<u>**Working document**</u>

Draft Commission communication in the framework of the implementation of Commission Regulation (EC) 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 …/… implementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of water heaters and hot water storage tanks

(Text wit EEA relevance)

(Publication of titles and references of transitional methods of measurement and calculation[1] for the implementation of Regulation (EC) No …/…, and in particular Annexes II and III thereof, and for the implementation of Regulation (EU) No …/…, and in particular Annexes VI and VIII thereof)

(20../C …/…)

Part 1: References

Measured/calculated parameter	Organisation	Reference	Title	Notes
Properties of energy inputs for testing purposes, all measurements	European Commission	Part 2, sections 2.2.1-2.2.3	2.2.1. Electricity and Fossil Fuels 2.2.2. Solar energy 2.2.3. Ambient energy	1
Values and tolerances on ambient and other numerical test parameters, all measurements	European Commission	Part 2, section 2.2.4	2.2.4. Ambient- and output test parameters	2
Calculation procedure of *Qdistr* and *Qrwaste*	European Commission	Part 2, section 3	3. Calculation of Qdistr and Qrwaste	3
Test procedure for *Qfuel* and *Qelec* in case of an ESWH, GSWH and GIWH	European Commission	Part 2, section 4	4. Standard Test Procedure	4
Test procedure for *Qfuel* and *Qelec* in case of an HPWH and SOLWH [SOLSIM method only]	European Commission	Part 2, section 5	5. Iterative Test Procedure	5

[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.

Test procedure for *Qelec* in case of EIWH	European Commission	Part 2, section 6	6. Test Procedure for Electric Instantaneous Water Heaters	6
Test procedure for the verification of 'smart' control in case of an EIWH	European Commission	Part 2, section 7	7. Smart control procedure for Electric Instantaneous Water Heaters	7
Rules for the selection of test and calculation methods for SOLWH	European Commission	Part 2, section 8.1	8.1. Scope	8
Test procedure for solar collector efficiency parameters parameters *eta0, a1, a2*	European Commission	Part 2, section 8.2	8.2. Solar Collector Testing	9
Calculation procedure for the assessment of *Qsol*, SOLCAL method as well as underlying parameters *Lsolwh, Qbuf* and *Qaux*	European Commission	Part 2, section 8.3	8.3. SOLCAL Method	10
Calculation procedure for the assessment of *Qsol*, SOLICS method	European Commission	Part 2, section 8.4	8.4. SOLICS Method	11
Calculation procedure for the assessment of *Qsol,* SOLSIM method	European Commission	Part 2, section 8.5	8.5. SOLSIM Method	12
Calculation procedure for deriving *Psbsol* from measurements of standing losses	European Commission	Part 2, section 9.1	9.1. Standing losses storage tanks, test and calculation	13
Calculation procedure for deriving *Psbhp* from measurements of standing losses	European Commission	Part 2, section 9.1	9.1. Standing losses storage tanks, test and calculation	14
Test procedure for *Vsol* and the volume of storage tanks	European Commission	Part 2, section 9.2	9.2. Storage volume test procedure	15

Assessment of *POS,* air intake, envelope volume, energy source and solaux	European Commission	Part 2, section 9.3	9.3. Assessment of designated position, air intake, envelope volume, energy source and solar pump power	16
Test procedure for *Asol, IAM* and additional elements of collector efficiency testing of parameters *eta0, a1, a2, IAM*	CEN	EN 12975-2:2006	Thermal solar systems and components - Solar collectors - Part 2: Test methods	18
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	19
Standby power consumption *solsb*	CEN	EN 62301:2005	Household Electrical Appliances: Measurement of standby power	20
Combustion efficiency *etacomb*, flue gas temperature *Tflue*	CEN	EN 13836:2006, Clause 7.8.1, 7.8.2	Gas fired central heating boilers - Type B boilers of nominal heat input exceeding 300 kW, but not exceeding 1000 kW	21
Test-rig for *Qelec* of ESWH	CEN	prEN 50440: 2005, Clause 7 and clause 9 , Fig. 1	Efficiency of domestic electrical storage water heaters	22
Test-rig for *Qelec* of EIWH	CEN	EN 50193:1997, Clause 6, 7.1 (incl. Fig.1), 7.2	Closed electrical instantaneous eater heaters, Methods for measuring performance.	23
Test-rig for *Qfuel* and *Qelec* of GIWH	CEN	EN 26:2006, Clause 7.1, except clause 7.1.5.4.	Gas-fired instantaneous water heaters for sanitary uses production, fitted with atmospheric burners	24
Test-rig for *Qfuel* and *Qelec* of GSWH	CEN	EN 89:2006, Clause 7.1, except clause 7.1.5.4.	Gas-fired storage water heaters for the production of domestic hot water	25
Test-preparation for *Qfuel* of GIWH and GS WH	CEN	EN 13203-2: 2005, 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	26
Test-rig for HPWH	CEN	prEN 255-3: 2008, Clause 5	Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors – Heating mode, Part 3: Testing and requirements for marking for saniatry hot water units	27
Standing losses storage tank *S*	CEN	EN 12897: 2006, clause 6.2.7 and Annex B	Water Supply – Specification for indirectly heated unvented (closed) storage water heaters.	28

Standing losses storage tank *S* and *Psbsol*	CEN	ENV 12977-3 :2001,	Thermal solar systems and components – Custom built systems – Part 3: Performance characterisation of stores for solar heating systems	29
Standing losses storage tank *S*	CEN	EN 15332: 2007, Clauses 5.1 and 5.4 (Measurement of standby-loss)	Heating boilers – Energetic assessment of hot water storage tanks	30
Standing losses storage tank *S*	CEN	EN 60379: 2004, clauses 9, 10, 11, 12 and 14	Methods for measuring the performance of electric storage water-heaters for household purposes	31

Tabel 2: Notes

1 The values and tolerances in this section represent the common elements of mandatory values, as well as a relevant elements of values and tolerances published EN (pre-) standards for several types of water heaters (prEN 50440:2005, EN 13203-2:2006, EN 26:2006, EN 89:2006, prEN 255-3:2008, EN 15316-4-3:2007, EN 12975-2:2006, EN 12976-2:2006, ISO 9459-2:1995, ISO 9459-5:2007).

2 As Note 1. Tolerances on values relating to the hot water temperature, flowrate, volume and the aggregated thermal energy, are only informative for the purposes of market surveillance; for these parameter the overall tolerances on energy consumption and -efficiency as required by Commission Regulation … and … prevail.

3 Calculation procedure for Qdistr and Qrwaste, requiring etacomb, Tflue, Psbhp, indoor noise as measured inputs not mentioned previously.

4 Represents the common elements of mandatory values, as well as relevant elements of published in EN (pre-) standards for several types of water heaters (prEN 50440:2005, EN 13203-2:2006).

5 Test procedure based on prEN 13203-3:2007 but aligned with the requirements of the load profiles in the Regulation and updated --with stakeholders-- to clarify all mandatory elements. For SOLWH the inputs tables 2 and 5 in Annex II of Regulation … apply for 24h solar irradiance and outdoor temperature respectively. For HPWH tables 5 and 6 in Annex II of the Regulation … apply for source temperatures/ humidity and maximum ventilation exhaust air available.

6 Test procedure proposed by stakeholders as implementation of Commission Mandate M993 but taking into account physical restrictions posed by the EIWH technology.

7 Applies only to EIWH. The assessment of 'smart control' for non-EIWH types is part of Commission Regulation … and … .

8 Stipulates on the basis of SOLWH characteristics which test and calculation procedure shall or can be used for the assessment of efficiency/ energy contribution.

9 Section 8.2 gives a summary of the test procedure in EN 12975:2006 for those parts where the aforementioned EN standard is ambiguous as to the voluntary and mandatory elements. Otherwise, the properties of the solar energy inputs (section 2.2.2) apply, as well as the parts of the test procedure that are not described in section 8.2.

10 Based on component testing method ('F-chart') in EN15316-4-3:2007, *Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-3: Heat generation systems, thermal solar systems,* amended in consultation with stakeholders and applied to load profiles as given in Table 1 of Commission Regulation and …. Calculation of Qsol requires assessment of Lsolwh, Qbuf and Qaux. Calculation of Lsolwh requires the (aggregated) measured parameters Asol, eta0, a1, a2, IAM, Vsol. Qbuf requires Psbsol and POS as external inputs. Qaux requires solaux and solsb as measured inputs. Average monthly values of daytime outdoor temperature Tout and global solar irradiation G and are to be taken from the appropriate tables (3 and 4) Commission Regulation … and .... .

11 Based on ISO 9459-5:2007, *Solar heating -Domestic water heating systems -- Part 5: System performance characterization by means of whole-system tests and computer simulation,* amended in consultation with stakeholders and applied to load profiles as given in Regulation … and Regulation …. Calculation of Qsol requires assessment of Qaux (as in note 10) and QL. For preheat systems QL follows from ISO 9459-5 directly. For solar plus supplementary system QL follows from (difference between) QD and Q aux,net. from ISO 9459-5.

12 Based on prEN 13203-3, *Solar supported gas-fired domestic appliances producing hot water - Appliances not exceeding 70 kW heat input and 500 liters water storage capacity - Part 3: Assessment of energy consumption,* amended in consultation with stakeholders and applied to load profiles as given in Regulation … and …. Assessment of Qsol requires the assessment of the hourly simulator power output $P_{sim,HE}$, which in turn requires collector parameters Asol, eta0 and a1.

13 Summarizes and harmonizes the requirements of relevant (pre-)standards EN 12897: 2007, EN 15332: 2007, EN 60379: 2004, prEN 12977-3:, prEN 50440:2005.

14 See Note 13.

15 See Note 13.

16 Section contains additional clarifications.

17 Specifies reporting requirements for market surveillance.

18 Defines Asol and IAM. For the testing of collector efficiency parameters this standard gives useful informative hints that may supplement subjects not covered in section 2.2.2 and 8.2 of this communication.

19 Indoor noise level is an input to determine the recovered heat Qrwaste in a table. EN 12102:2008 gives the noise parameter for heat pump water heaters. For electric appliances the indoor noise level is set at 35 dBA by default. For noise from fossil-fuel fired appliances standardisation is on-going and a reference is expected to be added later.

20 Required input for Qaux.

21 etacomb=1- flue losses. The standard referenced is just one example. It applies to boilers but also applies to gas-fired water heaters at nominal input. E.g. see also EN 15378:2007, *Heating systems in buildings - Inspection of boilers and heating systems*, Annex C.1.

22 Supplement for issues not explicitly mentioned in sections 2.2.2, 2.2.4 and 4 of this communication as regards the test set-up for ESWHs.

23 Supplement for issues not explicitly mentioned in sections 2.2.2, 2.2.4, 6 and 7 of this communication as regards the test set-up for EIWHs.

24 Supplement for issues not explicitly mentioned in sections 2.2.2, 2.2.4 and 4 of this communication as regards the test set-up for GIWHs.

25 Supplement for issues not explicitly mentioned in sections 2.2.2, 2.2.4 and 4 of this communication as regards the test set-up for GIWHs.

26 Supplement for issues not explicitly mentioned in sections 2.2.1, 2.2.4 and 4 of this communication, as well as the indicated clauses of EN 26 and EN 89, as regards the test set-up for GSWHs and GIWHs

27 Supplement for issues not explicitly mentioned in sections 2.2.3, 2.2.4 and 5 of this communication as regards the test set-up for HPWHs

28 The result of the measurement Qst is given in kWh/24h. Conversion to standing loss *S* in W shall be as indicated in section 9.1 of this communication.

29 For declaration of standing losses *S*, the measured value in W/K needs to be converted to W as indicated in section 9.1 of this communication.

30 The result of the measurement Q_B is given in kWh/24h. Conversion to standing loss *S* in W shall be as indicated in section 9.1 of this communication.

31 The result of the measurement Q_{pr} is given in kWh/24h. Conversion to standing loss *S* in W shall be as indicated in section 9.1 of this communication.

Abbreviations

ESWH	Electric Storage Water Heater
EIWH	Electric Instantaneous Water Heater
GSWH	Gas or oil-fired Storage Water Heater
SOLWH	Solar Water Heater
HPWH	Heat Pump Water Heater
SOLSIM	Method for solar water heater testing pursuant to the conditions set out in point (4a) of Annex II to Regulation… , and point (4a) of Annex VI to Regulation …
SOLCAL	Method for solar water heater testing pursuant to the conditions set out in the point (4b) of Annex II to Regulation…, and point (4b) of Annex VI to Regulation …
SOLICS	Method for solar water heater testing pursuant to the conditions set out in the point (4c) of Annex II to Regulation…, and point (4c) of Annex VI to Regulation …

Part 2: Additional elements for measurements and calculations related to the energy efficiency of water heaters and storage tanks

1. DEFINITIONS

In addition to the definitions set out in Article 2 and Annex I of Commission Regulation …(ecodesign) , and in Article 2 of Commission Regulation …(energy labelling) the following definitions apply:

(1) "uncertainty of measurement (accuracy)" is the precision with which an instrument is capable to represent an actual value as established by a highly-calibrated measurement reference;

(2) "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;

(3) "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) "instantaneous water heater" is a water heater where the heating of water is directly dependent on the draw-off [2];

(5) "storage water heater" is a water heater which heats and stores water contained in a vessel at a pre-set temperature and which has the heating source located inside the product.[3].

2. ENERGY INPUTS

2.1 Introduction

In the following characteristics of the relevant energy inputs are defined.

2.2 Tables

2.2.1. Conventional energy sources

Table 3. Electricity and Fossil Fuels

Measured quantity	Unit	Value	Permissible deviation (average over test period)	Uncertainty of measurement (accuracy)	Notes

[2] Definition from EN 26
[3] Definition from EN 89

Electricity					
Power	W			± 1 %	
energy	kWh			± 1 %	
voltage, *test-period > 48 h*	V	230/ 400	± 4 %	± 0.5 %	[1]
voltage, *test-period < 48h*	V	230/ 400	± 2 %		
voltage, *test-period < 1 h*	V	230/ 400	± 1 %	± 0.2 %	
electric current	A			± 0.5 %	
Frequency	Hz	50	± 1 %		
Gas					
Types	-	Test gases			[2]
net calorific value (NCV)	MJ/ m³	Test gases		± 1 %	[3]
Temperature	K	288.15		± 0.5	[3]
Pressure	mbar	1013.25		± 1 %	[3]
Density	dm³/kg			± 0.5 %	
flow rate	m³/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		[4]
net calorific value (NCV, Hi)	MJ/kg	42.689			[5]
gross calorific value (GCV, Hs)	MJ/kg	45.55			[6]
density **ρ15** at 15 °C:	kg/dm³	0.85			
Kerosene					
composition, *Carbon/ Hydrogen/ Sulfur*	kg/kg	85/ 14.1/ 0.4 %			
N-fraction	mg/kg	140	± 70		[4]
net calorific value (NCV, Hi)	MJ/kg	43.3			[5]
gross calorific value (CGV, Hs)	MJ/kg	46.2			[6]
density **ρ15** at 15 °C:	kg/dm³	0,79			

Notes

[1] Test periods >48 h apply to heat pump and/or solar assisted Products. Test periods <48 h apply to conventional Products. Test period <1 h applies to the simplified test procedures for electric instantaneous water heaters

[2] Test gases as in the essential requirements of the Gas Appliances Directive 90/396/EEC with amendments as in 93/68/EC

[3] A factor K has to be applied to correct the calorific value for the actual average atmospheric pressure pa and gas pressure pg as well as the average gas temperature Tg over the test period:

$$K = (pa + pg)/1013,25 \ + 288,15/(273,15+Tg)$$

[4] In case of low Sulfur test fuels, N-fractions lower than 70 mg/kg and lower S fractions are allowed. For example an N-fraction of 0-10 mg/kg for kerosene is reported.

[5] Default value, if value is not determined calorimetrically. Also other values are defaults. Alternatively, if volumetric mass and sulphur content are known (e.g. by basic analysis) the net heating value (Hi) may be determined with:

$$Hi = 52,92 - (11,93 \times \rho 15) - (0,3 - S) \text{ in MJ/kg}$$

[6] Calculated from net calorific value with multiplier 1,067 × GCV=1,067 × NCV

2.2.2 Solar energy

The table below gives additional data on testing conditions in addition to the provisions set out in Regulation … and Regulation …

Table 4. Solar energy parameters for solar collector tests. Set values and tolerances

Measured quantity	Unit	Value	Permissible deviation of the arithmetic mean values from set values	Permissible deviations of individual measured values from set values	Uncertainty of measurement (accuracy)	Notes
Solar collector (glazed)--> ***eta0, a1, a2 through least square curve fit for 4 x 4 test results; Asol***						
Test solar irradiance (global G, short wave)	W/m²	>700 W/m²	± 50 W/m² (test)		± 10 W/m² (indoors)	[1]
Diffuse solar irradiance (fraction of total G)	%	<30%				[2]
Thermal irradiance variation (indoors)	W/m²				± 10 W/m²	
Fluid temperature at collector inlet/outlet	°C/ K	range 0-99 ºC	± 0,1 K		± 0,1 K	[3]
Fluid temperature difference inlet/outlet					± 0,05 K	[4]
Incidence angle (to normal)	°	<20°	±2 % (<20°)			[5]
Air speed parallel to collector	m/s	3 ± 1 m/s			0,5 m/s	[6]
Fluid flow rate (also for simulator)	kg/s	0,02 kg/s per m² collector aperture area	± 10 % between tests	± 1 % (max dev in 1 test)		[7]
Tilt angle	°	see note				[8]
Collector area A (absorber, gross, aperture)	m²				± 0,3 %	
Pipe heat loss of loop in test	W/K	<0,2 W/K				

Notes:

[1] Measured by pyranometer, equivalent to Class I (ISO 9060) or better. With shading ring or pyrheliometer and provided with a dessicator. Regular inspection of the desiccator shall be observed. Test sample rate 30 s.
Pyranometer stays fixed in one test-point before data recording begins. Sensor shall be co-planar to collector ± 1°, at midheight of collector and receiving the same levels of direct, diffuse and reflected solar radiation as collector. When used with solar irradiance simulator minimize effect of infrared radiation at wavelength > 3µ

[2] If <30% can then be ignored (from EN 12975-2)

[3] Measure within 200 mm of collector connection or at a more distant location, in which latter case additional testing is required to demonstrate that the measurement of the fluid temperature is not affected. Appropriate measures shall be taken to ensure mixing of the fluid at the position of the temperature measurement.

[4] Preferable accuracy ± 0,02 K

[5] Measured by simple device: spike normal to collector and reference circles on collector plane to read spike shadow.

[6] Measure 10 to 50 mm above collector, use artificial wind generator if < 2m/s. Check uniform distribution with anemometer. Temperature of artificial wind is ambient ± 1K.

[7] A higher flow rate is allowed, following manufacturers instructions, when necessary for reproducible testing. This shall be clearly stated in the technical documentation of the product.

[8] The collector shall be tested at tilt angles such that the incidence angle modifier for the collector varies by no more than ±2 % from its value at normal incidence. For single glazed flat plate collectors, this condition will usually be satisfied if the angle of incidence of direct solar radiation at the collector aperture is less than 20°.

2.2.3. Ambient heat energy

The table below gives additional data on testing conditions in addition to the provisions set out in Regulation … and Regulation …

Table 5: Energy inputs and related parameters ambient heat/ heat pumps

Measured quantity	Unit [climate conditions]	Value	Permissible deviation (average over period	Permissible deviations of individual measured values	Uncertainty of measurement (accuracy)	Notes
Heat pump assistance: Liquid (heat transfer media: brine or water)						
brine inlet temperature	°C	Reg.	± 0,2	± 0,5	± 0,1	[1]
water inlet temperature	°C	Reg.				[1]
volume flow	m^3/s or l/min		± 2 %	± 5 %	± 5 %	
static pressure difference	Pa		--	± 10 %	± 5 Pa/ 5%	[2]
Heat pump assistance: Air (as heat source)						
outdoor air temperature (dry bulb) (*Toutair*)	°C **[A]** °C **[C]** °C **[W]**	Reg. 5,5 16	± 0,3	± 1	± 0,2	[3]
vent exhaust air temperature (*Tex*)	°C	20	± 0,3	± 1	± 0,2	
mixed air temperature (*Tmix*)	°C	see note	± 0,3	± 1	± 0,2	[4]
inlet air humdity *[A, C, W]*	g H2O/ m^3	5,5			± 5 %	[5]
volume flow	dm^3/s		± 5 %	± 10 %	± 5 %	
static pressure difference	Pa		--	± 10 %	± 5 Pa/ 5%	[6]

Notes

[1] 'Reg.' means that values are specified in Regulation …(ecodesign) and Regulation … (energy labelling)in theRegulation(s)

[1] maximum value according to manufacturer instructions shall be set at at liquid pump outlet, at nominal flow rate specified. Accuracy of measurement is ± 5 Pa if value < 100 Pa and 5% if value >100 Pa.

[2] Set values apply to average [A], colder [C] and warmer [W] climate conditions.

[3] In order to avoid over-ventilation a maximum availability of ventilation exhaust air at a temperature of 20 ºC is assumed, depending on the Load Profile. This parameter *ventex* [in m^3/h] is given below. If the actual nominal inlet air flow rate *ventreal* [in m^3/h] exceeds this value, the heat pump shall use the mixed air temperature *Tmix* [in ºC] for testing. *Tmix* is determined from the relative proportion of exhaust air temperature *Tex* [in ºC] and exhaust air flow rate *ventex* versus outdoor air temperature *Toutair* and the surplus air flow (*ventreal*-*ventex*). In formula:

$$Tmix = \{Tex \times ventex + Tout \times (ventreal - ventex)\} / ventreal$$

Default values *ventex* per water load profile are given in Regulation …, Annex II, Table 6

If *ventreal* is not known a default value of 300 m^3/kW nominal power of heat pump can be used.

[4] Note that an absolute humidity of 5,5 g/m^3 results in 37% Relative Humidity at 20 ºC dry bulb (12 ºC wet bulb), 65% RH at 10 ºC dry bulb (9 ºC wet bulb), etc.

[5] maximum value according to manufacturer instructions shall be set at duct outlet, with heat pump not operating. Nominal air flow shall be verified. Accuracy of measurement is ± 5 Pa is value is < 100 Pa and 5% if value >100 Pa.

2.2.4 Test conditions and tolerances on outputs

Table 6 gives additional test conditions and tolerances for test outputs (i.e. thermal energy).

Table 6: Test conditions and outputs. Set values and tolerances

Measured quantity	Unit	Value	Permissible deviation (average over test period)	Permissible deviations of individual measured values	Uncertainty of measurement (accuracy)	Notes
Ambient						
ambient temperature indoors *HP*	°C/ K	20 ± 5 °C	± 1 K	± 2 K	± 1 K	
ambient temperature indoors *gasfired*	°C/ K	20 ± 3 °C			± 1 K	
ambient temperature indoors *other*	°C/ K	20 ± 2 °C			± 1 K	
air speed *HP* (at WH off)	m/s	<1,5 m/s				
air speed *other*	m/s	<0,5 m/s				
Time						
Time *EIWH*	s				± 0,1 s	
Minimum sample rate SOLAR tests	s	30s			± 0,2 %	
Sanitary water						
cold water temperature *solar*	°C/ K	10 °C	± 1 K	± 1 K	± 0,2 K	
Cold water temperature *other*	°C/ K	10 °C	± 2 K	± 2 K	± 1 K	
Cold water pressure *gasfired WH*	bar	2 bar		± 0,1 bar		
Cold water pressure *other (except EIWH)*	bar	3 bar			± 5 %	
hot water temperature *gasfired WH*	°C/ K	pattern			± 0,5 K	[1]
hot water temperature *electric instantaneous*	°C/ K	pattern			± 1 K	[2]
water temperature (in-/outlet) *other*	°C/ K				± 0,5 K	
volume flowrate *HP*	dm^3 /s	pattern	± 5 %	± 10%	± 2 %	
volume flowrate *other WH*	dm^3 /s	pattern			± 1 %	
volume measurements *HP*	dm^3				± 2 %	
volume measurements *other*	dm^3				± 0,5 %	
thermal energy	kWh	pattern	± 2 % (overall)	± 2 % (or ±10Wh)	± 2 % (or ±10Wh)	[3]

Notes:

[1] To be measured by "rapid response thermometer", meaning an instrument that registers within 1 s. at least 90% of the final temperature rise from 15 to 100 °C when the sensor is plunged in still water.

[2] Thermocouple with a maximum diameter of 0,5mm, centred in stream, directly at outlet

[3] Apart from the maximum deviation a correction factor *Qref/QH2O* is applied, where *QH2O* is the energy content of the useful water actually delivered during the test. "Useful water" is water with a temperature higher than a threshold value *Tm*.
"Energy content" of one draw-off *QH2O[i]* follows from average in-/outlet temperature difference *ΔT[i]* in K, the useful water volume *V[i]* in litre. and the specific heat of water *cw* (1,163 Wh/litre):

$$QH2O[i] = \Delta T[i] \times V[i] \times \mathrm{cw}$$

For all the *n* draw-offs of one load profile the energy content is the sum:

$$QH2O = \sum QH2O[i] \quad \text{for } i=1 \text{ to } i=n$$

[NB: This formula can have several formats, e.g. more dynamic formats using flowrate and instantaneous temperature differences, but it comes down to the same result for the legislation.]

3. CALCULATION OF QDISTR AND QRWASTE

The distribution loss Q_{distr} , in kWh/day is defined as:

$$Q_{distr} = Q_{distref} \cdot \left(\frac{(Q_{fuel} + prim \cdot Q_{elec}) \cdot (1 - 0{,}07 \cdot smart) - (qrecov \cdot Q_{rwaste})}{Q_{ref}} \right)$$

with values for the reference distribution losses $Q_{distref}$ given in Table 7, and qrecov given in Table 8;

- For electric resistance water heates: $Q_{rwaste} = Q_{elec} - Q_{ref}$
- For fossil-fuel fired water heaters: $Q_{rwaste} = Q_{fuel} + Q_{elec} - Q_{ref} - Q_{fluegas}$

$$Q_{fluegas} = Q_{fuel} \cdot \left(1 - etacomb + LHL \cdot \frac{T_{flue} - 20}{dptc} \right)$$

where

- LHL is latent heat in fuel, set to 10% for gas and 6% for oil;
- $dptc$ is the corrected dew-point of the fuel in °C with values 52, 41 or 48 if fuel is gas, oil or LPG respectively;

For solar water heaters, waste heat recovery is already included in the SOLCAL and SOLICS method (Q_{rwaste}=0); for the SOLSIM method

$Q_{rwaste} = (0{,}5 + 0{,}5 \cdot POS) \cdot (Q_{fuel} + Q_{elec} + Q_{sol} - Q_{ref} - Q_{fluegas})$
where

- POS is the designated position of solar tank and back-up heater, where POS=1 if both are inside, POS=0 if both are outside and POS=0,5 if the tank is outside and the back-up heater is inside;

For heat pump water heaters
$Q_{rwaste} = 24 \cdot Psbhp/1000$
where

- $Psbhp$ is the standing heat loss of the storage tank under reference conditions in W. (see section 9.1)

Table 7. Determination of distribution losses *Qdistref* in kWh per day

Air intake	envelope volume	Load profile								
[–]	[m³]	XXS	XS	S	M	L	XL	XXL	3XL	4XL
none	<=0,5	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07

(electric)	>0,5	0,36	0,36	0,55	1,09	1,09	1,09	1,09	2,19	4,37
room sealed	<=0,1	0,07	0,07	0,36	0,55	1,09	1,09	1,09	2,19	4,37
	>0,1 ; <0,15	0,36	0,36	0,55	0,73	1,09	1,09	1,09	2,19	4,37
	>=0,15	0,36	0,36	0,55	1,09	1,09	1,09	1,09	2,19	4,37
open	any value	0,36	0,55	1,09	1,09	1,09	1,09	1,09	2,19	4,37

Table 8. Determination of heat recovery parameter ***qrecov***

designated position*	**designated energy source**	**envelope volume**	**noise**	***qrecov***
[-]	[-]	[m³]	[dB(A)]	[%]
indoor	electric	≤ 0.5	≤ 35	32%
			>35; ≤ 44	21%
			> 44	9%
		> 0.5	any value	9%
	fossil fuel	≤ 0.15	≤ 44	32%
			> 44	9%
		≤ 0.5; > 0.15	≤ 44	21%
			> 44	9%
		> 0.5	any value	9%
outdoor	any value	any value	any value	0%

*= Paramater POS. In case POS=0,5 use half of the qrecov indoor value.

4. TEST PROCEDURE FOR CONVENTIONAL WATER HEATERS

In the following the test procedure for conventional water heaters to establish the fuel and electricity consumption Qfuel and Qelec during a 24h measurement cycle is provided.

4.1 Installation

The conventional water heater, in the following called "Product", is installed in test environment according to manufacturer's instructions and in accordance with the requirements in Section 3. 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 shall be 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 shall be mounted according to manufacturer's instructions. The Product shall be shielded from direct solar radiation (except of course solar collectors).

Products with declared Load Profiles 3XL and/or 4XL may be tested on-site, provided test conditions are equivalent, possibly with correction factors, to the ones referenced here and in Section 3.

4.2 Stabilisation

The Product is kept at ambient conditions (test room) until all parts of the Product have reached ambient conditions ± 5 K (at least 24h for storage type Products).

[NB: Purpose: Ascertain that Product is at more or less 'normal' temperature after transport].

4.3 Filling and heat-up (Storage only)

Products with storage-facilities shall be filled with cold water. Filling stops at the applicable cold water pressure (see Section 3).

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) shall be used. The next stage starts at thermostat cut out.

4.4 Stabilisation at zero-load (Storage only)

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

For Products with storage-facilities subject to a control cycle this stage ends - and next stage starts - at the first thermostat cut-out after 12h.

During this stage the total fuel consumption [in kWh on Gross Calorific Value of the fuel], the total electricity consumption [in kWh electric] and the exact time elapsed [in h] are recorded. The ratio between fuel consumption and elapsed time is *P0antefuel* [in kW with three digit accuracy]. The ratio between electricity consumption and elapsed time is *P0anteelec* [in kW with three digit accuracy].

4.5 Water draw-offs

During the water draw-offs relevant technical parameters (power, temperature, etc.) are established. For dynamic parameters the overall sample rate is 10s or less. During draw-offs the recommended sample rate is 5s or less.

The fossil fuel and electricity consumption over the 24h measurement cycle, : *Qtestfuel* [in kWh Gross Calorific Value of fuel] and *Qtestelec* [in kWh electricity] are corrected for possible fuel temperature and pressure deviations as specified in Section 4.7.

Products to be classified as "Off-peak" shall be energized for a maximum period of 8 consecutive hours during 22:00h and 7:00h of the 24h measurement cycle.

4.6 Re-stabilisation at zero-load (Storage only)

This stage does not apply to Products without any hot water storage facilities.

The Product shall be kept at nominal operating conditions without draw-offs during at least 12 h.

For Products with storage-facilities subject to a control cycle this stage ends at the first thermostat cut-out after 12h.

During this stage the total fuel consumption [in kWh on Gross Calorific Value of the fuel], the total electricity consumption [in kWh electric] and the exact time elapsed [in h] are recorded. The ratio between fuel consumption and elapsed time is *P0postfuel* [in kW with three digit accuracy]. The ratio between electricity consumption and elapsed time is *P0postelec* [in kW with three digit accuracy].

4.7 Reporting of Qfuel and Qelec

Qtestfuel and *Qtestelec* shall be corrected for any energy surplus or deficit outside the strict 24h 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 *Qfuel* and *Qelec*.

$$Qfuel = (Qref/QH2O) \times \{Qtestfuel + 24 \times (P0postfuel - P0antefuel)\}$$

$$Qelec = (Qref/QH2O) \times \{Qtestelec + 24 \times (P0postelec - P0anteelec)\}$$

where *QH2O* [in kWh] is the useful energy content of the hot water drawn-off, established according to Note 3 of Section 2.2.4.

In case of instantaneous water heaters the values of *P0antefuel*, *P0postfue*l, *P0anteelec* and *P0postelec* are assumed to be zero (0).

5. ITERATIVE TEST PROCEDURE

In the following the test procedure for Products using solar and/or ambient heat is described. It differs from the procedure for conventional water heaters in the following ways:

- Additional installation prescriptions apply.
- Test set-ups for the energy inputs are more complex than the ones for conventional energy sources. For solar Products this requires the use of simulators.
- Steady-state operating conditions for these Products are not known at the beginning of the test, but are a part of the outcome of the test procedure. This requires repetitive testing to establish these steady state conditions.
- Testing at Colder and Warmer climate conditions is required.

5.1 Installation

In addition to the requirements set out in Section 4.1, the following requirements also apply.

For Heat Pump Products consisting of several parts (split units) the following installation conditions shall be used for the tests:

- The refrigerant line shall be installed in accordance with the manufacturer's instructions with the maximum stated length or 8 m, whichever is shorter,

- the lines shall be installed so that the difference in elevation does not exceed 1 m;
- thermal insulation shall be applied to the lines in accordance with the manufacturer's instructions.
- Unless constrained by the design at least half of the interconnecting lines shall be exposed to the outdoor conditions with the rest of the lines exposed to the indoor conditions.

For indirect Heat Pump Products[4] the water line shall be installed in accordance with the manufacturer's instructions to the maximum stated length or 5m, whichever is shorter. Otherwise instructions above shall be followed.

Air-source Heat Pump Products should have a minimum distance of 1 m between the air-inlet/ outlet of the Product and surface of the test room.

For Solar water heaters or solar preheat systems the following preparatory actions apply.

- Clean collector surface.
- Remove moisture by running collector at heat transfer fluid circulating at 80 ºC.
- Vent collector pipework (remove trapped air).
- Expose empty collector to irradiation for 5h at > 700 Wm^{-2} (performance test).
- Mount Product with lower edge >0,5 m above local ground surface. Warm air currents from near walls or roofs of buildings shall not be allowed to pass over collector surface. When mounted on roof: >2 m from the edge.

Two types of simulator set-ups can be used:

1. Solar irradiance simulator. This is an indoor test set-up whereby the solar irradiance is mimicked by one or more lamps with solar wavelength characteristics, emitting the relevant irradiance levels.

2. Solar collector simulator. For this, first the collector must be the tested or suitable test data shall be acquired. This type of testing may be done outdoors or indoors with a solar irradiance simulator (e.g. a lamp or set of lamps). The test determines the main efficiency parameters of the solar collector. These parameters, together with the solar cycle irradiance values, are then "translated" into a power output of an electric resistance immersion heater that replaces the solar collector in the Product.

5.2 Stabilisation

Requirements of Section 4.2 apply.

[4] Heat pump Products using a heat transfer fluid (water or brine) to the transfer the heat to the hot water . This is very rare, but not excluded.

5.3 Filling and heat-up

Products with storage-facilities shall be filled with cold water. Filling stops at the applicable cold water pressure (Section 3).

The Product is energized to reach the set temperature for possible hot water storage facilities according to the manufacturer's instruction. This applies only to storage facilities that are subject to a control cycle[5].

The Product's own means of control (thermostat) shall be used. The next stage starts at thermostat cut out. Alternatively, e.g. if there is a significant heat transfer between the controlled (part of the) storage tank and the preheat (part of the) storage tank, the heat up can also be interrupted prematurely at a temperature that would be most advantageous for reaching a steady-state condition at the load profiles.

Likewise, in order to accelerate the procedure, the preheat tank can be heated or filled with warm water of a temperature that is considered to be representative of the steady-state conditions.

5.4 Initial measurement cycle

During water draw-offs technical parameters (power, temperature, etc.) are established in accordance with specifications in Section 4. For dynamic parameters the overall sample rate is 30s or less. During draw-offs the recommended sample rate is 5s or less.

The fossil fuel and electricity consumption over the 24h measurement cycle, *Qtestfuel* [in kWh Gross Calorific Value of fuel] and *Qtestelec* [in kWh electricity] are corrected for any surplus or deficit in the delivered useful energy content of the hot water as follows:

$Qfuel = (Qref/QH2O) \times Qtestfuel$

$Qelec = (Qref/QH2O) \times Qtestelec$.where *QH2O* [in kWh] is the useful energy content of the hot water drawn-off, established according to Note 3 of Section 2.2.4.

5.5 Repetitive measurement cycles

The measurement cycle indicated above will continuously be repeated for consecutive 24h measurement cycles until the total primary energy consumption

$Qtap = Qfuel + 2{,}5 \times Qelec$ [in kWh]

between two consecutive 24h measurement cycles does not differ by more than 5%. If this criterion is not fulfilled after 6 measurement periods, testing stops.

5.6 Reporting of *Qfuel* and *Qelec*

In case the 5% criterion mentioned above is fulfilled, the *Qfuel* and *Qelec* of the final measurement period shall be reported.

[5] Safety devices, e.g maximum thermostats, excluded.

If the above criterion is not fulfilled after 6 measurement periods, the average value of *Qfuel* and *Qelec* during the last 3 measurement cycles shall be reported.

5.7 Colder and Warmer climate conditions

The steps of the procedure above shall be repeated with the appropriate values applicable for "colder" and "warmer" climate conditions.

6. TEST PROCEDURE FOR ELECTRIC INSTANTANEOUS WATER HEATERS

Electric instantaneous water heaters (EIWH) 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 (zero-load) losses are neglected.

First, static electric power losses are measured (Product of voltage and current) for the transformation from mains power supply to the electric resistance heating element at nominal load after at least 30 minutes of operation at this nominal load. For electronic instantaneous water heaters the voltage between the power terminals of the triacs is subtracted from the measured voltage. The measuring equipment should respond fast enough to enable correct measurement of power, including reactive power. Measurement can be done with measuring devices shall operate in their optimal measurement range and use a measurement time interval as long as necessary to attain reliable results.

Second, the time tstarti is measured, which elapses between energizing the heating element and the moment the Product delivers useful water, i.e. reaches specific Tmi values at flow rates fi, for each draw-off i for the load profile. For each combination of Tmi and fi at least three measurements shall be done; the resulting tstart is the mean value from these measurements.

The value of Qelec shall be calculated as follows:

$$Q_{elec} = \frac{V_1 \times I_1}{V_2 \times I_2} \times \left[Q_{ref} + \sum_{i=1}^{n} wh \times tstart_i \times \left(Tm_i - Tcold \right) \times f_i \right]$$

where

- V_1, V_2 are voltages of mains power supply (V_1) and electric heating element (V_2) respectively, measured across the terminals and the connectors of the heating elements, in Volts;

- I_1, I_2 are electric currents of mains power supply (I_1) and electric heating element (I_2), measured for each phase, in Ampere;

- *wh* is specific heat of water: 0,00116 kWh/litre.K;

- *n* is total number of draw-offs in the load profile;

- *i* is index of draw-off in the load profile;
- $tstart_i$ is time elapsed between energizing the heating element and the moment the Product delivers useful water for draw-off *i*, in h;
- Tm_i is the temperature from which counting of useful energy content starts for draw-off *i*, in ºC;
- *Tcold* is the cold water inlet temperature 10 ºC.

f_i [in kg/h] is the flowrate specified for draw-off *i* in the load profile (from Table 2, with 1 l/min= 1/3600 kg/h). If this flow rate is lower than the minimum flow rate specified by the manufacturer, the latter shall be used..Permissible deviations from general conditions for measurement are specified in Section 2.2.4. Water pressure (dynamic) at the water inlet shall be within the range indicated by the manufacturer. Mounting/positioning of appliance shall be done according to manufacturers instructions. The minimum measurement accuracies are specified in Section 2.2.2 and 2.2.4.

7. SMART CONTROL TEST PROCEDURE FOR ELECTRIC INSTANTANEOUS WATER HEATERS

This procedure applies only to Electric Instantaneous Water Heaters (EIWHs). It comprises control to supply the desired/required power to the water heating system by means of:

1. Power control capable of switching any required power between at least 50% and maximum rated power with a maximum power resolution of 200W depending on flow rate and water temperature to minimize power consumption;
2. devices to detect at least the flow rate and the inlet or outlet temperature;
3. 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.

Eligibility for the smart control bonus (parameter *dhwsmart*=1) is checked by measurement of the input power at minimum 5 different operating points (outlet water temperature and flow rate) within the specified operating range whereas the operating points should be selected at equidistant points in terms of input power, distributed over the variable power part at a tolerance of ±10%.

8. SOLAR WATER HEATERS, TESTING AND CALCULATION METHODS

8.1 Scope

For the assessment of the solar energy contribution Qsol in kWh/d the following methods are applicable

- The *SOLCAL* method[6]

- The *SOLICS* method[7]

- The *SOLSIM* method[8];

The *SOLCAL* and the *SOLSIM* methods have in common that the efficiency parameters of the solar collector have to be assessed separately and that the overall system performance has to be determined on the basis of the solar contribution of the solar system and the specific efficiency of a stand-alone water heater.

8.2 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 efficiency at the test point *eta* [9] . If possible, one inlet temperature shall be selected with $t_m = t_a \pm 3K$ to obtain an accurate assessment of the zero-load efficiency eta_0. With fixed collector (no automatic tracking) and test conditions permitting, two test samples should be done before solar noon and 2 after. Maximum temperature of the heat transfer fluid (i.e. the top of the operating range) shall be >80ºC. [10]. The recommended maximum value of the reduced temperature difference T^*_m is >0,09 m^2KW^{-1}. The flow rate during the tests is a given in Table 4).

For the instantaneous collector efficiency eta a continuous efficiency curve of the format as in [Equation 1] below shall be obtained by statistical curve fitting of the test point results, using the least square method.

$$eta = eta_0 - a_1 \times T^*_m - a_2 \times G\,(T^*_m)^2 \qquad \text{[Eq. 1]}$$

where

- eta_0 is the zero-loss collector efficiency (*eta at* T^*_m=0), reference to T^*_m [-] ;

- a_1 is the heat loss coefficient at $(T_m - T_a) = 0$ (first order coefficient), in $Wm^{-2}K^{-1}$;

- a_2 is the temperature dependence of the heat loss coefficient (second order coefficient) , in $Wm^{-2}K^{-1}$;

- T^*_m is the reduced temperature difference in m^2KW^{-1}

with

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6 EN15316-4-3, B based method

7 ISO 9459-5 based method

8 EN13203-3 based method

9 the instantaneous efficiency *eta* in a test is measured from the product of *flowrate*, temperature increase over the collector and the specific heat of water divided by the solar irradiance input during the test.

10 For instance, with water filled collectors and a test at Ta = 10 °C appropriate test values of T_{in} could be 10-35-60-85 °C

$T^*_m = (t_m – t_a)/ G$ [Eq. 2]

Here:

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

$t_m = t_{in} + 0,5 \times \Delta T$ [Eq. 3]

where

- t_{in} is the collector inlet temperature
- ΔT is temperature difference between fluid outlet and inlet ($= t_e – t_{in}$)[11].

Unless specified differently, all tests shall be performed according to EN 12975-2; 2006, 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 shall be determined in accordance with EN 12975-2.

8.3 SOLCAL method

The SOLCAL method requires

- Collector parameters *Asol*, eta_0, a_1, a_2 and *IAM*;
- The solar (part of the) storage tank volume *Vsol* in litres and specific standing loss psbsol in W/K (K expresses the difference between store and ambient temperature);
- The auxiliary electric power consumption at stabilised operating conditions *solaux*;
- The power consumption in standby-mode *solsb*.

The calculation assumes default values for the specific insulation of the collector loop pipes (0,3 W/Km), the pipe length of that loop (6m) and the heat capacity of the heat exchanger (100·*Asol* W/K). Furthermore, the smart control shall not apply (*smart*=0) and the waste heat recovery is already taken into account (Q_{rwaste}=0).

For the purpose of establishing the total energy efficiency performance of solar preheat system and back-up heater as defined in paragraph 7.5, the method determines the annual solar contribution *Qsol* in kWh/a primary energy with

Qsol=*Lsolwh* – *Qaux* – *Qbuf* in kWh/a

where

Lsolwh is the annual solar energy captured in kWh heat/a;

with *Lsolwh*= SUM($Lsolw_{tm}$)

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[11] t_e is the collector outlet (exit) temperature. Note: t_{in} and t_e were previously known as $T_{c,in}$ and $T_{c,out}$ in the 2001 Edition of EN 12975-2

SUM($Lsolw_{tm}$) is sum of the monthly net solar energy captured,

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

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

qdistri is the fraction of hot water distribution losses with $qdistri = Q_{distref}/Q_{ref}$, where $Q_{distref}$ is given in Table 7;

X_{tm} is an aggregated coefficient which for Lwhtm>0 is
$X_{tm} = usesolw \cdot Asol \cdot (a_c + UL) \cdot etaloop \cdot (Trefw - Tout_{tm}) \cdot ccap \cdot 0{,}732 / Lwh_{tm}$
under the boundary condition that if $X_{tm}<0$ then $X_{tm}=0$ and if $X_{tm}>18$ then $X_{tm}=18$ and
where

$usesolw_{tm}$ is utilisation factor with default value $usesolw_{tm} = 1$
$a_c = a_1 + a_2 \cdot 40$,
where

a_1 is the primary coefficient;
a_2 is the secondary coefficient;

$UL = 6 \cdot 0{,}3 / Asol$ is loop losses in W;
$Trefw = 11{,}6 + 1{,}18 \cdot 40 + 3{,}86 \cdot Tcold - 1{,}32 \cdot Toutm_{tm}$
where

Tcold is cold water temperature, default 10 °C ;
$Toutm_{tm}$ is average monthly daytime temperature , given for the Average climate in Regulation …, Annex II, Table 3 and for the Warmer and Colder climate conditions in Regulation …, Annex VI, Table 3
ccap is storage coefficient with $ccap = (75 \cdot Asol/Vsol)^{0,25}$;

Y_{tm} is an aggregated coefficient, which for $Lwh_{tm}>0$ is
$Y_{tm} = usesolw_{tm} \cdot Asol \cdot IAM \cdot eta_0 \cdot etaloop \cdot qsolm_{tm} \cdot 0{,}732 / Lwh_{tm}$
under the boundary condition that if $Y_{tm}<0$ then $Y_{tm}=0$ and if $Y_{tm}>3$ then $Y_{tm}=3$ and where

etaloop is loop efficiency with $etaloop = 1 - (eta_0 \cdot a_1)/40$
$qsolm_{tm}$ is the average monthly global solar irradiance in W/m² ,given for average climate conditions in Annex II, Table 4 of Regulation …, and for warmer and colder climate conditions in Annex VI, table 10 of Regulation …

For the SOLICS method more detailed data for qsolmtm and Touttm may be used, in accordance ISO 9459-5;2007, while the monthly averages shall be within +2% of the values mentioned in tables 9 and 10 above.

<u>Storage tank</u>

$Qbuf = SUM(Qbuf_{tm})$

$Qbuf_{tm} = usesolw_{tm} \cdot Psbsol \cdot (Tstore - Ta)) \cdot 0{,}183$
where

$Qbuf_{tm}$ is the solar storage tank correction in kWh/month;
Tstore is average storage temperature, default for water heating *Tstore*=60 °C;
Ta is the monthly average air temperature surrounding the heat store in °C,
with

Ta=20 if *POS*=1 and
$Ta=Tout_{tm}$ if *POS*=0;

Psbsol is specific standing loss of solar storage tank in W/K as established in accordance with paragraph 9.1;
0,183 is a factor that takes into account the average monthly hours *(24 * 30,5=732),* the conversion from W to kW *(factor 0,001),* a solar fraction of 50% with a 50% correction for heat recovery and efficiency upgrade at colder inlet temperatures (*0,5 * 0,5=0,25)*

Auxiliary energy

$Qaux = prim \cdot (solpump \cdot solhrs + solsb \cdot 24 \cdot 365) / 1000$
where

solhrs is the number of active solar hours in h,
with

solhrs=2000 for solar water heaters and
solhrs= 1165 for solar combi systems;

8.4 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 shall be mounted according to ISO 9459-5:2007, paragraph 5.1
- The test facility, instrumentation and sensor locations shall be 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, shall be 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:
    - o Climate date for the Average climate according to Annex II, Tables 3 and 4 and for the Warmer and Colder climates according to Tables 3 and 4 of Annex VI of Regulation … and 10 (tilt angle of the collector = 45^{o}, orientation of the collector: south)

- Mains water temperature: 10 ^{o}C
    - Ambient temperature of the store (buffer inside: 20 ^{o}C, buffer outside: ambient temperature)
    - Auxiliary power: By declaration, following references as given in Table 1 of this communication
    - Auxiliary set temperature: By declaration and with a minimum value of 60 ^{o}C
    - Auxiliary heater time control: By declaration
- The annual performance of the solar system is presented as:
    - For solar preheat systems: The heat delivered by the solar heating system (Q_L) in kWh/a.
    - For "solar plus" supplementary system: The difference between the heat demand (Q_D) and the net auxiliary energy demand ($Q_{aux,net}$), giving Q_L in kWh/a. When the system fails to meet one or more of the heat demands (Q_D), these values are not applicable.

The annual solar contribution *Qsol* in kWh/a for further calculations is established as follows:

$Qsol = Q_L - Qaux$

where *Qaux* is calculated as indicated in paragraph 7.3.

8.6. SOLSIM method

The SOLSIM method entails a 24-hour whole product test of solar collector emulator, tank, pump, back-up heater and controls, whereby a solar collector simulator is used, i.e. typically an electric resistance immersion heater in the circuit replacing the solar collector. This device mimics the heat output of the solar collector when exposed to the 24h solar cycle in the table below.

For this, first the characteristics eta0, a1, a2 and IAM of the solar collector have to be established, in accordance with the provisions in the previous paragraph.

Secondly, from the relevant characteristics the net output power of the simulator for any given time of the solar cycle (synchronous with the measurement cycle) is calculated , using the solar collector equations ‘ in reverse’ and the defined global solar irradiance values G* as defined in the table below.

$$P_{sim,HE} = A_a \cdot eta \cdot G^* \quad \text{[Eq. 1]}$$

where

- $P_{sim,HE}$ is the heating output of the heating element to simulate the real solar collector field, in W;

- *eta* is the instantaneous collector efficiency, with reference to $T^*_{m,}$, defined as in the previous paragraph (Equations 1 to 3) and subject to the condition that if eta<0 then eta=0;

– G^* is the global radiation on collector (solar cycle data), in W/m², as given for an Average climate in Annex II, Table 2 of Regulation …, and Annex VI, Table 2 of Regulation …and for warmer and colder climate conditions.

Notes:

[1]	Accuracy of measurement 10 W/m². Maximum permissible deviation of the simulator for a single period 5%. Maximum permissible deviation for Gtotal 5%. Correction factor *KG* shall be applied to the output, to correct for difference between actual and required irradiance: *KG* = Gtotal [required] / Gtotal [actual test]
[2]	Applicable outdoor temperatures throughout the 24 h test for the 3 climate test conditions | | | **C** | 5,5 ºC | **W** | 16 ºC | Accuracy of measurement 0,5 K. Maximum permissible deviation from set values ± 2 K (average over test period). Maximum permissible deviation from average ± 1 K.

After the collector tests and the calculation the net power output of the simulator shall replace the solar collector in the test configuration. The net power output is given for the whole collector aperture area *Asol*. The sum of net power output per hour is summed over 24h and the outcome is $Qsol_A$ in kWh for the average climate. For Colder and Warmer climate conditions it is referred to as $Qsol_C$ and $Qsol_W$ respectively.

The actual power input of the simulator for electric losses and thermal losses of the simulator shall be determined in the test rig. . The simulator – and storage vessels or other parts designated to be used outdoors - shall be tested at outdoor conditions (temperatures) for average, colder and warmer climate conditions. Unless indicated that all parts of the Product are to be used outdoors (parameter *POS*), the storage vessels and back-up heaters are tested at indoors conditions.

In order to determine Q_{elec} or Q_{fuel} of the back-up water heater, the 'iterative test procedure' as specified above applies, using the designated load profile at 60% of Q_{tap} for each water draw-off

9. Storage tank test procedures

9.1 Standing losses storage tanks, test and calculation

The standing heat losses of storage tanks can be assessed using any of the methods referenced in Table 1. This applies to the variable *S* for storage tanks, as well as the declared heat pump storage tank standing losses *Psbhp* and the standing losses of the solar (part of the) storage tank *Psbsol*. Where the measurement results from the applicable standards are expressed in kWh/24h, the result will be multiplied by (1000/24) to arrive at values for S and Psbhp 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

(*Tstore*=65 °C, *Tambient*=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* or *Psbhp* they shall be multiplied by 45.

9.2 Storage volume test procedure

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 and the result stated in litre, to the nearest one-tenth litre.

9.3 Assessment of designated position, air intake, envelope volume, energy source and solar pump power

The designated position POS of the water heater is an input for the assessment of Qrwaste in part 2, section 3 of this communication. The designated position of single package water heaters is indoors (POS=1), unless the manufacturer specifically indicates that its intended use is outdoors (Pos=0). For multi-package water heaters, such as solar water heaters and some types of heat pump water heaters, with one package indoors and another outdoors the value POS is 0,5.

The air-intake of a water heater is an input for the assessment of Qdistr in part 2, section 3 of this communication. If the water heater is not fossil fuel fired, the air-intake is 'none'. If the water heater is fossil fuel fired and takes its combustion air directly from outdoors through a dedicated duct, the air-intake is 'room-sealed', otherwise it is 'open'.

The envelope volume is an input in section 3 of this communication.. The water heater envelope is to be measured without duct- and pipework, but otherwise fully prepared for operation. In case of multi-package water heaters with one package outside and one package indoors, the envelope volume of only the indoor unit shall be declared.

The designated energy source is an input in section 3. Its value is 'electric' if the water heater uses no fossil fuel, otherwise it is 'fossil fuel'.

The solar pump power is the rated electrical power of the solar pump, unless the pump flow rate can be controlled in at least 3 steps. In the latter case, the applicable solar pump power is 50% of the rated electrical power of the solar pump.