Quality Assurance in Solar Heating and Cooling Technology

REPORT OF PROJECT

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Solar heating and cooling, commonly referred to as solar thermal, is one of the major Renewable Energy Sources. In fact, worldwide it is the main decentralized emission-free energy source.

Over the past decade, quality assurance has been one of the main challenges faced by the solar thermal sector. The development of standards and measures to promote quality products in the market has provided great opportunities for the industry. However, it has also meant a continuous effort to handle new requirements as well as avoid national barriers being erected.

The sector has met these challenges, as demonstrated by the implementation of a strict product quality policy such as the voluntary European quality mark - “Solar Keymark”.

The Solar Keymark has played a major role in the remarkable development of the European market for solar thermal products and services. It has brought us closer to a European solar thermal common market and in preventing the unfair competition of low quality products it has protected the interests of both industry and end-users.

However, with a growing market and technological developments come new applications to explore as well as new hurdles to overcome.

Therefore, a greater flexibility and ability to support innovation in the

![Figure 1: QAiST project consortium at its final project meeting, at ITC - Instituto Tecnológico de Canarias](image-url)
certification process and underlying standards is essential when a range of new products is introduced, production becomes more industrial and competition stiffer.

The Quality Assurance in Solar Heating and Cooling Technology project (QAiST) gathered a consortium consisting of 15 partners, representing some of the main European test laboratories dedicated to solar thermal in Europe.

During the three-year project (June 2009 to May 2012), co-funded by the Intelligent Energy Europe programme, these experts addressed the current and future challenges for quality assurance in the solar thermal sector.

QAiST focused on the best ways to enhance the competitiveness of the European solar thermal industry and further increase consumer confidence. These objectives to be achieved through improved standards and certification schemes, testing and certification harmonization and a widespread dissemination of the quality concept throughout Europe.

This publication presents briefly some of the main achievements of this project.

I am confident that QAiST’s results are already making a difference to the European solar thermal sector and will continue to do so in years to come.

On behalf of ESTIF, the industry federation that coordinated this project, and of the QAiST consortium, I sincerely hope that this publication truly reflects the work and achievements of this project, helping the reader to understand the results and the available resources provided by this project.

Pedro Renquinha Dias  
Project Coordinator
This report summarizes the results achieved by the project “Quality Assurance in Solar Heating and Cooling Technology – QAiST”.

One of a work packages (WP) covered solar thermal collectors. The main objective was to support the revision of the EN 12975 standard. Later, due to positive developments in International harmonization this objective was slightly revised. More ambitious objectives were to finalize and present the first draft of the new standard EN ISO 9806, based on the EN 12975-2, and to initiate in parallel a CEN/ISO public enquiry on this draft. Furthermore, the QAiST team contributed to the revision of EN 12975-1.

Two very useful documents were issued and are available to the relevant stakeholders: a brochure and a Guideline to the EN 12975 standard. Moreover, the Energy Output Calculation tool was devised and included in the Solar Keymark scheme rules.

The work on solar thermal systems constituted the focus of another work package. Here also, several important results have been achieved, such as the preparation of a revision of EN 12976 and the development of the relevant work for Energy Labelling purposes, i.e. assessing the impact of the EU tapping cycles on the long term prediction calculation procedure and determination of a method for assessment of “hot water comfort” of factory-made systems.

The QAiST project contributed also to the consolidation and enlargement of the Solar Keymark Network, with strong contributions from QAiST participants. A very relevant outcome of QAiST was the accomplishment and evaluation of the inter-laboratory comparison for collectors and systems (round-robin).

Another significant part of the work pinpointed new areas for quality assurance. For instance, the importance of developing a proposal for a definition of performance figures and system classification, as well as a description of the testing procedures for solar thermal and heat pump combined systems. Besides, it was imperative to collect and assess data regarding solar cooling systems in operation. The work in a task relating to function and yield control for large systems (FYC-LSTS) had to be redefined, finally resulting in a report on the state-of-the-art and recommendations for a future technology roadmap.

Regarding the international work on standardization, the coordination with ISO and with IEA-SHC Task 43 (global certification) had a strong impact on international standardization. Important developments occurred also in the promotion of quality
assurance and solar thermal certification in CEE & SEE countries.

There were several important lessons learned during the project. The partners concluded that the initial planning was critical to the success of the project. This includes the setting of intermediate objectives/targets and thus divide long and complex tasks.

It was also concluded that intensive interaction between partners is vital. Good communication tools are available today, though personal contact is still essential, in particular when there are difficult negotiations or discussions around technical documents. Therefore, it was important to foresee sufficient meetings, some only focusing on one aspect of the project (i.e. referring only to one work package). In particular, work-package leaders had additional requirements to participate in such meetings, therefore for some partners extra travel costs had to be budgeted for.

All the more justified by the fact that WP leaders are likely to participate more actively in dissemination tasks e.g. by presenting papers at conferences.

Partners also acknowledged a lack of information on quality assurance and that this subject is difficult to communicate, in particular to convey the relevant information.

Figure 2: Periodically, representatives of the QAiST project presented the latest developments to the Solar Keymark Network, for information and to gather inputs for its work.
A new version of the EN 12975 (EN 12975-1 and EN ISO 9896) is expected in 2013. Several proposals for the current and latest revision were developed within the QAiST project, on topics such as:

• Tracking concentrating collectors: these are now within the scope of EN 12975 and procedures for durability tests have also been developed. This will facilitate the market deployment of this type of collectors, increasing the potential of high temperature (up to 250 °C) applications in the European market;

• Introduction of “class definitions”: mechanical load tests, impact resistance and exposure tests will include class definition in the revised standard. This means that the tests will be defined in terms of classes corresponding to increasing levels of stress and that the manufacturers can decide in which class to test their products, allowing more flexibility also on defining requirements at national level;

• The description of test procedures was improved, e.g. for the rain and exposure tests, and will not only fast-track testing but also render the results’ evaluation more reliable;

• Evacuated Tube Collectors: looking into the needs to improve quality assurance for this type of collectors, common efforts led to an agreed input from the QAiST consortium to a revision of EN 12975.

The new collector standards will include improved durability test procedures and new test methods. A procedure for calculating annual collector performance will also be included.

Revision of EN 12976 for Factory-made systems was put forward, making this standard clearer. Moreover, procedures were developed for the certification of a complete family of systems based on testing only a few basic configurations. These procedures are part of the Solar Keymark certification scheme rules. Additionally, procedures adapting the results of system testing to the upcoming Energy Labelling were also developed.

The ENV 12977 series has been revised (and restructured) and has been published as CEN/TS (TS: Technical Specification).

It has been decided to extrapolate the CEN/TS documents to European Standards (EN’S), additionally making Solar Keymark available for custom-built systems including systems also providing space heating.

The inter-laboratory comparison (round robin) involved 12 participants for solar collectors and nine participants for solar thermal
systems. This can be considered as the largest ever inter-laboratory comparison carried out in the field of solar thermal technology. In addition, this round robin was evaluated by an independent institute using acknowledged procedures for the evaluation of proficiency tests.

The results were considered excellent, demonstrating that the level is already high, although indicating areas requiring further improvement.

Concerning new areas for quality assurance, the project gained a good insight into quality requirements for combined heat pump and solar thermal systems, as a result a common approach was developed in cooperation with the relevant task groups of the IEA implementing agreements for solar thermal and heat pump technologies.

The basis for a technology roadmap for function and yield control of large solar thermal systems has been established, in addition to the assessment of the current situation.

A technical report on requirements for durability and performance of solar cooling systems was prepared. It includes an updated list of solar cooling installations; a report on durability issues; maintenance and costs of these systems; a review on testing procedures and quality standards for thermally driven chillers; and an assessment of the possibility of incorporating solar thermal cooling systems. This can be considered as the largest ever inter-laboratory comparison carried out in the field of solar thermal technology. In addition, this round robin was evaluated by an independent institute using acknowledged procedures for the evaluation of proficiency tests.

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Figure 3: Addressing new areas for quality assurance meant dealing with new concepts, which are still niches in the market, though with a high potential. This is the case of SHP (combined solar thermal and heat pump systems). Below a representation of operating modes of SHP covered by QAiST work.
into EN 12977 series.

Furthermore, QAiST contributed to the consolidation of the Solar Keymark Network (SKN). Test labs from member states and candidate countries have been involved in the SKN and have also presented reports on the quality assurance situation in their countries.

Workshops on quality assurance have been successfully held in South-East Europe and Northern Europe. New materials have been produced to promote quality assurance and, in particular, the European quality mark for solar thermal products: the Solar Keymark, aimed at industry and public authorities.

There have been some drastic changes on the context of international harmonization thanks to the QAiST contribution. A new draft EN 12975-1 and a draft International standard (DIS) 9806 have been developed based on the revised EN 12975 series. As a result, test methods in the EN standard will be incorporated in a joint EN ISO 9806 standard.

Global certification is now a concrete and achievable concept, while at the beginning of the project it was only considered a distant dream.

All in all, QAiST has helped to shape the future of the industry in Europe, with standards updated to reflect developments and market requirements, looking into new areas, improving test laboratories’ performance and actively promoting quality assurance in Europe and beyond.

Figure 4: Presentation during QAiST workshop for industry and public authorities in Warsaw, Poland, hosted by PIMOT - Automotive Industry Institute.
STANDARDS FOR SOLAR THERMAL COLLECTORS

Situation before QAiST

The European standard for solar thermal collectors EN 12975, first published in 2001 and revised for the first time in 2006, is the cornerstone of the Solar Keymark certification of collectors. As a result of a growing market and the success of the Solar Keymark, the standard has been applied in numerous tests in many laboratories around Europe. A considerable experience from the application of the standard has thus been gained. Through this experience and the strong development of markets and technologies in recent years, it became apparent that the standard needed a complete revision. This mainly concerned the following aspects of the standard:

- In general, there was a need for clarification and stronger of requirements
- There was also a need for a more open approach to requirements, allowing manufacturers more freedom in innovation and design
- Evacuated tubular collectors (ETCs) were within the scope of the standard but some specific, and somewhat critical aspects of this collector type, were not adequately taken into consideration
- Tracking concentrating collectors were only partly covered by the standard and, as this was a rapidly emerging technology, it was important that all its aspects were covered by the standard
- With increasing opportunities for global trade, the harmonization of standards and certification systems became more urgent

Figures 5 & 6: Evacuated tube collectors, as well as concentrating and tracking collectors were two priorities for the work done within QAiST. On the left, a parabolic trough collector under test. On the right, evacuated tube collector being tested on an automatic tracker.
This called for a new approach to the requirements issue in the standard and to which loads to apply in different tests.

- Later, as the revision work was in progress, it also became apparent that the standard had grown significantly in terms of content as well as complexity. For this reason, and also due to the batch-like development that had taken place over the years, the standard had become rather unwieldy. Therefore, the whole standard needed restructuring.

As for the global situation for collector standards, no development had taken place in the ISO 9806 series of standards since the mid 90s. Since most national standards outside Europe are based on these standards, the same applied to standards used, for example, in the US, Canada, China and India. One recent exception is the Canadian development of standards for air collectors and another is the SRCC standard 600 for tracking concentrating collectors.

However, apart from these, the EN 12975, initiated in 1995 and which to a large extent stems from the ISO 9806, represented the widest scope and the most up-to-date knowledge on collector testing available in 2009 when the QAiST project started. Therefore, it seemed opportune that the QAiST project should define the tremendous task culminating in a globally harmonized standard based on the EN 12975.

Figure 7: World map of applicable solar thermal standards (2011)
Developments provided by QAiST

Four subtasks were defined for QAiST Work package 2 “Solar thermal collectors”:

• Performance of low to medium temperature collectors, focusing on tracking concentrating collectors and on ETCs

• Collectors’ durability and reliability, as well as for collector components and materials

• A guide to the EN 12975 standard

• A Performance calculation tool

Additionally, the task for international harmonization was outlined, with the explicit aim to cooperate with the recently created IEA SH&C Task 43 “Solar rating and certification”.

Inputs to standard revision

The previously-mentioned new approach to requirements in the standard, actualized by the needs for harmonization, was in general achieved through the introduction of classes for loads or stresses. As a result, for example, the mechanical load, the impact resistance and the outdoor exposure test now defined in classes of increasing severity. The collector manufacturer can then select a class or load level according to the toughest requirements applied in any of the markets in which the collector will be sold.

When it comes to collector components and materials, the work of QAiST also contributed to changes in standardization:

• A method for absorber surface characterization and durability assessment developed within the IEA SH&C Task X is on its way to publication as an ISO standard

• Standards for quality assessment of ETC tubes and heat pipes are under development.
Standards for collector glazing and collector insulation materials are expected shortly.

As inputs to the standards revision, effectively to the prEN 12975-1 and the EN ISO DIS 9806, are extensive as well as integrated in the complete standards; they are not reported separately but are only available as drafts. Additionally, the background work of QAiST for each specific topic is reported in a separate technical report, available on the QAiST website.

A guide to the EN 12975 standard

This guide is based on the current EN 12975:2006 and is intended primarily for two different target groups:

- New laboratories entering the field of solar collector testing. The main purpose here was to give these new laboratories a brief introduction to the standard thus facilitating their entry into the testing business. Additionally, it provides some in-depth information on some of the standards’ topics and, as such, it can also provide some extra guidance to experienced collector testers.

- Solar collector manufacturers and importers. An entire chapter of the guide is specifically written with the objective of explaining how most of the tests in the standard

Figure 8: Brochure for industry and non-experts about the collector test standard EN 12975.
can actually be performed “in-house”, by companies. Used this way, the standard can be a cheap, yet powerful tool, for product development (for manufacturers) and for general quality assessment (for importers) without requiring third party testing; of course, as long as the aim of the test is not certification.

To explain the standard in a simplified manner and encourage manufacturers and importers to use it, a small brochure giving a very condensed overview of both standard and guide, has also been issued.

A performance calculation tool

The QAiST partners have successfully completed the task of developing an Excel based tool for calculating the annual energy output from solar collectors based on performance test data according to EN 12975. This tool, called “Scenocalc” (abbreviation of Solar Collector Energy Output Calculator) can be applied to all types of solar thermal collectors, including tracking collectors. It gives the energy output in kilowatt hours per collector module and per year at three “standard” mean operating temperatures: 25, 50 and 75°C and for four “standard” locations: Stockholm, Athens, Davos and

Figure 9: The Solar Collector Energy Output Calculator (Scenocalc) is a publicly available calculation tool developed on the framework of the QAiST project. Below, output of this tool representing the annual energy yield per collector.
Würzburg. Alternatively, the energy output can be calculated at other temperatures and locations as well as, in principle, at any tilt and azimuth.

The development work within QAiST was followed by a model verification carried out by three partners; in addition one partner provided a validation of the model used in the tool. The validation and checks, as well as the programme itself including all equations used, are documented in one of the QAiST’s reports. This tool is freely available for download from the Solar Keymark Network website.

In October 2011 Scenocalc was approved by the Solar Keymark Network for inclusion in the Solar Keymark scheme rules. From January 2012 all new collector certificates include certified annual energy output based on EN 12975 performance tests and calculations made with Scenocalc. This tool has also been put forward for inclusion in the EN ISO 9806 draft.

**Outlook:**
**Future opportunities**

A fundamental revision of the EN 12975 standard for solar thermal collectors and the fact that this standard now forms the basis of a proposed global standard, are the two main achievements of QAiST work package 2. It is our strong belief that this work will play an important support role to future developments of solar thermal collectors worldwide. It will also serve as a solid platform for the supply of high quality products to the global market.

In particular, concentrating technologies and ETCs can be expected to develop further as there is a strong number of new applications coming on stream based on these e.g. process heat. This is also why a particular focus has been given to these collector types in the QAiST work. Moreover, we hope that the guide to the standard developed by QAiST, in particular the sections aimed at collector manufacturers, will encourage a more systematic and intensive development work. These sections should also result in cost savings for manufacturers, as inherent weaknesses in constructions can be revealed at the factory by applying the basic quality tests included in the standard. It is anticipated that the guide to the EN 12975 will need to be updated as soon as the new EN ISO 9806 has been published.

Within the framework of global harmonization, the new EN ISO 9806 is, of course, a great achievement as it is a prerequisite for a global collector certification. A draft for such a global certification scheme has already been elaborated within the Solar Keymark Network and the next few years will show whether this very ambitious task is feasible.
Another result of the project which should affect future collector manufacturing, is the work on standards for collector components and materials. So far, only one new standard is close to publication, i.e. the standard for absorber surface durability also including well-defined methods for assessment of the surfaces’ optical properties.

In the pipeline and under current development, are component standards for ETCs single tubes and heat pipes as well as standards for collector glazing and insulation materials. Altogether these standards are expected to contribute to a general rise in quality, as well as to a more rational product development, increased flexibility in collector certification and growing competition among component suppliers. All this should benefit the end users.

The Scenocalc tool, and its introduction in the Solar Keymark scheme rules, represent a critical milestone enabling the end-user to understand test results and compare collectors based on performance.

The tool is already subject to further upgrades financed by the Solar Keymark Certification fund to extend its applicability. Thus air collectors and PVT collectors are expected to be included within the scope of the tool and eventually maybe specialized applications such as large collector arrays in district heating systems.

Figure 10: Quality improvements on evacuated tube collectors present in the European market are one of the expected outcomes of QAiST. Here an infrared analysis of vacuum losses.
STANDARDS FOR SOLAR THERMAL SYSTEMS

Situation before QAiST

There was a trend in public support policies to introduce quality or performance requirements for solar thermal systems, going beyond those for collectors.

The general opinion was that requiring a Solar Keymark certified collector could not guarantee a good working system or a high energy yield. Previously such a guarantee was not available because for a major share of the market (custom-built) there was no final standard available. And, even for factory-made systems, the industry faced some difficulties as there was no definition for a system family and no extrapolation procedure between the test of one system and the performance of systems from the same family (same manufacturer).

This work was therefore both important and urgent, particularly because some member states were considering setting up their own system certification methods.

Considering the risk posed by those different national procedures; it was essential to improve European standards and the Solar Keymark, to avoid such barriers being erected.

Some member states indicated that if a good Solar Keymark procedure could be worked out, they would use it rather than a special national one.

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Figure 11: Factory made solar thermal systems are mostly thermosiphon systems, very common in southern Europe. Hence, facilitating improvements on the quality assurance of such systems was a major challenge for QAiST.
Developments provided by QAiST

To develop the EN standards for solar thermal systems the following issues had to be tackled:

- Improvement of standards for Factory-Made Systems (EN 12976 Part 1 and 2) focusing on aspects that needed clarification; so that certification of these products could take into account the different types of thermosiphons and forced circulation systems, as well as, uniform interpretation of test criteria when performed by different Certification Bodies and Test Laboratories;

- Improvement of standards for Custom-Built Systems (CEN/TS 12977 Parts 1, 2, 4 and 5 and EN 12977 Part 3) including the possibility of future certification of Storage tanks and complete systems according to improved standards;

- Development of an extrapolation procedure which is valid for different types of systems allowing for flexibility in the definition of systems families and reducing test costs for the manufacturers;

- Development of a procedure for converting the test results of the existing test method into results valid for the “EU reference tapping cycles”, necessary for Labelling of systems according to future European Directives;

The work developed within QAiST was the driving force behind the revision of the standard. Currently, a draft standard is under enquiry. All QAiST partners involved in the QAiST work on solar thermal systems, contributed to this undertaking.

The revision proposals from QAiST were communicated to to WG2 of CEN TC 312 who approved them at its meeting on September 2011, in Kassel, Germany.

Another important activity was the clarification for requirements of EN 12976 and prEN 12977. in connection with the methodologies adopted for reliability tests of different system types and preparation of checklists for the vague criteria related to requirements of EN 12976 (Part 1).

A guideline was also prepared to help laboratories and the industry in the interpretation of procedures for reliability tests of Factory-Made Systems.
Work on the extrapolation procedure allowing for flexibility in the definition of systems families and reducing test costs for manufacturers complemented some of the work started under the Solar Keymark II project. The proposal presented then was not approved by the Solar Keymark Network and the CEN Certification Board.

It was very important for the industry to have such a procedure in place as soon as possible. So this was given high priority in the project – with some support from ESTIF this process was fast-tracked and was then concluded at the first phase of the QAiST project.

This improved extrapolation procedure for the determination of factory-made systems’ performance includes the procedure approved in September 2009 and a revised version approved in March 2011, by both the Solar Keymark Network and the CEN Certification board meeting.

It was also decided within the QAiST project to establish a Round Robin Test of the DST evaluation and extrapolation method for system families. The result of this Round Robin is described in one of the QAiST project deliverables and constitutes an additional guideline for the application of the procedure.

The consortium also worked on the development of a procedure for converting the results from the existing test method, into results valid for the “EU reference tapping cycles”, necessary for labelling of systems according to future European Directives. The objective was to develop calculation methodologies for implementation of EU reference tapping cycles, which are the main part of the eco design directive (2009/125/EEC, 2010/30/EU).

Figure 12: QAiST addressed open topics related to the application of the existing test standards, such as testing procedures for factory made systems with integrated collector storage (ICS).
This would allow the use of test results already available for Factory-Made Systems or Custom-Built Systems according to test standards EN 12976 and prEN 12977, avoiding huge additional effort in testing.

Within this task, referring to Factory-Made Systems tested according to ISO 9459-5 (DST), EU reference tapping cycles were applied to the existing evaluation method. The tapping profiles were converted into sequencer files used for the ISS (InSitu Scientific Software). The annual performance for the four reference locations was calculated with the help of these sequencer files.

The performance indicators determined with this tapping profiles were compared to the performance indicators achieved with 100% evening tapping profiles. The results show, that it is not possible to use the original EU reference tapping cycles due to limitation of the ISS. An arbitrary solution was reached by altering the original EU reference tapping cycles to overcome the limitations.

A detailed description of how to apply the tapping profiles to the DST test method and how to convert the results into energy labels was elaborated and is included in one of QAiST’s deliverables: “Proposal to convert test results to “EU reference tapping cycles” for factory made systems.”

The same deliverable shows the work done to define a methodology for results conversion in relation to systems tested according to CSTG. Results showed that this is not possible.

In the case of Custom-Built Systems, the EU reference tapping cycles were converted into control

Figure 13: QAiST will contribute also to a good implementation of the Eco-design Directive for Heating appliances by developing a procedure for converting the test results of the existing test method into results valid for the “EU reference tapping cycles”, necessary for labelling of systems according to the European Directive.
files for TRNSYS (with equations and time dependent forcing functions) and applied to the evaluation of a system based on a TRNSYS simulation. A detailed description for the application of the EU reference tapping cycles to a system simulation in TRNSYS according to prEN 12977-2 was prepared.

With regard to the definition of a procedure for the assessment of hot water comfort provided by the store being part of a solar thermal system, the work was undertaken simultaneously for factory-made systems and for custom-built systems. Therefore, it was decided that the final results should be combined into one output.

A methodology for the assessment of the Hot Water Comfort of Factory-Made Systems and Custom Built Systems was established.

First, a definition for the term “high level of comfort for hot water” is proposed. Additionally, a suggestion was made for a test procedure covering a basic investigation of the issue as to whether a high level of comfort for hot water is provided by the thermal solar system. It was formulated as a pass/fail criterion.

This procedure is in line with that currently used in EN 12976-2. In order to harmonise both standard series EN 12976 and EN 12977 the proposed procedure for determining the ability to cover the load should be introduced into the EN 12977 series.

**Outlook:**

**Future opportunities**

The work performed in this work package - Solar thermal systems – opens the door to an updated standard, adapted to the market’s needs. Thanks to the contributions to the revision of EN 12976 prepared within QAiST, a draft

![Figure 14: During QAiST, some test procedures were discussed within the consortium to reach a common understanding and avoid inconsistencies as with, for instance, the measuring the bridge between tank and supports.](image-url)
version reached the enquiry phase by the end of the project. For that reason, immediately after the end of the project, the QAiST partners will have to follow up on this revision, continuing their major contribution.

Furthermore, based on the QAiST results, it is possible to clarify the requirements of EN 12976 and prEN 12977.

The work produced will facilitate the work of the laboratories and industry in the interpretation of procedures for reliability tests of factory-made systems developed within the project.

In the current software programme used for evaluating the energy yield of solar thermal systems, it will be necessary to continue promoting the methodology for the implementation of EU reference tapping cycles which form the main part of the eco-design directive.

It will also be essential to promote the methodology for the assessment of the Hot Water Comfort of Factory-Made Systems and Custom-Built Systems, to ensure that the benefits expected from this methodology materialize.
Situation before QAiST

Inter-laboratory comparison testing is an important aspect of quality assurance of testing Laboratories (see EN ISO/IEC 17025:2005, section 5.9).

Total confidence in the test results is essential for the market and a sine-qua-non condition for the development of quality assurance.

Consumers, industry and public authorities must believe that the testing, and the results provided are reliable and comparable, even when performed in different regions of Europe.

For instance, within the Solar Keymark network the industry should be as flexible as possible in the choice of test labs and inspection bodies. Even if only the results of accredited test labs and inspectors are considered valid, it is essential for the mutual acceptance of test results that the tests and inspections carried out have a uniform quality level. In order to ensure this, common quality assurance measures will be applied within the recognized test labs and inspection bodies.

Round robin testing has been conducted previously, although the results and experience gained from these tests showed the need for further improvement of the Round Robin test procedure and further quality assurance for the testing itself.

Reviewing some of the previous work, some gaps or shortcomings had been identified. On one hand, the round robin had not been managed by an independent body and on the other hand, no precise criteria had been defined and applied.

Finally, the analysis of test results was hardly possible due to lack of data and information.

Developments provided by QAiST

The round robin test for solar collectors (12 participants) and solar thermal systems (9 participants) can be considered as the largest ever carried out in the field of solar thermal technology.

In addition, for the first time ever, this round robin was evaluated by an independent institute (Institut für Eignungsprüfung, IfEP) using acknowledged procedures for the evaluation of proficiency tests.

Figure 12 shows an example of the tested flat plate collector.

The evaluation was carried out using the so-called Z-score with the following thresholds:

\[ |Z| \leq 2 \text{ satisfactory participated} \]
\[ |Z| \geq 3 \text{ unsatisfactory participated} \]
\[ 2 < |Z| < 3 \text{ result questionable} \]
IfEP considered the overall result as very good although different test procedures (e.g. steady state and quasi dynamic) were used.

“12 laboratories from 8 European nations participated in the proficiency test “QAiST testing of solar collectors and solar systems 2010-2011” that was evaluated by Institut für Eignungsprüfung (IfEP GmbH) in Marl, Germany.

The results submitted in 2010 and 2011 were evaluated on the basis of a robust statistical method, in order to minimize the influence of outliers regarding individual laboratory mean values. The total results show very good results. Although the tasks were very complex, the results were close together. Compared to other proficiency tests in the field of mechanical testing the results are clearly better. The number of unsatisfactory results is clearly lower. This shows a very good quality of work in the participating laboratories. It gives a conclusion of the high level of training of personnel and the high quality of the standards used.”

Extract from IfEP report

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**Figure 15:** Collector output of all measurements of the collector output at 1000 W m⁻² and a temperature difference between mean fluid and ambient temperature of 0 K for the flat plate collector.
The results, presented in a more scientific manner, give an estimation of the test results’ accuracy and help industry to understand this accuracy.

With the procedure consisting of two rounds of round robin (one in 2010 and one in 2011), with one interim report in between, it was therefore possible to make adjustment to the procedures and carry out an overall improvement of both the procedures and test laboratories.

In brief, the round robin test for collectors and systems was successfully completed and it shows the excellent work undertaken by the participating test laboratories.

**Outlook:**

**Future opportunities**

The round robin test performed within QAiST was considered to be the first step towards continuing such exercises in the future.

Further detailed analysis of round robin data will be done involving all test labs. This is aimed at further improving the quality of measurements.

The first exercise will be carried out within the framework of the Solar Keymark network, where the participants discuss in detail the differences between the results to improve the procedures further.

It will be important to perform round robins on a regular basis to maintain a high level of testing. In particular, it will be imperative to start a round robin on thermal stores according to EN 12977-3, using the purchased stores and the excellent experience gained during the round robin test for collectors and systems.

Finally, on the sequence of the European inter-laboratory test comparison undertaken within QAiST, a round robin on collectors involving the North American test labs has been initiated.
Situation before QAiST

Quality assurance measures are essential for a sustainable market development. However, they can also become a barrier for the introduction of innovations (either innovative products or product innovations) if not developed or updated accordingly. In order to do so, a good knowledge of the state-of-the-art for the technologies in question is, among other issues, essential.

In particular some areas have known interesting developments when the QAiST project was planned. Applications such as solar cooling, products such as solar thermal and heat pump (SHP) systems or systems allowing function and yield control for large solar thermal systems were considered important for the future development of solar thermal products and applications.

With reference to the combination of heat pump and solar thermal collectors, no systematic work had been carried out to compare different systems available on the market. There were no performance evaluation procedures and quality requirements available. In addition, there were no testing standards for these systems’ performance evaluation and quality assurance. Besides, the components optimized for an integrated operation i.e. the solar collector and the heat pump unit often do not meet the quality standards required by the respective labelling schemes for the single technology. This is mainly due to the fact, that current standards are not designed to cover many of the operating conditions, specific designs etc. which are found in combined systems. This could have a negative impact, in the mid and long term, on further development and marketing of SHP systems.

As for the function and yield controlling (FYC) of large solar thermal systems, among other obstacles to a significant market penetration identified by the project NEGST, were also high investment costs and lack of information for decision makers. To redress the situation, it became crucial to integrate a regulated maintenance of solar systems with the assistance of an automated function and yield control function. However, no common strategy for requirements at EU or member state level existed. Existing FYC devices and concepts had not been assessed and there were no technical guidelines in place.

In recent year the number of commissioned solar cooling installations has rapidly increased, especially in the small capacity range (<50 kW). This trend was mainly driven by the rising cooling demand and electricity grid instabilities due to overload during hot summer days caused by the use of a large number of electrically

NEW AREAS FOR QUALITY ASSURANCE SYSTEMS
driven chillers. However, there are still almost no quality assurance tools such as testing and rating standards, quality labels etc., which could ensure an appropriate support for a sustainable market development. Therefore, one of the goals of QAiST was to analyse the problems which solar cooling systems are facing in this respect and to provide a set of requirements for durability, reliability and performance testing of solar cooling systems.

**Developments provided by QAiST**

The QAiST project dedicated a major part of the work to new areas for quality assurance. It was decided to put the main focus on:
- Quality requirements and performance evaluation methods for solar thermal and heat pump systems
- Function and yield controlling of large solar thermal systems
- Quality requirements for solar cooling systems

A survey on available **solar and heat pump systems** in participating countries revealed approximately 80 different products. They vary substantially with regard to the level of integration, system configuration, heat source, collector type etc. However, they can be classified according to a number of features which would allow the development of testing and performance evaluation methods.

**Figure 16:** Durability issues, maintenance and costs of solar cooling systems were studied by the QAiST experts, performing an analysis of existing systems. The graph above represents specific peak cooling loads of different building types.
performance evaluation procedures for different families of products, thus reducing the standardization effort. A survey of available normative documents for testing and performance evaluation of SHP system did not yield any dedicated procedures for SHP systems. An assessment showed a number of deficiencies within standards regarding their application on components used in SHP systems. The validation of a proposal for an extension of existing solar collector models for unglazed collectors to cover condensation phenomena was also included.

A transparent and consistent definition of performance figures is required for the comparison of different SHP systems with each other, as well as other technologies. In cooperation with SHC Task 44 / HPP Annex 38, a proposal for main system performance figures was elaborated.

Finally, a number of testing procedures for SHP systems, being developed by different institutes, were described.

The scope of the task related to function and yield control for large solar thermal systems had to be modified during the course of the project due to limited availability of products and insufficient experience with the technology.

A survey on available concepts revealed only two market-ready products, both originating from Germany. These products, as well as further on-going and completed projects on that topic were documented and collated in one report. VDI guideline 2169 “Function control and solar yield rating for solar thermal systems”, as the only normative document available on FYC, was identified as a possible starting point for future standardization efforts at national and/or international levels.

Based on the experience of the participants, as well as on discussions with a number of external experts, preconditions for further development of the FYC technology were identified. Recommendation were made towards further FYC promotion and steps towards a harmonized views on FYC, as well as energy labelling of installed systems. External experts on the topic have been involved in the process to achieve a higher level of consensus within the community and a better dissemination of the results.

A comprehensive list of solar cooling systems in operation drawn up by IEA SHC Task 38 was updated with new installations and additional information on systems previously documented. A critical review of available standards for chillers with an emphasis on their application in solar cooling systems
highlighted the considerable shortcomings in all of available documents in this connection and substantial revisions would be needed. Based on a current German project, the incorporation of solar thermal cooling systems into EN 12977 was assessed. It was concluded, that integration is possible and that the approach used is promising. However, some additional work is still needed. According to a comprehensive survey among owners and operators of solar cooling systems, as well as renowned experts, the main problems regarding performance, reliability and durability of the installations were identified and recommendations for the avoidance of failures and problems during planning, installation and operation of systems were formulated. External experts have also been involved in the process to assess, on a wide experience basis, the needs of the technology regarding quality assurance. Involvement of external experts also ensures a better visibility for the project within the relevant community.

**Outlook: Future opportunities**

By establishing a good cooperation with other international activities, the results of the work package will be directly used as a basis for further developments in the area of quality assurance for solar and heat pump systems within IEA SHC Task 44 / HPP Annex 38 “Solar and Heat Pump Systems” and for solar cooling systems within IEA SHC Task 48 “Quality Assurance and Support Measures for Solar Cooling”.

**Figure 17:** Flowchart of the recommendations and timing for further needed activities in the field of function and yield control for large solar thermal systems (FYC-LSTS) proposed by the QAiST consortium.
The creation of a joint working group between CEN TCs 312 and 113 for the development of testing and performance evaluation standards for solar and heat pump systems has been initiated.

The basis for a technology roadmap for function and yield control of large solar thermal systems put forward by QAiST will be further developed and discussed within different platforms. It will also be used as a basis for the development of national and international activities in that connection.
Situation before QAiST

In the 1990s and early 2000s European companies wanting to either export to or set up in other member states encountered some hurdles in the form of different requirements that became an obstacle to market penetration. As a result, if a company wanted to sell one collector in different European countries, its products had to undergo several tests to obtain the requisite certificates and approvals.

This process was extremely complicated, expensive and cumbersome, and hindered the development of solar thermal in Europe as well as the growth of solar thermal manufacturers.

In 2003 the European Solar Thermal Industry and major testing institutes devised the Solar Keymark Scheme rules as a unique and simple solution to get solar thermal products recognised all over Europe.

As a result, more than two thirds of the collectors sold had Solar Keymark. Testing, inspection and certification were now organized into a single streamlined process which was recognized by authorities across Europe. Quality assurance in the European market became easier to implement and keep up-to-date.

Nevertheless, the solar thermal market in many EU member states was still in its infancy, at the start of the QAiST project...

It was important, therefore, to promote quality assurance measures, including the Solar Keymark in some of those countries, particularly several new member states and EU candidate countries.

The European Solar Keymark certification scheme was also a relatively new initiative that needed to be further consolidated.

Updating the Solar Keymark certification scheme and improving the operation of the Solar Keymark Network was a critical step to strengthen further the Solar Keymark label, to gain further acceptance across Europe.

Developments provided by QAiST

The Solar Keymark indicates that products conform to European standards adopted by CEN. This means that to continue meeting the market needs, the Solar Keymark will always depend on the relevant European Standard(s), the EN standards 12975 and 12976.

It also develops in parallel with the EN standards, anticipating the inclusion of the new soon after the standard is implemented.
The ongoing evolution of the standards also ensures that it shadows the market developments. This is why a major part of the communication effort of the QAiST project targeted the industry. It had to be involved in the work being undertaken towards developing the existing standards to obtain invaluable input for the process.

This implies an interface with industry over the entire project, to ensure a consistent and adequate contribution to European standardization. This also applied to the work within CEN and its structures.

The dissemination effort undertaken within QAiST had to be directed also to other stakeholders. That occurred throughout the QAiST project, in particular at the most advanced stages, when some of the project outputs were available or at least ready to be communicated. This was done in different ways, for instance, via presentations in relevant events related to solar thermal or at national expert meetings.

Another important QAiST objective was to promote quality assurance to new EU member states and candidate countries, with special emphasis on the Solar Keymark certification scheme.

Since its introduction, several national authorities in Europe have recognized the Solar Keymark certification in parallel with any valid national certification procedure. In many European countries the Solar Keymark is already a precondition for granting financial incentives or for compliance with the requirements of building codes. QAiST helped to broaden the knowledge and acceptance of the

Figure 18: QAiST supported the development of Solar Keymark promotional material, such as the brochure represented on the left. This brochure is now available in 8 languages, including Mandarin.
Solar Keymark in more countries. One of the tools used to this effect were workshops involving representatives of national public authorities and from industry. These workshops have been organised in Bucharest, Romania, in November 2010 and in Warsaw, Poland, in December 2011.

Furthermore, detailed reports on the status of quality assurance have been prepared for 11 countries. These reports include information regarding the regulatory framework, public incentives, testing and certification requirements, other relevant information, such as insurance demands or other trade barriers.

Concerning the expansion of the Solar Keymark Network, QAiST promoted the involvement of test labs from CEE-SEE countries in the Solar Keymark Network, such as Albania, Cyprus, Czech Republic, Macedonia (FYRO), Poland and Slovakia. The Slovak and Cypriot partners became members of the SK Network and other partners are considering this eventuality.

QAiST also supported the internal development of the Solar Keymark Network. It also supported the development of internal rules for the organisation as well as many other proposals that have been incorporated into the Solar Keymark Scheme rules. One in particular has had a major impact: the extrapolation procedure for system families. It has introduced flexibility into the procedure, reducing greatly testing costs. It has also facilitated the new funding structure of the Solar Keymark Network, making

![Figure 19: The Solar Keymark Network has now accredited test labs in 12 European countries. This recent expansion is also the result of the efforts done to this effect by the QAiST project.](image)
additional funding available for standardization and certification: the Solar Certification Fund.

Finally, QAiST has produced a lot of information about quality assurance missing at European and global level. Some of the results or data prepared by QAiST have been used in different presentations and publications.

Outlook: Future opportunities

The outlook in terms of quality assurance depends not only on the standardization work to which QAiST contributed, but also on other topics such as the CE marking for solar thermal products, or the energy labelling for heating products.

These issues are, in general, beyond the scope of QAiST but clearly the work done within QAiST will also be very relevant for those processes.

Solar Keymark is now widely accepted and recognized by almost all the national subsidy schemes and regulations. However, some minor add-on requirements continue to exist in few member states and other may appear. This work will then continue after the QAiST project, promoted mainly by ESTIF and the Solar Keymark Network, which have great interest in promoting the findings and this work.

QAiST leaves a clear legacy also in the future promotion of quality assurance. The work leading to the implementation of the Solar Certification Fund will enable the Solar Keymark network to sponsor activities related to testing and certification on a sustainable level for the foreseeable future.
Situation before QAiST

One of the issues that was raised is how to extrapolate the positive European Solar Keymark experience to a global level. Furthermore, would it even be feasible to have a global certification that would lower barriers to international trade.

During the planning of QAiST several opportunities were envisaged. Within IEA and its Implementing Agreement “Solar Heating and Cooling” a new task was proposed by the US representatives. This Task would focus on “Rating and Certification Procedures - Advanced Solar Thermal Testing and Characterization for Certification of Collectors and Systems”. This represented a unique opportunity, and combined and coordinated European efforts were critical to achieve good results within this task.

The planned revision of ISO 9806 standard and the Australian and US-American standards for solar thermal systems and components (e.g. AS/NZS 2712, ASHRAE 93) was also a unique opportunity.

Altogether it meant that it could be the right time to use the European experience to influence this work and try to get those standards closer to the EN 12975-2 and therefore make it easier for European industry to export in the global market.

Developments provided by QAiST

In an international context, common standards and certification schemes play an important role for a free market of quality products without technical trade barriers.

This has been experienced in Europe, where the common European Standards and the CEN Solar Keymark scheme have played a major part in developing a large and open European market for quality solar collectors.

There is some relevant experience accumulated to support the development process towards a global standard for solar thermal collectors, harmonized to the revised EN 12975. The unique gathering of some of the main test laboratories in Europe, achieved within the QAiST consortium, provided the opportunity of relying on the involvement of some of the best European experts, allowed for a strong cooperation but also coordination at European level in the field of standardization.

The objective was also to influence the harmonization of standards worldwide, contributing in this way to the acceptance of European Products tested according to European Standards in other markets. Hence, the promotion of
the concept of a global quality brand; be it the Solar Keymark or another label, that could make the best use of the European experience.

For that reason a close collaboration with ISO was established. In particular, the collaboration with ISO/TC 180 on collector test standards has occurred on a regular basis. It was agreed that the revision of the ISO 9806 series of standards for Solar thermal collectors would be based on the EN 12975-2 standard and that CEN would lead the revision work.

The QAiST contribution to this process was paramount. On one hand, the participants in the project were kept informed on the work developed at international level on standards related to Solar Thermal Collectors and Systems. On the other hand, they could contribute to the debate, passing on experiences, ideas, information to the group involved in the ISO standardization work.

Another important component of this international standardization work was the involvement of QAiST participants in a Task within the framework of the IEA Solar Heating and Cooling Programme: the Solar Rating and Certification Procedures - Advanced Solar Thermal Testing and Characterization for Certification of Collectors and Systems.

Within these two frameworks, the objective was to create a global

Figure 20: Map showing the different certification schemes for solar thermal products, existing at global level by the end of 2011.
framework for coordinating and harmonizing standards and test and certification procedures used around the world. Even if the work is not completed, this objective was achieved. The international cooperation in this field is at its peak, with a strong European involvement.

Naturally, these processes take time and will extend beyond the duration of the QAiST project.

Nevertheless, we can surely state that the work of the experts involved in the QAiST project made all the difference.

**Outlook:**

**Future opportunities**

The standardization and certification work is an on-going task. Even if the QAiST project represented a milestone, the work has not ended, either on the improvement of the standards or the development of the certification schemes.

The European cooperation established will be important in the upcoming revision of the ISO 9806 series of standards for solar thermal collectors.

This revision will then provide common standards at international level and result in the development of global certification.

This global certification can take different forms: extend globally an existing certification scheme mark, develop a new certification scheme or strengthen the mutual recognition of the existing schemes.
The project has produced many outputs, related to the various topics referred previously. Not all of them can be publicly available but the large majority is. We present below a description of the available outputs, which can be downloaded from the QAiST website: www.qaist.eu

**Solar Thermal Collectors**

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<td>Proposals for revision of the present EN 12975 with respect to tracking/concentrating and mid temperature collectors including ETC</td>
<td>Topic report: Performance testing of evacuated tubular collectors (R2.1)</td>
<td>Summary of work carried out, main results and proposals for standard revision</td>
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<td>Topic report: Experience from tests on concentrating and tracking collectors (R2.2)</td>
<td>Summary of work carried out, main results and proposals for standard revision</td>
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<td>Topic report: concentrating / tracking collector component characterization (R2.4)</td>
<td>Summary of work carried out, main results and recommendations for standard revision</td>
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<tr>
<td>A guideline to the EN 12975 allowing uniform interpretation of requirements, harmonized application of the standard and presentation of results</td>
<td>A guide to the standard EN 12975</td>
<td>A guide directed to established and new test laboratories for collector testing. The main purpose is to give a quick introduction to the standard for new laboratories and in general to contribute to a uniform interpretation of the standard and presentation of results.</td>
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<td>Understanding and using collector test standard EN 12975</td>
<td>A guide directed to manufacturers and importers of collectors. The purpose is to give a very light introduction to the standard and to explain how it is used for type testing as well as for innovation and development support.</td>
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<td>A procedure for calculation of energy output of solar thermal collectors</td>
<td>Scenocalc - Solar Collector Energy Output Calculator</td>
<td>Software developed to calculate the annual energy output from a solar thermal collector. The software is free of charge and can be downloaded from the Technical Research Institute of Sweden’s (SP) or the QAiST's webpages.</td>
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<td>Summary report on durability and reliability requirements (D2.2)</td>
<td>Summary report on durability and reliability requirements and test methods for collectors and components including proposal for changes or complements to current EN 12975. This report summarises the work carried out and the findings that are communicated with further detail in various reports.</td>
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<td>Summary report on rain penetration tests (R2.10)</td>
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<td>Summary report on one year exposure (R2.11)</td>
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<td>Summary report on pressure drop measurements (R2.13)</td>
<td>Background to pressure drop measurements on solar collectors and why a generalized method would be desirable; Review of pressure drop theory; Report from measurements on a flat plate collector using different fluids and temperatures; Proposals for a generalized method and for further work</td>
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<td>Summary report on freeze testing of heat pipes (R2.15)</td>
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<td>Background explanation of need for impact resistance test; Summary of four different methods: IEC test for PV modules, Swiss method and the two EN 12975 methods; Inputs to revision of EN 12975; Proposals for further work</td>
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<td>Summary report on mechanical load tests (R2.17)</td>
<td>Background explanation of what mechanical loads and the related testing is about in practice, how it relates to PV module testing, to CE-marking and to CPD (“Structural safety”) and how it is a topic of many different CEN TCs; Short review of shortcomings in the current methods of EN 12975 and 12976; Inputs to revision of EN 12975 and EN 12976 and to the guide to EN 12975 (Deliverable D2.3); Review of some on-going work and proposal for further work; Summary of detailed studies of loads on collectors and systems (Annex)</td>
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<td>Summary report on absorber surface durability (R2.18)</td>
<td>Background explanation of need for absorber surface durability testing; Short explanation of the Task X method* which is introduced as a new standard; Inputs to revision of EN 12975 and to a new ISO standard on collector components and materials; Proposals for further work</td>
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<td>Summary report on stagnation temperature determination (R2.19)</td>
<td>Background explanation of the need for stagnation temperature determination on solar collectors; Summary of approaches offered in the EN 12975 including sensor positioning descriptions; Evaluation of a new method for calculating the stagnation temperature based on performance test results; Inputs to revision of EN 12975</td>
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A report on durability and reliability requirements and testing methods for all collectors and its components (incl. new designs), including proposal for changes or complements to current EN12975.
## Solar Thermal Systems

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<td>Checklists for the reliability requirements of Factory Made Systems/Custom Built Systems (D3.1)</td>
<td>The document contains checklists for verification of requirements for Factory Made Systems and Custom Built Systems and for decision on applicable tests.</td>
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<td>Preparation of a Guide of procedures for Reliability tests of factory made systems</td>
<td>EN 12976 Guide for reliability test procedures of factory made solar thermal systems (D3.2)</td>
<td>This document intends to complement to the EN 12976 standard, focusing on parts 1 and 2 related to testing of solar thermal factory made systems. It is intended to support in the interpretation and application of the standard. The guide has been developed with two different target groups and objectives in mind: test laboratories, manufacturers and importers.</td>
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<td>Improved extrapolation procedure for the determination of the performance of factory made systems</td>
<td>Description and guidelines (D3.3)</td>
<td>Description of an extrapolation procedure for the determination of the performance of factory made systems, aiming at approval by the Solar Keymark Network and the CEN Certification Board. Analysis of the system performance extrapolation based on a questionnaire to test labs performing system testing and system performance experience and the evaluation of the Inter-laboratory comparison (Round Robin).</td>
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<td>Proposal to convert test results to “EU reference tapping cycles” for factory made systems</td>
<td>Energy Labelling of factory made systems - Part 1 (D3.4)</td>
<td>Development of a procedure for the existing (CSTG and DST) test methods, into results valid for the “EU reference tapping cycles”, necessary for the future European Directive. Only the Procedure for the DST test method was considered valid.</td>
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<td>Energy Labelling of factory made systems - Part 2: Annexes (D3.4)</td>
<td>Testing and manufacture data and CSTG LTPP result validation by comparison R vs. TRNSYS</td>
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## Proposal to convert test results to “EU reference tapping cycles” for custom built systems

**Document**: Energy Labelling of Custom Built Systems (D3.5)

**Content**: This document explains how custom built systems are tested according to current standards, shows an investigation of application of transitional calculation method for conversion of existing test methods to the reference conditions given by the new regulation and suggests amendments to the current standard to implement the harmonised, energy labelling specific boundary conditions to procedures used for evaluation of custom built solar thermal systems.

**Form**: Electronic / English

**Target group(s)**: SK Network; CEN; Experts; Industry

## Proposal for determination of Hot Water Comfort of factory made systems & custom built systems

**Document**: Methodology for the Assessment of the Hot Water Comfort of Factory Made Systems and Custom Built Systems (D3.6/7)

**Content**: Proposal for definition of appropriate clarification on terms and methods for the assessment of the hot water comfort, considering that the term “hot water comfort” is already used, but not defined, in EN 12977.

**Form**: Electronic / English

**Target group(s)**: SK Network; CEN; Experts; Industry

## Quality assurance of testing

## Improving the European Solar Keymark certification scheme

**Document**: Working Rules for the SK Network

**Content**: Finalised within the QAiST project, these working rules establish the procedures within the Solar Keymark Network, for its decision making processes, for its management and funding.

**Form**: Electronic / English

**Target group(s)**: SK Network / CEN

## Report describing the results of the Inter-Laboratory comparison of solar thermal collectors and systems testing (round robin)

**Document**: Proficiency Test QAiST testing of solar collectors and solar systems 2010-2011 (D4.2/3)

**Content**: This reports documents the proficiency test planned, carried out, assessed and documented on the basis of ISO/IEC 17043 “Conformity assessment - General requirements for proficiency testing” by IfEP GmbH.

**Form**: Electronic / English

**Target group(s)**: Industry; test institutes; public authorities
### New areas for quality assurance systems

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<td>Evaluation and categorisation of solar thermal and heat pump systems (SHP systems).</td>
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<td>Review of the testing and rating procedures for solar thermal and heat pump systems and components (TR5.1.2)</td>
<td>Analysis of relevant standards to assess their applicability for component and system testing of SHP products. The review covers three groups of available national and international standards and guidelines.</td>
<td>Electronic / English</td>
<td>industry; test labs, CEN</td>
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<td></td>
<td>Definition of performance figures for solar and heat pump systems (TR5.1.3)</td>
<td>Defining a set of performance indicators and definition of system boundaries and boundary conditions under which these indicators are determined in order to be able to compare different SHP systems among themselves, but also with other technologies for heating, cooling and domestic hot water preparation.</td>
<td>Electronic / English</td>
<td>Planners; installers; industry; test labs</td>
</tr>
<tr>
<td></td>
<td>Report on testing procedures for solar and heat pump systems (TR5.1.4)</td>
<td>Reporting on different performance test methods currently being developed, namely new component oriented testing procedure for SHP systems and testing procedure based on a test of the complete system (or most important subsystems) at once.</td>
<td>Electronic / English</td>
<td>industry; test labs, CEN</td>
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<tr>
<td></td>
<td>Report on specially designed components for solar and heat pump systems (TR5.1.5)</td>
<td>Validation of a dynamic model for unglazed collectors including condensation.</td>
<td>Electronic / English</td>
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<td>Undertaking</td>
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<tr>
<td>Technical report on the status and requirements for successful implementation of FYC for large solar thermal systems</td>
<td>Collection and assessment of available function and yield control concepts and devices for large solar thermal systems (TR5.2.1)</td>
<td>Analysis of the state of the art regarding function and yield control for large solar thermal systems. Description of available products and developed concepts, including current research and development efforts.</td>
<td>Electronic / English</td>
<td>Planners; installers; industry; test labs; R&amp;D institutions</td>
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<td></td>
<td>Recommendations for further needed activities in the field of function and yield control for large solar thermal systems (TR5.2.2)</td>
<td>Analysis of the required framework conditions for a successful function and yield control for large solar thermal systems’ technology development. Providing a set of recommendations to set a basis for a broader public discussion on the topic.</td>
<td>Electronic / English</td>
<td>Planners; installers; industry; test labs</td>
</tr>
<tr>
<td>Technical report on the requirements for durability and performance testing of solar cooling systems</td>
<td>Collated and updated list of solar cooling installations in participating countries (TR5.3.1)</td>
<td>Listing of solar thermal heating and cooling installations spread over the entire world, resulting from a QAIST survey and a previous Task 38 list. However, the focus is on European installations.</td>
<td>Electronic / English</td>
<td>Planners; installers; industry; test labs</td>
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<tr>
<td></td>
<td>Durability issues, maintenance and costs of solar cooling systems (TR5.3.2)</td>
<td>Detailed analysis of the outcome of the questionnaire on durability issues, maintenance and costs of solar cooling systems. Guideline regarding durability and reliability of solar cooling systems.</td>
<td>Electronic / English</td>
<td>Planners; installers; industry; test labs</td>
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<tr>
<td></td>
<td>Review on testing procedures and quality standards for thermally driven chillers (TR5.3.3)</td>
<td>Review of relevant testing and performance evaluation standards for thermally driven chillers, covering national and international standards, namely standards for testing and rating of thermally driven chillers; standards for performance evaluation of chillers and systems, and quality labelling schemes.</td>
<td>Electronic / English</td>
<td>Planners; industry; test labs; CEN</td>
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<tr>
<td></td>
<td>Assessment of the possibility of incorporating solar thermal cooling into EN 12977 series (TR5.3.4)</td>
<td>Analysis of the possibility to incorporate testing of solar cooling systems into EN1297.7</td>
<td>Electronic / English</td>
<td>industry; test labs; CEN</td>
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## Communication and dissemination

<table>
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<th>Undertaking</th>
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<tr>
<td>Information about quality assurance methods in solar thermal heating and cooling technology</td>
<td>Web sites references and screenshots (D6.1)</td>
<td>References to relevant websites on topics related to quality assurance in solar heating and cooling</td>
<td>Electronic / English</td>
<td>Public authorities, stakeholders from CEE</td>
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<tr>
<td></td>
<td>Country reports (D6.2)</td>
<td>Reports with a summary analysis of the situation in different countries regarding topics such as: regulatory framework; public incentives, testing &amp; certification obstacles and other information. Available country reports: AT, CZ, DE, DK, ES, FR, GR, MK, PL, PT, SE, SK.</td>
<td>Electronic / English</td>
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<td></td>
<td>Presentations given at ESTIF workshops on standards and certification (D6.6)</td>
<td>Presentations done from 2009 until 2011 in workshops on standards and certification organised by ESTIF for its members, including updates on the work done in QAiST: revision of the standards, global certification, promotion and development of the Solar Keymark.</td>
<td>Electronic / English</td>
<td>Industry</td>
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<tr>
<td></td>
<td>Presentations about the work in the QAiST project (D6.9)</td>
<td>Presentations done by QAiST partners in conference, symposia, meetings about the work being developed in the framework of the project. These can be presented in different forms: communications, abstracts, poster or other.</td>
<td>Electronic / English</td>
<td>Experts on Solar Heating and Cooling</td>
</tr>
<tr>
<td>Comprehensive information about Solar Keymark available in CEE new member states</td>
<td>Solar thermal Quality factsheets (D6.5)</td>
<td>Factsheets providing information and answers on common questions and doubts about quality assurance in solar thermal products. Includes topics such as: applicable standards, Solar Keymark, certifying a product, recognising a SK test lab and listing Certification Bodies.</td>
<td>Electronic / English</td>
<td>Industry &amp; test labs in EU NMS</td>
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<td></td>
<td>Manual and guides related to quality assurance (D6.5)</td>
<td>Brochure explaining the Solar Keymark certification, Guidelines on the use of the EN12975 (one for industry, one for test labs)</td>
<td>Electronic / English</td>
<td>Industry, test labs, certification bodies &amp; public authorities in EU NMS</td>
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<td></td>
<td>Presentation at workshops for SEE and CEE countries (D6.4)</td>
<td>Presentations done in workshops targeting new EU member states, held in Romania and Poland, covering topics such as: quality assurance in solar heating and cooling, Solar Keymark, recent changes in the standards and outlook, solar thermal markets in Europe, European and national policies promoting the development of the sector, latest developments of solar thermal technology, solar heating in building renovation or retrofitting, solar assisted district heating.</td>
<td>Electronic / English</td>
<td>Industry, test labs, certification bodies &amp; public authorities in EU NMS</td>
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The work done during the QAiST project led to important achievements. The project consortium discussed some of the main achievements, which could be considered as the success stories from the consortium perspective and hence be shared.

**International developments in standards & certification**

One of the main objectives of the QAiST project was to work for a global harmonization of solar thermal test standards and certification schemes. The European standards for solar thermal products as well as the Solar Keymark certification scheme has been developed over the past ten years during which standardization work on a global (ISO) level has been idle.

The European standards were applied successfully in numerous tests and certifications of European products as well as of products from outside Europe.

It was desirable to aim for a global harmonization based on these procedures, not only as it would mean benefits for the European industry but also because the European standards have also reached a more mature state and have a more generalized scope compared with all other, thus enabling testing, characterization and certification of a much wider range of products than would otherwise have been possible.

Within the QAiST project and the related IEA SH&C Task 43, the conclusion reached at an early stage was that solar collectors would be the first group of products to which the concept of globally harmonized standards and certifications would be applied. This due to the relative simplicity of the product and the fact that collectors are more easily traded all over the world without particular concern of national design traditions etc., as in the case of systems. As it turned out during the QAiST project, complementary work was carried out e.g. in the US related to tracking concentrating collectors.

The current standard proposal for collectors has consequently been able to benefit from additional ongoing work on testing of concentrating collectors. As a result, they are now for the first time fully integrated in the standard.

Thus, what started as a development of inputs to the revision of the European EN 12975 standard and an ambition to seek opportunities for global harmonization, developed into a global agreement for a new ISO standard based on the draft EN 12975. The new standard, currently on a public review as EN ISO 9806 will thus, once approved and published which is expected to take place late 2013, supersede
EN 12975-2 as well as ISO 9806-1, -2 and -3. The new global standard will have a huge impact in industry on the further development and broad introduction of solar thermal products worldwide. The fact that the global harmonization of standards has developed so well has also spurred work on a globally harmonized certification of collectors. The process of getting such a system in place, in cooperation with IEA SHC Task 43, has had a very good start thanks to the QAiST project.

**Bringing European experts together**

Partners in the QAiST project are mainly representing entities (institutes/universities) that have expertise in testing thermal solar systems and components. In most cases testing laboratories have worked in this field for a long time (some for more than thirty years) and are participating actively, in their own countries and at European level, in the development of Standards and Certification schemes.

Over the years, in many of these laboratories a new generation of experts has started working in this field. QAiST was very important in bringing together experts from different generations and providing an opportunity for the development of joint work, fulfilling not only the objectives of the project, but also fostering personal contacts thus sowing the seeds for future projects in this field.

Within QAiST it was also very important to learn how to use modern communication tools such as Webinars making a more efficient use of time for project meetings.

The working relations developed were very good and fruitful; they also showed that, although the laboratories are competitors in the testing services, they can work together towards the objective of better standards and certification schemes and higher expertise in testing. This will result in better services to industry and higher quality of thermal solar systems promoting a sense of trust among users.
Inter-laboratory comparison (round robin)

The Round Robin test for collectors has been a success story for a variety of reasons. On one hand, the results of these inter-laboratory tests were very good. All participating test laboratories achieved good results and passed the round robin test. It also showed that testing with different accepted test methods lead to similar results.

This gives a very good indication that these labs provide a positive contribution to quality assurance of solar thermal products to the European market and to the manufacturers. The results help industry understand the accuracy of results given in test reports and increased the trust in results provided by different test labs.

The preparation of this exercise and the round-robin tests allowed the test labs to improve their procedures and the common interpretation of the standard, helping them to tighten procedures. Finally, the scientific evaluation done by IfEP constitutes an important learning tool for the test laboratories.

Guides to the standards

Most national and especially international standards are difficult to understand. Sometimes, it takes several years until all details are well known and some will never be published. With the guides for the solar thermal collector standard EN 12975 as well as for the solar thermal system standard EN 12976, a perfect support is now available.

These guides will be used by different parties such as test lab newcomers, manufacturers but also by well-established test labs for clarification and training.

To get a good result (products) as well as harmonized test procedures, it is important, that all participating parties such as manufacturers, test labs and certification bodies fully understand the relevant standards and test procedures.

Especially for systems standard EN 12976, there was a major misunderstanding between manufacturers and test labs as to which tests were physical tests and those which were only document examinations with reference to other existing standards. With the new guide, there is now a concerted interpretation given by international experts. It will provide a strong support to the certification of complete systems in the field of Solar Keymark system certification.
The collector standard EN 12975 is well established and the guide will primarily support new test laboratories as well as manufacturers wishing to carry out their own tests prior certification testing or as part of their internal routine tests.

In conclusion, the guides will promote testing harmonization, its quality as well as the preparation by the manufacturer. So they will play a significant role in ensuring that good quality solar collectors and systems are placed on an increasingly globalized market

Identify needs and next steps for quality assurance

Solar cooling is a young but growing market which can strongly contribute to the fight against climate change and the depletion of non-renewable energy sources. To achieve wide acceptance and broad confidence from potential users, it is necessary to guarantee the quality of solar thermal cooling systems. As part of the QAiST project, a pan-European survey among operators and users of solar thermal cooling systems was carried out. The survey was designed to collect both quantitative system data and a qualitative assessment from operators and users.

The combination of these qualitative and quantitative data led to the identification of eventual problems related to the operation of solar thermal cooling systems. The outcome of this investigation are guidelines for planners, installers and operators of solar cooling systems. These guidelines include a catalogue of potential problems in solar thermal cooling systems and their solutions. Therefore they do not only cover the operation of the plant, but also show how to avoid typical pitfalls at the design stage and during maintenance.

The next step with regard to quality assurance of solar thermal is the development of a standardized test method for both operational and performance testing as well as for a comprehensive environmental assessment of solar thermal cooling systems. The results of the QAiST project contribute directly to the identification of criteria that are applied in such a standard. An appropriate standard regarding the overall assessment of solar thermal cooling systems will strengthen the confidence of potential users in this technology and lead to greater satisfaction from users.

Development of the Solar Keymark

Last, but definitely not least, we would like to refer to the development of the Solar Keymark promoted through QAiST as a success story in itself. Several success stories previously mentioned contributed also to the
development of the Solar Keymark quality certification scheme.

The **international developments in standards & certification** have contributed to international harmonization, which will lead to the potential development of global quality mark. Anyhow, it can only benefit the Solar Keymark to gain greater recognition beyond European frontiers.

**Bringing European experts together** had a major impact on the Solar Keymark. Most of the participants in the QAiST project are also members of the Solar Keymark Network. The cooperation within QAiST also facilitated the cooperation within the Solar Keymark Network. Furthermore, the results from the QAiST project could very quickly be implemented in the Solar Keymark certification scheme and applied immediately for the benefit of the European solar thermal industry.

**Inter-laboratory comparison** enhanced quality assurance in testing, also between the Solar Keymark recognized test laboratories. It gives more confidence in the results and the opportunity to compare them, which in turn provides additional confidence in the Solar Keymark certification scheme.

Besides, the development of **guides to the standards** will assist the test laboratories by providing a common interpretation of the test standards; it will also help other stakeholders, such as industry and public authorities, to understand in broad terms, the requirements of the solar thermal collector standard EN 12975.

There were, however, other important contributions to the development of the Solar Keymark. As an example, we can refer to the **system certification**. It was a clear message from the industry (expressed in ESTIF workshops and General Assemblies), that the Solar Keymark system certification should be more flexible - without the requirement for testing each and every system configuration. This message was taken on board by the QAiST participants and, within the project, procedures were developed to estimate the thermal performance of the whole “system family” based on tests of only 1 or 2 systems. The procedures were successfully validated - and now these flexible system certification procedures are implemented in the Solar Keymark certification scheme (Annex D of the Solar Keymark certification scheme). As a result very significant savings in testing costs have been achieved through the introduction of these procedures.

Another important outcome was the development a new **energy output calculation tool**. So far, the main collector performance indicator in
test results was always the collector efficiency curve and the related collector efficiency parameters. Although, the efficiency curve only shows that the collector is performing well in the low temperature and/or high temperature region. It was essential to go a step further and to provide information on the annual energy output of the collector. Within the QAiST project a spreadsheet tool, “ScenoCalc” was developed to calculate the annual energy output of a collector using the collector test results.

Finally, the Solar Keymark Network approved this new tool and decided that new collector test reports should include the collector annual output calculation for at least the four “CEN locations” (Athens, Davos, Stockholm, Würzburg) according to “ScenoCalc” calculations.

And furthermore, the contribution from QAiST to the development of the Solar Keymark is not limited to these issues. More examples could be mentioned, such as the enlargement of the Solar Keymark Network, the promotion of quality assurance effected in different countries, opening the door to the application of the Solar Keymark on more solar thermal products, etc.

If the EU co-funded projects Solar Keymark I and II have led to the creation and establishment the Solar Keymark, QAiST has helped
Throughout the QAiST project many lessons were learned. Some of the most relevant, related to both project management and communication, were:

**Management**

- **Interaction between partners:** there are limited opportunities for face to face meetings, while these meetings prove to be more effective. Other options such as telephone conferences may be good opportunities but these are not as effective in terms of reaching a consensus (e.g. discussion on the revision of the standards). Also some efforts to try to adapt would help in making the most of long distance meetings.

- **Initial planning:** the initial planning done at the kick-off meeting is essential and could be improved with more time available at that meeting. This extra time would be required for a better assessment of the competences and preferences of different partners, resulting in a more efficient allocation of responsibilities.

- **Intermediate targets:** considering that the QAiST deliverables were due at the end of the project, the creation of intermediate targets was very important to assure timely work and commitment.

- **Initial budgets:** It could have been foreseen that work package...
leaders would need more funding for travelling, than other partners.

**Communication and Dissemination**

- **Communicating “quality”:** quality assurance is not an easy subject to communicate to a broad group of stakeholders. It seems to be a topic that everyone thinks important, but that few people really grasp or are able to put a price-tag on. This complexity could have been addressed also in the project with more emphasis to find new ways of “spreading the word”

- **Lack of information on quality assurance:** information about quality assurance was very limited, in particular in connection with solar thermal. The production of project materials, data and content targeting different audiences was important. There is a need for more, but QAiST has provided a huge contribution, even beyond the European level

- **Timely communication:** in particular when addressing public authorities and industry, the timeliness of the communication is essential. This may be difficult to schedule in advance. Therefore a compromise has to be reached, between communicating the work and results of the project when these are available and addressing the relevant target groups when appropriate.

*Figure 22:* The UNEP “Guide on Standardisation and Quality Assurance for Solar Thermal” tackle the lack of information about quality assurance in solar thermal products at global level. This guide relied partly on data and information that was available thanks to the work done in QAiST.
The ambitious European targets for 2020 require a strong uptake of solar heating and cooling. The potential to cover an important share of the heating and cooling demand is huge. Therefore it is essential to provide to markets, the consumers and public authorities with adequate quality assurance.

The QAIST project provided an invaluable contribution to this goal, by promoting the development of the existing European Standards and the European quality mark for solar thermal – the Solar Keymark - but also by contributing largely to groundbreaking developments in international standardization and certification.

Xavier Noyon
Secretary General
ESTIF - European Solar Thermal Industry Federation

The QAIST project achieves a huge improvement on the testing methods of the current European Standards. It allows to put in common the extended knowledge of the main European testing labs in the Solar thermal heating and cooling area and to write documents really useful for the industry. The round-robin organized between the 12 main European testing labs allowed to validate the current procedures. The project also improve and settle the testing procedure in new and emerging technologies that could be the future of solar thermal industry. Finally this project allows harmonizing the entire Standard in an international level in order to join the existing EN and ISO testing procedure.

Enric Mateu Serrats
Engineer – Solar Thermal Energy Department
CENER – National Renewable Energy Centre

Even if solar thermal heating and cooling is no longer an innovative technology, many actions remain to be done in order to make the solar thermal industry even more competitive.

The QAIST project has contributed to this goal by keeping EN standards and certification schemes up-to-date and improving quality assurance and reliability of thermal solar components and systems.

CSTB, as a research and evaluation centre, will take advantage of the harmonization in testing and certification, as well as of the broad promotion of the quality concept.

Dominique Caccavelli
Head of the RES section
CSTB – Centre Scientifique et Technique du Bâtiment
Standards and certification are of critical importance for the broader dissemination of solar thermal technologies, to the degree that they enable the objective assessment of the efficiency and quality of the products, thus increasing the confidence of the potential users.

Within this context, the QAiST project provided the opportunity for experts in the field of solar thermal to work together on issues as the adaptation of standards to the current state of the art of the involved technologies or the verification of the level of excellence of the testing laboratories through the round-robin test.

Solar thermal industry is a vibrant industry sector constantly improving existing products and/or introducing new ones in order to enter new markets or to supply their customers with new applications. This process requires not only cutting-edge R&D effort – it has to be accompanied by state-of-the-art quality assurance measures, both for single components and whole systems.

The QAiST project brought together leading European solar institutes to support the further development of the solar thermal industry by keeping standards and methods up-to-date with the technological advance and to prepare the framework for quality assurance measures for new solar thermal products and applications.

Quality assurance in Solar Heating and Cooling technologies has been a major objective of solar energy European experts in this field since the 90’s. This has materialized into a set of standards (EN 12975; EN 12976; prEN 12977) and a certification scheme – Solar Keymark – supported by its Network of Testing Laboratories, Certification Bodies with the strong support of Industry in a way that may be exemplary to other technologies.

The QAiST project gave, during these three last years, a strong support to the work of experts towards the objective of achieving a framework of Standards and Certification Scheme Rules that will continue to assure the quality of Thermal Solar Systems.
Solar heating and cooling has a strong position as a renewable energy source. It is crucial that we get to know and understand the opportunities to improve efficiency of the energy conversion processes.

The essence of the QAiST project was the Quality Assurance. It gathered international experts and helped to develop an environment to determine the crucial information by tools as round-robin tests and standard development, where we are and where do we go from here.

I believe that the final results of the QAiST project already have a great impact on both the market/manufacturers and the certification/research sides of the industry.

Bringing such a big group of experts together and having them working on a big number of issues consequently and straightforward for three years was a great success. The project solved lots of problems and by the way established even a more cooperative network of solar thermal experts all over Europe.

From the technical point of view the work done in the project will prove its big impact in the coming years by applying the revised standard, the guidelines and the dissemination materials provided.

The QAiST project brought together European experts for solar thermal in a very fruitful and constructive way.

New approaches concerning new techniques and test procedures to assure good quality of products were discussed and evaluated by the partners.

The project had a great accelerating effect in European standardization process for solar thermal related products and serious impact on international standardization.
Solar thermal heating and cooling are key elements to reach the target proposed by European Commission in 2020 with respect to the renewable energies contribution.

The QAiST project made possible the definition of appropriate requirements and test methods needed to evaluate the performance and to assure quality and safe implementation of recent and upcoming developments in solar thermal collector technology and of emerging application areas of solar thermal energy. The improvement in quality assurance and systems reliability will benefit the solar thermal market and the competitiveness of the European industry.

B. Nicolás Díaz-Chico
Managing Director
ITC – Technological Institute of Canary Island

Within the QAiST project major extensions and improvements of the solar thermal test standards and certification schemes were initiated. Additional to that the 12 participating test labs had the exceptional opportunity to validate and improve their test procedures based on an independent supervised Round Robin test for solar collectors and solar thermal systems.

QAiST was a huge step to provide a reliable basis for further involved certification bodies and test institutes. For customer confidence and marked growth of this highly efficient renewable energy source it is fundamental to assure the proper functioning and long term performance of the installed solar thermal systems. Future work should take the development of appropriate standards for function and yield control into the focus.

Danjana Theis
Head of the solar test centre
IZES - Institut für ZukunftsEnergieSysteme

Important steps forward in international standardization has been taken due to the huge work done by the partners in the QAiST project:

- European Standards for solar thermal products have been significantly improved and also expanded in order to include new products on the market.
- The revised EN Standard for testing of solar collectors will be an ISO Standard too; this means that the same test procedures in the near future will be used (almost) all over the world.

These steps are important for the European and world market as they will assist in braking down trade and other barriers to an open market - for the benefit of deployment of quality solar products in Europe and other parts of the world.

Jan Erik Nielsen
Head of Dept.
PlanEnergi
Proven product quality and reliable data on potential savings are prerequisites for a strong development of the Solar thermal market. This is particularly true for new products that are introduced at increasing speed on a market which is becoming more and more global.

In this context QAiST has made a difference. Global harmonization, improved test methods and extended scope of standards and certification schemes has been achieved, partly beyond our most optimistic expectations. I actually believe that QAist has set an example for future work on Quality assurance in the field of renewables. It has been a true privilege to be a part of this team!

Peter Kovács  
Research Engineer  
SP - Technical Research Institute of Sweden

We want to thank the commission for the purpose of enabling TÜV Rheinland to participate in this excellent project. It was a great experience to work together with the leading European experts in the field of solar thermal research and testing.

With the new draft for an international collector standard, we’ve made a big step forward towards the chance of an international certification scheme. The QAIST-Project had contributed to display the overall testing quality in Europe and it had shown us the fields for further improvements and work to do.

Ulrich Fritzsche  
Director of Global Competence Center Solar Thermal Products  
TEU - TÜV Rheinland Energie und Umwelt GmbH

The major tools to create and improve the quality of solar thermal products are well elaborated standards, a corresponding certification scheme and well established research centres and test laboratories.

The QAIST project added to all the mentioned requirements. The standards could be significantly improved. The certification scheme Solar Keymark and its network have gained a much higher acceptance and influence than before the project and serve as examples for an upcoming global certification scheme. Last but not least the established research and testing centres demonstrated their competence by the outstanding result of the Round Robin test on collectors and systems.

Stephan Fischer  
Group leader testing of Research and Testing Centre for Thermal Solar Systems (TZS)  
ITW, Universität Stuttgart
Solar heating and cooling can play an important role in helping EU member states reaching their national 2020 targets for renewable energy. Today, solar thermal is the most important decentralized and emission-free renewable energy source in the world. However, in many regions, including several European countries, it has still to find a way to mass-market.

Quality assurance in solar heating and cooling technology is a precondition for a sustainable market development. It fosters wider consumer confidence by means of improved standards and certification schemes, via harmonization in testing and certification, as well as a broad promotion of the quality concept.

Promoting quality assurance for solar thermal products supports the efforts of public authorities while seeking to implement effective and sustainable policies encouraging the uptake of clean, cost-effective and reliable solar thermal energy in their countries.

Furthermore, standardization and certification at the European level help reduce trade barriers and create a single European market for solar thermal products, enhancing the competitiveness of the European solar thermal industry.

So far, in Europe, the harmonized European standards and the CEN Solar Keymark scheme have played a key role in developing a wide and open European market for quality solar collectors and systems.

However, the European solar thermal sector faced many challenges regarding quality assurance.

On one hand, it was important to improve the existing European standards to adapt them to the current and future market requirements. On the other hand, there was the long-term objective of supporting the development process towards a global standard for solar thermal collectors, harmonized to the revised EN 12975.

Besides the work on standardization, it was also important to have adequate testing in place in even more European countries.

While quality assurance in testing was important, it was also vital to develop the main third party testing and product certification scheme for solar thermal products in Europe: the Solar Keymark. This meant improved scheme rules and optimized operation of the Solar Keymark Network, resulting in a wider acceptance of this quality label.

These challenges were addressed during the QAiST project and, as demonstrated in this report, the
project was largely successful in meeting such challenges.

The work done within QAiST, through the different work packages, covered several important topics, such as:

- Standards for solar thermal collectors and solar thermal systems, providing a number of breakthroughs and submitting several drafts towards the revision of the existing standards;
- Quality assurance in testing, including an inter-laboratory comparison;
- New areas for quality assurance, to identify the latest developments, define next steps and draw up concrete proposals;
- General promotion of quality assurance and in particular the Solar Keymark;
- International standardization and certification;

All this contributed to the relevant achievements of the QAiST project acknowledged in this report. An important part of these are translated into different documents that are publicly available, as well as the contacts of the project consortium on the project website:

[www.qaist.eu](http://www.qaist.eu)
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