Project ECOTEST Deliverables D8.4 Analysis of the results and report D8.5 Proposal to CEN and communication	ECOTEST ECO_WP8_XXX_WP8-RRT4_V2

WP	WP 8 Solar Collector
Type	Annex to WP8 final report
Title	**Annex 1.4** **Extended RRT results and analysis** **RRT4 SWH System (EN 12976 / ISO 9459-5)**
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Dissemination	Free

Version	Status	Date	Comments
A	Internal for discussion in the WP	16.12.2018	
B	Version sent as progress report Dec. 2018		
C	Version sent as progress report Feb. 2019	26.02.2019	
D	Final version after steering group meeting for approval by WP8 testing laboratories	09.05.0219	
E	Final	02.06.2019	

Table of contents

1 Introduction

1.1 Context of the test

For the RRT4 a standard solar water heart system was circulated between the testing laboratories. The store is the same that used in RRT2. The two solar collectors are the same model as circulated in RRT1. All the collectors are coming from the same delivery and should therefore be as identic as possible.
The delivery of the system was delayed as a results of some misunderstandings. Usually solar water heaters are tested outdoor during summer time and there are requirements on minimum daily irradiations for some test sequences which can't be met in many places in Europe during winter months. This is however a rather basic problem for industry if testing cannot be done during the whole year. These minimum requirements are not well explained or justified. To deliver the results of the RRT in time, the last laboratory of the RRT had to make some of the tests with conditions not completely matching the requirements. This is considered as a chance to evaluate the impact of testing during winter time.

1.2 Time period

The test have started in February 2018 and were finished with some delay end of January 2019.

1.3 Laboratories involved

The following labs have been involved in the test of the system:

The following labs have been involved in the test of the collector:

ISE
TestLab Solar Thermal Systems
Division Thermal Systems and Building Technologies (TSB)
Fraunhofer-Institut für Solare Energiesysteme ISE
Heidenhofstrasse 2, 79110 Freiburg, Germany

SPF
SPF Institute for Solar Technology
Hochschule für Technik Rapperswil HSR
Oberseestrasse 10, 8640 Rapperswil, Switzerland

IGTE/ITW
Institute for Building Energetics, Thermotechnology and Energy Storage (IGTE)
Former Institute of Thermodynamics and Thermal Engineering (ITW)
Research and Testing Centre for Thermal Solar Systems (TZS)
University of Stuttgart
Pfaffenwaldring 6, 70550 Stuttgart, Germany

2 Appliance tested

2.1 Main features of the appliance tested.

The system consist of the store which was circulated in WP8-RRT2, with two collectors as circulated in WP8-RRT1. The two collector were selected from the four collectors which were used in WP8-RRT1. The description of the store and the collectors is found in the corresponding RRT reports. The test laboratories installed the system according the installer manual of the supplier of the complete system. Even if the collectors and the store are separable, the whole system was offered by the manufacturer as a complete package including the controller. All components are from the same manufacturer. The system for RRT4 is based on two collectors which is very typical for a 2-4 persons household, the same system (store) could however be operated also with three collectors of this type for higher solar yield.

2.2 Picture of the SWH system

Figure 1: The pair of collectors installed at two of the testing laboratories.

2.3 Origin of appliances used for the RRT

The collectors of the solar water heater were donated by a German manufacturer (see RRT1), the store was made available by one of the participating test laboratories (See RRT2). Both without further expectations.

3 Testing programme & testing equipment of labs

3.1 Programme

The solar water heater systems were tested according to the standard EN 12976-1 and EN 12976-2. The EN 12976 allows for using two different test procedures for thermal performance testing which are described in ISO 9569-2 (CSTG method) and in ISO 9459-5 (DST method). The DTS method is used by most test laboratories nowadays as it can be used for "Solar-plus-supplementary systems" as well as for "Solar-only and preheat systems". Furthermore the DST method is considered as less time consuming and less demanding with respect to the required weather conditions. For this reason the DST method was also used in this RRT. The difference between the methods was investigated some time ago in a European project called "bridging the gap" (Final report is filed as Eco test document ECO_WP8_046_Bridging the gap_final_report.pdf) and does not require further discussion here.

Following the standard ISO 9459-5 the system is installed close to a realistic situation. The store is inside a climate controlled room and the collectors installed outdoors. The test method consists of several test sequences with well-defined taping profiles and minimum requirements on the solar irradiance on the collectors. The main sequences are the following:

S-sol: A test sequence containing a number of consecutive days of measurement with significant solar input. The test sequence has to include daily operation conditions named **Test A** and **Test B**. During the Test A-days information about collector array performance at high efficiencies is being acquired. This is achieved by draw-offs designed to keep the collector inlet cold. The draw-offs specified for Test B days are designed to allow the system to become as hot as possible for as long as possible, while avoiding overheating of the store. The aim of this test is to acquire information about store heat losses and collector array performance at low efficiencies.

S-store: A store-loss test sequence.

S-aux: A test of the operation of the system with an integrated auxiliary heater under low solar irradiation conditions.

Similar to the store test sequences the system is conditioned (i.e. flushed until there is no temperature difference between in- and outlet) at the beginning to provide a well-defined initial system state. The test sequences are terminated as well by the same conditioning sequence to evaluate the energy and the temperature profile contained in the system.

The conditioning takes place during the night (or with covered collector surface) and with disabled auxiliary heating.

During the test sequences the measured data are the following, depending on eth variability with a repetition rate between 2 and 30 seconds

- Mains-water temperature
- T_S [°C] Store outlet temperature
- V_S [l/min] Volumetric draw-off rate
- P_{aux} [W] Auxiliary power
- G_t [$W \cdot m^{-2}$] Hemispherical irradiance
- T_{ca} [°C] Collector ambient air temperature
- T_{sa} [°C] Storage-tank ambient air temperature
- v [$m \cdot s^{-1}$] Surrounding air velocity

3.2 Test protocol(s) used

The test protocol used by all the test laboratories is following the standard EN 12976-1 and EN 12976-2 referencing to ISO 9459-5 (DST). The testing procedure is described in the ISO standard. The presentation of the system performance and conversion into ErP parameters is described in the Annexes of the EN 12976-2 and the transitional documents. In this WP8-RRT4 the SOLICS method as described in the transitional methods (2014/C 207/03) is used.

3.3 Overview of the main test equipment used by labs

The participating testing laboratories use tailor-made own test rigs and different sensors which are in full compliance with all the requirements of the EN 12976-2 and ISO 9459-5.

3.4 Test conditions

The test conditions are defined in the ISO 9569-5 for each of the test sequences described above. There are rather strict requirements especially concerning the daily irradiation which must be higher than ≥12MJ/m^2 for a valid test A.

Other requirements must be met depending on the test cycle and the appliance under test. This limits the applicability of the standard for central European testing laboratories to the summer months. For the industry this limitation is a severe problem as testing cannot be offered over the whole year. For northern countries the standard is almost not applicable. For this reason one of the test laboratories was performing the tests into winter months to check whether this restrictions with respect to the radiation are really necessary.

3.5 Other

The analysis of the test data requires a specific software[1] which is modelling the system[2] and which includes also a parameter identification procedure and the so called Long Term Prediction (LTP) procedures. This software was developed in the 1990s and was not developed further since then and is still running on XP computers. All the testing laboratories for EN 12976 therefore use this software as it is referenced in the ISO 9459-5.

[1] InSitu Scientific Software. Dynamic System Testing Program (Version 2.6). ISS, Kriegerstr. 23 d, D-82110 Germering, 1996.

[2] General model for testing solar domestic hot water systems, W.Spirkl and J.Muschaweck, Elsevier Solar Energy Materials and Solar Cells, Volume 28, Issue 1, October 1992, Pages 93-102

4 Definitions used for the statistical analysis (common to ECOTEST)

1. Median value
   The values are ranked from the smallest to the highest or from the highest to the lowest then the value just in the middle is the median value (if the number is odd) and arithmetic average of n/2 and (n/2+1) if n is even
2. Deviation from median value (Delta)
   Difference between any value and the median value
3. Arithmetic mean value
   Arithmetic mean of all value (sum of all values divided by the number of values)
4. Deviation from arithmetic mean value
   Difference between any value and the arithmetic mean value
5. Repeatability standard deviation sr
   The standard deviation of the values measured by each lab (in the column of each lab) and the standard deviation of all the values (in the column "total of all the labs)
6. Reproducibility Standard deviation (*) sR
   The standard deviation of the arithmetic values (if repeatability tests performed) or the value declared by each lab if no repeatability tests
7. Difference between maxi and mini arithmetic mean values.
   The difference between the maximum arithmetic average value and the minimum arithmetic average value (if repeatability test are done) or just the difference between the maximum value and minimum value of the declared values.

5 Measurement results of laboratories, statistics and analyse.

5.1 Overview Table of data measured

In this chapter the test results of the three participating test laboratories are presented as received. The laboratories are name 1, 2, 3 to avoid linking to the M, S, and T that are used in the text.

5.1.1 Solar water heater performance

Solar water heater data

LABORATORY		1	2	3	
EN 12976-1 / EN 12976-2 / ISO 9459-5					
Effective collector area	**A_C***	3.298	3.689	3.395	m^2
Effective collector loss coefficient	**u_C***	6.962	8.087	13.49	Wm^2/K
Total store heat loss coefficient	**U_S**	4.477	2.17	2.562	W/K
Total store heat capacity	**C_S**	1.587	1.524	1.434	MJ/K
Fraction of the store used for auxiliary heating	**f_{aux}**	0.454	0.3964	0.5	--
Mixing constant	**D_L**	0.02627	0.1208	0.02265	--
Stratification parameter	**S_C**	0	0	0.003368	--
Thermal resistance of load heat exchanger	**R_L**	-	-	-	K/W
M1 - Q_{nonsol} - av. climate cond. - load profile M	**Q_{nonsol}**	640	418	702	kWh/a
M2 - Q_{nonsol} - av. climate cond. - load profile M	**Q_{nonsol}**	640	418	702	kWh/a
M3 - Q_{nonsol} - av. climate cond. - load profile M	**Q_{nonsol}**	640	418	702	kWh/a
M4 - Q_{nonsol} - av. climate cond. - load profile M	**Q_{nonsol}**	641	419	703	kWh/a
M1 - Q_{nonsol} - av. climate cond. - load profile L	**Q_{nonsol}**	1139	871	1296	kWh/a
M2 - Q_{nonsol} - av. climate cond. - load profile L	**Q_{nonsol}**	1139	906	1296	kWh/a
M3 - Q_{nonsol} - av. climate cond. - load profile L	**Q_{nonsol}**	1139	871	1296	kWh/a
M4 - Q_{nonsol} - av. climate cond. - load profile L	**Q_{nonsol}**	1143	902	1301	kWh/a
M1 - Q_{nonsol} - av. climate cond. - load profile XL	**Q_{nonsol}**	1726	1375	1927	kWh/a
M2 - Q_{nonsol} - av. climate cond. - load profile XL	**Q_{nonsol}**	1953	1752	2208	kWh/a
M3 - Q_{nonsol} - av. climate cond. - load profile XL	**Q_{nonsol}**	1726	1375	1927	kWh/a
M4 - Q_{nonsol} - av. climate cond. - load profile XL	**Q_{nonsol}**	1961	1756	2203	kWh/a
M1 - Q_{nonsol} - av. climate cond. - load profile XXL	**Q_{nonsol}**	2137	1743	2391	kWh/a
M2 - Q_{nonsol} - av. climate cond. - load profile XXL	**Q_{nonsol}**	2759	2558	3075	kWh/a
M3 - Q_{nonsol} - av. climate cond. - load profile XXL	**Q_{nonsol}**	2137	1743	2391	kWh/a
M4 - Q_{nonsol} - av. climate cond. - load profile XXL	**Q_{nonsol}**	2757	2553	3081	kWh/a
Parasitic energy	**Q_{par}**	471.2	485.9	367.8	MJ
Power consumption pump	**$P_{solpump}$**	54.5	56.1	39.3	W
Standby power consumption controller	**P_{solsb}**	2.5	2.6	2.6	W
Annual auxiliary electricity consumption	**Q_{aux}**	130.9	135.0	102.2	kWh/a

Table 1: Measured parameters submitted by the participating test laboratories (final results)

M1: The auxiliary heating power is set to a fixed value of 17.6 kWh and $Q_{nonsol} = Q_{aux,net}$

M2: The auxiliary heating power is set to a fixed value of 17.6 kWh and $Q_{nonsol} = Q_{demand} – Q_{Sol}$

M3: The auxiliary heating power is set to the recommended value of 100 W per litre of auxiliary heated volume f_{aux} as determined by the EN12976:2017 Table B.1. and $Q_{nonsol} = Q_{aux,net}$

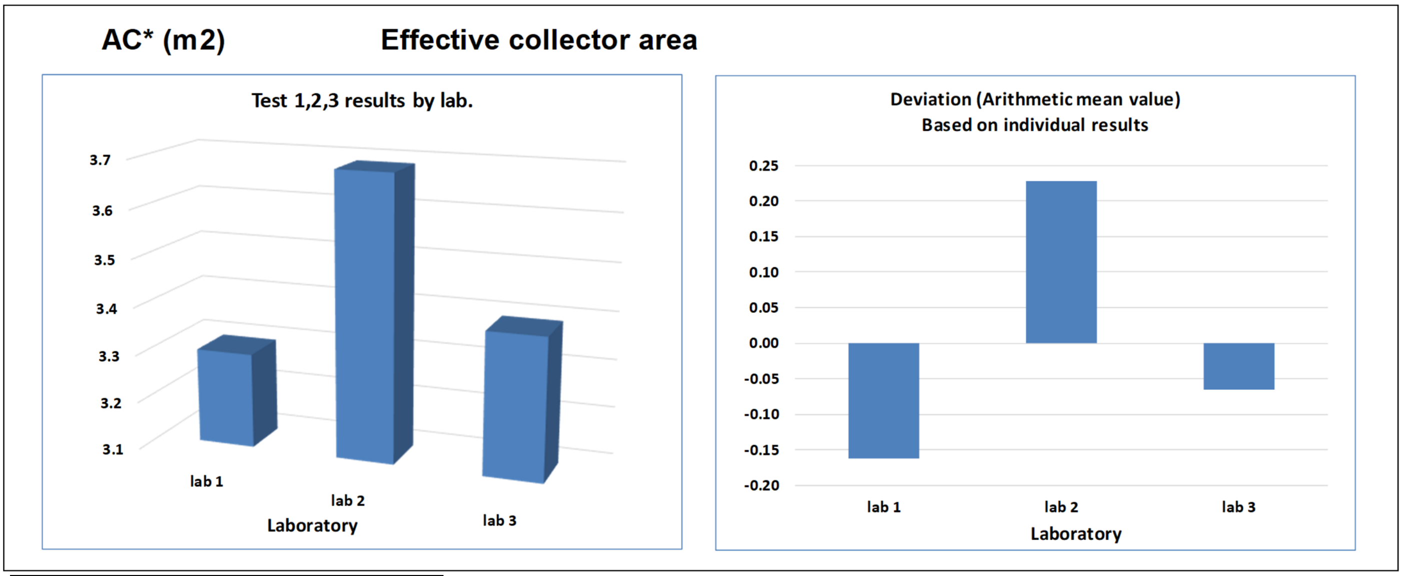
M4: The auxiliary heating power is set to the recommended value of 100 W per litre of auxiliary heated volume f_{aux} as determined by the EN12976:2017 Table B.1. and $Q_{nonsol} = Q_{demand} – Q_{Sol}$

5.2 Statistics on the main parameters

In this chapter the relevant parameters as determined by the participating testing laboratories are presented in the standard format required by the ECOTEST project. Comments and explanations in chapter 7. As there were only three testing laboratories the statistical relevance of the presented numbers is limited. Using directly these data for statistical purposes is not appropriate and should be avoided.

5.2.1 Effective collector area Ac*

Parameter	A_C* (m2)	Effective collector area		
universal statistical evaluation v3.4.SLG by ACLi	Total over all labs	lab 1	lab 2	lab 3
test result 1	Test1	3.298	3.689	3.395
Number of test results		1	1	1
Median value	3	3.30	3.69	3.40
Deviation from median value (Delta)		**-0.10**	**0.29**	**0.00**
Arithmetic mean value	3	3.30	3.69	3.40
Deviation from arithmetic mean value		**-0.16**	**0.23**	**-0.07**
Repeatability standard deviation s_r	-	-	-	-
Reproducibility Standard deviation (*) s_R	0.204			
Max - Min (arithmetic mean value)	**0.391**	Diff between max and min of the arithmetic means measured by all labs		
Max - Min (arithmetic mean value)	**0.391**	Diff between the max and min of all measured values by all labs		
(*) based on the arithmetic mean values				
Between-lab consistency - assumed classif.	correct	correct	correct	correct

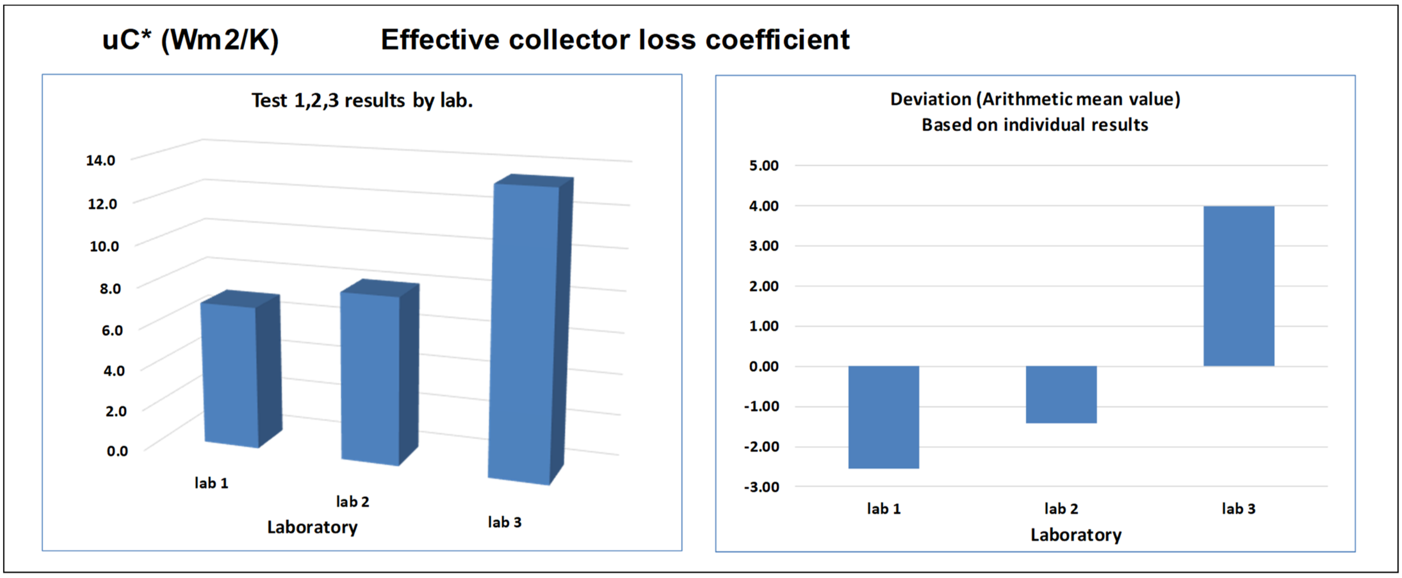


STATISTICS		
Median		3.395 m2
Arh. mean value		3.461 m2
R STD		0.204 m2
r STD	-	
Max - Min (M-m)		0.391 m2

*Figure 2: ECOTEST statistical representation of the results measured Ac**

5.2.2 Effective collector loss coefficient u_C*

Parameter	u_C* (Wm^2/K)	Effective collector loss coefficient		
universal statistical evaluation v3.4.SLG by ACLI	Total over all labs	lab 1	lab 2	lab 3
test result 1	Test1	6.962	8.087	13.490
Number of test results		1	1	1
Median value	8	6.96	8.09	13.49
Deviation from median value (Delta)		-1.13	0.00	5.40
Arithmetic mean value	10	6.96	8.09	13.49
Deviation from arithmetic mean value		-2.55	-1.43	3.98
Repeatability standard deviation s_r	-	-	-	-
Reproducibility Standard deviation (*) s_R	3.490			
Max - Min (arithmetic mean value)	6.528	Diff between max and min of the arithmetic means measured by all labs		
Max - Min (arithmetic mean value)	6.528	Diff between the max and min of all measured values by all labs		
(*) based on the arithmetic mean values				
Between-lab consistency - assumed classif.	correct	correct	correct	correct

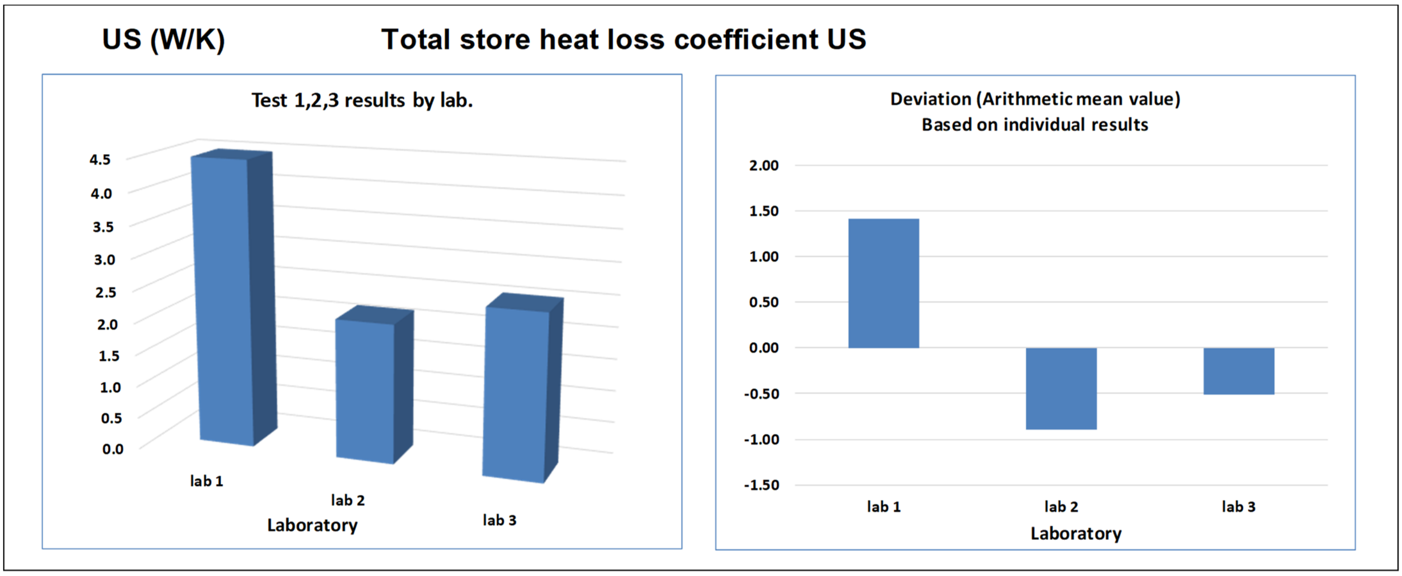


STATISTICS		
Median	8.087	Wm2/K
Arh. mean value	9.513	Wm2/K
R STD	3.490	Wm2/K
r STD	-	
Max - Min (M-m)	6.528	Wm2/K

*Figure 3: ECOTEST statistical representation of the results u_C**

5.2.3 Total store heat loss coefficient U_S

Parameter	U_S (W/K)	Total store heat loss coefficient US		
universal statistical evaluation v3.4.SLG by ACLi	Total over all labs	lab 1	lab 2	lab 3
test result 1	Test1	4.477	2.170	2.562
Number of test results		1	1	1
Median value	3	4.48	2.17	2.56
Deviation from median value (Delta)		1.92	-0.39	0.00
Arithmetic mean value	3	4.48	2.17	2.56
Deviation from arithmetic mean value		1.41	-0.90	-0.51
Repeatability standard deviation s_r	-	-	-	-
Reproducibility Standard deviation (*) s_R	1.234			
Max - Min (arithmetic mean value)	2.307	Diff between max and min of the arithmetic means measured by all labs		
Max - Min (arithmetic mean value)	2.307	Diff between the max and min of all measured values by all labs		
(*) based on the arithmetic mean values				
Between-lab consistency - assumed classif.	correct	correct	correct	correct



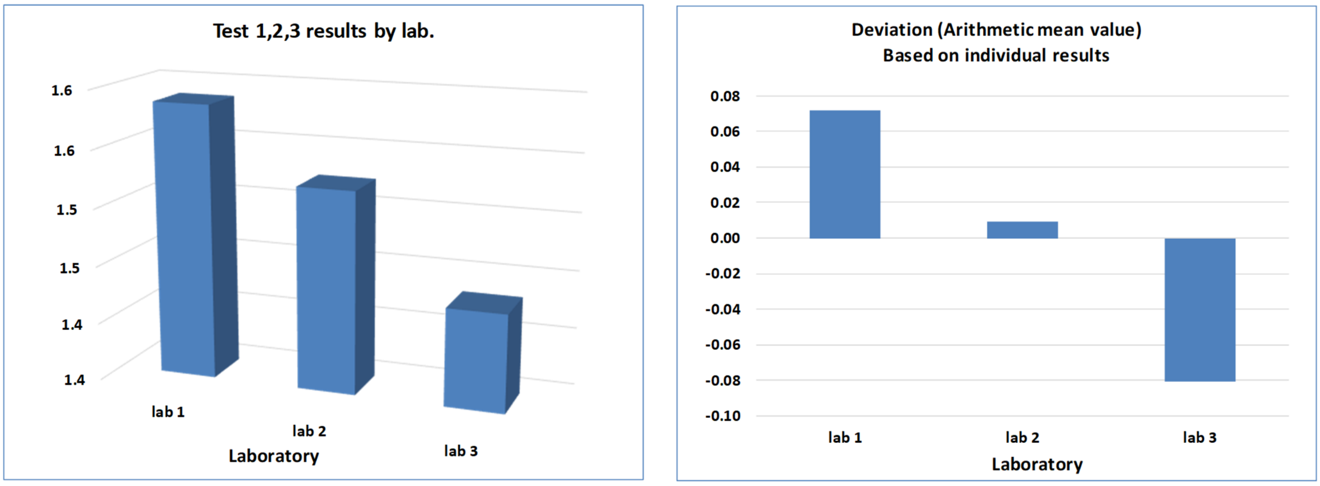
STATISTICS	
Median	2.562 W/K
Arh. mean value	3.070 W/K
R STD	1.234 W/K
r STD	-
Max - Min (M-m)	2.307 W/K

Figure 4: ECOTEST statistical representation of the results U_s

5.2.4 Total store heat capacity C_S

Parameter	C_S (MJ/K)	Total store heat capacity		
universal statistical evaluation v3.4.SLG by ACLi	Total over all labs	lab 1	lab 2	lab 3
test result 1	Test1	1.587	1.524	1.434
Number of test results		1	1	1
Median value	2	1.59	1.52	1.43
Deviation from median value (Delta)		0.06	0.00	-0.09
Arithmetic mean value	2	1.59	1.52	1.43
Deviation from arithmetic mean value		0.07	0.01	-0.08
Repeatability standard deviation s_r	-	-	-	-
Reproducibility Standard deviation (*) s_R	0.077			
Max - Min (arithmetic mean value)	0.153	Diff between max and min of the arithmetic means measured by all labs		
Max - Min (arithmetic mean value)	0.153	Diff between the max and min of all measured values by all labs		
(*) based on the arithmetic mean values				
Between-lab consistency - assumed classif.	correct	correct	correct	correct

CS (MJ/K) **Total store heat capacity**

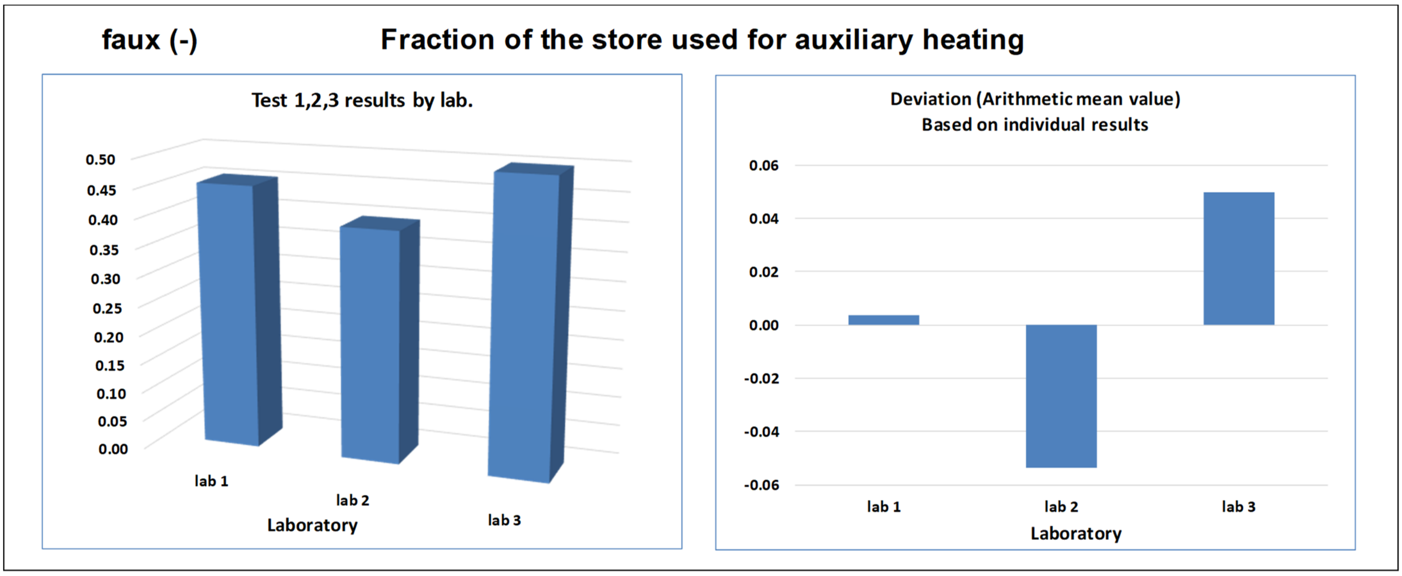


STATISTICS	
Median	1.524 MJ/K
Arh. mean value	1.515 MJ/K
R STD	0.077 MJ/K
r STD	-
Max - Min (M-m)	0.153 MJ/K

Figure 5: ECOTEST statistical representation of the results C_S

5.2.5 Fraction of the store used for auxiliary heating f_{Aux}

Parameter	f_{aux} (-)	Fraction of the store used for auxiliary heating		
universal statistical evaluation v3.4.SLG by ACLi	Total over all labs	lab 1	lab 2	lab 3
test result 1	Test1	0.454	0.396	0.500
Number of test results		1	1	1
Median value	0	0.45	0.40	0.50
Deviation from median value (Delta)		**0.00**	**-0.06**	**0.05**
Arithmetic mean value	0	0.45	0.40	0.50
Deviation from arithmetic mean value		**0.00**	**-0.05**	**0.05**
Repeatability standard deviation s_r	-	-	-	-
Reproducibility Standard deviation (*) s_R	**0.052**			
Max - Min (arithmetic mean value)	**0.104**	Diff between max and min of the arithmetic means measured by all labs		
Max - Min (arithmetic mean value)	**0.104**	Diff between the max and min of all measured values by all labs		
(*) based on the arithmetic mean values				
Between-lab consistency - assumed classif.	correct	correct	correct	correct

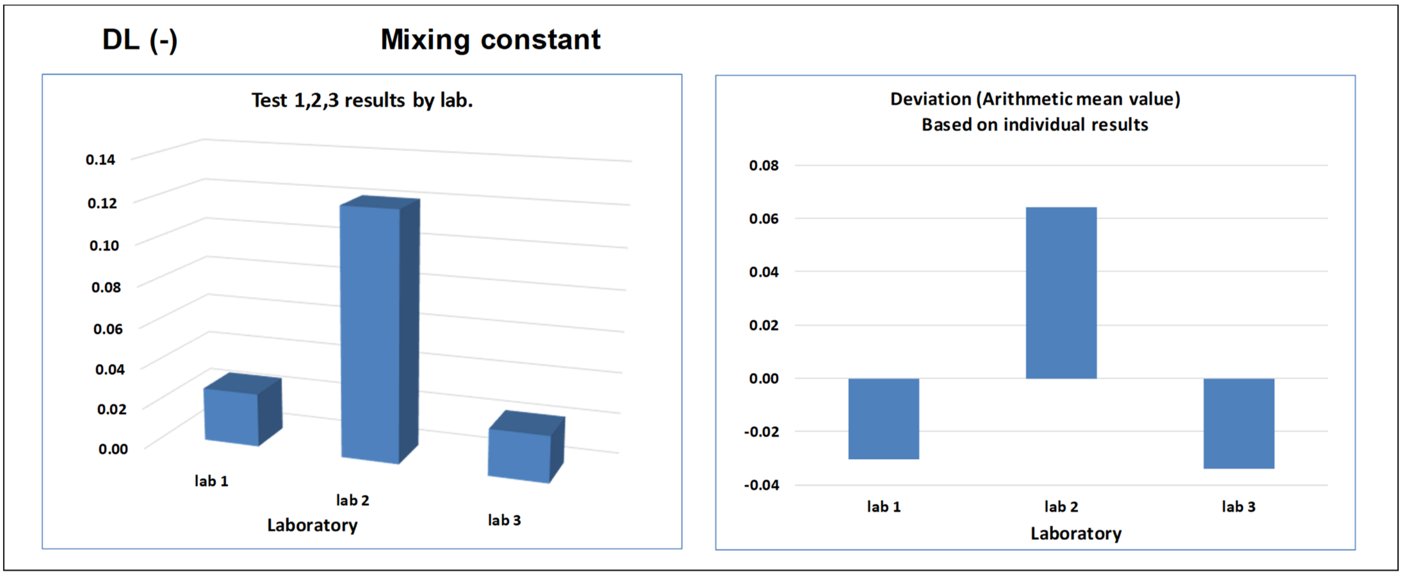


STATISTICS		
Median	0.454	-
Arh. mean value	0.450	-
R STD	0.052	-
r STD	-	
Max - Min (M-m)	0.104	-

Figure 6: ECOTEST statistical representation of the results f_{Aux}

5.2.6 Fraction of the store used for the mixing constant D_L

Parameter	D_L (-)	Mixing constant		
universal statistical evaluation v3.4.SLG by ACLi	Total over all labs	lab 1	lab 2	lab 3
test result 1	Test1	0.0263	0.1208	0.0227
Number of test results		1	1	1
Median value	0	0.03	0.12	0.02
Deviation from median value (Delta)		**0.00**	**0.09**	**0.00**
Arithmetic mean value	0	0.03	0.12	0.02
Deviation from arithmetic mean value		**-0.03**	**0.06**	**-0.03**
Repeatability standard deviation s_r	-	-	-	-
Reproducibility Standard deviation (*) s_R	0.056			
Max - Min (arithmetic mean value)	0.098	Diff between max and min of the arithmetic means measured by all labs		
Max - Min (arithmetic mean value)	0.098	Diff between the max and min of all measured values by all labs		
(*) based on the arithmetic mean values				
Between-lab consistency - assumed classif.	outlier	correct	outlier	correct

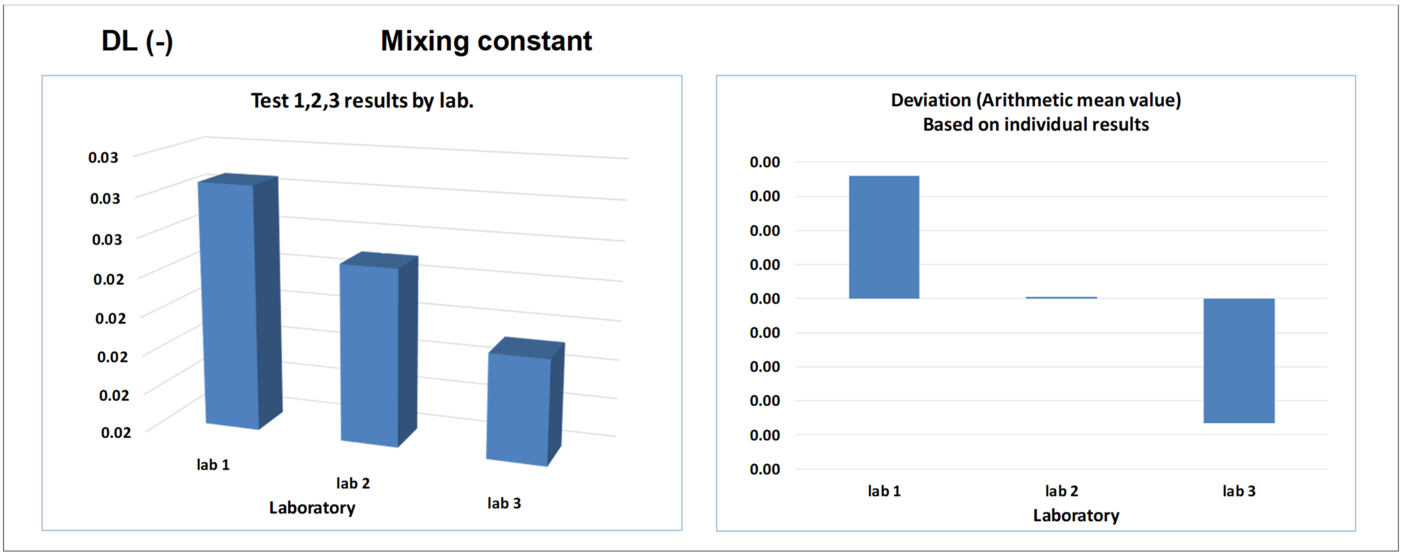


STATISTICS		
Median	0.026	-
Arh. mean value	0.057	-
R STD	0.056	-
r STD	-	
Max - Min (M-m)	0.098	-

Figure 7: ECOTEST statistical representation of the results D_L

5.2.7 Fraction of the store used for the mixing constant D_L (outlier removed)

Parameter	D_L (-)	Mixing constant		
universal statistical evaluation v3.4.5LG by ACLI	Total over all labs	lab 1	lab 2	lab 3
test result 1	Test1	0.0263	0.0245	0.0227
Number of test results		1	1	1
Median value	0	0.03	0.02	0.02
Deviation from median value (Delta)		0.00	0.00	0.00
Arithmetic mean value	0	0.03	0.02	0.02
Deviation from arithmetic mean value		0.00	0.00	0.00
Repeatability standard deviation s_r	-	-	-	-
Reproducibility Standard deviation (*) s_R	0.002			
Max - Min (arithmetic mean value)	0.004	Diff between max and min of the arithmetic means measured by all labs		
Max - Min (arithmetic mean value)	0.004	Diff between the max and min of all measured values by all labs		
(*) based on the arithmetic mean values				
Between-lab consistency - assumed classif.	correct	correct	correct	correct

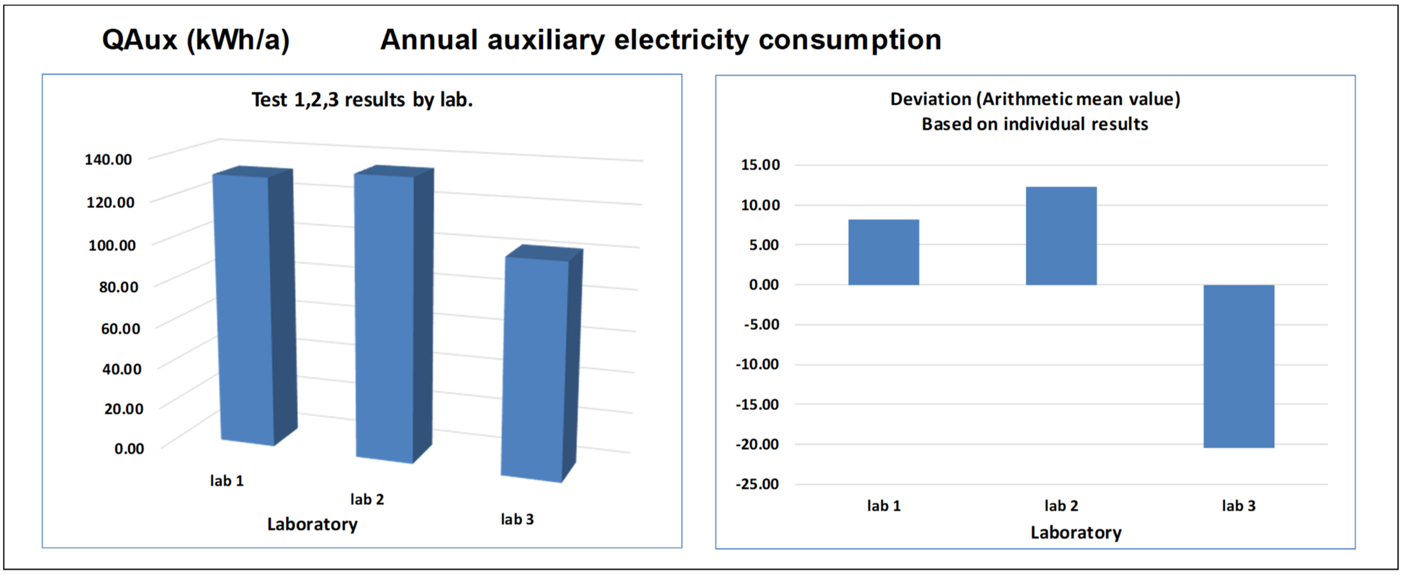


STATISTICS	
Median	0.025 -
Arh. mean value	0.024 -
R STD	0.002 -
r STD	-
Max - Min (M-m)	0.004 -

Figure 8: ECOTEST statistical representation of the results D_L without outlier results (see clause 7.1)

5.2.8 Auxiliary Electricity Q_{Aux}

Parameter	Q_{Aux} (kWh/a)	Annual auxiliary electricity consumption		
universal statistical evaluation v3.4.SLG by ACLi	Total over all labs	lab 1	lab 2	lab 3
test result 1	Test1	130.9	135.0	102.2
Number of test results		1	1	1
Median value	131	130.90	135.00	102.20
Deviation from median value (Delta)		0.00	4.10	-28.70
Arithmetic mean value	123	130.90	135.00	102.20
Deviation from arithmetic mean value		8.20	12.30	-20.50
Repeatability standard deviation s_r	-	-	-	-
Reproducibility Standard deviation (*) s_R	17.871			
Max - Min (arithmetic mean value)	32.800	Diff between max and min of the arithmetic means measured by all labs		
Max - Min (arithmetic mean value)	32.800	Diff between the max and min of all measured values by all labs		
(*) based on the arithmetic mean values				
Between-lab consistency - assumed classif.	correct	correct	correct	correct

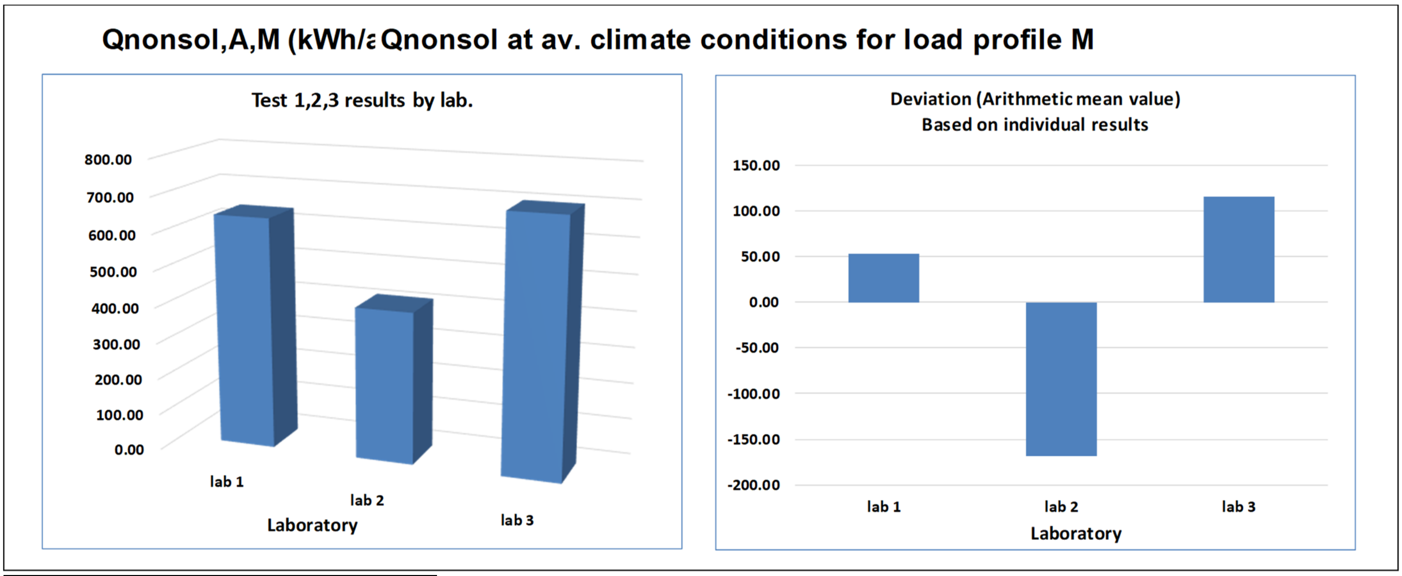


STATISTICS		
Median	130.900	kWh/a
Arh. mean value	122.700	kWh/a
R STD	17.871	kWh/a
r STD	-	
Max - Min (M-m)	32.800	kWh/a

Figure 9: ECOTEST statistical representation of the results Q_{Aux}

5.2.9 Q_{nonsol} for average climate conditions and load profile M (Method M3)

Parameter	$Q_{nonsol,A,M}$ (kWh/a)	Qnonsol at av. climate conditions for load profile M		
universal statistical evaluation v3.4.SLG by ACLi	Total over all labs	lab 1	lab 2	lab 3
test result 1	Test1	640	418	702
Number of test results		1	1	1
Median value	640	640	418	702
Deviation from median value (Delta)		0.00	-222.00	62.00
Arithmetic mean value	587	640	418	702
Deviation from arithmetic mean value		53.33	-168.67	115.33
Repeatability standard deviation s_r	-	-	-	-
Reproducibility Standard deviation (*) s_R	149.323			
Max - Min (arithmetic mean value)	284	Diff between max and min of the arithmetic means measured by all labs		
Max - Min (arithmetic mean value)	284	Diff between the max and min of all measured values by all labs		
(*) based on the arithmetic mean values				
Between-lab consistency - assumed classif.	correct	correct	correct	correct



STATISTICS	
Median	640.0 kWh/a
Arh. mean value	586.7 kWh/a
R STD	149.3 kWh/a
r STD	-
Max - Min (M-m)	284.0 kWh/a

Figure 10: ECOTEST statistical representation of the results for Q_{nonsol} at average conditions for the load profile M

6 Comments and explanation on the data tables of this report.

6.1 Introduction

The data from the table in this section are values sent by the laboratories. The data processing has been organised according the following work flow:

- Labs sending the RRT results (raw data tables) to the WPL- Reports V01
- WPL Preparing overview table and figures for discussion (not anonymous)
- WPL Physical WP meeting to discuss results and correct from possible issues
- Labs sending the RRT results to the WPL- Reports V02
- WPL organising the statistical analysis & RRT Report (anonymous)

Corrections were classified as in the following table and corrections have been made to correct for:

Class	Type	Impact on main results	To be reported in the correction journal	Example
0	Editorial	No impact	no	Use of W instead of kW or use of fraction of 1 instead of % but calculate correctly further on
1	Reporting error/ would not happen in normal reporting situation	Maybe	Yes, with explanation why it would not have happened in a normal situation. corrected data is given in the “after discussion” results, the original data given in the “before correction” results	Lab is using other excel evaluation or automated systems normally, error only occurred because labs were asked to use the RRT specific template
2	Misunderstanding of method/ procedure, due mainly to un-clarities in the standard	Maybe	Yes, with explanation how this can be avoided in future by introducing an improvement of the method/ clarification of the standard.	Using the boiler pump during testing. Wrong water temperature regimes etc.
3	Measurement error due to lab hardware.	Probably	Yes, the lab is asked to give more details. Test may be repeated to prove the issue and new data used.	Lab discovers that some hardware used (meter, analyser, sensor, etc.) was defect
4	Mistake made by the laboratory using a wrong method	Probably	Yes, ask lab to give more details If test repetition not possible (e.g. timing issue) and the original values show a “straggler” or “outlier” in the statistical, the after correction evaluation should be done with & without taking into account this lab.	Lab made the test not respecting the protocol.

Table 2: Classification of corrections (common in the whole ECOTEST project)

Any corrections (apart of editorial) is reported (anonymous) in a “journal” based on Laboratory declaration (see next section)
The origin of the issue is analysed and proposals will be made to introduce changes in procedures so to avoid such mistake in the future.

6.2 Journal of corrections made

Here is the list of corrections made to the data following the testing of the boiler and initial reporting:

Laboratory	Classification	Description of issue	For TC
All	2	After intense discussions between the test labs the measured test data were analysed again. The reason is that the parameter R_L "Thermal resistance of load heat exchanger" was not considered by one of the laboratories where the other two labs were considering R_L in the model. The investigations showed that the uncertainty of R_L is in the range or even exceeding the value of R_L. As a result the test laboratories agreed to not-consider R_L for this system and to re-analyse the measured data. The results presented in Table 1 of this report are therefore deviating from the results in the previous report.	Yes
All		The stratification parameter was indicated as S_C=0.00 K/W by all laboratories in the previous version of the report (as taken for the submitted results sheets). After the re-analysis one of the labs indicated a value of S_C = 0.003368 K/W, which would be again S_C=0.00 K/W if only two digits are considered. The parameter has virtually no impact on the result for this system. The results are therefore now presented as submitted after re-analysing.	Yes
S	1	The value for Parameter P_{solsb} from Laboratory S was corrected from 2.69 W to 2.6 W. This has a minor impact on the parameters Q_{par} and Q_{aux} as these are calculated values using P_{solsb}.	No
T	2	The P_{solsb} was computed using the transitional methods (2014/C 207/03) clause 4.10 (SOLICS, Solar pump power test procedure) indicating that P_{solsb} is rated as 50% of the rated electrical power. This has no impact on the thermal performance results (ISO 9459-5). For the indicated Q_{nonsol} all labs were using the measured pump power.	Yes
All	-	The values for the Q_{nonsol} were not corrected but required deeper analysis and were therefore not published before. The comprehensive analysis is found under 7.2	

Table 3: List of corrections that were made to obtain the final results as presented in Table 1.

6.3 Journal of corrections made

The Qnonsol were not corrected but required deeper analysis and were therefore not published before. The analysis is found under 7.2

List of correction made:

1.) The value for Parameter P_{solsb} from Laboratory S was corrected from 2.69 W to 2.6 W. This will have an impact on the parameter Q_{par} and Q_{aux} as these are calculated values using Ps_{olsb}. (Correction classification 1: Typo)

Parasitic energy	Q_{par}		~~367.9~~ 367.8	487.1	MJ
Power consumption pump	$P_{solpump}$	57	39.3	56.1	W
Standby power consumption controller	P_{solsb}	2.5	~~2.69~~ 2.6	2.6	W
Annual auxiliary electricity consumption	Q_{aux}		~~102.2~~ 102.2	117.5	kWh/a

2.) The parasitic energy Q_{par} and Q_{aux} from Laboratory T were not calculated before and were not correctly indicated from laboratory M. The reason for this is that in the transitional methods on page 207/40 Clause 4.10. "Solar pump power test procedure" it is stated that "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." But as the pump power was measured in this RRT4 as part of the normal testing anyway, it was decided to use the measured pump power.

Parasitic energy	Q_{par}	471.2	367.8	~~487.1~~ 485.9	MJ
Power consumption pump	$P_{solpump}$	54.5	39.3	56.1	W
Standby power consumption controller	P_{solsb}	2.5	2.6	2.6	W
Annual auxiliary electricity consumption	Q_{aux}	130.9	102.2	~~117.5~~ 135.0	kWh/a

7 Comments and analysis

7.1 Comments and additional information on the table and figure

As discussed in the Work package leader consortium, measurements with outlier results were re-analysed without the outlier. As there are only 3 laboratories involved in WP8 this would reduce the number of results to 2. The Excel sheets used to compute and present the results are not available for two laboratories. For this reason the outlier results was replaced as a compromised solution by an average value of the remaining values. This was done in clauses 5.2.7.

It is important to understand that the results {A_C*, u_C*, U_S, C_S, f_{aux}, D_L, S_C, R_L} shall be considered as ONE set of mathematical fitting parameters. This set has to be used always as a set and not as individual parameters. This implies that the parameters should not be misunderstood as real physical parameters. For example it shall not be expected that the "Effective collector area" is exactly the same as the physical real size of the collectors. It is not to be considered as a faulty result or as an irregular result if this area deviates by 20% or more from the physical dimension of the collector. Usually the A_C* is in the range of η_0 x "gross area", but deviations can also be explained by the fact that the incidence angle modifier is not considered in the simulation model. These simplifications are "absorbed" by an effective collector area which is smaller than the real collector area. On the other side a difference of 100% is a strong indicator that the data fitting was not successful or that there is a technical problem in the system.
The parameter sets are then used to compute the Q_L (i.e. the energy delivered at the outlet of the solar heating system) depending on defined demand volumes and on climate data (Long Term Prediction). The standard reporting climates are usually Davos, Stockholm, Würzburg and Athens (see also RRT1: Chapter on "Annual collector output in kWh/collector at mean fluid temperature ϑ_m") where for the European regulations Athens, Strasbourg and Helsinki were added. It is evident that the climate data have an essential impact on the results. The weather data are however not well defined in a standard or in the ErP regulations. The solar thermal testing laboratories have organised themselves for example in the Solar Keymark Network to harmonise the weather data which are being used for such standard performance computations. These annual weather data are given in a 1h resolution. This resolution could already be questioned as normal solar thermal systems react much faster than that. During the testing sequences the data are measured with a minimum rate 30 seconds, during draw offs even with a sampling rate of 2 seconds. On the other hand the available official data as published in Table 13 and 14 of COMMISSION DELEGATED REGULATION (EU) No 811/2013 or Table 4 and 5 of COMMISSION DELEGATED REGULATION (EU) No 812/2013) as well as the data given in Table B.6 and B.7 of the EN 12976-2:2017 are monthly data only.

7.2 Comments on possible discrepancies

The results for Q_{nonsol} show considerable variations between the participating testing laboratories. These deviations were investigated thoroughly as the variations are for sure in a range which cannot be attributed to simple measuring variations or sensor uncertainties.
The following assumptions for the differences were investigated.

Different assumptions on the auxiliary heating power: The standard EN 12976-2 does not give clear advice on the auxiliary heating power that must be used for the long term prediction and for the calculation of the Q_{nonsol}. In Table B.1 of the standard it is stated that "If the auxiliary heater is not delivered with the system and no restrictions have been given in the documentation, the auxiliary heater shall be modelled as an ideal heat source with no heat capacity and constant heating power." and "Power to be applied on auxiliary heat exchanger: (100 ± 30) W per litre of store volume above the lowest end of heat exchanger". This means that either the manufacturer has to indicate a certain power of the auxiliary heater or the test lab will select a power in the range of 100 ± 30 W per litre of the auxiliary heated volume which is determined by the fit parameter f_{aux}. This is a rather open definition of the auxiliary heating power. Both cases were investigated and the results are indicated in the result panels in clause 5.1.1., where M1 denotes the case where the auxiliary heating power is set to a fixed value of 17.6 kWh/y and M3 the case where the auxiliary heating power is set to the recommended value of 100 W per litre of auxiliary heated volume f_{aux} as determined by the EN 12976:2017 Table B.1. The results indicate the power of the auxiliary heater has virtually no impact on the overall solar performance which is rather surprising. The calculations were even repeated with an auxiliary power of 50 kWh/y without any effect on the results.

It was furthermore found, that that the tested configuration does not meet all the profiles which is evident as it is a rather small system with only two collectors and a store of 400 litres volume. Nevertheless the software delivers values for $Q_{aux,net}$ as a result of the long term prediction procedure. The sum $Q_{aux,net}$ + Q_{Sol} is however not equal to the Heat demand Q_{Demand} indicating that the demand is not met. The definition of $Q_{aux,net} = Q_{nonsol}$ in EN 12976:2017 Clause 5.9.3.6 should therefore be replaced by the definition $Q_{nonsol} = Q_{Demand} - Q_{Sol}$ which is then denoting the required non solar heat and not the delivered non solar contribution. There is no difference between the two definitions if the heat demand is met.
Using this definition the results are considered as more reasonable and denoted with M2 and M4 in the result tables in clause 5.1.1. For sure it is reasonable not to use the $Q_{nonsol} = Q_{aux,net}$ as in EN 12976:2017 when the result is indicating that the demand profile was not met.

The EN 12976 is furthermore unclear with respect to the reference conditions for annual performance calculations. In the normative Annex B.4 reference conditions are given in Table B.5 which shall be applied to calculate the annual performance for test results according to the method in ISO 9459-5. In Annex B.5 another set of reference conditions is defined (Table B.9) which are again mandatory and shall be applied to calculate the performance of the auxiliary heater for Solar-plus-Supplementary systems tested according to the method in ISO 9459-5. By agreement the WP8 decided to use the conditions of Annex B.4 and all calculations are now made using these reference conditions. In a first attempt one of the testing laboratories used the reference conditions defined in Table B.9. It is evident that using the different reference conditions leads to incomparable results.

The Tables B.5 and B.9 include the definition of the tapping profiles. The tapping profiles given in Annex VII Table 3 of the COMMISSION DELEGATED REGULATION (EU) No 812/2013 cannot be used with the software that for the ISO 9459-5 (too many tapping cycles) and therefore had to be redefined in the EN 12976. The tapping profiles given in the EN 12976 result in the same Q_{ref}, only the number of tapings was reduced and the single taps are prolonged. These revised tapping profiles do not have an impact on the RRT results, but of course could be a potential source for discussions when it comes to the comparability of the standards for different appliances under ErP.
Even if the mentioned problems with the reference conditions are eliminated by agreeing on a well-defined set of conditions and tapping profiles, the results of the three labs are still not very satisfactory as the results for Q_{nonsol} are in a range between 418 and 640 kWh/a, that is about ±25%.

For the further investigation of these deviations the test conditions in the different laboratories were analysed. As a first and probably most important difference between the test labs: One of the testing laboratories (M) made the tests during winter season. This was planned to investigate the dependency of the results on weather conditions. The current standard has rather narrow limits concerning the minimum daily radiation sums and ambient temperatures. This is a very limiting factor inducing that tests according to EN 12976 can basically only be done during summer months, which is of course a problem for the development cycles of the industry. New products which are not ready for certification in August usually will not be certified before summer of the next year. The test sequences from laboratory M are therefore not fulfilling the boundary conditions of the standard. The results show however that these results must be considered as outlier of the three results. For the time being it seems that the restrictions concerning the climatic conditions during the testing must be respected. It is however not clear whether this restrictions are also linked to the Spirkl software which probably cannot handle such conditions in an appropriate way. Probably a better software tool could allow to make winter tests as well.
Testing during winter requires furthermore a different inclination of the collectors (See pictures in Figure 1). This inclination may also be different for laboratories with different geographic locations. It is not clear how the inclination is affecting the results. From other round robin test which were made by different laboratories around Europe it can be assumed that here is no major problem as long as the radiation sums are in accordance with the requirements of the standard.

The current standards are not limited to outdoor testing and basically indoor testing could be an option, similar to collector testing. It is however important to make sure that the boundary conditions in terms of radiation and temperature are met. This is possible for smaller systems, however for standard systems with 2-3 collectors mos of the available solar simulators are too small to provide sufficient homogeneous radiation to be comparable with outdoor testing conditions. Even if the simulator would be able to provide radiation in a quality as required by the collector standard, the daily variations (incidence angle, radiation, weather conditions) must be simulated in an appropriate manner as well. This is not impossible from a technical point of view, but there is not yet sufficient experience with indoor system testing. It must be assumed that for standard solar thermal systems indoor testing is not a realistic option mainly due to the size and cost of the required equipment. It may make sense for smaller systems such as thermosiphon or Integrated storage collector systems. The specific requirements for such indoor testing are however not yet defined.

Another difference between the three laboratories was found late after the analysis of the results: Laboratory S was testing the system using a different pump power than the other two laboratories. The pump power is not clearly defined in the ISO 9459-5. Looking at the results it is evident that the Q_{nonsol} results for laboratory S are higher than for the other two labs. One reason could be that due to the lower pump power the flowrate in the collector was also lower thus leading to higher absorber temperatures with lower thermal performance in the collectors. This could explain at least partly the higher Q_{nonsol} results of laboratory S.

It is evident that the testing laboratories sometimes have different interpretations of the standards/regulations. It shall be mentioned for example that in the standards EN 12976-2, ISO 9459-5, in the EU COMMISSION REGULATIONS and in the Transitional documents the terminologies and parameter definitions are not defined in a well-coordinated manner. To avoid ambiguous interpretations the terminology in documents must be harmonised.
It would be reasonable to establish better communication between the commission and the technical experts from the CEN TCs to avoid contradictory and ambiguous terminology.

7.3 Comments in light of the iterative tests results

See 7.2

8 Iterative test results

No iterative test were foreseen for this RRT

8.1 Main conclusion

No iterative test were foreseen for this RRT

9 Procedures of standards that need to be modified and justification

9.1 Result from the brainstorming on standard

The input of the brainstorm on the EN 12976-1/2 is attached as annex to this report in the appropriate format that must be used for all input to the CEN TCs. The brainstorm on EN 12976 include some comments related with the ISO 9459-5 as the testing method itself is described there and not in the European standards. All other findings that were made during the RRT were also added to this report.

Some parameters are defined in an inhomogeneous way in the relevant documents EN 12976, ISO 9459-5, The European Regulations and the Transitional documents. As an important and illustrative example the term Q_{Aux} is defined in the COMMISSION DELEGATED REGULATION (EU) No 812/2013 as "*'auxiliary electricity consumption' (Q_{aux}), for the purpose of Figure 1 in Annex IV referred to as 'auxiliary electricity', means the annual electricity consumption of a solar water heater or a solar-only system that is due to the pump power consumption and the standby power consumption, expressed in kWh in terms of final energy;*" where in the ISO 9459-5:2017 the parameter Q_{Aux} is defined as "*Q_{aux} [MJ] Energy from auxiliary heating*" which is Q_{nonsol} in the language of the regulations. Such inconsistent definitions should be avoided as they are leading with all certainty to misinterpretations.

9.2 Procedures of standards that need to be modified and justification

One of the obvious problems of the performance rating according to EN 12976 standard is the specific software that must be used to analyse the data, to identify the parameters and to predict the performance. Apart from the problem that it is not running easily on modern computers, the main issue is that the code is not transparent. Another issue is the set of parameters which must be considered as fitting parameters and not directly as physical parameters. This implies that the results can be used to simulate annual performances only when using the same code that was used to determine the parameters. It is evident that this requires an urgent major revision.

In the frame of the ECOTEST project one pumped system made of standard flat plate collectors and a standard storage tank was analysed. These systems are common in central Europe. But there are other classes of solar thermal systems such as Thermosiphon systems and integrated storage collectors which are much more common in southern Europe. These systems make probably a bigger market share in Europe than the pumped systems, for sure they are the most common systems worldwide. As they currently fall under the same standards EN 12976 and ISO 9549-5 it is important to better adapt the standards also to these systems. One of the critical points which is being discussed is the definition of store volume and volume of the heat exchanger. These should be better defined and it must be clear for example whether the heat exchanger is part of the store volume or not.

In a next revision of the standards it would be important to adapt better the Long Term Prediction tool to the requirements of the ErP. For sure it must be possible to use the ErP tapping profiles as defined in Table 3 of the COMMISSION DELEGATED REGULATION (EU) No 812/2013, to adjust the daily calculations of η_{WH} to be able to take into account the heat demand as indicated in Annex VIII (3) of the COMMISSION DELEGATED REGULATION (EU) No 812/2013 and also to include local cold water temperatures profiles.

It is furthermore important to be very clear about the quality of the climate data which shall be used to compute results. For sure it is not appropriate to indicate only monthly average data as it is currently done. Furthermore it must be considered that usually the data files are taken from the supplier Meteonorm (https://meteonorm.com/) which however is updating from time to time the data files to consider for example effects of climate change. Such regular updates of the climate data are relevant for Solar applications as they have an impact on the energy demand and the availability of solar energy. To make sure that there is no substantial uncertainty induced by using different weather data files, it seems to be imperative to standardise and manage the weather data files for the reference places in a very strict way. A possible approach could be to harmonise the weather data with the ISO standard files published under https://standards.iso.org/iso/9459/-4/Climate%20Data/ not only for solar thermal products but for all appliances under the Eco-design umbrella.

9.3 Recommendations to CEN

As described above, the ISO 9459-5 requires a fundamental revision with special emphasis on the description and definition of the mathematical modelling of the system, the software/codes to be used for analysis, the parameter identification and the system simulation. It must be kept in mind however, the ISO/TC 180/SC4 chaired by a Chinese Convenor is responsible for the maintenance of the standard ISO 9459-5. For this reason it will not be a simple task to modify this standard in an appropriate way. There are already smaller projects ongoing which are targeting at a replacement of the currently used software. These projects are financed by industry through the Solar Keymark Certification Fund (SCF).

Weather data: Harmonise and manage the weather data sets which have to be used for all performance predictions and simulations. The physical parameters needed, their sampling rate and precision must be coordinated between the involved TCs. Best recommendation would be to harmonize with the ISO datasets mentioned above.

Terminology: Harmonise and manage the definitions and parameter names to avoid different definitions within the ErP-relevant TCs. Even more important is the harmonisation with the ErP regulations and the transitional method documents.

Apart from the thermal performance assessment, the EN 12976-1/-2 includes several additional general tests which seem to be unnecessary to be repeated in this standard as they are already covered by other regulations. For example "EN 12976-1, clause 4.1.2 Suitability for drinking water" requires that the system shall conform to EN 806-1 and EN 806-2. The standard EN 12976 should focus on non-redundant, solar specific topics only.

One important issue concerns the inclusion, or non-inclusion, of the heat exchanger volume to the store volume. This question was discussed on the RRT, although it is not very relevant for the system tested. However, for smaller systems and especially for most Thermosiphon systems it is very important to clarify this question. The current standard is not clear and it is known that not all testing laboratories have a common understanding.

10 Conclusion

The standards EN 12976-1, EN 12976-2 and ISO 9459-5 should be revised in several points to reduce the possibilities for misunderstandings or different interpretations of the methods. Furthermore the software that is used for the analysis must be replaced urgently.

Using the current setting (standards and software) the test conditions must be respected, even if this is limiting the testing season to about 6 months per year only. This limitation is probably linked to the simplified modelling of the system.

The general nomenclature and use of abbreviations should be harmonised between CEN, ISO and the commission. If this is not possible, an informative Annex in the standards with a translation table would be helpful.

Care must be taken when using the results of the long term prediction procedure. The software delivers results even if the load profile cannot be met.

11 ANNEXES

11.1 ANNEX 1 TEST PROTOCOL

Project ECOTEST / WP8 **RRT4: Solar Thermal Systems**	ECOTEST **ECO_WP8_026**

Version history

Version	status	date	
A0			To be discussed in WP To be discussed with TC 312 liaison
B			N/A
C0			N/A
C			Final version for second step (final C)

Based on Template B

See clause 1.10 of ECOTEST PART 01
The test protocols will be developed with the following methodology:

A. *First version of the test and measurement protocols based on the CEN standards (version A of the protocol)*
B. *Second version based on an evaluation of the existing CEN standards (desk) (version B of the protocol)*

The following questions will have to be considered:

1. *Are the most critical measurements identified reproducible? If not, which improvement would be suggested?*
2. *Other aspects of the protocol to evaluate:*
   a. *Is the protocol clearly understood by all? If not, define additional explanations.*
   b. *Are there points in the test method that are likely to be open for different interpretations? In this case, define additional descriptions.*
   c. *Are there points in the protocols that are not sufficiently described to guarantee the reproducibility of the testing among labs? In this case, define additional descriptions.*
   d. *Are there missing requirements (e.g. requirements on ambient temperature, etc.) that are likely to bring deviations in the results between labs? In this case, define additional descriptions.*

C. *Third version based on the first tests (version C of the protocol)*

To identify ambiguities in the standard, a preliminary discussion will be organized by each WP leader after the first tests to discuss the existing protocol point by point. Care is taken on how to exchange test results (see section 2.2.3).

The following method will be used.

- *Analysis of the measurements*
- *Have there been deviations?*
- *Can the reasons for discrepancies be identified?*
- *Can the reasons for deviations be removed by improving the test protocol and the descriptions of the tests?*

D. *A final version of the protocol will be proposed after the inter-comparison and in the light of the inter-comparison results and analysis + the results of the iterative tests*

1 Scope

This document is to provide the test protocol for the intercomparison test on a solar thermal systems for WP8.

This operative instruction gives the general instructions needed for managing all the aspects related to the tasks of receiving the system, commissioning and setting it up for testing, carrying out the reference tests, reporting the test results, decommissioning, assessing it for delivering and delivering it at the end.

2 General

The system RRT4 is performed with **one** reference system.

Due to the time restrictions the two step approach is not applicable: RRT4 is one step, depending on the testing conditions and lab capacities ambiguities in the standards may be identified.

To take into account variations of parameters additional tests may be performed by different laboratories (see clause Parameter variation) based on brainstorming on the standards.

3 References

EN 12976-1/-2:2017 Thermal solar systems and components - Custom built systems- Part 3: Performance test methods for solar thermal systems

4 Definitions

For the general technical terms used in this operative instruction see the applicable European standards listed above: chapter References
WPL: work package leader (WPL WP8: Andreas Bohren)
RRT: Round Robin test

5 Test materials and documents

- Reference system marked with “WP8 RRT4”.
  Laboratories can add their own tags for identification.
- Installer manual (ECO_WP8_031_RRT4_InstallerManual)
- Test protocol (ECO_WP8_026_RRT4_TestProtocol, this document)
- Test schedule (ECO_WP8_008_ScheduleAndApplianceTracker)
- Template test results (ECO_WP8_018_ RRT4_ResultDataSheet_lab)
- Reception sheet, (ECO_WP7_007_NoticeOfReception)
- Expedition sheet, (ECO_WP6_008_NoticeOfExpedition)

All documents will be provided on the ECOTEST website: http://ecotest.dgc.eu/wps/wp8/rrt

6 Reference materials

None

7 Ambient conditions

The test conditions as defined in the standard shall be considered.

8 Mounting, Installation and Setting

The system is installed according to the installation manual and as prescribed by the EN 12976-1/-2:2017.
Hydraulic connectors: Every test labs will receive its own connectors to the system as an interface to the laboratories hydraulic system.
Pictures of the system shall be made before / during / after the test.

9 Testing

The following tests are performed

9.1 Prediction of yearly performance indicators

The test is carried out according to EN 12976-1/-2:2017 using the boundary conditions described therein and the preferred methods used by the test lab.
The results obtained from the test shall be reported as required in the EN 12976-1/-2:2017 and in addition as required for the energy labelling regulations using the template (ECO_WP8_017_RRT4_ResultDataSheet_lab.xlsx).

10 Parameter variations

The following additional tests are performed to take into account the variations of different parameters

➔ None

11 Calculations

In addition to the Standard measurements the parameters used for the ERP shall be calculated and reported: (ECO_WP8_017_RRT4_ResultDataSheet_lab)

12 Reporting the test results

Once the tests are finished, the results are to be sent to the WPL (andreas.bohren@spf.ch).

For reporting the test results template is used and renamed by using the original document *ECO_WP8_017_RRT4_ResultDataSheet_lab* and replace "lab" by spf, ise or itw.
Do not wait for anything and immediately send the system using the box to the next recipient in the list indicated in the *ECO_WP8_008_ScheduleAndApplianceTracker*.
In case that this is not clear contact the WPL.
The raw data shall be saved properly and each laboratory shall be prepared to send raw data and additional information to the WPL. If required use the file name format *ECO_WP8_012_RRT4_ResultDataSheet_LOG_lab* and replace "lab" by spf, ise or itw

13 Sending the test material

The test material is sent using to the address agreed with the reference person of the next destination where the item has to be sent to.
Details on time schedule are available in the document test schedule *ECO_WP8_008_RRT4_ScheduleAndApplianceTracker*
NOTE: Please check on current versions of the schedule on: http://ecotest.dgc.eu/wps/wp8/rrt

14 Task for sender and recipient

Overview: Monitoring of the testing for RRT
All RRTs of the project will be organized according to the following table:

What	Information Action	Who	When (deadlines)
Receipt of the system	Send the reception sheet to all TL by email	Lab. X	Immediately upon receipt
Mounting and testing the appliance. Data processing	Send data to the WP leader	Lab. X	Immediately after receipt
Checking the data	If ok, give green light to send the appliance further.	WPL	Immediately after receipt
Sending the appliance to Lab. X+1	Send the expedition sheet to the WP leader and Lab X+1	Lab. X	Immediately after green light
Inform in case the system has not reached the lab within a week	Contact the WPL and Lab. X	Lab. X+1	After one week

14.1 Task for sender

The sender takes care of packaging the system to prevent from damage during the transportation.

- Pack the system using the package that belongs to the device.
- Attach the warning labels that are sent together with the sample
- Check with the next receiver the exact delivery address and delivery time.
- Put in a visible position a big and clear Label with the information of the recipient
- Deliver the crate using a reliable and trusted express courier
- Keep to the planned time schedule as defined in document test schedule.
- When the system is sent, send an e-mail with the expedition sheet to the reference person of the recipient to make him aware of the delivering:
  CC to the TL of WP8.

14.2 Task for recipient

The recipient looks at the crate to see if it have could been damaged during transportation: if it is an annotation is put on the travel documents accompanying the crate;

- Unpack the reference system.
- Make incoming goods control, make photos of the system as delivered.

- Make sure that there are no transport damages. If damages are noticed an e-mail shall be sent to inform the WPL. Check the packing list from the sender and the pictures provided by the sender.
- Inform by email the WG8 about the receipt of the system.
- Carry out the test plan following this operative instruction complying with the time schedule
- Send the test material to the next lab as specified in the time schedule.

11.2 ANNEX 2 Brainstorm on the standard EN 12976-1/-2

Nr	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[1]	Comments	Influence on Protocol? / To be included as variation of parameter (iterative test)?	Observations of the WPL

METHOD FOR THE EVALUATION:

a. Is the method of the standard clearly understood by all? If not, define additional explanations.
b. Are there points in that are likely to be open for different interpretations? In this case, define additional descriptions.
c. Are there points hat are not sufficiently described to guarantee the reproducibility of the testing among labs? In this case, define additional descriptions.
d. Are there missing requirements (e.g. requirements on ambient temperature, etc.) that are likely to bring deviations in the results between labs? In this case, define additional descriptions.
e. Are there requirements that are too weak to guarantee a good Interlaboratory reproducibility (eg. To high tolerance)
f. Are there not relevant requirements

Standards: (*)

EN 12975_1_2006_A1
EN 12976_1_2017
EN 12976_2_2017
EN 12977_2_2012
EN 12977_3_2012
EN 12977_4_2012
EN ISO 9806_2013
EN 12977_1_2012
ISO_9459_5_2007 (2013)
ISO_9806_2017(E)

Overall comment on this standard:

Nr	Line number	Clause/ Subclause	Paragraph/ Figure/ Table	Type of comment	Comments	Influence on Protocol?	Observations of the WPL
1	All	12976-1 12976-2	--	Ge/Te	"Guideline" on Uncertainty assessment is missing. How to compute/estimate uncertainty? (Energy Labelling / Market surveillance!)	Will not be resolved completely during the ECOTest. Comparison of different approaches from the test labs must be assessed at the end of the project.	
2	Spf	12976-1 12976-2	--	Ge/Te	Reparability / Material efficiency	These aspects must be considered in the near future. No impact for ECOTest	
3	Itw & all	12976-1 12976-2	--	GE	Improve readability of the standard.	Mandate to the WG to improve readability. No impact for ECOTest	
4	Itw	--	--	Ge/Te	EN 12976-1 Clause 4.6 Documentation. Much too many requirements. -> Reduce this list	Mandate to the WG to reduce 4.6. No impact on ECOTest	

1 **Type of comment:** **ge** = general **te** = technical **ed** = editorial

Nr	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[1]	Comments	Influence on Protocol? / To be included as variation of parameter (iterative test)?	Observations of the WPL
5	Itw	..	..	Ge/Te	Remove clauses such as 4.1.2, 4.1.3 / 4.1.9. etc. General safety aspects must not be repeated in a product specific standard.	Mandate to the WG No impact on ECOTest	
6	DTU	12976-2 5.9.1		TE	EN12976-2 5.9.1 *"This can be achieved, for example, if the pipe is directly going downwards after leaving the store or by using a siphon."* Be more precise in the description of "downwards". How much?	No impact on testing protocol. But should be discussed in the analysis of the RRT	
8	DTU	9459-5		TE	5.1.5.1 and 5.1.5.2 in iso-5 *"All parts of the integrated auxiliary heater that are located outside the store, the demand heater and all accompanying pipes shall be properly insulated so that thermal losses are minimized, and the measured energy corresponds to the actual auxiliary energy supply.* What does the term "properly" mean?	No impact on testing protocol. But should be discussed in the analysis of the RRT	
9	itw	9459-5		TE	**5.1.2.3 Collector tilt angle** *The tilt angle shall remain constant throughout the test. The system shall be tested with the collector at a tilt angle within ± 5° of the latitude of the test site, unless otherwise specified by the*	Mandate to the WG to find a better regulation on how to install. No impact on the ECOTest. Could have had an impact if other systems such as Thermosiphon systems were include (shadowing) or other test labs (more north more south) were involved.	

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Nr	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[1]	Comments	Influence on Protocol? / To be included as variation of parameter (iterative test)?	Observations of the WPL
					manufacturer. This shall be reported with the test results. ➔ This requirement does not make sense in general. Is depending on the system, location of test laboratory etc.		
10	Costas	12976-1	4.7 ENERGY LABELING	ED	I think that first paragraph should be edited. Further it's not clear that this is a second label: Confusion between Energy label and product label	No impact on the ECOTest.	
11	Costas	EN12976-2	5.9.3.5.2 Table 4	TE	5.9.3.5.2 In table 4 Q_{nonsol} should be Q_{ref} 5.9.3.5.3 In the last line Q_{nonsol} is not defined	Error in the standard: To be considered during the ECO test	
12	Costas	EN 12976-2	5.9.3.6	TE	Why the method is limited to test results according to ISO 9459-5? At least for solar preheater also ISO 9459-2 should also be considered.	To be discussed in the WG. No impact on the RRT.	

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