



TITLE: Solar power system for cold and freezer rooms	
<i>Product verification protocol:</i>	E001/PVAC-VP1.0
<i>Product specification:</i>	E001/PVAC 01
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1. Scope

Public sector consultations and reports from the field have identified the need for solar power systems for walk-in cold rooms and walk-in freezer rooms.

This specification describes the requirements for a generic [hybrid solar power system](#) generating electricity (single or three-phase [alternating current \(AC\)](#) electricity) with a photovoltaic (PV) solar array and additional source of [back-up power](#) for cold rooms (CR) or freezer rooms (FR) that comply with **WHO PQS E001/CR-FR01** specifications. It also describes the [installation](#) and maintenance advisory services that all [legal manufacturers](#) must offer in order to become a prequalified supplier of CR-FR [hybrid solar power systems](#).

Historically, CR and FR operate with electric vapor compression refrigeration which is powered with single or three-phase [alternating current \(AC\)](#) electricity supplied by an electric grid (mains). This power supply is typically backed-up by a fuel-fired generator that is capable of providing 100% of the CR-FR electrical requirements.

The [hybrid solar power system](#) must be capable of providing 100% of the site-specific CR-FR electrical requirements, both as a [hybrid solar power system](#) with [back-up power](#) and as a [standalone](#) solar power system operating with no [back-up power](#) system. Typically, [hybrid solar power systems](#) will require a solar array, battery, battery charge control, over current protection devices, a DC to AC [inverter](#) and a [back-up power](#) system capable of also providing 100% of the CR-FR electrical requirements including battery recharging.

If an unreliable electrical grid (mains power with history of frequent and/or prolonged power outages) is available and, if allowed by the local electrical supply authority, a [grid-connected](#) solar power system can be used to import power for battery chargers and the CR-FR load. An unreliable grid connection will not, however, be considered a [back-up power](#) system. In such cases, the [hybrid solar power system](#) would require 100% solar power capability, 100% [back-up power](#) capability (e.g. with generators) and have capability to utilize the grid connection.

[Grid-tied](#) solar power systems that are synchronized to export power to a reliable grid (mains), [direct current \(DC\)](#) -only solar power systems and solar direct drive CR-FR are not included this specification.

The following documents are associated with this specification:

- **E001/PVAC-VP1** is a type-examination protocol which will be used for prequalification evaluations.
- **E001/PVAC-VP2** is completed by an [employer](#) or his [QA assessor](#) and sets out the requirements for a specific [installation](#). The document also specifies the [installation](#), commissioning and handover procedure. The completed protocol should be read in conjunction with **E001/PVAC 01**, to which it refers.

E001/PVAC 01 and a completed **E001/PVAC 01-VP2**, together with an [employer's](#) other documents, are intended to form the basis for a contractual agreement between the [employer](#) and the [legal manufacturer](#) or [reseller](#) for the supply of the components required for a specific [installation](#). This also forms the basis for a contractual agreement between the [employer](#) and the approved [installer](#).

2. Terms and definitions

Note: Solar energy definitions are contained in **IEC 61194**.

[Alternating current \(AC\)](#): an electric current that reverses its direction at regularly recurring intervals whose value varies as a sine wave.

[Autonomy](#): time in days that a solar power system can maintain the vaccine load within the acceptable temperature range under low solar radiation conditions (e.g. rain). Autonomy is determined as described in Clause 4.2.3 Battery set sizing.

[Back-up power](#): a secondary, auxiliary power source (e.g. generator) capable of independently powering 100% of all CR-FR electrical needs and battery recharging.

Design day: for purposes of sizing the solar power system, the design day requires the largest of the following three options for sizing the solar array to meet all CR-FR electrical load requirements: 1) based on the lowest monthly solar radiation reference period; 2) based on the highest average daily electrical load requirement for a given month; or 3) both simultaneously.

Direct current (DC): an electric current flowing in one direction.

Employer: the organization that contracts with the legal manufacturer or reseller who will supply the system components and the installation and maintenance advisory services described in this specification. The employer will typically contract with an installer who will install and commission the installation under the supervision of a QA assessor and also with a maintenance contractor who will maintain the installation.

Grid-connected: solar power system that imports electricity from a power grid (mains).

Grid-tied: grid-connected solar power system that also is synchronized to export electricity into a power grid (mains).

Hybrid solar power system: solar power system with one or more auxiliary sources of power (e.g. a diesel or petrol-fueled stand-by generator).

In writing: communication by letter, fax or email.

Installation: the complete hybrid solar power system installation described in this specification and in the companion **E001/PVAC01-VP2** document, together with any other employer's requirements documentation issued for a specific installation or installations including voltage stabilizers and standby generators where these are listed in the employer's requirements.

Installer: a person or organization who has been appointed by the employer to carry out the installation of the system. A qualified installer may be either a legal manufacturer or a reseller or an approved representative and must:

- supply a coherent, correctly sized installation where the settings of all the components have been adjusted for optimum performance at the installation site,
- have installed and supported (e.g. by providing on-going technical assistance, spare parts and system documents) at least five hybrid photovoltaic systems in a developing country or countries for at least two years (detailed references, including donors, locations and contacts, must be provided for independent verification),
- have the capacity and financial resources to provide long-term support to the systems in the country of destination.

Inverter: electronic component to convert DC to AC electricity.

Legal manufacturer: the natural or legal person with responsibility for the design, manufacture or integration of components, packaging and labeling of a product or device before it is placed on the market under their own name, regardless of whether these operations are carried out by that person themselves or on their behalf by a third party.

Maintenance contractor: a person or organization contracted by the employer to maintain the installation.

Maximum power point tracking (MPPT) control: a type of photovoltaic-to-battery charge control that optimizes solar array output by operating as a DC to DC converter. It uses the DC input from the PV array and converts it back to a different DC voltage and current output so that the PV module is correctly matched to the battery. This allows a solar array to be wired at optimal voltage to overcome long cable distances that otherwise would result in excessive voltage drop or unacceptably large cable diameter.

Montreal Protocol: Montreal Protocol on Substances that Deplete the Ozone Layer.

QA assessor: the person or organization appointed by the employer to assess the suitability of candidate installers, to evaluate their proposals and to monitor the assembly and commissioning of the installation on site.

QA: quality assurance.

Region: a contiguous geographical area within which the legal manufacturer or reseller is able to provide the full range of services described in this specification.

Reseller: a commercial entity, licensed to act on behalf of a legal manufacturer, and which carries product liability and warranty responsibilities no less onerous than those carried by the legal manufacturer.

Solar radiation reference period: the minimum average daily solar radiation on the plane of the solar array that is required to properly power the CR-FR, expressed in kWh/m²/day.

Standalone: solar power system capable of independently powering 100% of all CR-FR electrical needs. It is the primary source of power for the CR-FR and can be coupled to a back-up power source (generator) to also operate as a hybrid solar power system.

User: the person responsible for the day to day operation and temperature monitoring of the (CR-FR) room and/or solar power system.

3. Normative references

(Use most current version)

BS EN 60529:1992+A2:2013: Degrees of Protection by Enclosures (IP Code)

EMAS: European Union Eco-Management and Audit Scheme.

IEC 60335-1: 2006 Household and similar electrical appliances - Safety - Part 1: General requirements.

IEC 60364-1: 2005 Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions.

IEC 61000-6-1 edition 2.0: 2005 Electromagnetic compatibility (EMC) Generic standards - Immunity for residential, commercial and light-industrial environments.

IEC 61000-6-3 edition 2.1: 2011 Electromagnetic compatibility (EMC) Generic standards - Emission standard for residential, commercial and light-industrial environments.

IEC 61194: 1992 Characteristic parameters of stand-alone photovoltaic (PV) systems.

IEC 61215: 2005 Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval.

IEC 61646: 2008 Thin film terrestrial photovoltaic (PV) modules – Design qualification and type approval.

IEC 62109-1 Safety of power converters for use in photovoltaic power systems – Part 1: General requirements.

IEC 62109-2 Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters.

IEC TS 62804-1:2015 Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Crystalline silicon.

IEEE 937: Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic (PV) Systems.

IEEE 1562: 2007 Guide for Array and Battery Sizing in Stand-Alone Photovoltaic (PV) Systems.

ISO 1461: 2009 Hot dip galvanized coatings on iron and steel articles - specifications and test methods.

ISO 9001: Quality Management Systems – Requirements.

ISO 14001: 2004 Environmental management systems - Requirements with guidance for use.

ISO 20282-1: 2006 Ease of operation of everyday products - Part 1: Context of use and user characteristics.

Solar Autonomy Calculation Tool, H.Toma and T. Markvart, University of Southampton, UK 2009.

WHO PQS E001/CR-FR01.4: Cold rooms and freezer rooms.

WHO PQS E001/PVAC 01: Solar power system for cold and freezer rooms.

WHO PQS E001/PVAC 01-VP.2: Quality Assurance Protocol.

4. Applicability

Type-examination will be carried out by an independent evaluator, appointed by WHO. The extent of the geographical limits of any grant of per-qualification status will be reviewed and decided upon by WHO.

5. Sample-examination checklist

5.1 Evidence of conformity assessment

Key components must carry the CE mark and/or equivalent internationally accepted evidence of conformity assessment.

5.2 Samples and supporting material

The [legal manufacturer](#) or [reseller](#) must supply the [employer](#) with a full duplicate set of the Product Dossier already supplied to WHO in accordance with the requirements of specification Clause 7, together with the following:

- 5.2.1 A fully worked example of a solar array sizing, battery sizing, [inverter](#) sizing and an [autonomy](#) calculation for all [load\(s\)](#) included and at a specified location. Confirmation of the model(s) of PQS prequalified [CR-FR](#) and other [load\(s\)](#) included as part of a complete [installation](#).
- 5.2.2 A fully worked example of the [back-up power](#) system sizing and an [autonomy](#) calculation for all [load\(s\)](#) included, at a specified location per **WHO PQS E001/CR-FR01.4: Cold rooms and freezer rooms.**
- 5.2.3 Confirmation of the type(s) of solar array support structure, meeting specification Clause 4.2.2. Provide detailed photographs of each type that is offered.
- 5.2.4 Sample of the instructions listed in Clause 4.11, in English language.

5.2.5 Detailed high-resolution digital images of a typical solar array, battery and [inverter](#), in jpeg format.

5.3 Test 1 - type-examination

- **Step 1:** Complete the compliance checklist in Annex 1. Record general comments and recommendations for each section.
- **Step 2:** Obtain any additional supporting information required [in writing](#) from the [legal manufacturer](#) or [reseller](#) and attach this information to the report.

Acceptance criteria: Inspection indicates full conformity with all major specification requirements.

5.4 Criteria for qualification

A final report must be issued after the type-examination is complete. The report must contain the following data and analyses:

- **Summary:** Conclusions and recommendations.
- **Compliance checklist:** Completed Annex 1 checklist.
- **Photographs:** Submitted photographs as listed in Clause 5.2.
- **Annexes:** Additional supporting documentation requested and received from the [legal manufacturer](#) or [reseller](#) during the course of the type examination.

Annex 1 – Compliance checklist¹

Specification Clause	Item	
A. General information:		
7.	Dossier fee received:	Yes No Part payment
7.	Type-examination fee received:	Yes No Part payment
7.	System identification: Code: Model:	
4.2.4	Battery type(s) offered	Flooded lead acid Valve regulated lead acid
7.	Legal manufacturer details: Name: Address 1: Address 2: Address 3: Address 4: Tel: Fax: Email: Web:	
7.	Reseller details: Name: Address 1: Address 2: Address 3: Address 4: Tel: Fax: Email: Web:	Applicable Not applicable
4.1.1	Status:	Legal manufacturer Reseller
4.1.2	Countries/regions where support services can be offered:	

¹ This is a Word 'Form' document. It needs to be copied and 'protected' before it can be used for data entry. Then activate View/Toolbars/Forms and click the 'lock' icon on the Forms toolbar. See also Word Help. Margins can be adjusted so form fits on a single page.

<i>General information comments:</i>			
<i>B. Technical details:</i>			
4.1.3	Load(s) specified	Conforms to specification?	Yes No
4.1.3	Solar power sizing	Conforms to specification?	Yes No
4.1.4	Autonomy calculation	Conforms to specification?	Yes No
<i>Comments on example calculations:</i>			
4.2.1	Solar module array	Conforms to specification?	Yes No
4.2.1	Cable: Manufacturer, diameter and rating type	Conforms to specification?	Yes No
<i>Comments on array:</i>			
4.2.2	Array support structure	Roof/ground mounting offered?	Yes No
		Pitched roof mounting offered?	Yes No
		Flat roof mounting offered?	Yes No
		Ground mounting offered?	Yes No
		Pole mounting offered?	Yes No
		Materials conform to specification?	Yes No
		Lightening protection conforms to specification?	Yes No
<i>Comments on array support structure:</i>			
4.2.3	Battery set sizing	Conforms to specification?	Yes No

4.2.4	Battery type	Conforms to specification?	Yes No
<i>Comments on batteries:</i>			
4.2.5	Battery set housing	Conforms to specification?	Yes No
<i>Comments on battery housing:</i>			
4.2.6	Hybrid system battery charge regulator.	Conforms to specification?	Yes No
4.2.7	Battery safety kit	Conforms to specification?	Yes No
4.2.8	Inverter	Conforms to specification?	Yes No
<i>Comments on battery charge regulator and inverter:</i>			
4.2.9	Back-up generator	Conforms to E001/CR-FR?	Yes No
4.2.10	Electrical safety rating	Certified as conforming to IEC 60335-1?	Yes No
4.2.11	Electrical protection	Conforms to specification?	Yes No
4.2.12	Lightning surge Protection	Conforms to specification?	Yes No
4.2.13	Tool kits	User's kit conforms to specification?	Yes No
		Installer's kit conforms to specification?	Yes No
4.2.14	Electromagnetic comp.	Certified conforming IEC61000-6-1&6-3?	Yes No
4.2.15	Firefighting equipment	Conforms to specification?	Yes No
<i>Comments on electrical safety:</i>			
4.3.1	Ambient temperature during transport & storage	Conforms to specification?	Yes No
4.3.2	Ambient temperature during use	Conforms to specification?	Yes No

4.3.3	Ambient humidity range	Conforms to specification?	Yes No
<i>Comments on environmental requirements:</i>			
4.4.1	Overall dimensions	Component sizes comply?	Yes No
4.4.2	Weight	Component weights comply?	Yes No
<i>Comments on physical characteristics:</i>			
4.5.1	CR-FR interface components complete	Conforms to specification?	Yes No
4.6.1	General human factors	Conforms to specification?	Yes No
4.6.2	Safe access	If observed, conforms to specification?	Yes No
<i>Comments on human factors:</i>			
4.7.1	Restricted materials	Conforms to specification?	Yes No
4.8	Warranty	Conforms to specification?	Yes No
4.9.1	Servicing provision	Conforms to specification?	Yes No
4.9.2	Spare parts, supplies	Conforms to specification?	Yes No
4.10	Disposal and recycling	Conforms to specification?	Yes No
4.11	Instructions	User instructions conforms to specification?	Yes No
		Installer instructions Conform to specification?	Yes No
4.11	Sample manual(s)	Is it satisfactory?	Yes No
4.12	User training	Conforms to specification?	Yes No
5.	Packaging	Conforms to specification?	Yes No

C. Norms and standards:			
6.	On-site installation	Offered? If YES is it satisfactory?	Yes No Yes No
7.	List of installations:	Details supplied: Satisfactory?	Yes No
7.	Environmental audit scheme	Type: Current? (Note: not mandatory)	Yes No
7.	Laboratory test reports	Details: Satisfactory?	Yes No
7.	Type approval details:	Details supplied: Satisfactory?	Yes No
7.	Current ISO 9001: certification:	Either Satisfactory?	Yes No. Or Pending
8.	On-site maintenance service (optional)	Offered? If YES is it satisfactory?	Yes No Yes No
<i>Norms and standards comments:</i>			
D. Conclusions:			
Overall summary:			
		DECISION:	Prequalify? Reject?
		QA Assessor Contact info	

Revision history			
Date	Change summary	Reason for change	Approved