SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

UTILISATION OF ISO9806:2017 IN GLOBAL SOLAR CERTIFICATION

A REPORT FOR IEA SHC TASK 57 SOLAR RATING AND CERTIFICATION

K Guthrie J Parker and L Guthrie

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sustainable energy TRANSFORMATION

Summary

ISO 9806 *Solar energy - Solar thermal collectors - Test methods*, the international standard for testing solar thermal collectors, was first published in 1994. Since that time there have been advances in technology, resulting in a need for the standard to be updated. The most recent update was completed in 2017. The thirty four member nations of the European Committee for Standardisation (CEN) have adopted ISO 9806:2017.

This study investigates the likelihood that ISO 9806:2017 will be adopted in other countries around the world and follows up on a similar study in 2014 regarding ISO 9806:2013. To determine this, a survey which received 84 responses from 35 countries was conducted. Respondents were asked how likely their countries were to adopt the standard and what, if any changes could be made to the standard to improve it.

Sixteen countries outside of the CEN membership were identified as having reasonably large solar market size and were targeted by the 2014 study have again been targeted by this study as well. Responses were received from thirteen of these countries, many of which suggested alterations to ISO 9806 in order to increase the likelihood of adoption in their country and will be used to inform the next revision of ISO 9806.

Table 1 – Summary of results collected on the sixteen target countries

			2014		2018		
Country	**Total[1] [MWh]**	**World Market share [%]**	**Changes recommended**	**Adoption likelihood**	**Usable responses**	**Changes recommended**	**Adoption likelihood**
China	27,664	76%		50%	2	Editorial Corrections and local issues should be included	65%
Brazil	913.4	2.5%		50%	1		65%
India	841	2.3%			2		75%
USA	697.2	1.9%	Clearer description to avoid misinterpretation	100%	1		85%
Australia	402.9	1.1%	Clearer description to avoid misinterpretation, and stagnation temperature	33%	9	Editorial Corrections, local issues should be included, and less expensive test methods	70%
Israel	294.7	0.8%	Some additional tests or requirements needed	100%	1	Some additional tests or requirements needed, and large, concentrating, polymeric or PVT collectors	85%
Mexico	256.4	0.7%			2	Air Collectors	Adopted
South Africa	88.4	0.2%			0		
Taiwan, PoC	70.1	0.2%			0		
Japan	55	0.2%	Similar to another standard	50%	2		85%
Tunisia	47.4	0.1%		100%	4		Adopted
Lebanon	38.5	0.1%			0		
Canada	25.3	0.1%	Air Collectors, Editorial Corrections & Clearer description to avoid misinterpretation	50%	1	Local issues should be included and less expensive test methods	85%
Korea	20.3	0.1%			1		Adopted
Barbados	8	0.02%		100%	2		65%
Jordan	N/A	N/A			1		Adopted

[1] From Solar Heat Worldwide, Weiss and Spörk-Dür, 2018

Contents

IEA Solar Heating and Cooling Programme

The Solar Heating and Cooling Technology Collaboration Programme was founded in 1977 as one of the first multilateral technology initiatives ("Implementing Agreements") of the International Energy Agency. Its mission is *"to enhance collective knowledge and application of solar heating and cooling through international collaboration to reach the goal set in the vision of solar thermal energy meeting 50% of low temperature heating and cooling demand by 2050.*

The members of the IEA SHC collaborate on projects (referred to as "Tasks") in the field of research, development, demonstration (RD&D), and test methods for solar thermal energy and solar buildings.

Research topics and the associated Tasks in parenthesis include:

- Solar Space Heating and Water Heating (Tasks 14, 19, 26, 44, 54)
- Solar Cooling (Tasks 25, 38, 48, 53)
- Solar Heat or Industrial or Agricultural Processes (Tasks 29, 33, 49)
- Solar District Heating (Tasks 7, 45, 55)
- Solar Buildings/Architecture/Urban Planning (Tasks 8, 11, 12, 13, 20, 22, 23, 28, 37, 40, 41, 47, 51, 52, 56, 59)
- Solar Thermal & PV (Tasks 16, 35, 60)
- Daylighting/Lighting (Tasks 21, 31, 50, 61)
- Materials/Components for Solar Heating and Cooling (Tasks 2, 3, 6, 10, 18, 27, 39)
- Standards, Certification, and Test Methods (Tasks 14, 24, 34, 43, 57)
- Resource Assessment (Tasks 1, 4, 5, 9, 17, 36, 46)
- Storage of Solar Heat (Tasks 7, 32, 42, 58)

In addition to our Task work, other activities of the IEA SHC include our:

- International Conference on Solar Heating and Cooling for Buildings and Industry
- Solar Heat Worldwide report – annual statistics publication
- Memorandum of Understanding – working agreement with solar thermal trade organizations
- Workshops and seminars

Country Members

Australia	France	Slovakia
Austria	Germany	South Africa
Belgium	Italy	Spain
Canada	Mexico	Sweden
China	Netherlands	Switzerland
Denmark	Norway	Turkey
European Commission	Portugal	United Kingdom

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European Copper Institute	International Solar Energy Society
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Background

The adoption of an international standard for the testing of performance and quality is desirable as it can enable new products to reach a global market without duplicating testing in each individual country. This lowers the barrier to entry and enables more innovative, lower cost options to grow the industry to be competitive with other technologies (Ping, 2011). In 1994, ISO 9806 was published to provide a common method for testing of the most common solar heating collectors at the time. This was adopted in part or whole by many countries but did not include many of the durability and reliability tests required in many national standards. Since then, there have been many advances in technology, and testing experience, and therefore the new ISO 9806 was published in November 2013 to include these innovations and revised again in 2017.

This study presents the results from a survey to determine the likelihood of adoption of this new standard in the main global markets. Beyond the adoption of the standard, a Global Certification program that certifies compliance to the new standard is operational supported by IEA SHC's Task 57 (Nielsen, 2014).

If ISO 9806:2013 *Solar energy - Solar thermal collectors - Test methods* is to be the basis of Global Certification it requires countries with significant market size to adopt it. A target list of 16 countries that have a reasonable market size and the option to adopt the standard was developed. As the CEN member countries are all required to adopt ISO 9806 these countries are not included in the target list. The CEN member list includes the 28 European Union Countries, the Former Yugoslav Republic of Macedonia, Serbia, and Turkey plus three countries of the European Free Trade Association (Iceland, Norway and Switzerland) (European Committee for Standardization, 2014).

A questionnaire was developed for global survey of suitable persons to answer the following research questions

1. Is it likely that countries outside Europe will take up the new standard?
2. Are there any improvements required for countries to take adopt it?
3. Are there any other improvements that may be necessary or desired to improve the Standard? This question was relevant for all countries including European countries.

The questionnaire

A questionnaire was developed to ask 19 questions. These covered general and specific information such as, their identity and country, and their understanding of their country's standards body's intention to adopt the standard. It also sought any changes needed to the new standard either to improve it or increase the likelihood of adoption in their country. To maintain consistency and be able to see changes through time, most of the questions were based off the 2014 survey.

The survey was opened on 26 July 2018 and closed on 3 September 2018 and then particular countries were approached to get responses to fill in any specific gaps. Reminders were sent after ISO and SHC Task 57 meetings in the week of 10 September. In total 113 responses were received of which 84 were able to comment of the adoption of ISO 9806 in their country and were therefore usable.

A list of the questions is shown below. The exact format and presentation of questions as well as potential answers appears in appendix 1.

1. Are you able to comment on behalf of your country about the possible adoption of ISO 9806-2017 Solar thermal collectors test methods?
2. Does your country have a Mirror Committee for ISO Standards Committee TC180 and/or a National Standards committee that provides Solar Heating testing Standards?
3. Are you a member of that committee?
4. Does your country currently have any National standard for a solar heating collector test methodology?
5. Does it incorporate the same methods as international standards such as EN 12975 or ISO 9806?
6. Does your country currently recognise other solar heating collector test methodologies such as EN 12975 or ISO 9806?
7. How likely is it that your country will take up ISO 9806:2017 as a National Standard or recognise it for purposes such as Regulations and/or Certification?
8. What changes would need to be made in order for your country to adopt ISO 9806-2017 as its standard solar heating collector test methodology?
9. Do you have additional national requirements for testing due to national regulation, insurance, financing, etc.?
10. Can you provide details of the additional national requirements?
11. Have you provided feedback on a previous survey on ISO 9806-2017?
12. Has the revision addressed all of your previous concerns?
13. Are there any changes to ISO 9806 that you consider would improve that Standard?
14. What changes to ISO 9806 that you consider would improve that Standard?
15. Does your Country have a certification system for solar collectors?
16. How is the certification scheme used?
17. Please provide a contact or a website for further information on the certification system
18. Please add any other comments
19. Please provide contact information of relevant person in your country who can comment on possible adoption of ISO 9806-2017 Solar thermal collectors test methods below

Target Countries

The survey was disseminated using a snowball sampling method. The survey was distributed through the mailing list for ISO TC180 "Solar Energy", and list of data providers to Solar Heat Worldwide (Weiss & Spörk-Dür, 2018). It was intended that the industry leaders on these lists would pass the survey to all relevant contacts in their country. Given the number of responses, this seemed effective in distributing the survey.

Of particular interest were countries that may adopt ISO 9806 and have a reasonable share of the world's solar market. The 2014 study brought together a list of target countries comprising the largest solar markets outside of Europe. With updated data there was no country with 0.1% or greater world market share, therefore to maintain consistency the same target countries were used for this. These countries in order of market share in 2016 are displayed in Table 2.

Table 2 - Newly installed capacity of target countries

Country	Total[2] [MWh]	World Market share [%]	Usable responses
China	27,664	76%	2
Brazil	913.4	2.5%	1
India	841	2.3%	2
USA	697.2	1.9%	1
Australia	402.9	1.1%	9
Israel	294.7	0.8%	1
Mexico	256.4	0.7%	2
South Africa	88.4	0.2%	0
Taiwan, PoC	70.1	0.2%	0
Japan	55	0.2%	2
Tunisia	47.4	0.1%	4
Lebanon	38.5	0.1%	0
Canada	25.3	0.1%	1
Korea	20.3	0.1%	1
Barbados	8	0.02%	2
Jordan	N/A	N/A	1

[2] (Weiss & Spörk-Dür, 2018)

Results

Who responded

The survey had 84 usable responses from a total of 35 countries responding, including 13 of the 16 "target countries". Of the target countries, only South Africa, Taiwan PoC, and Canada were not represented in responses. Responses represented over 94% of the world's market (Weiss and Spörk-Dür, 2018).

In total of 113 responses from 38 countries were received. While some of the responses were incomplete in some sections, the majority of responses were completed, and many findings can be drawn from the results. Response that answered that they were not able to comment on the uptake of ISO 9806 in their country (answering "no" to question one) were removed as well as duplicate or erroneous entries, leaving 84 usable responses from 35 counties. Of these 35 countries 25 had mirror committees and 42 respondents were members of those committees.

While respondents were asked to provide their country, a number of the respondents did not include it. For these responses, the IP address was used to geo-locate where the survey was completed. **Error! Reference source not found.** shows the proportion of countries with response to the survey, while the location of each country that received responses has been mapped in Figure 2.

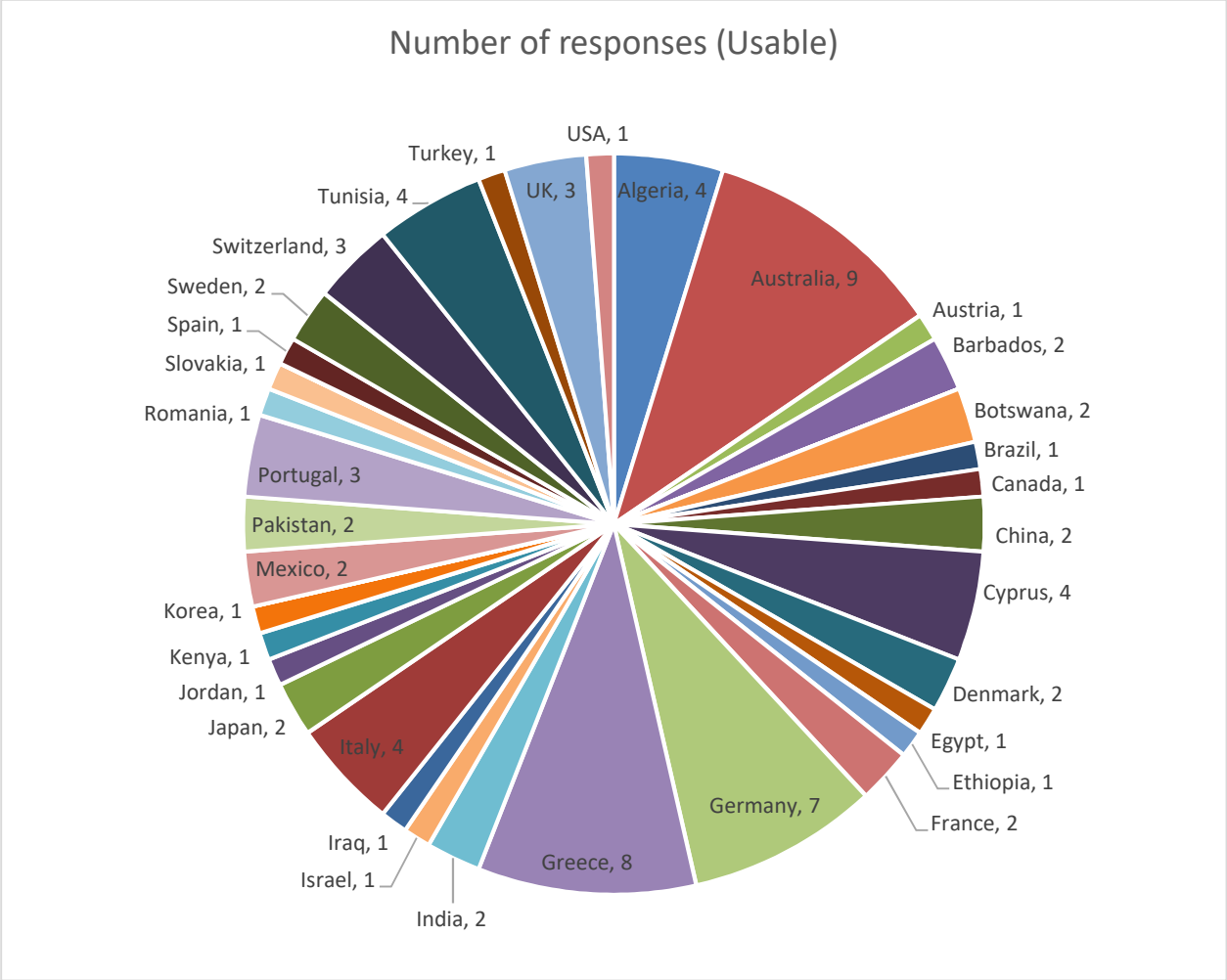

Figure 1 - Number of responses in each country

Figure 2 - Countries with responses

Adoption of ISO 9806

The key results of this study were to determine which countries had adopted ISO 9806 and if they had not, how likely they were to adopt it.

To determine what standard methodologies for testing solar heater collectors were used in each country respondents were asked two questions in relation to this;

4. Does your country currently have any National standard for a solar heating collector test methodology?

For this question, respondents could answer one of the following;

- Yes - adoption of ISO 9806
- Yes - a standard specific to this country or region
- No
- Unsure

If they answered *Yes - a standard specific to this country or region* they were then asked question five;

5. Does it incorporate the same methods as international standards such as EN 12975 or ISO 9806?

For this question the respondents could answer yes, no, or unsure.

From the responses from these two questions, analysis was able to determine the relevant standard in place in each country. Following CEN member countries (CEN, 2018) being marked as European, the two questions were combined to give one of the answers below for each country. In some instances, responses from the same country conflicted with one another, analysis was required to determine what the most likely correct response was. In most cases an answer of no was taken over an answer of unsure, and an answer of yes was taken over either no or unsure.

The answers for these two questions could be;

- European
- Yes - adoption of ISO 9806

- Yes - a standard specific to this country or region incorporating the same methods as international standards such as EN 12975 or ISO 986
- Yes - a standard specific to this country or region **not** incorporating the same methods as international standards such as EN 12975 or ISO 986
- No
- Unsure

Of the countries that have not adopted ISO 9806 the survey determined how likely the country was to take up ISO 9806. Respondents were asked;

7. How likely is it that your country will take up ISO 9806:2017 as a National Standard or recognise it for purposes such as Regulations and/or Certification?

and given six choices of answers;

- Very likely
- Somewhat likely
- Neither likely nor unlikely
- Somewhat unlikely
- Very unlikely
- Unsure

In the following analysis very likely was considered as 85% likelihood that ISO 9806 would be adopted, somewhat likely was considered 65%, neither likely nor unlikely 50%, somewhat unlikely 35%, and very unlikely 15%. When countries received multiple answers, the mean average was taken for that country. Answers of unsure were not considered in the analysis.

Table 3 shows the situation of solar heating collector test methodology standards in each country and the likelihood the ISO:9806 will be adopted in each country that usable responses were received for;

Table 3 – Adoption status and likelihood of adoption of ISO 9806 according to countries

Country	Does your country currently have any National standard for a solar heating collector test methodology?	Likelihood of adoption
Algeria	Yes - adoption of ISO 9806	100%
Australia	Yes - a country standard incorporating the ISO 9806 method	70%
Austria	European	100%
Barbados	Yes - a country standard **not** incorporating the ISO 9806 method	65%
Botswana	Yes - adoption of ISO 9806	100%
Brazil	Yes - a country standard incorporating the ISO 9806 method	65%
Canada	Yes - a country standard incorporating the ISO 9806 method	85%
China	Yes - a country standard **not** incorporating the ISO 9806 method	65%
Cyprus	European	100%
Denmark	European	100%
Egypt	Yes - adoption of ISO 9806	100%
Ethiopia	Unsure	
France	European	100%
Germany	European	100%
Greece	European	100%
India	Yes - a country standard incorporating the ISO 9806 method	75%
Israel	Yes - a country standard incorporating the ISO 9806 method	85%
Iraq	No	85%
Italy	European	100%
Japan	Yes - a country standard **not** incorporating the ISO 9806 method	85%
Jordan	Yes - adoption of ISO 9806	100%
Kenya	Yes - adoption of ISO 9806	100%
Korea	Yes - adoption of ISO 9806	100%
Mexico	Yes - adoption of ISO 9806	100%
Pakistan	No	85%
Portugal	European	100%
Romania	European	100%
Slovakia	European	100%
Spain	European	100%
Sweden	European	100%
Switzerland	European	100%
Tunisia	Yes - adoption of ISO 9806	100%
Turkey	European	100%
UK	European	100%
USA	Yes - a country standard incorporating the ISO 9806 method	85%

Figure 3 shows each of the countries from which responses were received and their likelihood of adoption. It shows that the majority of countries have adopted ISO 9806 and that other countries are all somewhat or very likely to adopt it.

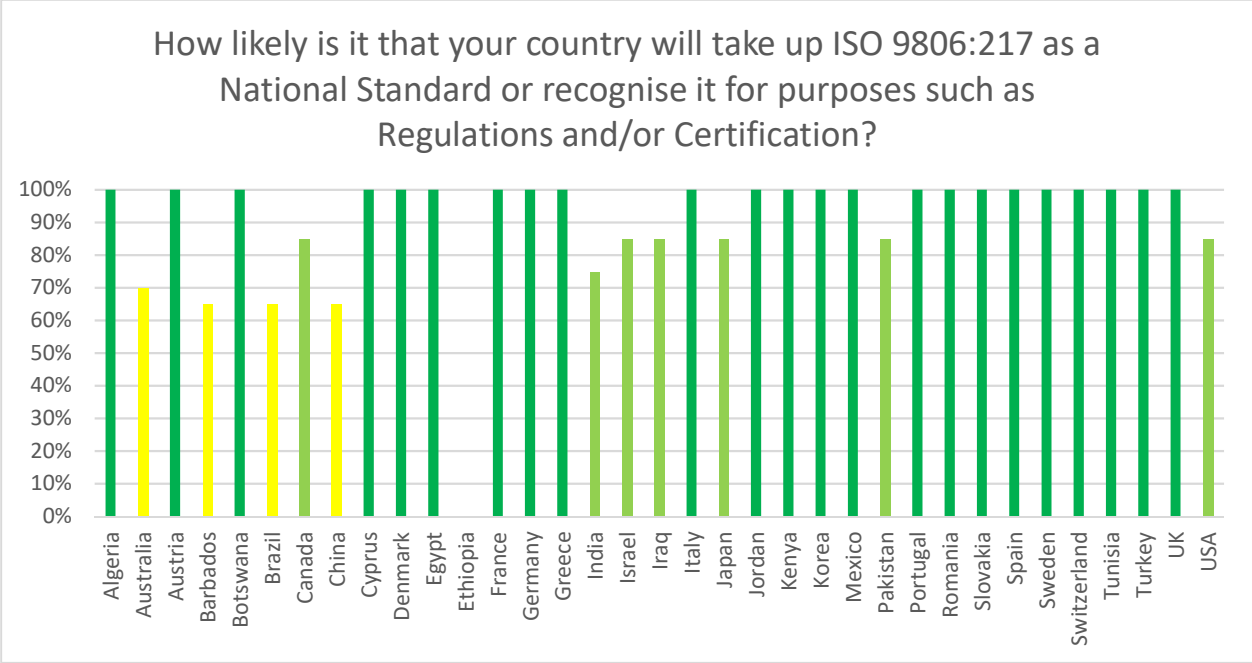

Figure 3 - Likelihood of adoption in all countries that recieved usable responses (100% indicates that ISO 9806 has already been adopted)

Figure 4 and Figure 5 show the information in Table 3 on world maps.

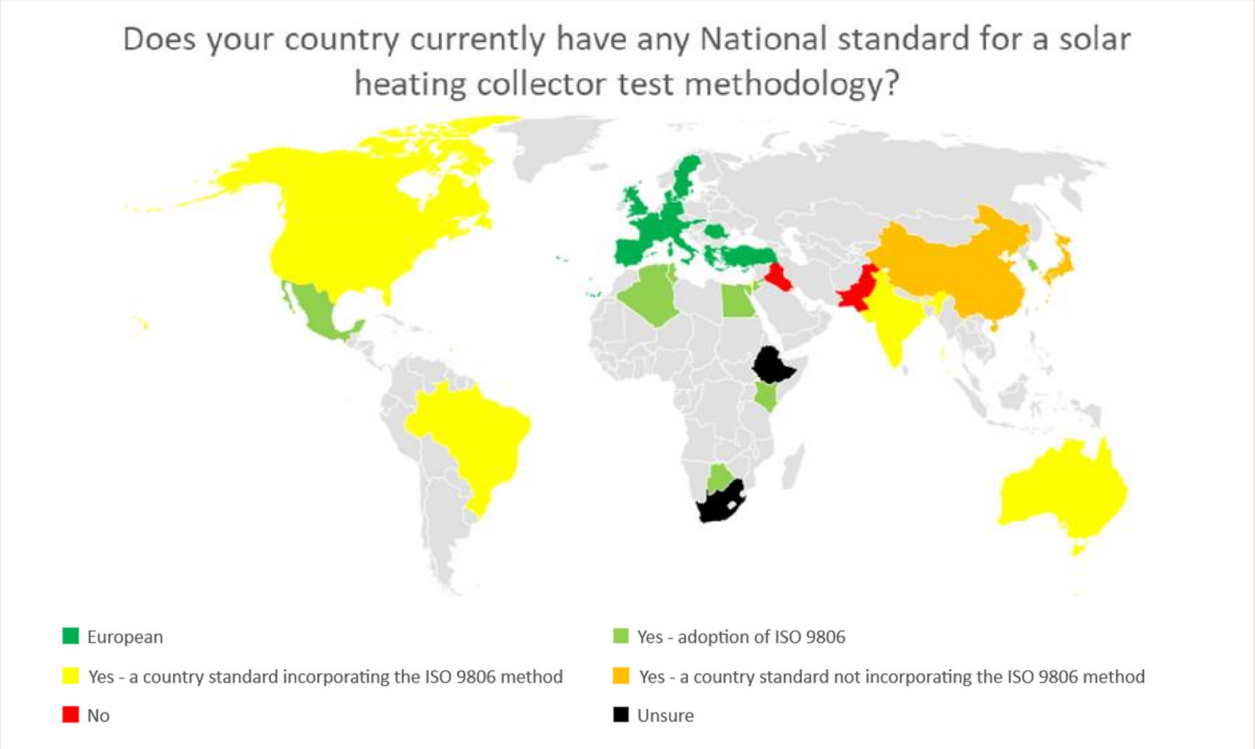

Figure 4 - Countries that received responses categorised by their standards for solar testing methodologies

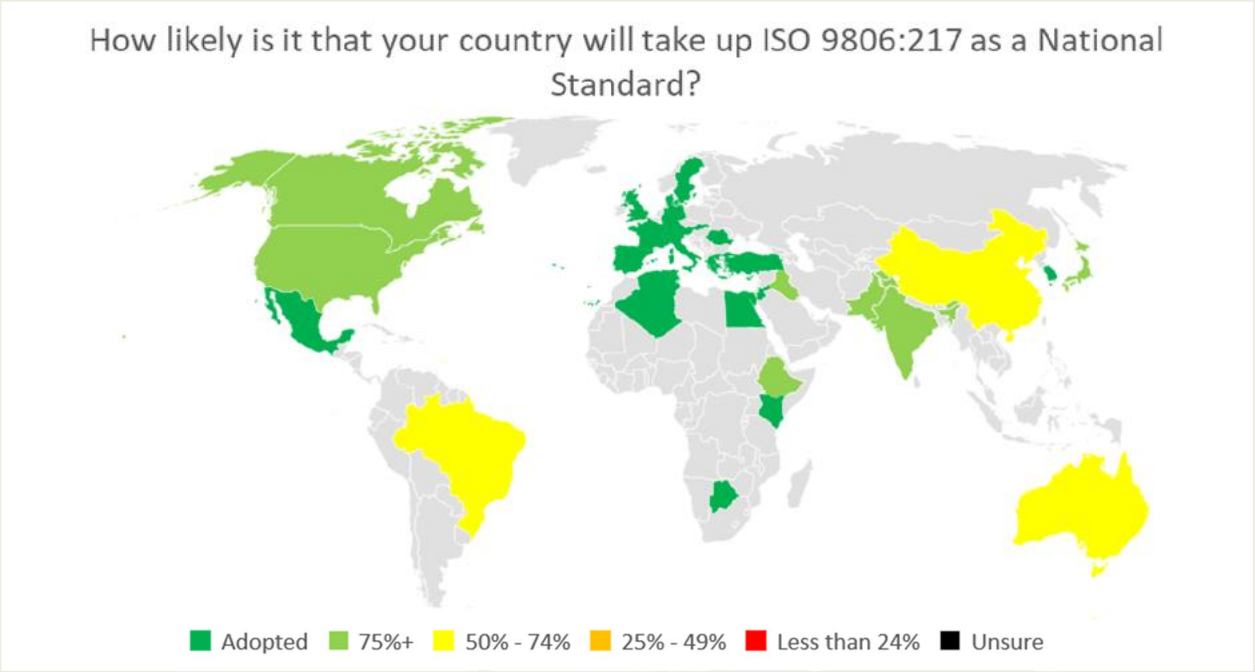

Figure 5 - Countries that received responses categorised by likelihood of adoption

Figure 6 to Figure 11 show the number of countries and market share of each of the adoption categories and the likelihood of adoption quartiles. As China overwhelmingly dominates global market share of solar collectors, Figure 8 and Figure 11 show the market share with China removed.

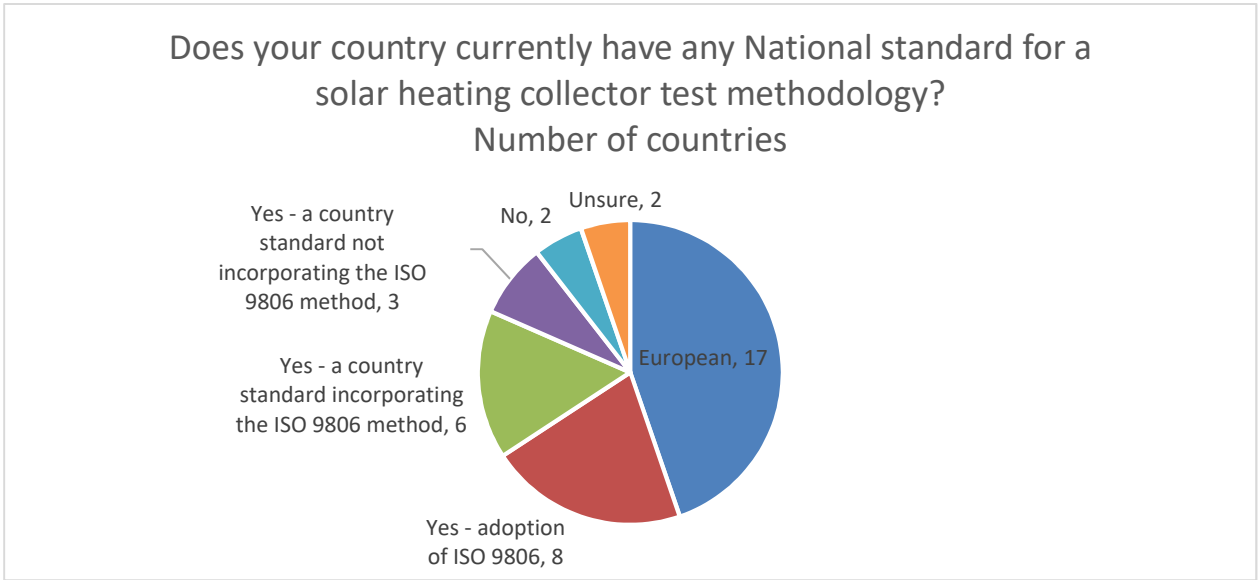

Figure 6 - Number of countries in each of the adoption categories

Figure 6 shows that the vast majority of countries surveyed have adopted ISO 9806 or at least incorporate its methods into their own standard. Only two countries that received responses did not have a testing standard these were Iraq and Pakistan.

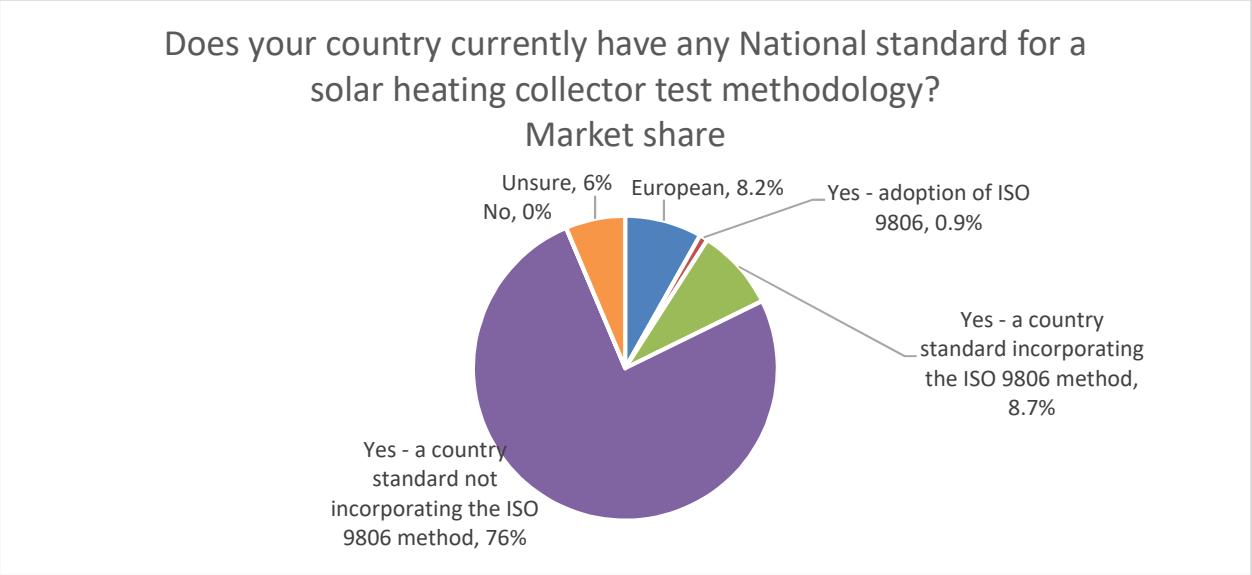

Figure 7 - Market share of each of the adoption categories

Figure 7 shows the market share of each of the adoption categories. As China has its own standard that does not incorporate ISO 9806 methods, this category has an overwhelming majority.

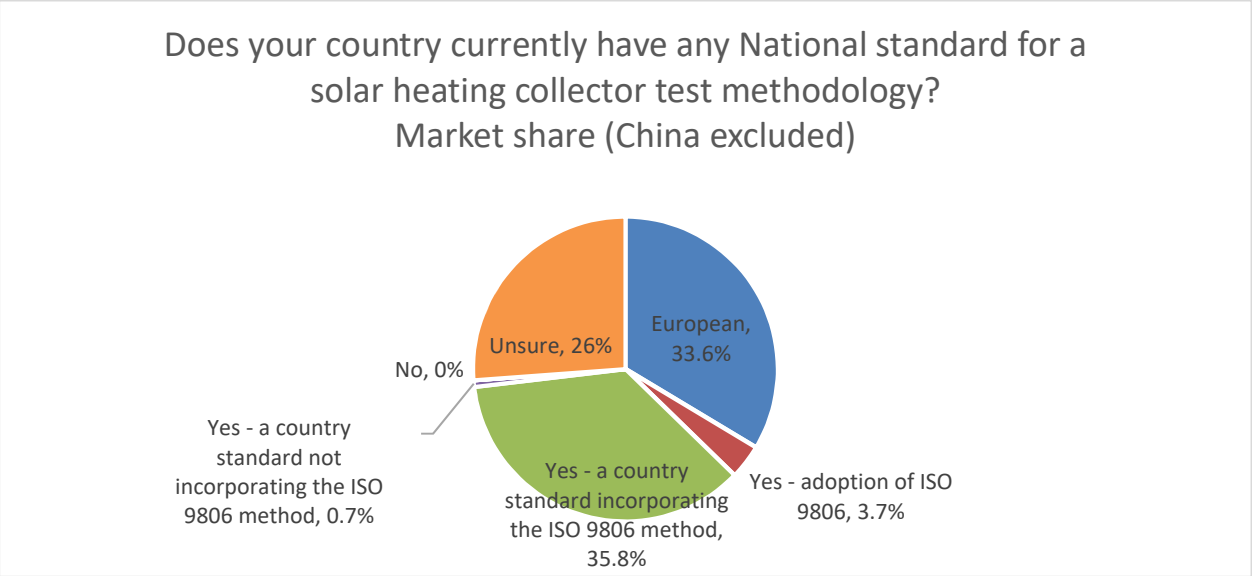

Figure 8 - Market share of each of the adoption categories (Excluding China)

Figure 8 shows the market share of each adoption category with China excluded, without China the nuance of the other categories is more clearly displayed. The highest category is country specific standards that incorporate ISO 9806 methods, which include India, Brazil, the USA, Australia, and Israel all are top ten countries in terms of market share. Other than European countries, the unsure category is the next highest because it includes the 6% market share of countries that did not receive responses, of the other two unsure countries Ethiopia is not included in Solar Heat Worldwide 2018 and South Africa has 0.2% market share.

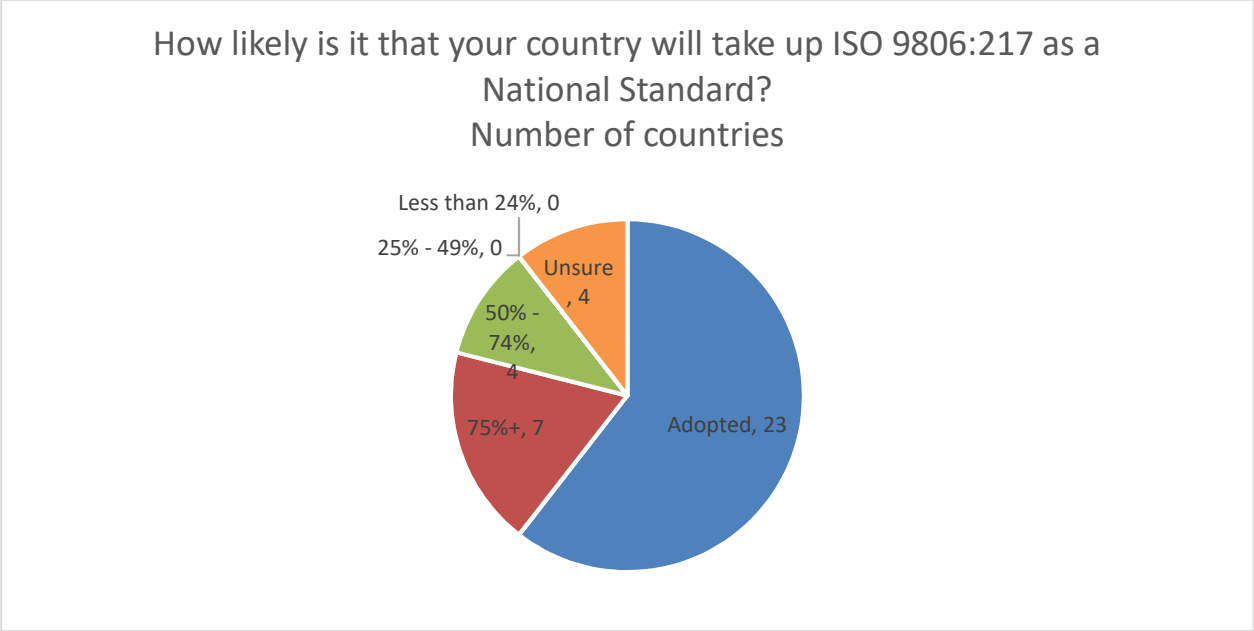

Figure 9 - Number of countries in quartiles of likelihood adoption

Figure 9 shows that the majority of countries with responses either have adopted ISO 9806 or are likely to.

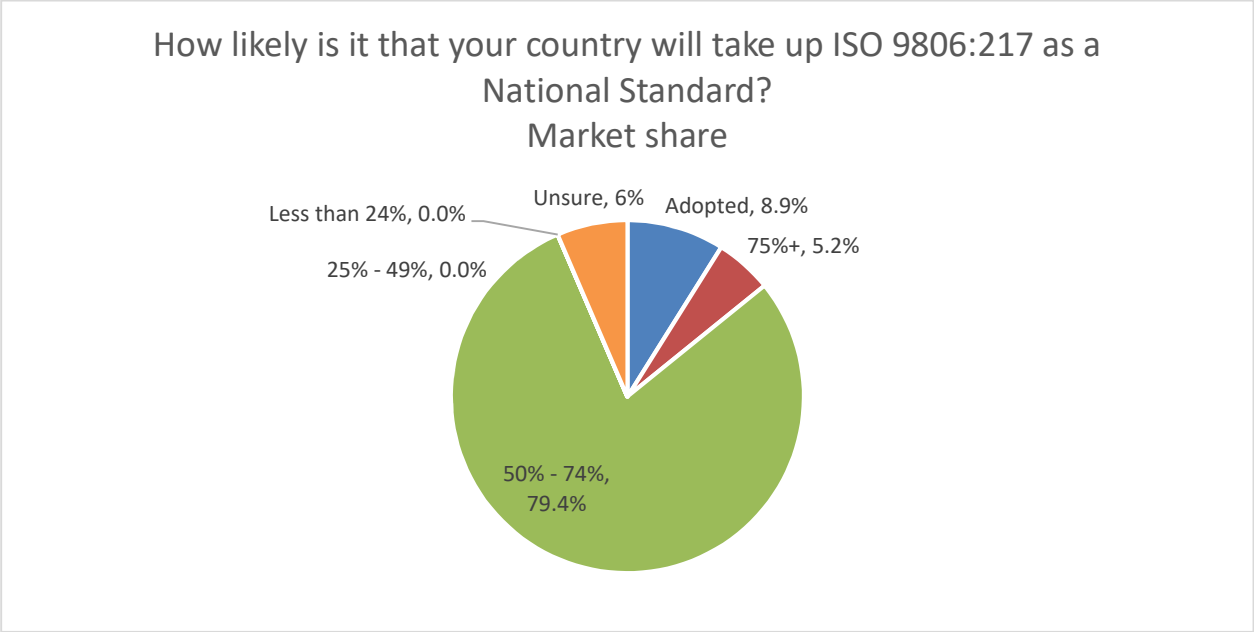

Figure 10 – Market share of quartiles of likelihood adoption

Figure 10 shows the market share of quartile of adoption likelihood. Similar to Figure 7, as China is 65% likely to adopt ISO 9806, the 50% - 74% quartile has an overwhelming majority.

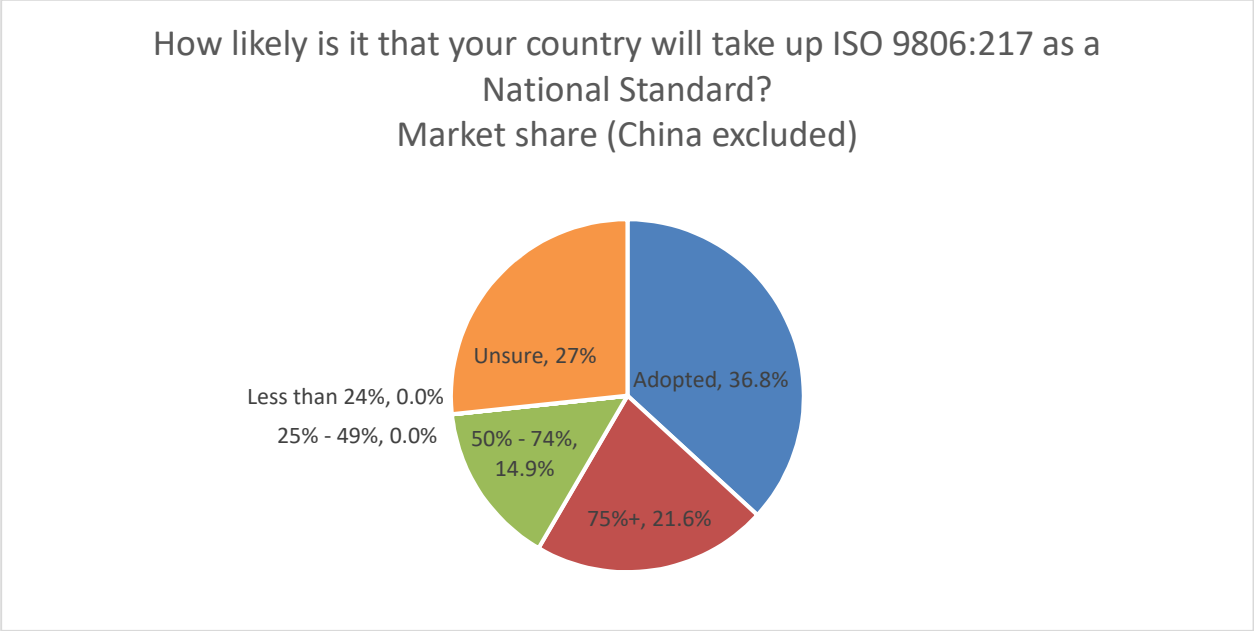

Figure 11 - Market share of quartiles of likelihood adoption (Excluding China)

Figure 11 shows the market share of each of the quartiles of likelihood of adoption, with China excluded. Like Figure 8 unsure features highly because of the countries that did not receive responses. The largest percentage is the countries that have already adopted ISO 9068. India, Israel, and the USA make up the majority of the 75%+ quartile and Australia and Brazil make up the majority of the 50% - 74% quartile.

Improvements to ISO 9806

Another key result from the survey is what improvements the respondents believe can be made to ISO 9806. To determine this, two open response questions were asked;

8. What changes would need to be made in order for your country to adopt ISO 9806-2017 as its standard solar heating collector test methodology?
13. Are there any changes to ISO 9806 that you consider would improve that Standard?

Further, there were some extra comments received in question 18 that were considered comments on improvements to ISO 9806.

Question 8 only received two responses, these are shown in Table 4 along with how likely the respondent thought it would be that ISO 9806 would be adopted in their country.

Table 4 - Changes that are required for ISO 9806 to be adopted

Country	What changes would need to be made in order for your country to adopt ISO 9806-2017 as its standard solar heating collector test methodology?	Likelihood of adoption?
Japan	We use the one closer to ISO 9806-2013 as the standard. I think that it is desirable to follow ISO 9806, but it changed to ISO 9806-2017 and it was greatly changed. However, I do not fully understand the purpose of the change. I think that a commentary etc. that understands the purpose of change is necessary.	Unsure
USA	SRCC Standard 100 would have to be abandoned/withdrawn.	Somewhat unlikely

Of all the countries there were 28 respondents that included comments about how to improve the standards, as shown in Figure 12.

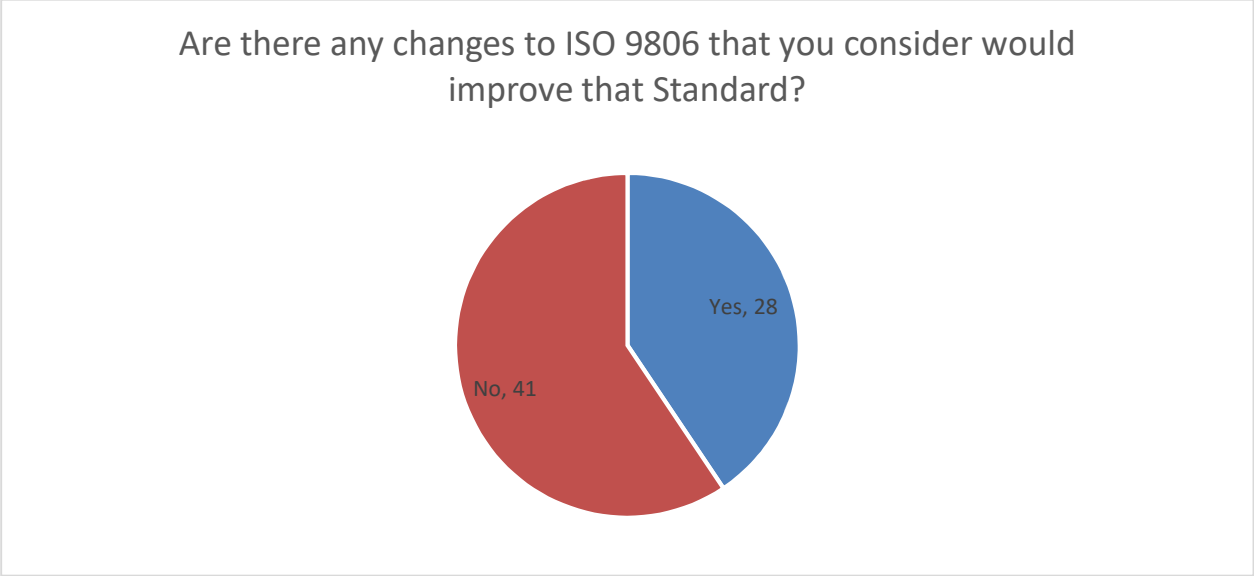

Figure 12 - How many respondents had comments to improve ISO 9806

Each comment was assessed and coded into nine potential categories. For consistency the categories were similar to the 2014 study. The categories *less expensive test methods* and *large, concentrating, polymeric or PVT collectors* where included while the category *similar to another standard* was kept even though there were no responses for this category. Each response could be coded into more than one category as appropriate. The response categories were;

- Air Collectors
- Editorial Corrections
- Local issues should be included
- Clearer description to avoid misinterpretation
- Similar to another standard
- Some additional tests or requirements needed
- Less expensive test methods
- Large, concentrating, polymeric or PVT collectors
- Not specified

Figure 13 shows the breakdown of the responses received.

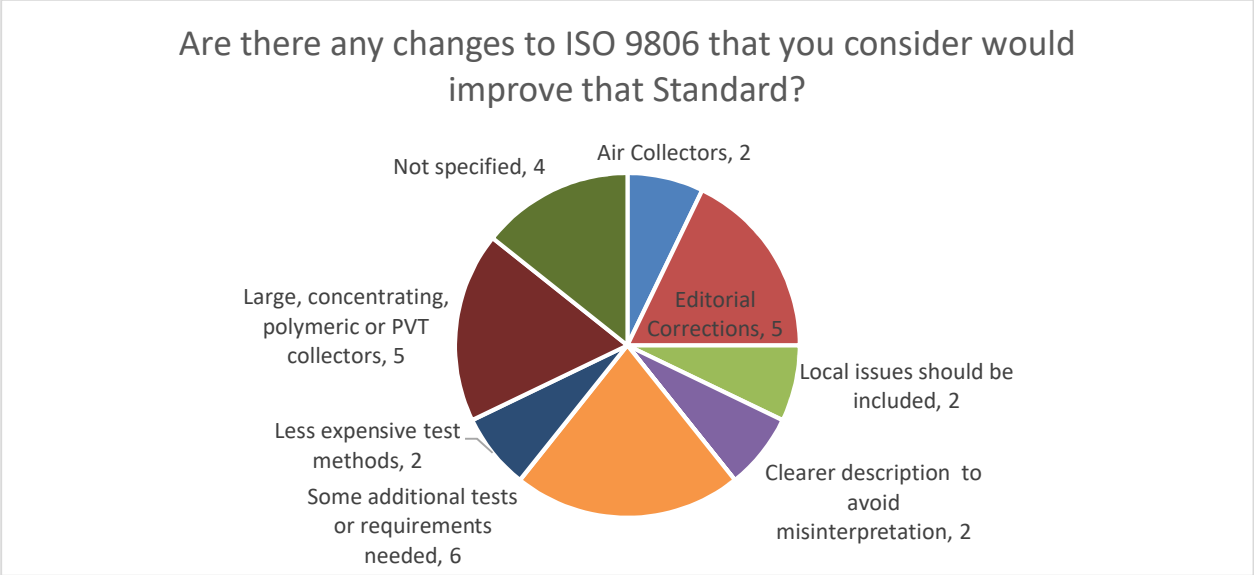

Figure 13 - Breakdown of comments on improvements to ISO 9806

Table 5 shows the response categories and the countries that gave them.

Table 5 - Improvements to ISO 9806 and countries that the responses were attributed to

Are there any changes to ISO 9806 that you consider would improve that Standard?	Country
Air Collectors	France, Mexico
Editorial Corrections	Australia, China, Germany, Portugal
Local issues should be included	Canada, Egypt
Clearer description to avoid misinterpretation	Australia, China
Similar to another standard	
Some additional tests or requirements needed	Algeria, Germany, Greece, Israel
Less expensive test methods	Australia, Canada
Large, concentrating, polymeric or PVT collectors	Denmark, France, Germany, Israel, Italy

Large, concentrating, polymeric or PVT collectors was the category with the most countries and *some additional tests or requirements needed* had the most responses, *editorial corrections* was another prevalent response. Of the target countries with larger markets and have not adopted the standard, of which China is the most important, *editorial corrections, clearer description to avoid misinterpretation,* and *less expensive test methods* were the most prevalent. It is noteworthy that no responses from the USA included any suggestions to improve the standard, even though it was unlikely the standard would be adopted in the USA.

Appendix 2 includes all the worded responses.

Additional requirements

A further finding of this survey was gaining an understanding of any additional requirements in specific countries. Two questions were asked to understand if countries had extra national

requirements, if the respondent answered yes to question nine they were able to submit an open worded answer for question 10.

9. Do you have additional national requirements for testing due to national regulation, insurance, financing, etc.?
10. Can you provide details of the additional national requirements?

The responses from question 10 were then assessed and coded into nine categories, responses could be included in more than one category. The response categories were;

- Laboratory quality infrastructure
- Durability and reliability
- Finance
- Climate
- Guarantee/Quality
- Additional hail, wind and snow testing
- Minimum collector efficiency
- Drinking water guidelines
- Meet requirements of additional local standard or regulation

Figure 14 shows the number categorised responses for question 10.

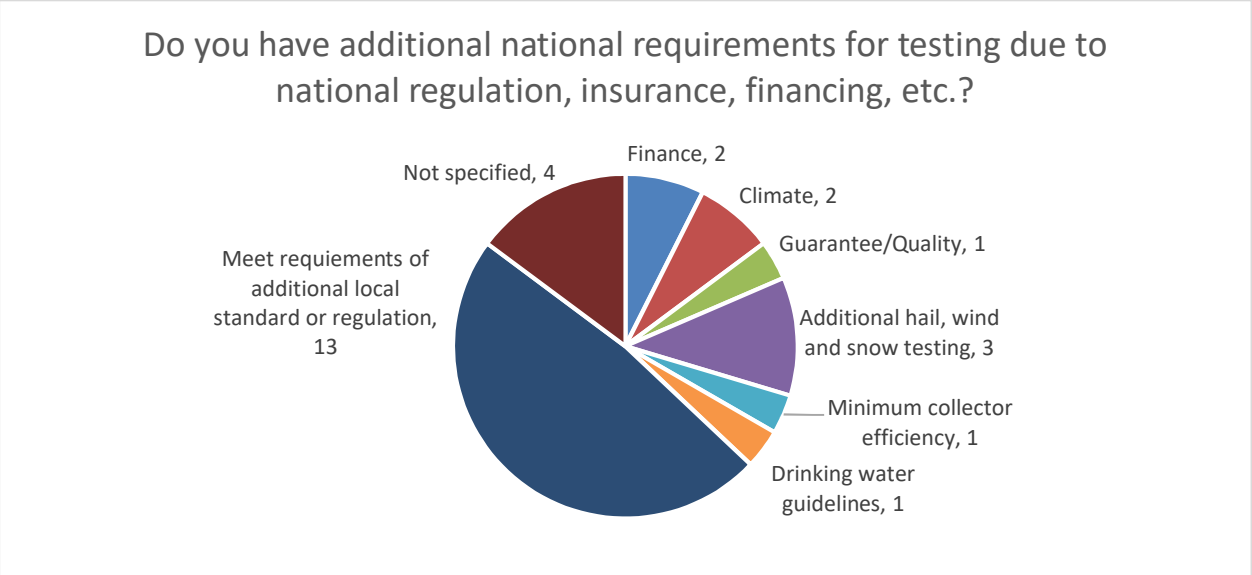

Figure 14 - Country specific requirements additional to the methods in ISO 9806

Table 6 shows the additional requirements and the countries that they were attributed to.

Table 6 - Additional requirements attributed to countries

Do you have additional national requirements for testing due to national regulation, insurance, financing, etc.?	Country
Laboratory quality infrastructure	Algeria
Durability and reliability	Australia
Finance	Egypt, USA
Climate	Egypt, Iraq
Guarantee/Quality	Kenya

Additional hail, wind and snow testing	France, Switzerland
Minimum collector efficiency	Israel
Drinking water guidelines	Israel
Meet requirements of additional local standard or regulation	Australia, France, Germany, India, Israel, Kenya, Mexico, Tunisia, UK, USA

The majority of the additional requirements occurred in countries with either hot or cold climates. Several of the target countries, particularly those with the biggest markets (China is the notable exclusion) responded that there were additional local requirements.

Appendix 2 includes all the text in the responses.

Previous responses to surveys

As this was the second study of this type on this standard, an interesting finding was to determine if respondents felt their previous comments were incorporated into the current standard. Questions 11 and 12 asked '*have you provided feedback on a previous survey on ISO 9806-2017?'* and '*has the revision addressed all of your previous concerns?'* respectively. Of the 13 respondents that had provided feedback on ISO 9806 before, only two had not had their concerns addressed. These responses were from Denmark and Switzerland with the Danish respondent suggesting that "*Optional tests for (large) collector modules considering fluid type, flow rate and collector inclination"* be included into the standard.

As the majority of respondents that had previously given feedback felt their concerns had been addressed, this shows there is value in surveys such as this.

Other country specific information

Several other questions were asked to understand the standard situation in specific countries. Analysis using these questions used to determine if the country had a mirror committee for ISO standards, a certification system for solar collectors, and if so how that system was used. These questions were;

2. Does your country have a Mirror Committee for ISO Standards Committee TC180 and/or a National Standards committee that provides Solar Heating testing Standards?
15. Does your Country have a certification system for solar collectors?
16. How is the certification scheme used?

Questions 2 and 15 could be answered with yes, no, or unsure, if a respondent answered yes for question 15, they were able to answer question 16 with as many of the following answers that applied;

- It is required for subsidies
- It is required to show compliance with regulations
- It is voluntary - used to establish the quality of the product

In some instances, responses from the same country conflicted with one another, analysis was required to determine what the most likely correct response was. In most cases an answer of no was taken over an answer of unsure, and an answer of yes was taken over either no or unsure. The rationale for this was that if a respondent answered no, there may still be a mirror committee or a certification system, that they were not aware of it. In the case of question 16, many respondents left this blank and some answers conflicted with others (a certification system cannot be both voluntary and required for compliance). Table 7 shows the extra information gathered for each country.

Table 7 - Extra information for each country

Country	Does your country have a Mirror Committee for ISO Standards Committee?	Does your Country have a certification system for solar collectors?	How is the certification scheme used?
Algeria	Yes	Yes	Compliance
Australia	Yes	Yes	Compliance, and subsidies
Austria	Yes	Unsure	
Barbados	No	No	
Botswana	Yes	Yes	Voluntary
Brazil	Yes	Yes	Compliance
Canada	Yes	No	
China	Yes	Yes	Subsidies
Cyprus	Yes	Yes	Subsidies
Denmark	Yes	No	
Egypt	Yes	Yes	Unsure
Ethiopia	Unsure	Unsure	
France	Yes	Yes	Voluntary but required for compliance and subsidies
Germany	Yes	Yes	Voluntary but required for compliance and subsidies
Greece	Yes	Yes	Voluntary but required for compliance and subsidies
India	Yes	Yes	Voluntary but required for subsidies
Israel	Yes	Yes	Compliance
Iraq	No	No	
Italy	Yes	Yes	Subsidies
Japan	No	Yes	Subsidies
Jordan	No	Yes	Voluntary
Kenya	Yes	Yes	Compliance
Korea	Yes	Yes	Voluntary but required for compliance and subsidies
Mexico	Yes	Yes	Compliance, and subsides
Pakistan	No	No	
Portugal	Yes	Yes	Compliance
Romania	Yes	Unsure	
Slovakia	No	No	
Spain	Yes	Yes	Voluntary
Sweden	No	Yes	Voluntary
Switzerland	Yes	Yes	Voluntary but required for subsidies
Tunisia	Yes	Yes	Compliance
Turkey	Unsure	Unsure	

UK	Yes	Yes	Subsidies
USA	No	Yes	Compliance, and subsidies

There were four countries that recorded responses for all three potential answers to question 16 and after analysis were considered *voluntary but required for compliance and subsidies* which appears to be conflicting. However, potentially there may be extra contextual information, not captured by the survey that is relevant to this point.

Other responses of note

Several responses, mainly responding to the extra comments question, noted interesting things that were not included in other sections of this report. These interesting comments and the countries they were received from are shown in Table 8.

Table 8 - Interesting extra information

Country	Comment
Pakistan	Pakistan standard quality control authority (PSQCA) is in progress to made setup for certification
Jordan	it will be on JSMO web site soon
Canada	The CSA F378 standard will be withdrawn soon. References to collector conformance and testing on other Canadian standards should refer to ICC (which refers to ISO) or to ISO directly.
India	A sponsored training programme for developing countries on ISO 9806 for better understanding.

These comments show that there is work currently underway to incorporate the standard into certification systems in Jordan, Pakistan, and Canada, Canada is the only one of these in the target countries. Further, a respondent has suggested a capacity building program for developing countries to build their capacity to implement the standard. Low and middle income countries (The World Bank, 2018) make up 85% of the global solar market, including several target countries, therefore this capacity building program could be extremely helpful.

Differences with 2014 survey

This survey received 84 usable responses from a total of 35 countries representing a 94% share of the world's total solar market. The 2014 study received 63 usable responses from 30 countries representing 90% of the world's solar market. Both studies received responses from 13 of the 16 target countries. This shows that there was a significant increase in the number of responses and therefore means that this study is more robust than the study conducted in 2014.

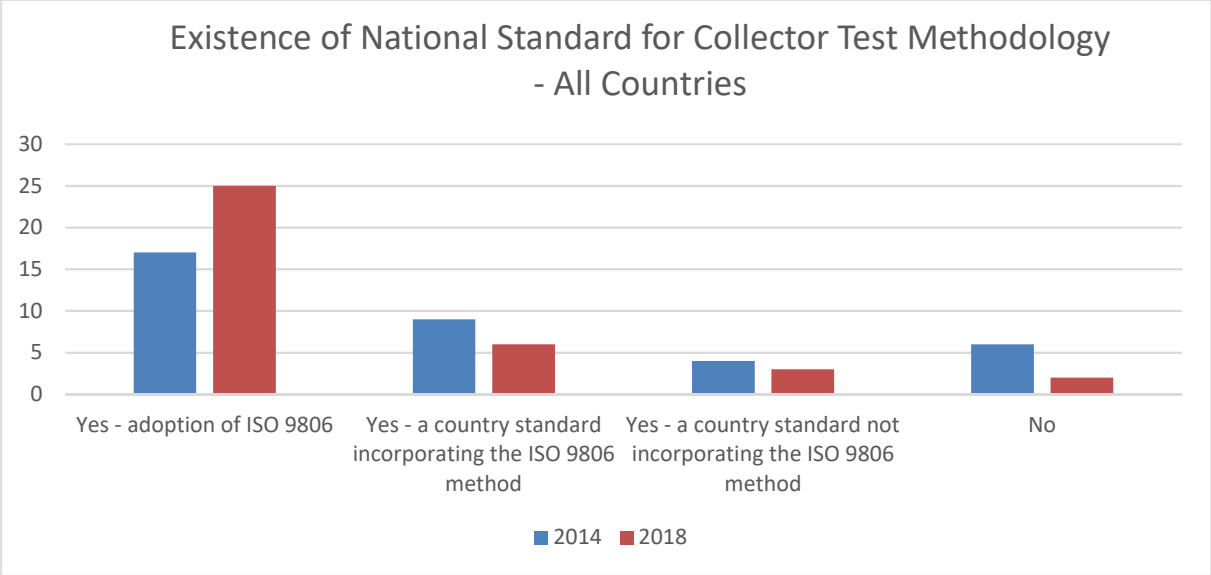

Figure 15 - Existence of National Standard for Collector Test Methodology - All Countries

During the four years between surveys there has been a significant increase in the number of countries that have adopted ISO 9806. Even though there was an increase in the number of countries represented in the 2018 study, only the *adoption of ISO 9806* adoption category increased. Other categories decreased with the *no* category decreasing the most. Figure 15 shows the adoption categories for all the countries that received useable responses in the 2014 and 2018 studies.

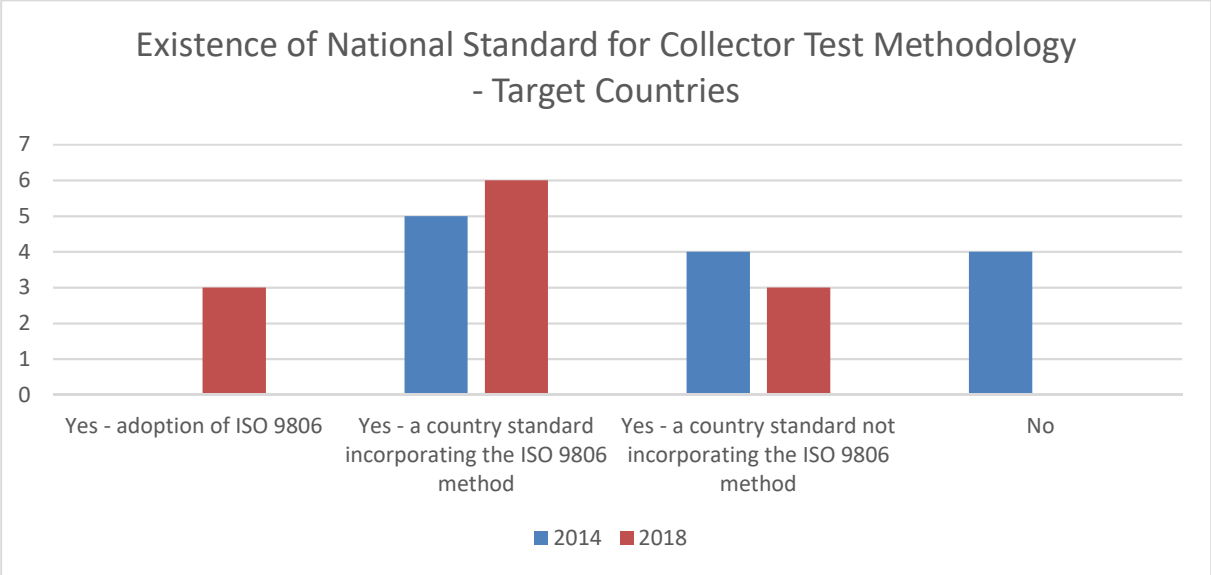

Figure 16 - Existence of National Standard for Collector Test Methodology - Target Countries

The same trend has been shown in the target countries with *adoption of ISO 9806* increasing and *no* decreasing the most. The other two categories stayed relatively the same. Figure 16 shows the adoption categories for only the target countries in 2014 and 2018.

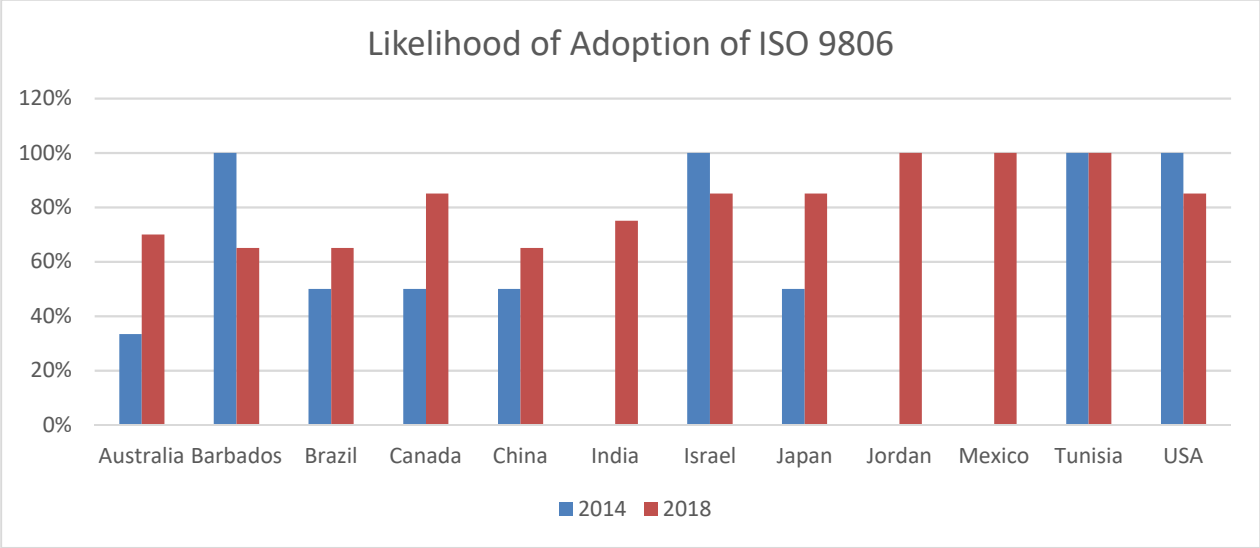

Figure 17 - Likelihood of adoption of target countries in 2014 and in 2018

Figure 17 shows the likelihood that each of the target countries will adopt ISO 9806. Of the countries that said they would adopt ISO 9806 in 2014, only Tunisia has adopted it, Israel and the USA remain highly likely to adopt, and Barbados is somewhat likely. Most other countries have increased their likelihood of adoption between the surveys.

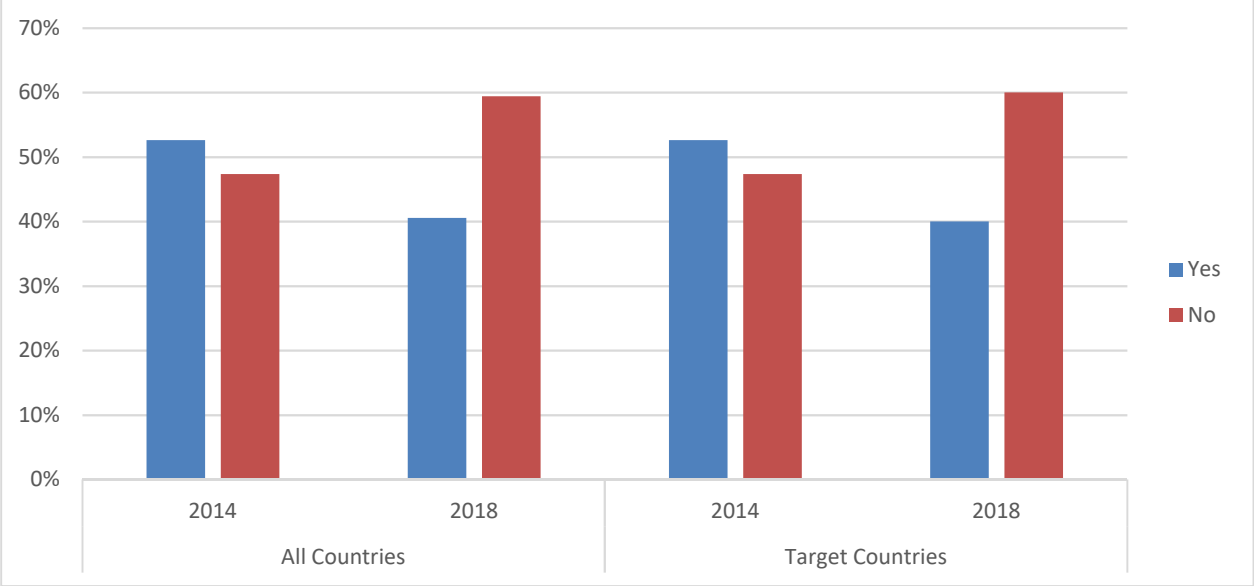

Figure 18 - Responses to whether or not respondents had comments to improve ISO 9806

Figure 18 shows the percentage of respondents that had comments to improve ISO 9806. It shows that there is a significant reduction in the number of comments respondents had between the two studies. The trend was almost identical between all countries and target countries.

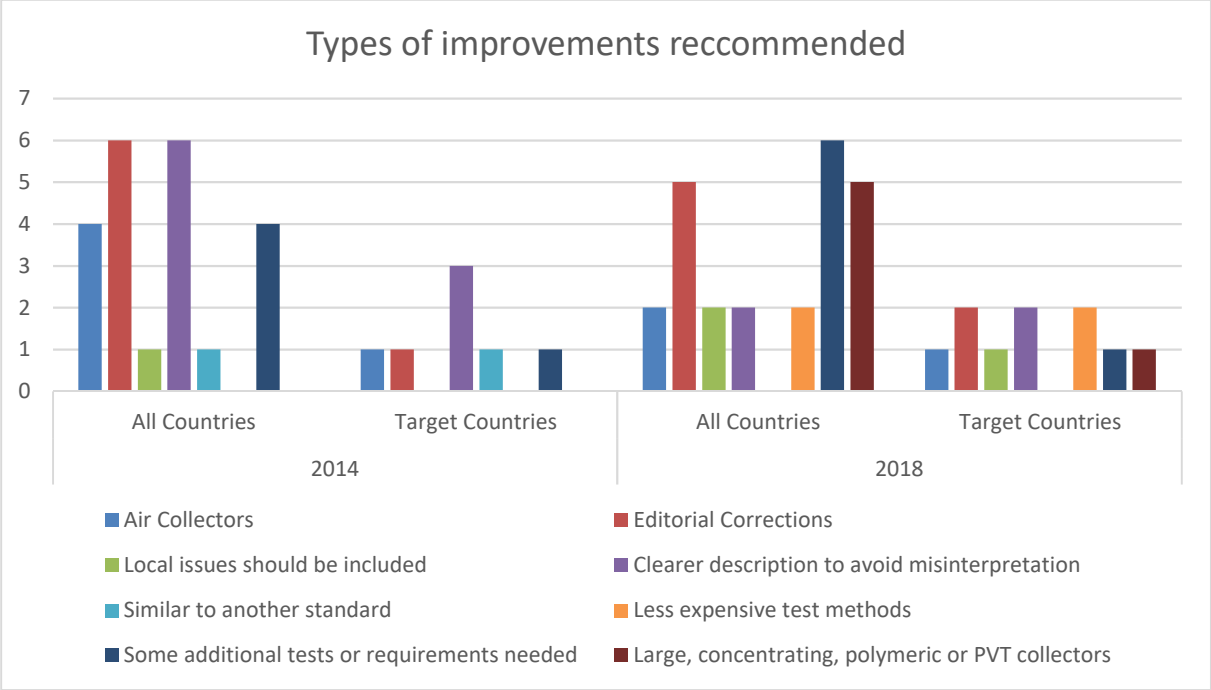

Figure 19 - The improvements to ISO 9806 recommended

Figure 19 shows the improvements that were recommended by respondents. The 2018 study had slightly less editorial corrections and some additional test needed was approximately the same (considering approximately 1/3 more responses were received). In the 2018 study two new categories for *less expensive test methods* and *large, concentrating, polymeric or PVT collectors* was needed as these are emerging areas of interest.

Discussion

Since the 2014 version of this study, many more countries have adopted ISO 9806. The survey received responses from 25 countries that have adopted ISO 9806 as their standard. Further, there is an overarching trend that the likelihood of adoption has increased worldwide and that there has been a reduction in the number of improvements needed in the standard. Along with the vast majority of respondents who had thought their previous comments had been address, this points to the standard being an improvement on 2013 version and validates the value of surveys and studies like this one.

This study has also been able to show that there is increasing harmonisation of standards in regard to solar testing. Since the 2014 study more countries have adopted ISO 9806, incorporated its methods into their own standards, or created national standards when they did not have one. This is promising for a potential global certification system in the future.

This study received responses representing 13 of the 16 target countries, of those the majority either increased or remained similarly likely to adopt ISO 9806. After the survey commentary from experts was sought and they believed that it remained very likely that the USA would adopt the standard. The USA has an existing national standard which will soon incorporate ISO 9806. Further, Canada, Mexico, and Barbados (all target countries) are investigating adopting SRCC 100 as their national standard.

From the target countries the majority of the changes recommended came from Australia, Israel, Mexico, and Canada. Their recommended changes included editorial corrections that need to be

made, local issues that should be included, test methods being made less expensive, air collectors need to be considered, some additional tests or requirements are needed, and large, concentrating, polymeric or PVT collectors should be considered. Mexico has adopted ISO 9806 and Australia, Canada, and Israel are all likely to adopt it while they currently have national standards that incorporate ISO 9806 methods. Therefore, while it is important that these recommendations be incorporated into any future changes to ISO 9806, this is also not a pressing concern.

The inclusion of large, concentrating, polymeric or PVT collectors into ISO 9806 was recommended by five respondents, making it one of the most popular comments. This comment was not received in the 2014 study, showing that is an emerging market that should be considered in future changes to ISO 9806.

The Chinese market includes 76% of the global solar market making it by far the largest and most important solar market in the world. Currently China has a national standard, but this does not incorporate the methods used in ISO 9806, and China is 65% likely to adopt ISO 9806. Adding to this complexity is a reasonable amount of disunity of opinions of the two responses from China. One respondent believed that it was somewhat likely that ISO 9806 would be adopted in China and the second believed it was very unlikely. Conversations with experts from China uncovered that it has been recently proposed that methods from ISO 9806 be incorporated into their national standard. If this proposal proceeds China will become like the USA. Because of these factors, especially with the proposal underway, it is very important to include the editorial corrections and the local issues that Chinese respondents have recommended in future iterations of ISO 9806. Further, only two response were received from China showing that work should be completed to engage more with the Chinese market.

Finally, a comment was received from one respondent suggesting that capacity building in developing countries may be very helpful. As low and middle income countries (The World Bank, 2018) make up 85% of the global solar market, including several target countries, there could be a significant benefit in building the capacity of these countries.

Conclusion

This survey shows that countries are increasingly adopting ISO 9806, validating the value of the similar study completed in 2014. Further, this study has captured many extra recommended changes which if included in future revisions of ISO 9806, will make it more likely to continue being adopted.

This study has found that incorporating the recommended changes from China is the most pressing concern when considering future revisions of ISO 9806.

Finally, this study has gathered much valuable information about the systems and markets that exist in each country. Table 7 includes information about the mirror committees and certification systems that exist in each country. Further, Appendix 3 includes details of certification organisations in many countries. These lists are on top of the lists of trade associations and testing laboratories collected during the 2014 study.

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- Andreas Bohren

Appendix 1
Actual text responses outlining changes
Table A1 - Responses to how ISO 9806 needs to be improved from all respondents.

Responses to Question 8. *What changes would need to be made in order for your country to adopt ISO 9806-2017 as its standard solar heating collector test methodology?*	
We use the one closer to ISO 9806-2013 as the standard. I think that it is desirable to follow ISO 9806, but it changed to ISO 9806-2017 and it was greatly changed. However, I do not fully understand the purpose of the change. I think that a commentary etc. that understands the purpose of change is necessary.	Japan
SRCC Standard 100 would have to be abandoned/withdrawn.	USA
Responses to Question 10. *Can you provide details of the additional national requirements?*	
- Equipement calibration laboratories ; - Accurate measurment equipments; - it is not easy to practice inter-laboratory compareason	Algeria
AS2535 is the Australian Standard for Test Methods for Solar Collectors that is very close to ISO 9806. Technically it is AS2535 that is called up in AS/NZS 2712 and AS/NZS 4234 that are referenced in Australian regulation and as such ISO 9806 is not directly called up. However the test methods from ISO 9806 and AS2535 are nearly the same hence certifying bodies have accepted in the past test reports to ISO 9806 as equivalent to AS2535 for equivalent clauses and these results as long as from a AS2535 certified testing laboratory have been accepted as evidence of conformance.	Australia
AS/NZS 2712 has specific design, material and performance requirements. ISO9806 defines test methodologies but does not specify requirements.	Australia
AS/NZS2712	Australia
AS 2712 Durability and reliability	Australia
climatic features - Financial issues	Egypt
In order to obtain ten-year guarantee for end user, solar thermal collectors intended to be integrated shall comply with the european standard 12179.	France
DRAFT prEN 12975 Augsut 2018	Germany
DRAFT prEN 12975 August 2018	Germany
climate temperature	Iraq
THE ENERGY (SOLAR WATER HEATING) REGULATIONS, 2012	Kenya
It is supposed to comply with ISO 9806 standards.	Korea
In Mexico, the national standard according to International Standard ISO 9806 is: NMX-ES-001-NORMEX-2016, but aditional to this NMX, there is one regulation the name is: Dictamen De Idoneidad Técnica De Calentador Solar (DIT) (Technical Suitability of Solar Heater) this is a national document, but the specfications in this document there are not acording to international specifications. And in particular in Mexico City, there is a regional standard with the title: PROY-NADF-008-AMBT-2017,	Mexico

which establishes the technical requirements for the use of solar energy in water heating in buildings, facilities and establishments.	
We will adopt the International Standard	Portugal
- Different hail testing (required by some building insurances for some regions) - Different snow load testing (required by some building insurances for some regions)	Switzerland
Impact: other categories for hailstone Wind- and snowload: special test procedure	Switzerland
the Prosol Programme	Tunisia
Microgeneration Certification Scheme	UK
For the federal investment tax credit of 30%: CERTIFICATION OF SOLAR WATER HEATING PROPERTY- No credit shall be allowed under this section for an item of property described in subsection (d)(1) unless such property is certified for performance by the non-profit Solar Rating Certification Corporation or a comparable entity endorsed by the government of the State in which such property is installed.	USA
Responses to Question 14. ***What changes to ISO 9806 that you consider would improve that Standard?***	
- climatic conditions for the reliability test - time of the collector exposure relative to the stagnation temperature determination	Algeria
Difficult to determine pass/fail criteria on water penetration testing without a measured value (previously by weight) and without prior thermal efficiency tests (even so the uncertainties of comparing 2 collector efficiency tests are quite large and difficult to pinpoint as being due to water penetration which in real life may accumulate more than the 4 hours of spray tests). Need to define "significant" in Section 13.1	Australia
Whilst I support the scientific accuracy of the current test methods - particularity those around collector performance, I really believe they are very costly due to their perfection required in the test equipment and the time specified in the test methods. This means it is restrictive to trade in that there needs to be a critical volume of sales to justify the cost of the testing. I would challenge the committee to consider faster, cheaper, easier test methods that may not be as accurate as those currently specified however could provide results with a relatively high accuracy on performance predictions. This would help improve the uptake of solar collectors being tested to this standard (maybe as a lower performance test method that then has a penalty of uncertainty added to the test results, or the customer could request the current test method). The cost of the test equipment effectively limits the global test locations and this is also restrictive to obtaining results to this standard.	Australia
1) the judgement of rain test pass or fail shall be more clear; 2) the min. requirement of mechanical load pressure shall be mentioned.	China
Optional tests for (large) collector modules considering fluid type, flow rate and collector inclination	Denmark
To take into consideration the climatic specification of the Arab region	Egypt
PVT collectors test method and air collectors	France
the implementation of or the reference to a standardized PVT-test procedure would improve the standard	Germany

A new validation test sequence could be added to improve the reproducibility of performance parameters and harmonize the two test methods SS and QD. It could maybe also shorten the test duration and get more precise results. Currently there is a SCF project (SCF9 –ValiColl) to examine this possibility.	Germany
Validation test sequence to harmonize the results of performance testing by SS and QDT testing and maybe to simplify and shorten the testing as well as more exact and reproducible parameters. Currently there is an ongoing SCF project (SCF9 –ValiColl) to evaluate this possibility.	Germany
Change Chapter 16.3 clause b) to the following text: b) Evacuated tube collectors: For each ice ball diameter or height of drop, one randomly chosen tube of the collector shall be tested. The points of impact shall be located at a maximum of 75 mm from the upper visible end and from the lower visible end. The shot direction shall be normal to the tube axis. The tube shall be hit twice at the upper end and twice at the lower end.	Germany
I would like to comment about the tolerances of the tests and also if the same collector is tested in defferent labs, the results are always different.	Greece
About the calculation of the efficiency of a system.	Greece
more specific the stardarization of the testing methods and the display of them in the technical data sheets.	Greece
Detailed description of test methodology applicable to solar concentrators	Italy
The point : 5.2.6 Air and liquid heating collectors	Mexico
"A) Some editorial errors in : In section 11.3,	Portugal
Responses to Question 18. *Please add any other comments?*	
-Somme informations have to be added in ISO 9806 2017, as : Test data number in the steady state solar collector (16 pts ???) it is note precised Test method for determine the incidence angle modifier have to fetailed solar collector heat capacity: the entrance of water in the collector have to be precised. they are somme other comment that if you considere that are intersting do not hesitate to contact me	Algeria
IANOR (Algérien certification body) is working on a certification scheme based on ISO 9806.	Algeria
No national certification - the European Solar Keymark is used	Denmark
This is the secretary of the German national mirror committee. The answers I have given represent your mirrored questionnaire. However, there was only 1 participant in the mirrored questionnaire, because some experts already answered your questionnaire directly and didn't want to do it again. Kind regards, Saleh	Germany
In the Solar Keymark certification scheme there is also included a calculation of the annual output for selected locations and temperatures. This enables better understanding of the performance of solar thermal collectors. This could be a valuable amendment to the ISO 9806. Furthermore it provides the option to introduce one simple paramater called annual efficiency which could describe the performance of solar collectors in comaprison to other technologies like PV and thus effectively respond to regulatory and market needs.	Germany

As ISO 9806 only contains test methods it would also be good to have an international standard that also contains requirements for solar thermal collectors	Germany
I don't remember if I commented the previous. TC 35 (mirror com. for TC 312) is not active Solarkeymark is used as certification system but it's not obligatory. Another existing certification system developed before solarkeymark is not in practical use.	Greece
Though not specific to Solar Collectors , our product certification scheme requires that all collectors whether manufactured locally or imported have a quality mark.	Kenya
For Mexico this topic is important. NORMEX, is a National Standardization and Certification body we are working with the International Standards ISO. We are convinced that are necessary, for us is complicated to attend the meetings by the cost to travel but we revise all the documents. Best regards from Mexico. Antonio Muñoz Trejo.	Mexico
Pakistan standard quality control authority (PSQCA) is in progress to made setup for certification	Pakistan
There is no country certification system but the SolarKeymark is accepted	Portugal
Solar Keymark for subsidies	Switzerland
RAS	Tunisia
Currently the UK has to adopt 9806 because it is an EN ISO. That won't change with Brexit. Not that we don't usually have enough sunshine to make it useful.	UK
As national secretary I only publish the standard. I don't use it.	UK

Appendix 2
List of website for further information on the certification system

Table A2 – List of certification organisation websites

Country	Certification organisation	Website
Algeria	Organisme Algérien d'Accréditation (ALGERAC)	www.algerac.dz
Algeria	Algerian Institute of Standardization (IANOR)	www.ianor.dz
Australia	Clean Energy Regulator	www.cleanenergyregulator.gov.au
Australia	Joint Accreditation System of Australia and New Zealand (JAS ANZ)	www.jas-anz.org
Botswana	Botswana Bureau of Standards	www.bobstandards.bw
Brazil	Instituto Nacional de Metrologia, Qualidade e Tecnologia (Inmetro)	www.inmetro.gov.br
China	China National Accreditation Service for Conformity Assessment	www.cnas.org.cn
Egypt	The Solar Heating Arab Mark and Certification Inniative (SHAMCI)	www.shamci.net
Europe	Solar Keymark	www.estif.org/solarkeymarknew
France	Certita	http://www.certita.fr
Germany	TÜV Rheinland - Din Certco	www.dincertco.de
Greece	Demokritos	www.solar.demokritos.gr
India	Bureau of Indian Standards (BIS)	www.bis.org.in
Israel	The Standards Institution of Israel	www.sii.org.il
Jordan	Jordan Standards and Metrology Organization	www.jsmo.gov.jo
Kenya	Kenya Bureau of Standards	www.kebs.org
Korea	Korea New and Renewable Energy Center (KNREC)	www.knrec.or.kr
Portugal	Laboratório Nacional de Energia e Geologia (LNEG)	www.lneg.pt
Spain	Asociación Española de Normalización y Certificación (AENOR)	www.aenor.com
Sweden	Research Institutes of Sweden (RISE)	www.ri.se
Switzerland	Institut für Solartechnik (SPF)	www.spf.ch
Tunisia	Conseil National d'Accréditation (TUNAC)	www.tunac.tn
UK	Microgeneration Certification Scheme	www.microgenerationcertification.org
USA	IAPMO R&T	www.iapmort.org/Pages/SolarCertification.aspx
USA	Solar Rating & Certification Corporation (ICC-SRCC)	www.solar-rating.org