SLOVENSKI STANDARD
SIST EN 12976-2:2002

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Toplotni sonį ni sistemi in sestavni deli - Industrijsko izdelani sistemi - 2. del: Preskusne metode

Thermal solar systems and components - Factory made systems - Part 2: Test methods

Thermische Solaranlagen und ihre Bauteile - Vorgefertigte Anlagen - Teil 2: Prüfverfahren

Installations solaires thermiques et leurs composants - Installations préfabriquées en usine - Partie 2: Méthodes d'essais

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Thermal solar systems and components - Factory made systems - Part 2: Test methods

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 312 "Thermal solar systems and components", the secretariat of which is held by ELOT.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2001, and conflicting national standards shall be withdrawn at the latest by June 2001.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

The annexes A and B are normative. The annexes C, D, E, F, G and H are informative.

Introduction

Drinking water quality

In respect of potential adverse effects on the quality of water intended for human consumption, caused by the product covered by this standard:

a) This standard provides no information as to whether the product may be used without restriction in any of the Member States of the EU or EFTA;

b) It should be noted that, while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

Factory Made and Custom Built solar heating systems

The standards EN 12976-1:2000 as well as EN 12976-2 and the prestandards prENV 12977-1:2000 to prENV 12977-3:2000 distinguish two categories of solar heating systems: **Factory Made** solar heating systems and **Custom Built** solar heating systems. The classification of a system as Factory Made or Custom Built is a choice of the final supplier, in accordance with the following definitions:

Factory Made solar heating systems are batch products with one trade name, sold as complete and ready to install kits, with fixed configurations. Systems of this category are considered as a single product and assessed as a whole.

If a Factory Made Solar Heating System is modified by changing its configuration or by changing one or more of its components, the modified system is considered as a new system for which a new test report is necessary. Requirements and test methods for Factory Made solar heating systems are given in EN 12976-1:2000 and EN 12976-2.

Custom Built solar heating systems are either uniquely built, or assembled by choosing from an assortment of components. Systems of this category are regarded as a set of components. The components are separately tested and test results are integrated to an assessment of the whole system. Requirements for Custom Built solar heating systems are given in prENV 12977-1:2000, test methods are specified in prENV 12977-2:2000 and prENV 12977-3:2000.

Custom Built solar heating systems are subdivided into two categories:

- **Large Custom Built systems** are uniquely designed for a specific situation. In general HVAC engineers, manufacturers or other experts design them.
- **Small Custom Built systems** offered by a company are described in a so-called assortment file, in which all components and possible system configurations, marketed by the company, are specified. Each possible combination of a system configuration with components from the assortment is considered as **one** Custom Built system.

Table 1 shows the division for different system types:

Table 1 - Division for factory made and custom built solar heating systems

Factory Made Solar Heating Systems (EN 12976-1, -2)	Custom Built Solar Heating Systems (ENV 12977-1, -2, -3)
Integral collector-storage systems for domestic hot water preparation	Forced-circulation systems for hot water preparation and/or space heating, assembled using components and configurations described in a documentation file (mostly small systems)
Thermosiphon systems for domestic hot water preparation	
Forced-circulation systems as batch product with fixed configuration for domestic hot water preparation	Uniquely designed and assembled systems for hot water preparation and/or space heating (mostly large systems)

NOTE 1 Forced circulation systems can be classified either as Factory Made or as Custom Built, depending on the market approach chosen by the final supplier.

NOTE 2 Both Factory Made and Custom Built systems are performance tested under the same set of reference conditions as specified in Annex B of the present standard and Annex A of prENV 12977-2:2000. In practice, the installation conditions may differ from these reference conditions.

NOTE 3 A Factory Made system for domestic hot water preparation may have an option for space heating, however this option should not be used or considered during testing as a Factory Made system.

1 Scope

This European Standard specifies test methods for validating the requirements for Factory Made Thermal Solar Heating Systems as specified in EN 12976-1:2000. The standard also includes two test methods for thermal performance characterization by means of whole system testing.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

prEN 1717:1999, *Protection against pollution of potable water in drinking water installations and general requirements of devices to prevent pollution by backflow*

ENV 1991-2-3 *Eurocode 1 – Basis of design and actions on structures - Part 2 - 3: Action on structures - Snow loads*

ENV 1991-2-4 *Eurocode 1 – Basis of design and actions on structures - Part 2 - 4: Action on structures - Wind loads*

prEN 12975-2:2000 *Thermal solar systems and components - Solar collectors - Test methods*

EN 12976-1:2000 *Thermal solar systems and components - Factory made systems - General requirements*

prENV 12977-2:2000 *Thermal solar systems and components – Custom built systems – Test methods*

EN 60335-1 *Safety of household and similar electrical appliances - Part 1: General requirements (IEC 60335-1:1991 modified)*

EN 60335-2-21:1999 *Safety of household and similar electrical appliances - Part 2: Particular requirements for storage water heaters (IEC 60335-2-21:1997 + Corrigendum 1998, modified)*

EN 60343 *Recommended test methods for determining the relative resistance of insulating materials to breakdown by surface discharges (IEC 60343: 1991)*

ENV 61024-1 *Protection of structures against lightning - Part 1: General principles (IEC 61024-1:1990, modified)*

EN ISO 9488 *Solar energy – Vocabulary (ISO 9488:1999)*

ISO 9459-2 *Solar heating – Domestic water heating systems – Part 2: Outdoor test method for system performance characterization and yearly performance prediction for solar-only systems*

ISO/DIS 9459-5:1997 *Solar heating – Domestic water heating systems – Part 5: System performance characterization by means of whole-system tests and computer simulation*

ISO/DIS 11924 *Solar heating – Domestic water heating systems – Test methods for the assessment of reliability and safety*

3 Terms and definitions

For the purpose of this standard, the terms and definitions given in EN ISO 9488 apply, together with the definitions given in clause 3 of EN 12976-1:2000.

4 Symbols and abbreviations

$Q_{aux,\ net}$	net auxiliary energy demand of a solar heating system delivered by the auxiliary heater to the store or directly to the distribution system (see 5.9.3.2)
Q_d	heat demand
Q_L	energy delivered at the outlet of the solar heating system
Q_{par}	parasitic energy (electricity) for the collector loop pump(s) and control unit
H_c	hemispherical solar irradiation in the collector plane
Q_l	store heat loss
Q_{ohp}	heat diverted from the store as active overheating protection, if any
Q_{sol}	heat delivered by the collector loop to the store

5 Testing

5.1 Freeze resistance

5.1.1 General

The following checks are given to ensure that the protective antifreezing provisions are operating properly. There are many possible forms of protective provisions, and the testing authority shall first identify which method has been employed.

The provision shall then be checked in accordance with the appropriate section of the following list (see 5.1.2 to 5.1.6) in accordance to the manufacturer's recommendations.

5.1.2 Systems using antifreeze fluid

The system components which are exposed to low ambient temperature are filled with an antifreeze fluid, usually a glycol/water mixture, having a low enough freezing point.

For these systems, no freezing test is performed. However, if no sufficient data is available on the freezing point of the antifreeze fluid, the freezing point shall be measured and checked against the minimal system temperature as given by the manufacturer.

> NOTE In general, the minimal allowed temperature of the system is equal to the freezing point of the antifreeze fluid. If the concentration of some antifreeze fluids - like glycol's - exceeds a certain limit, they can freeze without damaging the system. In this case the minimal allowed temperature can be lower than the freezing point of the antifreeze fluid.

Check the freezing point by measuring the glycol concentration (e.g. using a portable refractometer). The freezing point should be as recommended by the manufacturer in agreement with the local climate (minimum expected air temperature, radiative cooling of the collectors).

The composition of the fluid shall be checked whether it is in accordance with the manufacturer's specifications.

5.1.3 Drain-back systems

The fluid in the system components, which are exposed to low ambient temperature, is drained into a storage vessel for subsequent reuse when freezing danger occurs.

Check the pipe slope of the horizontal tubes with a spirit level. The slope should be in accordance with the manufacturer's recommendations in the installer manual or at least 20 mm/m.

Filling may be observed from the pressure gauge or from water level indicator. Switch the pump on, and observe the pressure gauge or water level indicator. If the system does not include a pressure gauge or level indicator, other means for checking filling provided by the manufacturer shall be used in accordance with the instruction manual.

Drain-back may be observed from the decreasing reading of the pressure gauge or water level indicator. Switch the pump OFF, and observe the pressure gauge or water level indicator. If the system does not include a pressure gauge or level indicator, other means for checking drain-back provided by the manufacturer shall be used in accordance with the instruction manual. It might be necessary to repeat the check at high storage temperature (90 °C) in order to insure drain-back in all situations (see 5.2).

5.1.4 Drain-down systems

The fluid in the system components, which are exposed to low ambient temperature, is drained and run to waste when freezing danger occurs.

Check the proper opening and closing of the vacuum relief valve.

If there is a solenoid drain valve independent of the control unit, simulate the opening temperature.

If there is a non-electrically operated freeze-protection valve, a check can be made using a freezing spray. The temperature-sensing element shall be sprayed. The measured temperature of the valve opening is to be compared with the nominal value given by the manufacturer. It is important that the sensing part of the freeze-protection valve be properly placed.

Check the pipe slope of the horizontal pipe runs with a spirit level. The slope should be in accordance with the manufacturer's recommendations or at least 20 mm/m.

Open drain-down valve manually and measure the drain rate with a vessel and a stop-watch.

If the system uses an electrically operated freeze-protection valve, drain down shall be checked while interrupting the power.

5.1.5 Freeze protection and control functions combined

For systems where the freeze-protection and control functions are combined, the control unit shall be checked as follows:

Set the simulated temperature of the freeze-protection sensor to a value deactivating the freeze protection. Decrease the simulated temperature slowly. Measure the temperature T_{FP} (freeze-protection) of the related actuator. Compare it with the nominal value given by the manufacturer.

5.1.6 Other systems

For all other systems, the pump control system, drain-down valve or any other freeze protection device or system shall be checked to the manufacturer's specification and the minimum allowed temperature specified by the manufacturer. For ICS systems, or other SDHW systems with the tank placed outside, special frost resistance tests should be carried out, as described in C.1.

5.2 Over temperature protection

The purpose of this test is to determine whether the solar water heating system is protected against damage and the user is protected from scalding hot water delivery after a period of no hot water draw and failure of electrical power.

The system, both as described in the installation manual and as installed on the test facility, shall be first checked on overheating safety, e.g. if safety valves and other overheating protection devices are present and installed at the right place, if there are no valves between components and relief valves etc. For systems containing antifreeze fluids, it shall be checked whether sufficient precautions have been taken to prevent the antifreeze fluid from deterioration as a result of high temperature conditions (See also 5.7).

The system shall be tested in accordance with 5.1 of ISO/DIS 11924. However, the minimum total solar irradiation on the plane of the collector and the minimum solar lamp intensity shall be chosen in accordance with Table 2.

Table 2 - Minimal solar irradiation and lamp intensity for over temperature protection test

Climate Zone	Required total solar irradiation on the plane of the collector MJ/(m²·d)	Minimum solar lamp intensity at the plane of the collector W/m²
Northern European	20	700
Central European	20	850
Mountain	25	1050
Mediterranean	25	1050

Furthermore, if non-metallic materials are used in any circuit, the highest temperature in the circuit shall be measured during the over temperature protection test, for use in the pressure resistance test.

5.3 Pressure resistance

The system, both as described in the installation manual and as installed on the test facility, shall be first checked on pressure safety, e.g. if safety valves and other overheating protection devices are present and installed at the right place, if there are no valves between components and relief valves etc.

The system shall be tested in accordance with 6.1 of ISO/DIS 11924. However, if a non-metallic material is used in any circuit, this circuit shall be pressure tested for 1 h at the highest temperature measured during the over temperature protection test +10 °C.

5.4 Water contamination

See prEN 1717:1999.

5.5 Lightning protection

Annexes E and F give information to assist manufacturers in meeting the requirements given in ENV 61024-1.

5.6 Mechanical strength of supporting frame

In the Annexes G and H, an optional test is described to validate the mechanical strength of the supporting frame.

5.7 Safety equipment

5.7.1 Safety valves

Check the system documentation to verify that each collector circuit or group of collectors circuits is fitted with at least one safety valve.

Check the specification of the safety valves, whether the materials conform to requirements given in 4.4.1 of EN 12976-1:2000.

Check whether the size of the safety valve is correct in conformity with the requirements given in 4.4.1 of EN 12976-1:2000.

Check whether the temperature of the heat transfer medium at the release pressure of the safety valve exceeds the maximum allowed temperature of the heat transfer medium.

To check the applicability of the specified maintenance frequency of a thermostatic valve, the ageing test for thermostatic valves should be carried out, as described in Annex D.

5.7.2 Safety lines and expansion lines

Check the system documentation to verify that safety and expansion lines, if any, cannot be shut-off.

Check the internal diameter of the expansion line, if any, with respect to the requirements given in 4.4.2 of EN 12976-1:2000.

Check the system documentation to verify that the expansion line and the safety line, if any, are connected and laid in such a way that any accumulation of dirt, scale or similar impurities are avoided.

5.7.3 Blow-off lines

Check the hydraulic scheme and system documentation to verify that the blow-off lines, if any, conform to requirements given in 4.4.3 of EN 12976-1:2000.

5.8 Marking

Check the Marking plate or Label of the Solar System and examine if all items of the Marking list are completed (as specified in 4.7 of EN 12976-1:2000).

5.9 Thermal performance characterisation

5.9.1 Introduction

In this clause the methods for performance testing are described. The thermal performance of the system shall be characterised as described in 5.9.2 and presented as specified in 5.9.3

5.9.2 Test procedure

Before starting performance testing, all tests specified in 5.1 to 5.8 (excluding those indicated as optional) shall have been completed. In case the system fails one or more of these tests, the malfunction or defect shall be eliminated by the manufacturer prior to performance testing. If this is not possible, the malfunction shall be stated in the performance test report.

One of the following test methods shall be used, as described in Table 3.

a) Test method in accordance with ISO 9459-2.

This test method shall be applied on solar only or preheat systems.

b) Test method in accordance with ISO/DIS 9459-5:1997.

This test method shall be applied on solar-plus-supplementary systems

Table 3 - Selection of the performance test method

Test method	Solar-plus-supplementary systems *)	Solar-only and preheat systems
ISO 9459-2 (CSTG)	no	yes
ISO/DIS 9459-5:1997 (DST)	yes	no *)
*) If, in the future, a conversion factor between the CSTG and DST test methods is established, actions will be taken to incorporate it in this standard by the means of an addendum or otherwise, in this way allowing the DST method to be used in preheat and solar-only systems too.		

NOTE Some systems have allowances for variations in the installation instructions that may affect the performance of the system. In cases where the circumstances are not uniquely defined by the Reference Conditions given in Annex B, the most unfavourable conditions should be chosen for testing and reporting of the system performance. For example, systems without forced circulation should be tested with the lowest position of the storage above the collector and the longest pipe length between collector and storage specified by the manufacturer.

5.9.3 Prediction of yearly performance indicators

5.9.3.1 General

NOTE In the following, performance indicators for solar heating systems for hot water preparation only are specified. The text of these paragraphs is identical for this standard and for Custom Built Systems (prENV 12977-2:2000). Performance indicators for space heating systems are presently excluded, since there is not yet enough experience available. This is a preliminary step for the standardisation of this procedure. After enough experience has been gained, also the performance indicators for space heating systems will be elaborated.

Uniform reference conditions for the calculation of the performance are specified in the identical Annex B of this standard or Annex A of prENV 12977-2:2000. For these conditions, the following performance indicators shall be derived from the performance test results:

For solar-plus-supplementary systems

a) the net auxiliary energy demand $Q_{aux,\,net}$

b) parasitic energy Q_{par}

For solar-only and preheat systems:

c) the heat delivered by the solar heating system Q_L

d) the solar fraction f_{sol}

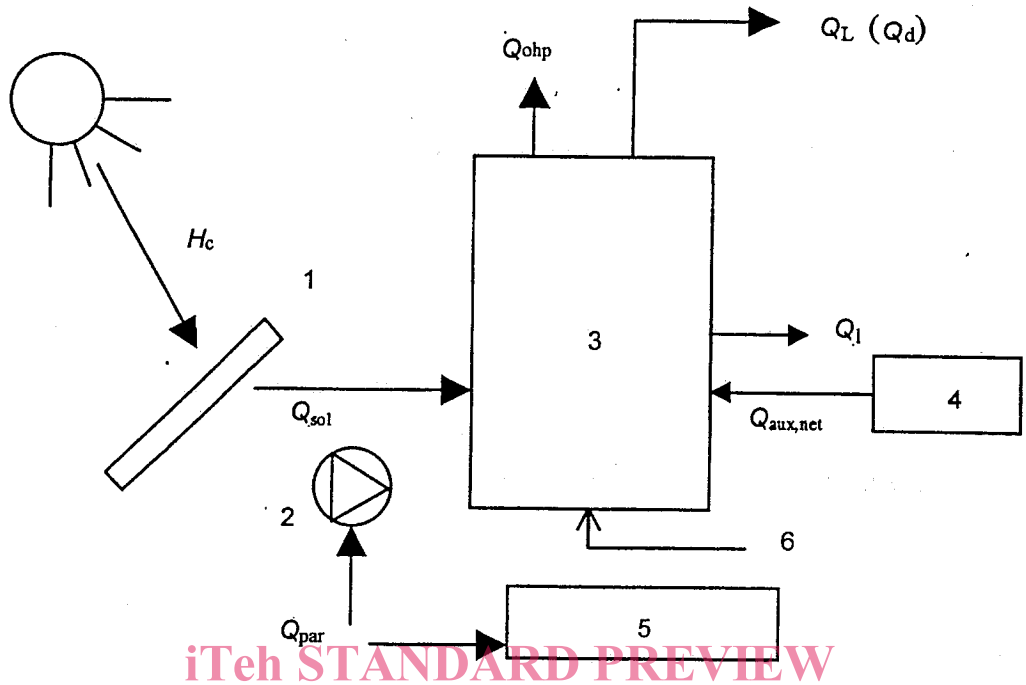
e) the parasitic energy, Q_{par}, if any

5.9.3.2 Calculation of the net auxiliary energy demand for solar-plus-supplementary systems

Calculate the yearly net auxiliary energy demand $Q_{aux,\,net}$ directly by computer simulation (long term performance prediction) as specified in 5.9.2 of this standard (for Factory Made systems) or 7.5.1 of prENV 12977-2:2000 (for Custom Built Systems). Additional indication on the quantities entering the energy balance of an one-store solar-plus-supplementary heating system may be found in Figure 1.

If a solar-plus-supplementary system cannot meet the heat demand to such a degree that the energy delivered to the user is less than 90 % of the yearly heat demand, this shall be stated in the test report.

NOTE The energy delivered to the user can be less than the heat demand for example when the power of the auxiliary heater is not sufficient or when strong mixing occurs in the store during draw-offs.



Key

1 Collector
2 Pump
3 Store
4 Auxiliary heater
5 Control unit
6 Cold water

Figure 1 - Energy balance for one-store solar-plus-supplementary systems (example)

5.9.3.3 Calculation of the solar fraction for solar-only and preheat systems

Compute the system energy balance on a yearly basis. This includes the following energy quantities (see Figure 2 and Figure 3), calculated using the reference data and conditions given in Annex B of this standard or Annex A of prENV 12977-2:2000.

Q_d heat demand;

Q_L heat delivered by the solar heating system (load)

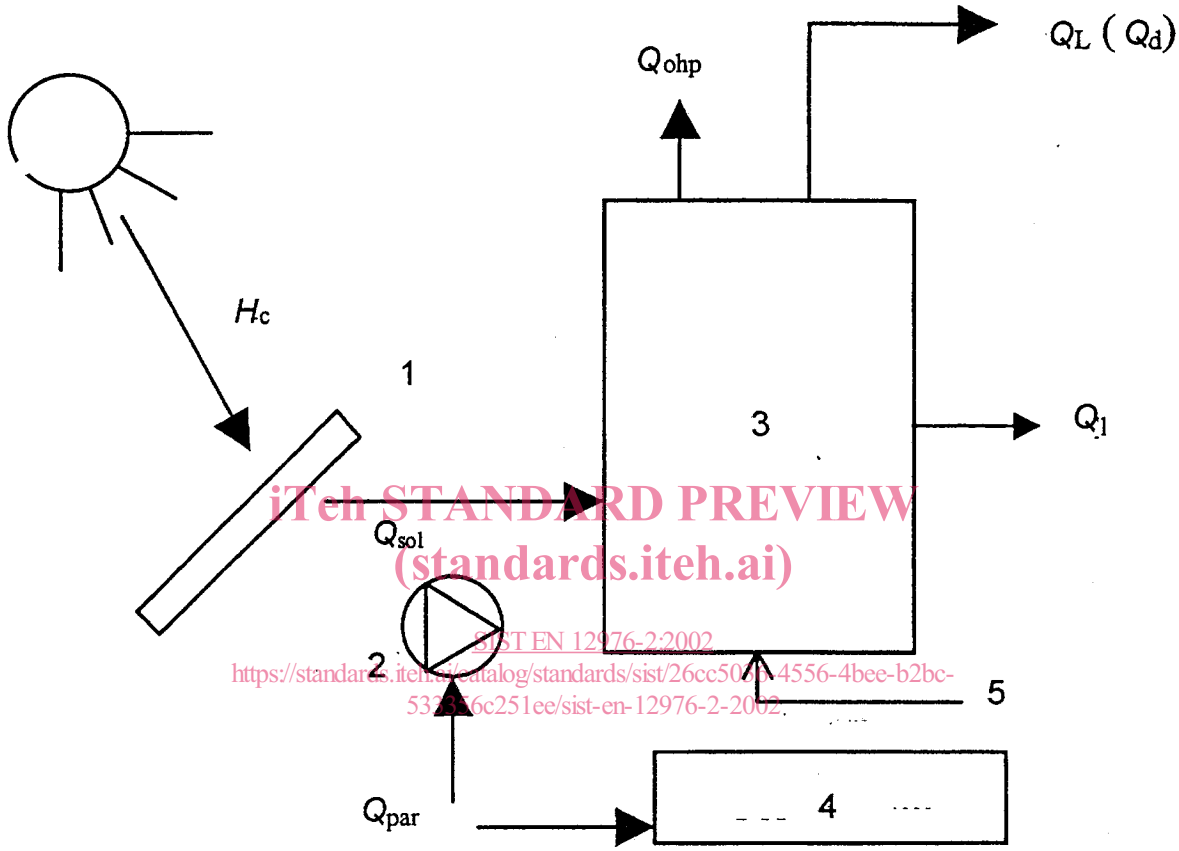
Q_{par} parasitic energy (electricity) for pump and controls

The parasitic energy Q_{par} shall be calculated according to 5.9.3.4.

NOTE 1 The reference locations for calculating the load Q_L are the store ports or the load-side heat exchanger ports, if provided. The reference temperature for calculating the loads is the cold water temperature. Heat losses of the circulation line are not included in the loads.

NOTE 2 According to EN ISO 9488, a solar preheat system is a solar system to preheat water or air prior to its entry into any other type of water or air heater. This water or air heater is not part of the solar preheat system itself. Hence, for this type of system the energy delivered by the solar heating system Q_L is calculated at the outlet of the solar heating system and the store heat loss Q_l is the heat loss of the solar store itself (see figure 3)

NOTE 3 The yearly heat demand is calculated using the load volume, cold water temperature and the desired temperature for hot water as specified in Annex B.



Key

1 Collector
2 Pump
3 Store
4 Control unit
5 Cold water

Figure 2 - Energy balance for solar-only systems