

**Use of the below check list:**

The below listed point of attention can be used while evaluating offers for off-grid Solar Energy Systems (SES) in order to come to equal technical offers and to receive a reliable Solar Energy System solution.

Item #	Item description	Remarks
<b>1</b>	<b>System energy requirement / load list</b>	
1.1	Is the total load consumption (= energy consumption) defined at the nominal system voltage (Vnom = 12.0Vdc, 24.0Vdc or 48.0Vdc)?	
1.2	Is the runtime (e.g. duty cycle) taken into account when defining the required total daily load?	Using the right runtime could result in lowering the load which will result in a smaller Solar Energy System.
1.3	Have efficiency losses for solar energy system's internal DC/DC converters, inverters or regulators for load outputs been taken into account?	Datasheets to be provided that the used efficiencies are correct. Not including the correct efficiencies will lead to under sizing the Solar Energy System.
<b>2</b>	<b>Solar Energy System sizing calculations</b>	
2.1	Does the system sizing consider the worst case scenario (= solar insolation in winter period or monsoon season)?	Using yearly average values will lead to under sizing the Solar Energy System therefore worst case values to be used. Values for insolation to be provided from an Internationally recognized source.
2.2	Is the tilt-angle optimized for the worst case scenario?	The tilt angle depends on the actual location of the system.
2.3	Has the (correct) reduction factor for battery ambient temperature been considered for battery sizing at lower or higher temperatures?	If indicated by the project specifications the worst case ambient temperature to be used. Note: each battery brand and type has its' own temperature reduction factor. A statement from the battery manufacturer to be requested for review.
2.4	Have the reduction factors for dust (solar modules) and ageing (solar modules and battery) according project specifications been considered?	Not including the correct reduction factors will lead to under sizing the Solar Energy System.
<b>3</b>	<b>PV modules</b>	
3.1	Are offered safe area PV modules certified according IEC 61215 and IEC 61730?	
3.2	For a PWM charge controller the maximum power point voltage (Umpp) should be within the correct limits for the nominal system voltage Umpp = 16.7Vdc ≤ 18.5Vdc (for 12Vdc), Umpp = 33.5Vdc ≤ 37.0Vdc (for 24Vdc).	A voltage less than 16.7V/33.5V will result in not being able to fully charge battery banks. A voltage above 18.5V/37V is not required for charging batteries sufficiently. A too high Umpp will lead to higher costs and more space will be required. For an MPPT charge controller the minimum and maximum array input voltage should be observed.

3.3	Is the performance warranty on offered PV modules 10 years for 90% output and 25 years for 80% output?	This is nowadays the standard performance warranty offered.
3.4	Is the nominal Watt peak value 0% - +5% (or +/-5Wp) according PV module datasheet?	A possible negative tolerance could result in a lower output of the PV array. This negative tolerance should be considered as additional losses for PV modules in the system sizing.
<b>4</b>	<b>Charge controller equipment</b>	
4.1	Is the charge controller controlling the solar array input, battery as well as controlling the load?	A real charge controller performs these 3 functions together in one unit and not be separate components. Often controlling the load (=switching off the load at low State of Charge) is performed by a separate component as the offered solar charger is often not providing the 3 functions. Adding extra connections and components results in lower reliability.
4.2	Is the charge controller operating with a high charging efficiency (>98%) and suitable for the actual ambient temperature range between -10° C and +75° C under full load conditions and without any derating?	Note that the temperature inside a control enclosure will be higher (can be up to 25°C higher) than the ambient temperature as per project specifications. A too high charge controller temperature can lead to a shutdown of the system as many charge controllers start derating at 40-50°C.
4.3	Is the charge controller provided with a field-test facility for easy system diagnostics?	During maintenance the performance of the charge controller can be quickly checked with such a facility.
4.4	Is the charge controller provided with multiple array inputs for more accurate battery charging?	At least 2 array inputs are required to spread energy generation and provide a higher system reliability. If only one array is used a bad connection or damaged cable will lead to not charging a battery.
4.5	In case more charge controllers are required they should be controlled by one main charge controller in a so called master-slave configuration.	
4.6	Is the charge controller provided with an electronic array input switching device and (build in) electronic reverse current protection?	Mechanical relays will have a low (< 5 year) lifetime expectancy due to the very frequent switching in float charge mode. Diodes often used for reverse current protection will lead to extra power loss and extra connections.
4.7	Is temperature compensation for the battery charging voltage included and fail safe?	To avoid overcharging of a battery a temperature compensated charge voltage should be used. In case of a malfunctioning temperature sensor, a backup mechanism must be available to keep the charging voltage within safe limits to prevent overcharging battery banks.
4.8	Is the charge controller/system capable of providing the peak load current under all circumstances?	Peak currents should be delivered by each individual sub-system in case of malfunctioning of a sub-system.

4.9	Is the charge regime designed and optimized for the offered battery cell type?	Lead acid battery cells require a different charge regime compared to NiCd battery cells. The used charge regime should be confirmed by the battery supplier.
<b>5</b>	<b>Battery banks</b>	
5.1	Do battery cells comply to IEC 61427-1 (for use in pv applications)?	Often batteries which are only suitable for UPS (= constant voltage) applications are offered which will result in a shorter lifetime. Compliance to IEC 61427-1 should be confirmed by a respectable notified body.
5.2	Is the minimum number of duty cycles for 20% DOD = 6000 @ 25°C?	DOD = Depth of discharge. A lower amount of cycles is not desirable for a high reliable SES as the lifetime expectancy will become too low.
5.3	Is a maximum number of 4 battery sets in parallel considered for each (sub-)system?	More than 4 battery sets in parallel will result in an improper / less accurate / unbalanced battery charging which will lead to a shorter battery lifetime for all battery sets. This is also a recommendation provided by the battery manufacturers.
5.4	Is the minimum SOC (for VRLA) or maximum SOC (for NiCd) considered for a correct system sizing?	The full battery capacity is never available since a VRLA battery should not be discharged completely (minimum SOC 15%-20%). A NiCd battery for solar can be discharged up to SOC 0% but cannot be charged completely (maximum SOC 95%).
<b>6</b>	<b>Battery box</b>	
6.1	Is the battery box providing enough ventilation even after being in service for a few months?	In order to cool the batteries and to ventilate eventual hazardous gasses a good natural ventilation should be provided. The use of filters should be avoided as they get full of dust blocking the required ventilation. An IP43 battery enclosure is providing the required ventilation and enough protection against water ingress.
<b>7</b>	<b>ATEX/IECEX specific requirements</b>	
7.1	Are the offered hazardous area PV modules certified according to the latest ATEX/IECEX standard and allowed to be used at areas with a high change of an impact?	An ATEX/IECEX Certificate of the PV module should be provided by the supplier and the special conditions for safe use to be read as sometimes these includes restrictions for use in the environment in which the PV module will be installed.
7.2	Are the offered hazardous area PV modules or enclosures certified for the ambient temperature in which it will be used?	The ambient temperature should be mentioned on the ATEX/IECEX certificate. If not mentioned the maximum ambient temperature is 40°C.
7.3	Ex e PV modules, assembled Ex de enclosures and complete Ex de control racks can only be fabricated by ATEX/IECEX certified companies.	A valid ATEX examination certificate and/or IECEX notification should be provided proving that the company is allowed to fabricate Ex e and/or Ex d certified equipment.