



ETV Verification Statement

Technology type	Solar powered refrigeration without battery backup	
Application	Adequate cooling of refrigerated products using solar power only.	
Product name	SolarChill B	
Company (vendor)	Vestfrost Solutions / SolarChill	
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DANETV, The Danish Centre for Verification of Climate and Environmental Technologies, undertakes independent tests of environmental technologies and monitoring equipment.

DANETV is a co-operation between five technological service institutes, DHI, Danish Technological Institute, FORCE Technology, Delta and AgroTech. DANETV was established with financial support from the Danish Ministry of Science, Technology and Innovation. Information and DANETV documents are available at www.etv-denmark.com.

The verifications and tests are planned and conducted in accordance with the guidelines for the ETV Scheme currently being established by the European Union.

This verification statement summarizes the results from the ETV test of the SolarChill B refrigerator used for refrigeration of foods, drinks, etc.

Descriptions of technology

The SolarChill B refrigerator series provides cooling by the means of a DC compressor powered by an external PV array. The cooling cycle is a Rankine vapor-compression refrigeration cycle with a natural refrigerant, isobutane (R600a), as working fluid.

The PV array consists of 3 x 60 W modules providing 12 V DC, which can be directly connected to the compressor.

The compressor is equipped with an electronic control with a build-in adaptive speed control known as Adaptive Energy Optimizer – AEO. Thereby the compressor will stepwise speed up from low speed to maximum speed in increments of 12.5 rpm. If the power from the PV array is not sufficient the compressor will stop, thereafter it will try to start every minute until the power is sufficient again. The compressor also has a “soft-start” feature, thus requiring a low starting current. The speed range of the compressor is 2000 – 3500 rpm. The compressor is thus enabled to deliver a varying cooling capacity that accordingly utilizes

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most of the energy potential collected by PV array. The characteristics of the PV array and the implementation of the adaptive speed control ensures that power from the PV array is delivered at the maximum power point (MPP).

When there is no or negligible solar radiation during overcast days or during the nighttime the cooling demand is met by means of convection from a thermal energy storage that consists of ice. The cooling capacity of the refrigerator is principally dictated by the amount of solar radiation being converted into power delivered to the compressor. When the compressors instantaneous cooling capacity exceeds the cooling demand, energy is stored in the thermal energy storage, as ice, for later use. Accordingly, when the cooling demand is higher than the compressors cooling capacity, or when the compressor is turned off, additional cooling capacity is released from the thermal energy storage.

The temperature inside the refrigerator compartment is regulated by a mechanical thermostat with a sensor inside the cabinet. The thermostat can be set by the user. When the temperature gets to cold inside the compartment the compressor is stopped by the thermostat and vice versa.



Figure 1 A SolarChill B cabinet with a single PV module

Application of technology

The intended application of the product tested is defined in terms of the matrix, the target and the effect of the product. The matrix is the type of material that the product is intended for. Targets are the measurable properties that are affected by the product and the effects describe how the targets are affected.

Matrix	Refrigerated products (food, drinks, etc.)
Targets	Adequate cooling of refrigerated products using solar power only
Effects	<p>The effect of this application is primarily: Refrigeration of products without external power supply or batteries. Secondly the application will:</p> <ul style="list-style-type: none"> -Provide refrigeration technology to people with a need or wish to refrigerate food or drinks in parts of the world with no or unreliable electricity supply. -Provide a more reliable, safer and cleaner form of refrigeration than kerosene refrigerators. -Provide a refrigeration technology that is environmentally friendly as it does not use any ozone depleting or potent global warming substances. -Improve on existing solar powered cooling technologies by bypassing the use of conventional lead batteries which have proven to be a major obstacle to the uptake of solar technology in developing countries.
Exclusions	The effect of the product was only verified using a prototype version of the refrigerator. No door openings were done during the various tests.

Description of test

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The testing of SolarChill B refrigerator was based existing refrigeration standards with alterations to temperature requirements, test packages, and packing plan. These alterations were made to ensure the verification of proper food safety and hygiene, and relevance to the intended use of the product, which is refrigeration of perishable foods and drinks.

Furthermore, to give a better idea of how the refrigerator performs in an actual setting only being powered by a PV array, the voltage and current supplied from the PV array was measured at the maximum power point at different solar radiation levels according to a solar radiation reference period. The measured voltage and current was then used as the refrigerator was supplied by an external power supply during different performance related tests carried out in a climate chamber. Establishing the actual performance characteristics of the PV array prior to the tests in the climate chamber ensures that vendor claims are verified and that tests between different models and makes are comparable.

Verification results

This section summarizes, in brief, the results of the test and verification as described in the test report and verification report respectively.

The various tests were performed in a simulated setting representing a combination of a moderate ambient temperature T: 32°C and a high solar radiation reference period equal to 6 kWh/m²/day, which resembles a setting with a temperate to subtropical climate.

On the basis of the results of the various tests, it has been concluded that the tested prototype SolarChill B refrigerator generally performs as claimed by adequately cooling refrigerated products (such as vegetables, milk, poultry, etc.) without the need of an external power supply or battery.

As the tested SolarChill B prototype was made from a modified and widely sold vaccine cooler the only available maintenance- and user instructions related to the original vaccine cooler. It is therefore strongly recommended that a revised set of maintenance- and user instructions are written specifically for the use and care of the SolarChill B refrigerator, as proper procedures for food safety and hygiene may otherwise be jeopardized.

NOTE: Some of the performed tests on the SolarChill B refrigerator are based on existing standards for tests of refrigerators for household use; the verified performance of the SolarChill B refrigerator is therefore comparable to that of a conventional household appliance.

Quality assurance

The test and verification have been performed according to the DANETV Quality Manual. As a part of the quality assurance two technical experts provided review of the planning, conducting and reporting of the verification and tests.

	17/8'11		17/8-2011
Signed by Claus S. Poulsen Test Centre Management representative	Date	Signed by Bjarke Paaske Verification responsible	Date

NOTICE: ETV verifications are based on an evaluation of technology performance under specific, predetermined operational conditions and parameters and the appropriate quality assurance procedures. DANETV and DTI make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate as verified. The end user is solely responsible for complying with any and all applicable regulatory requirements.