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Draft

COMMUNICATION FROM THE COMMISSION

**in the framework of the implementation of Commission Regulation (EU) No .../...
implementing Directive 2009/125/EC of the European Parliament and of the Council
with regard to ecodesign requirements for water heaters and hot water storage tanks,
and of the implementation of Commission Delegated Regulation (EU) No .../...
supplementing Directive 2010/30/EU of the European Parliament and of the Council
with regard to energy labelling of water heaters, hot water storage tanks and packages
of water heater and solar device**

(2013/C .../...)

(Text with EEA relevance)

1. Publication of titles and references of transitional methods of measurement and calculation¹ for the implementation of Regulation (EU) No .../..., and in particular Annexes III, IV and V thereof, and for the implementation of Regulation (EU) No .../..., and in particular Annexes VII, VIII and IX thereof.
2. Parameters *in italics* are determined in Regulation (EU) No .../... and in Regulation (EU) No .../...
3. References

Measured/calculated parameter	Organisation	Reference	Title
Test procedure for A_{sob} , IAM and additional elements of collector efficiency testing of parameters η_0 , a_1 , a_2 , IAM	CEN	EN 12975-2:2006	Thermal solar systems and components - Solar collectors - Part 2: Test methods
Sound power level of heat pump water heaters	CEN	EN 12102 :2008	Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling - Measurement of airborne noise - Determination of the sound power
Sound power level of gas-fired instantaneous and storage water heaters	CEN	EN 15036-1:2006 ISO EN 3741:2010	Heating boilers. Test regulations for airborne noise emissions from heat generators. Airborne noise emissions from heat generators Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms
Test gases	CEN	EN 437:2003/A1:2009	Test gases - Test pressures - Appliance categories
Standby power consumption $solsb$	CLC	EN 62301:2005	Household Electrical Appliances: Measurement of standby power
Test-rig for Q_{elec} of electric storage water heaters	CLC	prEN 50440:2012	Efficiency of domestic electrical storage water heaters
Test-rig for Q_{elec} of electric instantaneous	CLC	EN 50193-1:2012	Closed electrical instantaneous water heaters, Methods for

¹ It is intended that these transitional methods will ultimately be replaced by harmonised standard(s). When available, reference(s) to the harmonised standard(s) will be published in the Official Journal of the European Union in accordance with Articles 9 and 10 of Directive 2009/125/EC.

Measured/calculated parameter	Organisation	Reference	Title
water heaters			measuring performance.
Test-rig for Q_{fuel} and Q_{elec} of gas-fired instantaneous water heaters	CEN	EN 26:1997/A3:2006, Clause 7.1, except clause 7.1.5.4.	Gas-fired instantaneous water heaters for sanitary uses production, fitted with atmospheric burners
Test-rig for Q_{fuel} and Q_{elec} of gas-fired storage water heaters	CEN	EN 89:1999/A4:2006, Clause 7.1, except clause 7.1.5.4.	Gas-fired storage water heaters for the production of domestic hot water
Test-preparation for Q_{fuel} of gas-fired instantaneous water heaters and gas-fired storage water heaters	CEN	EN 13203-2: 2006, Annex B	Gas-fired domestic appliances producing hot water - Appliances not exceeding 70 kW heat input and 300 litres water storage capacity - Part 2: Assessment of energy consumption
Test-rig for heat pump water heaters	CEN	EN 16147:2011	Heat pumps with electrically driven compressors - Testing and requirements for marking for domestic hot water units
Standing loss S of storage tanks	CEN	EN 12897: 2006, clause 6.2.7 and Annex B	Water Supply – Specification for indirectly heated unvented (closed) storage water heaters.
Standing loss S and psbsol of storage tanks	CEN	EN 12977-3:2008	Thermal solar systems and components - Custom built systems - Part 3: Performance test methods for solar water heater stores
Standing loss S of storage tanks	CEN	EN 15332:2007, Clauses 5.1 and 5.4 (Measurement of standby-loss)	Heating boilers – Energy assessment of hot water storage tanks
Standing loss S of storage tanks	CLC	EN 60379: 2004, clauses 9, 10, 11, 12 and 14	Methods for measuring the performance of electric storage water-heaters for household purposes
Emission of nitrogen oxides NO_x	CEN	FprEN 15502-1: July 2010, clause 8.13 NOx	Classification, test- and calculation methods
Water heating energy efficiency η_{wh} of water heaters and standing loss S of storage tanks	European Commission	Point 4 of this Communication	Additional elements for measurements and calculations related to the energy efficiency of water heaters and storage tanks

4. Additional elements for measurements and calculations related to the energy efficiency of water heaters and storage tanks

4.1. Definitions

- “uncertainty of measurement (accuracy)” is the precision with which an instrument or a chain of instruments is capable to represent an actual value as established by a highly-calibrated measurement reference;
- “permissible deviation (average over test period)” is the maximum difference, negatively or positively, allowed between a measured parameter, averaged over the test period, and a set value;
- “permissible deviations of individual measured values from average values” is the maximum difference, negatively or positively, allowed between a measured parameter and the average value of that parameter over the test period;

4.2. Energy inputs

- (a) Electricity and fossil fuels

Measured parameter	Unit	Value	Permissible deviation (average over test period)	Uncertainty of measurement (accuracy)
Electricity				
Power	W			± 2 %
Energy	kWh			± 2 %
Voltage, test-period > 48 h	V	230 / 400	± 4 %	± 0,5 %
Voltage, test-period < 48h	V	230 / 400	± 2 %	
Voltage, test-period < 1 h	V	230 / 400	± 1 %	± 0,5 %
Electric current	A			± 0,5 %
Frequency	Hz	50	± 1 %	
Gas				
Types	-	Test gases EN 437		
Net calorific value (NCV)	MJ/m ³	Test gases EN 437		± 1 %
Temperature	K	288,15		± 0,5
Pressure	mbar	1 013,25		± 1 %
Density	dm ³ /kg			± 0,5 %
Flow rate	m ³ /s or l/min			± 1 %
Oil				
Heating gas oil				
Composition, Carbon/ Hydrogen/ Sulfur	kg/kg	86/13,6/0,2 %		
N-fraction	mg/kg	140	± 70	
Net calorific value (NCV, Hi)	MJ/kg	42,689		
Gross calorific value (GCV, Hs)	MJ/kg	45,55		
Density ρ ₁₅ at 15 °C	kg/dm ³	0,85		
Kerosene				
composition, Carbon/ Hydrogen/ Sulfur	kg/kg	85/14,1/0,4 %		
N-fraction	mg/kg	140	± 70	
Net calorific value (NCV, Hi)	MJ/kg	43,3		
Gross calorific value (GCV, Hs)	MJ/kg	46,2		
density ρ ₁₅ at 15 °C	kg/dm ³	0,79		

(b) Solar energy for solar collector tests

Measured parameter	Unit	Value	Permissible deviation (average over test period)	Uncertainty of measurement (accuracy)
Test solar irradiance (global G, short wave)	W/m ²	> 700 W/m ²	± 50 W/m ² (test)	± 10 W/m ² (indoors)
Diffuse solar irradiance (fraction of total G)	%	< 30%		
Thermal irradiance variation (indoors)	W/m ²			± 10 W/m ²
Fluid temperature at collector inlet/outlet	°C/ K	range 0-99 °C	± 0,1 K	± 0,1 K
Fluid temperature difference inlet/outlet				± 0,05 K
Incidence angle (to normal)	°	< 20°	± 2 % (<20°)	
Air speed parallel to collector	m/s	3 ± 1 m/s		0,5 m/s
Fluid flow rate (also for simulator)	kg/s	0,02 kg/s per m ² collector aperture area	± 10 % between tests	
Pipe heat loss of loop in test	W/K	<0,2 W/K		

(c) Ambient heat energy

Measured parameter	Unit	Permissible deviation (average over test period)	Permissible deviations (individual tests)	Uncertainty of measurement (accuracy)
Brine or water heat source				
<i>Water/brine inlet temperature</i>	°C	± 0,2	± 0,5	± 0,1
<i>Volume flow</i>	m ³ /s or l/min	± 2 %	± 5 %	± 5 %
Static pressure difference	Pa	-	± 10 %	± 5 Pa/ 5 %
Air heat source				
<i>Outdoor air temperature (dry bulb) T_j</i>	°C	± 0,3	± 1	± 0,2
<i>Vent exhaust air temperature</i>	°C	± 0,3	± 1	± 0,2
Indoor air temperature	°C	± 0,3	± 1	± 0,2
<i>Volume flow</i>	dm ³ /s	± 5 %	± 10 %	± 5 %

Static pressure difference	Pa	-	± 10 %	± 5 Pa/ 5 %
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(d) Test conditions and tolerances on outputs

Measured parameter	Unit	Value	Permissible deviation (average over test period)	Permissible deviations (individual tests)	Uncertainty of measurement (accuracy)
Ambient					
<i>Ambient temperature indoors</i>	°C or K	20 °C	± 1 K	± 2 K	± 1 K
Air speed heat pump (at water heater off)	m/s	< 1,5 m/s			
Air speed other	m/s	< 0,5 m/s			
Sanitary water					
Cold water temperature solar	°C or K	10 °C	± 1 K	± 1 K	± 0,2 K
Cold water temperature other	°C or K	10 °C	± 1 K	± 1 K	± 1 K
Cold water pressure gas-fired water heaters	bar	2 bar		± 0,1 bar	
Cold water pressure other (except electric instantaneous water heaters)	bar	3 bar			± 5 %
Hot water temperature gas-fired water heaters	°C or K				± 0,5 K
Hot water temperature electric instantaneous	°C or K				± 1 K
Water temperature (in-/outlet) other	°C or K				± 0,5 K
Volume flow rate heat pump water heaters	dm ³ /s		± 5 %	± 10%	± 2 %
Volume flow rate other water heaters	dm ³ /s				± 1 %

4.3. Test procedure for storage water heaters

The test procedure for storage water heaters to establish the daily electricity consumption Q_{elec} and the daily fuel consumption Q_{fuel} fuel during a 24-hour measurement cycle is the following:

(a) Installation

The product is installed in test environment according to manufacturer's instructions. Designated floor-standing appliances may be placed on the floor, on a stand supplied with the product, or on a platform for easy access. Wall-mounted products are mounted on a panel at least 150 mm from any structural wall with a free space of at least 250 mm above and below the product and at least 700 mm to the sides. Products designated to be built-in are mounted according to manufacturer's instructions. The product is shielded from direct solar radiation, except solar collectors.

(b) Stabilisation

The product is kept at ambient conditions until all parts of the product have reached ambient conditions ± 2 K, at least 24 hours for storage type products.

(c) Filling and heat-up

The product is filled with cold water. Filling stops at the applicable cold water pressure.

The product is energized to reach "out-of-the-box" factory settings, e.g. for storage temperature. The product's own means of control (thermostat) is used. The next stage starts at thermostat cut out.

(d) Stabilisation at zero-load

The product is kept at normal operating conditions as specified by the manufacturer without draw-offs during at least 12 hours.

Subject to a control cycle this stage ends - and next stage starts - at the first thermostat cut-out after 12 hours.

During this stage the total fuel consumption in kWh in terms of *GCV*, the total electricity consumption in kWh in terms of final energy and the exact time elapsed in h are recorded.

(e) Water draw-offs

For the declared *load profile*, draw-offs are made in accordance with the specifications of the appropriate 24h tapping pattern. This stage starts directly after thermostat cut out from stabilisation part with the first tapping at 07:00 time-value. The tapping period ends 24h later.

During the water draw-offs relevant technical parameters (power, temperature, etc.) are established. For dynamic parameters the overall sample rate is 60 s or less. During draw-offs the recommended sample rate is 5 s or less.

The fossil fuel and electricity consumption over the 24-hour measurement cycle, $Q_{testfuel}$ and $Q_{testelec}$, are corrected as specified in point (g).

(f) Re-stabilisation at zero-load

The product is kept at nominal operating conditions without draw-offs during at least 12 hours.

Subject to a control cycle this stage ends at the first thermostat cut-out after 12 hours.

During this stage the total fuel consumption in kWh in terms of *GCV*, the total electricity consumption in kWh final energy and the exact time elapsed in hours are recorded.

(g) *Mixed water at 40 °C (V40)*

Immediately following measurement according to point (f) the water heater is switched off after the last cut-out of the thermostat.

Then a quantity of water equal to the rated capacity is withdrawn through the outlet at a constant rate of flow by supplying cold water. The flow of water from open outlet water heaters is controlled by the inlet valve. The flow in any other type of water heaters is kept constant by means of a valve fitted in the outlet or the inlet.

The rate of flow is adjusted to the maximum value according to the declared load profile.

The normalised value of the average temperature is calculated according to the following equation:

$$\theta_p \text{ [}^\circ\text{C]} = \left(T_{set} - 10 \right) \times \frac{\left(\theta'_p - \theta_c \right)}{\left(T_{set} - \theta_c \right)} + 10$$

Where:

- T_{set} in °C is the water temperature, without withdrawal of water, measured with a thermocouple placed inside the upper section of the tank. For metal tanks the thermocouple may be placed on the outer surface of the tank as well. This value is the water temperature measured after the last cut-out of the thermostat during the step set out in point (f),
- θ_c in °C is the average temperature of inlet cold water during the test,

- θ'_p in °C is the average temperature of outlet water and its normalized value is named θ_p in °C.

Temperature readings are preferable taken continuously. Alternatively, they may be taken at equal intervals evenly spread over the discharge, for example every 5 litres (maximum). If there is a sharp drop in temperature, additional readings may be necessary in order to correctly calculate the average value θ'_p .

Outlet water temperature is always ≥ 40 °C which is to be taken into account for the calculation of θ_p .

Quantity of hot water V_{40} in litres delivered with a temperature of at least 40 °C will be calculated by the following equation:

$$V_{40} [\text{litres}] = V_{40\text{exp}} \cdot \frac{(\theta_p - 10)}{30}$$

Where:

- the volume $V_{40\text{exp}}$ in litres corresponds to the quantity of water delivered at least 40 °C.

(h) Reporting of Q_{fuel} and Q_{elec}

$Q_{testfuel}$ and $Q_{testelec}$ are corrected for any energy surplus or deficit outside the strict 24-hour measurement cycle, i.e. a possible energy difference before and after is taken into account. Furthermore, any surplus or deficit in the delivered useful energy content of the hot water is taken into account in the following equations for Q_{fuel} and Q_{elec} :

$$Q_{fuel} = \left(\frac{Q_{ref}}{Q_{H2O}} \right) \times \left\{ Q_{testfuel} + \frac{1,163 \times C_{act} \times (T_3(t_3) - T_5(t_5))}{1000} \right\}$$

$$Q_{elec} = \left(\frac{Q_{ref}}{Q_{H2O}} \right) \times \left\{ Q_{testelec} + \frac{1,163 \times C_{act} \times (T_3(t_3) - T_5(t_5))}{1000} \right\}$$

Where:

- Q_{H2O} in kWh is the useful energy content of the hot water drawn-off,
- T_3 and T_5 are water temperatures measured at the dome of water heater, respectively at the beginning (t_3) and at the end (t_5) of the 24h measurement cycle.

4.4. Test procedure for heat pump water heaters using electricity

(a) Installation

The product is installed in test environment according to manufacturer's instructions. Designated floor-standing appliances may be placed on the floor,

on a stand supplied with the product, or on a platform for easy access. Wall-mounted products are mounted on a panel at least 150 mm from any structural wall with a free space of at least 250 mm above and below the product and at least 700 mm to the sides. Products designated to be built-in are mounted according to manufacturer's instructions.

Products with declared load profiles 3XL or 4XL may be tested on-site, provided test conditions are equivalent, possibly with correction factors, to the ones referenced here.

The installation requirements described in clauses 5.2, 5.4 and 5.5 of EN 16147 are respected.

(b) Stabilisation

The product is kept at ambient conditions until all parts of the product have reached ambient conditions ± 2 K (at least 24h for storage heat pump water heater).

The purpose is to verify that the product is working at normal temperature after transport.

(c) Filling and storage volume (actual capacity)

The volume of the tank is measured as follows.

The heating of the product is switched off. Then the storage is filled with cold water in accordance with the manufacturer's instruction under cold water pressure and the water supply is cut off.

It is then emptied through the water inlet or, if it is not possible, through the drain plug opening.

Water in the feed cistern of a cistern-fed water-heater is excluded from the quantity withdrawn.

The water withdrawn is measured.

(d) Filling and heat-up

Products with storage-facilities are filled with cold water (10 ± 2 °C). Filling stops are at the applicable cold water pressure.

The product is energized to reach out-of-the-box factory settings, e.g. for storage temperature. The product's own means of control (thermostat) are used. The step is performed following the procedure of clause 6.3 of EN 16147. The next step starts at thermostat cut out.

(e) Standby power input

The standby power input is determined by measuring the electrical power input over an integral number of on-off cycles of the heat pump, initiated by the thermostat situated in the tank, when no hot water is drawn off.

The step is performed following the procedure of clause 6.4 of EN 16147 and the value of P_{stby} [kW] is determined as equal to P_{es} [kW].

(f) Water draw-offs

For the declared *load profile*, draw-offs are made in accordance with the specifications of the appropriate 24h tapping pattern. Tapping pattern starts at 07:00 time-value. The tapping period ends 24h later. The required useful energy content of the hot water is the total Q_{ref} [in kWh].

The step is performed following the procedure of clauses 6.5.2 to 6.5.3.5 of EN 16147. The $\Delta T_{desired}$ in the EN 16147 is defined using T_p :

$$\Delta T_{desired} = T_p - 10$$

At the end of the step Q_{elec} [kWh] is determined as equal to W_{el-tc} of EN 16147.

Products to be classified as off-peak products are energized for a maximum period of 8 consecutive hours between 22:00 and 07:00 of the 24h tapping pattern. At the end of the 24h tapping pattern the products are energized till the end of the step.

(g) *Mixed water at 40 °C (V40)*

The step is performed following the procedure of clause 6.6 of EN 16147 and the value of $V40$ [L] is determined as equal to V_{max} .

4.5. Test procedure for electric instantaneous water heaters

Electric instantaneous water heaters are a relatively homogenous product group, where differences in test results between individual products are small and in the order of magnitude of allowable tolerances. For that reason a simplified, but more accurate test method with a better repeatability is foreseen. Thermal losses from heat transfer processes during operation and standby losses are neglected.

(a) Set points

If the product has a power selector, the selector is adjusted to the highest value. If the product has an independent flow control, it is adjusted to achieve manufacturers stated set point.

If the product has a temperature control, the selector is adjusted to the highest value.

The prescribed minimum flow rate f_i of each individual draw off of the tapping pattern is used as defined in load profiles. If the minimum flow rate is not achievable, the flow rate is increased until the product is switching on. This increased flow rate is used for the individual draw off instead of the prescribed minimum flow rate.

(b) Static efficiency

The static loss of the product P_{loss} at nominal load P_{nom} under steady state conditions is determined. The value of P_{loss} is the sum of all internal power losses (product of current and voltage losses between the terminals and heating elements) of the product after a minimum of 30 minutes of operation under full load conditions.

This test result is in wide ranges independent from the water inlet temperature. This test can be carried out with a cold water inlet temperature in the range of 10 to 25 °C.

For electronic instantaneous water heaters with semiconductor power switches, the voltage across the semiconductor power terminals is subtracted from the measured voltage losses, if the semiconductor power switches are thermally connected to the inlet pipe. In this case, the heat developed by the semiconductor power switches is transferred to useful energy to heat up the water.

The static efficiency is calculated as:

$$\eta_{static} = \frac{P_{nom} - P_{loss}}{P_{nom}}$$

Where:

- P_{nom} is the nominal power consumption of the product in kW,
- P_{loss} are the measured internal static losses of the product in kW,
- η_{static} is the static efficiency of the appliance as factor,

(c) Start up losses

This test determines the time $t_{start\ i}$ which elapses between energizing the heating elements and the delivery of useable water for each draw off of the declared load profile. The test method assumes that the power consumption of the appliance during the start-up period is equal to the power consumed in static mode. $P_{static\ i}$ is the static power consumption in steady state conditions of the appliance for the specific draw off i .

Three measurements are done for each different draw off i . The result is the mean value from these three measurements.

The start up losses are calculated as:

$$Q_{start\ i} = P_{static\ i} \times \frac{t_{start\ i}}{3600}$$

Where:

- $t_{start\ i}$ is the measured start up time in sec,

- $P_{static\ i}$ is the measured steady state power consumption in kW for specific draw off I ,
- $Q_{start\ i}$ are the start-up losses in kWh for a specific draw of i .

(d) Calculation of energy demand

The daily energy demand Q_{elec} is the sum of losses and useful energy of all individual draw offs i per day. The daily energy demand is calculated as:

$$Q_{elec} = \sum_{i=1}^n \left(Q_{start\ i} + \frac{Q_{tap\ i}}{\eta_{static}} \right)$$

Where:

- $Q_{start\ i}$ are the start-up losses for the specific draw off i in kWh,
- $Q_{tap\ i}$ is the predefined useful energy per draw off i in kWh,
- η_{static} is the static efficiency of the product.

4.6. Smart control test procedure for water heaters

(a) Electric storage water heaters

Use the test methodology described in prEN 50440.

(b) Electric Instantaneous Water Heaters

The test procedure for electric instantaneous water heaters comprises control to supply the required power to the water heating system by means of:

- Power control capable of switching any required power between at least 50 % and maximum rated power with a maximum power resolution of 200 W depending on flow rate and water temperature to minimize power consumption;
- devices to detect at least the flow rate and the inlet or outlet temperature;
- a device which calculates without user intervention, the power required to stabilize the temperature of the outlet water at the desired level in-between switch on flow rate and power limit, regardless of flow rate, water pressure and inlet temperature.

(c) Heat pump water heaters

Use the test methodology proposed by TC59X/WG4.

(d) The following *SCF* ranges are typical:

- Declared load profiles XXS to S: 7 % to 15 %;
- Declared load profiles M to 4XL: 10 % to 20 %.

4.7. Solar water heaters and solar-only systems, testing and calculation methods

For the assessment of the annual non-solar heat contribution Q_{nonsol} in kWh in terms of primary energy and/or kWh in terms of GCV the following methods are applicable:

- The SOLCAL method²
- The SOLICS method³

The SOLCAL method requires that the efficiency parameters of the solar collector are assessed separately and that the overall system performance is determined on the basis of the non-solar heat contribution to the solar system and the specific efficiency of a stand-alone water heater.

(a) Solar collector testing

For solar collectors at least 4 x 4 tests apply, with 4 different collector inlet temperatures t_{in} evenly spaced over the operating range and 4 test samples per collector inlet temperature are measured to obtain test values for the water outlet temperature t_e , the ambient temperature t_a , the solar irradiance G and the measured collector efficiency at the test point η_{col} . If possible, one inlet temperature is selected with $t_m = t_a \pm 3$ K to obtain an accurate assessment of the zero-load efficiency η_0 . With fixed collector (no automatic tracking) and test conditions permitting, two test samples are done before solar noon and 2 after. Maximum temperature of the heat transfer fluid (i.e. the top of the operating range) is > 80 °C. The recommended maximum value of the reduced temperature difference T_m^* is $> 0,09$ m²KW⁻¹.

For the instantaneous collector efficiency η_{col} a continuous efficiency curve of the format as in the following equation is obtained by statistical curve fitting of the test point results, using the least square method:

$$\eta_{col} = \eta_0 - a_1 \times T_m^* - a_2 \times G (T_m^*)^2$$

Where:

- T_m^* is the reduced temperature difference in m²KW⁻¹, with

$$T_m^* = (t_m - t_a) / G$$

Where:

- t_a is the ambient or surrounding air temperature;
- t_m is the mean temperature of the heat transfer fluid:

$$t_m = t_{in} + 0,5 \times \Delta T$$

² EN15316-4-3, B based method

³ ISO 9459-5 based method

Where:

- t_{in} is the collector inlet temperature;
- ΔT is temperature difference between fluid outlet and inlet ($= t_e - t_{in}$).

All tests are performed according to EN 12975-2, EN 12977-2 and EN 12977-3. Converting so-called quasi-dynamic model parameters to a steady-state reference case to arrive at the parameters above is permitted. The Incidence Angle Modifier IAM is determined in accordance with EN 12975-2.

(b) SOLCAL method

The SOLCAL method requires

- The solar collector parameters A_{sol} , η_0 , a_1 , a_2 and IAM ;
- The nominal volume of the storage tank volume (V_{nom}) in litres, the volume of the non-solar heat storage (V_{bu}) in litres and the specific standing loss (psb_{sol}) in W/K (K expresses the difference between store and ambient temperature);
- The auxiliary electricity consumption at stabilised operating conditions Q_{aux} ;
- The standby power consumption $sol_{standby}$;
- The pump power consumption sol_{pump} .

The calculation assumes default values for the specific insulation of the collector loop pipes ($= 6 + 0,3 \text{ W/Km}^2$) and the heat capacity of the heat exchanger ($100 \cdot \text{W/Km}^2$). m^2 stands for the collector aperture area. Furthermore, it is assumed that the solar heat store periods are less than one month.

For the purpose of establishing the total energy efficiency performance of solar-only system and conventional water heater or of a solar water heater, the SOLCAL method determines the annual non-solar heat contribution Q_{nonsol} in kWh with

$$Q_{nonsol} = \text{SUM} (Q_{nonsol_{tm}}) \text{ in kWh/a}$$

Where:

- $\text{SUM} (Q_{nonsol_{tm}})$ is the sum of the all monthly non-solar heat contribution of the conventional water heater or the conventional heat generator being part of a solar water heater; with

$$Q_{nonsol_{tm}} = Lwh_{tm} - LsolW_{tm} + psbSol \cdot V_{bu} / V_{nom} \cdot (60 - T_a) \cdot 0,732$$

The monthly heat demand for the solar thermal system is defined as:

$$Lwh_{tm} = 30,5 \cdot 0,6 \cdot (Q_{ref} + 1,09)$$

Where:

- 0,6 represents a factor to calculate the average heat demand from the load profile;
- 1,09 represents the average distribution losses.

The following calculations are performed:

$$L_{solW1tm} = L_{wh_{tm}} \cdot (1,029 \cdot Y_{tm} - 0,065 \cdot X_{tm} - 0,245 \cdot Y_{tm}^2 + 0,0018 \cdot X_{tm}^2 + 0,0215 \cdot Y_{tm}^3)$$

$$L_{solW_{tm}} = L_{solW1tm} - Q_{buf_{tm}}$$

The minimum value of $L_{solW_{tm}}$ is 0 and the maximum value is $L_{wh_{tm}}$.

Where:

- $Q_{buf_{tm}}$ is the solar storage tank correction in kWh/month; with

$$Q_{buf_{tm}} = P_{sbsol} \cdot (V_{nom} - V_{bu}) / V_{nom} \cdot (10 - 50 \cdot L_{solW1tm} / L_{wh_{tm}} - T_a) \cdot 0,732;$$

Where:

- 0,732 is a factor that takes into account the average monthly hours ($24 \cdot 30,5$);
- P_{sbsol} is the specific standing loss of the solar heat store in W/K as determined in accordance with point 4.8(a);
- T_a is the monthly average air temperature surrounding the heat store in °C; with
- $T_a = 20$ when the heat store is inside the building envelope;
- $T_a = T_{out_{tm}}$ when the heat store is outside the building envelope;
- $T_{out_{tm}}$ is the average daytime temperature in °C for average, colder and warmer climate conditions.

X_{tm} and Y_{tm} are aggregated coefficients:

$$X_{tm} = A_{sol} \cdot (Ac + UL) \cdot \epsilon_{tloop} \cdot (T_{refw} - T_{out_{tm}}) \cdot c_{cap} \cdot 0,732 / L_{wh_{tm}}$$

The minimum value of X_{tm} is 0 and the maximum value is 18.

Where:

- $Ac = a_1 + a_2 \cdot 40$;
- $UL = (6 + 0,3 \cdot A_{sol}) / A_{sol}$ is loop losses in W/(m²K);
- $\epsilon_{tloop} = 1 - (\eta_0 \cdot a_1) / 100$;

- $T_{refw} = 11,6 + 1,18 \cdot 40 + 3,86 \cdot T_{cold} - 1,32 \cdot T_{out_{tm}}$;
- T_{cold} is the cold water temperature, default 10 °C;
- $T_{out_{tm}}$ is the *average daytime temperature in °C for average, colder and warmer climate conditions*;
- $ccap$ is storage coefficient with $ccap = (75 \cdot A_{sol} / V_{sol})^{0,25}$;

$$Y_{tm} = A_{sol} \cdot IAM \cdot \eta_0 \cdot \eta_{loop} \cdot Q_{solM_{tm}} \cdot 0,732 / L_{wh_{tm}}$$

The minimum value of Y_{tm} is 0 and the maximum value is 3.

Where:

- η_{loop} is loop efficiency with $\eta_{loop} = 1 - (\eta_0 \cdot a_1)/100$;
- $Q_{solM_{tm}}$ is the *average global solar irradiance in W/m^2 for average, colder and warmer climate conditions*.

The auxiliary electricity consumption Q_{aux} is calculated as follows:

$$Q_{aux} = (sol_{pump} \cdot sol_{hrs} + sol_{standby} \cdot 24 \cdot 365) / 1000$$

Where:

- sol_{hrs} is the number of active solar hours in h; with
- $sol_{hrs} = 2\,000$ for solar water heaters.

(c) SOLICS Method

The SOLICS method is based on the test method described in ISO 9459-5:2007. The procedure to determine the solar output is referenced as follows:

- Terms and definitions according to ISO 9459-5:2007, chapter 3;
- Symbols, units and nomenclature according to ISO 9459-5:2007, chapter 4;
- The system is mounted according to ISO 9459-5:2007, paragraph 5.1;
- The test facility, instrumentation and sensor locations are according to ISO 9459-5:2007, chapter 5;
- The tests are performed according to ISO 9459-5:2007, chapter 6;
- Based on the test results the system parameters are identified according to ISO 9459-5:2007, chapter 7. The dynamic fitting algorithm and simulation model as described in ISO 9459-5:2007, Annex A, are used;

- The annual performance is calculated with the simulation model as described in ISO 9459-5:2007, Annex A, the identified parameters and the following settings:
- *Average daytime temperature in °C for average, colder and warmer climate conditions and average global solar irradiance in W/m² for average, colder and warmer climate conditions;*
- Hourly values for global solar irradiance according to an appropriate CEC test reference year;
- Mains water temperature: 10 °C;
- Ambient temperature of the store (buffer inside: 20 °C, buffer outside: ambient temperature);
- Auxiliary electricity consumption: by declaration;
- Auxiliary set temperature: by declaration and with a minimum value of 60 °C;
- Auxiliary heater time control: by declaration.

$$\text{Annual heat demand: } 0,6 \cdot 366 \cdot (Q_{ref} + 1,09)$$

Where:

- 0,6 represents a factor to calculate the average heat demand from the load profile;
- 1,09 represents the average distribution losses.

The auxiliary electricity consumption Q_{aux} is calculated as follows:

$$Q_{aux} = (solpump \cdot solhrs + solstandby \cdot 24 \cdot 365) / 1000$$

Where

- solhrs is the number of active solar hours in h; with
- solhrs = 2 000 for solar water heaters.

For the purpose of establishing the total energy efficiency performance of solar-only system and conventional water heater or of a solar water heater, the SOLICS method determines the annual non-solar heat contribution Q_{nonsol} in kWh in terms of primary energy and/or kWh in terms of GCV as follows:

- For solar-only systems:

$$Q_{nonsol} = 0,6 \cdot 366 \cdot (Q_{ref} + 1,09) - QL$$

Where:

- QL is the heat delivered by the solar heating system in kWh/a.
- For solar water heater:

$$Q_{nonsol} = Q_{aux,net}$$

Where:

- Q_{aux,net} is the net non-solar energy demand in kWh/a.

4.8. Storage tank test procedures

(a) Standing loss

The standing loss *S* of storage tanks can be assessed using any of the methods referenced in point 3, including the standing loss of the solar storage tank *psbsol*. Where the measurement results from the applicable standards are expressed in kWh/24 hours, the result will be divided by (1000/24) to arrive at values for *S* in W. For the specific standing loss – per degree of temperature difference between store and ambient — of solar storage tanks *psbsol*, the heat loss can be determined in W/K directly by using EN 12977-3 or it can be found indirectly by dividing the heat loss in W by 45 (*T*_{store} = 65 °C, *T*_{ambient} = 20 °C) to arrive at a value in W/K. Where the results of EN 12977-3, expressed in W/K, are used for the assessment of *S* they are multiplied by 45.

(b) Storage volume

The volume of the tank in a storage electric water heater is measured as follows:

The heating of the storage water heater is switched off. Then the storage water heater is filled with cold water in accordance with the manufacturer's instruction and the water supply is cut off.

It is then emptied through the water inlet or, if this is not possible, through the drain plug opening.

Water in the feed cistern of a cistern-fed water-heater is excluded from the quantity withdrawn.

The water withdrawn is measured.

4.9. Solar pump power test procedure

The solar pump power is rated as the electrical consumption under nominal operating conditions. Start-up effects under 5 minutes are disregarded. Solar pumps that are continuously controlled, or controlled in at least three steps, are rated as 50% of the rated electrical power of the solar pump.