto the broad, rearward longitudinally stiffening hollow-chamber profile using the connecting profile 19g shown in Figure 22.

[0067] While exemplary embodiments of non-concentrating photovoltaic systems have been described so far, Figures 25 to 27 illustrate a photovoltaic system of the V-trough concentrator type. Figure 25 shows a cross section through a support profile 28 used for this purpose, which is similar to the support profiles explained above with a front-face module contact surface 2 and thermally conductive rib structure 3 integrally formed directly on the rear face, with module boundary stops 29 being formed on the support profile 28 itself in this example, in order to bound the module contact surface 2 at the side. A plurality of these support profiles 28 can be plugged together with the interposition of a respective connecting profile 30, a cross section of which is illustrated in Figure 26, in order to form larger units. For this purpose, the connecting profile 30 has a longitudinal groove 31a, 31b on each of its two sides, in which the plug-in profile or edge area on the longitudinal side of each of the support profiles 28 can be held. This can be seen in Figure 27, which illustrates a support profile 28 and the two adjacent connecting profiles 30 of a corresponding V-trough concentrator system.

[0068] As can be seen from Figures 26 and 27, the connecting profiles 30 in this exemplary embodiment extend forwards with a triangular cross section from the height of their support profile holding grooves 31a, 31b, thus providing reflector functional areas 32 for the V-trough concentrator type. In other words, the connecting profiles 30 have a triangular cross section and form V-trough reflector functional areas 32 in order to inject radiation 33 incident thereon in a concentrating form onto a respective solar module 34 which is fitted to the module contact surface 2 of the support profile 28. This results in a concentration factor depending on the ratio of the projection area of the reflective V-trough surfaces 32 to the active area of the solar modules 34, with the concentration factor in the illustrated example being about two. Depending on the system configuration, the front triangular surfaces 32 of the connecting profiles 30 are intrinsically designed themselves to be reflective, or they are fitted with a planar reflector element, for example a suitable reflector sheet.

[0069] In the exemplary embodiment shown in Figures 25 to 27, the respective support profile 28 can be removed, with the solar module 34 fitted, when required, even with the V-trough concentrator system in the completely assembled state, without having to remove the rest of the structure to do so. For this purpose, the support profile 28 is held, such that it can be moved slightly laterally, in the corresponding holding grooves 31a, 31b of the adjacent connecting profiles 30, being held firmly by a latching connection in the in-use position, as shown in Figure 27, when in the assembled state. The latching connection includes a flexible latching tongue 35 which projects outward and is integrally formed on a longitudinal side of the support profile 28, and a latching tab 36, which

interacts therewith forming a catch, on the connecting profile 30. The latching tongue 35 can be released from its position latched behind the latching tab 36, by pushing the latching tongue 35 down, after which the support profile 28 can be moved to the right in Figure 27, as far as the end stop of the associated holding groove 31a, so that it moves out of the other holding groove 31b and can be removed to the rear, that is to say downward in Figure 27, during which process the connecting profiles 30 may remain stationary.

[0070] Figures 28 to 32 show a variant of the V-trough concentrator type shown in Figures 25 to 27, in which support profiles 37 are used whose cross-sectional shape corresponds very largely to that in the exemplary embodiment shown in Figures 14 and 15. Figure 28 shows the relevant support profile 37, which is provided along its two longitudinal sides with in each case one corresponding plug-in profile 10f, which has latching tongues with latching tabs at the ends. As a variant of the support profile 37 shown in Figure 14, Figure 28A shows a support profile 37A with additional hollow ducts 8c, which provide mechanical robustness and can also be used as cooling ducts or cable ducts. Figure 29 shows a cross section through an associated connecting profile 38, which corresponds, as shown, essentially to that shown in Figure 26 and in particular has the V-trough reflector functional areas 32. The connecting profile 38 in Figure 29 differs from the connecting profile 30 in Figure 26 essentially in that, instead of the support profile holding grooves 31a, 31b on both longitudinal sides, it is provided with a plug-in profile 20a which fits the plug-in profile 10f of the support profile 37, in a similar manner to the plug-in profile 20 of the connecting profile 19 in the exemplary embodiment shown in Figures 14 and 15. Figure 30 shows a support profile 37 in its in-use state with a solar module 34 fitted and with connecting

profiles 38 plugged on by latching on the sides. Apart from this, this system variant, as can be seen, corresponds to that of the V-trough concentrator system shown in Figures 25 to 27.

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[0071] Figures 31 and 32 respectively show a plan view and a cross-sectional view of a complete system unit of the V-trough concentrator type corresponding to the example in Figures 28 to 30 with five support
10 profiles 37 located alongside one another, and with the connecting profiles 38 which are in each case adjacent at the side and provide the V-trough reflector surfaces. Four solar modules 34 of a conventional type are arranged successively in the longitudinal direction
15 along each support profile 37, and in particular solar modules of a laminated type with a transparent front sheet can be used for this purpose.

[0072] As explained above with reference to various
20 exemplary embodiments, a plurality of support profiles can be joined to one another to form a broader unit, using connecting profiles. In certain cases, for example for some roof installations, it may be advantageous for the support profiles and the
25 connecting profiles not to have to be plugged together only once they are in the installation location. On the other hand, this may be impracticable if excessively large units must be prepared and transported to the installation and assembly location. In situations such
30 as this, it is possible to provide for only a certain number of support profiles to be plugged together with the aid of the connecting profiles to form units of a specific size which can still be handled, and for these units then to be transported to the final installation
35 location, where they can be connected to one another at the sides to form the final, relatively large unit.

[0073] Figures 33 to 36 show one advantageous solution for this application using suitably designed terminating profiles. Specifically, Figures 33 and 34 in this context each individually show one of two
5 terminating profiles 21a, 21b, which are associated in pairs, representing modifications of the terminating profile 21 shown in Figure 14. Like the latter, these have a plug-in profile 20' by means of which they can be plugged at the side, as a termination on the
10 longitudinal side, to a corresponding support profile that is not shown. On the terminating side facing away from the plug-in profile 20' the terminating profiles 21a, 21b have been modified from the terminating profile 21 shown in Figure 14 by being
15 provided there with connecting flanges 210, 211, which have U-shaped cross sections in opposite senses, and whose design is chosen such that the terminating profiles 21a, 21b can be joined to one another at the sides in a rainproof manner, by the flanges 210, 211
20 overlapping and engaging in one another in the form of a roof tile assembly or a labyrinth seal, as is illustrated in Figure 35.

[0074] In this way, two units which have been
25 prefabricated using appropriate support and connecting profiles and have been terminated on the sides by the terminating profiles 21a, 21b can be transported to the final installation location and can be joined together there in a rainproof manner by connecting their
30 terminating profiles 21a, 21b such that they engage in one another, as shown in Figure 35. The rainproof connection via the flanges 210, 211 of the terminating profiles 21a, 21b is preferably produced leaving a certain gap S in order to compensate for any
35 manufacturing tolerances and in particular to act as an expansion joint, which can absorb temperature-dependent expansion of the support structure.

[0075] Figure 36 shows the corresponding measure, as explained above with reference to Figures 33 to 35, for the rainproof connection via suitably designed terminating profiles using the example of a support structure formed using the support profiles shown in Figure 9. In this context, Figure 36 shows a representative detail with two support profiles 16a, 16b, which each represent an outer support profile of two preassembled units, which apart from this are not shown in any more detail for the sake of clarity, possibly composed of a plurality of support profiles with interposed connecting profiles in the form shown in Figure 13. For rainproof connection of these two preassembled units, the two illustrated support profiles 16a, 16b are provided on their facing longitudinal sides with plugged-on pairs of terminating profiles 112, 111, whose plug-in profile design corresponds to the connecting profiles in Figures 10 and 11 and which have suitable U-shaped connecting flanges 111a, 112a for this purpose on their terminating side, which overlap and engage in one another in a rainproof manner, as shown, as in the example in Figure 35. This allows the preassembled units to be connected to one another at the sides such that they are rainproof in a very simple manner, to form larger units at the final installation location. Once again, this connection is also advantageously provided with a certain gap S in order to provide an expansion joint.

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[0076] The support structure according to the invention allows relatively long lengths to be produced, depending on the system configuration, without any additional lateral supports, for example without any problems between about 2 m and about 10 m and in particular between about 4 m and about 6 m long. In applications in which a plurality of units which have been plugged together from one or more support

profiles and may have connecting profiles between them are also intended to be arranged in a row in the longitudinal direction, for example for installation of systems on roofs with long fascias, suitable lateral supports can be used as end connecting elements and are in the form of weather-resistant shingles, in which case the lateral supports can also be used for end attachment of the support profiles and, if appropriate, of the connecting profiles, and if required can be manufactured like them, for example as extruded profiles.

[0077] In exemplary applications which make use of the connecting profiles, it is preferable to produce not only the support profiles but also the connecting profiles from highly thermally conductive material, and also for the connection of the support profiles to the connecting profiles to be designed to be thermally conductive. This results in both the support profiles and the connecting profiles acting as effective cooling areas. By way of example, this is advantageous in the embodiments of the V-trough type shown in Figures 26 to 32 since the connecting profiles 30, 38 there form relatively large-area or large-volume profile bodies, which provide correspondingly large heat dissipation areas and high heat absorption capacities in addition to the surface areas of the support profiles and their heat dissipation structure.

[0078] Figures 37 to 39 show a system variant of the parabolic concentrator type composed of support profiles 60, which are joined to one another by plugging them in at the sides, corresponding to Figure 37 and connecting profiles 61 corresponding to Figure 38. In particular, each support profile 60, as is illustrated in detail in Figure 37, is in the form of a hollow-duct profile which is symmetrical about the longitudinal center and has two reflector functional

areas in the form of parabolic reflectors 62a, 62b and plug-in profiles 63 on the longitudinal sides, with the shape of the plug-in profiles 63 corresponding to that of the plug-in profiles 10e of the support profile 17 shown in Figure 14. The connecting profile 61 which is illustrated on its own in the form of a cross section in Figure 38 has plug-in profiles 64 on both sides which correspond to the plug-in profile 63 of the support profile 60, and to this extent corresponds to the connecting profile 19 shown in Figure 14. Furthermore, a tubular profiled part 65 is integrally formed on the front face of the profiled base body, to which the plug-in profiles 64 are fitted, of the connecting profile 61, and acts as a solar module functional area or solar module element.

[0079] Figure 39 shows a detail of the system design which has been plugged together using these two basic elements, that is to say the support profile 60 shown in Figure 37 and the connecting profile 61 shown in Figure 38, in which any desired number of support profiles 60 are plugged together on the longitudinal side, with the interposition of the connecting profiles 61. To this extent, reference can be made to the above statements relating, for example, to the system shown in Figure 15, and the variants derived from it. Each of the reflector surfaces 62a, 62b which are provided on the front face of the support profiles 60 reflects radiation that is incident on its front face in a concentrated form in the direction of the respective solar module element 65 which is adjacent at the side, projects on the front face of the connecting profile 61 and is therefore located at the focal point of the relevant reflector 62a, 62b. As can be seen from Figure 39, two adjacent reflectors 62a, 62b which are associated with two adjacent support profiles 60 in each case act on the same solar module element 65 between them. The

reflectors 62a, 62b may be formed by the relevant support profile surface itself or may be applied to this surface, for example as a reflector sheet or by coating.

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[0080] Depending on the application, the solar module element 65 may be a thermal solar collector element or a photovoltaic element. In the former case, the solar module element 65 is, for example, in the form of
10 thermal solar collector tubes of a conventional type per se, in which a heat carrier medium, which can be heated by the concentrated incident radiation, is carried in the interior of the tubes. In the latter case, the solar module element may, for example, be in
15 the form of a monolithic photovoltaic module body or a photovoltaic sheet element or a photovoltaic coating, which is applied to a suitably shaped mount which may have the illustrated tubular shape or, in alternative exemplary embodiments, any other desired shape, as
20 well.

[0081] In the illustrated example, the solar module element 65 forms an integral component of the connecting profile 61, so that they can be manufactured
25 jointly as a single profiled body, with the solar module element 65 being connected to the connecting profile base body via a web 66. If the connecting profile 61 is produced from thermally conductive material, the web 66 at the same times forms a
30 thermally conductive connection from the solar module element 65 to the connecting profile base body, and thus to the support structure of the plugged-together system as shown in Figure 39, overall. In alternative embodiments, the solar module element is manufactured
35 as a separate component, separately from the connecting profile, and is attached to it or to other structural parts of the support structure of the overall system. By way of example, the attachment to the respective

connecting profile may be made as required by means of a thermally conductive or thermally insulating connection, in order to thermally couple the solar module element to the rest of the support structure in the desired manner, or to keep them thermally decoupled.

[0082] As will be clear from the illustrated exemplary embodiments and those explained above, the invention provides a combined support and cooling profile which can be produced comparatively easily, is designed to be self-supporting as a rib longitudinal profile and/or hollow longitudinal profile, and includes an integrally formed heat dissipation structure which is thermally conductively connected to a module holding surface and/or a reflector functional area, as in the case of the illustrated V-trough and parabolic concentrator types, so that heat can be effectively dissipated from there. The reduction that this allows to be achieved in the operating temperature of solar modules that have been fitted allows a greater energy yield. This applies both to photovoltaic cells composed of crystalline silicon and to thin-film solar cells on a sheet, sheet metal or membrane mount. The support profiles can be produced very easily and at low cost, for example by extrusion, strand drawing or roll forming from thermally conductive material, such as aluminum, magnesium, stainless steel, galvanized steel or a thermally conductive plastic material. The support structure concept according to the invention allows a very high level of prefabrication and parallel assembly for corresponding photovoltaic systems. It is self-evident that the invention can be used in the same way for thermal solar collector systems.

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[0083] The support structure concept according to the invention is suitable for large-scale integrated photovoltaic systems in large power stations in the

same way as in the open air and for building integration. Roof or facade elements including shadow laminate installations can be installed without a complex substructure, with relatively little
5 installation effort, for example as a building skin. A high degree of modularity of such a facade and roof systems is achieved, which can be oriented primarily to the physical constraints, such as the facade grid, storey height etc.

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[0084] Self-supporting photovoltaic module units of a relatively low weight can be produced with high robustness and in particular with longitudinal stiffness particularly advantageously by a combination
15 of support profiles composed of aluminum, which for example are manufactured as strand-drawn elements, with photovoltaic sheet laminates, in which case embodiments both of the flat module type and of the concentrated V-trough type as well as of the concentrating parabolic
20 linear concentrator type are possible, as explained above. The concentrator types are preferably suitable for installations with readjustment facility. The systems of the flat module type are suitable not only for rigid outdoor installations but also for outdoor
25 installations with readjustment, and for building integration on facades and on roofs.

[0085] In all the applications, the invention represents a support structure which can be produced
30 easily and has a combined support/cooling profile, with comparatively high torsional and bending stiffness and a long minimum support width. The support/cooling profile carries out the entire support function for the solar module elements and/or reflector elements that
35 are fitted and are attached thereto, for example, by suitable clamped joints, joining techniques and/or adhesive joints. At the same time, the support profile acts as a heat sink.

[0086] If required, the support profiles are connected at the end, for example via integrated screw ducts and/or on slot ducts in the form of a drawn-in attachment, to suitable, conventional lateral supports, to form larger support units. In the variants with side plug-in profiles, the support profiles are plugged together directly or with connecting profiles between them in each case to form larger support units as required, in order to accommodate more and/or larger solar modules and/or reflector elements. Depending on the type, the support profiles are first of all connected to form a closed contact surface, to which the solar modules or reflector elements are then applied, thus allowing a very high coverage degree, or the individual support profiles first of all have the solar modules and/or reflector elements applied to them, and they are then connected to form relatively large functional areas, based on the building-block method. An analogous procedure may, of course, also be adopted with support profile groups composed of a plurality of connected support profiles.

[0087] The solar modules are preferably provided with transparent front sheets instead of front glasses, which has advantages in terms of the thermal expansion coefficient, weight, risk of fracture and format restriction and they are connected with a good thermal contact to the support profile located underneath, for example by direct lamination on or indirectly by adhesive bonding or clamping on of prelaminated units, for example photovoltaic laminates without glass.

[0088] When flat module units are statically integrated into the building skin, the support profiles which are provided with side plug-in profiles may, for example, be preassembled to form relatively large support units matched to the building grid system, and

are then provided with a photovoltaic sheet composite as a solar module by lamination, adhesive bonding etc. In the case of systems with readjustment, the support units are mounted on appropriate lateral supports such that they can rotate. In corresponding embodiments, a plurality of support units are combined via suitable coupling elements, such as tie rods and compression rods, to form relatively large system units, and are readjusted to follow the incident light, by means of a common drive. For example, ten or more rotating units in each case with a solar module area of about 7.5 m² may be connected to form a subsystem on a stand. Installations such as these on stands can be installed both outdoors as well as on flat roofs and inclined roofs. For systems with readjustment, it is possible to use solar module units according to the invention both of the flat module type and of the concentrating V-trough type, as well as of the concentrating parabolic trough type.

[0089] In a further advantageous embodiment with a stand, the support profiles are assembled for solar readjustment to form large table units and are connected via drawn-in lateral supports to a central rotation apparatus with a vertical rotation axis. In this arrangement, which is particularly suitable for outdoor use, rotation units or subsystems with a solar module area of more than 100 m² can be produced. In a further optimized stand form, the inclination angle of the rotating tables can also be swiveled, thus allowing two-axis readjustment for the time of day.

[0090] It should be stressed once again that the implementation according to the invention of the support profiles as self-supporting rib longitudinal profiles and/or hollow longitudinal profiles is adequate to support the support structures constructed in this way in the end face areas, and there is no

absolute necessity for further lateral bracing between the end holder or mounting of the support structures constructed in this way. This is because the support profiles have adequate self-supporting longitudinal
5 stiffness with a comparatively low natural weight, by virtue of their rib-profile and/or hollow-profile structure.

Patent Claims

1. A solar module system having
 - a self-supporting support structure (37, 38) and
 - at least one solar module element or reflector element adapted to be arranged on the support structure, characterized in that
 - the support structure includes at least one self-supporting rib or hollow longitudinal profile as a support profile (9, 60) with a solar module functional area (2) and/or a reflector functional area (62a, 62b), the support profile having a plug-in profile (10b, 63) on the longitudinal side for attachment of a further support profile or of a connecting profile (38) or of a terminating profile (11, 12) at the side.

2. The solar module system as claimed in claim 1, further characterized in that the solar module system is of the V-trough concentrator type and the connecting profile is in the form of a hollow-chamber longitudinal profile (38), which has at least one profile side surface which acts as a reflector functional area (32) in order to provide a reflective V-trough wall surface.

3. The solar module system as claimed in claim 1, further characterized in that the solar module system is of a parabolic concentrator type, in which the support profile has a parabolic reflector functional
5 area (62a, 62b), which is associated with a solar module element (65) which is arranged or formed on a front face of a connecting profile or terminating profile which is attached to the support profile at the side.

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4. The solar module system as claimed in one of claims 1 to 3, further characterized in that one or more hollow chambers (8a, 8b, 8c, 17b) is or are formed on the support profile (28) and/or on the connecting
15 profile (30), and/or the plug connection of the plug-in profile on the longitudinal side and/or the terminating profile have/has a shape for forming a hollow chamber or chambers.

20 5. The solar module system as claimed in one of claims 1 to 4, further characterized in that the connecting profile can be attached to the support profile at the side by means of a thermally conductive connection.

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6. The solar module system as claimed in one of claims 1 to 5, further characterized in that the plug-in profile is designed such that a respective support profile (28) can be fitted, by latching between
30 two stationary connecting profiles (30) and can be removed by unlatching it.

7. The solar module system as claimed in one of claims 1 to 6, further characterized in that pairs of
35 terminating profiles (21a, 21b) are provided and are designed for connection, engaging in one another, in a rainproof manner.

8. The solar module system as claimed in one of claims 1 to 7, further characterized in that the support profile and/or the connecting profile and/or the terminating profile are/is in the form of an
5 extruded, strand-drawn or roll-formed profile.

9. The solar module system as claimed in one of claims 1 to 8, further characterized in that the support profile and/or the connecting profile and/or
10 the terminating profile are/is formed from aluminum, magnesium, stainless steel, a galvanized steel material or a thermally conductive plastic material.

10. The solar module system as claimed in one of
15 claims 1 to 9, further characterized in that the plug-in profile and/or the connecting profile are/is designed to connect in each case two support profiles with an aligned useful face, forming a continuous solar module useful surface/reflector useful surface.