SOLTIGUA: experience in FP7 projects

V1.0 – 10/14

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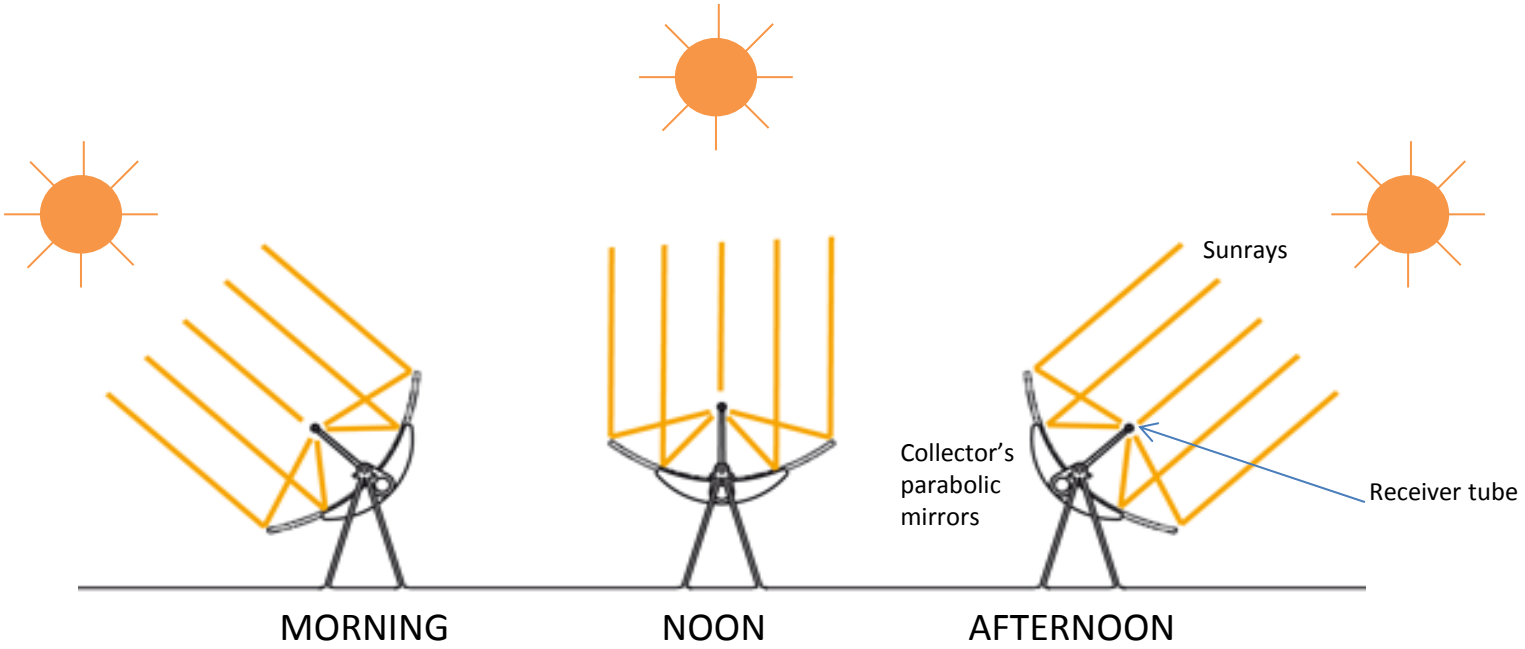
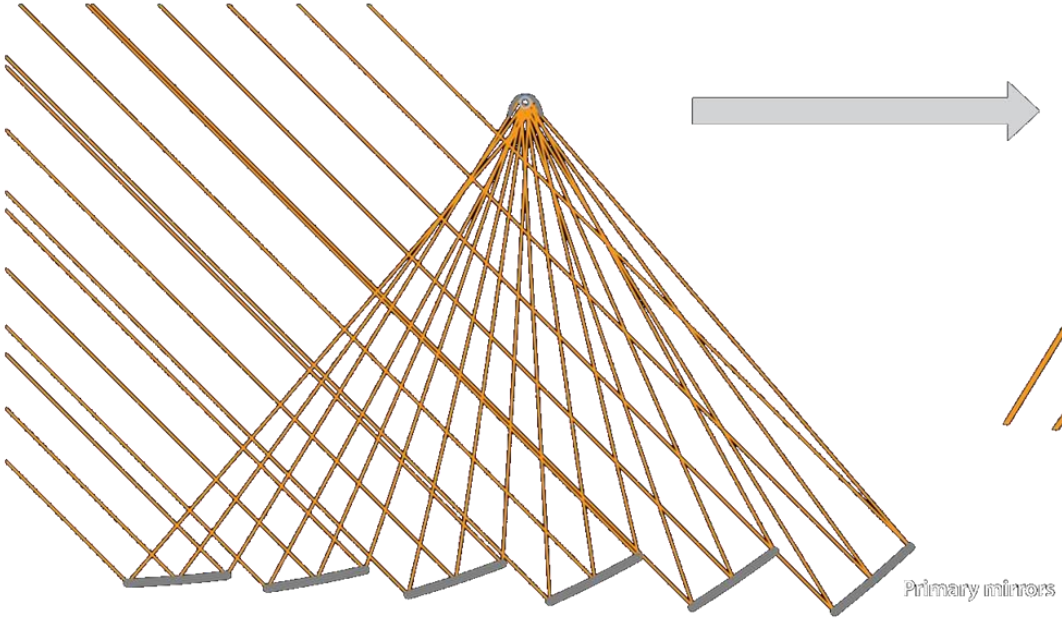
TECHNOLOGY

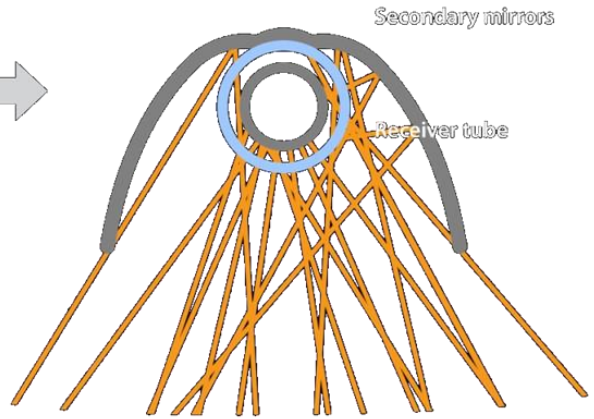
Parabolic trough – operating principle



- Sunrays are concentrated by the mirrors on the receiver tube, where the circulating fluid is heated.
- The collector tracks the sun throughout the day, to heat the fluid continuosly.

Fresnel working concept





A secondary mirror helps to concentrate all incoming sun rays on the receiver tube

- A parabola is cut into “slices” that track the sun in the same plane
- The receiver tube is fixed
- Because of the fixed receiver, the efficiency is lower
- It generates lower wind loads and is ideal for rooftops

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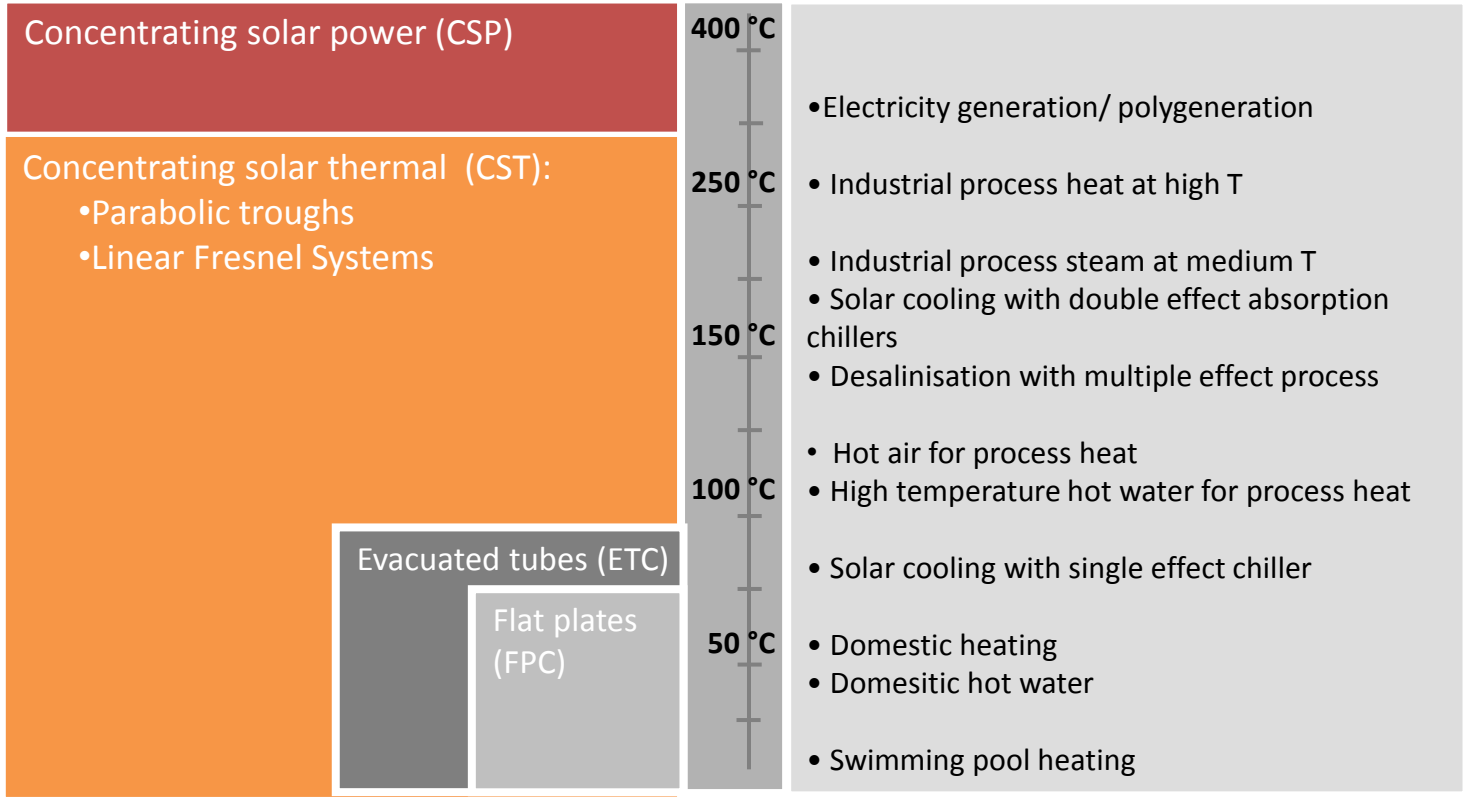
CST: new opportunities for solar energy



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Broad spectrum of industrial sectors

INDUSTRIAL SECTOR	PROCESS	TEMPERATURE[°C]
Food and beverages	Washing	80 – 150
	Pasteurization	80 – 110
	Sterilization	130 – 150
	Drying	130 – 240
	Cooking	80 – 100
Plastics	Extrusion and Drying	150 – 180
Chemical	Heat treatment	150 – 180
	Boiling	95 – 105
	Distillation	110 – 300
	Drying	150 – 180
Paper	Bleaching and drying	130 – 180
Textile	Washing	80 – 100
	Heat treatment	80 – 130
	Bleaching	60 – 100
	Dyeing	100 - 160
Industrial cleaning	Steam Washing	150
Commercial sector	Air conditioning	180
All	Electricity generation/Polygeneration	250-300

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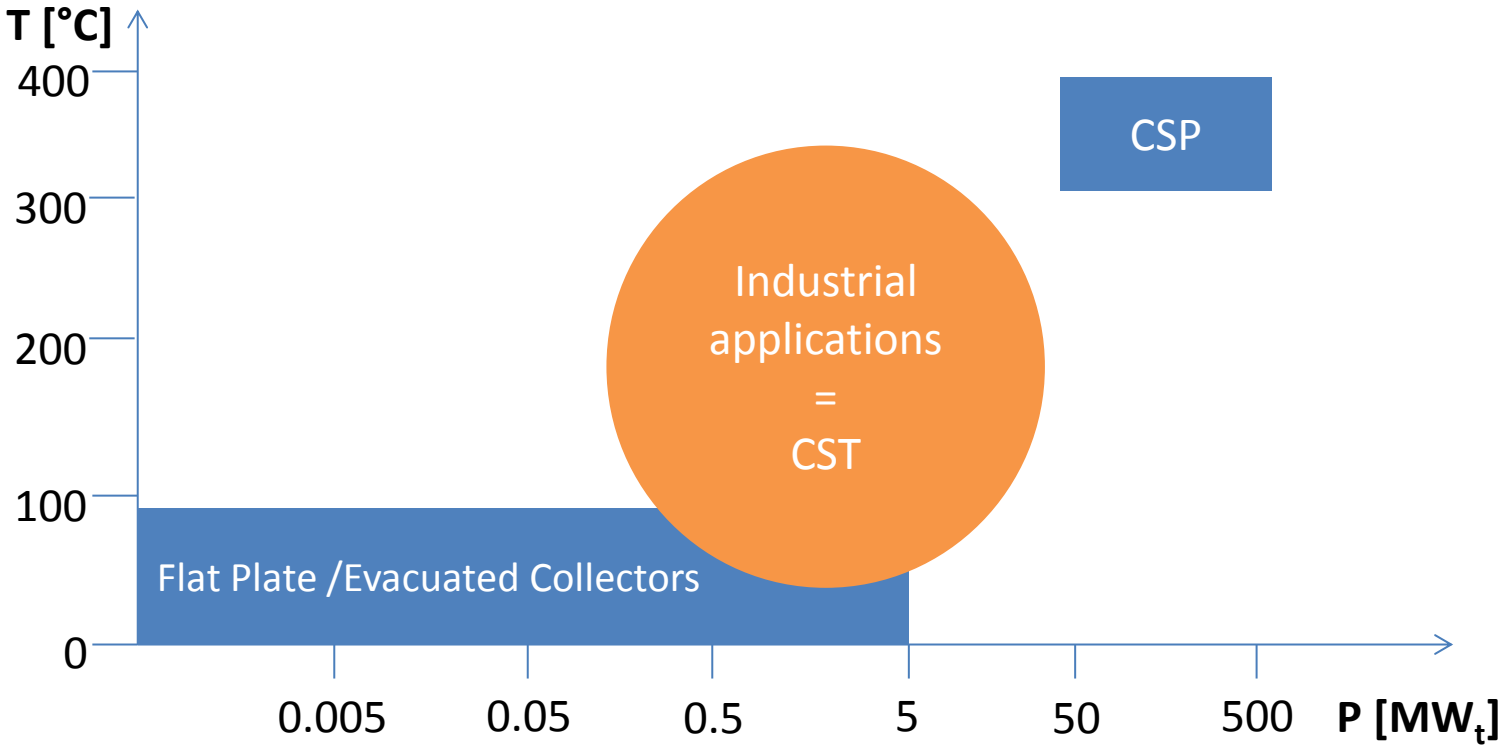
CST covers the gap



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COMPANY PROFILE

Soltigua

Soltigua, an Italian company, develops **solutions for process heat** which are:

- environmentally friendly
- economically attractive
- based on solar energy

Soltigua's distinguishing feature is in its products' **technical excellence**, shown in its unique product portfolio:

- PTM/PTMx series (Parabolic Trough Mirrors)
- FLT series (Linear Fresnel Mirrors)

Soltigua is the only company offering both technologies to the market

Soltigua's **quality and reliability** are proven by PTM certification up to 250°C according to EN-12975

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Product portfolio

Soltigua is the only company offering two 2 solar concentrating technologies dedicated to industrial process heat

PTM – parabolic trough

FLT – linear Fresnel

MAIN FEATURES

- Fully automatic (PLC- based)
- Modular design
- High performing receiver
- Weather-resistant, safe tempered glass mirrors
- Sun tracking drive and motor
- Hot-dip galvanized frame
- Fluid: hot water (up to 110°C) or thermal oil (up to 300°C)
- Working pressure: up to 25 bar
- Electric panel at 230 V

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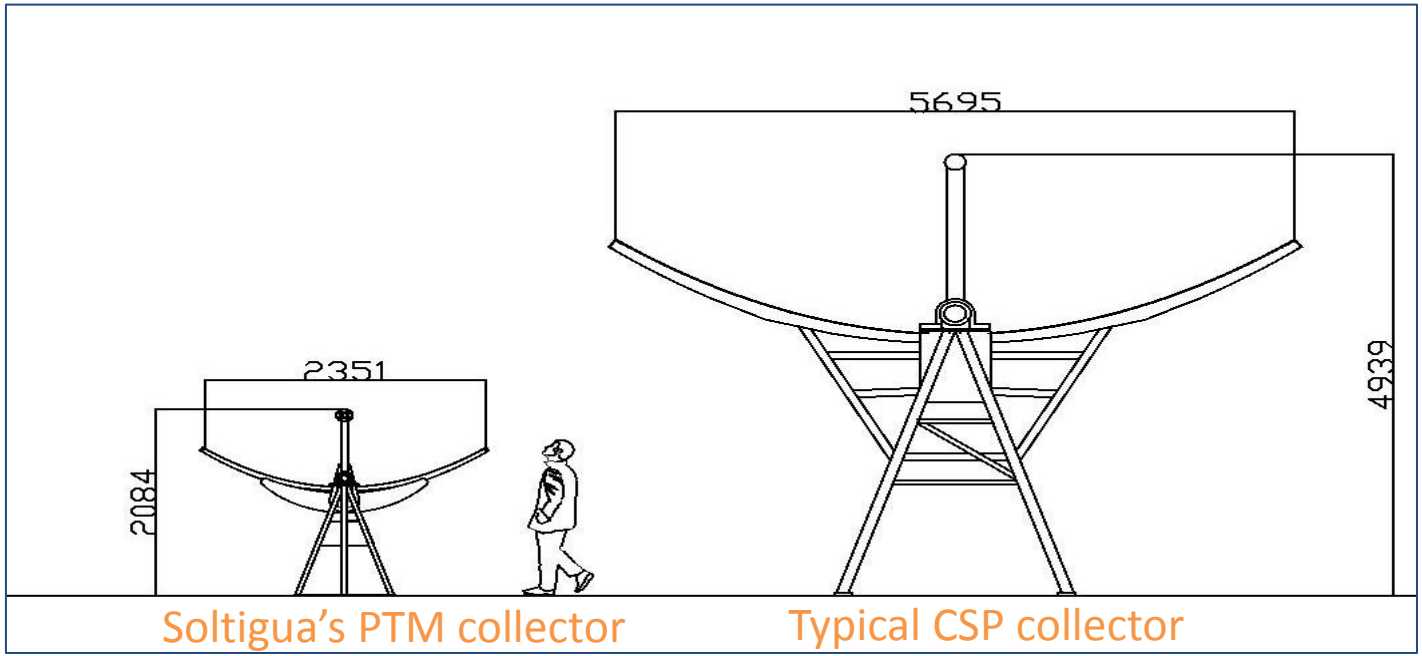
Collectors engineered for smaller applications



Soltigua's PTM collector

Typical CSP collector

The size does not require specific equipment for installation and does not create constraints for maintenance

Example: it has to be cleaned with truck system => corridors for trucks must be considered

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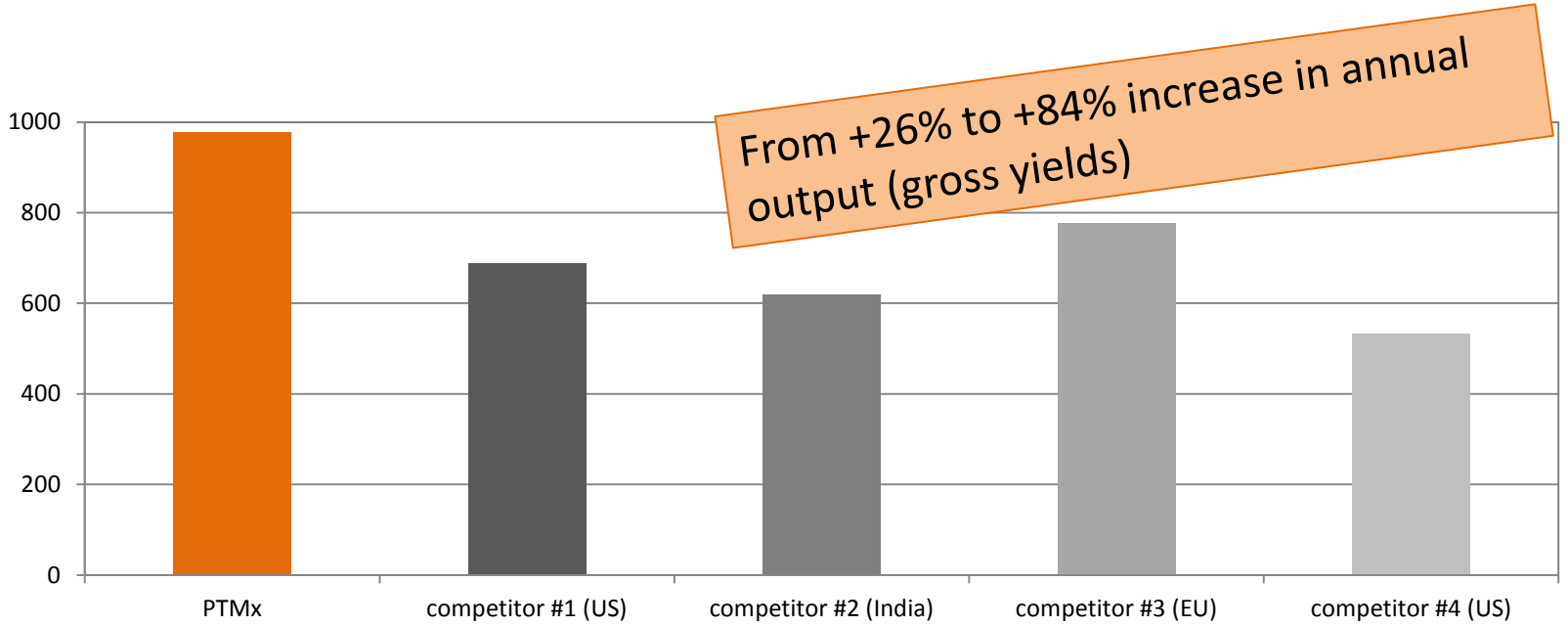
Best in class performance



Location: Vadodara, India

Solar field working temperatures:

- T_{inlet} = 175°C;
- T_{outlet} = 195°C

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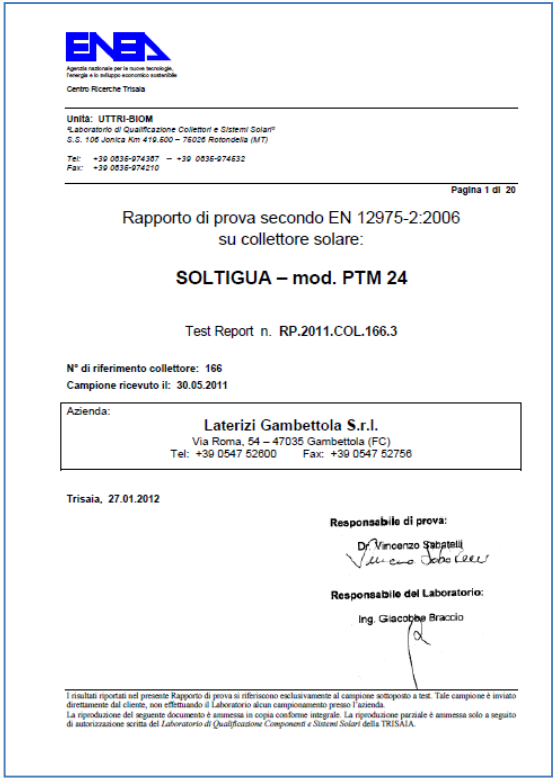
Product certification and awards

inter solar award 2012 WINNER

PTM is the first collector certified according to EU standard EN 12975 up to 250°C



ENEA

Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile

Centro Ricerche Trisaia

Unità: UTTRI-BIOM
Laboratorio di Qualificazione Collettori e Sistemi Solari
S.S. 106 Jonica Km 419.500 – 75026 Rotondella (MT)

Tel: +39 0835-974387 – +39 0835-974632
Fax: +39 0835-974210

Pagina 1 di 20

Rapporto di prova secondo EN 12975-2:2006
su collettore solare:

SOLTIGUA – mod. PTM 24

Test Report n. **RP.2011.COL.166.3**

N° di riferimento collettore: 166
Campione ricevuto il: 30.05.2011

Azienda:
Laterizi Gambettola S.r.l.
Via Roma, 54 – 47035 Gambettola (FC)
Tel: +39 0547 52600 Fax: +39 0547 52756

Trisaia, 27.01.2012

Responsabile di prova:
Dr. Vincenzo Sabatelli

Responsabile del Laboratorio:
Ing. Giacobbe Braccio

I risultati riportati nel presente Rapporto di prova si riferiscono esclusivamente al campione sottoposto a test. Tale campione è inviato direttamente dal cliente, non effettuando il Laboratorio alcun campionamento presso l'azienda.
La riproduzione del seguente documento è ammessa in copia conforme integrale. La riproduzione parziale è ammessa solo a seguito di autorizzazione scritta del *Laboratorio di Qualificazione Componenti e Sistemi Solari* della TRISAIA.

PTMx won the Intersolar award for innovation in 2012.
In 2013 it has been certified to EN 12975

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World-class R&D

R&D resources include a dedicated team of engineers and researchers to develop innovative concepts for collectors and integration solutions.

Soltigua cooperates with leading European solar R&D, including:

– Fraunhofer ISE (D)

– DLR – German Aerospace Center (D)

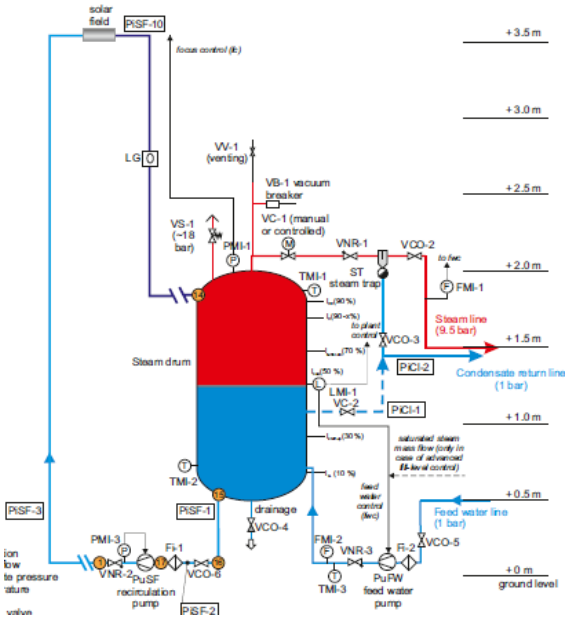
– SPF Rapperswill (CH)

Fraunhofer ISE

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

SPF INSTITUT FÜR SOLARTECHNIK

For example, Soltigua is currently developing an innovative Linear Fresnel Concentrator with an enhanced receiver tube and working on the generation of process steam directly in the receiver tubes



P&I of Soltigua's Solar Direct Steam Generation

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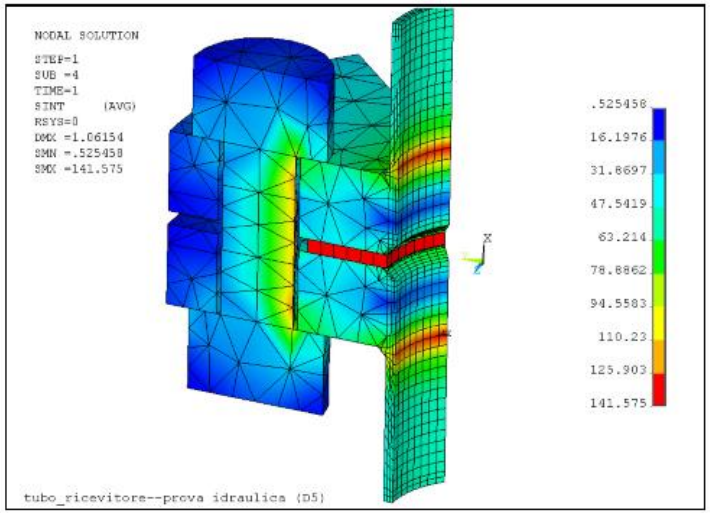
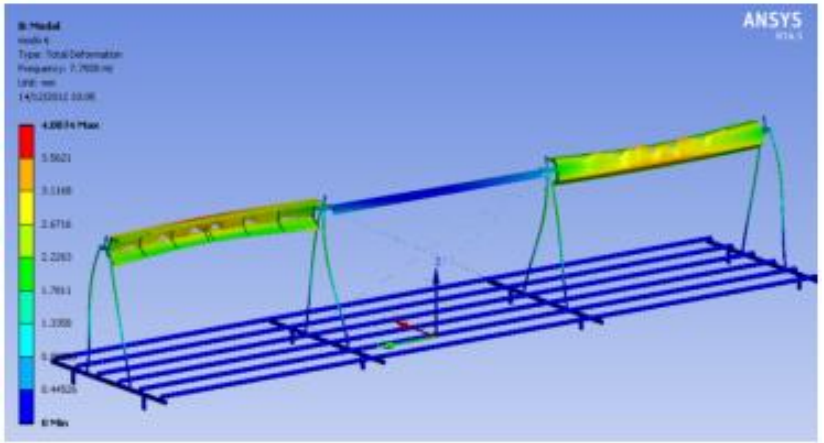
Advanced engineering capabilities

3D modeling and FEM calculations are used to ensure compliance to international standards





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Extensive manufacturing capacity

- Soltigua's solar collectors dedicated manufacturing plant develops over 2'000 m^2 of covered plant and 10'000 open storage area.
- Soltigua's annual manufacturing capacity is approximately 30 MW (~60'000 m^2).
- Soltigua's designs and manufactures all key components of its solar collectors, to maintain the highest quality standards

Receiver tubes

Tempered glass mirrors

Torque tubes

Integrated supply chain

- Solar collectors components are manufactured according to the most modern technologies available on the market, including:
  - Metal sheet laser cut
  - Metal tubes laser cut
  - Automatic bending
  - PLC based control
- Electronic components are chosen from top international brands (Schneider electric, Siemens)
- All main suppliers are quality certified

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Remote monitoring and datalogging

Online remote monitoring

Data logging

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Commercial Projects: long lead time…

PROJECT REVIEW WITH REFERENCE TO PROMOTIONAL ACTIVITIES - SOLTIGUA									
2014 Sales									
Project					Dates		Promotion		
Code	Location	Collector	m2	Application	Start	End	Type	First contact	Lead time
S12024	Cile	Parabolic	490	Process heat	29/11/2013	28/02/2013	Trade fair	15/06/2011	29,9
S13089	Italy	Fresnel	66	Solar cooling	09/04/2014	30/06/2014	Soltigua direct contact on client	01/08/2013	8,4
S11108	Italy	Parabolic	2.856	Process heat	27/05/2014	31/12/2014	Client enquiry - word of mouth	15/12/2011	29,8
S12075	Italy	Parabolic	136	Solar cooling	08/08/2014	15/11/2014	Client enquiry - word of mouth	15/06/2012	26,1
S13113	Spain	Parabolic	41	Solar cooling	11/08/2014	31/12/2014	Client enquiry - web/phone	29/10/2013	9,5
S14033-A	Marocco	Parabolic	54	Pilot	18/09/2014	18/06/2014	Client enquiry - word of mouth	15/04/2014	5,2
S14033-B	Marocco	Fresnel	11.435	CSP	24/10/2014	24/04/2016	Client enquiry - word of mouth	15/04/2014	6,4
2015 - Selected prospects									
S13081	Jordan	Fresnel	1.764	Process heat	15/01/2015		Trade fair	15/06/2013	19,3
S13056	Greece	Parabolic	490	CSP	15/01/2015		Client enquiry - web/phone	05/05/2013	20,7
S14012	Italy	Parabolic	1.142	Process heat	15/03/2015		Client enquiry - web/phone	14/01/2013	26,3
S13115	Italy	Fresnel	11.000	CSP	15/03/2015		Soltigua direct contact on client	29/10/2013	16,7

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FP7 projects: … longer lead time!!!

					Dates			Lead time	
Name	Year	Score	result	Application	Start	End	First contact	to start	to end
DiSCo	2011	12	no	Process heat			10/09/2010		
InSun	2011	13	yes	Solar cooling	01/04/2012	30/09/2015	15/11/2010	17	59
JOSH	2011	7	no	Process heat					
FRESH NRG	2012	12,5	yes	Solar cooling	01/03/2013	31/08/2016	10/09/2010	30	73
SUNTIES	2012	11,5	no	Solar cooling			10/09/2011		
SUNMOV-R	2012	8	no	Pilot					
REELCOOP	2013	12,5	yes	CSP	01/09/2013	31/08/2017	10/09/2011	24	73
BRICKER	2013	12?	yes		01/10/2013	30/09/2017	10/08/2012	14	63
ZEROLOSSFACTORY	2013	9	no						

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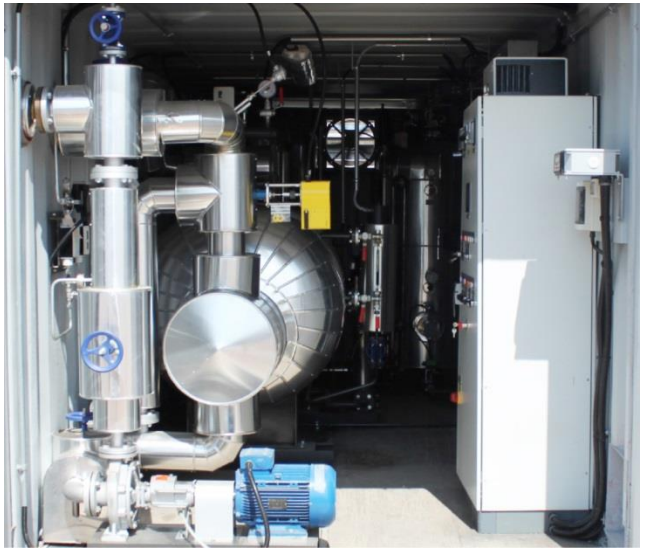
InSun: Solar Process Heat (Italy & Austria)



Website: http://www.fp7-insun.eu/InSun_Start.htm

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 296009

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InSun – Abstract (1)

The InSun project will demonstrate the reliability and quality of large scale solar thermal systems for different types of industrial process heat applications on medium and high temperature levels and provide one stop shop business models for this type of technology.

InSun focuses on the promotion of large solar collector technologies via demonstration installations. The market deployment will target a 25% share of RES increase for solar thermal within the EU 27 countries by providing clearly valuable solutions to suitable industrial customers.

The demonstration project will help to provide confidence in this technology. Besides this the project will allow to offer - starting in 2015- industrial solar thermal investments with an expected payback time of about 10 years without any incentive. The development of simulation based commissioning methods will significantly reduce the commissioning time after system installation and the automated simulation based performance observation will help to increase the trust in this technology.

With regard to the current EU 20-20-20 target a contribution of 25% of RES increase for solar thermal in the 5 years after the end of the project (2015 to 2020) is planned. This target can be achieved by winning only a 1% share of the European industrial thermal consumption at low temperatures. Thus substantial CO2 savings can be generated.

InSun – Abstract (2)

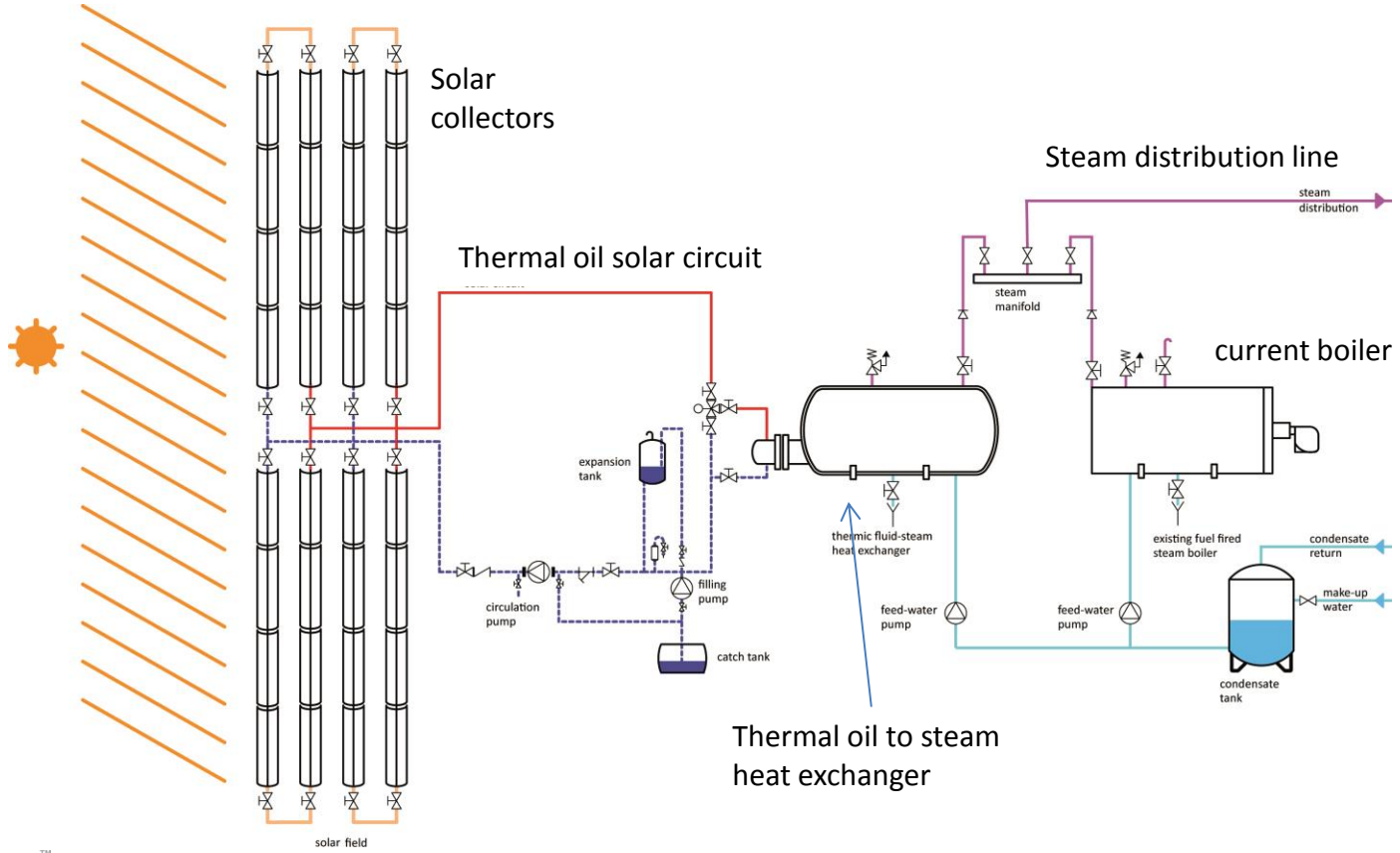
The very close collaboration with key industrial partners including collector producers and demonstration partners supported by the two research institutes within InSun is essential to reach these goals.

Periodically organized international expert workshops with strong support from ESTIF will include selected external experts from other ongoing research or commercial projects in the field of industrial solar process heat.

These workshops will ensure a broad and complete view on the topic and the outcomes will not only support the progress of InSun but will also deliver results useful for the standardization and development progress of the technology.

For further expert knowledge exchange and dissemination of the InSun results, the InSun project significantly contributes to the new IEA Task 49 coordinated by AEE INTEC. Additionally, InSun actively contributes to the IEA Task 45.

InSun - Process steam – P&I diagram



Purely indicative information. Soltigua does not guarantee its accuracy

FRESH NRG: collector development & test

Website: http://www.fresh-nrg.eu/

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308792

FRESH NRG – Abstract

FRESH NRG will target efficiency of 60% at 250°C with a Linear Fresnel Collector (LFC) optimized for industrial use. Our integrated approach will design, implement and test disruptive innovations in **4 key parts of the value chain.** A highly innovative **sol-gel coated non evacuated receiver** will combine robustness, durability and performance (transmittance >96%, absorbtivity >95%, emissivity$_{250°C}$ <7%). To increase the annual yield, a **LFC design with radically new geometry** will differentiate the width of the primary mirrors. Concentration factor >90 will limit heat losses. Ultra light mirror panels will combine safety, durability and reflectivity >93%. Modular "plug-in" components (e.g. clip-on secondary mirrors) will simplify transport and installation. Laboratory and field tests of the new LFC and its key components will include existing methods (e.g. EN12975) and methods that are currently revised or will be developed in IEA-SHC/SolarPaces Task 49. A first-of-its-kind **lean manufacturing system** including coating equipment, receiver assembly, and mirror production will be prototyped and co-located to optimize cost reduction. Integration packages for **Mediterranean industrial applications** will include a new control logic to optimize energy output for industrial use. A full blown polygeneration system in Jordan will provide actual use of the new LFC for power generation, heating and cooling. **A clear plan for the exploitation** of the technical results will include a highly multi-disciplinary approach. Detailed bottom-up prospection of high-potential applications will be analysed to drive industrial strategy towards a large economic impact. Relevant key findings will be shared also with policymakers and industry regulators. Knowledge dissemination will promote the innovative results of the project (e.g. comparison of test methods) to achieve a full scientific impact at EU level.

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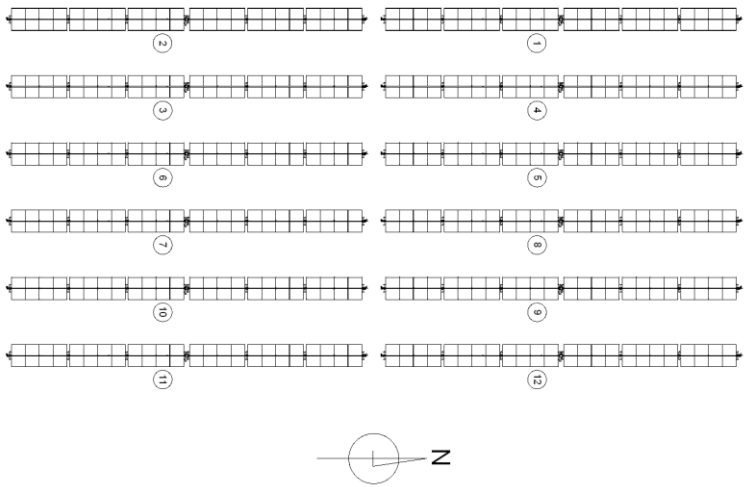
REELCOOP: DSG PED PTC CSP PCM (Tunis)



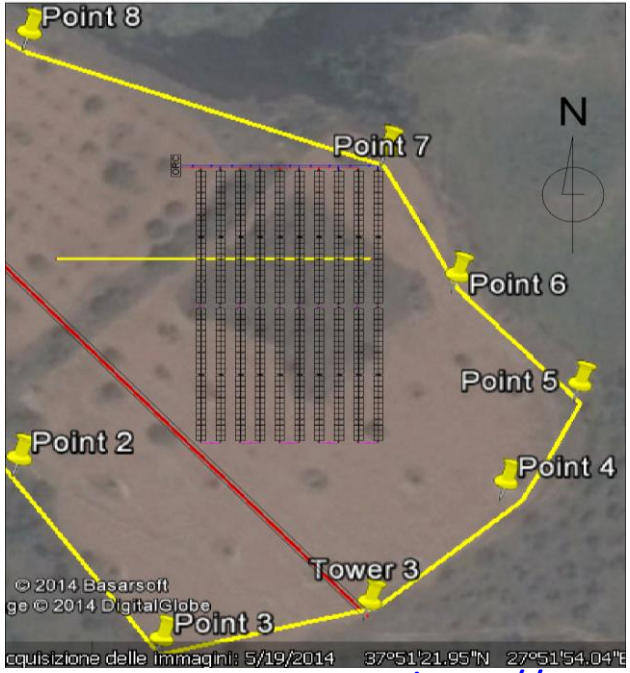
Website: http://www.reelcoop.com/project

Project funded by the European Union's Seventh Programme for research, technological development and demonstration under grant agreement n. 608466

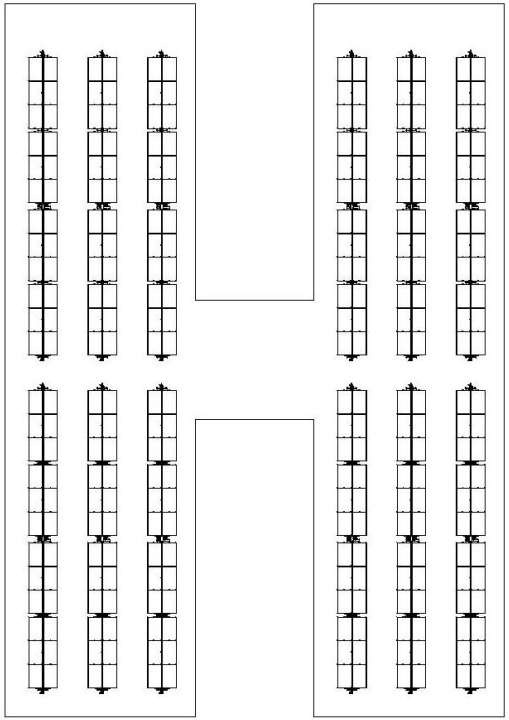
REELCOOP – Abstract

REELCOOP will address 5 areas: photovoltaics (PV), concentrated solar power (CSP), solar thermal (ST), bioenergy and grid integration. REELCOOP will develop decentralised (distributed) building integrated PV systems and ST/biomass micro-cogeneration systems, as well as centralised generation of electricity in hybrid solar/biomass power plants. This is in accordance with the EU SET-Plan approach of developing a European electricity grid able to integrate renewable and decentralised energy sources. The overall aim of REELCOOP will be to significantly enhance research cooperation and knowledge creation on renewable electricity generation, involving Mediterranean partner countries (MPC), while at the same time developing and testing new renewable electricity generation systems. The proposed systems will be developed in European organisations with collaboration of MPC partners, and tested under real-life operating conditions in the MENA region, thus establishing a cooperation network amongst partner countries. Three novel prototype systems will be developed and tested, being representative of both micro (distributed) and large (centralised) scale approaches to electricity generation: prototypes 1 and 2 are representative of typical micro-generation systems, while prototype 3 is representative of a large scale power plant on a reduced scale. The development of the 3 prototypes will also contribute to bring to the market energy efficient, renewable electricity generation systems. The environmental sustainability and economics of the prototype systems will be assessed, and the results obtained will be disseminated to industry and research, as proof-of-concept of renewable electricity generation solutions. Grid integration will also be assessed. The prototype systems will have a great potential for exploitation and commercialization. The commercialisation of the systems will bring economic and environmental benefits to the EU.

BRICKER: public buildings CSP (TUR,ESP)



Website:
http://www.bricker-project.com/



This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 60907 - See more at: http://www.bricker-project.com/#sthash.XE5OEcPk.dpuf

BRICKER – Abstract

A scalable, replicable, high energy efficient, zero emissions and cost effective SYSTEM to refurbish existing public-owned non-residential buildings to achieve at least 50% energy consumption reduction through:

a) A systemic methodology for optimal building retrofitting towards zero emissions, developed to ensure cost effectiveness, scalability and replicability of the interventions taking into account external (geographical, climatic, resources, social) and internal (envelope, facilities and use) building boundary conditions.

b) Development of demand reduction strategies: Based on envelope U-value improvement through innovative technologies, material applications and design techniques.

c) Development of Energy reduction strategies: An effective interaction and integration of an innovative, scalable, high efficient renewable HVAC hybrid cogeneration system fed with locally available RES, including thermal energy storage strategies as the core of the methodology´s implementation.

d) Effective interactions of energy flows: building to building, building to electrical grid and building to heating and cooling networks and improved methodologies for interconnectivity of smart grids and heating and cooling networks under the control of a building level energy operation system.

Buildings will be considered as single energy-consumption units and at the same time, connected to other buildings forming high energy efficient districts prepared to be connected with other districts around. These energy units will be able to provide advanced energy services (electrical and thermal) to other buildings in their district, which will make the building strategies replicable al district level in order to attract investments.

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PTMX – PRODUCT FEATURES

PTMx product range and capacity

PTMx is available in 4 different models which can be used according to space availability

Model	N. of modules	Surface (m^2)	Length (m)	Peak capacity STEAM@10 bar (kg/hr) – [kW]	Peak capacity HOT WATER 15-90°C (lt/hr) – [kW]	Peak capacity HOT WATER 70-90°C (lt/hr) – [kW]
PTMx-18	3	41	19.7	28 kg/hr [20 kW]	270 lt/hr [24 kW]	1000 lt/hr [23 kW]
PTMx-24	4	54	26.2	38 kg/hr [27 kW]	360 lt/hr [31 kW]	1343 lt/hr [31 kW]
PTMx-30	5	68	32.2	47 kg/hr [34 kW]	450 lt/hr [39 kW]	1678 lt/hr [39 kW]
PTMx-36	6	81	38.6	56 kg/hr [41 kW]	540 lt/hr [47 kW]	2014 lt/hr [47 kW]

*: considering:
DNI=900 W/m2,
IAM = 0.95
primary circuit losses = 5%

Purely indicative information. Soltigua does not guarantee its accuracy

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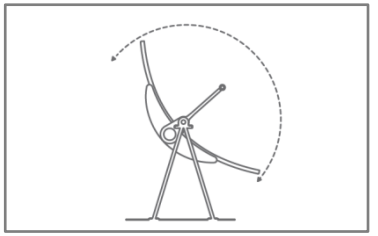
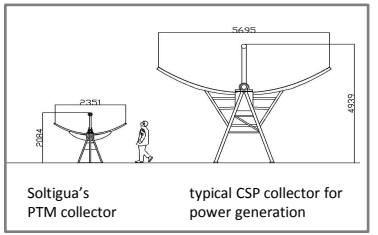
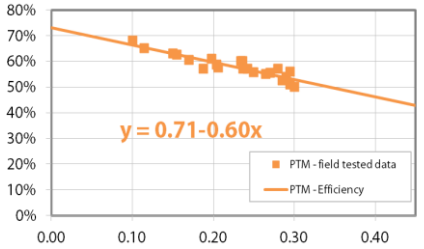
PTMx unique value proposition

- **Concentrating collector**
  - it exploits **all benefits of sun-tracking** unlike flat-plate collectors, PTM can be “switched off” (turned upside-down into sleeping position) when not used, avoiding any risk of overheating in the system
  - Thanks to concetration, PTM has a **very high performance at medium temperatures** (from 90° up to 250°C)
- **Designed specifically for industrial applications**
  - Collectors **engineered** specifically **for** industrial applications and **easiness of human interaction** (eg. manual cleaning)
  - **Embedded sensors** (weather station, temperature, flow, power) generate warnings and alarms
  - PTMx is **CE marked** as a proof of reliability and safety
- **Highest energy yield**
  - Technical excellence generates the **highest performance** per unit of surface installed, with optical efficiency up to 76%*
  - Annual energy yield can be **80% higher** than other concentrating collectors
  - Performance **certified by third party** (ENEA) according to standard EN 12975







*: depending on the type of mirror

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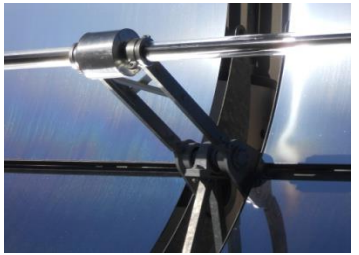
PTMx unique value proposition

- **Industrial PLC-based automation**
  - The PLC takes care of tracking, safety controls, automatic functioning
  - PTMx solar fields operate **completely unattended**
  - A user-friendly web-based interface allow **remote monitoring** via LAN
  - Functioning parameters can be customised
- **Designed for the roughest environments**
  - Reliability and availability maximised through **FEM calculations** and **field tests** (Resistance (wind and snow) and fatigue (lifecycle))
  - High wind resistance (up to 93 km/h in full aperture)
  - Exceptional torsional stiffness is given **by torque tube metal structure**
  - Weather resistence given by **hot deep galvanised structural parts**
- **Ease-of-use is provided by patented mountable connections**
  - Equipment is tested in factory to guarantee product quality
  - **No calibration of pieces is requested on site** during solar field erection
  - Patented solution requires **no welding of receiver tubes during installation** (and related possible leakages)



Purely indicative information. Soltigua does not guarantee its accuracy

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PTMx unique value proposition

- **Reliable and extremely accurate sun tracking system**
  - Every collector line has a **separate drive system** to avoid backlashes which reduce energy yield or periodic adjustiments
  - Tracking Is based on **very precise astronomic formulas** → no periodic adjustments not required (potential source of error)
  - PTMx tracking **does not use wearable light sensors** which can be unprecise in non-ideal irradiation conditions

- **Robust mirrors**
  - Mirrors are made of **tempered glass**: there is no risk of damage (bending or scratching) during installation and cleaning

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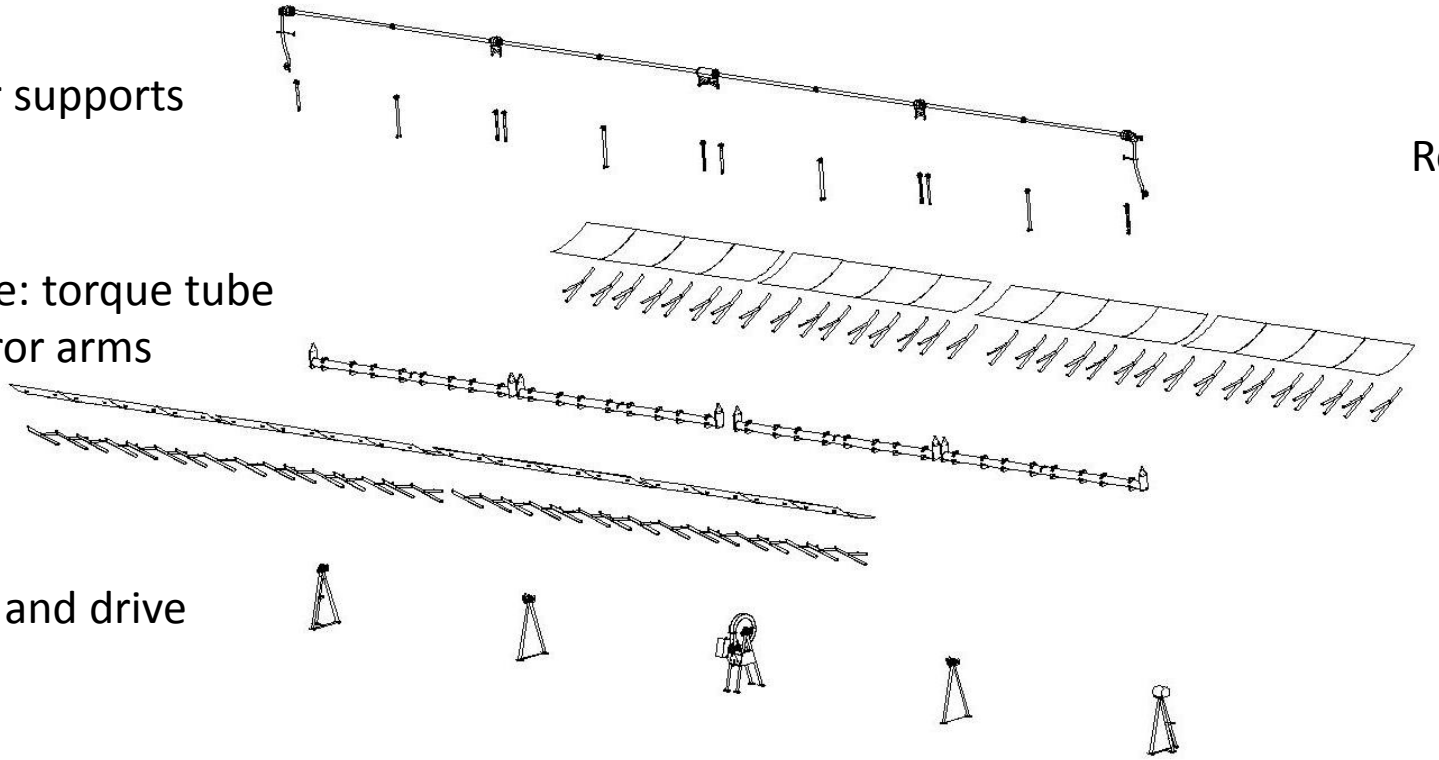
PTMx: the assembly concept

Receiver supports

Metal
Structure: torque tube
and mirror arms

Pylons and drive



Receivers

Mirrors

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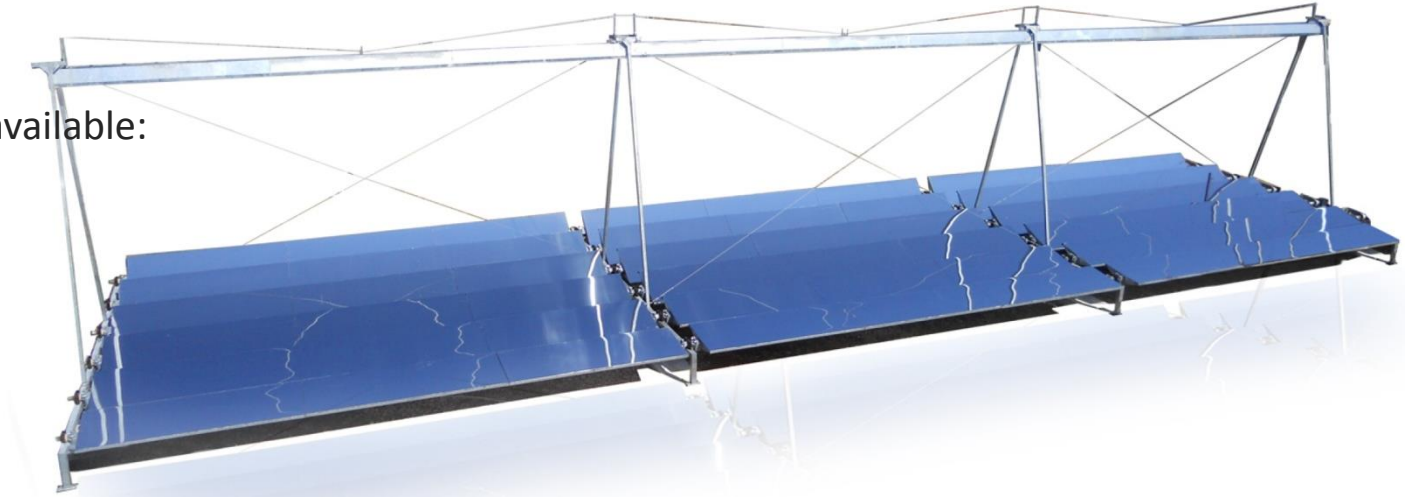
APPENDIX - LINEAR FRESNEL SYSTEM

FLT main dimensions

- Modular design
  - Surface = 74.25 m^2/module
  - Length = 12.3 3mt/module
  - Width = 8.05 mt

- Several models are available:
  - FLT-24
  - FLT-36
  - FLT-42
  - FLT-48
  - FLT-60
  - FLT-72



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