Contribution of Solar Heating and Cooling to a 100% Renewable Energy System

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IEA Solar Heating and Cooling Programme
Director, AEE INTEC, Austria

Contents

IEA SHC - Member Countries

SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY


Australia


Austria


Belgium

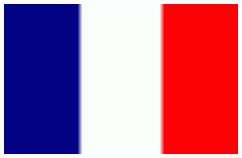

Canada


China


Denmark


EC


Finland


France


Germany


Italy


Mexico


Netherlands


Norway


Portugal


Singapore


South Africa


Spain


Sweden


Switzerland


United States

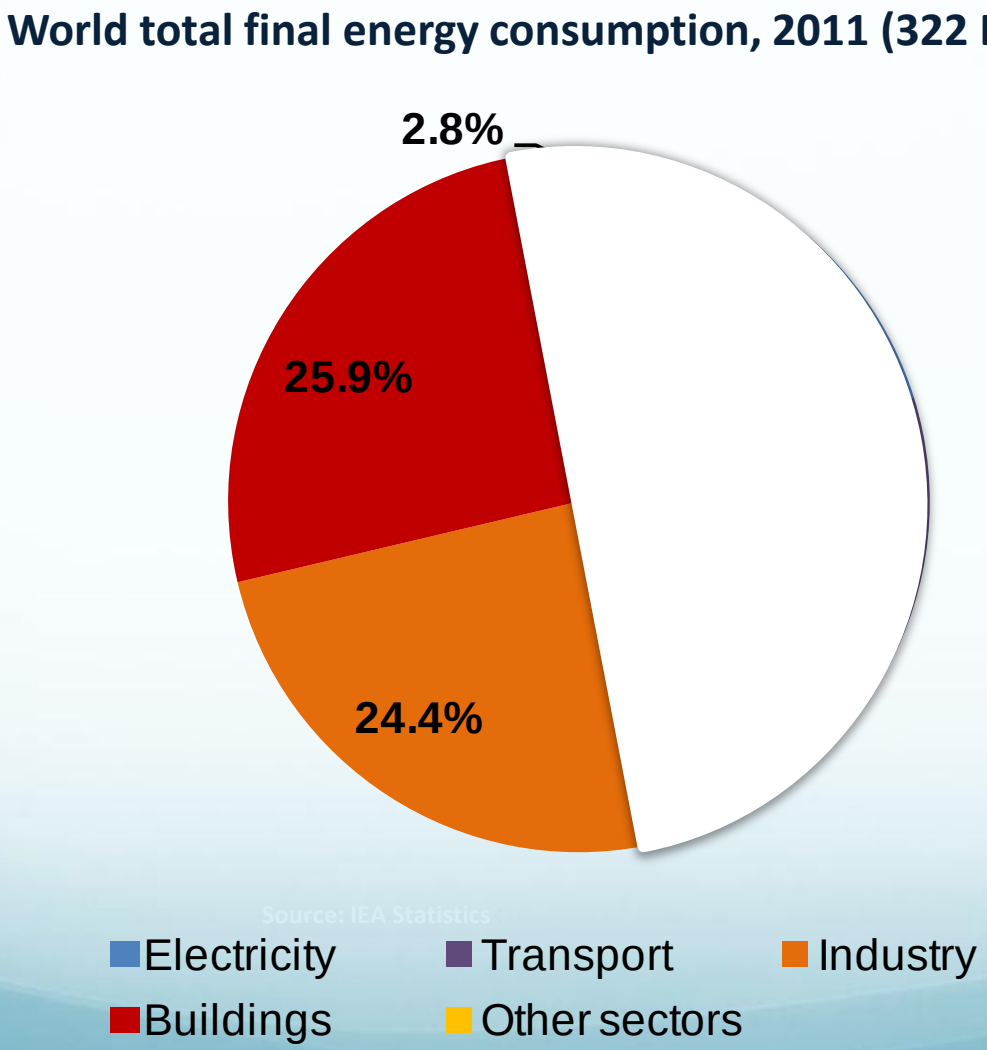
IEA SHC – Current Tasks

13 Tasks (research projects)
550 researchers and experts

2 Tasks on solar thermal components
5 Tasks on solar thermal systems
3 solar building related Tasks
1 Task each on:

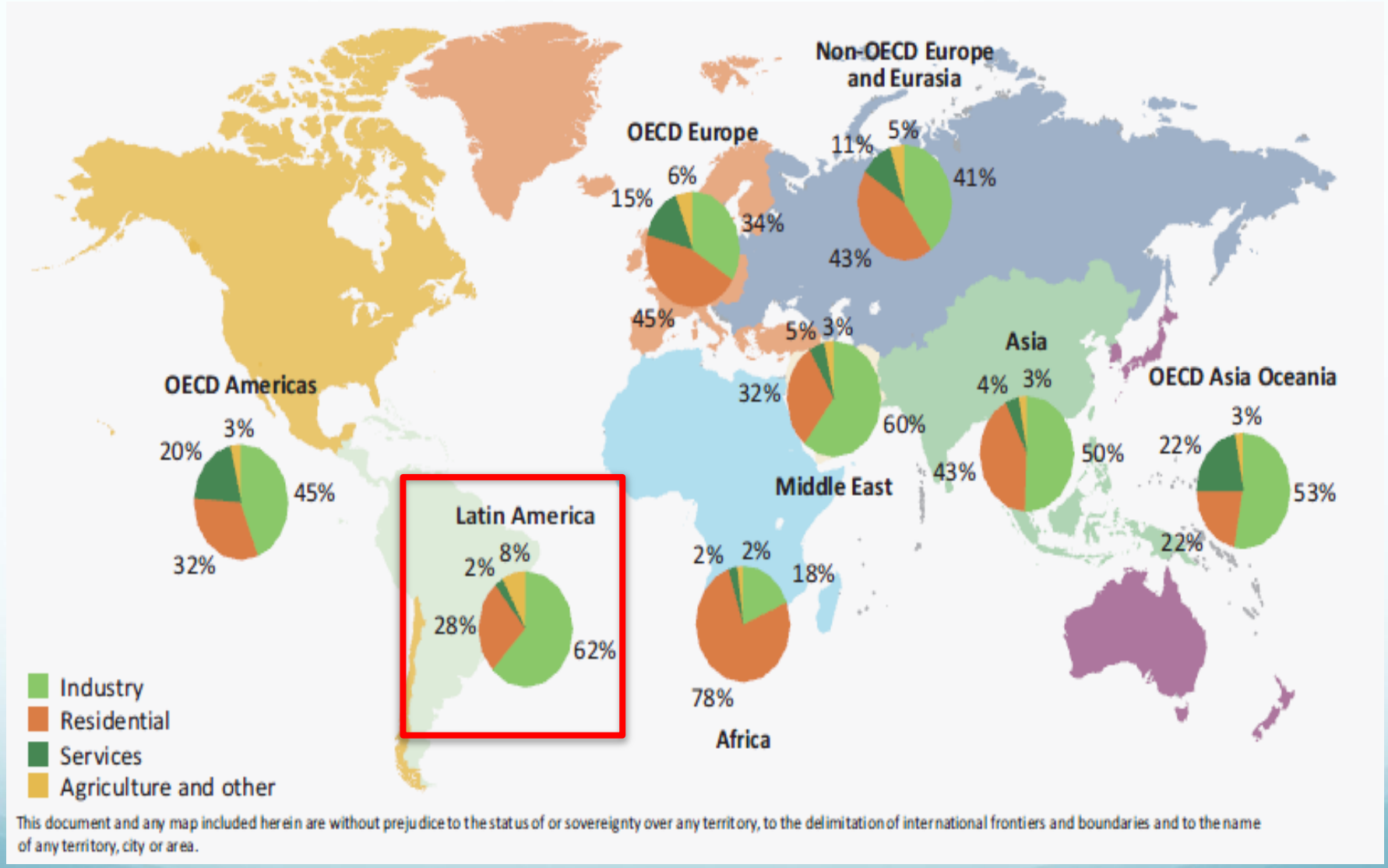
- Solar Resource Assessment and Forecasting
- Rating and Certification Procedures
- Advanced Lighting Solutions for Retrofitting Buildings

Heat accounts for more than half of world's total final energy consumption today



Source: Paolo Frankl, IEA, Paris

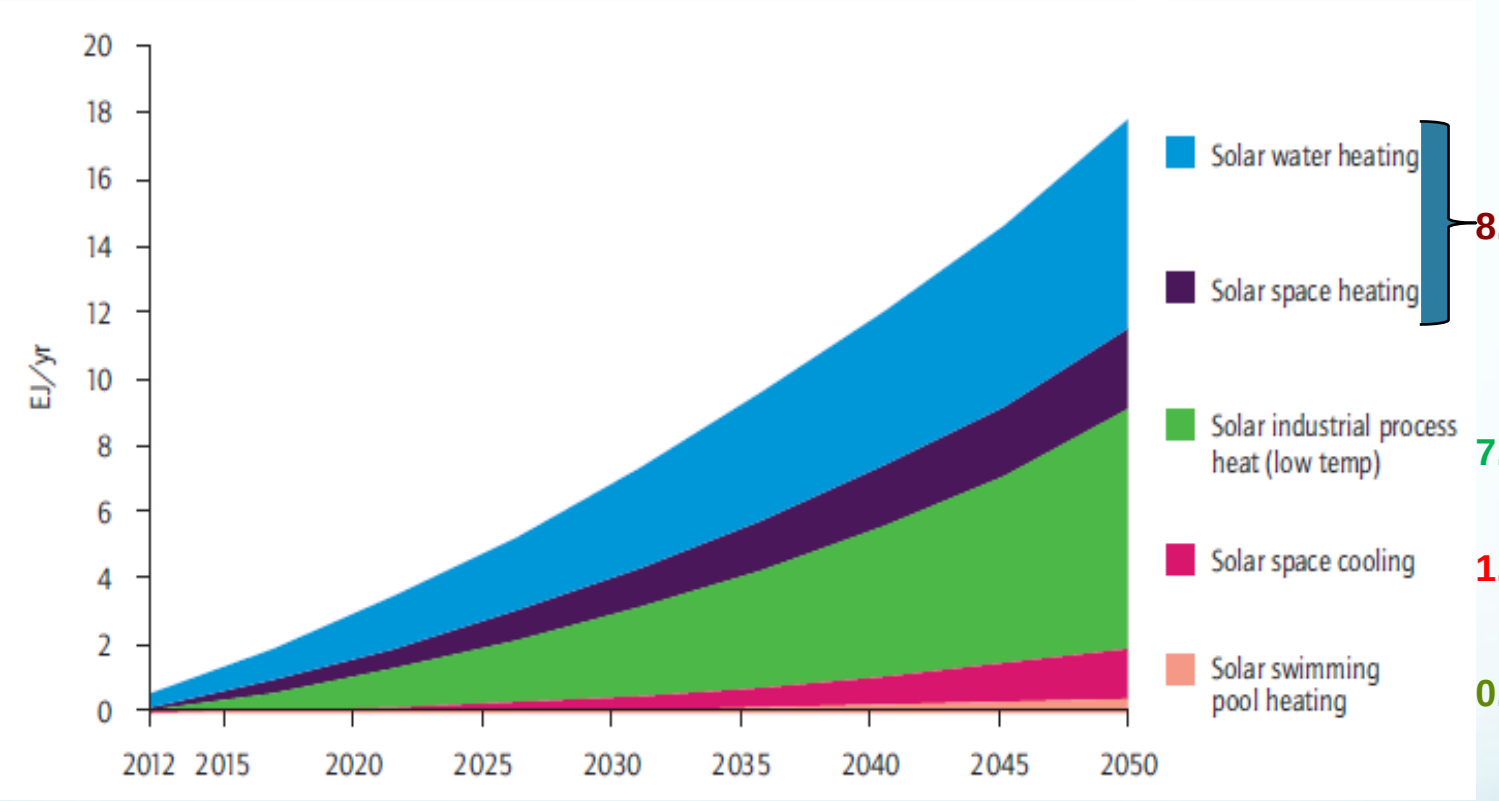
Heat plays important role worldwide



Note: Figure based on 2009 data

Source: Energy Technology **Perspectives** 2012

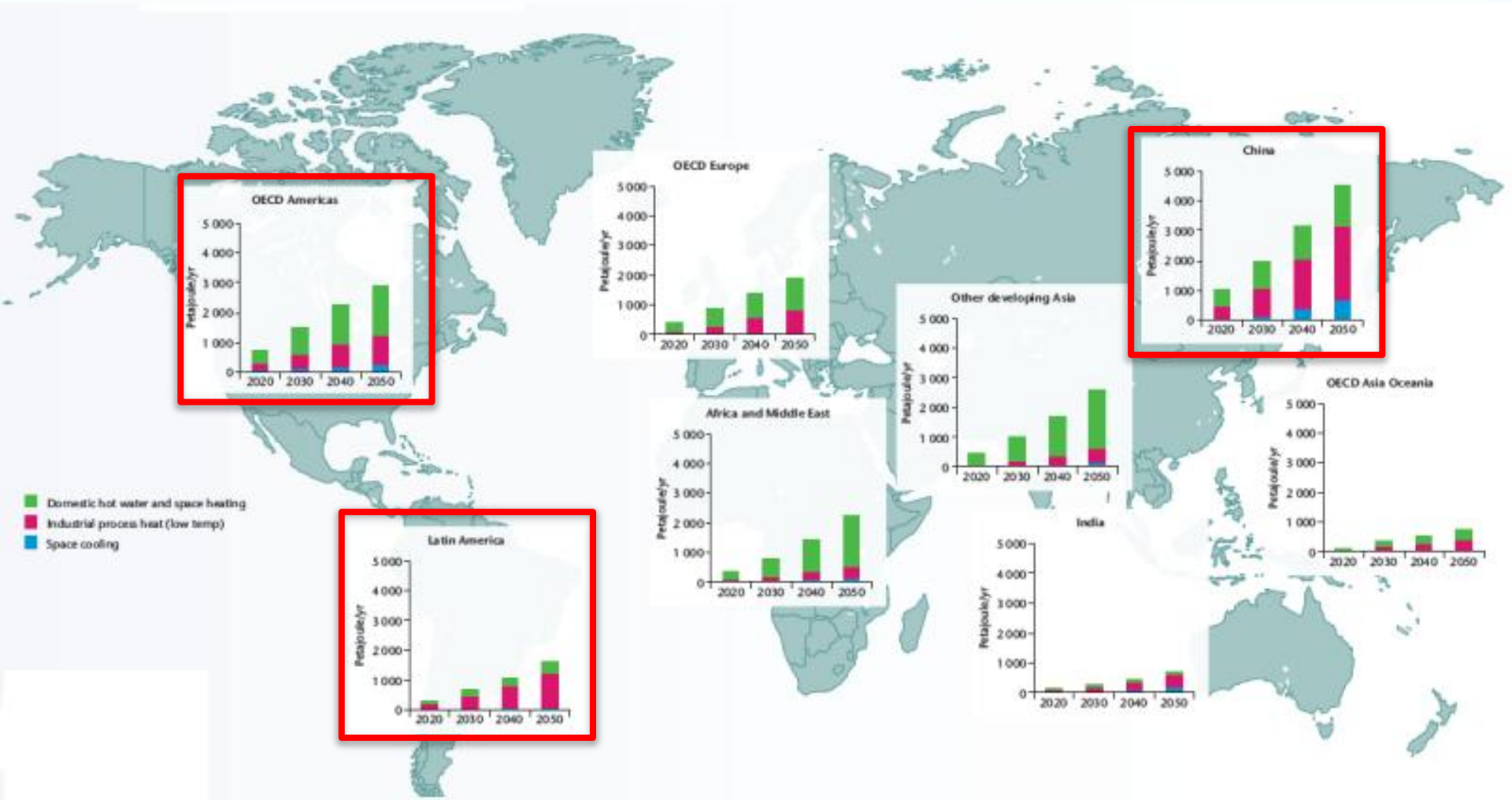
IEA Roadmap vision of solar heating and cooling by sector (EJ/yr)



Solar heating and cooling capacity could produce annually by 2050:
- 16.5 EJ solar heat (16% of TFE low temp. heat)
- 1.5 EJ solar cooling (17% of TFE cooling)

Source: IEA Technology Roadmap – Solar Heating & Cooling

Regional solar heating and cooling generation in buildings and industry



Source: IEA Technology Roadmap – Solar Heating & Cooling

Global Solar Heating and Cooling Markets

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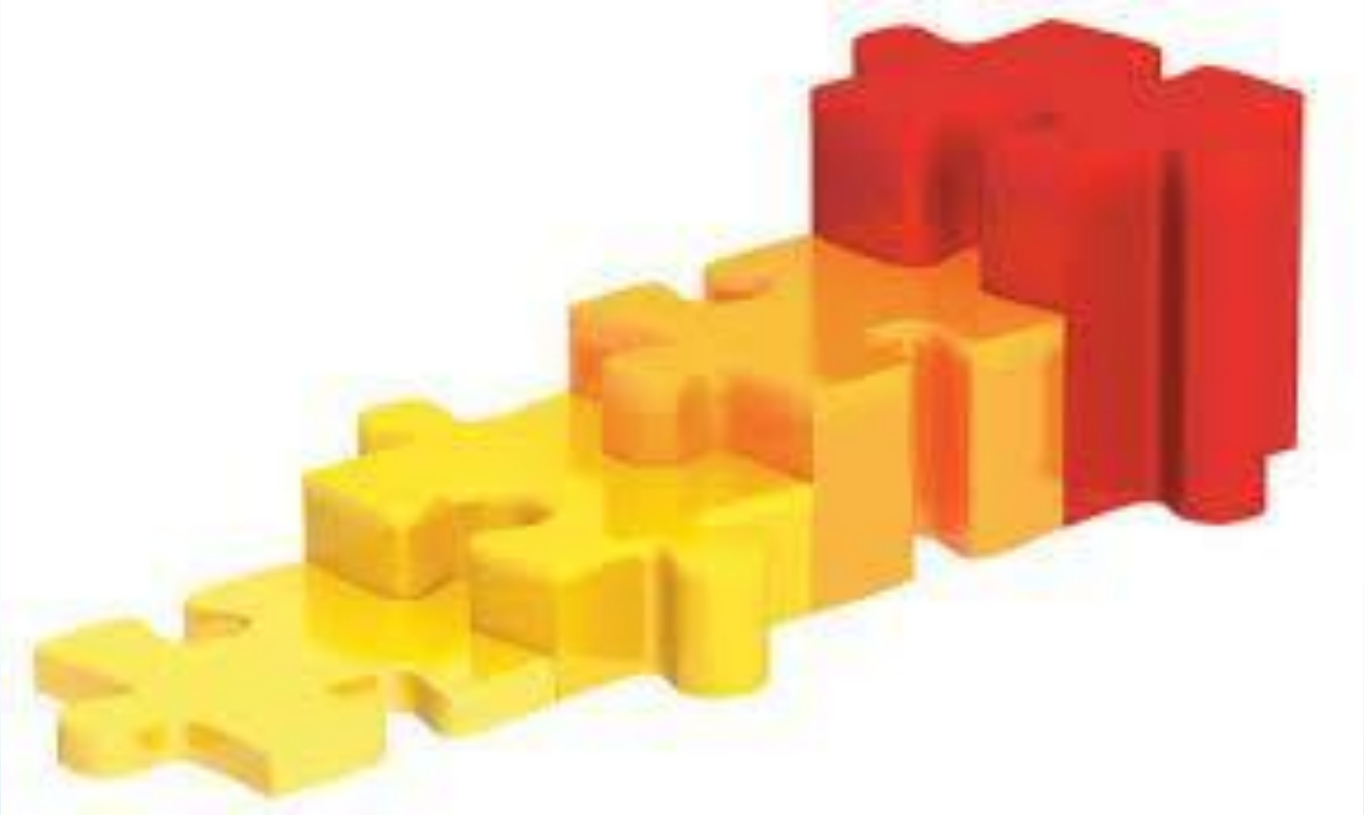
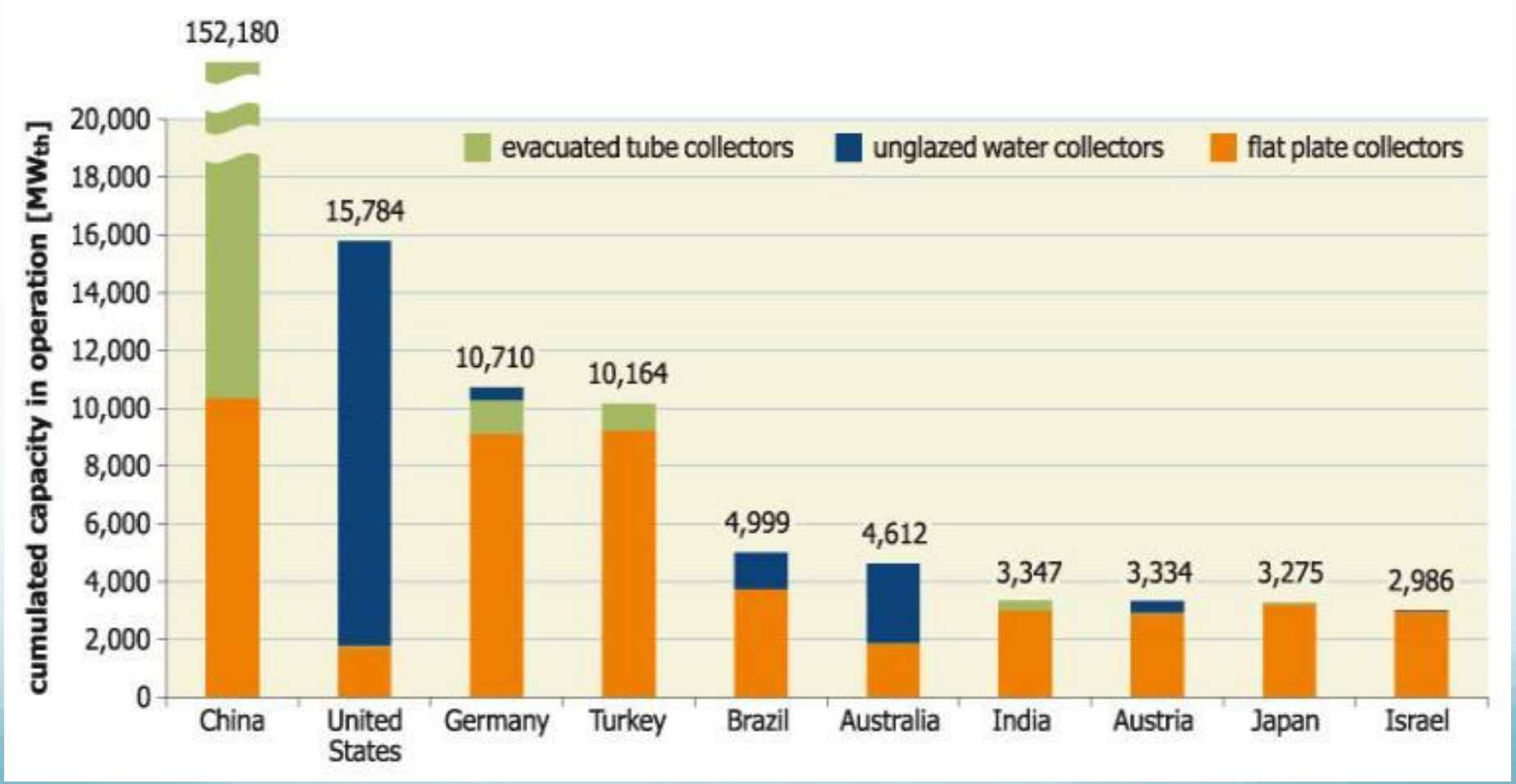
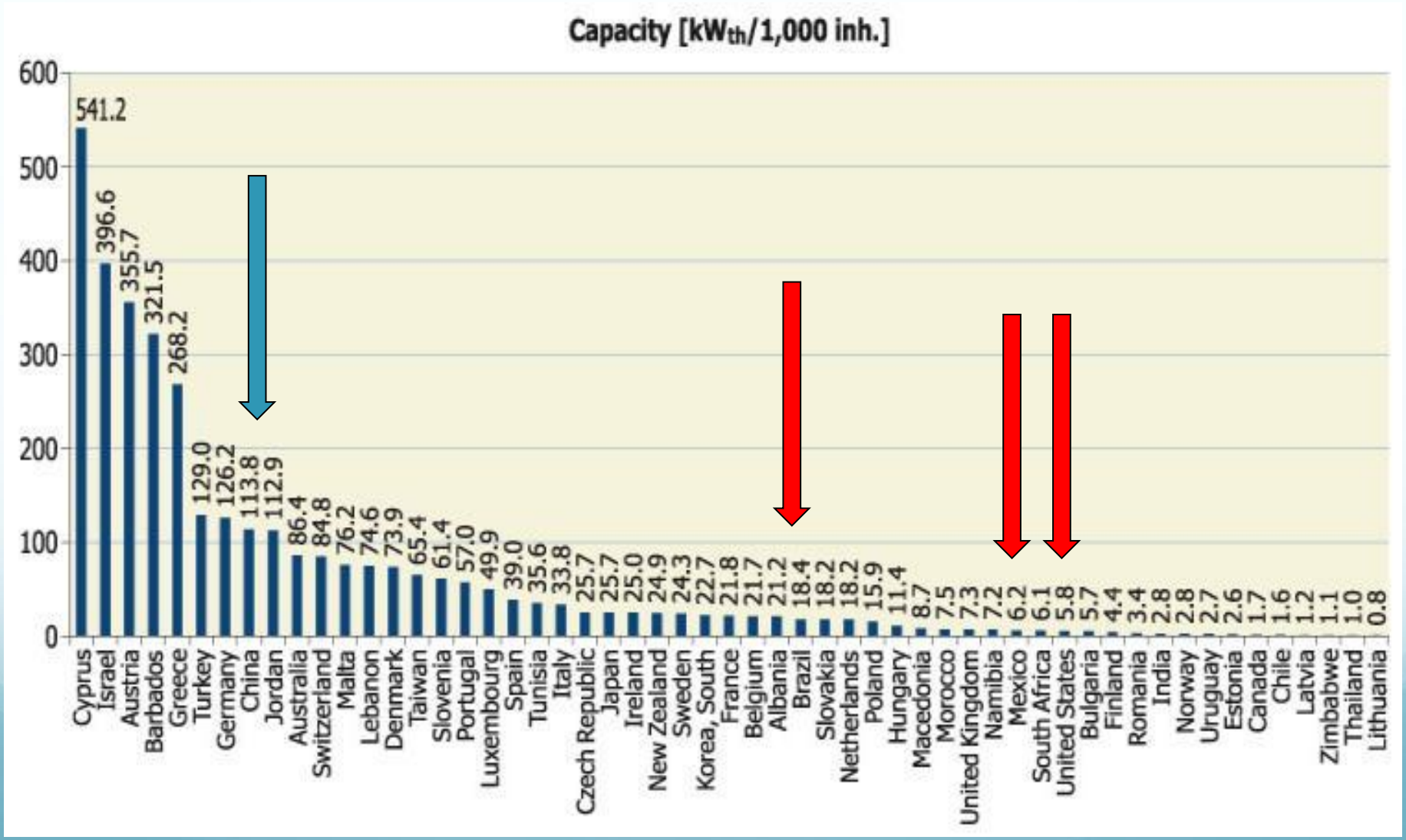


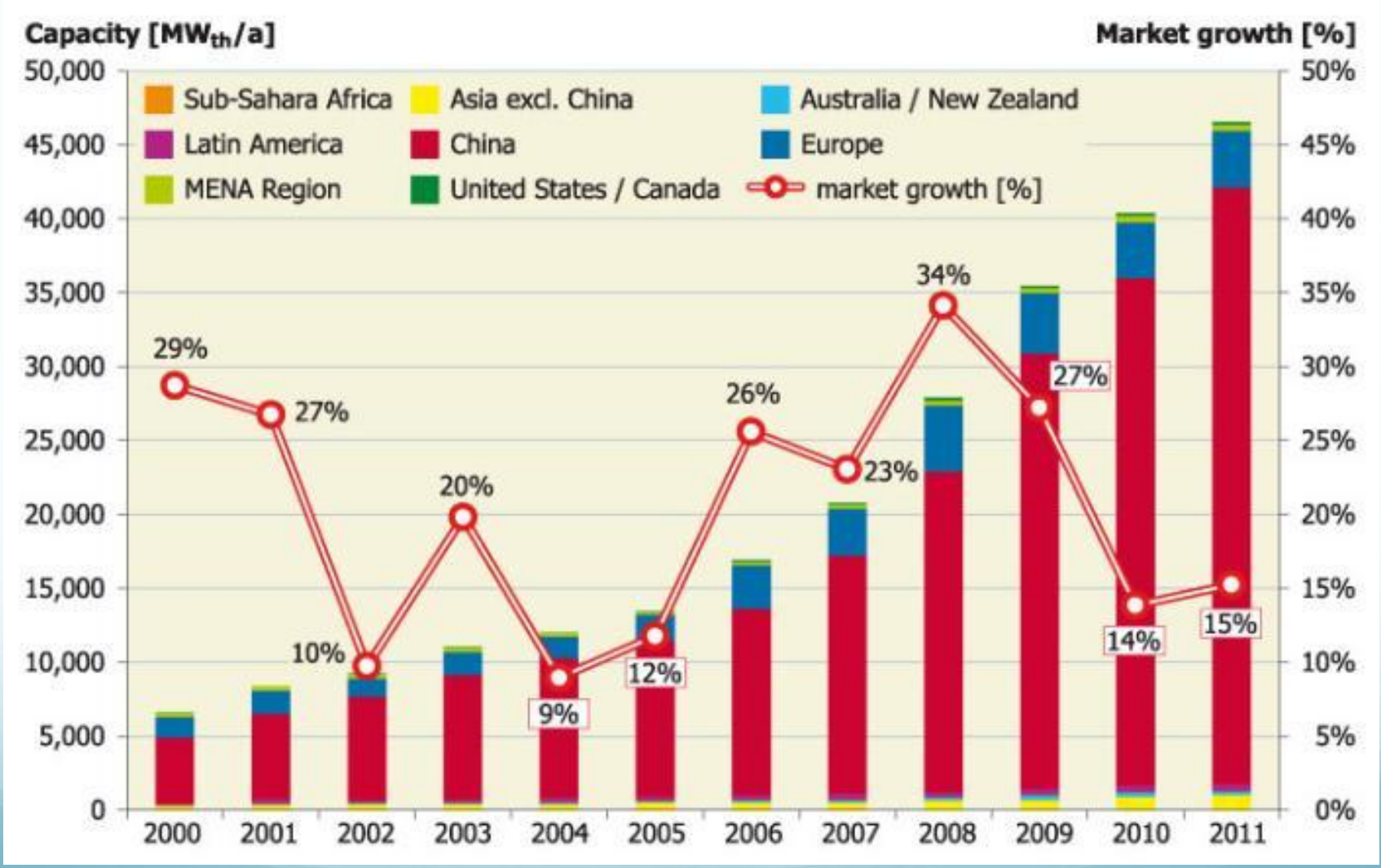
Total installed capacity of unglazed and glazed water collectors in operation in the 10 leading countries by the end of 2011



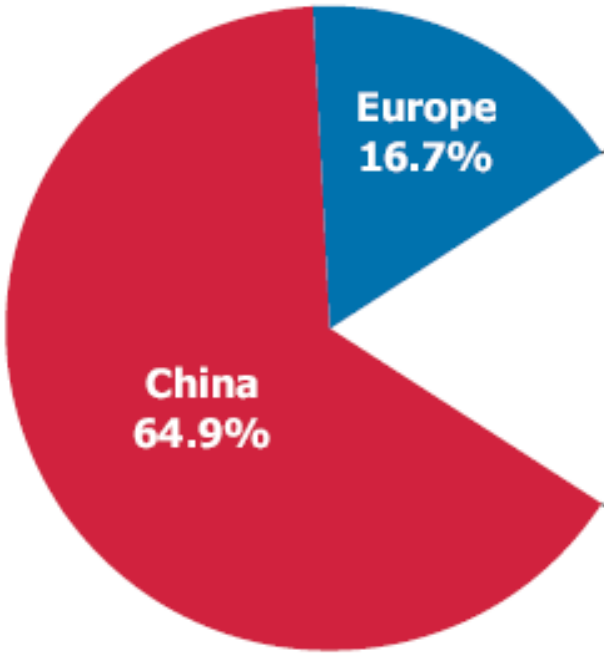
Total capacity of glazed flat plate and evacuated tube collectors in operation in kW$_{th}$ per 1,000 inhabitants by the end of 2011



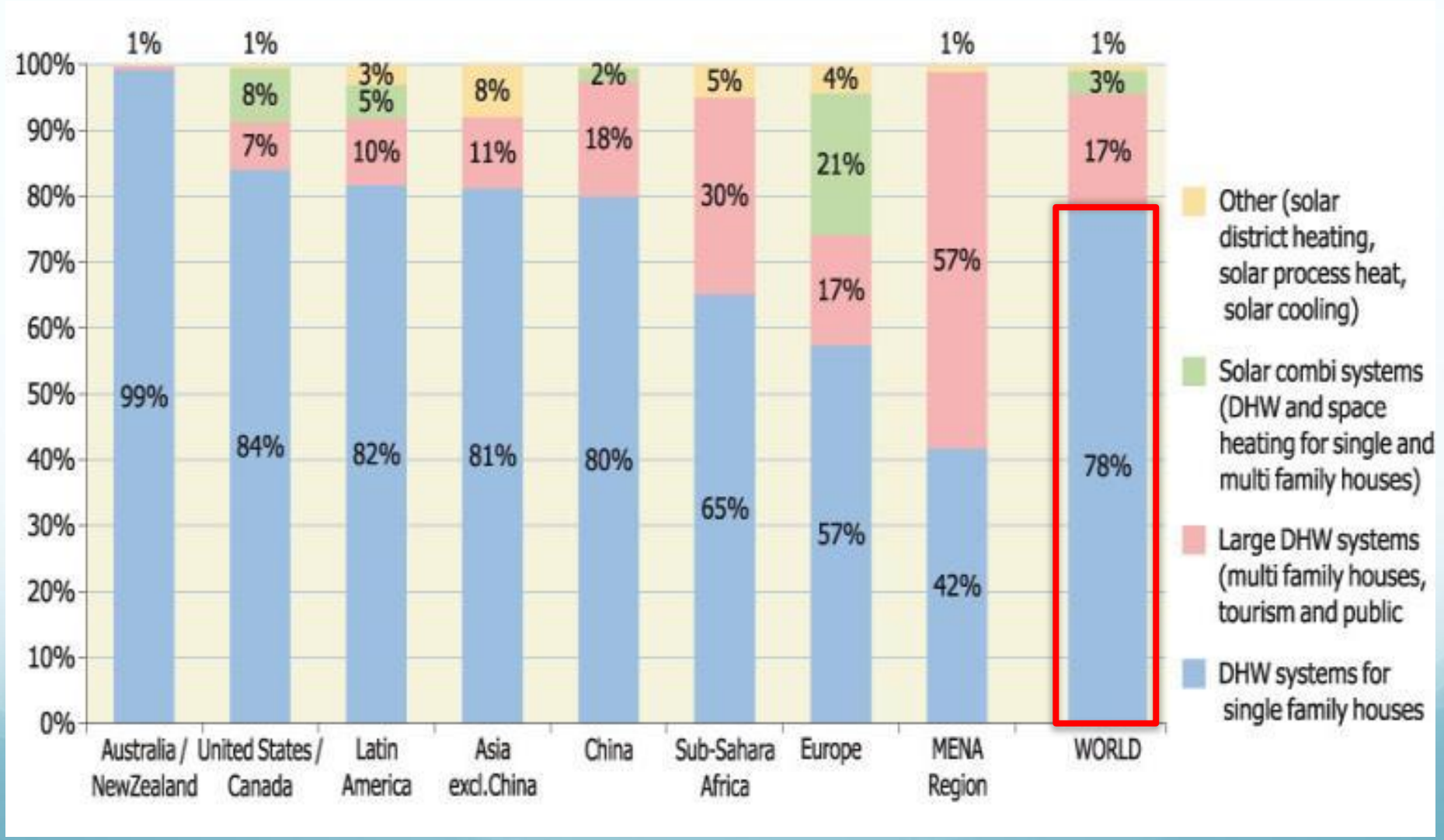
Annual installed capacity of flat plate and evacuated tube collectors from 2000 to 2011



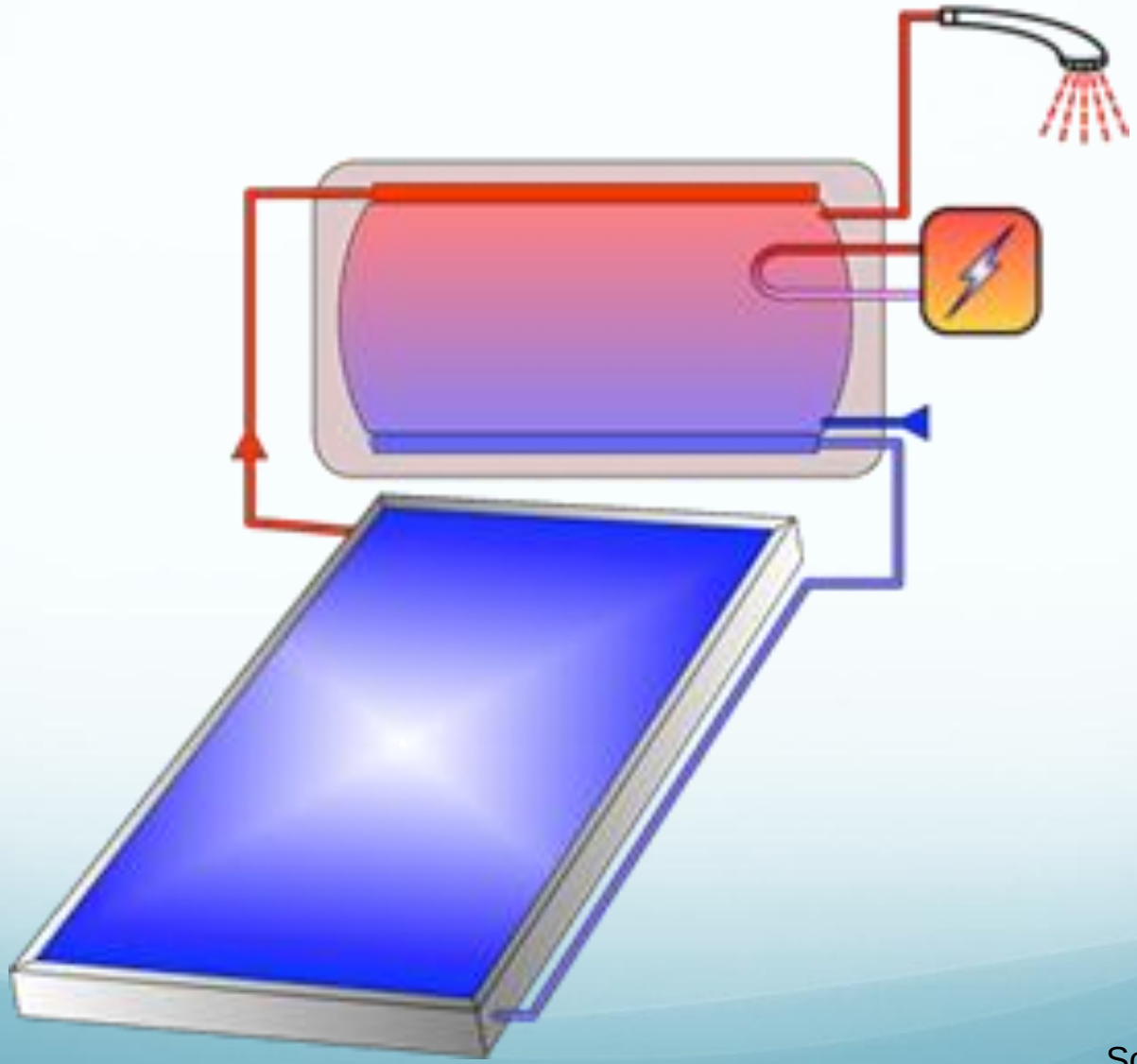
Total installed capacity in operation by economic regions at the end of 2011



Distribution of solar thermal systems by application for the newly installed glazed water collector capacity of by economic region in 2011

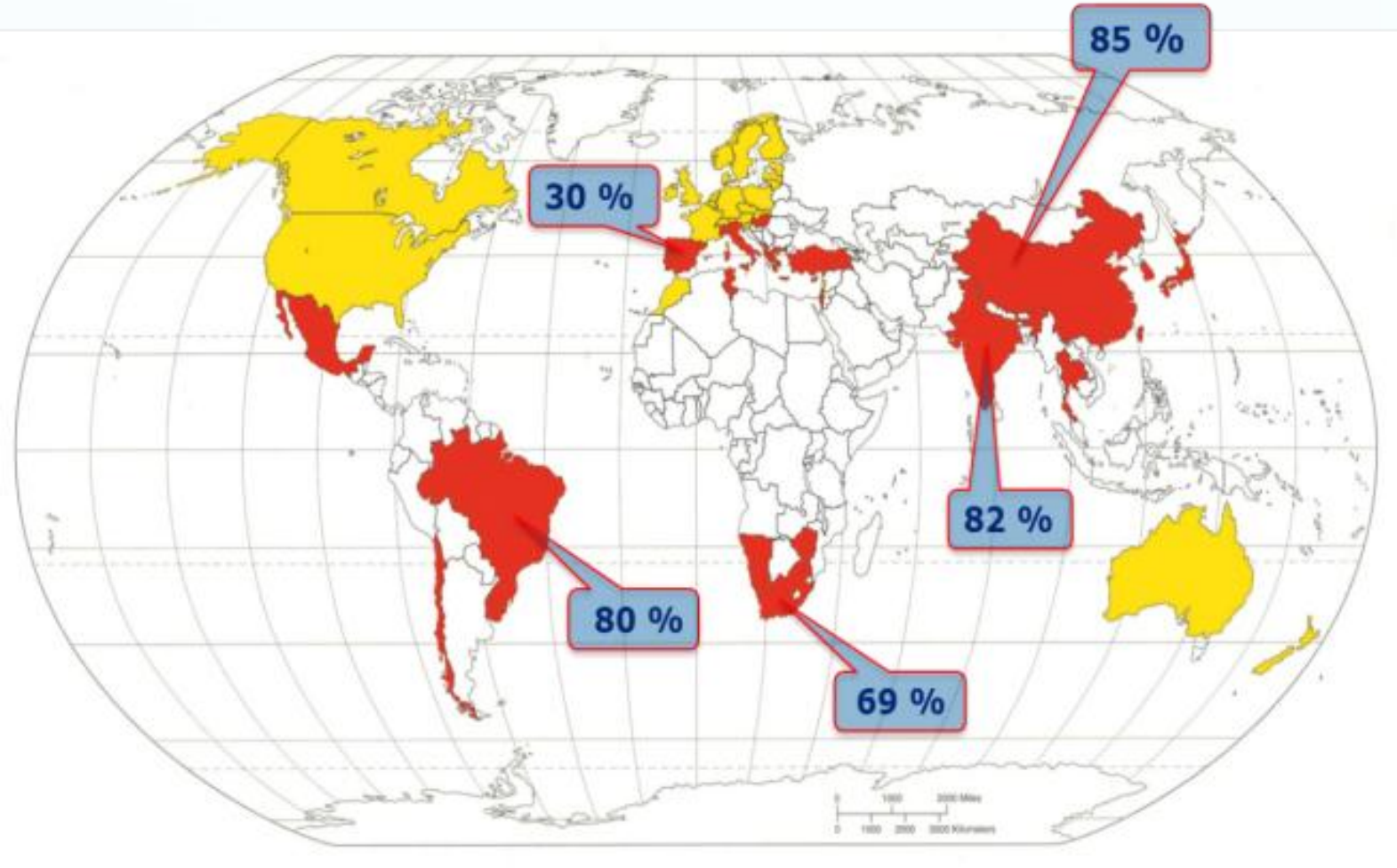


Thermosiphon systems for domestic hot water preparation



Source: ESTTP - SRP

Fraction of thermosyphon systems in the most important solar thermal markets



South African
1 Million Solar Water Heater Program

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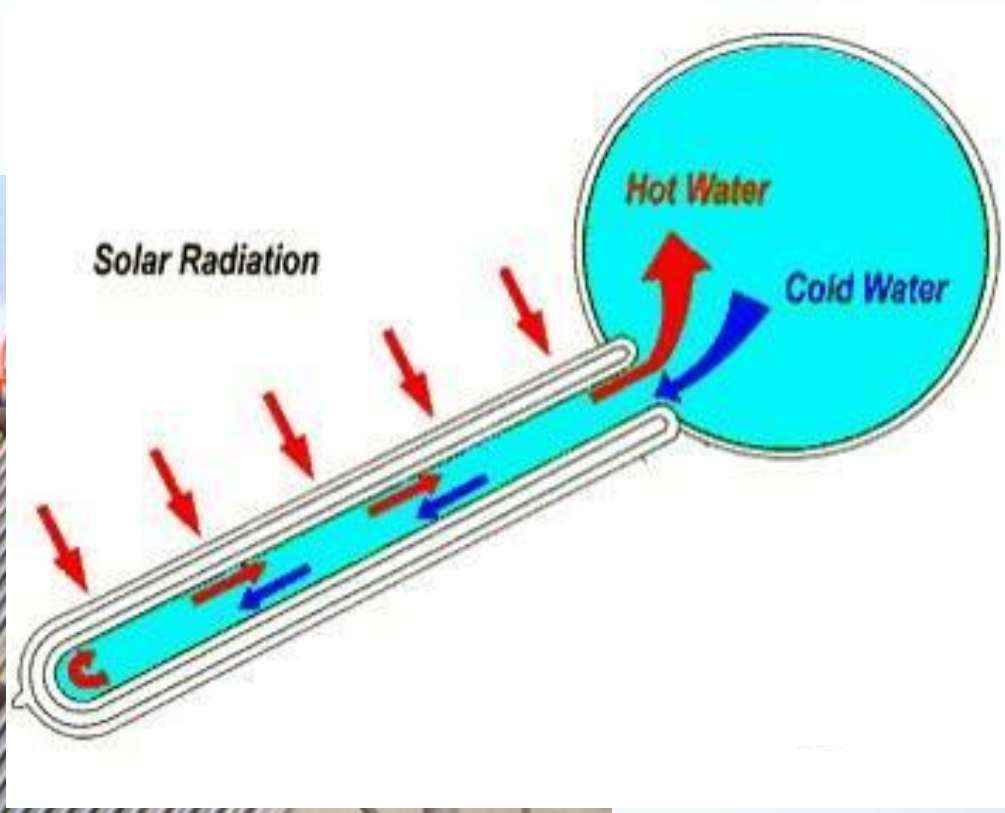
Turkey – Collective System - MFH

China – world leader in thermosyphon

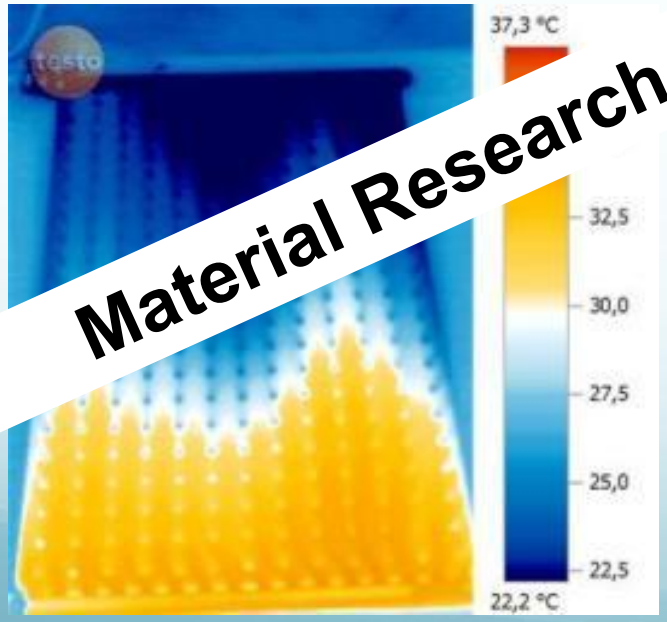
Thermosyphon systems - China

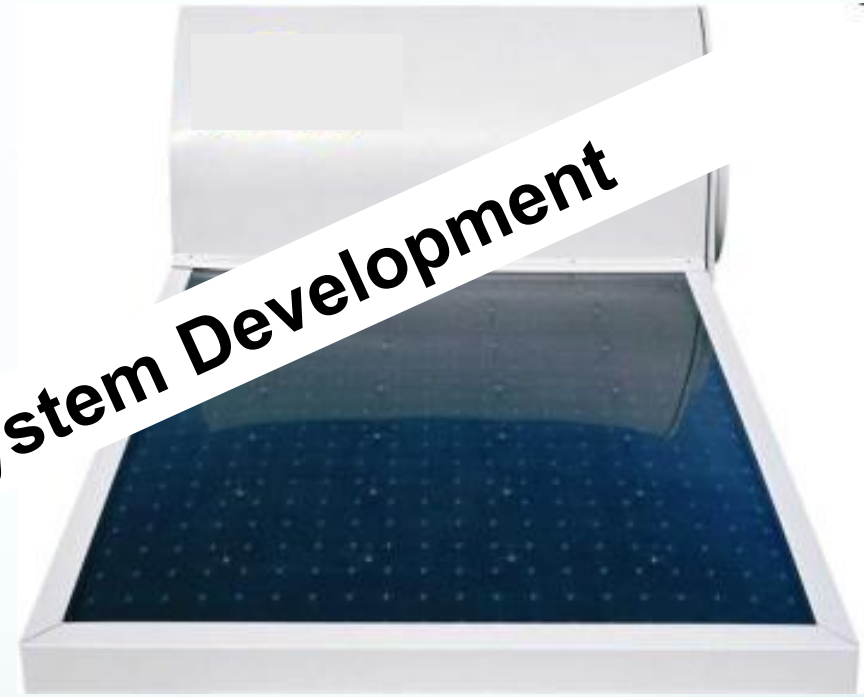


Challenges and Opportunities

Increase the quality and reliability
New materials
Building integration

Polymeric Materials

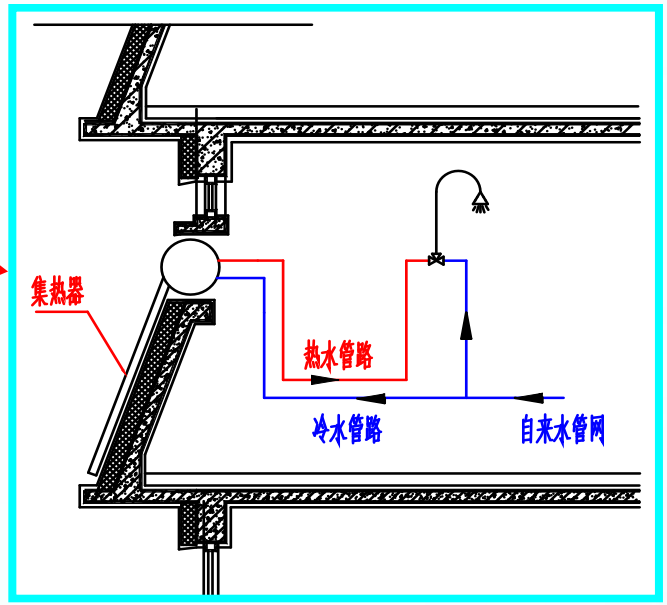


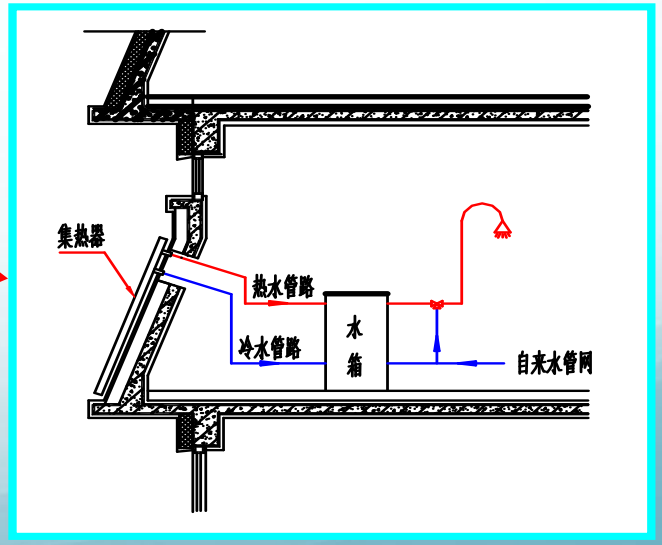


Material Research & System Development

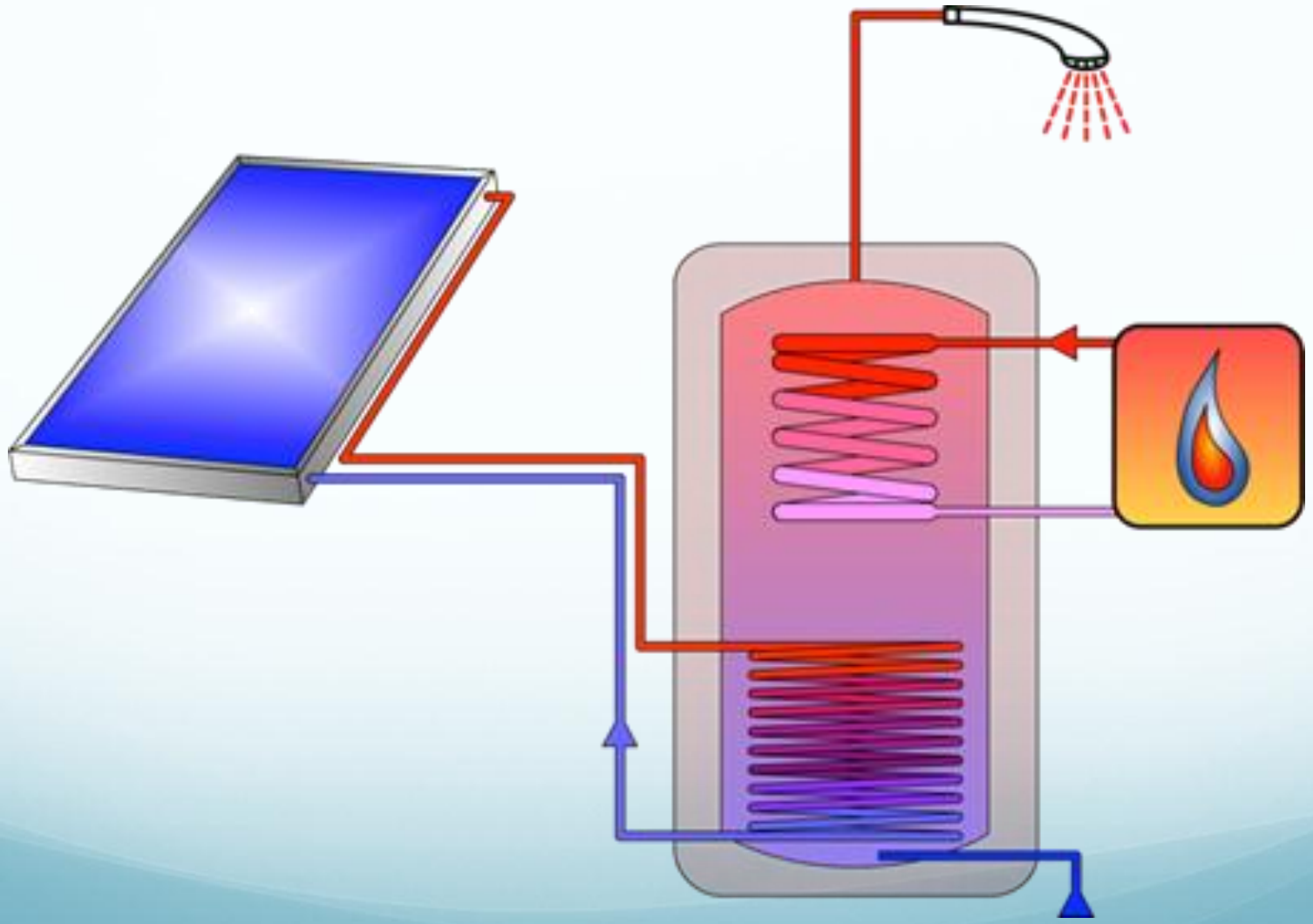
Thermosyphon Systems - façade integrated

Thermosyphon Systems - façade integrated





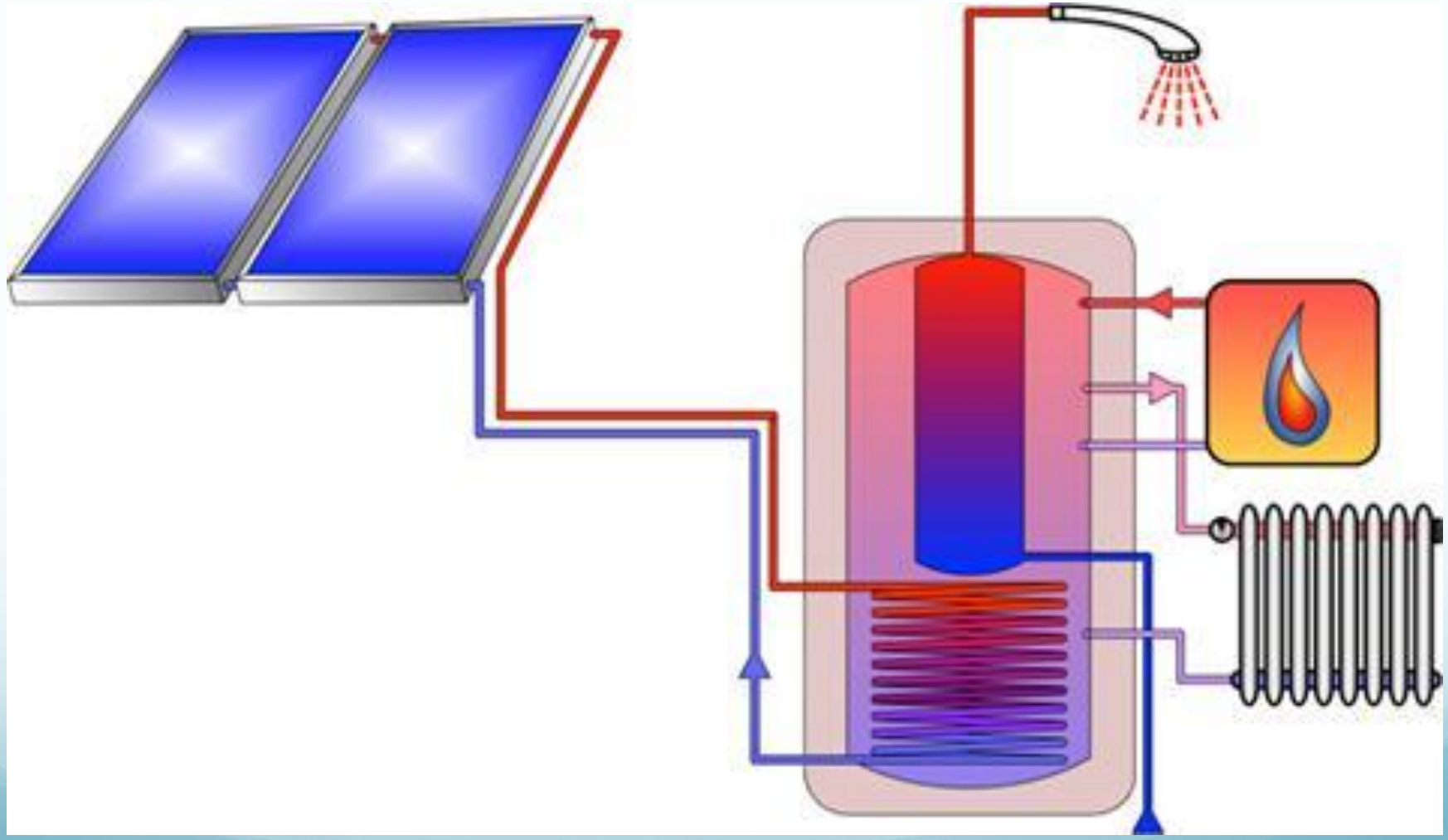
Forced circulated system for domestic hot water preparation



Source: ESTTP - SRP

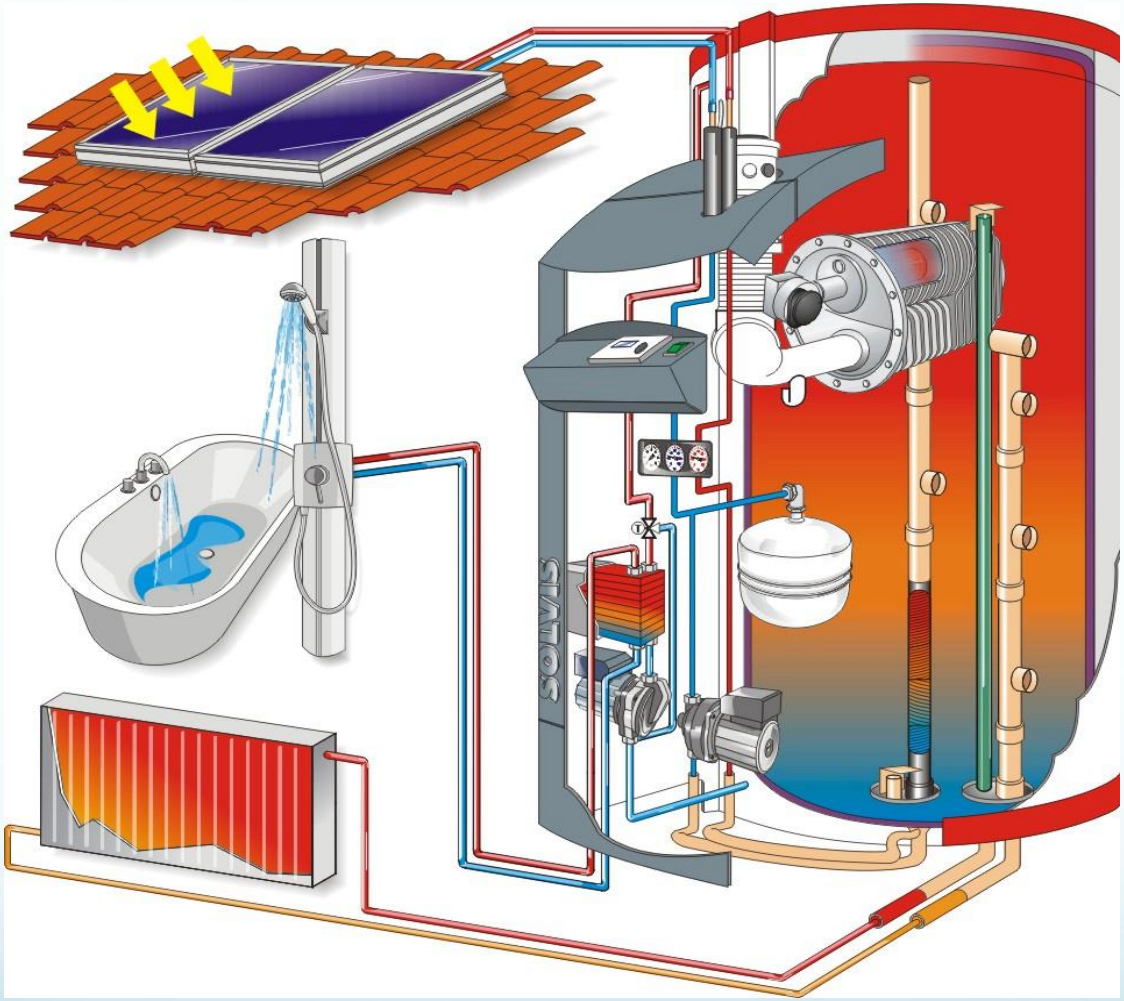
Forced circulated system for domestic hot water preparation

Solar thermal combi-system for domestic hot water preparation and space heating



Source: ESTTP - SRP

Advanced Solar Combi System



Source: Solvis

Solar Combi Systems for SFH

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100% Solar Heated Houses

Multi family house Switzerland

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Source: Jenni, CH

Integrated facade systems

Prefabricated facade systems

Multi family houses

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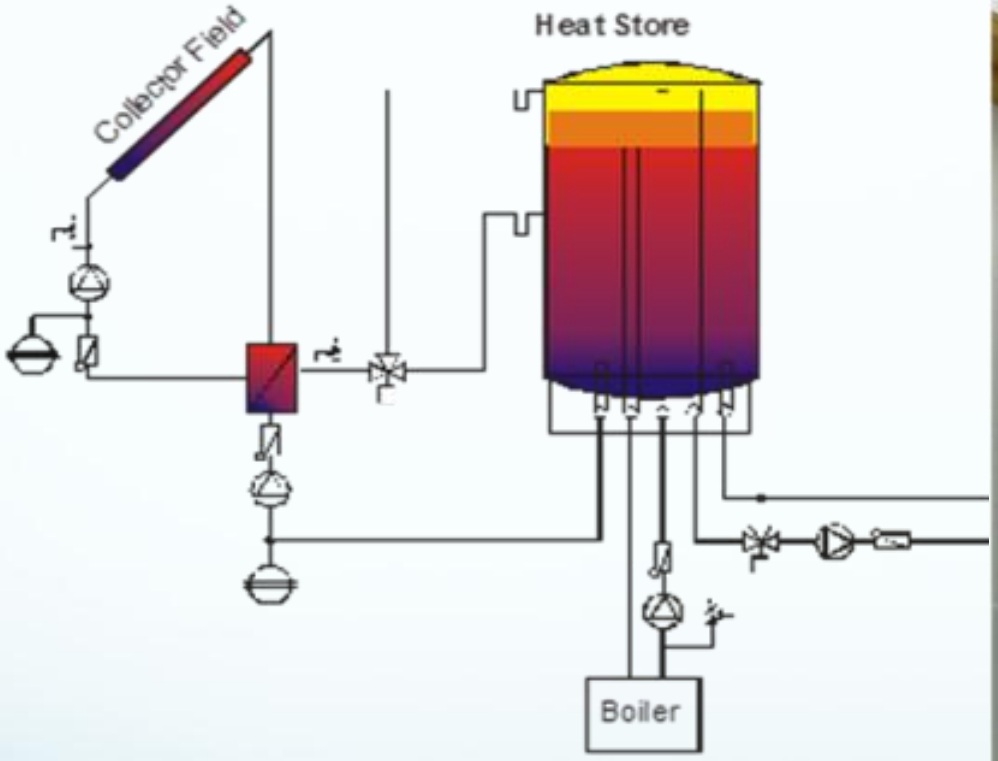
Two pipe hydraulic concept for multi family houses



Source: AEE INTEC

Solar thermal systems for Hotels

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Challenges and Opportunities

Active Solar Houses

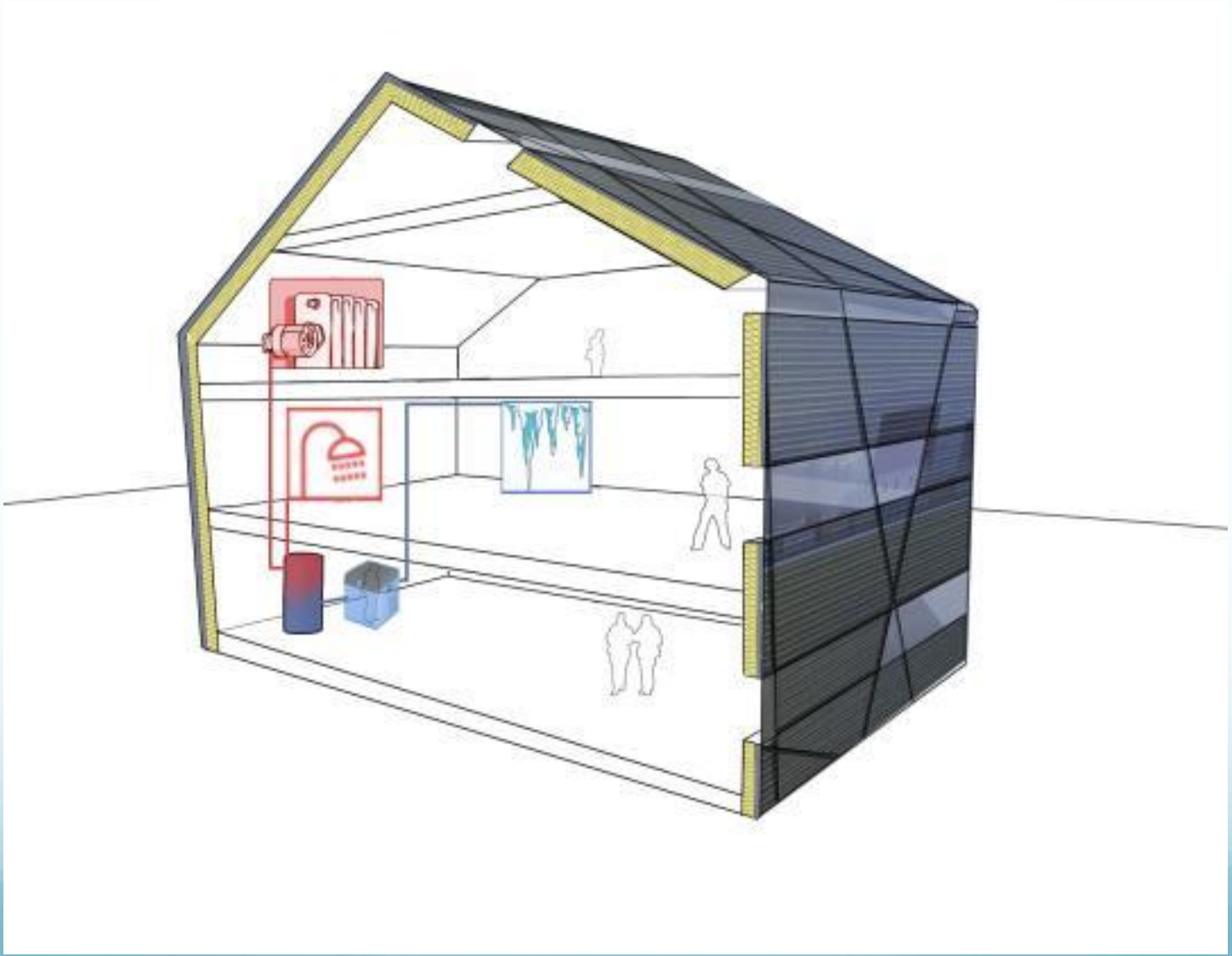
Simple frost and stagnation protection

Building integration

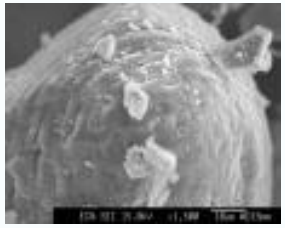
High solar fractions

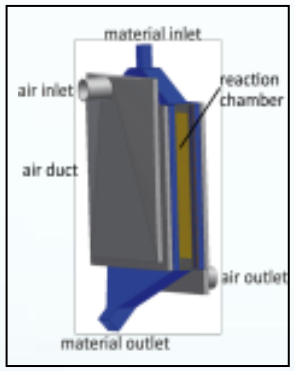
Compact thermal energy storage

ENERGY STORAGE – THE KEY ISSUE
Task 42/24



Current fields of Development





Materials

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

Components

- heat exchangers
- mass transport
- sensoring, control

Systems

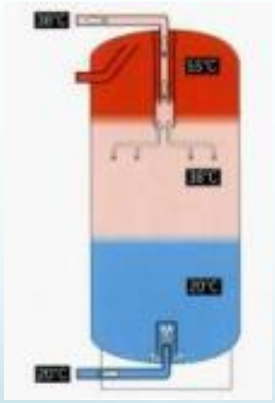
- Integration
- control

Source: IEA SHC Task 42

Development Stages of TES Technologies

Water (sensible)

Market mature



Source: IEA SHC Task 42

Sorption Storage – AEE INTEC

Source: AEE INTEC

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Development of small capacity thermally driven chillers - IEA SHC Task 38

Main achievements:

- Development of small capacity thermally driven chillers (<35 kW_{cold})
- Optimization of the heat rejection subsystem

Sortech AG

EAW

Pink GmbH

Solar Air Conditioning and Refrigeration

IEA SHC Task 38 / Task 48

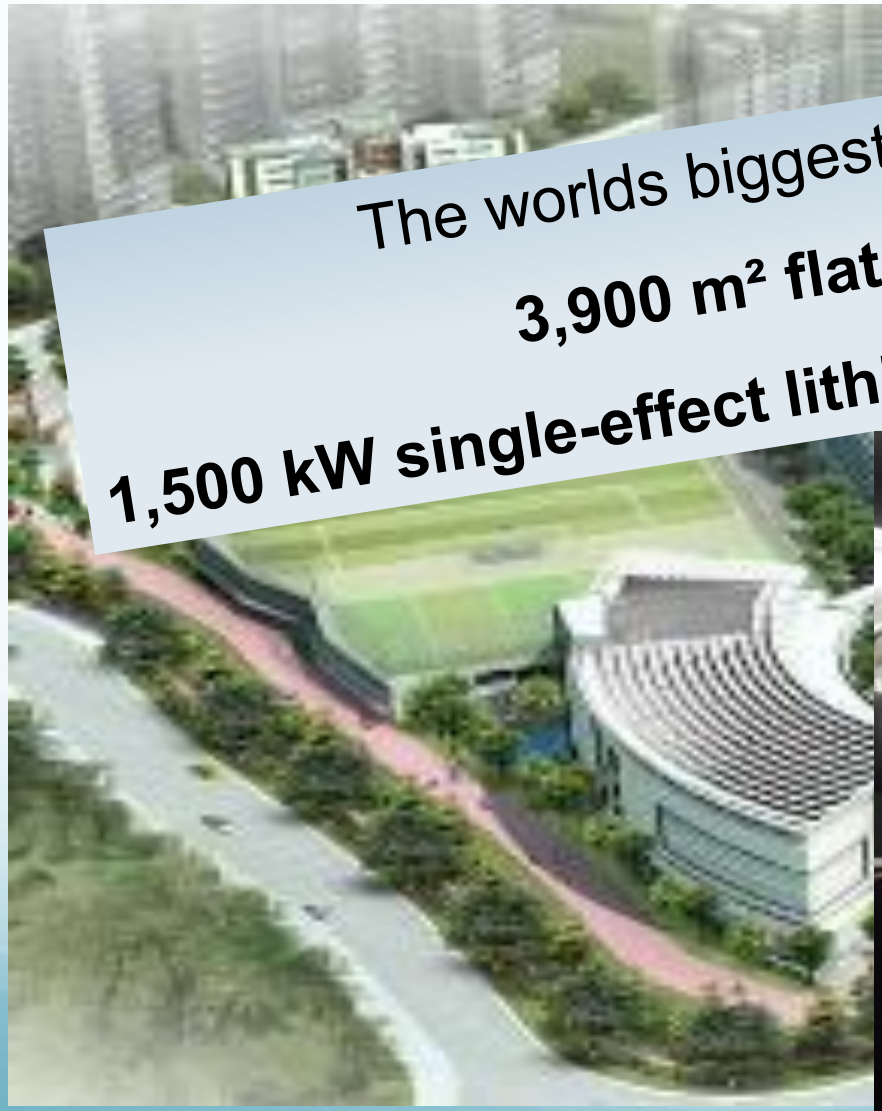
The United World Colleges, Singapore

IEA SHC Task 38 / Task 48

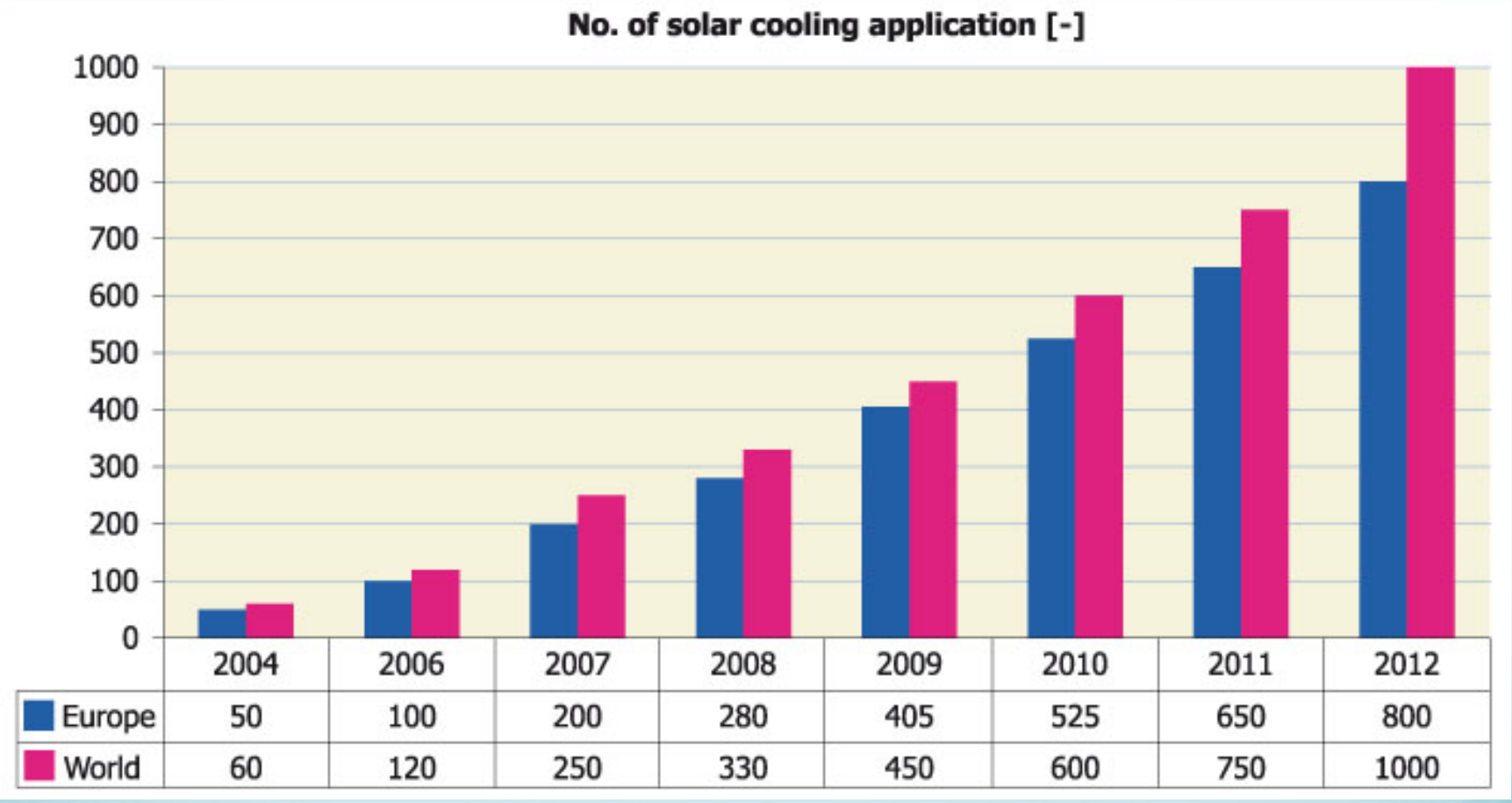
The worlds biggest solar cooling system

3,900 m² flat plate collectors

1,500 kW single-effect lithium bromide absorption chiller



Solar Cooling Systems in Operation



	2004	2006	2007	2008	2009	2010	2011	2012
Europe	50	100	200	280	405	525	650	800
World	60	120	250	330	450	600	750	1000

Sources: Solem Consulting / Green Chiller

Challenges and Opportunities

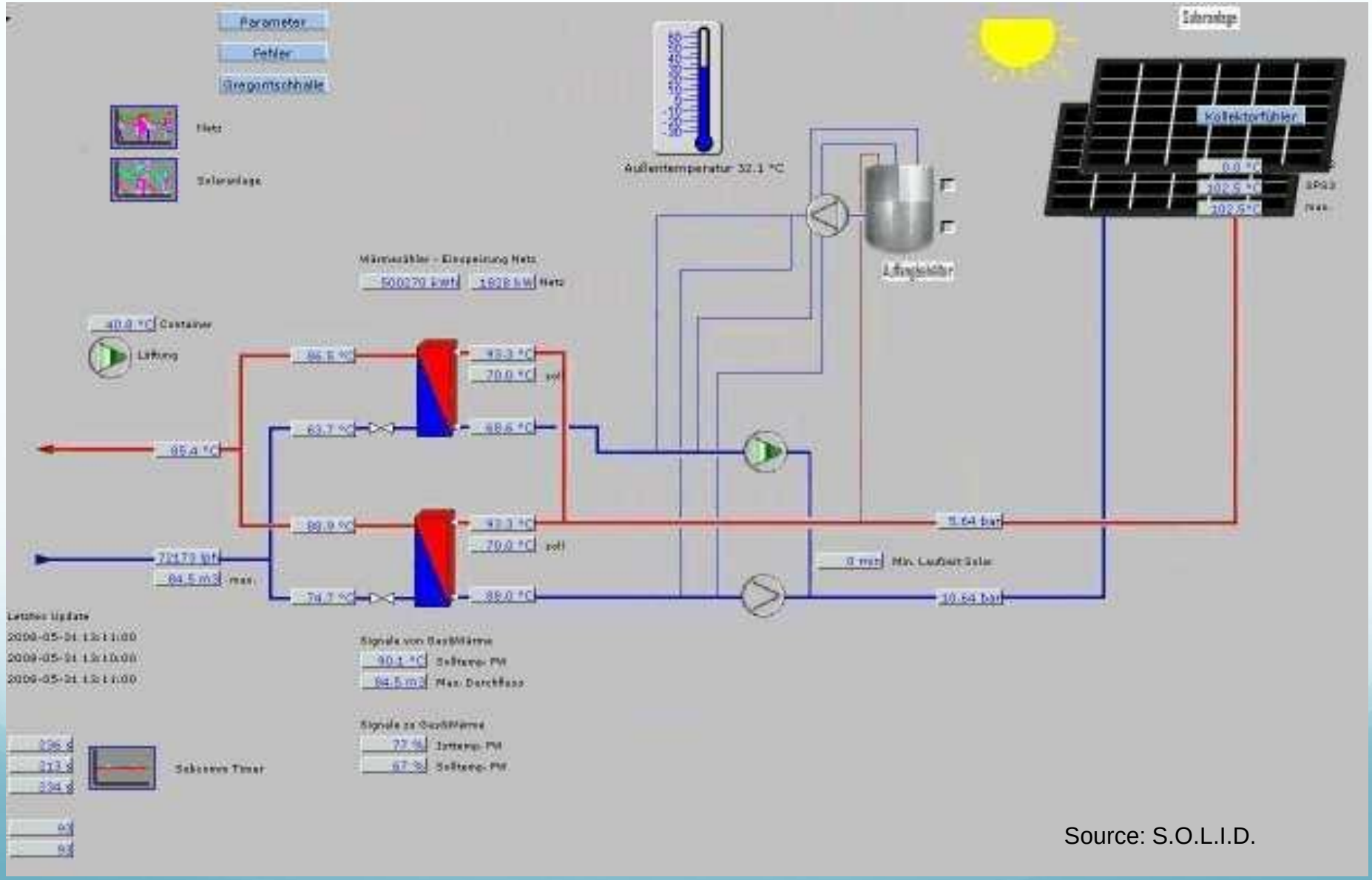
Small systems: Competition with PV and HP
Big systems for offices and hotel sector


Solar assisted
District Heating

District Heating – 3,5 MW_{th}, Graz, Austria

IEA SHC Task 45

Simple system concept for urban district heating



Source: S.O.L.I.D.

Biggest District Heating System Worldwide
Saudi Arabia, 36.000 m² / 25 MW_{th}

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Biggest District Heating System Worldwide
Saudi Arabia, 36.000 m² / 25 MW_{th}

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Pipes and Heat Exchangers

Solar Space Heating with High Solar Fraction

Drake Landing Solar Community, Canada

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Drake Landing Solar Community
IEA SHC Task 45

Location: Okotoks, Alberta, Canada

Number of homes: 52

Collector area: 2,293 m² (1.6 MWth)

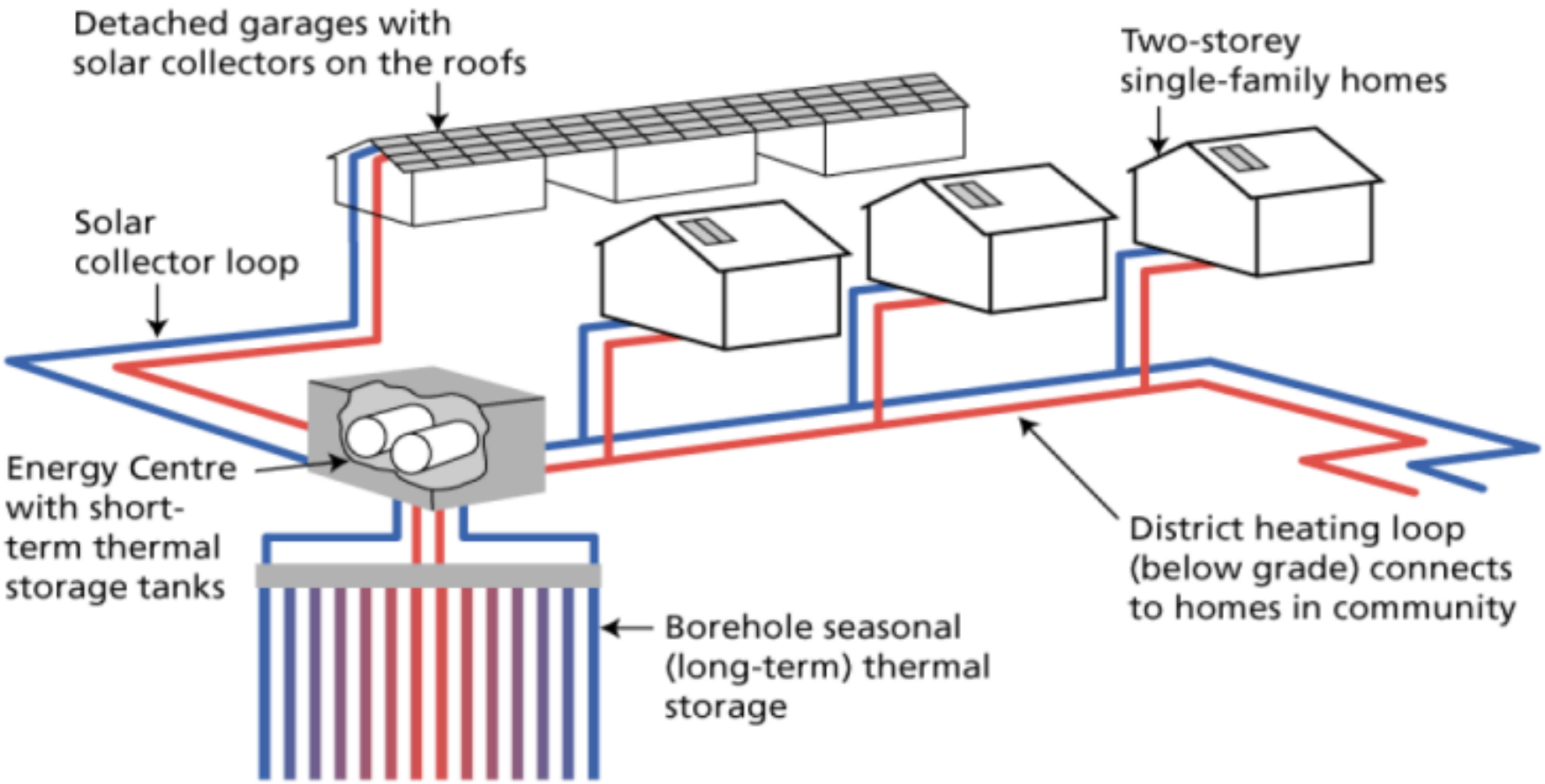
Addition independent solar domestic hot water systems for each home

Short-term storage tank: 2 x 120 m³ steel tanks

Borehole thermal energy storage: 34,000 m³ earth, 144 boreholes

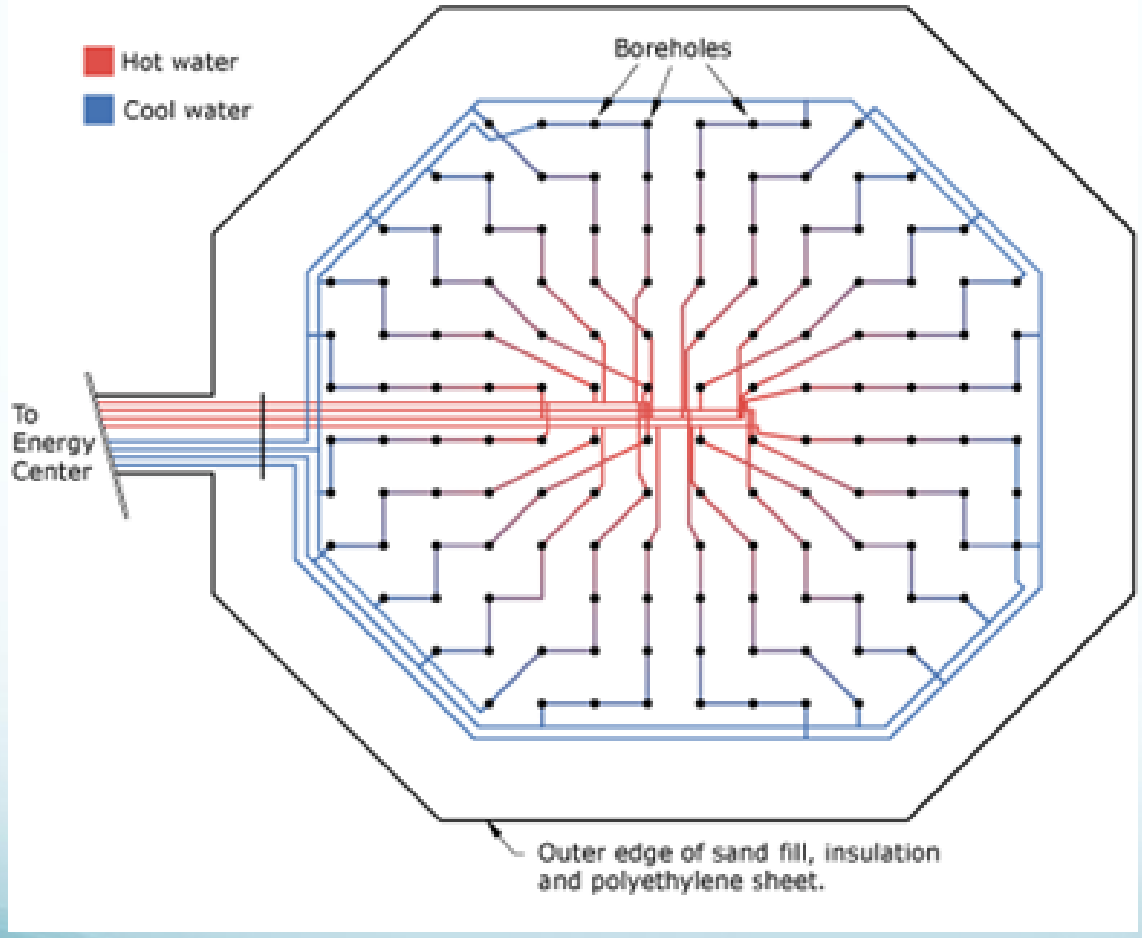
Commissioning: July 2007

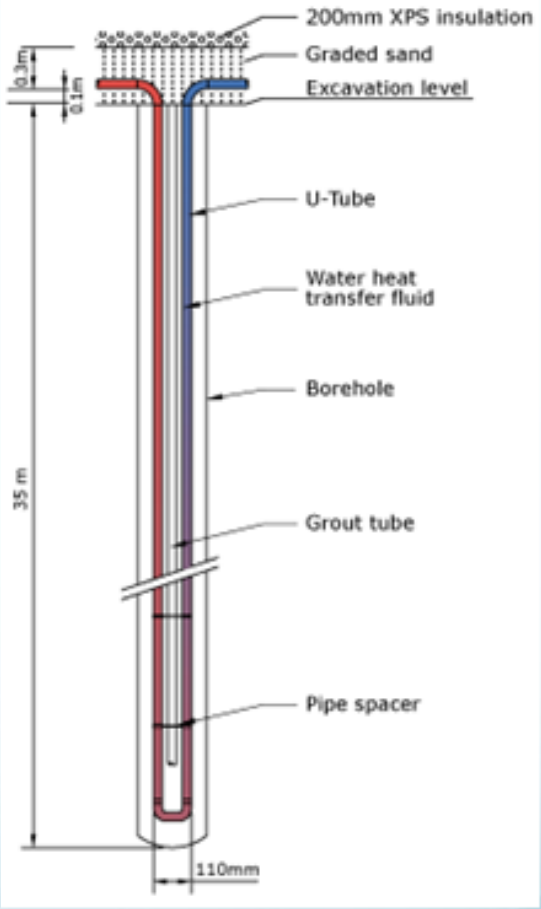
Seasonal Borehole Thermal Energy Storage



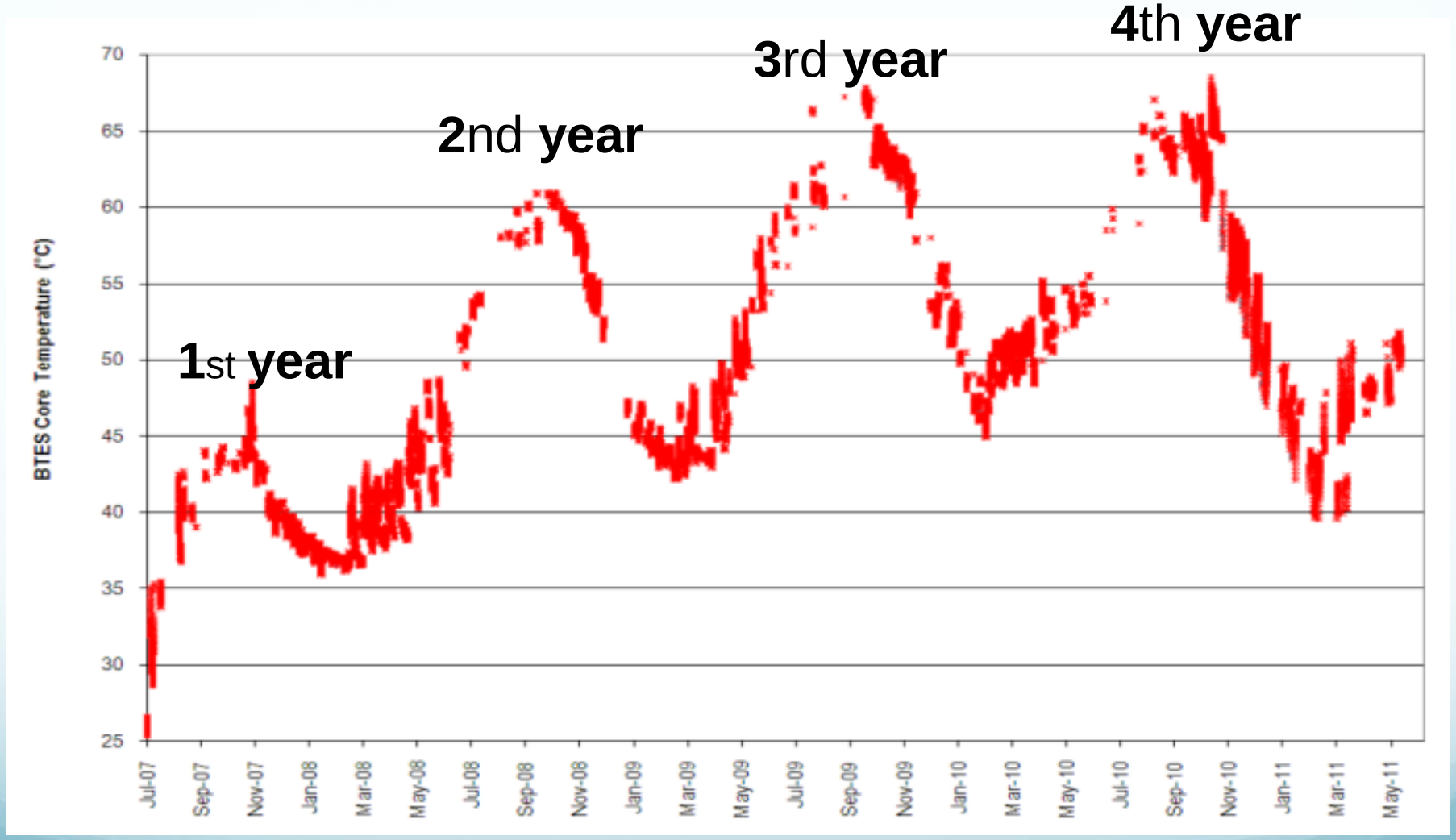
Source: CanmetENERGY, Ottawa

Borehole Thermal Energy Storage



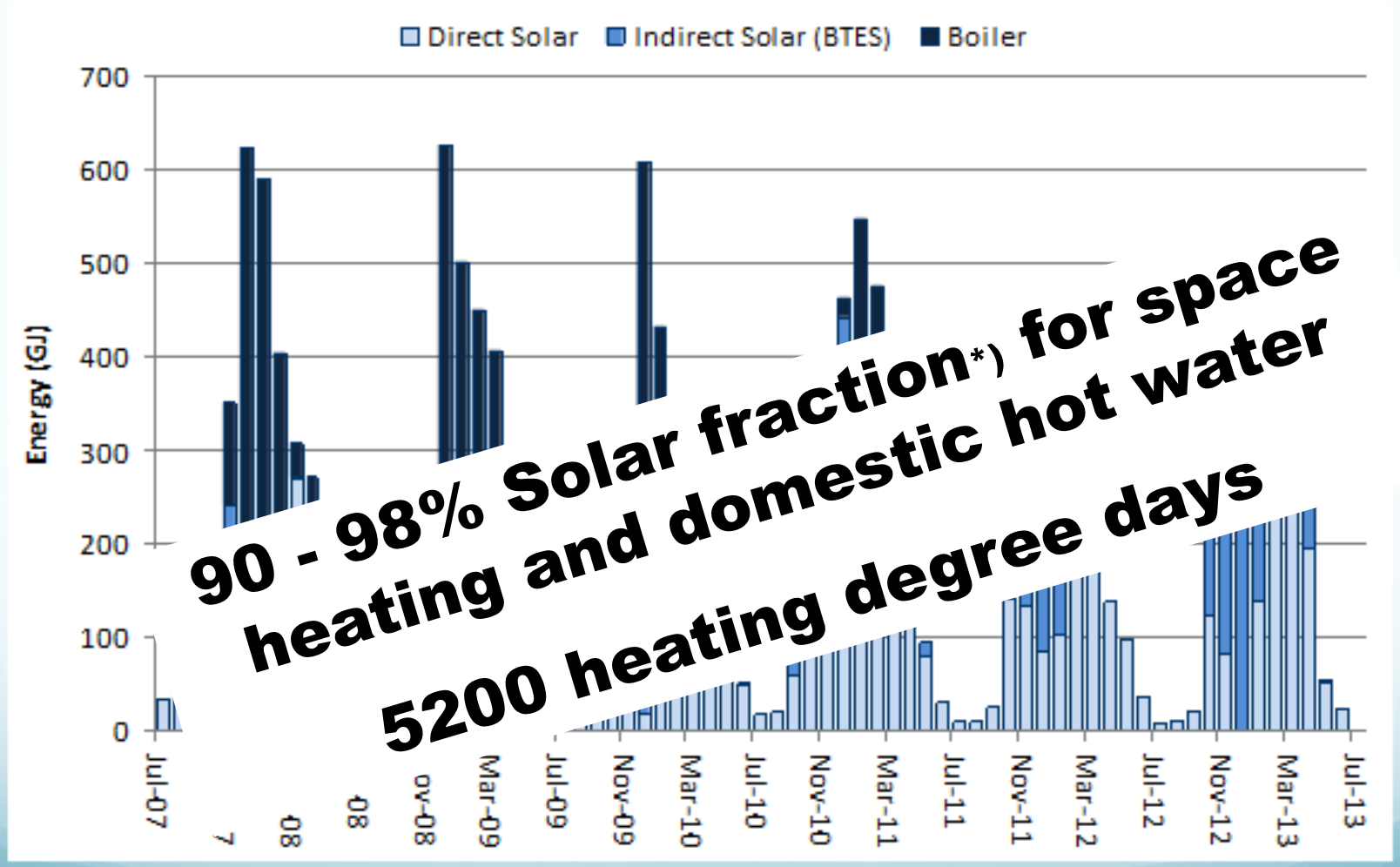


BTES Core Temperatures
July 2007 – May 2011



Source: CanmetENERGY, Ottawa

Energy supplied to the Distribution Loop July 2007 – July 2013



*) 2011 and 2012

Source: CanmetENERGY, Ottawa

Marstal Solar District Heating, DK

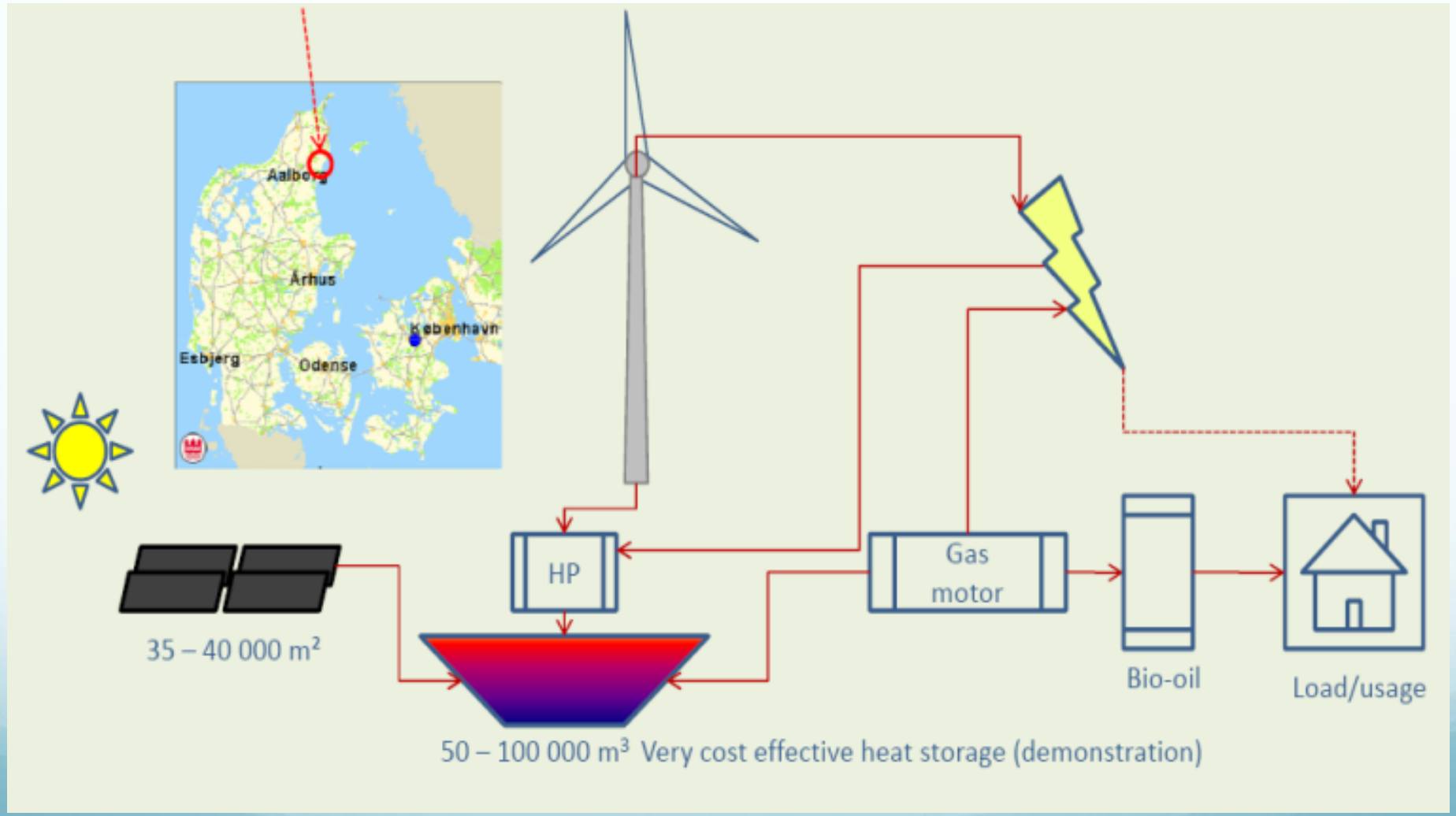
Source: Leo Holm, Marstal Fjernvarme


18/11/2011 12:29


01/24/2012

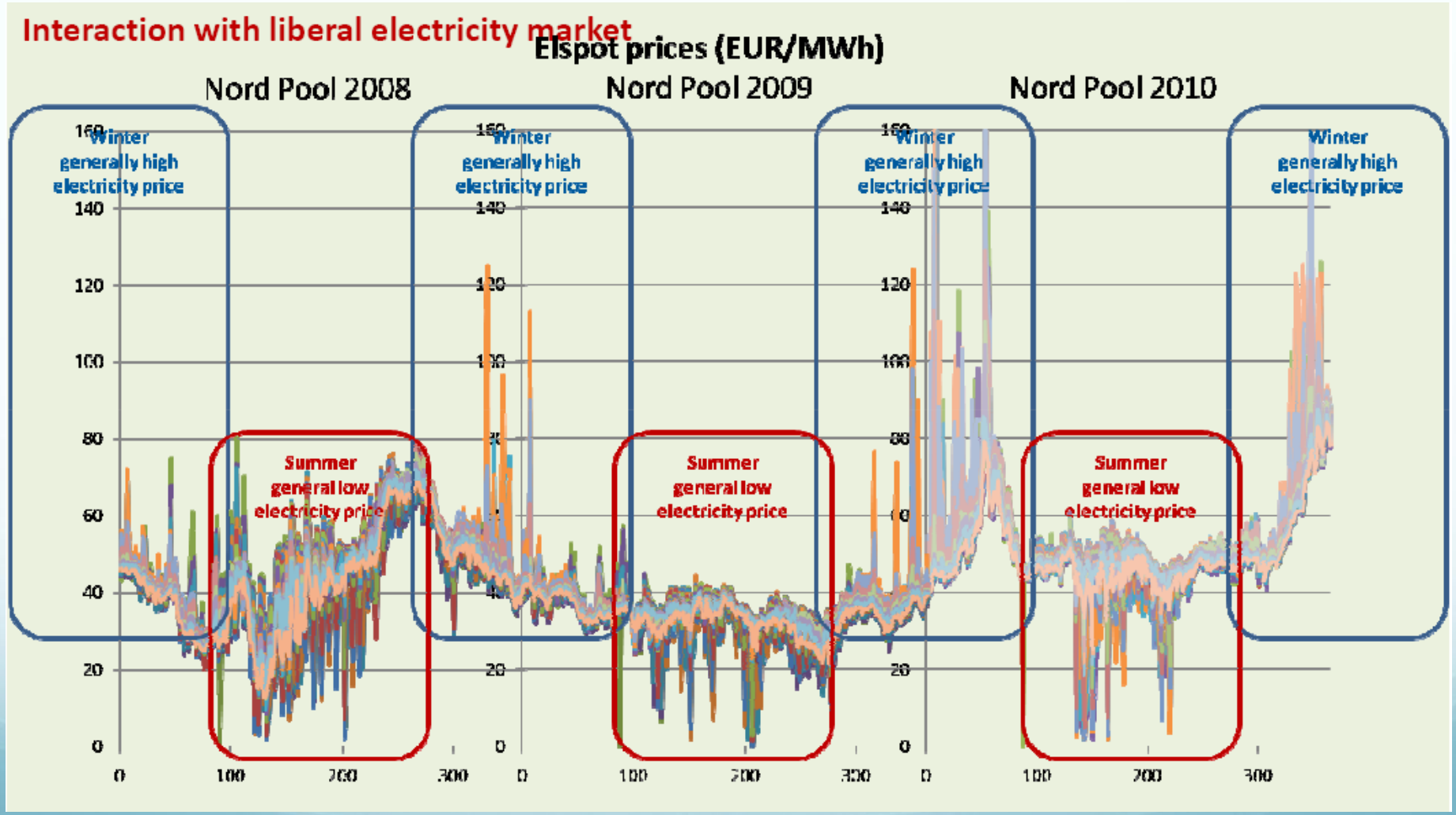
Source: Leo Holm, Marstal Fjernvarme

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

Electricity prices during the summer and winter period in Denmark



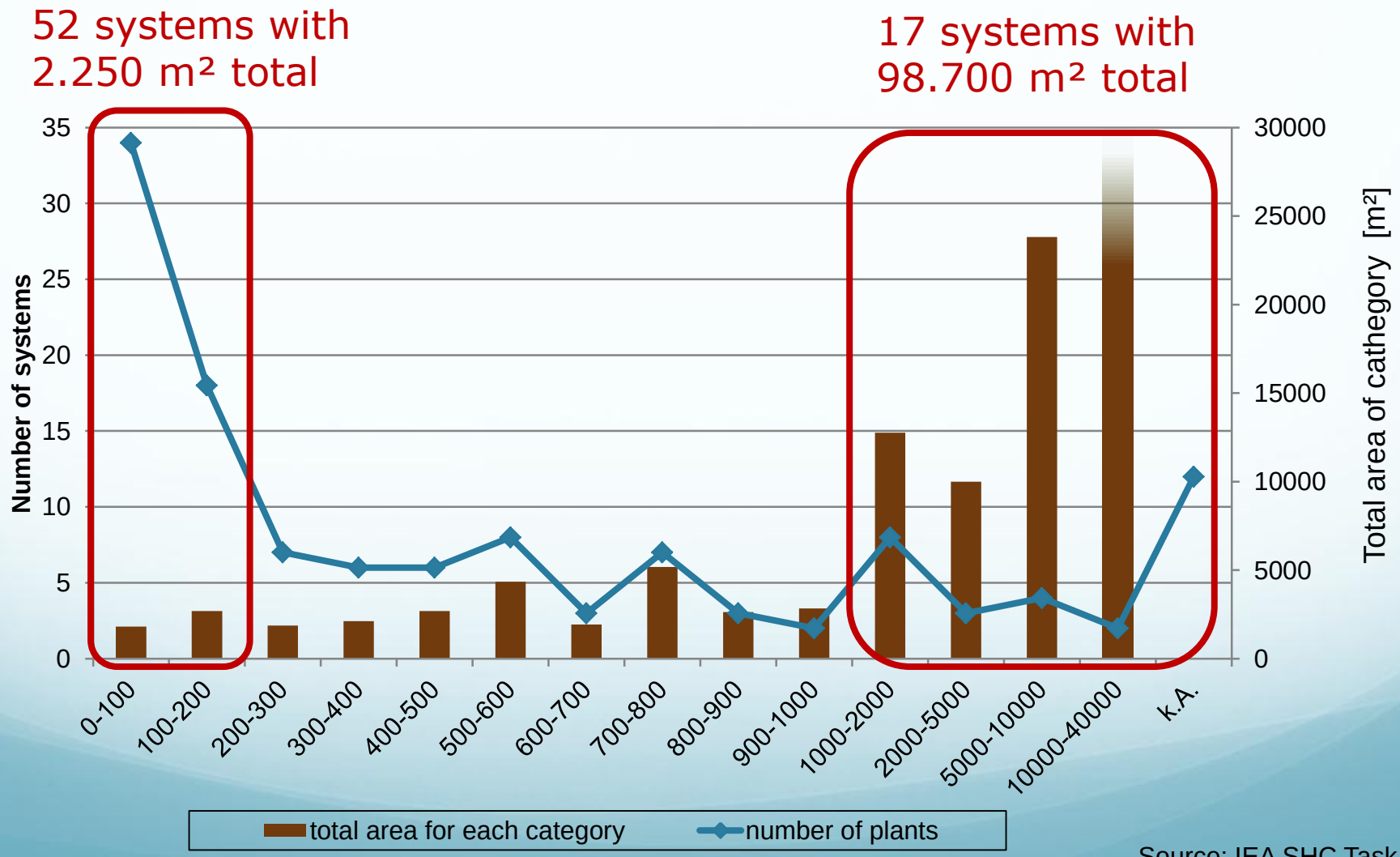
Challenges and Opportunities

Optimized collector field hydraulics
Integrated thermal / electric grids
Smart control and metering
New business concepts (ESCO)


Solar
Process Heat

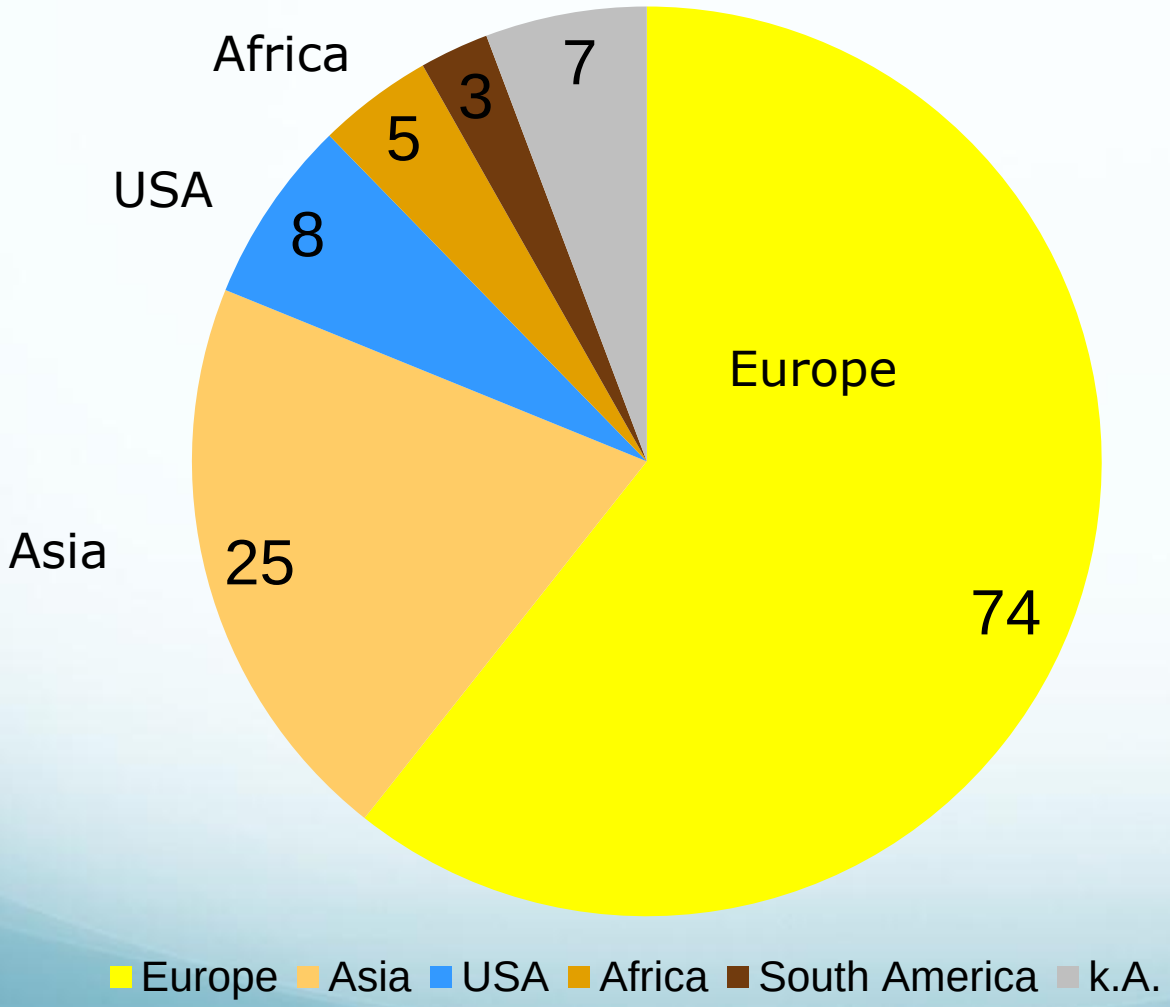
First Results – IEA SHC Task 49 Data base

122 systems, 125,600 m² , 87.8 MW



Source: IEA SHC Task 49

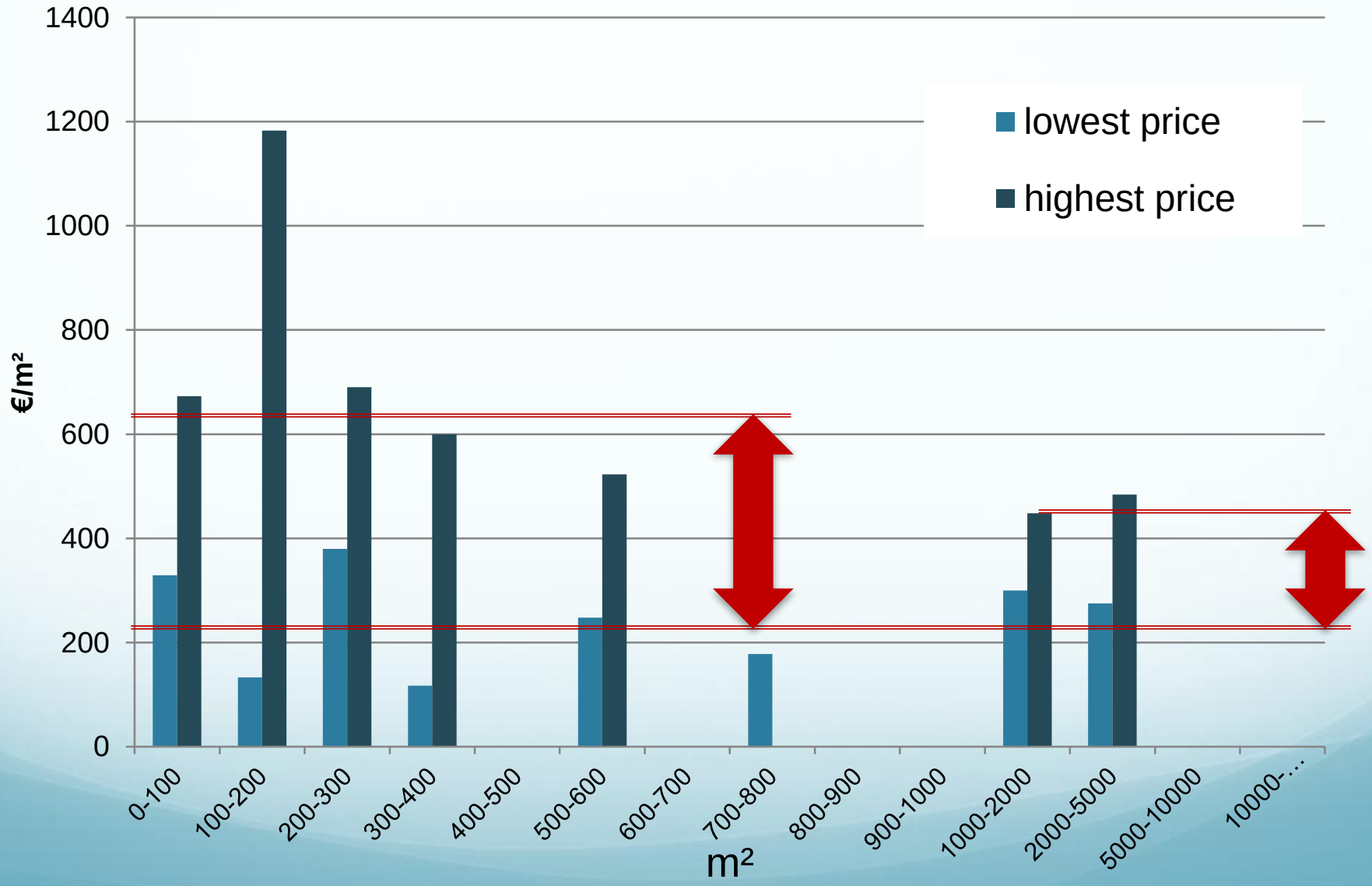
First Results IEA SHC Task 49 - Countries



Country	quantity
Austria	20
Germany	13
Greece	13
Spain	12
Portugal	4
Switzerland	4
France	2
Romania	2
Cyprus	1
Czech Republic	1
Sweden	1
Turkey	1
India	8
China	5
Thailand	3
Vietnam	3
Indonesia	1
Saudi Arabia	1
Jordan	4
USA	8
Tunisia	1
Egypt	2
Kenya	1
Panama	1
Argentinia	1
Chile	1
Costa Rica	1
k.A.	7

Source: IEA SHC Task 49

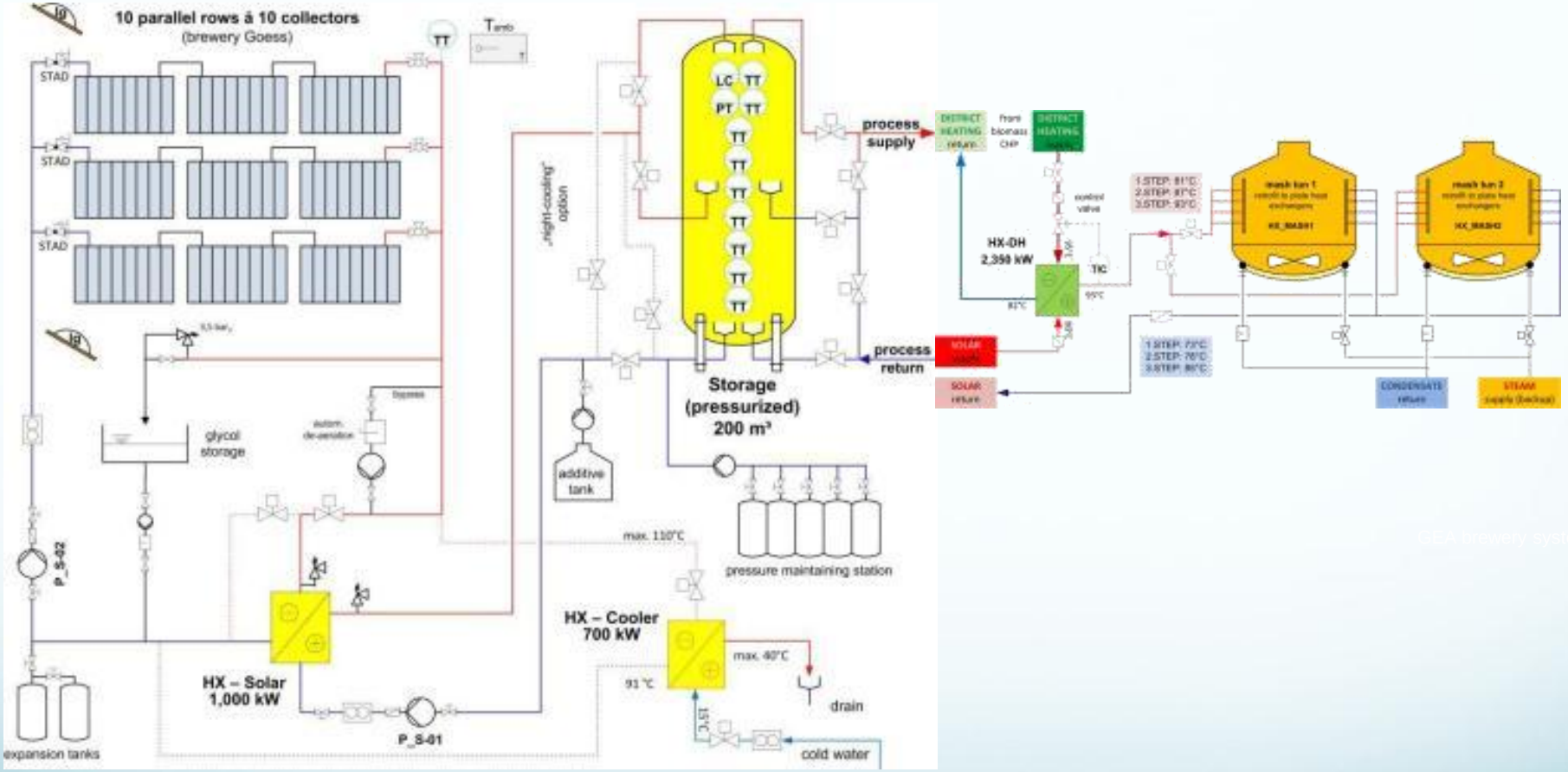
System price related to system size



Brewery Göss, Austria

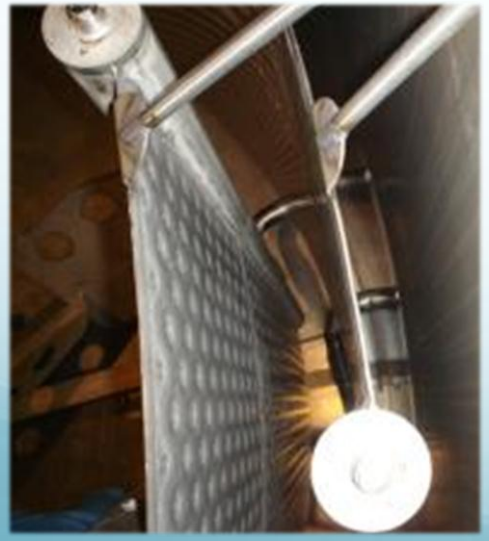
Source: AEE INTEC

Integration into the mashing process



Source: AEE INTEC

Integration into the mashing process



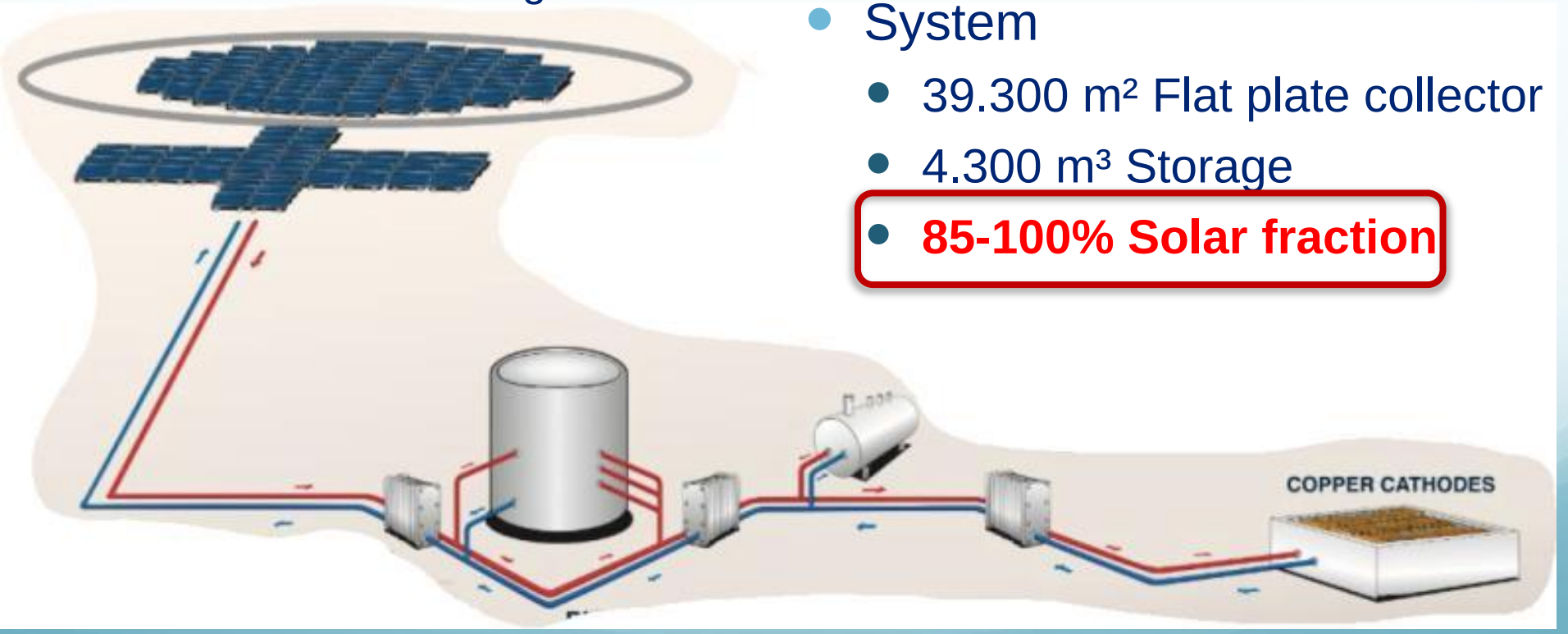
Textile Industry Hangzhou China 13000㎡ (9 MW_{th})

Copper Mine in Chile – 26MWth

Copper Mine "Gabriela Mistral", **Chile**
26MW$_{th}$ (39,300 m²)

- **Process**
  - ⇨ Electro winning of copper
  - ⇨ Electrolyte is kept on a constant Temp. of 50 °C
  - ⇨ Cleaning Processes

- System
  - 39.300 m² Flat plate collector
  - 4.300 m³ Storage
  - **85-100% Solar fraction**



Source: SUNMARK and IEA SHC Task 49

Copper Mine “Gabriela Mistral”, **Chile**
26MW$_{th}$ (39,300 m²)

Source: SUNMARK

High Vacuum Flat-plate, Trough and Fresnel Collectors

High vacuum flat-plate collector by TVP SOLAR in Masdar City (Abu-Dhabi, UAE)

Challenges and Opportunities

Medium temperature collector development

Self carrying collectors

Process integration

…

The Future of Solar Heating and Cooling?

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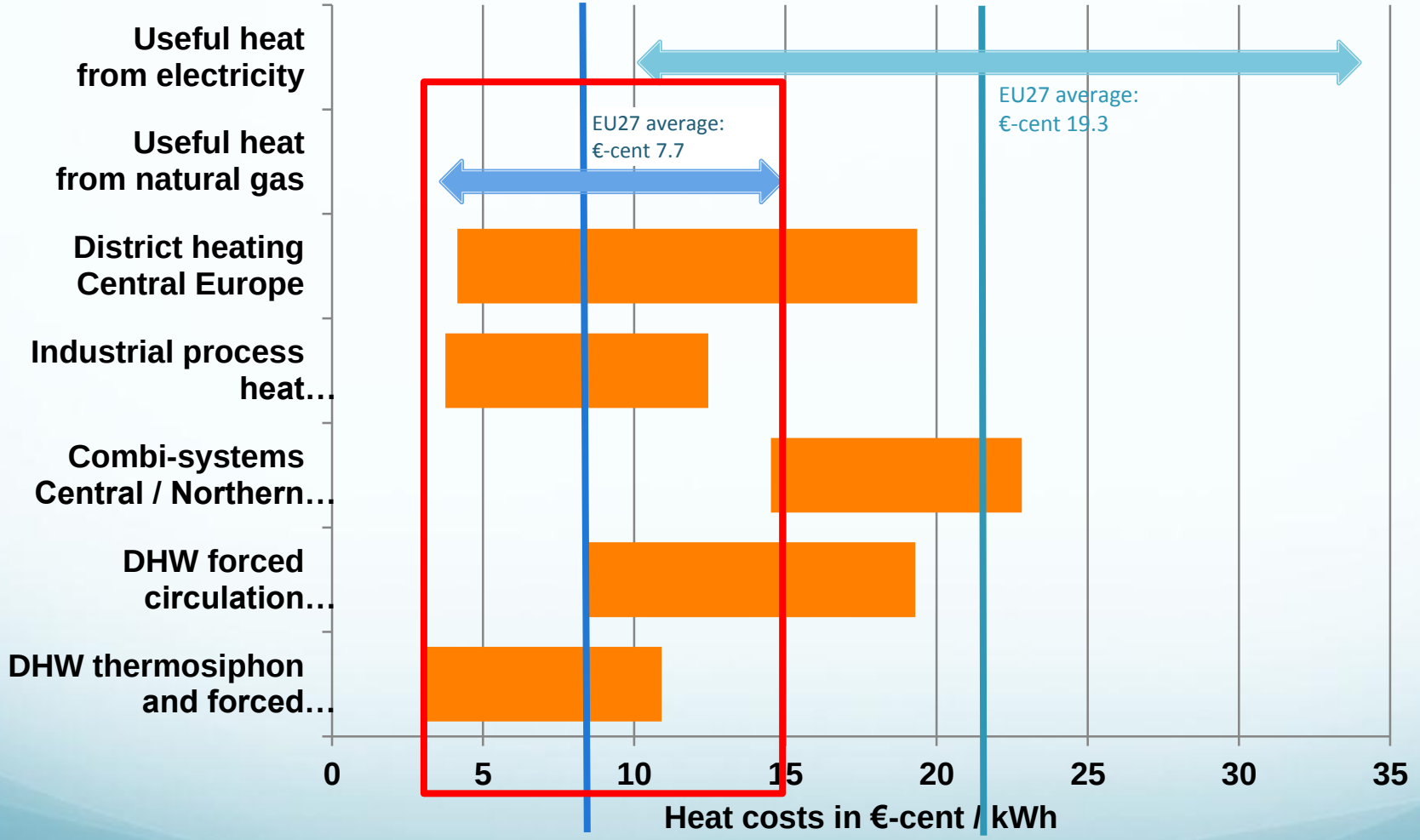
INTERNATIONAL ENERGY AGENCY

Cost of Solar Heat in Europe



Quelle: ETP RHC (2013)

Conclusions

- Potential generation of 1/6 of world total final energy for low-temp heat and cooling by 2050
- Similar potential in both building and industrial (process heat) sectors
- Economics differ per climate
- Gas heat price parity reached for different applications
- Crucial to address non-economic barriers: high up-front investment, information failures, split-incentives, quality insurance
- Need to transfer experience and knowledge to regions with good resource but less experience

To make use of the potential...