IEA
Solar Heating & Cooling Programme

Dr. Ricardo Enríquez Miranda, IEA SHC programme

Task53 Workshop on the New Generation of Solar Cooling and Heating Systems driven by Photovoltaic or Solar Thermal Energy

IDAE, Madrid, 11 April, 2016

SHC Member Countries

SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

www.iea-shc.org

SHC Sponsors

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ECREEE
ECOWAS Regional Centre for Renewable Energy and Energy Efficiency

ECI
European Copper Institute

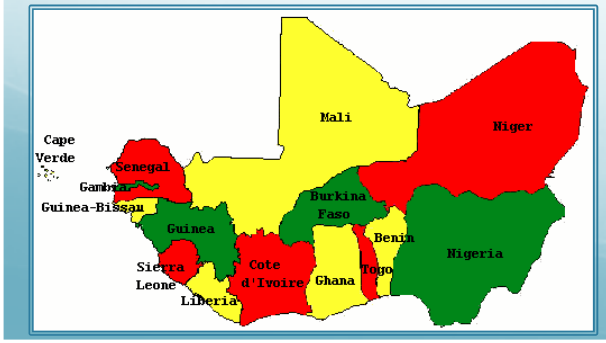
RCREEE
Regional Centre for Renewable Energy and Energy

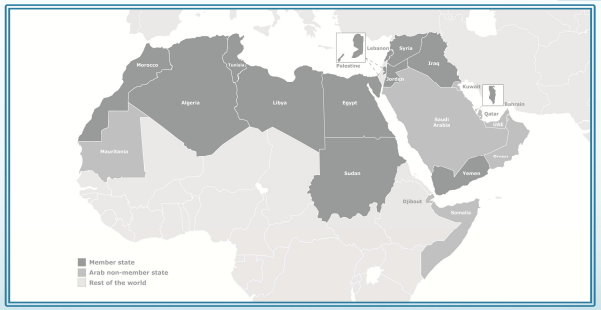
GORD
Gulf Organization for Research & Development
(in process)

European Copper Institute
Copper Alliance

RCREEE
Regional Center for Renewable Energy and Energy Efficiency
المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

GORD
المنظمة الخليجية للبحث والتطوير
Gulf Organisation for Research & Development

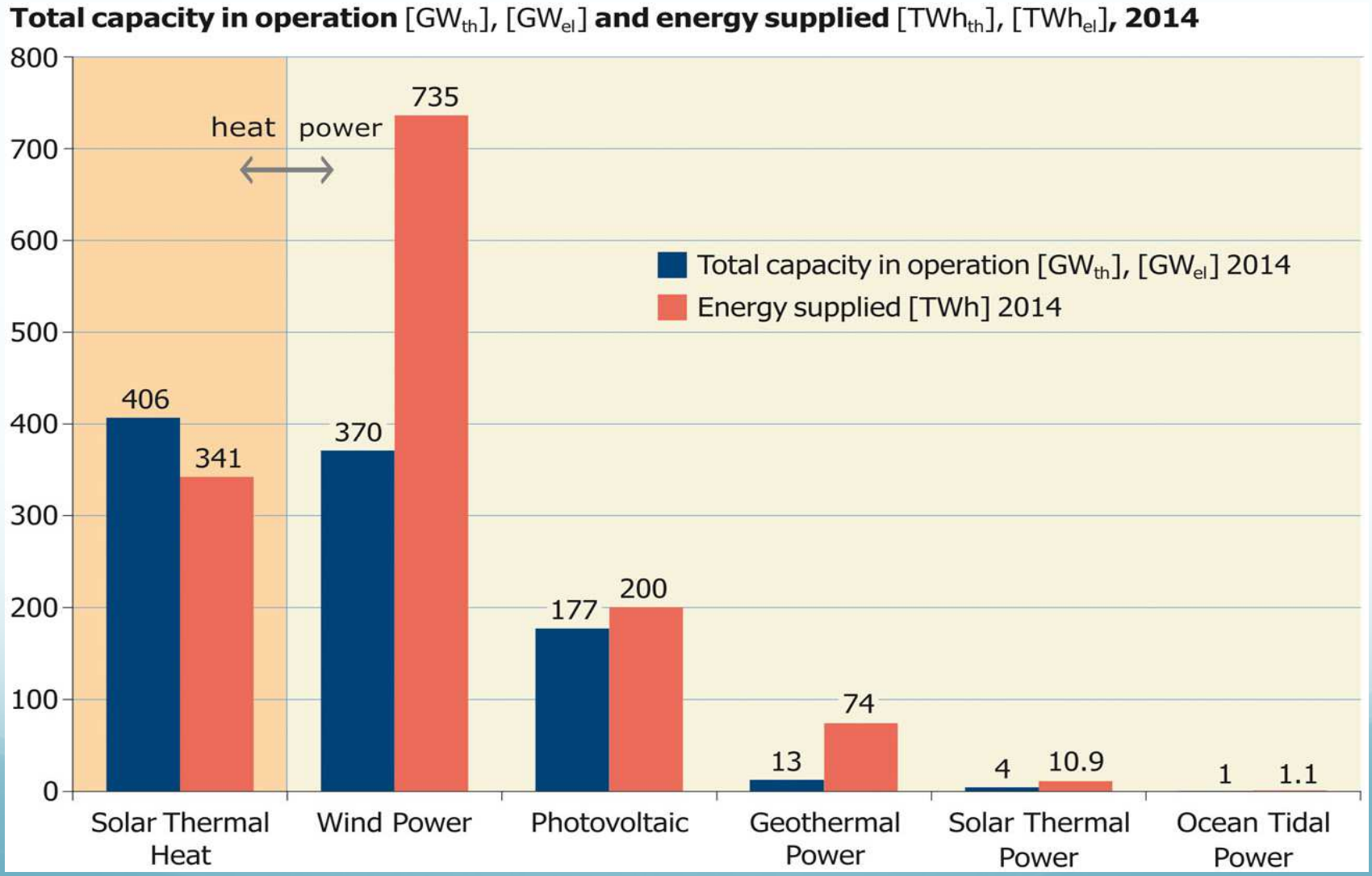




New sponsor in February: International Solar Energy Society!!!!!

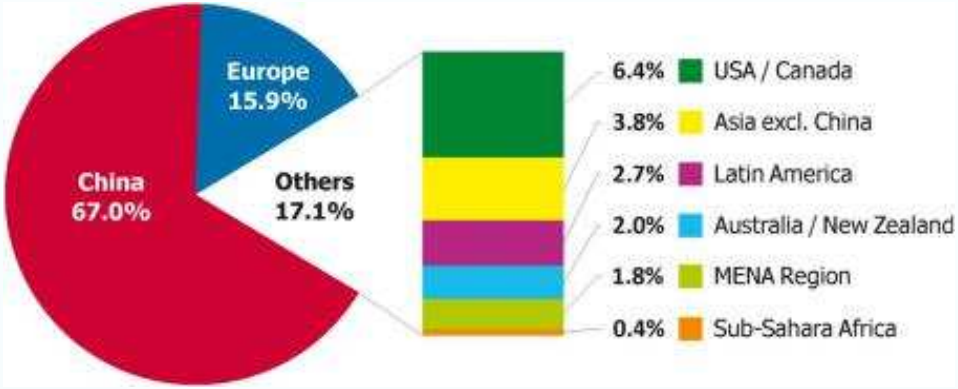
IEA SHC ANNUAL STATISTICS

Solar Heat Worldwide 2014



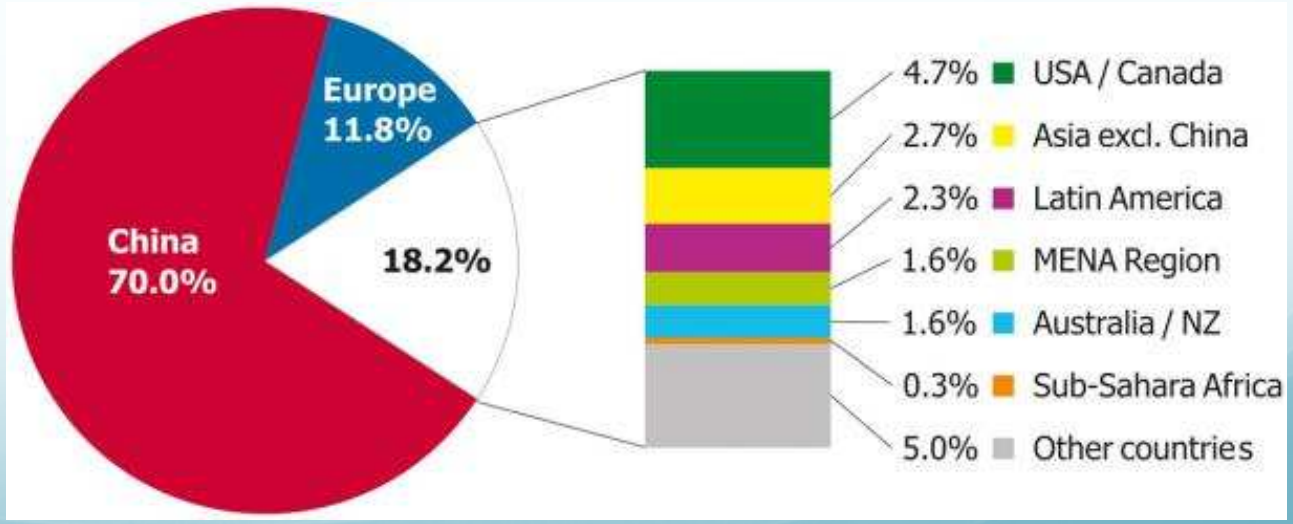
Global Capacity in Operation 2014

Total installed capacity in operation by economic regions at the end of 2012/2013



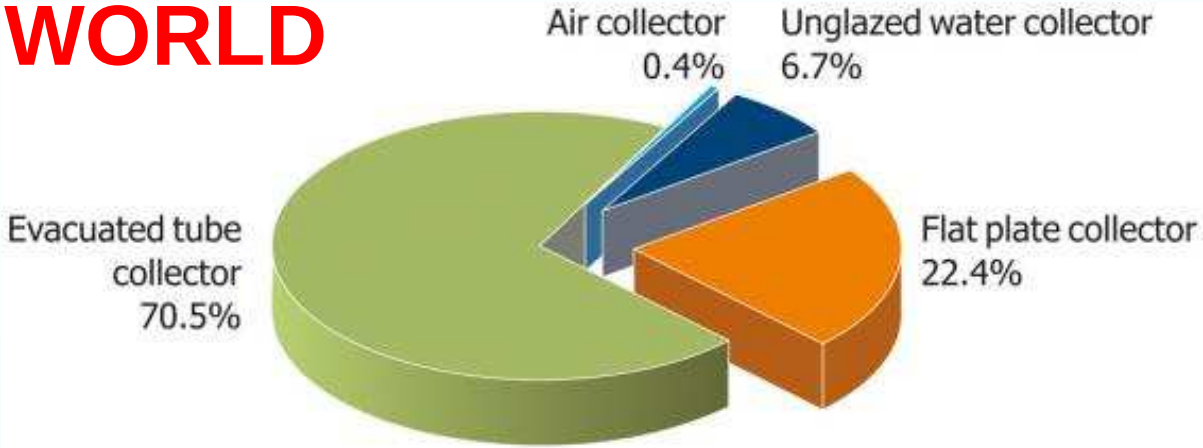
2012

2013

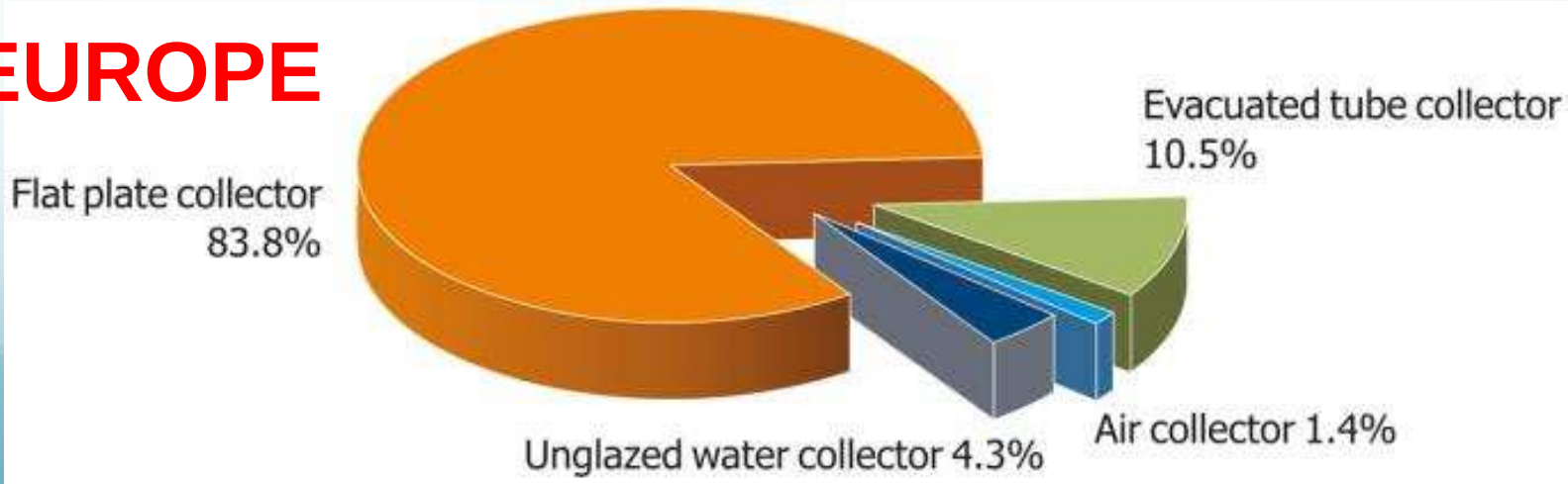


Distribution of the total installed capacity in operation by collector type in 2013

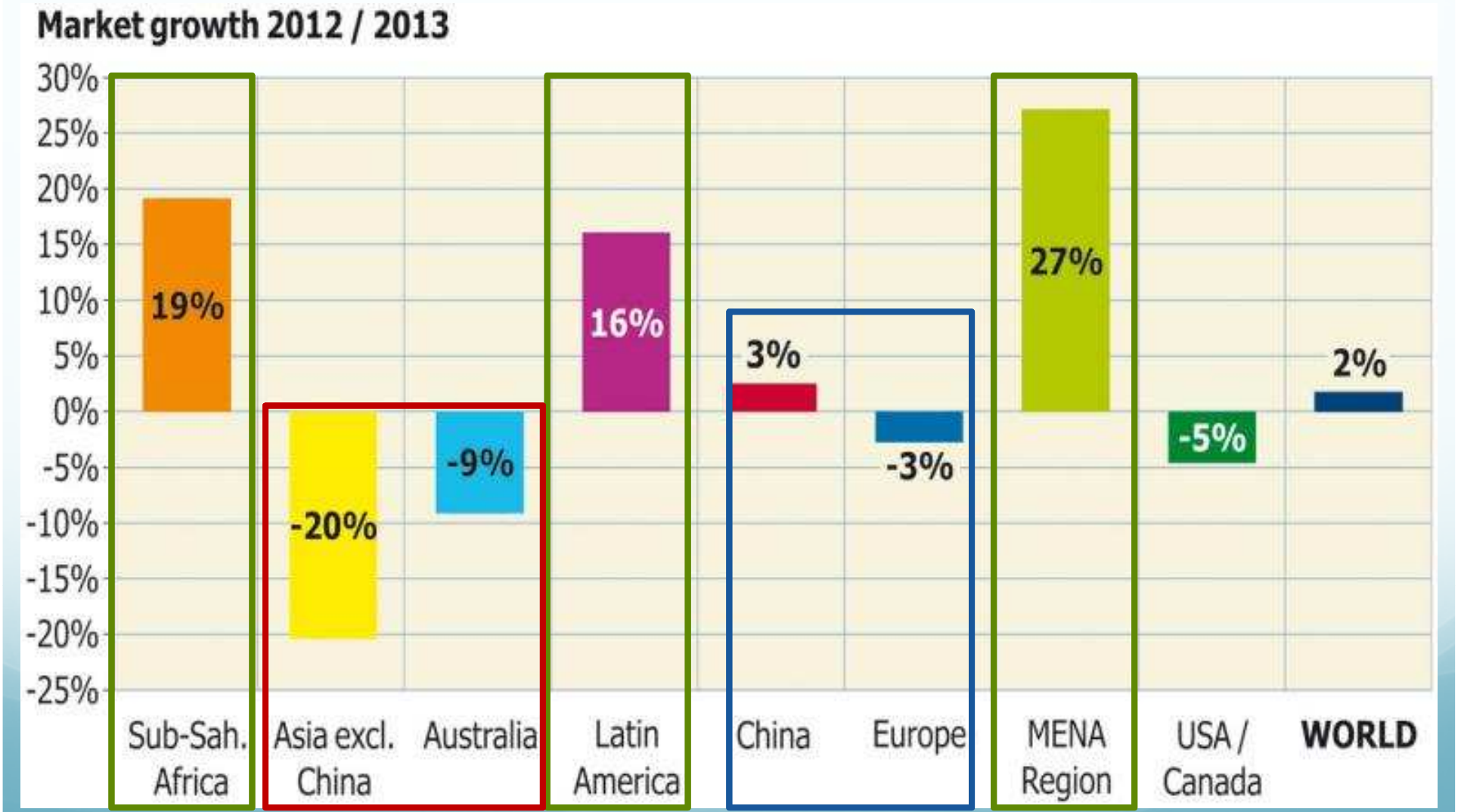
WORLD



EUROPE

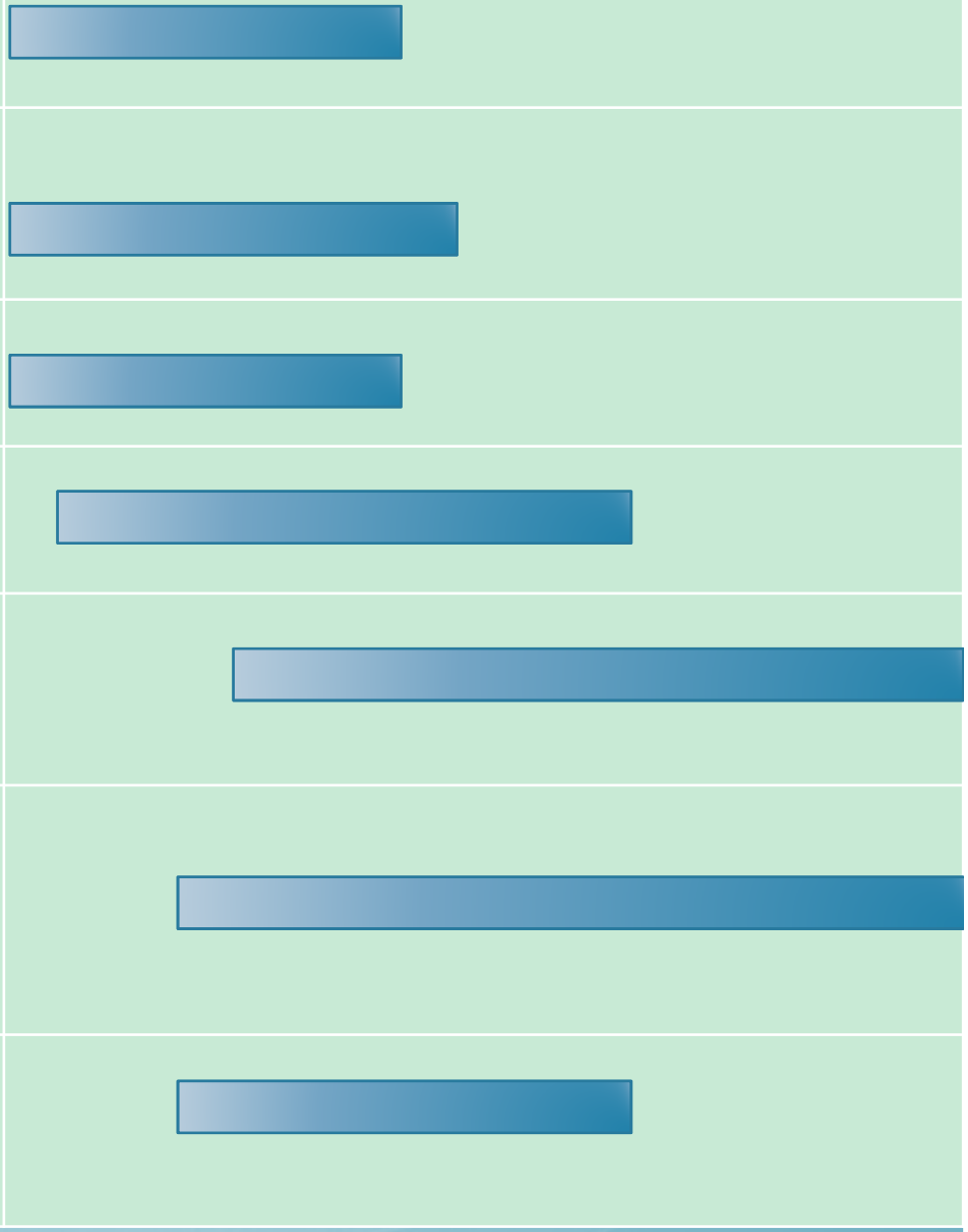


Market growth 2012 / 2013

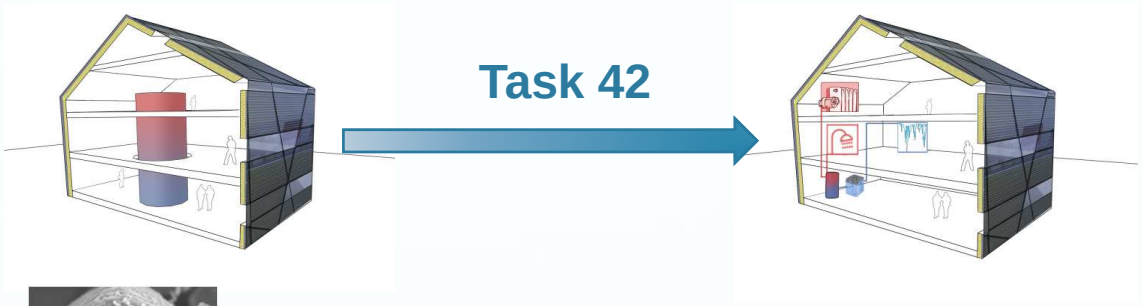


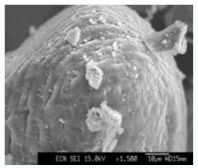
	2015	2016	2017	2018	2019	2020
Task 42: Compact Thermal Energy Storage(Switzerland)						
Task 43: Rating & Certification Procedures (Denmark, US)						
Task 45: Large Solar Heating/Cooling Systems (Denmark)						
Task 46: Solar Resource Assessment and Forecasting (United States)						
Task 48: Quality Assurance and Support Measures for Solar Cooling Systems (France)						
Task 49: Solar Heat Integration in Industrial Processes (Austria)						
Task 50: Advanced Lighting Solutions for Retrofitting Buildings (Germany)						

	2015	2016	2017	2018	2019	2020
Task 51: Solar Energy and Urban Planning (Sweden)						
Task 52: Solar Thermal & Energy Economics in Urban Environments (Germany)						
Task 53: New Generation Solar Cooling & Heating Systems (France)						
Task 54: Price Reduction of Solar Thermal Systems						
Task 55: Towards the Integration of Large SHC Systems into DHC Networks						
Task 56: Building Integrated Solar Envelope Systems for HVAC and Lighting						
Task 57: International Standards & Global Certification						



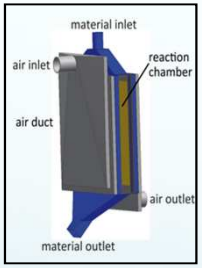
ENERGY STORAGE





Materials

- improve performance (capacity, power)
- reduce costs (basic material, production technology)



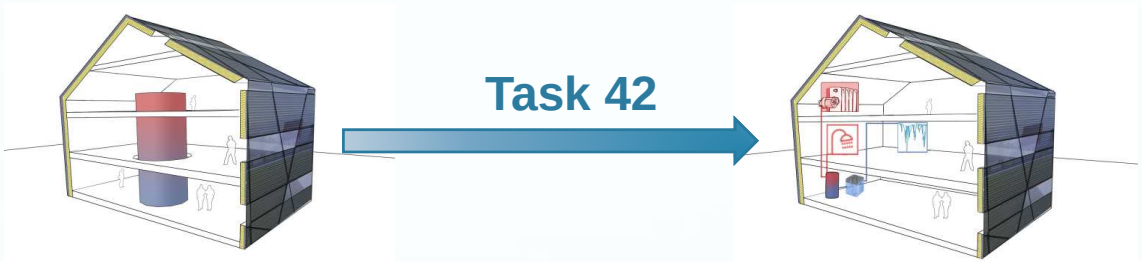
Components

- heat exchangers
- mass transport
- sensoring, control

Systems

- Integration
- control

ENERGY STORAGE



Task 42 Ended (Huge Topic). Achievements:

A data base for PCM, TCM and sorption materials was developed and established.

A new standard for an improved DSC (Differential scanning calorimetry) measurement method has been developed in the task. Advances have been made in the numerical modelling of materials.

Assessment of potential of PCM and TCM materials ("Four Temperatures Method").

A tool for the economic evaluation of thermal energy storages has been developed.

There is plenty of room for new SHC-ECES new activity: **Material and component development for thermal storage systems**. The key objectives are:

1. Development and characterization of storage materials to enhance TES performance
2. Development of materials testing and characterization procedures, including material testing under application conditions
3. Development of components for compact thermal energy storage systems
4. Mapping and evaluating the TES application opportunities

ACCESSING INTERNATIONAL MARKETS

- There are a range of different requirements for market access in countries and regions.

No guarantee for correct/complete listing

- Often extra testing is required that:
  - duplicates tests already done.
  - leads to additional cost to access new markets
- ***However, some differences are justifiable, to maintain market confidence in different climates***.

ACCESSING INTERNATIONAL MARKETS

- Global Solar Certification Network
  - Established by IEA SHC Task 43
  - Task 57 to maintain support for 2 years
  - Membership now open
- Moving toward a single collector test standard.
  - ISO 9806:2013 *Solar energy - Solar thermal collectors - Test methods* under revision
  - Consistent tests. 'Pass' Requirements may vary for different countries or regions - appropriate to climate and use.

LARGE SCALE

- Large solar heating systems (SHC Task 45)
- Solar industrial process heat (SHC Task 49)
- Solar energy and urban planning (SHC Task 51)
  - to provide case studies and tools to avoid public backlash regarding intrusive visibility in the landscape
- Solar Heat and Energy Economics in Urban Environments (SHC Task 52)
- New Task 55, **Large Scale Solar District Heating and Cooling Systems** (Time to join!!!)

Solar Space Heating with High Solar Fraction

Drake Landing Solar Community, Canada

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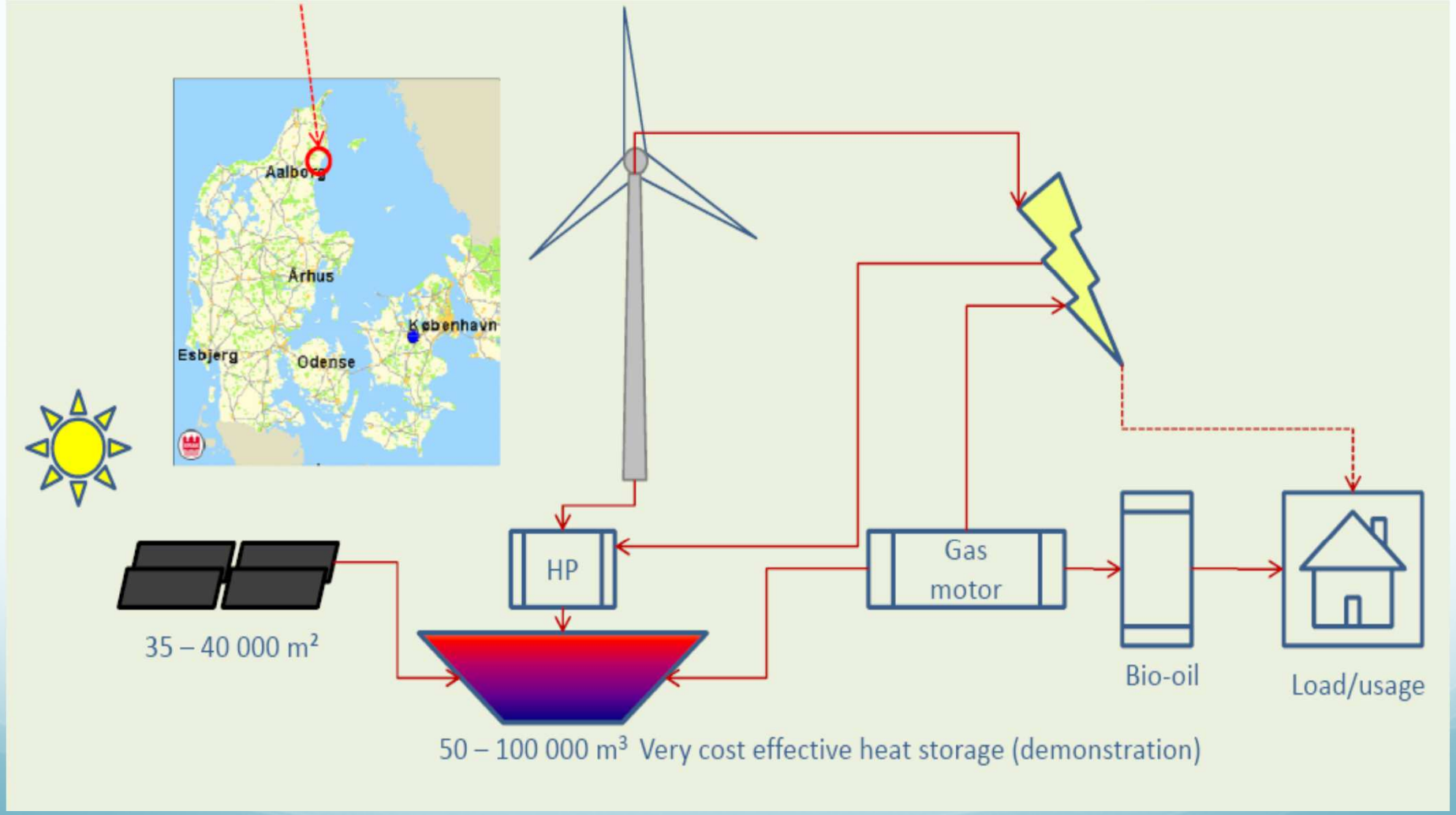
LARGE SCALE

- **World Largest Solar District Heating Plant**

Vojens, DK
70,000 m²
(49 MW),
200,000 m³.

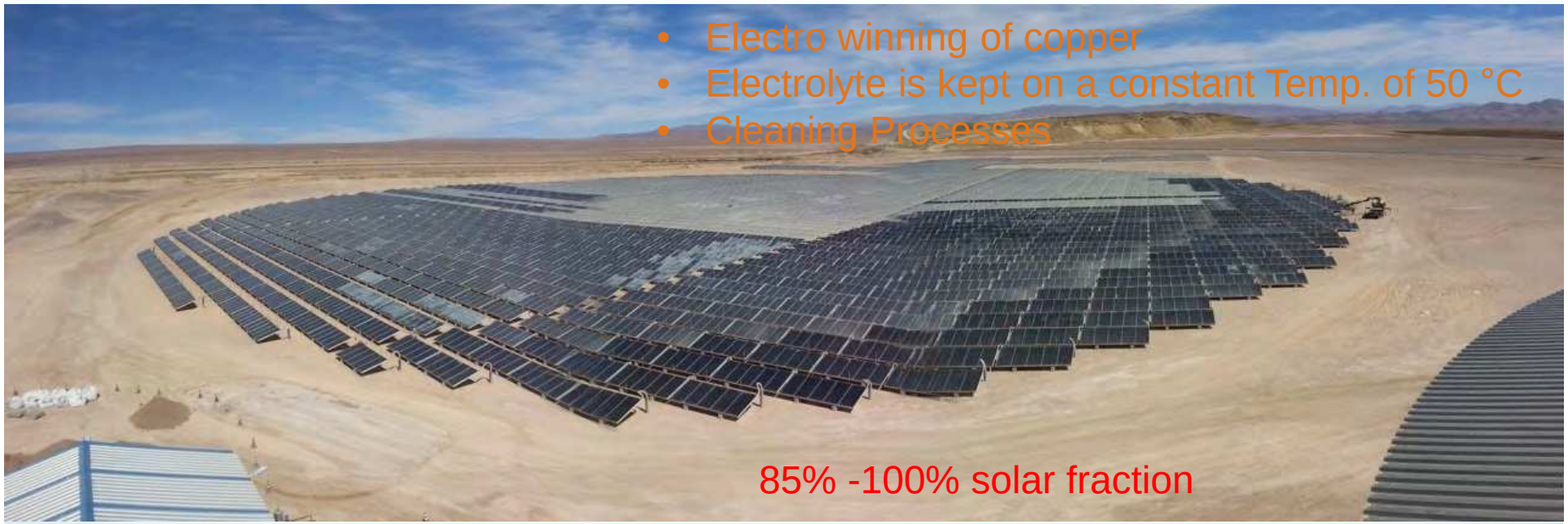
Source: http://www.vojensfjernvarme.dk

Smart District Heating Systems
Integration of heat and electrical grids



Source: Jan-Erik Nielsen, PlanEnergi, Cost source: SDH, Report, Success factors in district heating, Dec 2010

- CODELCO Copper Mine in Chile



39,300 m^2 (26MWth) field 4,300 m^3 Storage

Source: ARCON SUNMARK

INDUSTRIAL PROCESS HEAT

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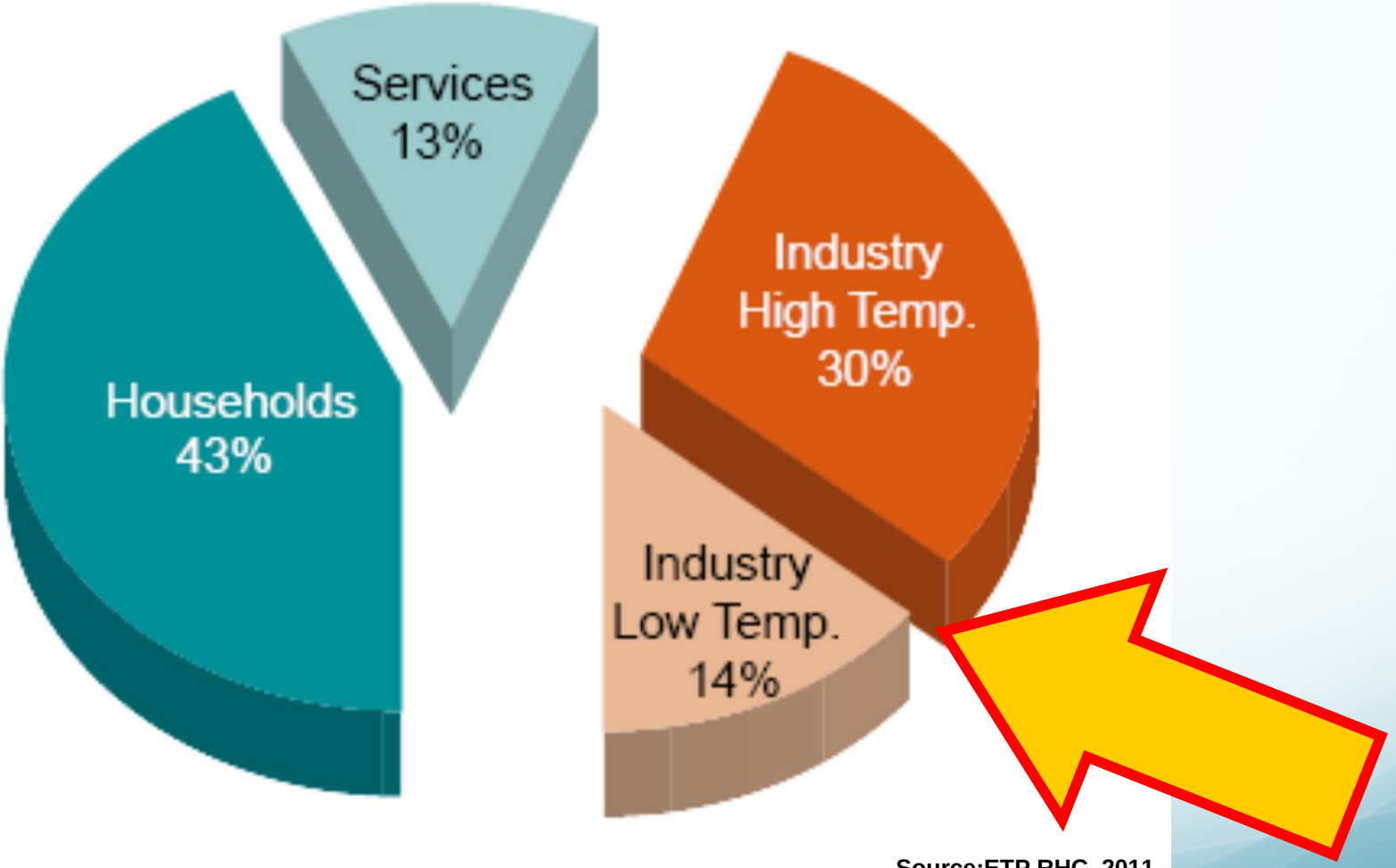
Heat Demand by Sector – EU 27

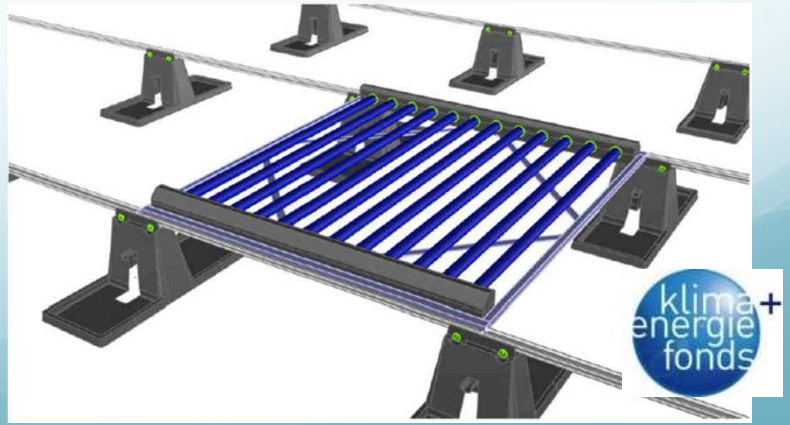


Source:ETP RHC, 2011

T49. Solar Process Heat for Production and Advanced Applications

Subtask A: **Process heat collector**

- Solar collector database
- New collector development
- Guideline on testing procedures for collectors used in solar process heat



T49. Solar Process Heat for Production and Advanced Applications

Subtask B: **Process integration and Process Intensification combined with solar process heat**

Several new SHIP Integrations (Worldwide):

- Sugar mill production (steam for drying and steam upgrading)
- Waste heat from cooling devices in meat production in combination with solar thermal energy
- Solar furnace concept. A prototype of reactor heated by direct solar radiation has been developed for glass melting in semi-continuous mode
- Solar tower for metal treatment

Software Tools for process integartion in combi with SHIP

T49. Solar Process Heat for Production and Advanced Applications

APPLICATION: Subtask C: **largest SHIP application under construction**

Generate steam for thermal enhanced oil recovery (EOR). In thermal EOR, steam is injected into an oil reservoir to heat the oil, making it easier to pump to the surface.

ENERGY PRODUCTION

1,021 MW thermal (1 GW)

TOTAL PROJECT AREA

3 Mio m^2

TECHNOLOGY

GlassPoint enclosed trough

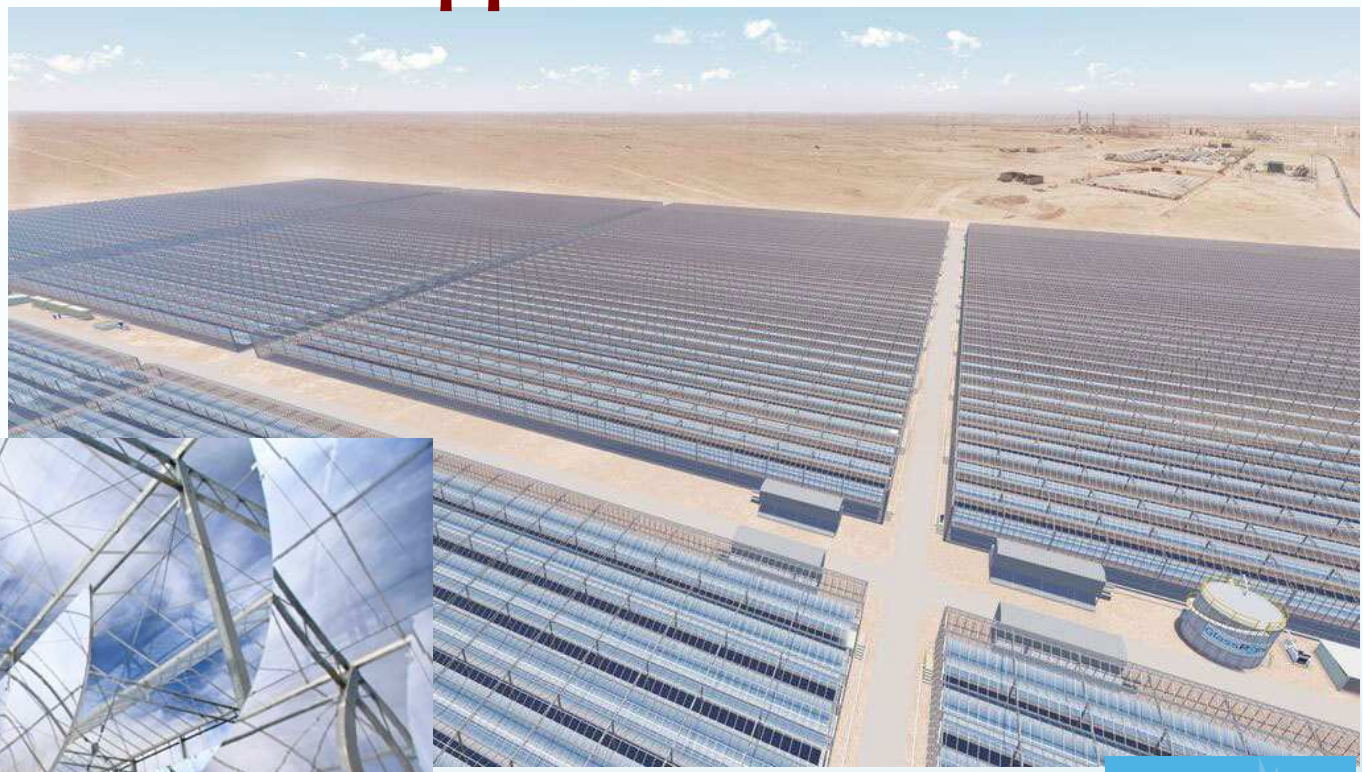
CONSTRUCTION START: 2015

FIRST STEAM: 2017

Mirrah, Oman

T49. Solar Process Heat for Production and Advanced Applications

Parabolic troughs protected from soiling



GlassPoint

…in a greenhouse (Glasspoint technology)

T49. Solar Process Heat for Production and Advanced Applications

6000 t steam per day for enhanced oil recovery operations

GlassPoint

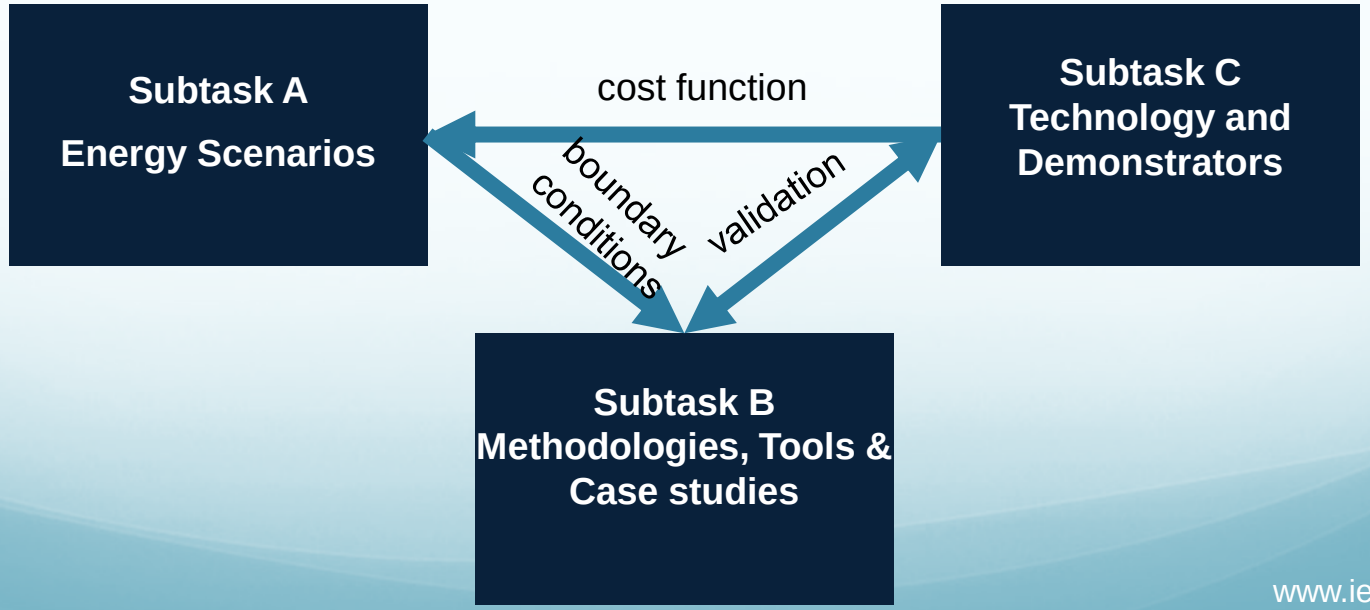
…saving 1600 GWh_{th} gas, and 300 000 tCO2 a year

Solar Economy

- SHC Task 46, Solar Resource Assessment and Forecasting.
- Solar Heat and Energy Economics in Urban Environments (SHC Task 52)
- New Task 54, **Price Reduction of Solar Thermal Systems** (Time to join!!!)

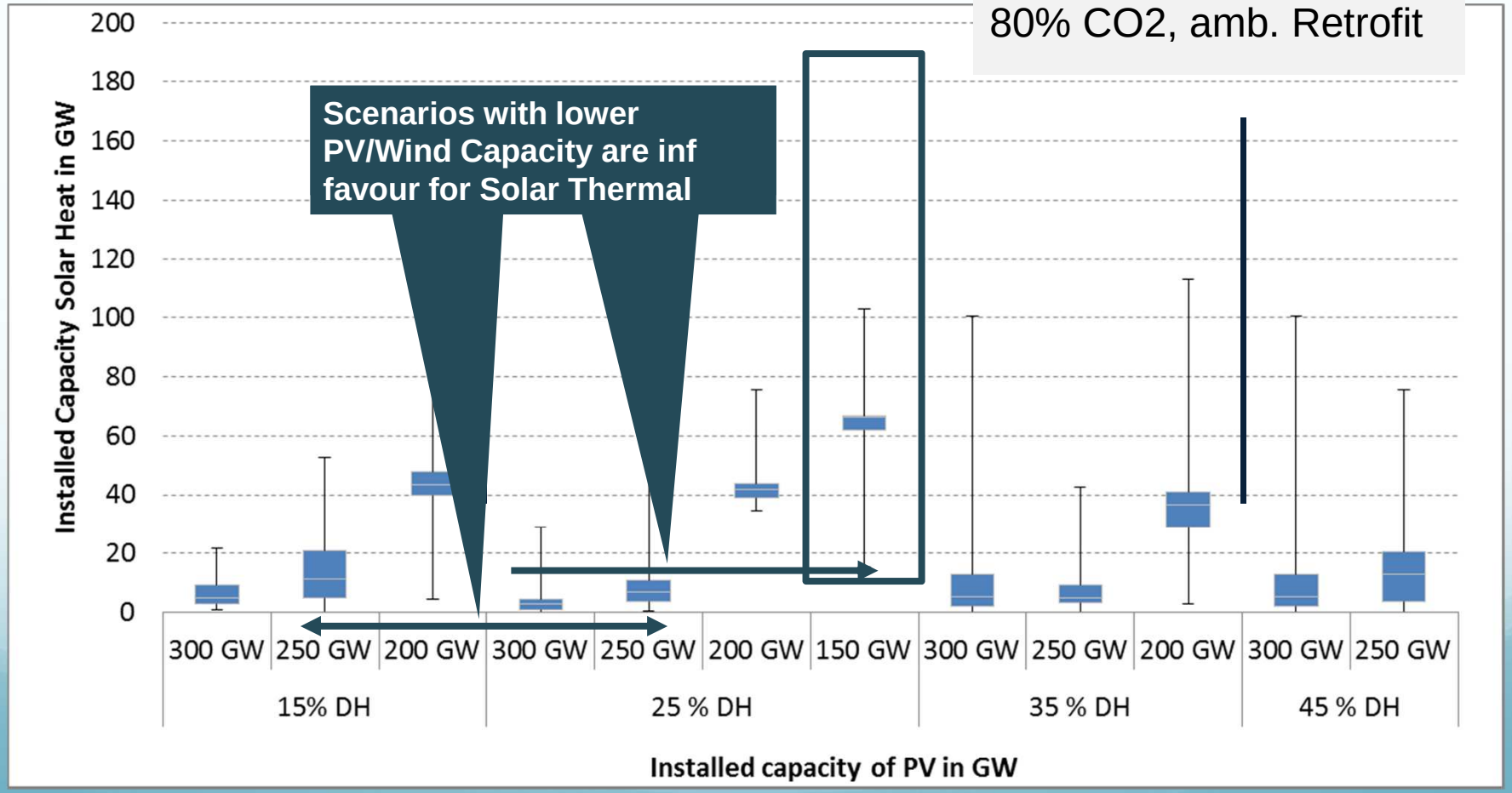
T52: SOLAR HEAT AND ENERGY ECONOMICS IN URBAN ENVIRONMENTS

- Help energy consultants, utilities and urban planners to better understand the role of solar thermal systems in energy supply systems of urban environments
- This includes the development of long term scenarios for energy supply systems integration fluctuating electric and heat sources and sinks.



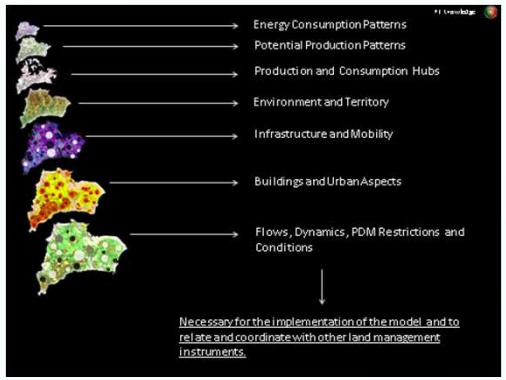
T52. Subtask A: Scenarios
Installed Capacity Solar Thermal vs. share of District Heating and PV

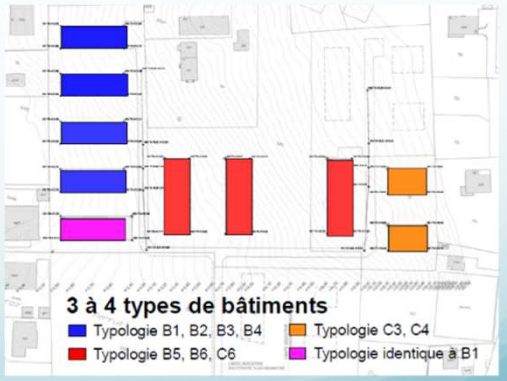
STEP 1: 2050, Germany
80% CO2, amb. Retrofit



T52. Subtask B: Methodologies, Tools & Case studies for Urban Energy concepts

- Development of methodologies with focus on performance indicators (different stakeholders)
- Energy planning tools and toolboxes (from Urban planning to neighbourhoods)
- Case studies analysis of different regions



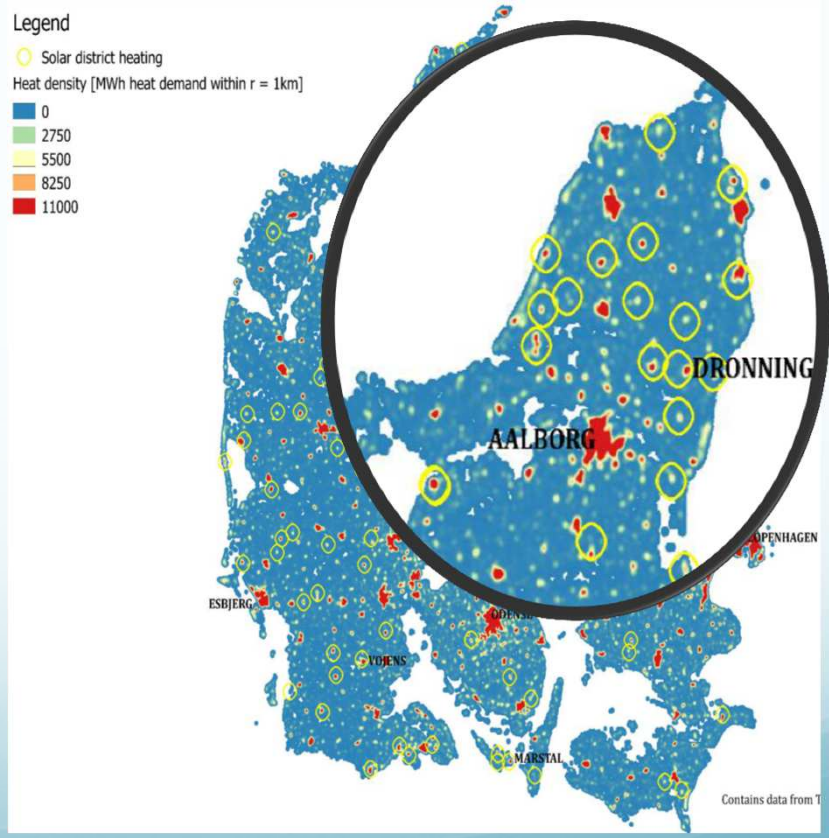


T52. Subtask C: Technology and Demonstrators

Analysis of trends in the establishment of large scale ST systems in DK

Correlation possibilities

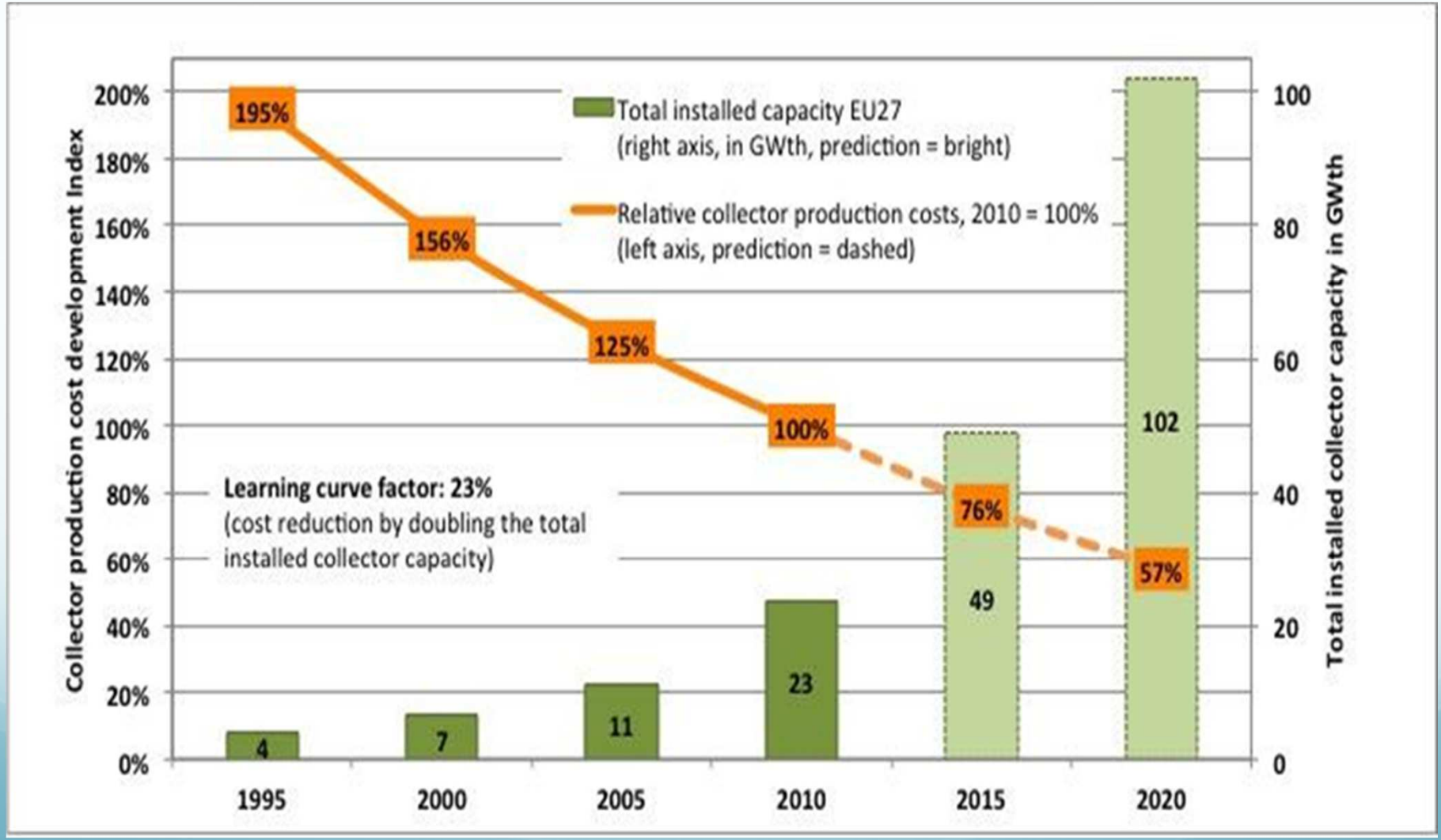
- Population
- Heat demand
- DH price
- Availability of land



T54. Price Reduction of Solar Thermal Systems

- Objectives:
  - Reduction of the purchase price of solar thermal systems up to 40% for end-users
  - Optimization along the whole value chain
    - m**aterial, sub-component, system-component** and **system level**
    - **process optimization**;
    - **post-production cost drivers**, e.g. costs of distribution, installation, maintenance and operation
  - Definition of reference systems for selected markets and cost analyses

T54. Price Reduction of Solar Thermal Systems



T54. Price Reduction of Solar Thermal Systems

Subtask A	Market success factors and cost analysis
Subtask B	System design, installation, operation and maintenance
Subtask C	Cost-efficient materials, production processes and components
Subtask D	Information, dissemination and stakeholder involvement





Now is the time to get involved!

Solar Cooling

- SHC Task 48: Quality Assurance and Support Measures for Solar Cooling Systems

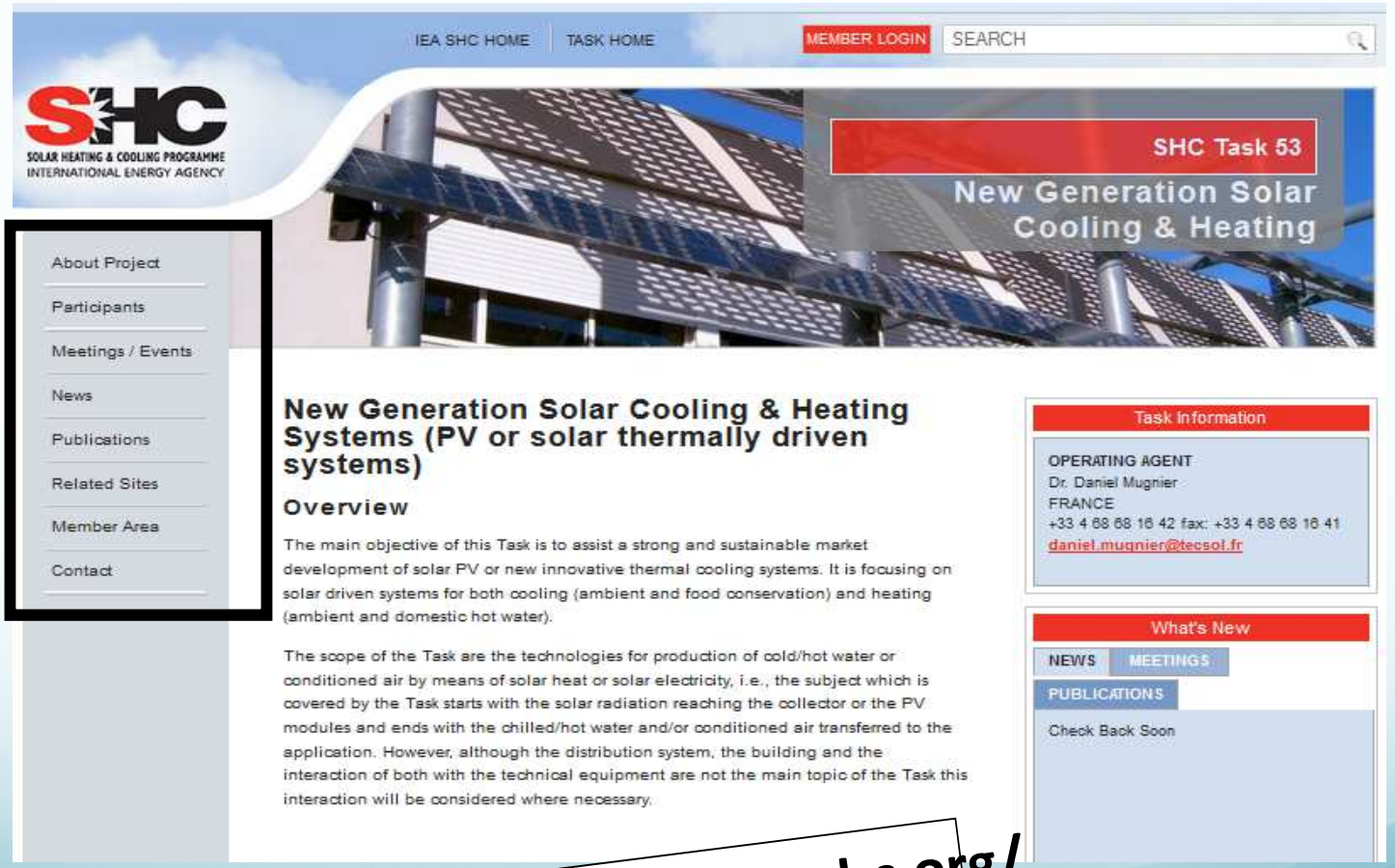
- SHC Task 53, New Generation Solar Cooling & Heating Systems

T53: NEW GENERATION SOLAR COOLING & HEATING SYSTEMS

Main objectives

- Investigate new small to medium size solar cooling systems (thermal and PV) and develop best suited cooling and heating system technology with a focus on reliability, adaptability and quality.
- Demonstrate the cost effectiveness of new solar cooling and heating systems.
- Investigate life cycle performances on energy and environmental terms (LCA) of different options.
- Support the market deployment of new solar cooling and heating systems for buildings.

T53: NEW GENERATION SOLAR COOLING & HEATING SYSTEMS



http://task53.iea-shc.org/

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T53: NEW GENERATION SOLAR COOLING & HEATING SYSTEMS

State of the art presented at the Solar Cooling Weel

(no claim for completeness)

T53: NEW GENERATION SOLAR COOLING & HEATING SYSTEMS

SubTask B. Control, Simulation and Design

Ongoing set up work of building TRNSYS models for simulating reference systems

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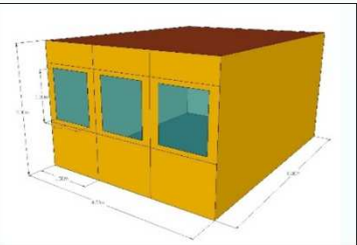
Sketch and picture	 
Zoning	
Zone height/width/depth	3.0 / 4.5 / 6.0 m Ceiling height 2.8 m
Zone floor area / volume	27 m² / 81 m³
Office area per floor	6 to 12 offices per floor
Number of floors	3 to 7
Roof type	Flat concrete roof
Glazing ratio	30 % to 60%

MILESTONE REPORT TO BE AVAILABLE IN END OF DECEMBER

T53: NEW GENERATION SOLAR COOLING & HEATING SYSTEMS

Subtask C: Testing and demonstration projects

Monitoring procedure
KPI's
Reference conditions
Example

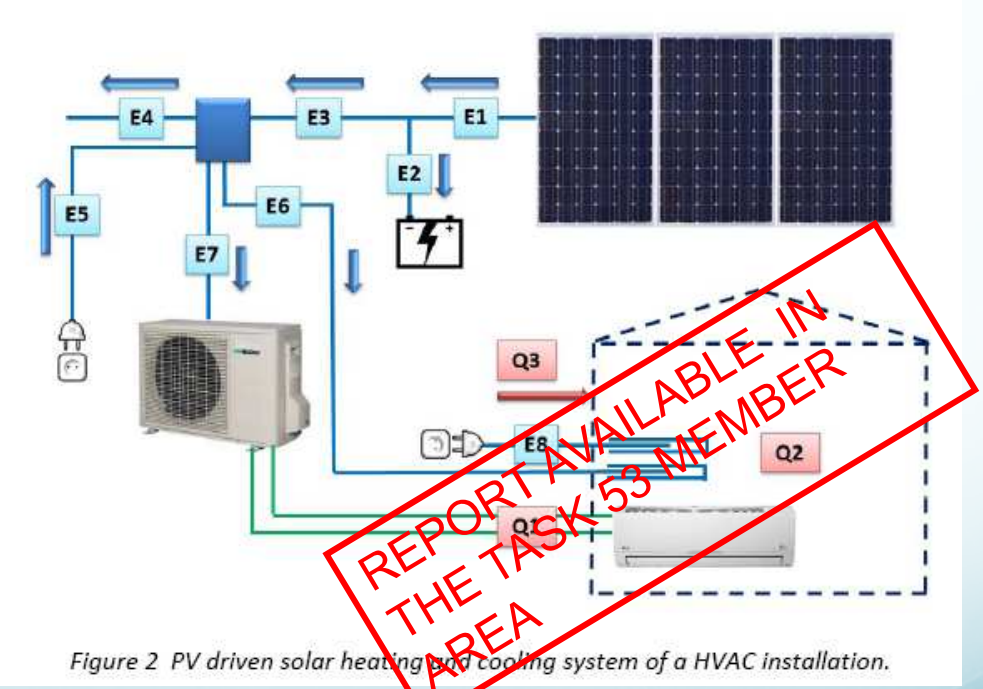


Figure 2 PV driven solar heating and cooling system of a HVAC installation.

Monitoring procedure for field test & demo systems

Solar Architecture & Lighting

- SHC Task 41, Solar Energy and Architecture
- SHC Task 50, Advanced Lighting Solutions For Retrofitting Buildings
- SHC Task 51, Solar Energy in Urban Planning
- New Task 56, Building Integrated Solar Envelope Systems for HVAC and Lighting (Time to join!!!)

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T41: SOLAR ENERGY AND ARCHITECTURE

Unglazed flat plate collectors

Swimming pool, Ilanz Switzerland, by P. Curschellas, 1996

Building facts
Mountain area
Uncovered swimming pool with 3 basins for a total of 1250 m2
Standard hot water supply in summer / heating help in winter
Situation : On roof
Other relevant facts

Solar product
Energie Solaire SA, CH - 3960 Sierre, www.energie-solaire.com
Unglazed stainless steel collectors, could be mounted on oblique or curved roof and facade.
Dimensions : 248 x 86 x 0.5 [cm] / solar effective : 1.93 m2
Installation size: 353m2 on curved roof and 100m2 on oblique roof
Solar fraction: 95% *for DHW, for Space heating*

Integration achievements

Collector used as multifunctional construction element	+
Field position and dimension	+
Visible materials	+
Surface texture	+
Surface colour	+
Module shape & size	+
Jointing	+/-

Unglazed solar thermal collector

Single-family house, Dresden (D), Arch. Schulze S., 2003

Building facts
Climate Type: Temperate
Building Size: 223 m2 / 3 occupants
Energy Standard: Low energy house
Constructive aspects: Heavy-weight construction with roofstructure in concrete and wood, plus thermal insulation on rooftop.
Zink roofing integrates an invisible solar thermal system connected with a geothermal heat pump.

Solar product
Rheinzink Quick Step Solar Thermie
Olienhauerstrasse 101 – D-13403, Berlin
www.rheinzink.de.
Product characteristics:
Integrated solar thermal system in zinc for rooftops with ver simple installation.
System size and orientation: 250 mm x 400-600 mm

Integration achievements

Collector used as multifunctional construction element	+
Field position and dimension	+
Visible materials	+
Surface texture	+
Surface colour	+
Module shape & size	+/-
Jointing	+

T51: SOLAR ENERGY IN URBAN PLANNING

Main objectives

- Provide support to urban planners, authorities and architects to achieve urban areas and eventually whole cities with architecturally integrated solar energy solutions (active and passive), highly contributing to cities with a large fraction of renewable energy supply.
- Develop processes, methods and tools capable of assisting cities in developing a long term urban energy strategy.
- Prepare for and strengthen education at universities on solar energy in urban planning, by testing and developing teaching material (post graduate courses and continuing professional development).

T51: SOLAR ENERGY IN URBAN PLANNING

Subtasks

A. Legal Framework, Barriers and Opportunities

Subtask leader: Mark Snow, University NSW, Australia

B. Processes, Methods and Tools

Subtask leader: Marja Lundgren & Johan Dahlberg, White Arkitekter, Sweden

C. Case Studies and Action Research*

Subtask leader: Annemie Wyckmans & Carmel Lindkvist/Gabriele Lobaccaro, NTNU/ZEB, Norway

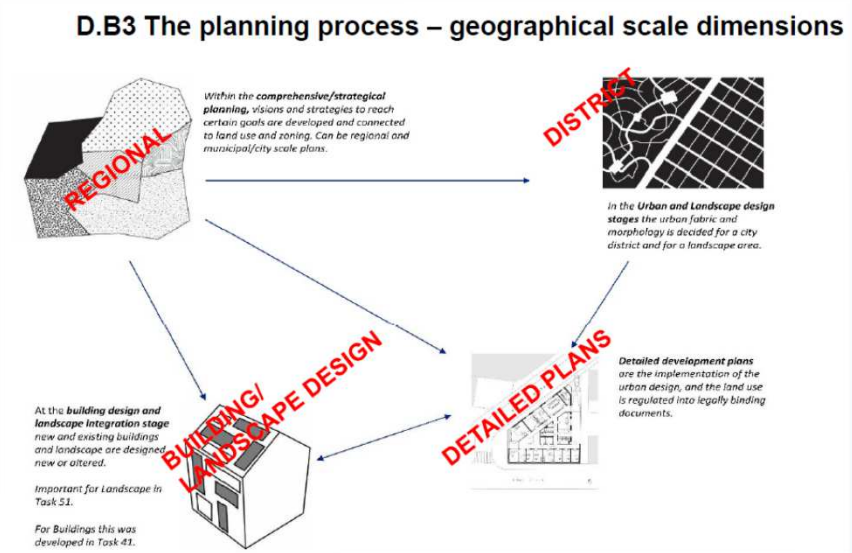
D. Education and Dissemination

Subtask leader: Tanja Siems & Katharina Simon, Wuppertal University, Germany

*) *Action research involves the process of actively participating in an organization change situation whilst conducting research*

T 51: SOLAR ENERGY IN URBAN PLANNING

Processes, methods and tools:



NEW REPORT/DELIVERABLE IN PLANNING:

"Multi-Criteria Decision Strategies"

The aim is to:

- give a theoretical background to the complex decision making context in urban planning
- present ways on how to inform and support decision making in urban planning regarding solar
- present how new and developed AMTs fit into this **context**

T51: SOLAR ENERGY IN URBAN PLANNING

Educational materials:

Urban Planning Education *from page 13*

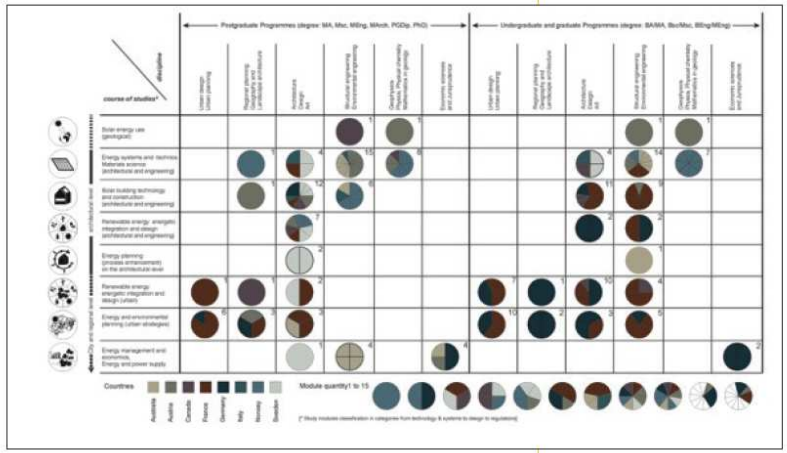


Figure 2. Matrix on the study modules classification in categories. Each pie shows the number of identified and investigated courses in each country in relation to the educational program and course category.
(Source: Siems, Simon).

Task 51

State-of-the-Art: Solar Energy in Urban Planning Education

Education and dissemination are important issues for SHC Task 51 on Solar Energy in Urban Planning. As part of this work, Subtask D experts are focusing on educational issues to strengthen the knowledge and competence in solar energy and urban planning of relevant stakeholders, including university students, planners and other professionals. The creation of a substantial link between research and education as well as between research and practice is the core of Subtask D. This subtask is working to determine where deficits currently exist and then will evaluate the reasons for these deficits and propose solutions and strategies to overcome these shortcomings.

Task's Education Work

The goal of this work is to inform students as well as planners and professionals within the field of urban design and development on how to find relevant courses and to create a solar urban planning platform for dissemination and education. To do this, Task participants are integrating relevant methods for using digital and analogue tools and compiling experiences from case studies of completed projects and ongoing "action research/case stories."

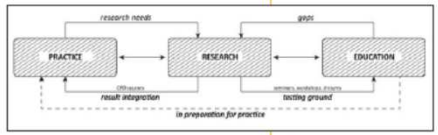


Figure 1. Diagram of inter-dependencies of practice, research and teaching. (Source: Simon)

The experts in Subtask D are clearly summarizing the shortcomings and barriers in existing courses, and the related teaching methods, in order to provide relevant seminars, lectures and tools for educating the next generation of architects, urban planners and specialist planners.

The Subtask's modus operandi on how to find and evaluate existing teaching material was based at first on general online research, followed by a survey of the relevant programs and courses in regards to teaching about solar energy at universities and colleges. After identifying and analyzing

T51: SOLAR ENERGY IN URBAN PLANNING

Case studies. Best practices.

Solar energy in Swedish urban planning

- Urban planners have no legal instruments to require the installation of solar thermal / PV systems on (new) buildings
  - It is up to each urban planner or city to promote solar energy (renewable)
- There is no standard procedure how to 'plan for solar energy' within the urban planning process

Action research in Malmö / Lund

- Researchers from Energy and Building Design (Lund University) *actively participate* in the urban planning process of Malmö Hyllie and Lund Brunnshög
- Both districts are showcases on how to plan energy-efficient districts with renewable energy production on-site
  - Focus on solar energy production
  - Hyllie/Malmö: ST + PV
    Brunnshög/Lund: PV

ESS/Team Henning Larsen Architects

European Spallation Source (ESS) in Lund – generates a lot of waste heat

T50: ADVANCED LIGHTING SOLUTIONS FOR RETROFITTING BUILDINGS

The **objective** is to accelerate retrofitting of daylighting and electric lighting solutions in the non-domestic sector using cost - effective, best practice – approaches, which can be used on a wide range of typical existing buildings.

T50: ADVANCED LIGHTING SOLUTIONS FOR RETROFITTING BUILDINGS

Joint Working Group: Lighting Retrofit Adviser

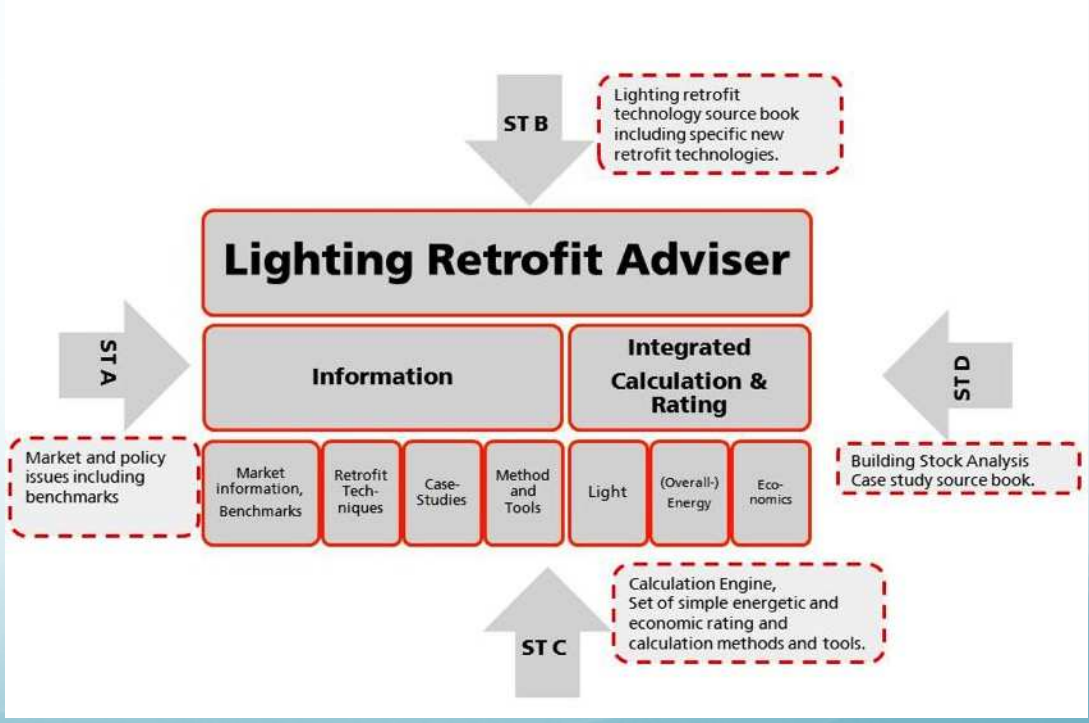
Objective: To develop an electronic interactive source book (Lighting Retrofit Adviser) including and presenting all Task results in an user-friendly and target group specific way

JWG.1 Software Specification (Concept, Architecture and software design)

JWG.2 Concept evaluation and proof

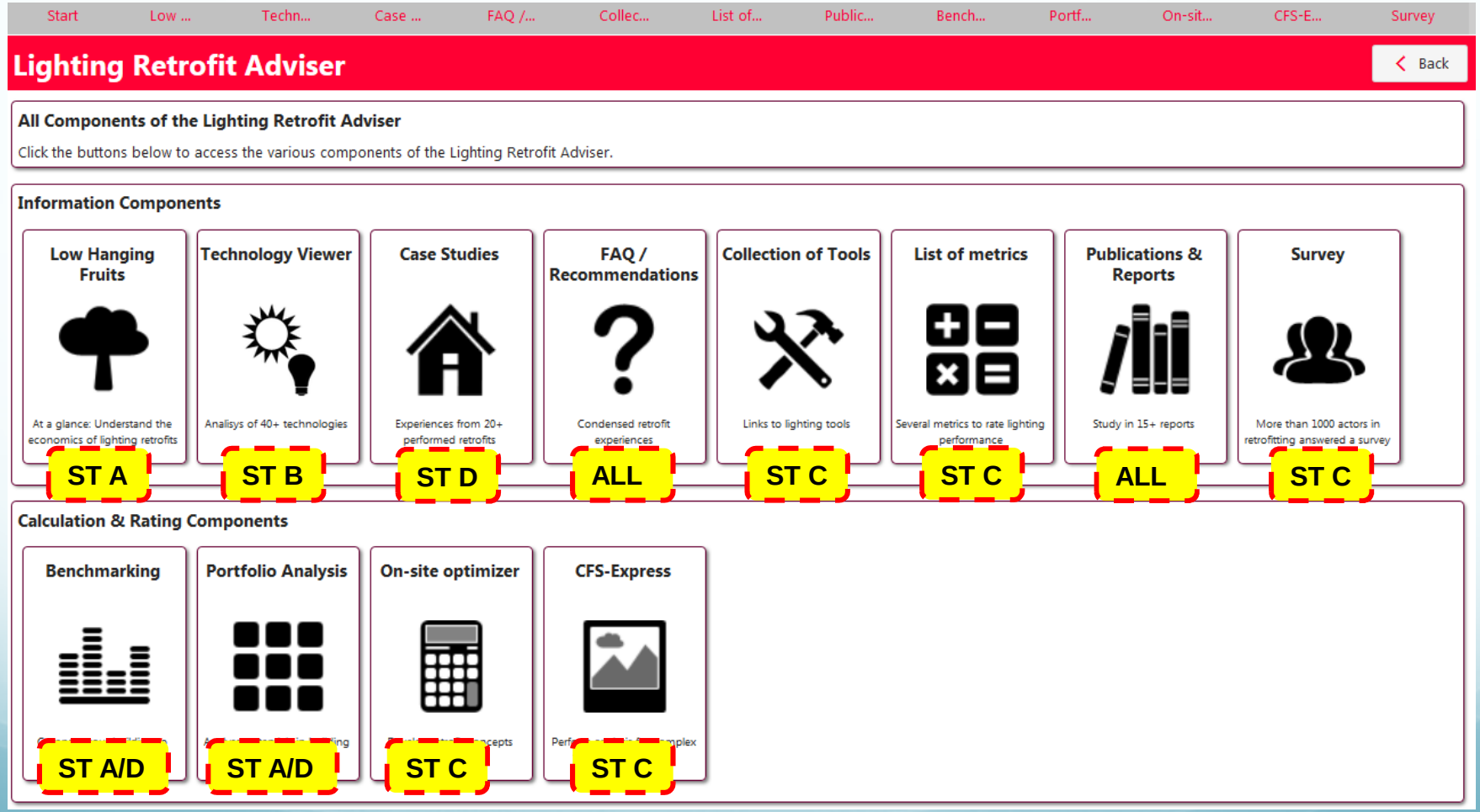
JWG.3 Implementation

JWG.4 Quality assurance, validation and national adaptions



T50: ADVANCED LIGHTING SOLUTIONS FOR RETROFITTING BUILDINGS

T50: ADVANCED LIGHTING SOLUTIONS FOR RETROFITTING BUILDINGS



T50: ADVANCED LIGHTING SOLUTIONS FOR RETROFITTING BUILDINGS

A following Task to be discussed at the next ExCo meeting

- user centred, integrated controls (light, non visual…)
- hybrid facades
- daylight mimicking
- artificial windows
- integrated design tools
- …

T56: Building Integrated Solar Envelope Systems for HVAC and Lighting

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

FOCUS:

NEW Task. Time to join!!!!!

- **Residential and tertiary buildings** (offices, schools, hospitals, factories) are addressed.
- Techniques for **new-built and renovated constructions** are analysed, accounting for the specificity of the tackled intervention.
- The Task will pose the attention on **solutions looking at the mass market through an industrialised integration of active components into envelope modules**.

Currently at definition phase

New initiative: Solar Academy

In order to intensify the use of the SHC Task results and to make use of the comprehensive knowledge of the task experts a "**Solar Academy**" shall be established.

Based on Task results the "Solar Academy" shall provide:

- training courses
- capacity building services on solar thermal heating and cooling and solar buildings on different levels.

The courses could be carried out by:

- Operating Agents or
- international experts

who participated in IEA SHC Tasks.


To Learn More...
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SHC Conference

SOLAR HEATING & COOLING PROGRAMME
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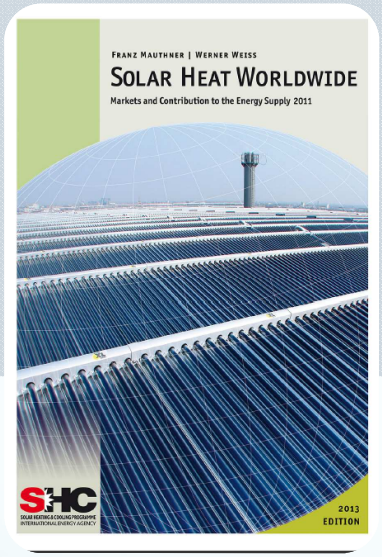
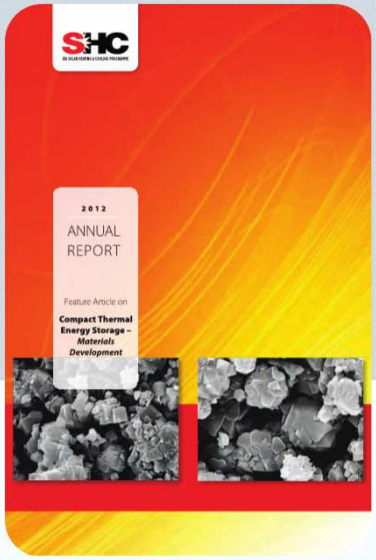
Discussing next editions and collaborations

Publications

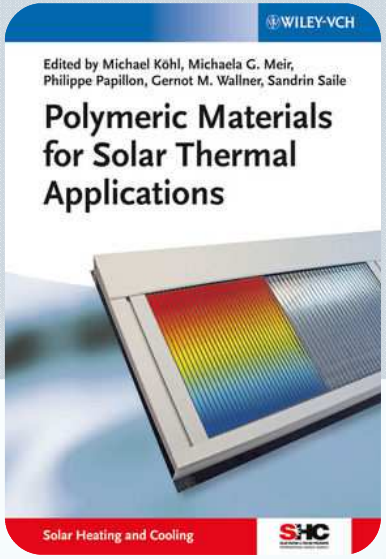


Solar Heat Worldwide

Solar Update



Annual Report



Task Publications

SHC
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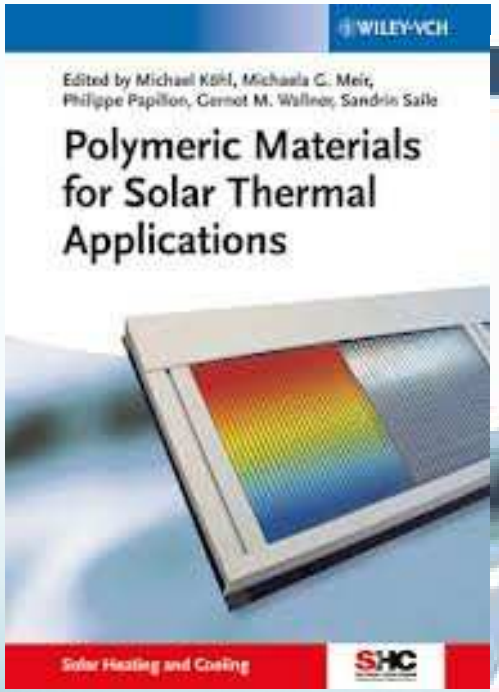
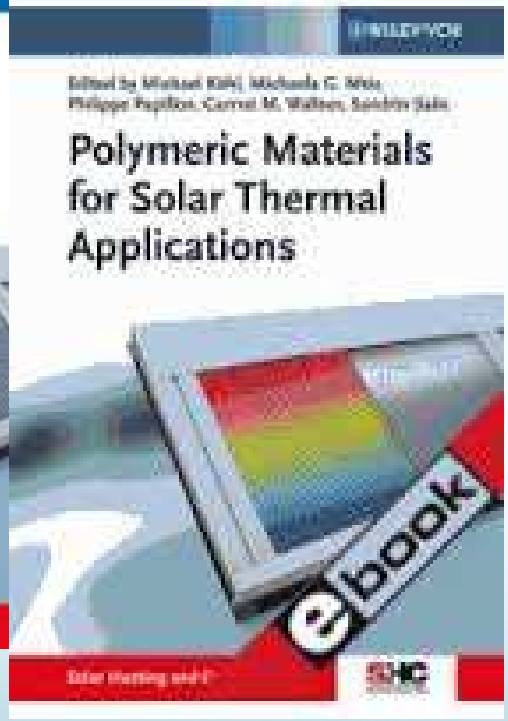
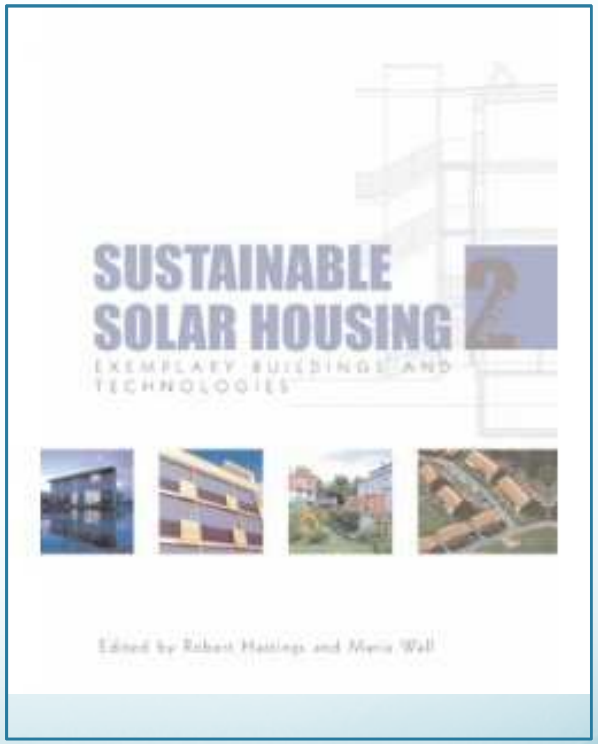
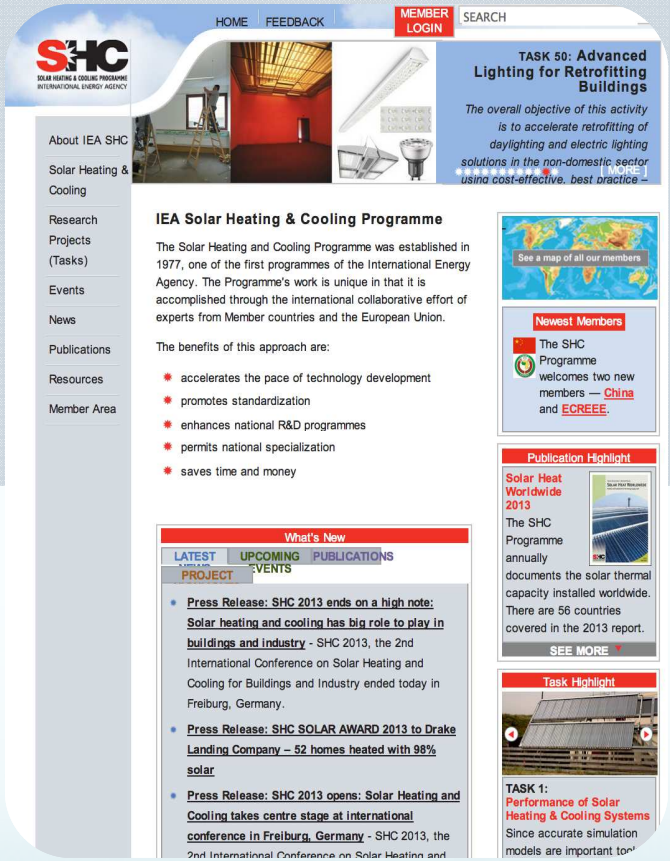






www.iea-shc.org

Website



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