SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Task 48

Final deliverable

State of the art on new collectors & characterization

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IEA Solar Heating and Cooling Program

The Solar Heating and Cooling 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 member countries of the Programme 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.

A total of 53 such projects have been initiated to-date, 39 of which have been completed. Research topics include:

- Solar Space Heating and Water Heating (Tasks 14, 19, 26, 44)
- Solar Cooling (Tasks 25, 38, 48, 53)
- Solar Heat for Industrial or Agricultural Processes (Tasks 29, 33, 49)
- Solar District Heating (Tasks 7, 45)
- Solar Buildings/Architecture/Urban Planning (Tasks 8, 11, 12, 13, 20, 22, 23, 28, 37, 40, 41, 47, 51, 52)
- Solar Thermal & PV (Tasks 16, 35)
- Daylighting/Lighting (Tasks 21, 31, 50)
- 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)
- Resource Assessment (Tasks 1, 4, 5, 9, 17, 36, 46)
- Storage of Solar Heat (Tasks 7, 32, 42)

In addition to the project work, there are special activities:

- SHC International Conference on Solar Heating and Cooling for Buildings and Industry
- Solar Heat Worldwide – annual statistics publication
- Memorandum of Understanding with solar thermal trade organizations
- Workshops and conferences
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Country Members

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

Sponsor Members

European Copper Institute	Gulf Organization for Research and Development
ECREEE	RCREEE

Contents

1 General scope

An extensive market overview of existing concentrating collectors has been conducted so as to create easy to consult database (like the existing Solar Key mark one for certified collectors).

This database has been periodically updated during IEA Task 48 work and extended with information relating the certification process of such collectors. Concentrating collectors can nowadays be tested according to several standards (see also Kramer, Mehnert et al. 2011), the most important and enhanced one (also basis for certification according Keymark, SRCC, and others) is (Norm ISO 9806:2013[E]).
New components and approaches, currently under development, have been included into the survey and their use in existing solar cooling plants has been investigated.

2 Participating entities

Entities	Person in charge	Country	Role
Polimi	Marco Calderoni	Italy	Activity Leader
Fraunhofer ISE	Jochen Doell	Germany	Contributor
Fraunhofer ISE	Korbinian	Kramer	Contributor
CSIRO	Stephen	White	Contributor
TECSOL	Daniel	Mugnier	Contributor
Green Chiller	Uli	Joakob	Contributor
Industrial Solar	Christian	Zahler	Contributor

3 Milestones

No	Description	Month
M-A6.1	Start extensive market overview of concentrating collectors	12
M-A6.2	Creation of the database on market available concentrating technologies	18
M-A6.3	Updated version of the database	30
M-A6.4	Final version of the database on concentrating collectors	42

4 Collector database

An extended research on existing collector manufacturers has been initiated, in co-operation with IEA SHC Task 49. The results are presented into an excel file, which will be updated before each project meeting.
The excel file, as well as a folder containing product technical sheets, is available as attachment and the content of this excel file can be found as well in annex of the present report.

5 Experiences of manufacturers of medium temperature collectors with sorption machines

Some manufacturers of medium temperature collectors have been asked to tell about their experience with sorption machines. Few of them indeed gave useful answers.

Inquiries have been sent to the following companies: PSA, DLR, University of Balearic, Industrial Solar, Chromasun, Itcollect, TVP, NEP Solar, Sopogy, Absolicon, Novatec, Smirro, Abengoa, Soltigua, Dr. Vetter, SOLID, ECS, Helioclim.

A special acknowledgment must be addressed to the following companies among the quoted list above because they agreed to share their feedbacks on their solar cooling applications :

- SMIRRO (http://www.smirro.de/)

- HELIOCLIM (http://en.helioclim.fr)

- INDUSTRIAL SOLAR (www.industrial-solar.de)

The main feedbacks are summarized in the following table.

Manufacturer of collectors	Type of sorption machine	Feedback from practical experience on solar cooling	Control strategies implemented
Smirro – parabolic trough collectors	• Absorption (NH_3/H_2O) • Single stage • Dry cooler • 20 kW_{cold} • Nominal working temperature: 180°C	• Installation sensible points: delivery of some components (E.g. polluted thermal oil ended in meters cleaning and refilling the cycle), issues with a leaking oil gauge glass on the sensible heat storage ended in isolation damages. • Operation: not always possible to mantain the 180 °C. Producers cold performance of 11-15 kW could not be proved. Bad working re-cooling systems led to low COPs. Big losses in the heat storage between the absorption machine and the parabolic collectors.	• An order is implemented in a PLC associated to the collectors, so that every time that a fixed limit temperature is reached, they track to a position in which less radiation is absorbed.
Smirro – parabolic trough collectors	• Adsorption (H2O/Zeolithe) • Single stage • Dry cooler • 10 kW_{cold} • Nominal working temperature: 85°C	• Operation sensible points : need of the 2 chambers of the chiller to work in parallel. Need that all the piping system is isolated to avoid losses.	• An order is implemented in a PLC associated to the collectors so that every time that a fixed limit temperature is reached, They track to a position in which less radiation is absorbed. • Chiller can have some limit values as constrains for too high or low driving, chilling and recooling temperatures. If a set value of the constraints is reached the chiller stops and changes into the standby mode and waits for further requests. (E.g. minimal driving temperature of 75°C, minimal inlet temperature of 17 °C, the chiller switched off in stand by mode)

Manufacturer of collectors	Type of sorption machine	Feedback from practical experience on solar cooling	Control strategies implemented
Helioclim – parabolic trough collectors	• Absorption (NH_3/H_2O) • Single stage • Dry cooler • 10 kW_{cold} • Nominal working temperature: 160°C	• Hydraulic sensible parts needing caution: thermoelastic issues, rotating unions. • Control management: tracking system based on theorical sun position sufficient or do we need an active position controller? Choice of thermal sensors adapted to harsh conditions. • Installation cautions: fine tuning of solar collector positionning, integration of thermal sensors. • Operation cautions: waterproofing of rotating unions, magnetite sludge formation.	• Automatic focussing based on theoritical sun position. Automatic defocussing when there is no sun power during more than 5 minutes and in case of high wind, fluid temperature and pressure superior to safety values, fluid circulation failure. • Start of chiller when solar heat loop superior to a minimum value + cooling/heating needs >0
Industrial Solar – linear Fresnel	• Absorption (NH_3-H_2O and H_2O-LiBr) • Double stage • 2 x 175 kW_{cold}, 330 kW_{cold}, 600 kW_{cold} • Nominal working temperature: 180°C		• Variable mass flow, reduction of aperture area to avoid overheating at maximum flowrate • Project dependent: if minimum power from collectors available -> chiller on

6 Collector certification

Certification is a crucial issue for market introduction of new technologies such as medium temperature collectors. Certification schemes are already available and very common for conventional collectors worldwide (EN 12975 and Solar Keymark in Europe, SRCC in USA, AS/NZS 2712:2007 in Australia).

Why collector certification?

Reasons for pushing for the introduction of collector certification are summarized in the following list:

- certification may introduce minimum standards for product quality;
- certification helps investors and designers in choosing the most suitable product for a certain application;
- certification protects market from bad experiences;
- certification can be used as a market tool by manufacturers;
- certification raises market transparence.

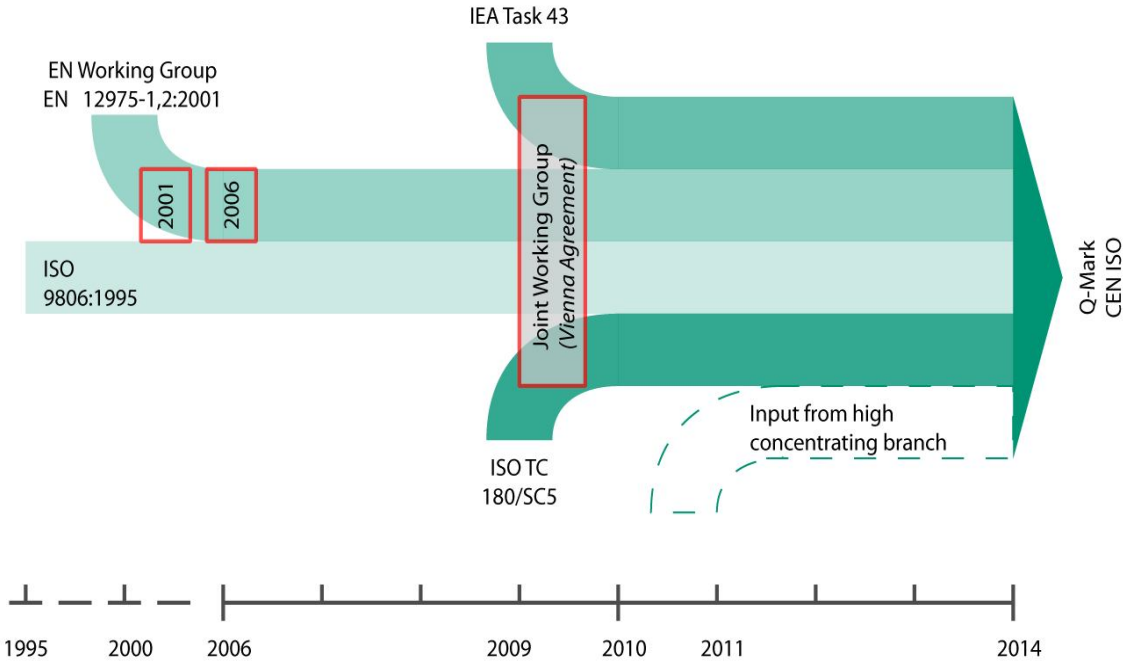
European experience with standards

There is a European standard for collector testing and certification (Norm prEN ISO 9806:2012 and EN 12975-1:2006-A1:2010). This standard provides:

- requirements on function
- requirements on materials
- testing instructions for function tests
- testing instructions on performance tests

Based on this standard (and precessing), Solar Keymark label was introduced in Europe in 2003. Solar Keymark is a volunteer label which adds further quality requirements to EN 12975, although some countries are introducing it as a mandatory label for access to subsidy programs. It experienced a quick growth in labeled products after 2007: in January 2011 around 1.200 collector models were labeled. It is operated by the existing network of accreditation bodies, empowered bodies, certification bodies and several accredited testing laboratories. Today through the enhancement of the standards a certification for concentrating collectors is possible.

Path towards certification procedure for medium temperature collectors are summarized in the following picture:



Process for introduction of a certification procedure for medium temperature collectors (source: Korbinian Kramer - Fraunhofer ISE - TestLab Solar Thermal System)

ANNEX

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ID	Collector typology	Manufacturer	Product name	Temperature range	Size of single module [m]	Efficiency curve	IAM	Web	Research or commercial readiness level	Documented experience with sorption cooling	comments
1	Improved flat plate collectors - double glazing	Arcon	HT-SA 28/10 AR-glass+ETFE -film	up to 120 °C	see attachment	see attachment	-	www.arcon.dk/	commercial	yes	
2	Improved flat plate collectors - double glazing	ökoTech	ökoTech HT collector	up to 120 °C	see attachment	see attachment	-	www.oekotech.biz	commercial	yes	
3	Improved flat plate collectors - vacuum + internal reflector	SRB Energy Research	Evacuated flat solar collector	up to 300 °C	0,64 x 3	n.a.	n.a.	www.srbenergy.com/	commercial	yes	
4	Improved flat plate collectors - vacuum	TVP Solar	MT Power	up to 200 °C	0,7 x 1,7	see attachment	-	www.tvpsolar.com	commercial	yes	
5	Improved flat plate collectors - vacuum	Solarfocus	CPC Kollektor	-	2,125 x 1,155	η0 = 0,74 a1 = 3,3 a2 = 0,012	see attachment	www.solarfocus.at	commercial	not available on website	
6	CPC Evacuated tubes collectors	Ritter XL Solar	CPC 45 XL	up to 140 °C	2,033 x 2,427	η0 = 0,644 a1 = 0,749 a2 = 0,005	Ktrans, (50°) = 0,98 Klong (50°) = 0,95	www.rittersolar.de	commercial	yes	
7	Improved Evacuated tubes collectors	Viessmann	Vitosol 200-T SD2	up to 270 °C	1,33 - 1,60 - 3,19 m²	η0 = 0,82 a1 = 1,62 a2 = 0,0068	-	www.viessmann.it	commercial	yes	
8	Improved Evacuated tubes collectors	Viessmann	Vitosol 200-SPL	up to 130°C	Aperture area : 1,69 m²	η0 = 0,71 a1 = 0,95 a2 = 0,005	-	www.viessmann.it	commercial (Solar Keymark certification ongoing)	yes	
9	Parabolic trough collectors	Nep Solar	PolyTrough 1200	up to 200 °C	1,2 x 24 , see attachment	η0 = 0,68 a1 = 0,04 a2 = 0,0015	see attachment	www.nep-solar.com	commercial	yes	
10	Parabolic trough collectors	Nep Solar	PolyTrough 1800	up to 250 °C	1,85 x 20 , see attachment	η0 = 0,68 a1 = 0,03 a2 = 0,0010	see attachment	www.nep-solar.com	commercial	yes	
11	Parabolic trough collectors	Solitem	Trough PTC1800	up to 180 °C	5,02 x 1,8	η0 = 0,6833 a1 = 0 a2 = 0,0033	see attachment	www.solitem.de	commercial	yes	all in all 4 sizes are available (PTC 1100, PTC 1800, PTC3000, PTC4000)
12	Parabolic trough collectors	Soltigua	PTM 18, 24, 30, 36	up to 250 °C	depending on module - see attachment	η0 = 0,71 a1 = 0,6	see attachment	www.soltigua.com	commercial	yes	
13	Parabolic trough collectors	Solarlite	4600	up to 400 °C	12 x 4,6	n.a.	n.a.	www.solarlite.de	commercial	not available on website	
14	Parabolic trough collectors	Trivelli Energia	SWCH	up to 300 °C	8,2 x 1,25	not publishable	not publishable	www.trivellienergia.eu	commercial	yes	
15	Parabolic trough collectors	Dr. Vetter	Itcollect	up to 200 °C	2,16 x 0,56 (for roof integration)	η0 = 0,656 a1 = 0,788	see attachment	www.itcollect.de	R&D	not available on website	

ID	Collector typology	Manufacturer	Product name	Temperature range	Size of single module [m]	Efficiency curve	IAM	Web	Research or commercial readiness level	Documented experience with sorption cooling	comments
16	Parabolic trough collectors	CIEMAT	Capsol	up to 250 °C	1 x 2	see attachment	see attachment	www.psa.es/webesp/projects/capsol/results.php	R&D	not available on website	
17	Parabolic trough collectors	Smirro	Smirro	up to 250 °C	1,14 x 3	n.a.	n.a.	http://smirro.de	commercial	yes	
18	Parabolic trough collectors	Absolicon	MT10	up to 160 °C	n.a.	n.a.	n.a.	www.absolicon.com	commercial	yes	
19	Parabolic trough collectors	Pro Target	n.a.	up to 400 °C	n.a.	n.a.	n.a.	www.protarget-ag.de/	R&D	not available on website	
20	Parabolic trough collectors	Abengoa	PT-1	up to 250 °C	2,3 x 6,1	n.a.	n.a.	www.abengoasolar.com	commercial	not available on website	
21	Parabolic trough collectors	Wihtestar Energy	W11-C	n.a.	Aperture area: 2,112 m²	see attachment	see attachment	www.whitestarenergies.com	R&D	not available on website	
22	Parabolic trough collectors	Focal Point Energy	Energy Driver™	n.a.	3,048 x 12,192 (10 ft. x 40 ft.)	n.a.	n.a.	http://focalpointenergy.com	commercial	not available on website	
23	Parabolic trough collectors	Helioclim	Helioclim Solar Collectors	up to 220 °C	1,48 x 3,08	n.a.	n.a.	http://en.helioclim.fr	commercial (Solar Keymark certification ongoing)	yes	
24	Parabolic trough collectors	SLT Energy	SOL Yatna CSP	up to 400 °C	12 x 5	n.a.	n.a.	http://sltenergy.com	R&D	not available on website	
25	Parabolic trough collectors	Archimede Solar Energy	HCESH	up to 550 °C	see attachment	see attachment	see attachment	http://www.archimedesolarenergy.it	R&D	not available on website	ASE produces receiver tubes
26	Fresnel collectors	Novatec Solar	Nova - 1	up to 500 °C	44,8 x 16,56	η0 = 0,67 a1 = 0,056 a2 = 0,000213	see attachment	www.novatecsolar.com	commercial	not available on website	
27	Fresnel collectors	Industrial Solar	LF-11	up to 400 °C	4,06 x 7,5	η0 = 0,635 a1 = 0 a2 = 0,00043	see attachment	www.industrial-solar.de	commercial	yes	
28	Fresnel collectors	Chromasun	MCT	up to 200 °C	3,39 x 1,23	η0 = 0,565 a1 = 0,054 a2 = 0,0032	see attachment	http://chromasun.com	commercial	yes	
29	Fresnel collectors	Soltigua	FTM 18, 24, 30, 36	up to 250 °C	depending on module - see attachment	η0 = 0,60 a1 = 0,38	see attachment	www.soltigua.com	commercial	yes	
30	Fresnel collectors	KGDS	n.a.	n.a.	n.a.	n.a.	n.a.	http://solar.kgisl.com/	R&D	not available on website	
31	Fresnel collectors	Hitachi	HSLPF	up to 340 °C	115,7 x 9,8	see attachment	see attachment	www.hitachizosen.co.jp/	R&D	not available on website	
32	Point focussing collectors	Isomorph	Linear Mirror II	up to 100 °C	Aperture area: 13,8 m²	see attachment	see attachment	www.isomorph-production.it/	R&D	not available on website	