The right solar module

Criteria for assessing the quality of crystalline solar modules in practice

- **Once installed, modules should last for well over 20 years and achieve a high output day after day**
- **Price and efficiency alone are not sufficient decision criterias**
- **Further characteristics of the module quality affect yield and durability – and thereby investment security**

When assessing the total yield of a solar energy system, today the focus is often on the time it takes to break even or the length of time that the state will fund the project. A basic assumption is that the system will operate without errors, although this is not always true. Often, users base their solar module choice solely on the nominal degree of efficiency and peak price per watt. From a long-term perspective, however, other criteria should be taken into consideration during the assessment. A good module should be able to achieve a reliably high yield for well over two decades. This edition of the Practical knowledge series gives advice on what to look for when choosing modules.

Module components

Cells

At the heart of the solar module is the solar cell. A careful combination of efficient cells with uniform properties is the prerequisite for a high degree of module efficiency, a long service life and high yields.

The most commonly used cells throughout the world are made from polycrystalline silicon. These cells are always square and can be easily identified by their uneven markings. Cells made from monocrystalline silicon usually feature a somewhat higher degree of efficiency. The typical "cropped" corners, however, reduce the size of the active cell surface and the higher cell efficiency is not fully converted into a higher overall module efficiency. In terms of the output generated and durability, there is no difference between the two types.

Practical tip No. 1: Note the number of busbars.

To be able to conduct the electricity generated by the cell to a load, this must have an electrical contact. This is formed by the metallic contact grid mounted on the cell surface that consists of thin fingers and wide strips - the so-called busbar.
A number of module manufacturers use cells with two busbars, as these cells can be obtained from various sources and often possess a high degree of cell efficiency. To be able to conduct the electricity generated particularly reliably, cells are being fitted with three busbars, as this allows the load to be better distributed and contact resistances between the cells to be reduced. This enables cells with three busbars to achieve a higher degree of module efficiency and at the same time improved reliability.

Glass

The glass is a stabilising, translucent support material on the module. In contrast to window glass, highly transparent, thermally pre-stressed toughened glass (solar glass) is usually used for modules.

Practical tip No. 2: Check the glass surface.

A wide range of different solar glasses are available on the market: flat, unstructured, microstructured, heavily structured glasses or even specially coated glasses. The task of these glass types is to channel as much sunlight as possible into the module. Heavily structured glasses, however, tend to be prone to contamination, which can have a negative impact on the module output over time. Better suited to European latitudes is the use of microstructured glass, which features a self-cleaning

effect when subjected to occasional rainfall and is far less likely to result in the build-up of moss.

Modules with anti-reflective-coated glass are also available on the market. Here, it is important to ensure that the durability of the coating is guaranteed for the extended service life of the module (at least 20 years). As with spectacle lenses, the anti-reflective coating can age or even flake off, which in extreme cases can lead to the deterioration of the module output.

Frame

The module frame protects the delicate outer edges of the glass film laminate and, together with the special glass, guarantees stability and torsional rigidity

Practical tip No. 3: Check the condition and quality of the frame.

The most robust and stable frames are those made from anodised aluminium, which in contrast to coated frames are less prone to scratches. Frames should not feature any closed cavities as these can collect water, which will turn to ice in winter. This can cause the frame to bend or to break completely. In winter, a flat runoff edge along the cells can also prevent the formation of ice and snow, the force of which can detach the frame from the module. In the summer, contamination such as pollen or dust cannot collect on flat frame edges, which means that moss is unable to grow. Such contamination is particularly critical when it covers parts of the cells, as this can considerably reduce the output of the module.

A good frame is screwed together. Special screws connect all parts of the frame in such a way that they are mechanically and electrically conductive and thereby enable the module to be earthed throughout. Frame parts that are not screwed together but rather interlocked, and non-metallic corner connections are not recommended. The frame should of course feature good, clean workmanship without sharp edges or protruding screws.

Also ensure that the frame parts are properly attached to the laminate. On the rear of the frame, on the inside edges, special frame hinges ensure a clean and consistent seal. Ensure the parallel and straight alignment of the hinge. Silicon can also provide adhesion when applied evenly and flush and not sprayed onto the frame. Silicon is, however, more susceptible to climatic conditions and should therefore be avoided.

Junction box

The primary task of a junction box is to channel the direct current generated by the module to the outside. If incorrectly designed or manufactured, however, it can represent a risk of fire for the photovoltaic system in certain circumstances.

Practical tip No. 4: Check for soldered and encapsulated junction boxes.

Soldered or welded connections created in automated processes are secure and stable. Proceed with caution with clamped, plug-in or screw connections. If these are improperly manufactured, they can become loose or rust and thus cause a short circuit. The resulting electric arc can cause fires in the junction box.

Junction boxes cast with flame-retardant plastic are protected against the ingress of moisture and air. This provides additional safety.

Practical tip No. 5: Bypass diodes protect cells from damage.

Bypass diodes support optimised operation, even under unfavourable operating conditions. If cells are covered temporarily, e. g. by leaves, the bypass diodes channel the electricity from the cells that are not covered across the covered cells and thereby protect them against damage. When the cells are no longer covered, the bypass diodes switch back to their original state and the module is again able to achieve its full output. Good modules have several bypass diodes, each of which should be connected to a maximum of 16-20 cells. A special diode cooling system dissipates the heat generated by the diodes.

It is also important to ensure that in the box, the connection area of the cells is electrically and thermally isolated from the diode area. Also avoid plugged-in diodes here. This guarantees maintenance-free operation of the module throughout its entire service life. It is not necessary to replace the diodes.

The hidden values

It is not only the materials and components used which testify to the quality of a module. Other features, which guarantee the usability of the modules in standard applications and beyond, are also important.

Practical tip No. 6: Only positive performance tolerances will allow you to achieve the full output for your money.

Performance tolerances are specified by manufacturers in order to indicate production-related deviations from the nominal output. Minus tolerances indicate lower actual module outputs than the nominal values specified (and thereby paid for). If a positive performance tolerance is guaranteed, customers always receive at least the specified output for their money. In practice, this can be exceeded by up to a certain percentage and thus lead to a higher yield. The specified positive tolerance should not be too high, however, as the large variation in real measured values can hinder string optimisation.

Look for sensible tolerance specifications: A positive tolerance of 3% when the modules are sorted into 5 W classes does not make mathematical sense (at this tolerance, a 220 W module could achieve a maximum of 226.6 W – which corresponds to the next level of performance).

Practical tip No. 7: Check for evidence of weak light performance.

The sun does not shine from a cloudless blue sky every day. When the output of the modules is determined in a production plant, exactly these conditions are simulated – these are the so-called standard testing conditions (STC): 1000 W/m² irradiation, 25° C module temperature, atmospheric depth AM 1.5. An irradiation of 800 W/m² is known as weak light. This can be converted into electrical energy extremely efficiently. Modules, therefore, should possess evidence of good weak light performance in order to ensure the highest possible average annual yields.

Practical tip No. 8: Permissible loads of 5400 Pascal provide static safety.

Modules are usually tested in accordance with the applicable standard for pressure loads and tensile loads of up to 2400 Pa. This often does not provide sufficient safety for special weather conditions, as the modules are subjected to higher surface loads in areas prone to snow, for example.Modules with a bearing load of at least 5400 Pa guarantee planning reliability. When mounted correctly, the modules can support snow drifts of more than three metres.

Practical tip No. 9: Check for approval for upright and crossways installation as well as a low dead weight.

For installation, it should not only be possible to attach modules along their long sides – they should also have approved clamping points on their short sides. This allows them to be used securely both in upright and crossways format and to be installed flexibly in accordance with individual requirements.

It is also advantageous for modules to have a low dead weight, which means that they can be installed on roofs with a low bearing load. Today, light modules weigh less than 90 g/Wp.

Warning: The light weight should not be favoured over a low pressure and tensile load. Top-quality modules meet both criteria.

Practical tip No. 10: Remember operational safety and ease of installation.

Light modules simplify transport and handling during installation. Connection cables with a screw cap also make work quick and easy. It is also important that the cable ends are fixed to the module (e. g. clamped onto the junction box) for transport to the installation site and thus do not represent a trip hazard.

Practical tip No. 11: Do not be confused by a large range of products.

Many manufacturers offer an inexhaustible range of module types, which ultimately designed to achieve same thing: producing electricity. Do not let this confuse you. A good module can be installed in a variety of systems. Size-optimised modules can be helpful, however, as these allow for an improved roof layout, for example.

Guarantees

Product and performance guarantees may be offered by a manufacturer in addition to and independently of the legal seller's warranties which provide additional investment security.

Practical tip No. 12: Take note of warranty periods and transparent conditions.

The warranty periods for solar modules should be at least five years. Some manufacturers also offer optional warranty extensions, which provide additional investment security.

Performance guarantees apply to various periods and minimum performance of the module (in percentages) (e. g. 20 years at 80 % of the nominal output).

The actual performance scope is defined by each manufacturer on an individual basis. It is therefore important that you carefully check any warranty conditions and ensure the clear, unambiguous formulation of the requirements and precise performance descriptions. As a general rule, warranty cases must be proven by the customer. Transparent warranties prevent unpleasant surprises in the event of damage and simplify the processing of claims.

Practical tip No. 13: Take note of the applicable laws, court of jurisdiction and accessibility of the warranty provider.

If claims have to be legally enforced in foreign countries, a range of laws apply. In addition to high legal fees, valuable time can be lost clarifying and eliminating damage, which can also result in a loss of income. It has therefore been extremely beneficial for European law to be made applicable and the court of jurisdiction to be in Europe.

Certifications and directives

As with guarantees, certifications can offer additional security, for example when using solar modules in coastal regions or in agriculture.

The International Electrotechnical Commission (IEC) developed safety standards for the international module trade.

The following IEC certificates are required for crystalline modules:

- IEC 61215: Crystalline silicon terrestrial photovoltaic (PV) modules Design qualification and type approval
- IEC 61730: Photovoltaic module safety qualification

In the USA and Canada, the North American safety certificate UL 1703 must be provided.

Examples of further national requirements in Europe are the CSTB guideline for the French market and the MCS certificate for Great Britain, which is strongly linked to the IEC safety standards.

Practical tip No. 14: Note the relevant certifications for the construction of solar energy systems in coastal regions or in agriculture.

When used in coastal regions, the IEC 61701 standard comes into force, which certifies the corrosion resistance of the module in the presence of salt fog.

For agricultural customers, the "Ammonia resistance" focus test by the German Agricultural Society (DLG) will be of interest. The DLG certificate certifies that modules can withstand chemical loads from the air in barns.

The fact that the places of module manufacture are certified in accordance with ISO 9001 and ISO 14001 is important from quality and environmental perspectives. This guarantees adherence to environment protection requirements as well as a quality management system which consistently ensures the high quality of the modules produced.