

Project ECOTEST

Final report of the WP8 Deliverables D8.4 and D8.5



ECO_WP8_XXX_WP8-RRT4_V2

WP	WP 8 Solar Collector
Type	WP8 final report
Title	Final report of the WP8
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Dissemination	Free
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			Month																				
WP8 Solar heaters	WP	task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	20,5
Administration /Organisation	8	0										D8.0											
Practical organisation of the test	8	1																					
Preparing a test protocol.	8	2		D8.2																			
Execution of the RRT	8	3																					
Analysis of the resuts and report	8	4																			D8.4		
Proposal to CEN and communication	8	5																					D8.5

1. Tasks of WP8

This report is constructed as a general part for the deliverables D8.4 and D8.5.

The tasks covered by WP8 are the following:

1. Organise an INTER-COMPARISON test between laboratories in order to estimate the interlaboratory reproducibility for the value of the heating and hot water efficiency and all the measured parameters needed to calculate seasonal efficiency (η_s) according to EN 12976 and EN 12977 series. For this purpose, two complete standard solar water heater system consisting of collectors (EN 12975), a solar water heater store (EN 12977-3) and a solar combi-store (EN 12977-4) shall be tested by different laboratories as individual components. The same water heater and collectors shall furthermore be tested as factory made system according to EN12976.
2. Analysis of the test results.
3. Cooperation with CEN/TC 312 to propose possible improvements of the relevant standards.

The RRTs were separated into six subtasks as follows

- RRT1: Solar Thermal Collector (EN 12975, EN ISO 9806)
Determination of the relevant thermal performance parameters for ErP
- RRT2: Solar water heater store (EN 12977-3)
Determination of the relevant thermal performance parameters for ErP
- RRT3: Solar combi store (EN 12977-3)
Determination of the relevant thermal performance parameters for ErP
- RRT4: Factory made solar thermal system (EN 12976, DST)
Determination of Q_{nonsol}
- RRT5: Solar water heater system (EN 12977, SOLCAL, SOTHERM)
Determination of Q_{nonsol} based on results from RRT1, RRT2
- RRT6: Solar combi systems (EN 12977, SOLTHERM)
Determination of Q_{nonsol} based on results from RRT1, RRT3

The details for the appliances and results are found in the individual reports as listed in the Annex1 of this report.

The horizontal results and conclusions are summarized in the "Final Report WP8 Solar thermal Executive summary and proposals".

2. Administrative and organisational aspects

The works in WP8 were administrated and organised as planned.

3. WP overall situation: Any modification of the contract

	(Yes/No)	Explanations (if answer is (Yes))	Notification made (when & to whom)
Change in the WP programme?	No	--	--
Change in the WP appliance to be tested	No	--	--
Change in partnership	No	--	--
Other	No	--	--

4. WP Meetings during the project (common meetings WP1-WP3)

To save travelling time and expenses, most of the meetings were held as web-conferences and/or as side events of others meetings (such as Conferences or international standardisation meetings) where members of the testing laboratories and members of CEN/TC 312 were meeting anyway. In between these meetings several webmeetings and phone conferences took place (not all listed below).

	Date	Possible comments
Meeting 1a	18.10.2017	Preparatory meeting for the RRT in Cyprus (side meeting of SKN meeting)
Meeting 1b	01.11.2017	Preparatory meeting between the test laboratories (Side meeting of SHC in Abu Dhabi)
Meeting 1c	04.11.2017	Webmeeting
Meeting 2	30.11.2017	Webmeeting
Meeting 3	14.12.2017	Webmeeting (incl. Brainstorm)
Meeting 4	02.05.2018	Webmeeting (incl. Brainstorm)
Meeting 5	17.05.2018 / 18.05.2018	Meeting in Brussels. Report to the WP8 members
Meeting 6	14.09.2018	Meeting in Rapperswil (side event of EUROSUN conference and ISO/TC 180)
Meeting 7	6./7.11.2018	Brussels
Meeting 8	22.01.2019	Meeting of test laboratories in Frankfurt (side event of EkTSub meeting)

Meeting 9	06.03.2019	Meeting of the test labs in Stockholm (side meeting of SKN meeting and CEN/TC 312)
Meeting 10	21.03.2019	Webmeeting with CEN TC 312
Meeting 11	15.05.2019	Reporting Webmeeting

5. Deliverables situation

Derived from original table from <http://ecotest.dgc.eu/deliverables>

	Type	Task	Author	Dissemination	Content	Title	Comment
D8.0	Note	Administration / Organisation	WP leader	Internal	See detailed content in the section 1.5.4 Midterm Intermediate results by WP	Midterm report by WP	
D8.1	NR	Practical organisation of the test	WP leader	Internal	-	-	
D8.2	Note	Preparing a Test protocol	WP leader	Internal	Final test protocol resulting from the discussion.	Test protocols	
D8.4	RRT	Analysis of the RRT results	WP leader	Public	Extended results and analysis	FINAL REPORT OF THE WP	Merged with D8.5
D8.5	Note	Proposal to CEN and communication with the TC during the project	WP leader	Public	Summary and proposals (incl. brainstorm on standards)	FINAL REPORT OF THE WP	Merged with D8.4

6. Appliance purchase situation

Appliance	Purchase type
Solar thermal collectors RRT1	For free from a manufacturer
Solar water heater store for RRT2	Made available by one the participating testing laboratories
Solar combi heater store for RRT3	Made available by one the participating testing laboratories
Solar water heater system for RRT4	Collectors For free from a manufacturer, Store taken from RRT2
SOLCAL, SOLICS AND SOLTHERM for RRT5 / RRT6	Software for SOLICS is available at the participating testing laboratories. SOLCAL is available as webtool in 2013 and 2017 version from LabelPack + (http://www.label-pack-a-plus.eu/) SOLTHERM was made available in the latest version by www.vaconsult.net

7. Results of the Work packages

The results of the work packages are summarized in individual final reports for each RRT. See Annex 1.

8. Evaluation of the RRT Results, Recommendations to the TC

The evaluation of the RRT results, the recommendations to the TC and conclusions are done individually for the appliance concerned. All horizontal issues, general findings and recommendations related with Solar thermal appliances are summarized in an additional horizontal report. All results are discussed critically and evaluated finally, and the relevant data of the tests are reported in the following Annexes documents

Annex	Title	Standards	Appliance covered	
0	Final report WP8/Executive Summary	All	All	Annex to this report
1	Final report WP8/RRT1	EN 12975-1/-2 EN ISO 9806	Solar thermal collector	Annex to this report
2	Final report WP8/RRT2	EN 12977-3	Solar water heater store	Annex to this report
3	Final report WP8/RRT3	EN 12977-4	Solar combi store	Annex to this report
4	Final report WP8/RRT4	EN 12976-1/-2 ISO 9549-5	Factory made solar water heater system	Annex to this report
5	Final report WP8/RRT5	EN 12977-2	Custom built solar water heater	Annex to this report
6	Final report WP8/RRT4	EN 12977-2	Custom built solar combi heater	Annex to this report

9. Brainstorming on standards

The partners held brainstorming about possible improvements and modifications of the relevant standards. It is however important to note that most of the standards in the scope of the ECOTEST project have been revised during the project, are currently in revision, have been submitted to CEN for publication or are under . Some of the comments are therefore possibly already included in the next version of the standards.

Furthermore, the testing laboratories are all members of the relevant working groups of the CEN/TC 312.

The details of the brainstorming are found in the individual RRT reports.

10. Summary of contacts with CEN/TC 312 and ISO/TC 180

The participating testing laboratories have at least one member in the relevant working groups and sub committees of the standardisation committees CEN/TC 312 and ISO/TC 180.

- CEN/TC 312/WG1 "Solar collectors", (EN 12975-1, EN 12975-2, EN 12975, EN ISO 9806)
- CEN/TC 312/WG2 "Factory made systems", (EN 12976-1, EN 12976-2)
- CEN/TC 312/WG3 "Thermal solar systems and components; Custom built systems", (EN 12977-1 to -5)
- ISO/TC 180/SC 4 "Systems - Thermal performance, reliability and durability", (ISO 9459-5)
- ISO/TC 180/WG4 "Solar collectors", (ISO 9806)

All are members of the Solar Keymark Network, the European certification system for solar thermal product on the basis of the CEN Internal Regulations Part 4. This Network is also acting as preparatory body for European standardisation projects and is (co-)financing projects such as the development of Scenocalc and SOLTHERM software which were used in this project.

The WP8 project leader is furthermore convenor of CEN/TC 312/WG1 and ISO/TC 180/WG4.

During the ECOTEST test project several standardisation meetings took place with contacts between the WP8 and the members of the above mentioned WGs and TCs.

11. Summary of results of the Work package and Conclusions

The results of the work packages are summarized in individual final reports for each RRT. Horizontal results and conclusions are summarized in the "Final Report WP8 Solar thermal Executive summary and proposals".

The list of the reports is found in Annex 1.

Annex 1 List of final reports

The following annexes are integral part of the final report for WP8. For practical reasons the reports are separated from the main document (this report).

Annex 1.0	Final report WP8/Executive Summary
Annex 1.1	Final report WP8/RRT1
Annex 1.2	Final report WP8/RRT2
Annex 1.3	Final report WP8/RRT3
Annex 1.4	Final report WP8/RRT4
Annex 1.5	Final report WP8/RRT5
Annex 1.6	Final report WP8/RRT4

Annex 2 contract specifications (Commented)

The following text in *italic* is copy-paste from "Annex 8A ECOTEST PART01 - Workprogram details final_2.pdf" with greenish highlighted comments.

2.8 WP8 Work package with CEN/TC 312 (solar heaters)

2.8.1 Contents of the call for tender (from annex IV)

The work proposed shall include the following points:

1. Organise an INTER-COMPARISON test between laboratories in order to estimate the inter-laboratory reproducibility for the value of the heating and hot water efficiency and all the measured parameters needed to calculate seasonal efficiency (η_s) according to EN 12976 and EN 12977 series. For this purpose, two complete standard solar water heater system consisting of collectors (EN 12975), a solar water heater store (EN 12977-3) and a solar combi-store (EN 12977-4) shall be tested by different laboratories as individual components. The same water heater and collectors shall furthermore be tested as factory made system according to EN 12976.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

2. Analyses of results

The test results of the individual components (collectors, stores) shall be compared directly as well as the calculated annual efficiencies of the water heater system if tested under EN 12976 and if tested under EN 12977. For a real statistical analysis the number of samples is too small. Therefore, the main result of this comparison of the results would be to identify the main drivers of deviations (if there are) between the final results. Based on these insights dedicated recommendations and guidelines for better testing of solar devices could be elaborated in future projects.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

3. Cooperation with CEN/TC 312 to propose possible improvements of the standard. Any insights of these comparative tests would be included in the future revisions of the standards anyway.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

There are two main issues to be addressed when the testing solar appliances:

- 1.) For some products there are different methods or even standards for testing the same product. It must be expected that there are deviations between the results of the different methods.*
- 2.) There may be some deviations between results from different test labs. In addition to the laboratories own uncertainties of measurement, the possible sources are: Reliability/reproducibility of the method itself and/or interpretation of the standards.*

The WP shall address these two issues by taking systems that can be tested according to different standards/methods. Then comparing the results and identifying the sources of the deviations, if there are. This has not been done before and therefore will provide for the first time a solid basis of test results for further discussions and input to

standardisation, for better defining the methods itself, identifying sources for deviations and better defining which method to be used for what type of system. This will include also a desk evaluation of indoor test method.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Indoor testing is well-defined in ISO 9806 and does not require further investigations. Indoor testing for systems is discussed in the report WP8-RRT4.

The work will include the existing analyses and discussions about methods in collaboration with the relevant stakeholders.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Measurements, other round robins that have been carried out in the frame of the Solar Keymark Scheme and any other previous studies on the comparability of test results will be considered, if available.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Because of the cost of testing, the number of laboratories for this WP will be restricted to 3 only. A special care should therefore be taken by choosing the laboratories in term of experience, quality of the technical equipment and about the skills of the staff.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

2.8.2 Comments (Project team point of view) about the present situation (testing/standardization) in relation to the project activities

The performance and safety of solar thermal heaters are rated using the standards series EN 12975, EN 12976 and EN 12977. The standard EN 12975, which is linked to the ISO 9806, is providing the required performance parameters for solar thermal collectors. This standard is under revision mainly to comply with the Construction Product Regulation (CPR - (EU) 305/ 2011), but the currently valid version, EN 12975-1, already describes the same parameters required for the calculation of the solar water heater efficiencies. EN 12976 is dedicated to factory made systems, i.e. systems consisting of a fixed configuration of storage and collector. EN 12977-1 to EN 12977-5 is a modular standard for custom-built systems, i.e. where different configurations of stores, collectors and controllers are tested separately to allow for different combinations of the components. EN 12976 and EN 12977 have been approved and are expected for citation in the OJEU.

Depending on the system type, different parameters must be measured to compute the seasonal efficiency as required by the regulations. For all solar water heaters the performance parameters of the solar thermal collector are mandatory. Systems under the EN 12976 are tested and modelled as complete system. For systems under the EN 12977 the storage tank or the combistore are tested on their own. Standard pumped warm water systems could be tested under both standards. Using the results of these tests according to the relevant EN standards the efficiency class is then determined according to the indications in the directives /1/ and /2/.

The general objectives of this WP are to conform to the overall common objectives of the WPs dedicated to technologies (see Introduction to WP3 to 8).

As required in the call, because of the cost of testing, the number of laboratories for this WP will be restricted to 3 only, but 2 more laboratories having expertise in testing solar heaters will make some desk support work.

Possible discrepancy compared in the execution of the project compared to the above plan:

Because of the complexity of the matter, only one external laboratory (DTU) from Denmark provided important input to the project. However, in the participating laboratories there are experts for collector testing and experts for system testing. By involving the experts of the other appliances this support by "external expertise" was available in a more efficient way than proposed initially.

2.8.3 Work programme details

A well-selected standard solar water heater system consisting of collectors (EN 12975) and a solar water heater store can be tested according to the different applicable standards for solar water heaters (EN 12977-3) and (EN 12977-4). Using these parameters the system performance for a so-called custom built system (EN 12977). The same water heater and collectors shall furthermore be tested as so-called factory made system according to EN 12976. Testing the same system according to the different standards provides more information about the comparability of the results than testing different systems.

List of tasks WP8 Solar heaters

- 0 Administration / Organisation
- 1 Practical organisation of the test
- 2 Preparing a test protocol
- 3 Execution of the RRT
- 4 Analysis of the results and report
- 5 Proposal to CEN and communication with the TC during the project

Task WP8-0 Administration / Organisation

The WP leader will be in charge of the organization of the work in the WP (according to the role specifications for WP leader) given in section 1.1.

The WP leader will organize the work according to the specifications of the section1 that applies to all WPs:

- Communication (section 1.2)
- Meetings (section 1.3)
- Partnership and involvement of partners in each WP (section 1.4)
- Deliverables (section 1.5)

The timing of the tasks in the WP is given the table in section 1.5.1.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Task WP8-1 Practical organisation of the test

The RRT will be organized using the documents prepared by WP2 (RRT procedure) and possibly adapted when relevant (see overall info on RRT procedure in 1.9.1 and details already given for the procedure in WP2 in section 2.2.3)

The overall requirements of section 1.6 will apply for the organisation and execution of the testing. The choice and purchase of appliances to be tested in WP8-3 will be made in this task according to the specifications of section 1.7.

This task also includes

- Communication and clarification of the test planning with the other involved partners in the WP

- Establishment with all partners of the testing schedule (circulation list) of the appliance(s)

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Task WP8-2 Preparing a test protocol

The test protocol will be established by the WP according to the details given in section 1.9.2 and according to the method described in 1.10.

WP8 will elaborate on the test protocols with the input from WP1. The main findings from task 1 will be integrated to make sure that the test protocol will include the elements of influence that have been identified. The test protocol will be based on the current standard versions. In case a current draft version to be published in PI, UAP or FV is available in the relevant TC or WG, this document is also taken into account as far as possible. The deliverable D8.2 will report the test protocol and the detailed test planning.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Task WP8-3 Execution of the RRT

This work will be executed by all labs involved (see laboratories that are involved in the table of section 1.4) with the appliances chosen according to the specifications of section 1.7 and respecting the procedures established in WP2 (as described in section 2.2.3).

The overall description of section 1.6 will apply for the organisation and execution of the testing. The appliance specific details are given in the descriptions WP8-3a to WP8-3e. As some of the tests are outdoor tests depending on the local weather conditions, some flexibility in the time plan is required. By proper planning and under normal weather conditions, it will be possible to execute all the tests within the required time frame. An escalation plan will be developed for the case of delays due to unforeseeable weather conditions.

The exercise will consist in testing the solar thermal system according to the permissible standards:

1. Solar collectors and solar water store sold separately (WP8-3a + - WP8-3b)

With these results the system performance is calculated (WP8-3c)

2. Solar collectors and store in fixed combination (WP8-3d)

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Task WP8-3a Solar Thermal Collector (EN 12975)

The selected solar thermal collector will be sent to the test laboratories (see 1.3) for performance testing according to EN ISO 9806. The test labs may use their preferred test procedure as defined in the standard (Quasi-dynamic or Steady State). The results will be presented in the harmonized format as to be introduced in the coming ISO 9806:2017 Table A.6. The tests will include the thermal performance, incidence angle modifier and thermal heat capacity as needed for the determination of the system performance (see WPs below).

To check the integrity of the collectors before and after the RRT, the thermal performance of the collectors will be determined in a solar simulator before and after the RRT by the WP Leader. To reduce ageing effects during the RRT, the collectors are pre-aged by the WP Leader with a half exposure for climate class A according to ISO9806:2017 Table 2.

The outcome of this task will be communicated as deliverable D8.4 (see in 1.5).

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Task WP8-3b solar water heater store (EN 12977-3) and (EN 12977-4)

The selected solar water heat store will be sent to the laboratories (see 1.3) for performance testing according to EN 12977-3 of the parameters related with ECODESIGN (i.e. standing losses S and volumes). The same parameters have to be determined for solar combi-stores (EN 12977-4) using the same methods and procedures. The WP8-3b therefore also covers EN 12977-4 with respect to the required parameters for this project.

The outcome of this task will be communicated as deliverable D8.4 (see in 1.5).

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Task WP8-3c Custom-built solar system (EN 12977)

This task is system calculation based on the above testing. Using the measured data of WP8-3a and WP8-3b the test lab will determine the ECODESIGN relevant parameters and determine the package label of the system using the SOLCAL method.

The outcome of this task will be communicated as deliverable D8.4 (see in 1.5).

The following tasks are system calculation based on the above testing.

Task WP8-3d Factory made solar thermal system (EN 12976)

The selected system consisting of the collectors (WP8-3a) and the solar water heater store (WP8-3b) will be sent to the involved test labs to determine parameters as required in EN 12976, and the energy label is determined using the SOLICS method.

The outcome of this task will be communicated as deliverable D8.4 (see in 1.5)

Possible discrepancy compared in the execution of the project compared to the above plan:

In addition to the mentioned (and cited) SOLCAL version of 2013 and the SOLICS method, the performance was also evaluated using the SOLCAL 2017 version and also using the newly developed SOLTHERM method.

All tasks have been executed.

Task WP8-4 Analysis of the results and reports

The analysis of the results will be carried out with the involvement the partners as indicated in the table 1.4.

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

Task WP8-5 Proposal to CEN and communication with the TC during the project

See section 1.1.

The reporting and communication (including the communication with CEN) will be done according to section 1.2.

The reporting, preparation of notes, reports etc. will be done according to the deliverable plans in section 1.5.

The outcome of this task will be communicated as deliverable D8.5 (see in 1.5).

Possible discrepancy compared in the execution of the project compared to the above plan:

There was no changes. All tasks have been executed.

See list of WP8 reports in Annex 1