Global trends
Power versus heat
Applications in warm countries
Challenges

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Content

Potential and global trends

Power versus heat

Contribution to Energy Supply

Applications in warm countries

Challenges (value creation, pay back periods, local and national drivers, pioneers)
A sustainable energy future

Source: NASA / NOAA
A sustainable energy future
**Content**

- Potential and global trends
- Power versus heat
- Contribution to Energy Supply
- Applications in warm countries
- Challenges (value creation, pay back periods, local and national drivers, pioneers)
Heat accounts for more than half of world’s total final energy consumption today.

Source: IEA Statistics

World total final energy consumption, 2011 (322 EJ)

- **Electricity**: 25.9%
- **Transport**: 2.8%
- **Industry**: 24.4%
- **Buildings**: 20.2%
- **Other sectors**: 26.7%

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
www.aee-intec.at  AEE - Institute for Sustainable Technologies
Regional solar heating and cooling generation in buildings and industry

Source: IEA Technology Roadmap – Solar Heating & Cooling
Roadmap vision of **solar heating and cooling by economic region (EJ/yr)**

Solar heating and cooling widely applicable, although some countries show more favourable conditions (solar resource, domestic hot water demand, low temp industrial demand)
In this vision, solar hot water and space heating in buildings will increase by 7.1% annually between 2010 and 2050, while the total energy used for water and space heating increases only 1.3% (or 0.8 EJ). By 2050, solar hot water accounts for 25% of water heating energy use, while solar space heating will have a 7% share.
Solar heat has a significant role to play in the industrial sector. By 2050, the *ETP 2012 2DS* scenario estimates the potential for solar heat in industrial applications to contribute up to 7 200 PJ per year (7.2 EJ/yr), on the basis of an installed capacity of over 3200 GW$_{th}$, in industrial low-temperature applications up to 120°C.
Achievements 2013

Total Capacity in Operation [GWel], [GWth] and Produced Energy [TWhel], [TWhth], 2013

- Solar Thermal Heat: 330 [GW], 277 [TWh]
- Wind Power: 662 [GW], 318 [TWh]
- Photovoltaic: 138 [GW], 160 [TWh]
- Geothermal Power: 12 [GW], 76 [TWh]
- Solar Thermal Power: 3 [GW], 5 [TWh]
- Ocean Tidal Power: 1 [GW], 1 [TWh]

www.aee-intec.at  AEE - Institute for Sustainable Technologies
Solar Heat Worldwide 2012

Share of the total installed capacity in operation by economic region at the end of 2012*

- World CUMULATED 2012 (95%): 269.2 GW\(_{th}\) (384.6 Mio. m\(^2\))
- World CUMULATED 2012 (100%): 283.4 GW\(_{th}\) (404.8 Mio. m\(^2\))

*All collector types considered (glazed and unglazed water and air collectors)
Solar Heat Worldwide 2012

Distribution of the total installed capacity in operation by collector type in 2012
Solar Heat Worldwide 2012

Top 10 countries of cumulated glazed and unglazed water collector installations*

- absolute figures in MW$_{th}$

*unglazed water collectors (swimming pool absorbers) + flat plate collectors + evacuated tube collectors
Solar Heat Worldwide 2012

Top 10 countries of cumulated glazed and unglazed water collector installations
- relative figures in $kW_{th}$ per 1,000 inhabitants

*unglazed water collectors (swimming pool absorbers) + flat plate collectors + evacuated tube collectors
Solar Heat Worldwide 2012

Share of the new installed capacity in 2012 by economic region*

- World NEW 2012 (100%): \(55.4 \text{ GW}_{\text{th}}\) (79.2 Mio. m²)

*All collector types considered (glazed and unglazed water and air collectors)
Solar Heat Worldwide 2012

Top 10 markets for glazed and unglazed water collectors* in 2012
- absolute figures in MWth

* unglazed water collectors (swimming pool absorbers) + flat plate collectors + evacuated tube collectors
Potential

Global Irradiation: year [kWh/m²]

-180 - 170
-180 - 180
-120 - 110
-80 - 90
-40 - 50
-20 - 30
-10 - 20
10 - 30
40 - 50
80 - 90
120 - 130
160 - 170
200 - 210
240 - 250

1700 – 2300 kWh/m² a
Availability of direct solar radiation
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Electricity Production
Solar Water Heaters for the ECOWAS region
Population: 300 Mill.
Solar Water Heater Programme

System parameters

3 m² collector area = \(2.1 \text{ kW}_{\text{th}}\)

Hot water storage: 200 ltr.

Daily hot water consumption: 150 ltr.

Annual Savings

3400 kWh electricity / system

\(\text{CO}_2: 2300 \text{ kg}\)
Market penetration like in Cyprus or Israel

105 GWth

88 TWh electricity

Basic electricity for 88 Million people
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Solar Water Heating Systems
Simple direct thermosiphon systems, Zimbabwe
CHINA
THERMOSYPHON SYSTEM - China
Fraction of thermosyphon systems in the most important solar thermal markets
SEA WATER DESALINATION

Pilot System Spain, CIEMAT, INETI
252 CPC AO SOL (499 m²)
Seawater Desalination – Gran Canaria, Spain

Fraunhofer ISE, Germany
Clinics, Hospitals...
Katutura State Hospital in Windhoek, Namibia
SOLITEM PTC 1800
Demonstration Project in Turkey

Hotel, Turkey, Steam is used for the cooling machine and the laundry
70 kWth (180 m² PTC)
Steam Production: 120 kg/hr
Source: SOLITEM, DLR
Hammam in Attaouia, Morocco
Hammam in Attaouia, Morocco
Solar Thermal Systems for the Hotel Sector
Solar Thermal Systems for the Tourism Sector

Hotel Shangri-La Bangkok

Collector area: 938 m² The system powers a solar water heating system, generating enough renewable energy to heat 25 million liters of water a year, sufficient hot water production for the 802 guestrooms
Flat plate Collectors – Roof Integrated
Evacuated Tube Collectors – Building Integrated
Evacuated Tube Collectors – Building Integrated

[Image of a modern building with integrated solar panels]

www.tee-in-tec.at  AEE - Institute for Sustainable Technologies
Evacuated Tube Collectors on Flat Roofs

Source: Fraunhofer ISE
Building Integration

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

Source: Himin
Combined Solar Water Heating and Cooling
Biggest System Worldwide, Saudi Arabia
36,000 m² / 25 MW\text{th}
Biggest System Worldwide, Saudi Arabia

36,000 m² / 25 MW<sub>th</sub>
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Biggest System Worldwide, Saudi Arabia
36,000 m² / 25 MW<sub>th</sub>
Pipes and Heat Exchangers
Solar Process Heat
Potential of Industrial Process Heat

(Source: IEA SHC Roadmap, 2012)
Parabolic Trough Baking Device developed in Lesotho

Source: Ivan Yaholnitsky, BBCDC
Drying Applications
Solar Drying in Guatemala

Source: CONA
Air based Drying System
Generic System - 1Nso

Main Applications

- Coffee Drying
- Tea Drying
- Maize Drying
- Tobacco Drying

Temperature range for the processes: 30 - 80°C

Heat carrier: air

Recommended Collector Types:

- glazed or unglazed air collector
- Solar Wall ®
Air based Drying Systems in India

Source: C.PALANIAPPAN, PAN
Leather Drier with Solar Hot Air Ducts
M/S M.A. KHIZAR HUSSAIN & SONS, RANIPET

Source: C.PALANIAPPAN, PAN
Mzuri Sana Farm - Zimbabwe
Sadesa Leather (1)

Sadesa, Thailand
  Tanery
  Hot water for tanning process

System
  Aschoff solar
  Start of operation: 2013
  1,890 m² Vacuum tube collector
  35 m³ heat store
  30 - 80 °C
Sadesa Leather (2)
Food Industry
Tyras dairy, Trikala, Greece

Installed Capacity: 728 kWth (1040 m² FK)
Prestage Food (1)

⇒ North Carolina, USA
Prestage Food (2)

Poultry Company in NC, USA
Energy-Contractor: FLS Energy → Owner of the Solar System

Demand 568 [m³/d] Hot water at (>60 °C) for cleaning processes

System
Start of operation 2012
7,804 m² Flat plate collectors
852 m³ Heat Storage (10 x 85 [m³])
50% Solar Fraction (Hot water)

Source of pictures: FLS Energy
Beverage Industry
Nestle Waters (1)

Al Manhal, Riad, Saudi Arabia

System

Millennium Energy Industries
Start of operation: January 2012
515 m² Flat plate collectors
15 m³ Heat Storage
Replacement of electricity for bottle washing (~ 70 °C)

IEA SHC Task 49
Textile Industry
Textile Industry Hangzhou China 13000 m² (9 MWth)
Metal Industry
Electroplating Bath in Ludhiana, India
500 m² collector area (350 kWth)

The temperature of the electroplating bath is to be maintained at 55 to 60 °C for 12 hours a day.

158,000 m² of the total installed collector area in India was used for industrial applications (2009)

Sources: Greentech Knowledge Solution and Intersolar Systems, India
Mining
Solar Heat for Copper Mining in Cyprus - 0.5MWth

Source: Millennium Energy Industries
Copper Mine in Chile - 26MW<sup>th</sup>
Copper Mine “Gabriela Mistral”, Chile
26MWth (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<sub>th</sub> (39,300 m<sup>2</sup>)

Source: SUNMARK
Copper Mine “Gabriela Mistral”, Chile Facts and Challenges

Contracting System performed by Pampa Elvira Solar
Codelco has signed an agreement with the Chilean company Pampa Elvira Solar to deliver solar heat to the mining factory over a 10-year period. Pampa Elvira Solar owns the solar field and is responsible for its operation.

Flow and return temperatures:
primary side: 85 / 55 °C
secondary side – supplying the mine - at 80 / 60 °C

Expected output: specific yield of 1,272 kWh/m²

Challenge:
A special machine for dry-cleaning the collectors was developed by Sunmark. The Gaby mine is in one of the driest areas on earth, with rain only pouring down every 50 years.
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Challenges -1

Lack of awareness

Lack of (sustainable) political support mechanisms

Low (subsidised) energy prices

Lack of trained people

Upfront investment
Challenges - 2

Local production versus imports?

Job creation

Quality of local production

Quality of imported components and systems

Local drivers and pioneers (companies, traders, Universities???)
COST OF SOLAR THERMAL HEAT
Thank you for your Attention