
European Perspectives in Research and Development on Solar Thermal Collectors and Systems



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CISBAT2013

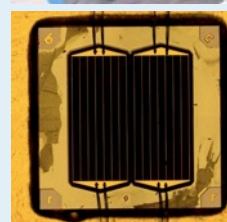
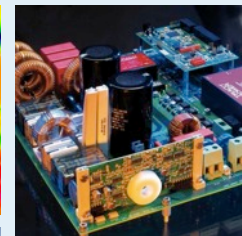
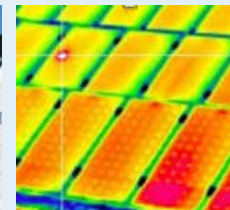
Lausanne, Swiss, 4 September 2013

Fraunhofer Institute for Solar Energy Systems ISE

- Applied research on Renewable Energies since 1981
- Largest Solar Research Institute in Europe
1300 employees incl. 300 PhD and diploma students
- Director: Prof. Eicke R. Weber
- Part of the Fraunhofer Society with 60 institutes and 20000 employees, largest applied research network

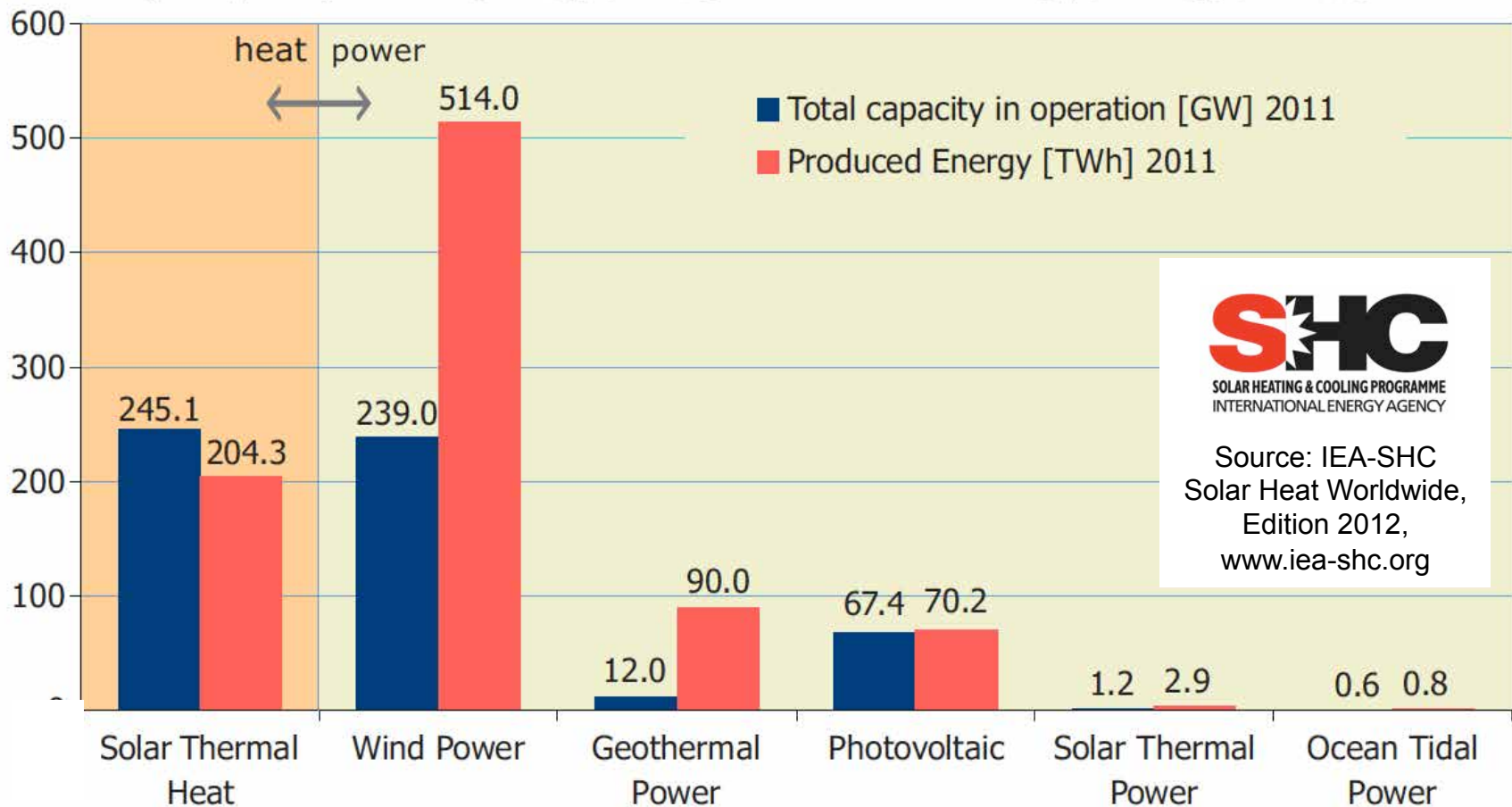


- Energy Efficient Buildings
- Applied Optics, Functional Surfaces
- Solar Thermal Technology
- Silicon Photovoltaics
- Alternative PV Technologies
- Renewable Power Supply
- Hydrogen Technology

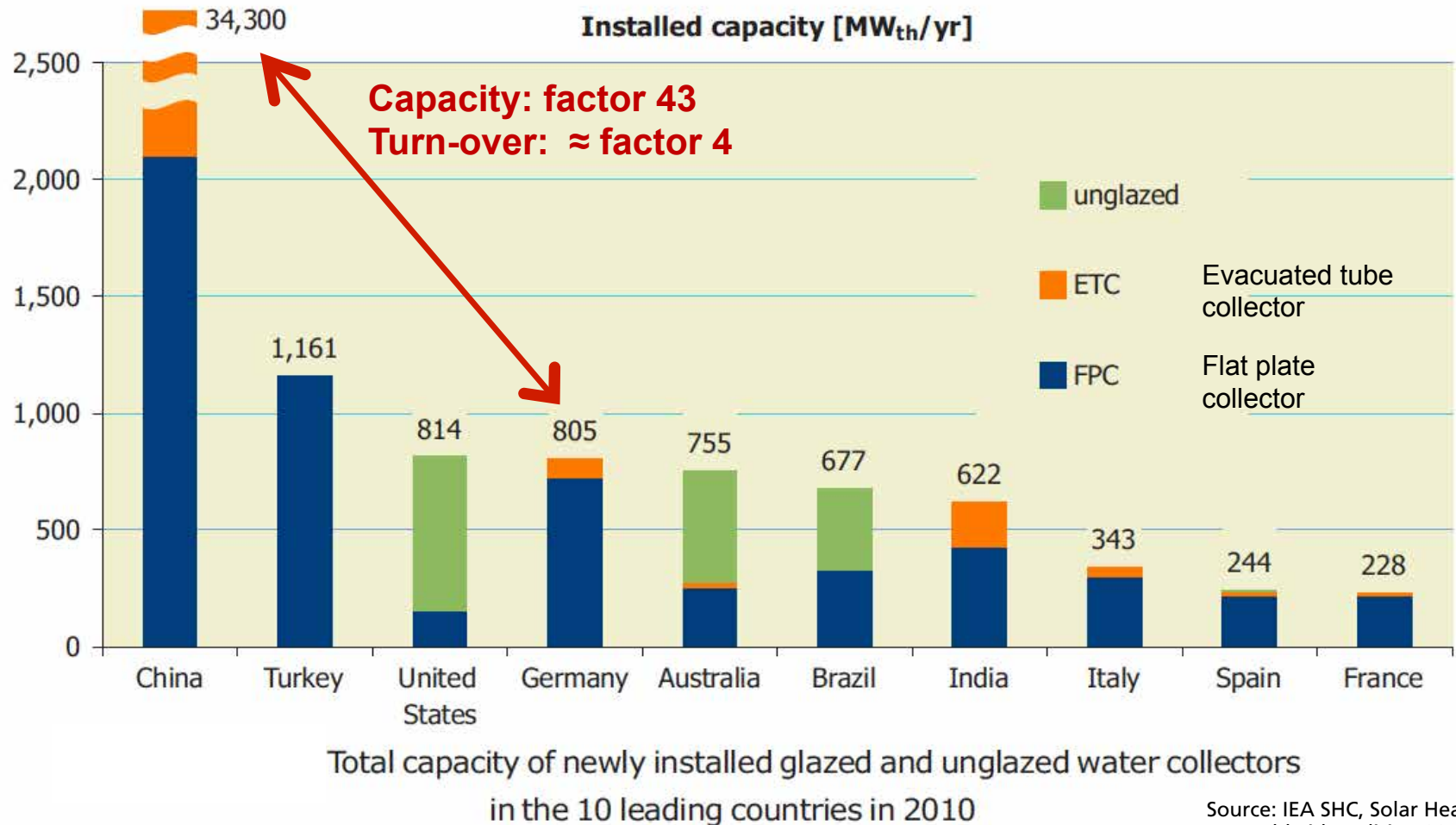


Solar Thermal Energy: Underestimated Source of Power

Total Capacity in Operation [GW_{el}], [GW_{th}] and Produced Energy [TWh_{el}], [TWh_{th}], 2011



Solar thermal world market 2010 – 10 leading countries



Source: IEA SHC, Solar Heat Worldwide, Edition 2012

Market status and perspective Germany and EU27

Development of the German solar thermal market

■ Solar thermal market Germany

2009: - 25% 2010: - 25%

2011: + 10% 2012: - 9%

1-7/2013: - 12%

=> Stagnation

■ Solar thermal market Europe

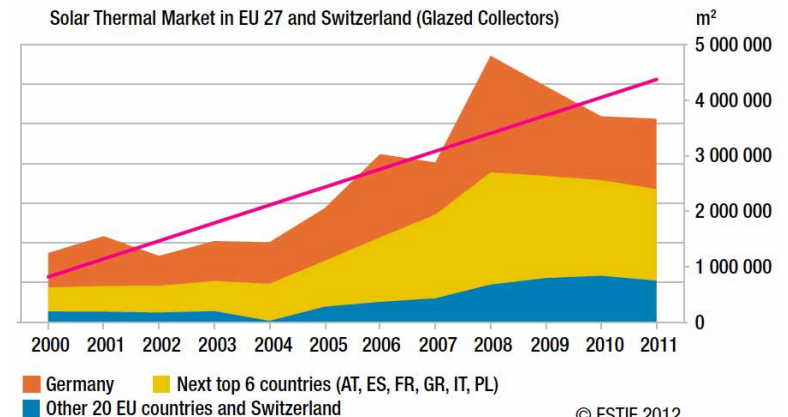
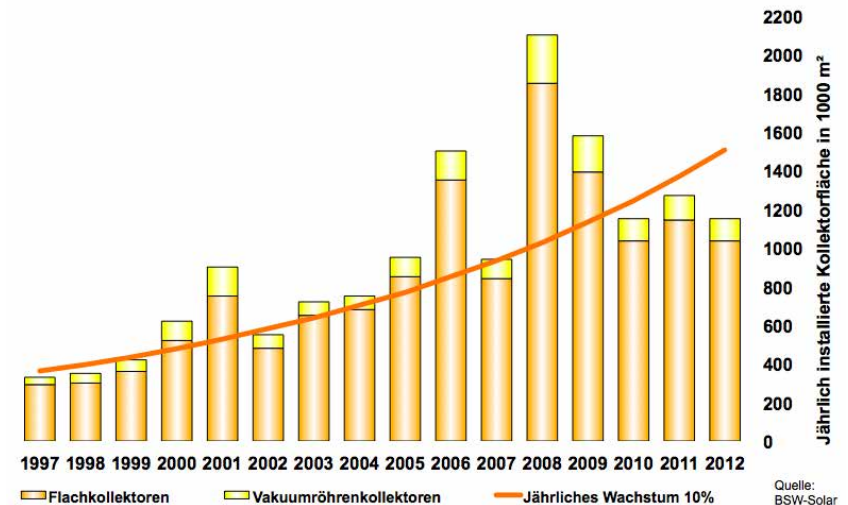
Dynamic countries Most countries are declining or stagnating (France, Spain, Italy) a few countries are growing: Poland,...

■ Perspective 2020

National Action Plans of EU member countries assume moderate growing demand

■ Long-term vision (2030-2050)

High targets are set in the vision of the European Technology Platform (50% Solar thermal on heat demand = 8 m² collector area/inhabitant)



Relevance of heating & cooling in the energy sector

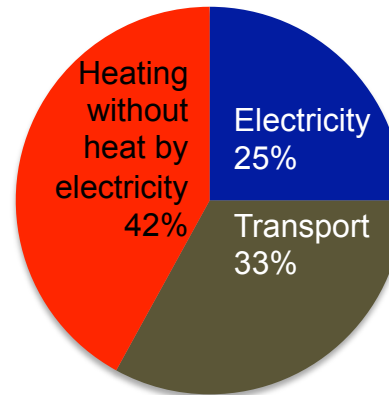
Heating & cooling: the largest share on final energy demand

Oil and natural gas price: increasing continuously

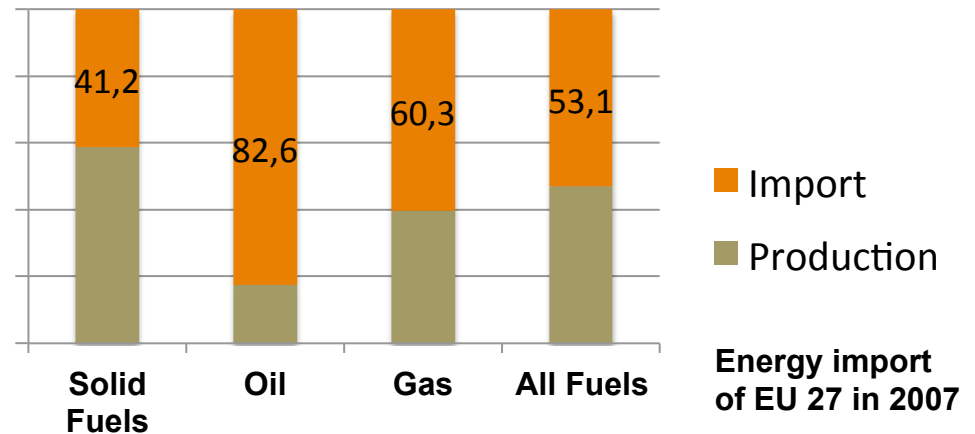
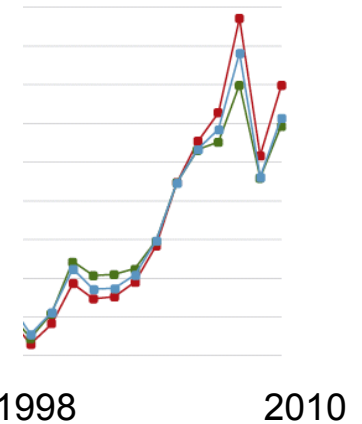
Dependency on fossil fuels: increasing continuously

⇒ **In future, energy policy must focus equally on electricity, transport AND heating & cooling**

Final energy EU 27



Oil price development



Important Part of the Solution: RHC-Technologies

RHC = Renewable Heating and Cooling

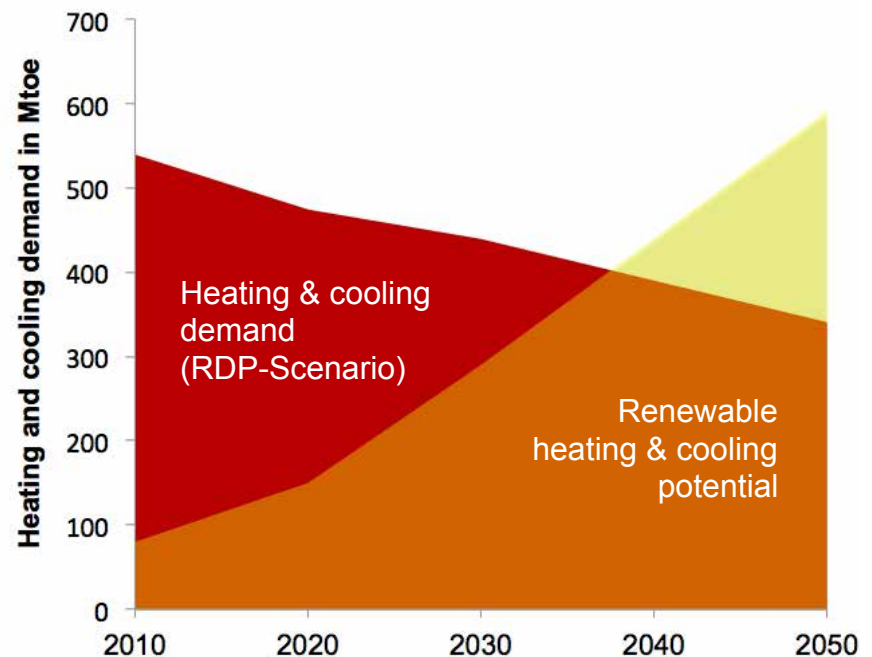
Heating & cooling demand can be reduced significantly and satisfied increasingly by RHC.

⇒ **Until 2040 we can reach 100% RES for heating & cooling**

Benefits of RHC-technologies

- Mitigation of climate change
- Reducing import dependencies
- High security of supply
- Protection against oil price increase (social aspects)
- Local added value, creating jobs

Heating and cooling demand and RHC-potential in EU 27



Source: EHC-platform, Common vision for the RHC-sector, 2011
RDP-Scenario = Full Research, development and policy scenario

Heating and Cooling Market is often Omitted - Why?

SET-Plan (EC):

“The SET-Plan establishes an energy technology policy for Europe to accelerate the development and deployment of low carbon technologies.”

8 Initiatives:

Bio Energy (fuels), CCS, Electricity Grid, Fuel Cells and Hydrogen, Sustainable Nuclear, Solar (PV + CSP), Wind

=> Heating & Cooling is only part of Smart Cities & Communities Initiative

Energy 2050 (Roadmap of EC): Acknowledges that *renewable heating and cooling is vital to decarbonisation*

=> A thorough analysis of the heating & cooling sector is omitted

REASONS

- **H&C sector** is decentralized and very inhomogenous in its structure (technologies, actors, demand, sources, costs, ...)
=> Difficult to understand
- **H&C market** depends strongly on oil price fluctuations
=> Difficult to influence by policy
- **Policy instruments** in the H&C sector are weak or expensive (subsidies), complex or hard to implement (obligations)
=> Difficult to influence

Data

- Founded in 2008
- 4 panels, led by steering committees
- Supported by the European Commission
- More than 600 members
- Free membership

www.rhc-platform.org



Cross Cutting Technologies



TECHNOLOGIES

- District heating and cooling (DHC)
- Thermal energy storage (TE)
- Hybrid systems and heat pumps

CHARACTERISTICS

- Enabling technologies for high uptake of renewable energy
- Optimization / integration to framework conditions necessary

CHALLENGES

- Develop smart solutions and ICT for complex systems
- Increase efficiency and COP
- Reduce costs

APPLICATIONS

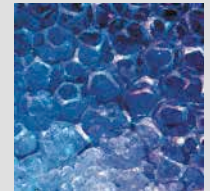
DHC

- District heating
- District cooling
- DH&C with seasonal storage



TE Storage

- Water storage
- PCM
- Thermo chemical
- Underground storage (UTES)



Hybrid systems and heat pumps

- Innovative system design
- Ground, water and air heat pumps



COP = Coefficient of performance, PCM = Phase change material, GT = Geothermal, UTES = Underground Thermal Energy Storage



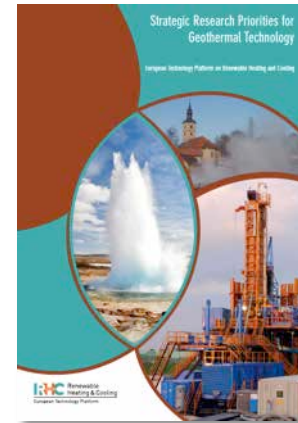
**Common
Vision
2020 - 2030 -
2050**



**Solar
thermal**



Biomass



**Geo
thermal**

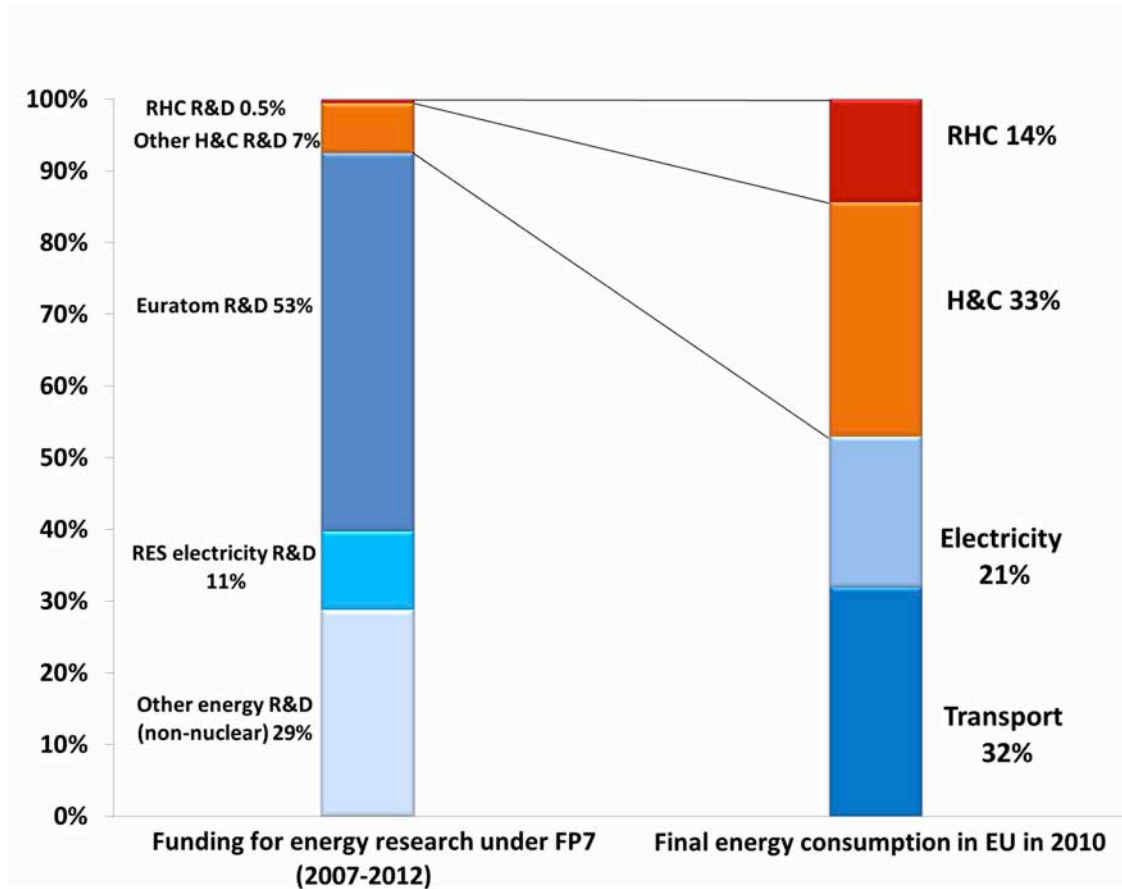


**Cross-
cutting**

Under development: Strategic Research Agenda of the RHC-Platform

Lack of R&D funding for RHC technologies

FP7 budget distribution to different sectors in comparison to the energy demand distribution

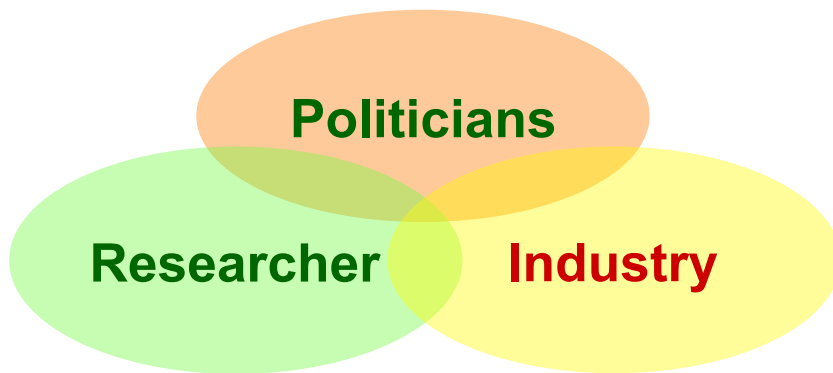


What is needed to strengthening the technological development

- higher R&D budgets
- better R&D infrastructure
- RHC at universities
- more scientists working on RHC technologies

RHC-platform work programme

Objective: strengthening the technological development



Vision 2030

Role of RHC technologies in 2030,
which technologies will be used?



Strategic Research Agenda

Which R&D is necessary
to let the vision become reality?



Implementation

Stimulation of new R&D programs,
political advice, lobbying,...

Solar Thermal Vision 2030

of the Solar Thermal Technology Panel of
the European Technology Platform on RHC

- **New buildings: Solar-Active-House**
100% solar heated buildings (building standard)
- **Existing building stock: Solar Refurbishment**
Solar refurbished buildings will be the most cost effective way to refurbish the building stock (solar fraction > 50%)
- **Industrial + Agricultural Solar Applications**
Solar thermal systems will cover process heating and cooling demands
- **Solar district heating and cooling networks**
will be widely used in urban areas

Overall goal: ca. 50% of the low temperature needs (up to 250°C) will be provided by solar thermal

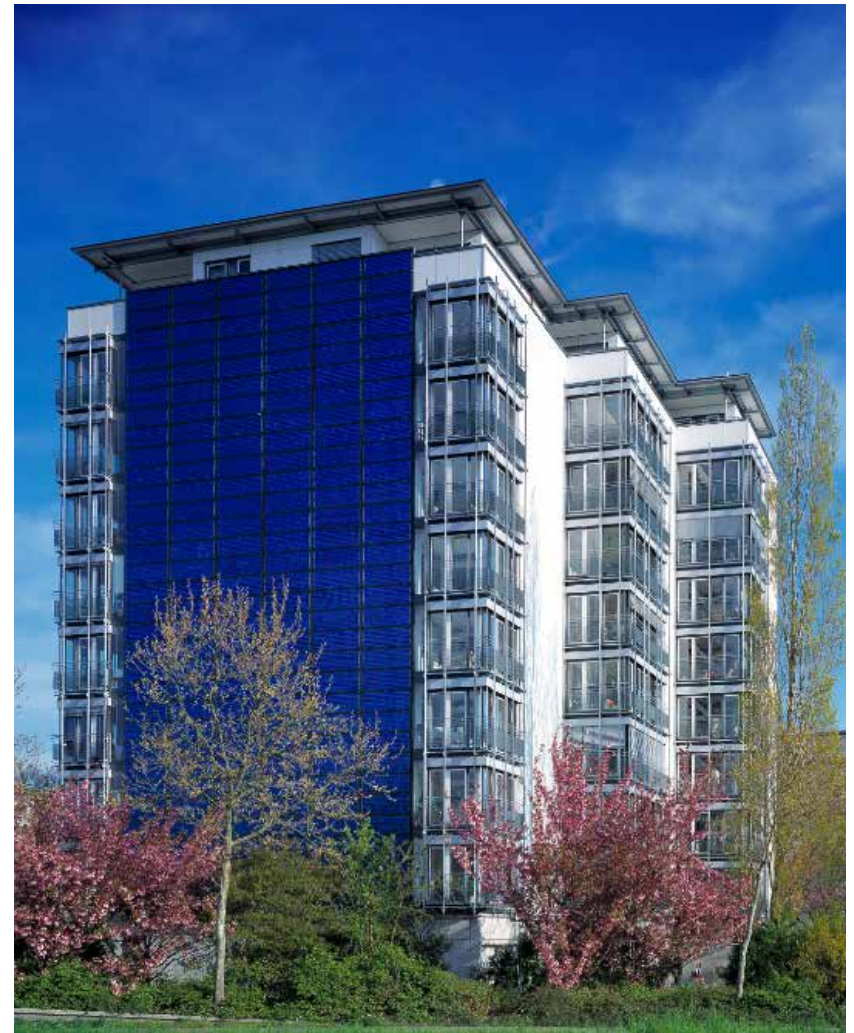


Buildings will become zero or plus energy houses

Solar Thermal will contribute to achieve the goal of the European Directive: From 2020 on new buildings must be “Nearly zero energy buildings”
Buildings will use their roof and their façades to produce electricity and heat



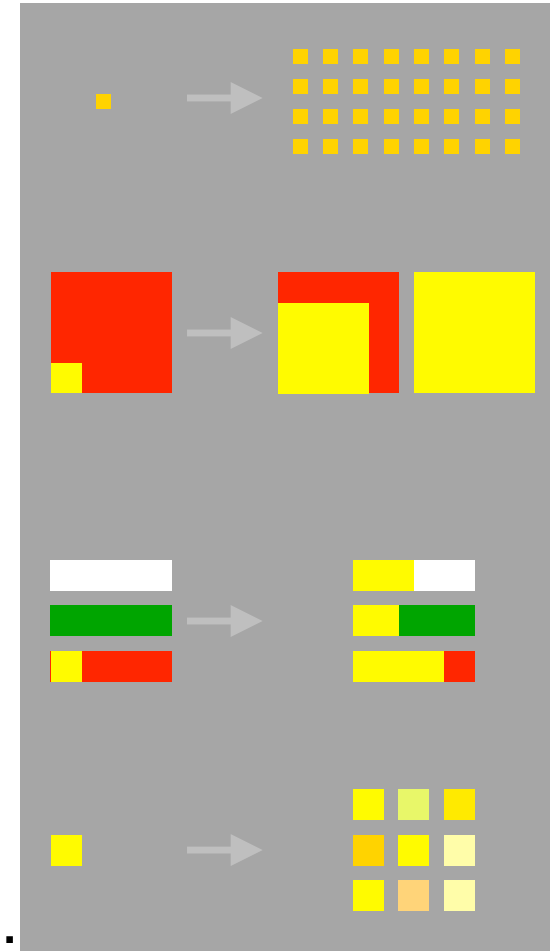
Source: Schüco



Source: Hotz Architekten

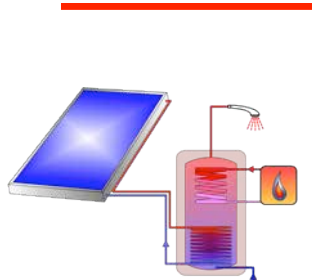
Four Strategies to develop the full potential of ST and related R&D tasks

1. The **number of solar thermal systems** has to be sharply increased
=> lower costs for standard technology,...
2. The **share of solar thermal energy per building** has to be increased step-by-step up to 100%
=> system technology, storage tanks,...
3. **Existing technology to be introduced in new market segments** like public buildings and commercial sector
=> collector & system technology,...
4. **New technologies & applications** have to be developed like district and process heating and on longer-term solar assisted cooling
=> component, system & application technology,...

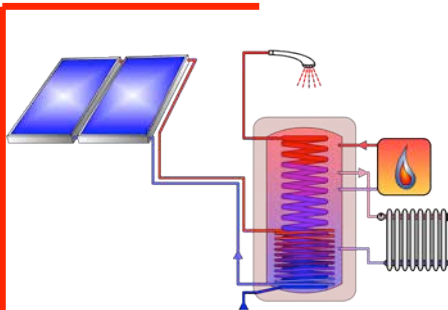


From SDHW only to 100% Solar Heated Houses

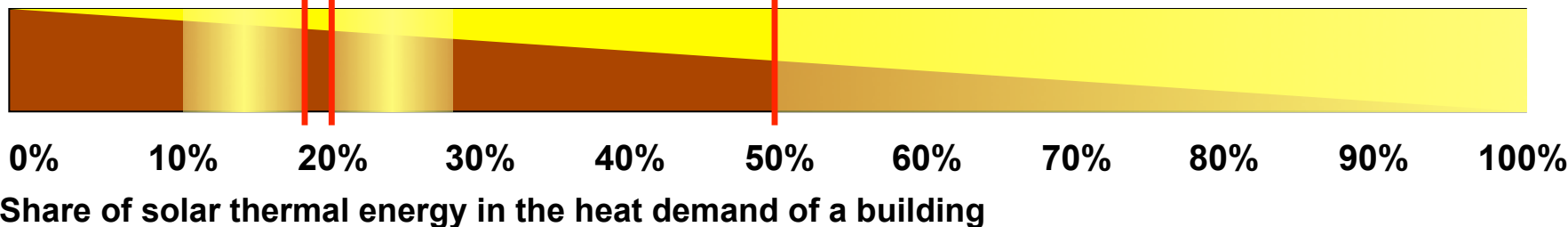
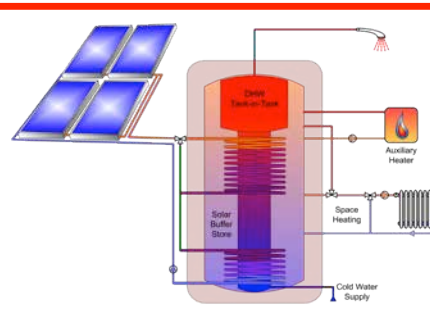
SDHW
solar domestic
hot water heating
10%-20%



**SDHW + space
heating support**
20%-30%



'Solar Active House' mainly heated by solar
SDHW + space heating support (large share)
50% - - - - - 100%



Concept of Solar Heated Building



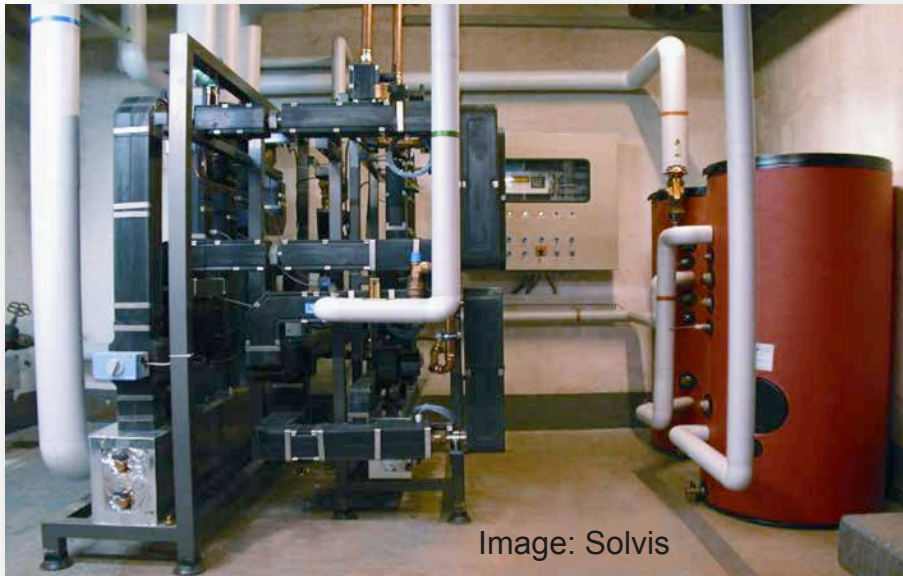
Solar Thermal
Collectors
30m² - 60m²

Seasonal Heat
Storage (Water)
6 – 10 m³

Solar Fraction
(share of
the overall
heat demand):
60% - 70%

Large Solar Thermal Systems

- For multi family homes, hotels, hospitals, nursing homes
- Crucial: smart and efficient management of the heat sources



Promising Application

Solar District Heating

- will play a big role in the future



Solar District Heating, Marstal, Denmark
collector area 17,000 m²

© Arcon



Semi-detached houses in Neckarsulm, Germany

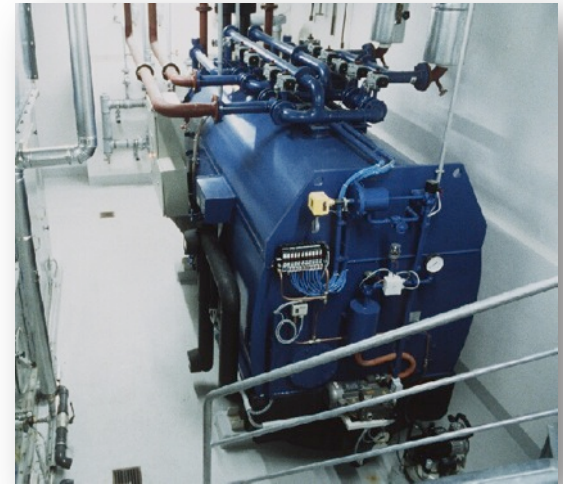


12,000 m³ seasonal storage, Friedrichshafen, Germany

Promising Technology (long-term)

Solar Assisted Cooling

- (Solar) thermally driven cooling machines
- Cooling demand and solar supply patterns match well
- There are already more than 400 pilot systems installed in Europe
- Small systems are under development



Adsorption cooling machine

Building: Governmental Press Office Berlin



Source: Viessmann

Building: IHK Freiburg



Source: Fraunhofer ISE

Important field of application: process heat generation

Example: R&D activities at Fraunhofer ISE

- Developing of new process heat collectors
- Working on optimized system design
- Development of branch solutions
- Testing and certification



Reference flat-plate collectors (glass-foil, front) and newly developed RefleC-collectors (back)

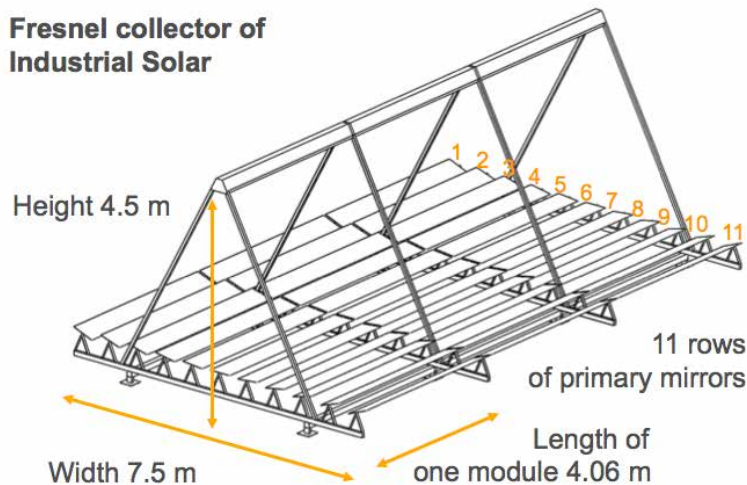
Medium and high temperature Fresnel-collectors

- Production of process heat up to 400 °C possible
- Fields of applications
 - Solar assisted cooling
 - High temperature processes in industry

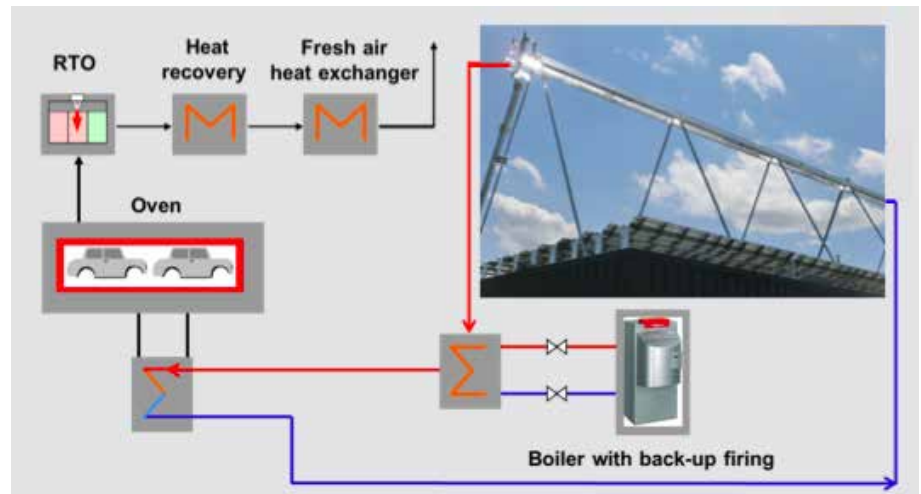


Solar assisted cooling at football stadium in Doha

Fresnel collector of Industrial Solar



All pictures: Industrial Solar



Process heat for drying process in car industry

Solar Thermal R&D topics identified

- **Solar Thermal Collectors**
- **Thermal storages for single buildings**
- **Seasonal thermal storages for district heating grids**
- **System technology**
- **Solar process heat**
- **Solar cooling and refrigeration**



Example: R&D topics of flat plate collectors

Overall goals: Cost reduction, adapted to application

New materials

- plastic, steel, ...

New production methods

- absorber, housing,...

Security, operation

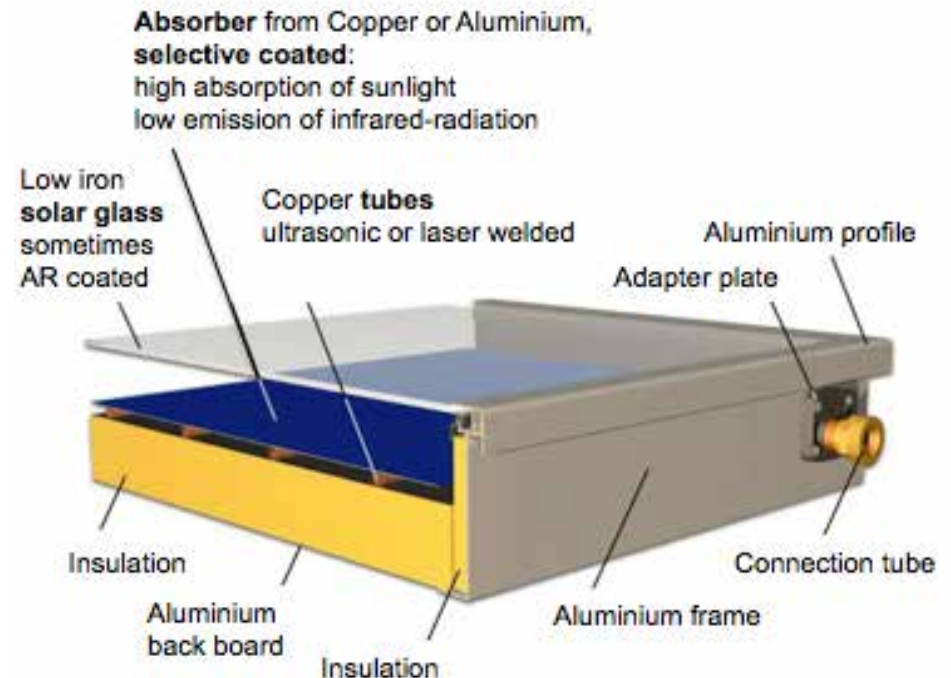
- avoid stagnation (switchable,...)

Adapted to the application

- temperature up to 250 °C
- Roof / façade integration

Special constructions

- Air collectors
- PV-Thermal hybrid collectors
- Integrated storage collectors



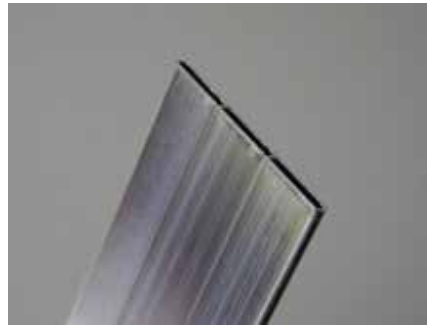
Source: [GreenOneTec](#)

Sample research topics and products collectors

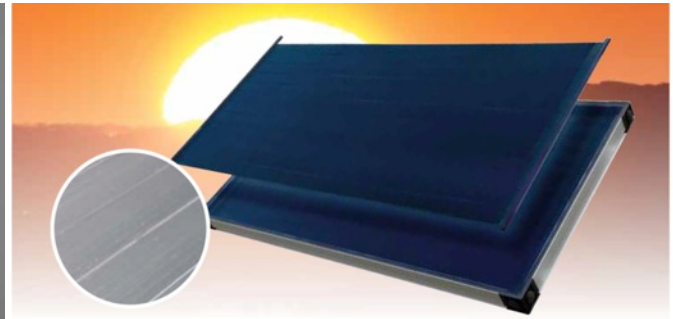
■ Cost reduction through replacement of copper by aluminium



www.hydro.com

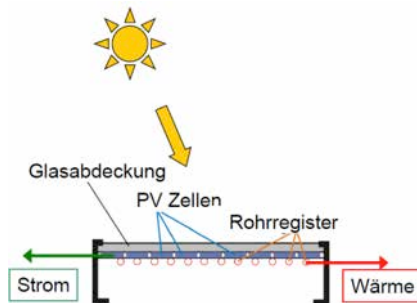


www.hydro.com



www.savosolar.fi

■ Photovoltaic-Thermal (PVT) collectors



www.isfh.de



www.isfh.de



www.absolicon.com

Source: Michael Hermann

Sample research topics and products collectors

■ High-efficiency collectors (e. g. for solar process heat)



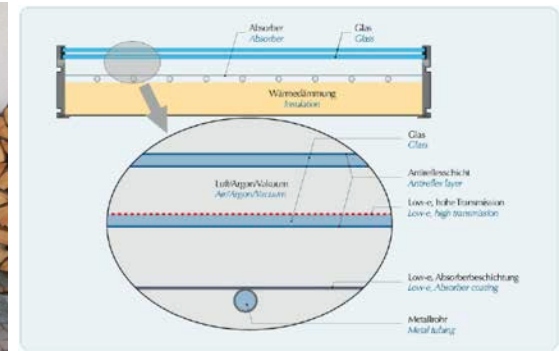
www.absolicon.com



www.chromasun.com



www.itcollect.de



www.isfh.de

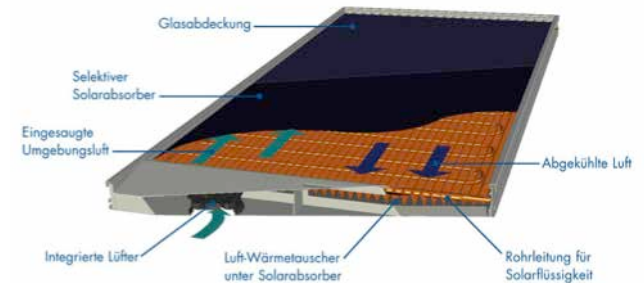
■ Multifunctional collectors



www.robinsun.com



www.wicono.de

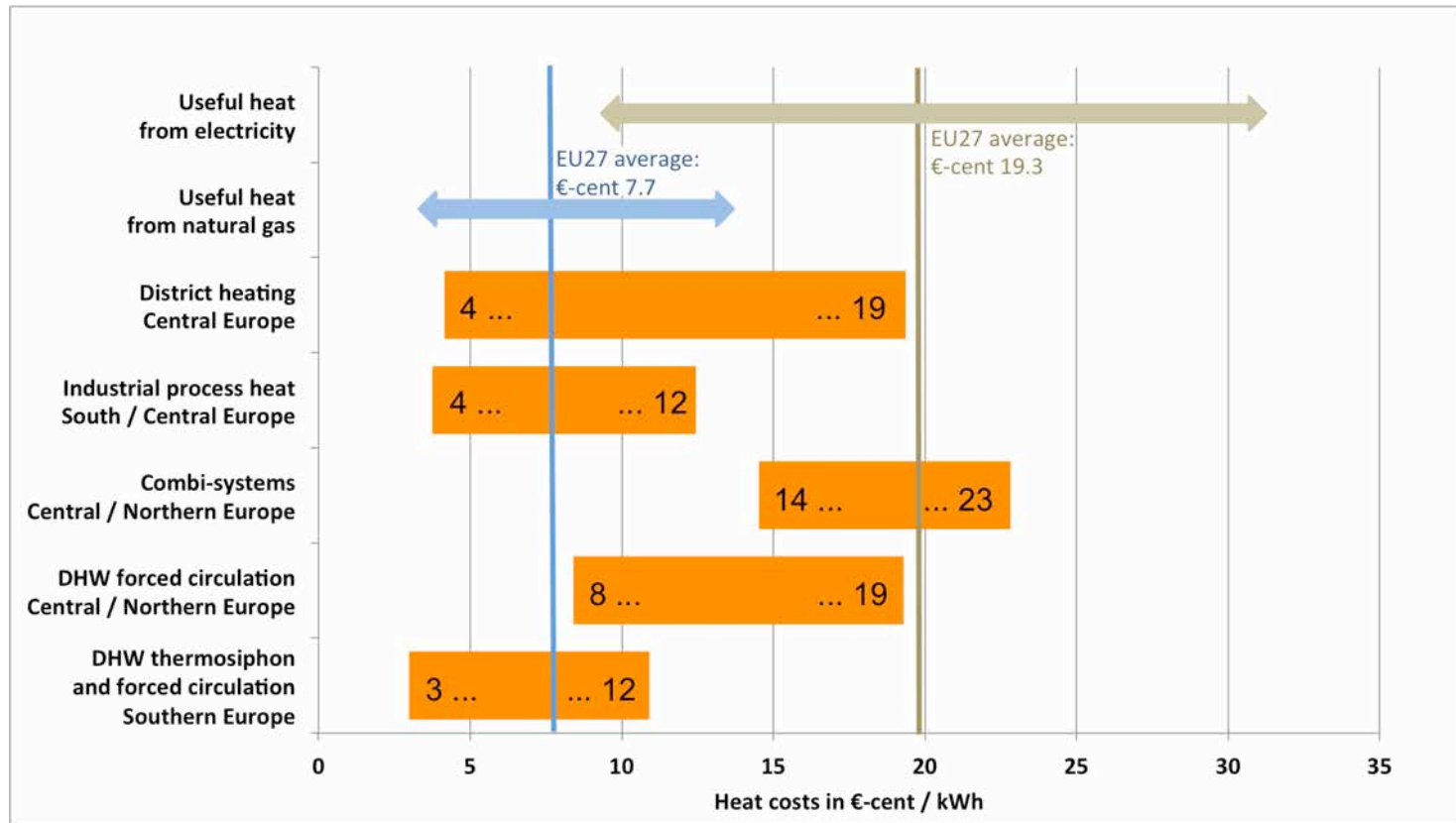


www.consolar.de

Source: Michael Hermann

Main objective of research on RHC technologies: Increasing cost-competitiveness

Status solar thermal heat prices for different applications in different European regions in comparison to heat from electricity and natural gas

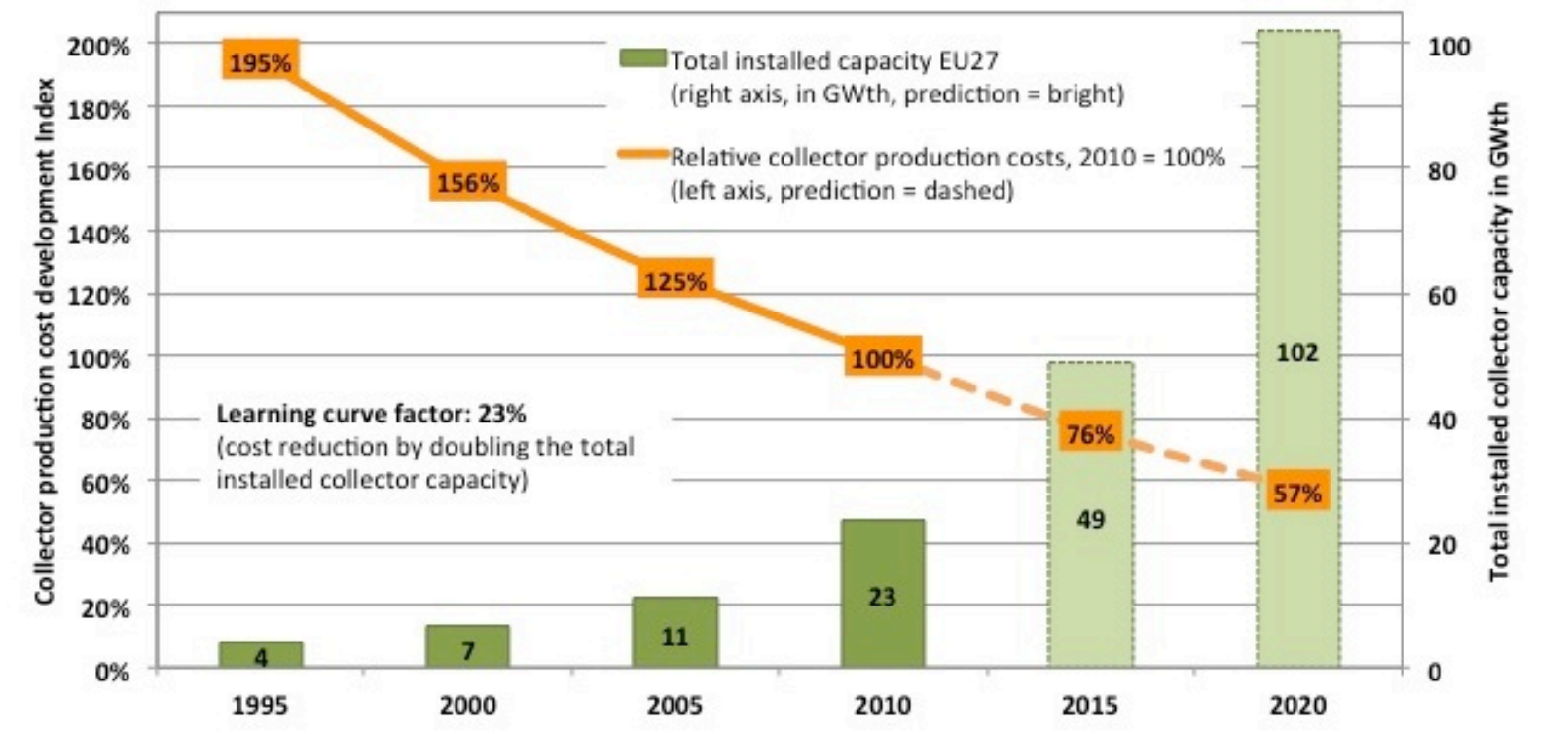


Source: Strategic Research Priorities for Solar Thermal Technology, RHC-Platform 2012

Cost reduction potential of solar thermal energy

To demonstrate the success of cost reduction, not the system price is compared, since the type of systems and their solar fraction are increasing, but the collector production costs

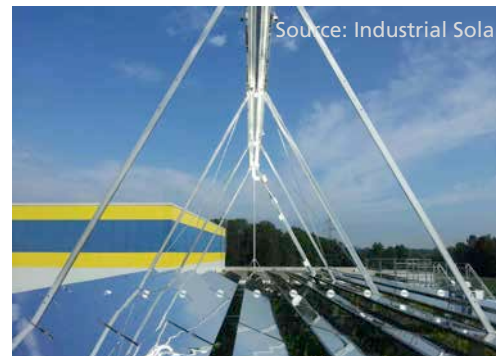
Production costs development for European standard collectors (2.0 – 2.5 m²)



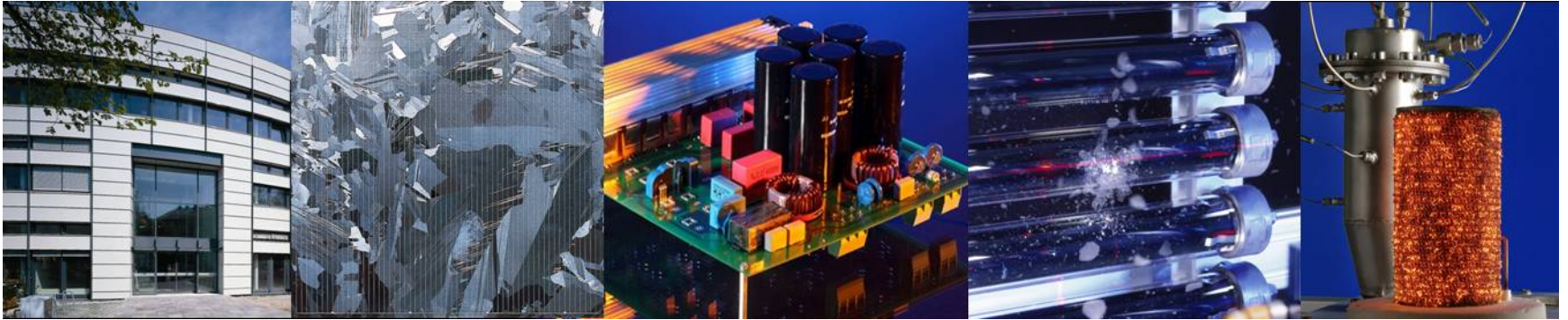
Source: Strategic Research Priorities for Solar Thermal Technology, RHC-Platform 2012

Conclusions

- **Solar thermal energy can cover up to 50%** of the overall energy demand for heating and cooling in Germany and Europe
- There is a huge potential for **solar thermal technology development**
- **Key words for solar thermal R&D** are:
cost reduction – new materials –
increased reliability – fail-safe installation –
smart controller – monitoring systems –
hybrid systems – high density storage –
medium and high temperature collectors –
multifunctional façade collectors –
solar thermal cooling systems – ...



Thank you very much for your attention!



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