Solarthermie - F&E Schwerpunkte und deren Implementierungsstrategie

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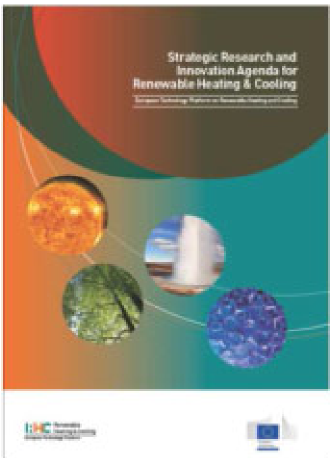
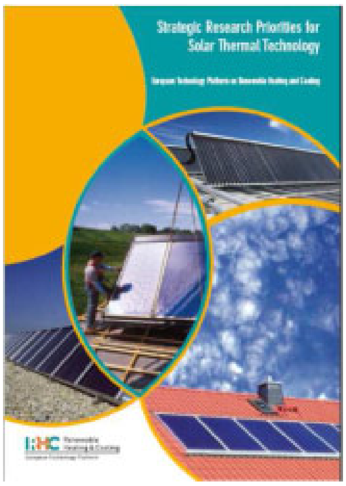
ETP RHC Basisdokumente





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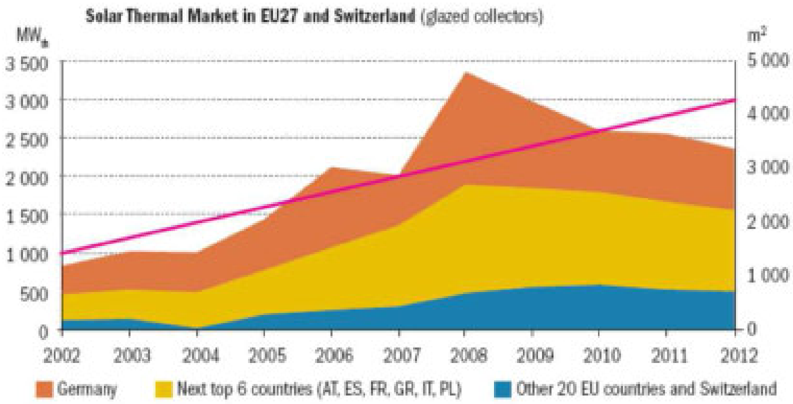
State of the art in Europe



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Annual installed capacity of flat plate and evacuated tube collectors from 2000 to 2011

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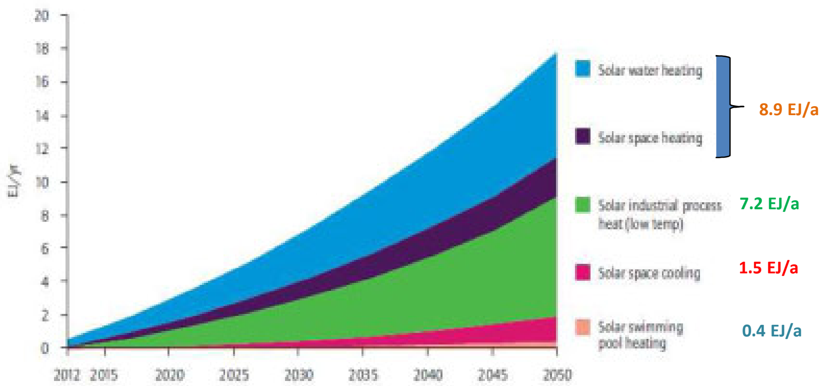
IEA Roadmap vision of solar heating and cooling by sector (EJ/yr)



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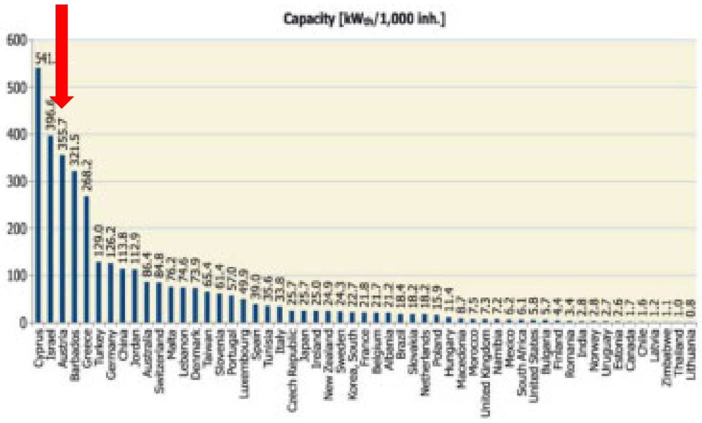
Source: IEA Technology Roadmap – Solar Heating & Cooling

Total capacity of glazed flat plate and evacuated tube collectors in operation in kWth per 1,000 inhabitants by the end of 2011



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Vision of the sector

Considering the European energy mix in 2005 (reference year of the "RES Directive"), solar thermal systems will contribute for a share equivalent to **12% of the total new renewable energy capacity installed by 2020** to meet the EU targets".

Post-2020, the RDP scenario shows contributions of solar thermal to total European low-temperature heat demand of 3.6% in 2020, 15% in 2030 and 47% in 2050.

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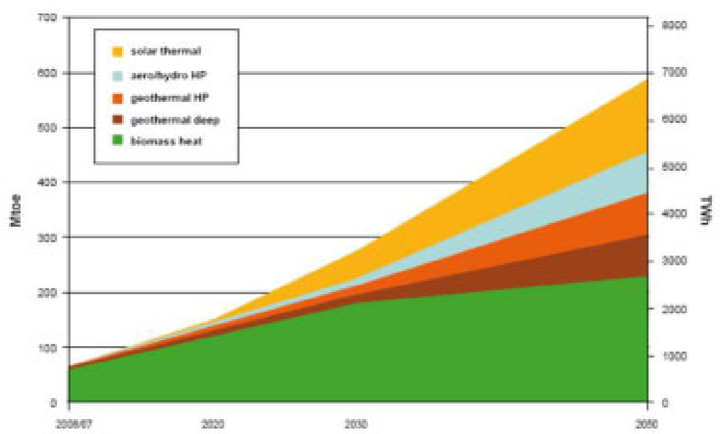
Vision of the sector



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F&E priorities for residential buildings

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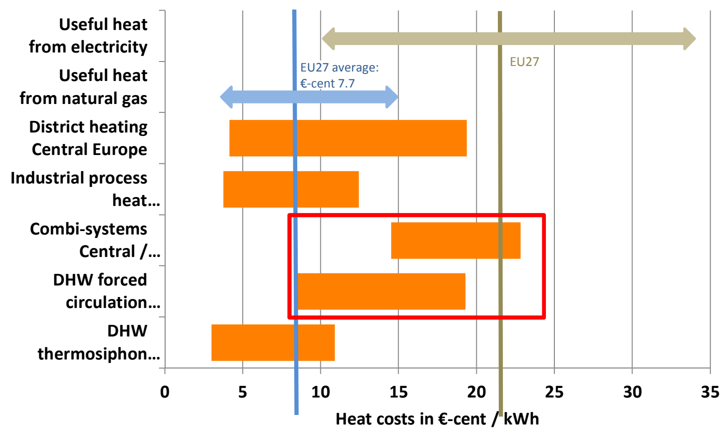
Cost of Solar Heat in Europe



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Quelle: ETP RHC (2013)

The overall goals by 2020 are to increase the already high system performance by 10% and to reduce the system costs by 50%. These targets can be achieved by focusing R&D on the following topics:

ST.1	New surfaces, coatings, materials, construction designs, and manufacturing technologies for solar thermal collectors
Objective	The objective of collector development is the reduction of costs, increase of efficiency and enhancement of reliability. This will be achieved by transparent cover materials with anti-reflection coatings for high optical transmission; switchable coatings that reduce the stagnation temperatures; highly reflective, light materials for reflectors; new absorber materials with low-emission coatings and optimised heat transfer; temperature-resistant and switchable super insulating materials and alternative medium and high temperature materials like polymers or rubbers for collector parts. Efficiency can be increased and costs can be reduced by further development of photovoltaic-thermal (PVT) hybrid-collectors, air collectors and low temperature process heat collectors. Also evacuated flat plate and tube collectors with high efficiency can reduce costs in some applications. Finally, a continued improvement in the collector construction design and manufacturing processes, focusing on mass production of tailored systems and systematic recycling of materials, will lead to further cost reduction of solar thermal collectors.
State-of-the-art	Today, flat plate collector modules with about 2.5 m² area are most commonly used. With spectral selective absorber coatings, they achieve absorbance values of 95% limit infrared emittance to 10%. Sometimes even cover glass with antireflection-coating is used. They are used as all-purpose collector modules, since they are produced in relatively high numbers. However, the further reduction of costs requires a change in materials from expensive to cheaper metals, e.g. aluminium not only for the absorber sheet but also for the piping, or polymers in combination with construction design and coatings and surfaces, which protects the collector against overheating or aggressive environment, and increases reliability.
Target	50% cost decrease by 2020 for solar collectors inclusive mounting rack and installation
Type of activity	40% Research / 50% Development / 10% Demonstration

ST.2	Cost effective solar based hybrid systems able to satisfy the entire building heating demand
Objective	The objective is to develop solar-based hybrid systems, which provide a full heat supply for small and multifamily residential buildings by combining the solar thermal components with a backup heater in one compact unit including a smart controller. This solution will be particularly suited for the retrofitting of existing systems. This will enable cost reduction of "plug and function" systems for material and installation labour time significantly, since the complexity of the system is limited to the prefabricated inner part of the hybrid unit. The performance will be increased and trouble-free operation of the hybrid heating unit will be achieved. These systems will cover at least 30% of the overall heat demand in residential buildings. Innovative system concepts and storage tanks will be developed, which will allow optimal combination of the heat sources. Improved hydraulic designs and components will reduce losses and new controllers will manage the heat flows in an optimal way.
State-of-the-art	Often installers combine a solar thermal system with a backup heater with often suboptimal system design and hydraulics, a big effort in designing and building the system with a lot of hydraulic connections, and the risk of failures. Often the controllers of both heat sources are not coupled with the risk that they have contradictory control strategies.
Targets	A 50% lower price for the ready installed full heat supply hybrid units as compared to the total investment of a solar thermal system plus a backup heater, which will be replaced by the hybrid unit. The system performance will be enhanced by 30% by increasing the solar yield and reducing system losses.
Type of activity	25% Research / 50% Development / 25% Demonstration

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ST.3	Optimised heating systems for 'Solar-Active-Houses'
Objective	In 'Solar-Active-Houses' at least 50% of the heat demand for domestic hot water and space heating will be covered by solar thermal energy. This requires a large collector area and a large storage volume. To develop 'Solar-Active-Houses' to a building standard for residential buildings, costs will be reduced and the system performance increased. New concepts for the integration of the collector area and storage volume into the building as well as for innovative system designs will be developed. To manage and control the building's entire energy system, innovative controllers must be developed, including weather and load forecast as well as improved performance monitoring functions. System design and commissioning tools will be available to allow architects and planners to design optimised 'Solar-Active-Houses'.
State-of-the-art	In central Europe there are about 1300 'Solar-Active-Houses' with typically 60% to 70%, sometimes up to 100% solar fraction. The increase of energy efficiency in buildings, together with the use of passive solar technology is reducing the heat demand in buildings, making it easier to increase the solar fraction. Nevertheless, further improvements are required.
Target	Achieve cost-effective, standardised technical solutions for 'Solar-Active-Houses' fulfilling the requirement of at least 50% of solar fraction.
Type of activity	25% Research / 50% Development / 25% Demonstration

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F&E priorities for non residential buildings

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ST.6	Multifunctional building components, including façade and roof integrated collectors, for new and existing buildings
Objective	Solar thermal systems will be integrated into the building envelope by means of multifunctional components. Collectors, storage and other components will become structural elements fulfilling multiple functions in the building, such as heat generation, storage and distribution as well as static function. They will optimise the use of passive and active solar energy in the buil… generating heat, regulating the building temperature, distributing and storing h… Some building components will become itself part of the heating and… proved aesthetics and integration of multifunctional compo… of buildings regarding security and maintenance.
State-of-the-art	Today, solar thermal system compo… – separated from the buil… distribution is increasingly… the roof tiles, however it is… functionality, such as insula… lations have been realised u… the outside, a heat distributio…
Targets	Development of multifunctional… e.g. solar collectors as roof and… functionalities and high flexibility… by 2020. Availability of prefabrica… refurbishment of existing buildings…
Type of activity	20% Research / 50% Development…

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ST.7	Highly efficient solar assisted cooling systems combining heating and cooling
Objective	The main research regarding cooling components will focus on developing technical solutions to make the systems more economically attractive and well performing on a long-term basis. For the first criteria, plug and function systems will be developed so as to decrease installation cost. These systems will require hydraulic configurations as simple as possible when at the same time leading to very low primary energy consumption when coupled with back up. Specific building applications will be identified so as to maximise the solar energy usability all year long as well on cooling as heating (space and DHW). Specific developments are expected on the adaptation of solar system to low parasitic consumption through new heat rejection concepts and on system architecture leading to very low cost for operation and maintenance. Finally lots of effort should be devoted to the development of packaged solutions reducing installation hassle and increasing the level of standardisation of solar cooling systems, either they are small, medium and even large capacity.
State-of-the-art	In 2011 about 750 solar cooling systems were installed worldwide, including installations with small capacity (less than 20kW)[10]. Due to the large number of system components, i.e. cooling equipment, solar collectors and heat storage appliances, which are not optimized yet, the investment costs are high and solar thermal cooling systems are not yet cost-competitive with conventional electrically-driven cooling systems.
Targets	Overall efficiency (in equivalent power consumption) of the solar system for heating and cooling of more than 10 (COP) and solar cooling system costs halved by 2020.
Type of activity	30 % Research / 40% Development / 30% Demonstration

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F&E priorities for industrial processes

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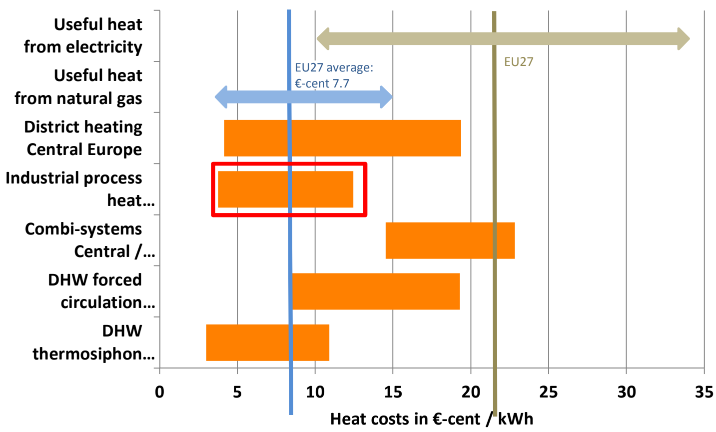
Cost of Solar Heat in Europe



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Quelle: ETP RHC (2013)

ST.10	Medium temperature collectors developed and demonstrated in industrial applications
Objective	Using solar thermal collectors in medium and high temperature (100°C–400°C) systems imposes constraints on collectors.
	Applied research should result in the development of new, high temperature-resistant materials, as well as new collector designs. the following aspects are particularly important : • Adapting and improving collector technology (flat-plate and evacuated tube) which is currently used in low-temperature applications (e.g. either through better insulation or noble gas atmospheres); or, • Developing specific concentrating collectors using light-weight, stable, highly performing and dirt-proof or self-cleaning reflectors which are resistant to degradation due to mechanical cleaning and weathering. Moreover, cost-effective fixing systems are needed for specific installation and maintenance requirements of large-scale applications.
State-of-the-art	Pilot solar systems used for industrial process heat are available in Europe. Many systems for industrial heat are configured to work at higher temperatures than the process would require. Today, arrays of flat plate collectors constitute the majority of the installed capacity due to cost, reliability and modularity reasons. However the use is limited to low temperature processes.
Targets	50% cost reduction on installed collector with increased reliability (lower O&M costs).
Type of activity	10% Research / 50% Development / 40% Demonstration

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	Research and Innovation Priorities	Predominant type of activity	Impact
ST.10	Optimize large-scale solar collector arrays for uniform flow distribution and low pumping power	Development	By 2020
ST.11	Turn-key solar thermal process heat systems	Research	By 2030

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F&E priorities for district heating and cooling

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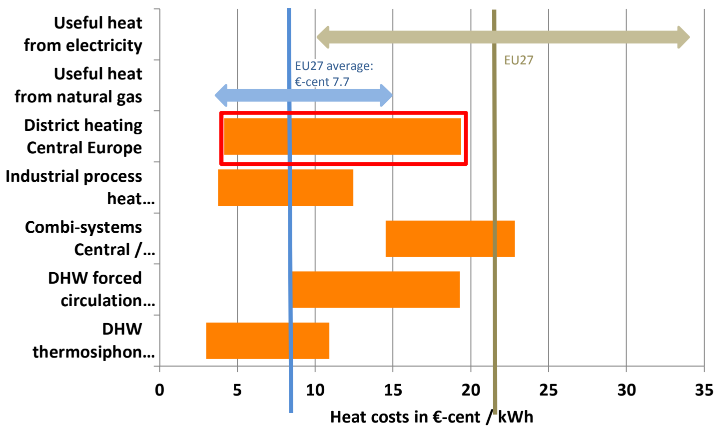
Cost of Solar Heat in Europe



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Quelle: ETP RHC (2013)

ST.12	Optimize large-scale solar collector arrays for uniform flow distribution and low pumping power
Objective	Development of large-scale collectors and advanced hydraulic concepts, which are especially designed for huge collector arrays. Basic theoretical computational approaches should be developed and validated by means of adapted methods (CFD, laboratory measurements, and measurements at large real solar collector fields). Particularly, the flow and temperature distribution, as well as the total efficiency and the electricity consumption of pumps and the related friction pressure loss at all hydraulic levels have to be considered. These advanced large-scale collectors, hydraulic concepts, calculation and simulation tools have to provide uniform flow distribution, reduced pumping power and favourable stagnation behaviour. Furthermore also cost effective fixing systems are needed.
State-of-the-art	Due to their size and the need to adapt to each specific application, large-scale systems for solar district heating, industrial process heat, agricultural and water treatment applications are tailor-made. This implies more complex design, such as planning system hydraulics. State-of-the-art collector fields cost around € 285/kWth (€ 200/ m²) when ground mounted and € 360/ kWth (€ 250 / m²) when mounted on flat roofs. Currently, the main challenge is to achieve a theoretically correct design of a large-scale collector field, as well as modelling parallel connections comprising multiple hydraulic levels (collectors, zones, groups).
Targets	Cost reduction of 50% compared to the field cost of state-of-the-art collectors.
Type of activity	50% Research / 30% Development / 20% Demonstration.

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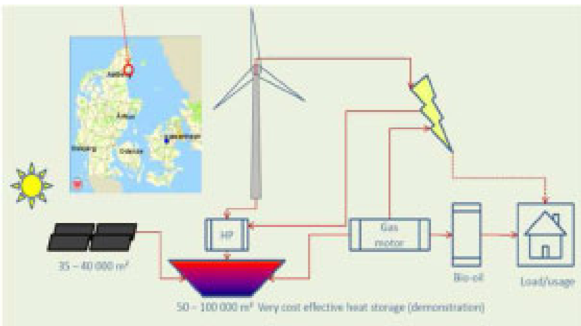
	Research and Innovation Priorities	Predominant type of activity	Impact
ST.12	Optimize large-scale solar collector arrays for uniform flow distribution and low pumping power	Research	By 2020
ST.13	Advanced solutions for the integration of large solar thermal systems into smart thermal/electrical grids.	Research	By 2030



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Implementing Roadmaps

1. Solar Active House
2. Solar based compact hybrid heating systems
3. Solar heat for Industrial Processes

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ROADMAP
Solar Heat for Industrial Processes

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Objectives

The main objective of the SHIP Roadmap is to reduce significantly the cost of solar heat, to overcome technical and non-technical barriers and to contribute to the significantly increased use of solar heat in industrial processes.

Scope

The scope of the SHIP Roadmap are all industrial applications with process temperatures up to 250°C
.

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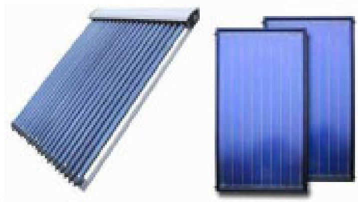
Technologies

- Flat plate collectors (covered and uncovered)
- Evacuated tube collectors
- CPC collectors
- All kinds of concentrating collectors (parabolic trough, Linear fresnel…)



Applications

- All industrial processes with temperatures up to 250°C (sectors: food and beverage industry, textile, metal surface treatment, agro industry; automotive sector…)
- Integration of the solar thermal system on the process level
- Integration of the solar thermal system on the supply level

Size of systems

>500 m² collector area or 350 kW_{th} (0,35 – 10 MW_{th})

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The specific objectives of the SHIP Roadmap are:

- Cost optimal solar thermal process heat-systems (2014 – 2017)
- Development and demonstration of the next generation of solar thermal process heat-systems (2017 – 2020)
- About 600 SHIP systems installed in different climatic zones and for all relevant industrial applications by 2020

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2014 - 2017
Demo
Phase I
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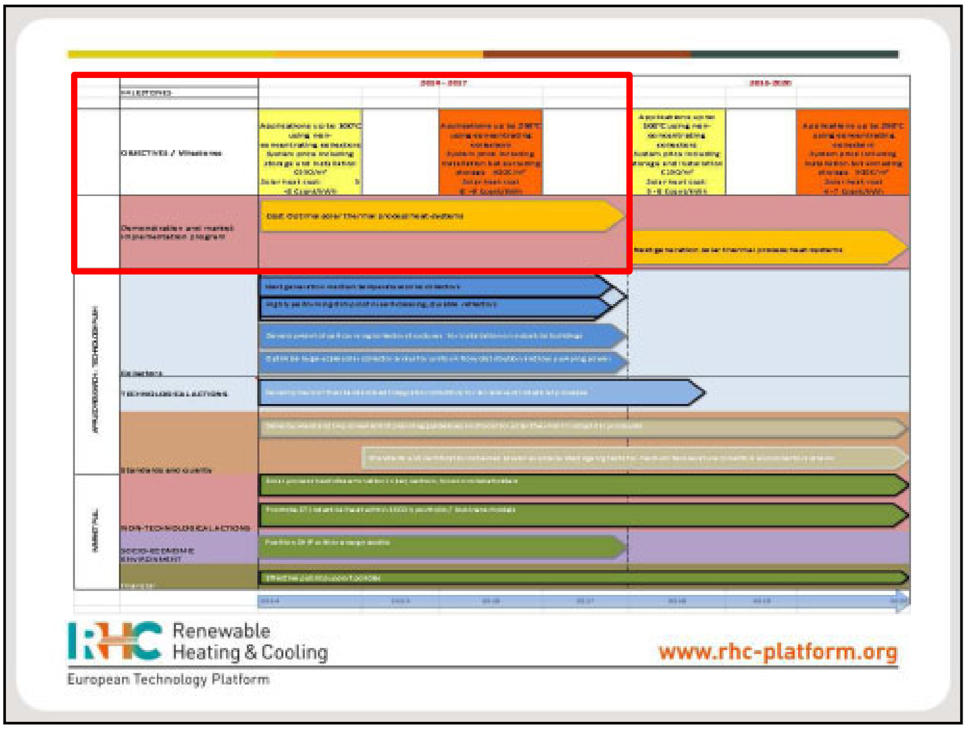
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Cost optimal solar thermal process heat-systems (2014 – 2017)

	2014 - 2017			
MILESTONES				
OBJECTIVES / Milestones	**Applications up to 100°C using non-concentrating collectors** System price including storage and installation €350/m² Solar heat cost: 5 -8 €cent/kWh		**Applications up to 250°C using concentrating collectors** System price including installation but excluding storage 400€/m² Solar heat cost 6 -9 €cent/kWh	
Demonstration and market implementation program	**Cost Optimal solar thermal process heat-systems**			

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Demonstration phase 1:

Cost optimal solar thermal process heat-systems (2014 – 2017)

Solar heat price:

5 - 8 €cent/kWh for low temperature applications
6 - 9 €cent/kWh for medium temperature applications by 2017

System price reduction to:

€ 350/m² (low temp. applications)
€ 400/m² collector area (medium temp.) for systems bigger 1000 m² (including storage and installation).

These ***cost optimal solar thermal process heat-systems have to be based on the R&D achievements of FP7 projects and results obtained in member states in the years 2010 – 2013.***

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Demonstration phase 1:
Cost optimal solar thermal process heat-systems (2014 – 2017)

Number of Systems to have an impact on the market:
200 systems with a total collector area of 300,000 m² in low temperature (up to 100°C process temperature) SHIP applications

100 systems with a total collector area of 150,000 m² using concentrating collectors have to be installed.

Investment
€ 165 Mill. For all systems
If a subsidy rate of 40% is assumed for the demonstration systems – a broad demonstration system program would require a total budget of € 66 Mill.

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Demonstration phase 1:
Cost optimal solar thermal process heat-systems (2014 – 2017)

Accompanying R&D program
An accompanying R&D program for system development and monitoring would be in the range of additional 22 Million.

Funding
If these programs are split between HORIZON 2020 and the member states an budget of € 50 Mill would be required from EU funds for the time period 2014 – 2017 (annual € 12.5 Mill)

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Focused R&D projects
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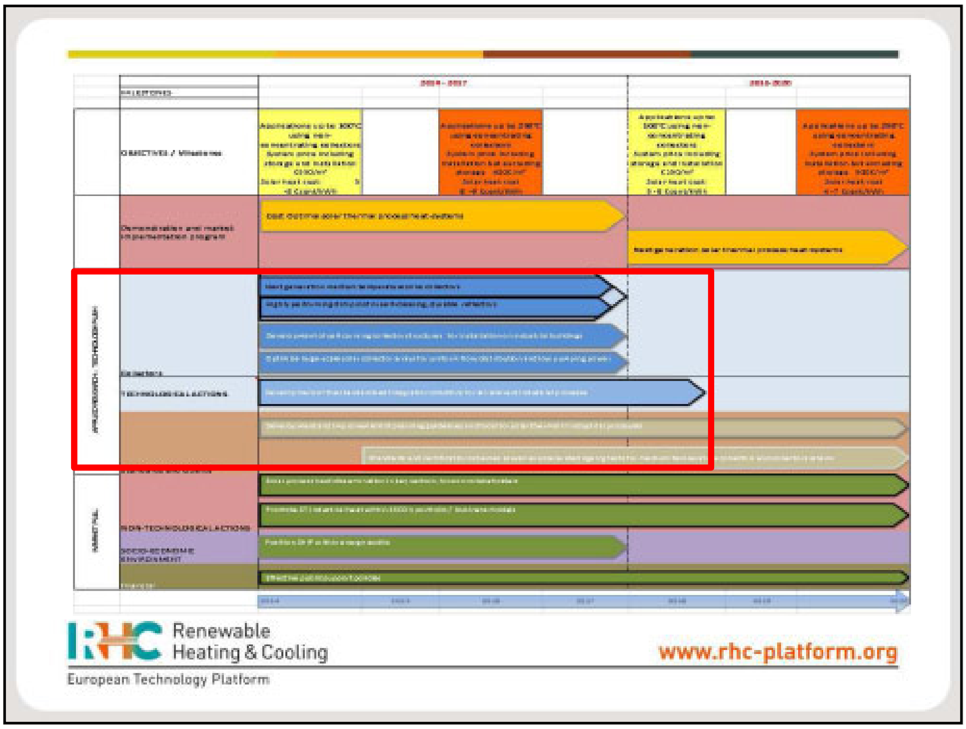
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Focused R&D projects

In parallel to the 1st demonstration and market implementation program ***focused R&D projects*** based on the R&D priorities as outlined in the Strategic Research Priorities for Solar Thermal have to be carried out in the timeframe from 2014 – 2017 in order to be able to achieve a further reduction of the solar heat price and to demonstrate the next generation solar thermal process heat-systems in the timeframe from 2018 – 2020.

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Focused R&D projects

Focused R&D projects shall focus on the following topics:

- Next generation medium temperature solar collectors
- Development of self-carrying collector structures for installation on industrial buildings
- Optimized large-scale solar collector arrays for uniform flow distribution and low pumping power
- Development of the standardized integration solutions for all relevant industrial processes.

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Next generation solar thermal process heat-systems (2018 – 2020)

2018-2020		
Applications up to 100°C using non-concentrating collectors System price including storage and installation €250/m² Solar heat cost: 3 -6 €cent/kWh		**Applications up to 250°C using concentrating collectors** System price including installation but excluding storage 300€/m² Solar heat cost 4 -7 €cent/kWh

Next generation solar thermal process heat-systems

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Demonstration phase 2:
Next generation solar thermal process heat-systems (2018 – 2020)

Solar heat price:
3- 6 €cent/kWh for low temperature applications
4 - 7 €cent/kWh for medium temperature applications by 2020

System price reduction to:
€ 250/m² (low temp. applications)
€ 300/m² collector area (medium temp.) for systems bigger 1000 m² (including storage and installation).

The ***next generation of solar thermal process heat-systems has to be based on the R&D achievements of HORIZON 2020 projects which are carried out in the timeframe from 2018 -2020***

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Demonstration phase 2:
Next generation solar thermal process heat-systems (2018 – 2020)

Number of Systems to have an impact on the market:
220 systems with a total collector area of 400,000 m² in low temperature (up to 100°C process temperature) SHIP applications

120 systems with a total collector area of 360,000 m² using concentrating collectors have to be installed.

Investment
€ 228 Mill. For all systems
If a subsidy rate of 40% is assumed for the demonstration systems – a broad demonstration system program would require a total budget of € 91 Mill.

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Demonstration phase 2:
Next generation solar thermal process heat-systems (2018 – 2020)

Accompanying R&D program
An accompanying R&D program for system development and monitoring would be in the range of additional 44 Million.

Funding
If these programs are split between HORIZON 2020 and the member states an budget of € 66 Mill would be required from EU funds for the time period 2014 – 2017 (annual € 22 Mill)

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Results

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Cost reduction:

Low temperature applications
10 €cent/kWh → 3- 6 €cent/kWh by 2020

15 €cent/kWh → 4 - 7 €cent/kWh by 2020

Demonstration Systems

700 systems
1.2 Mill m² = 1.9 GWth installed

Thank you for your Attention