Technology Options of Solar Thermal Systems in South East Asia

- Lessons learnt from Thailand and Vietnam

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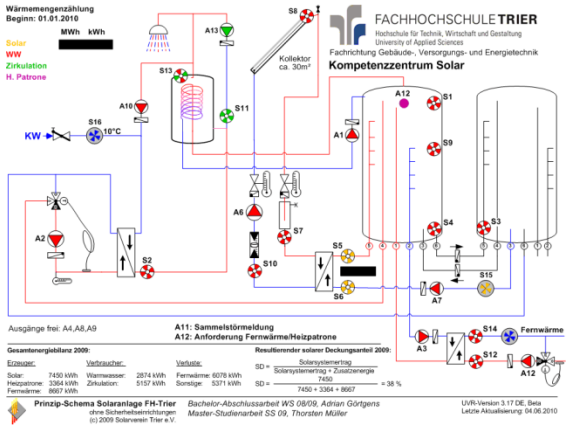
Solar Centre of Excellence

Introduction

FACHHOCHSCHULE TRIER
Hochschule für Technik, Wirtschaft und Gestaltung
University of Applied Sciences

Solar Centre of Excellence, University of Applied Sciences Trier

- design
- planning
- optimization
- monitoring
- performance check and fault detection
- simulation



www.fh-trier.de/go/solar

Solar Thermal Systems

Photovoltaic

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Solar Thermal Contribution to energy supply

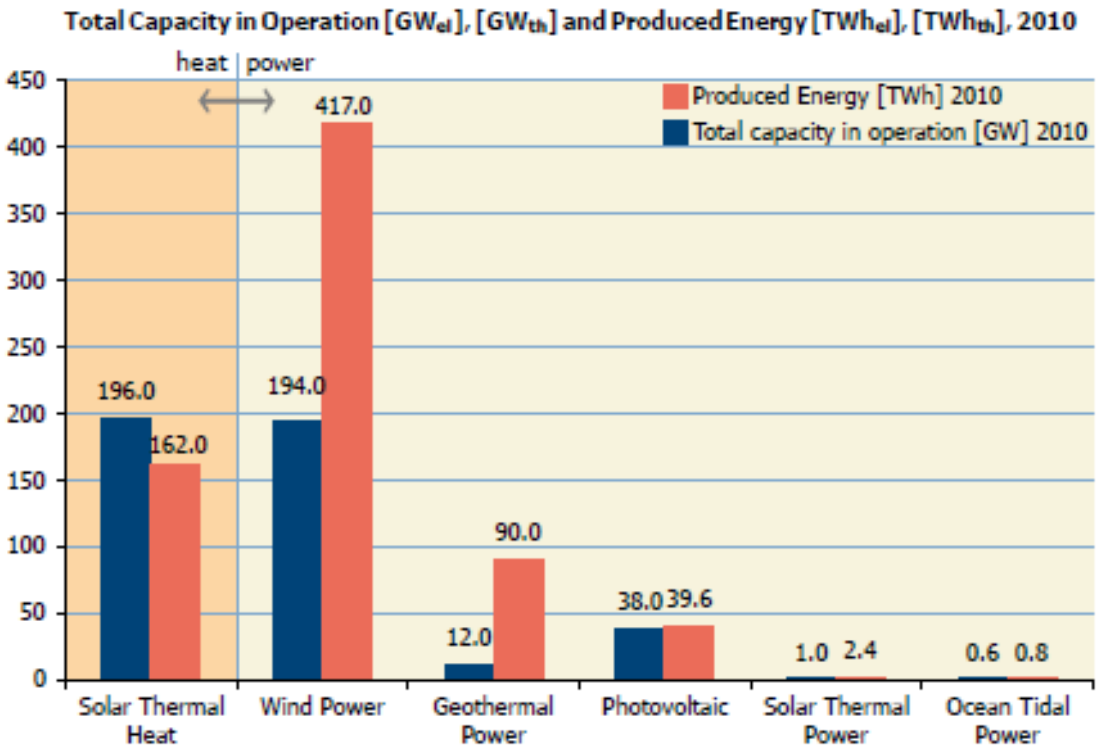


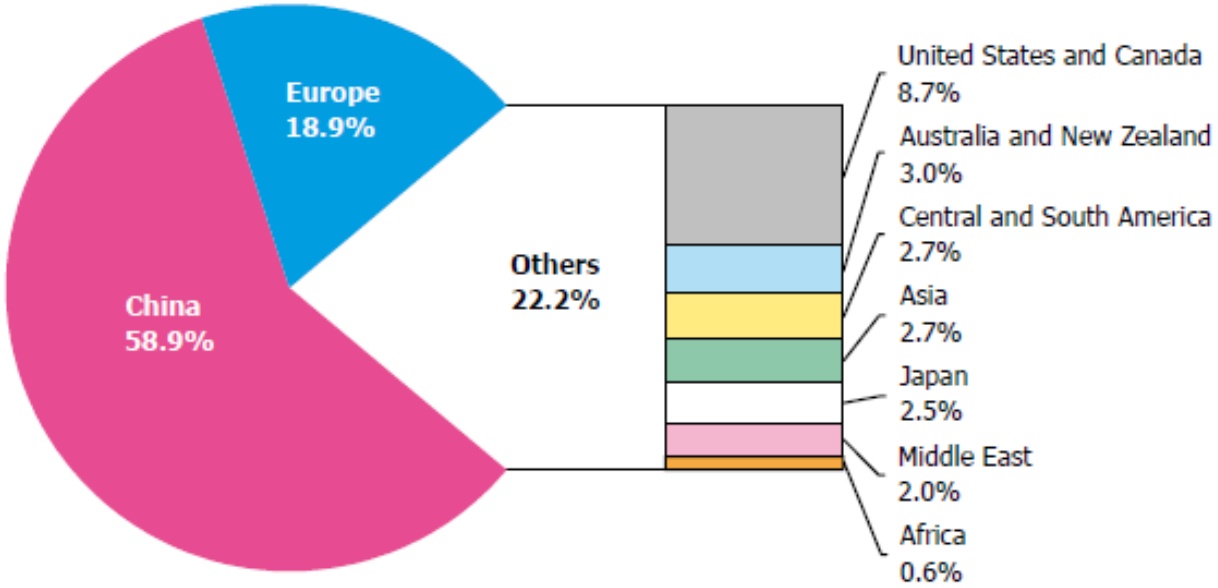
Figure 2: Total capacity in operation [GW_{el}], [GW_{th}] 2010 and annually energy generated [TWh_{el}], [TWh_{th}]. Sources: EWEA, EPIA, GWEC, IEA SHC 2011, Morse Associates Inc., REN 21

Source: Solar Heat Worldwide, SHC 2011

Solar Heat Worldwide – Facts and Figures

- Solar thermal collector capacity worldwide equaled 172 GW_{th}
- 246 million m^2 end of the year 2009
- 152 GW_{th} were for flat-plate and evacuated tube collectors;
- 20 GW_{th} for unglazed water collectors; Air collector 1 $GW_{th.}$
- Vast majority of all collectors are installed in China (102 GW_{th}),
- Europe (33 GW_{th}), North America (15 GW_{th})
- Australia (5 GW_{th}), Central & South America (5 GW_{th}),
- **Asian Countries** (India, South Korea, Taiwan, Thailand (5 GW_{th}), Japan (4 GW_{th}),
- Middle East (Israel and Jordan (4 GW_{th}); Africa (1 GW_{th})

Share of total installed capacity collectors by regions 2009



Africa:	Namibia, South Africa, Tunisia, Zimbabwe
Asia:	India, South Korea, Taiwan, Thailand
Central + South America:	Barbados, Brazil, Chile, Mexico, Uruguay
Europe:	EU 27, Albania, Former Yugoslav Republic of Macedonia, Norway, Switzerland, Turkey
Middle East:	Israel, Jordan

Source: Solar Heat Worldwide, SHC 2011

Annual increase of newly installed solar collectors

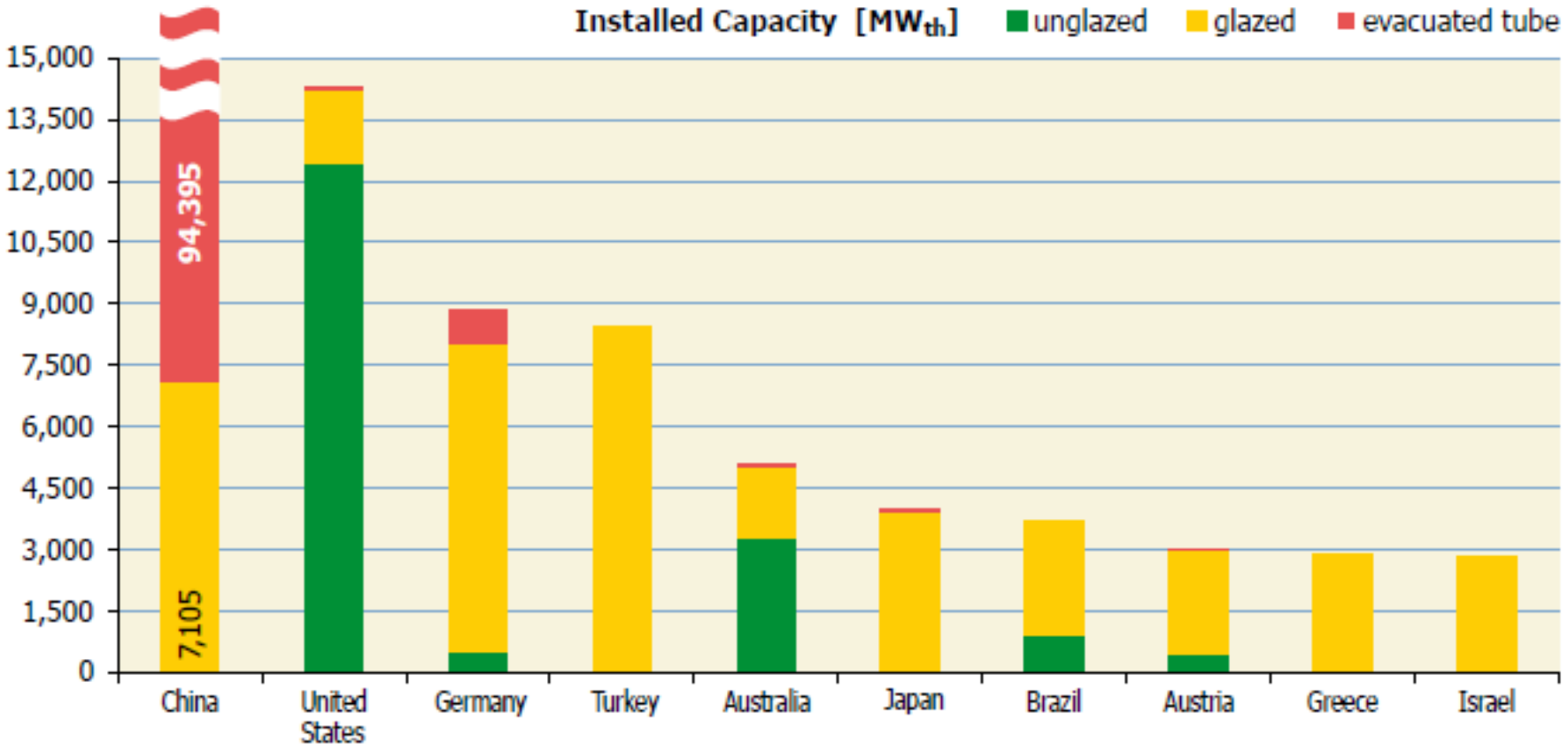
- In 2009 a capacity of 37 GW_{th} corresponding to 52 million square meters of solar collectors were newly installed worldwide!

- This means an increase in collector installations of 25 % compared to the year 2008!

Distribution of systems by system type and application

- **Thermosiphon systems** more advanced in the Asian countries (esp. China), Africa and the Middle East, market dominated by China
- In Europe, the US and in Australia **pumped systems** by far more common
- 70 – 80% of the total installed systems and > 85% of the 2009 newly installed systems worldwide are thermosiphon systems!
- Spain, **Germany** and **Austria** have the most sophisticated markets for different solar thermal applications.
- They include systems for hot water preparation,
  - systems for **space heating** of single- ; multi-family houses and hotels,
  - large-scale plants for **district heating**
  - and a growing number of **systems for air conditioning, cooling**
  - and **industrial applications**.

Total installed capacity of water collectors in the 10 leading countries by the end of 2009

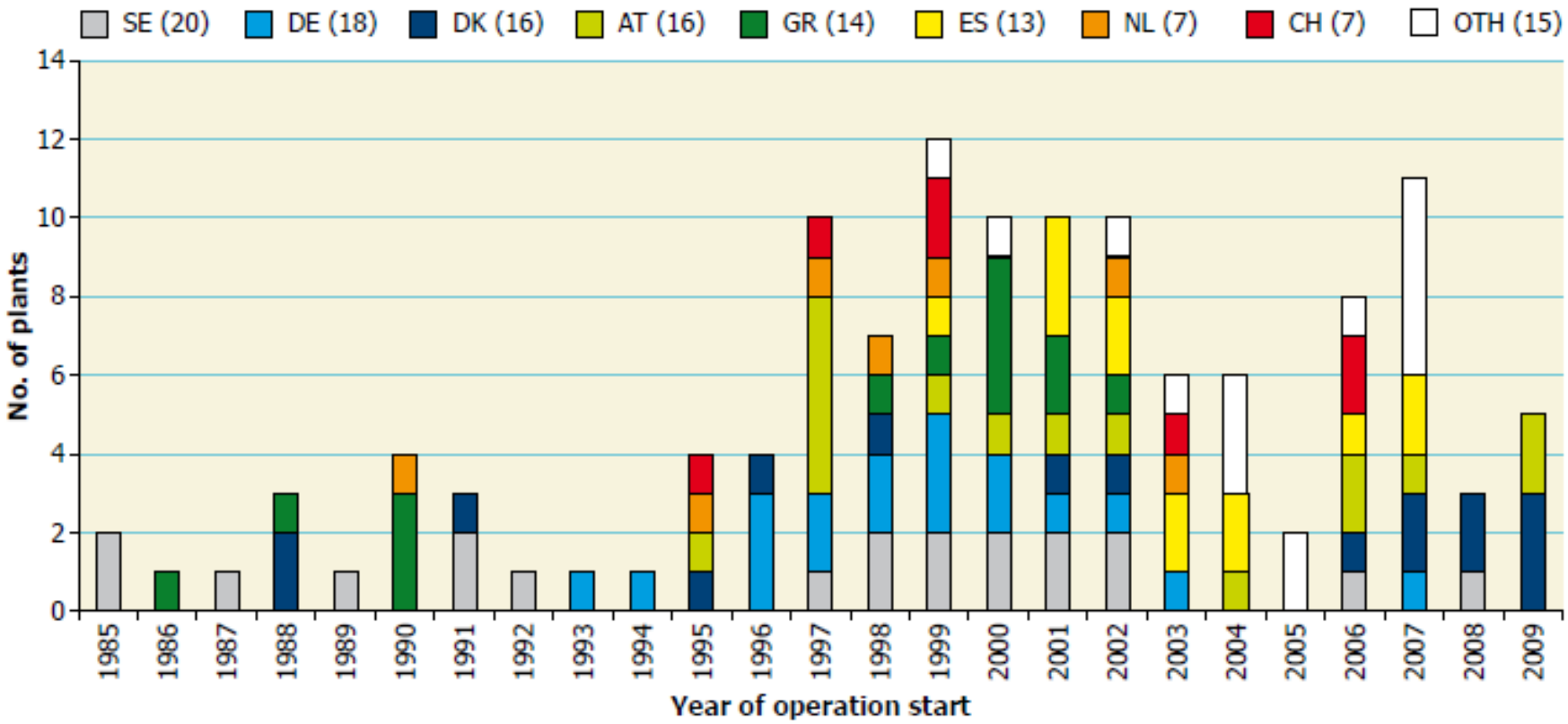


Source: Solar Heat Worldwide, SHC 2011

Worldwide Large Scale Solar Thermal Applications

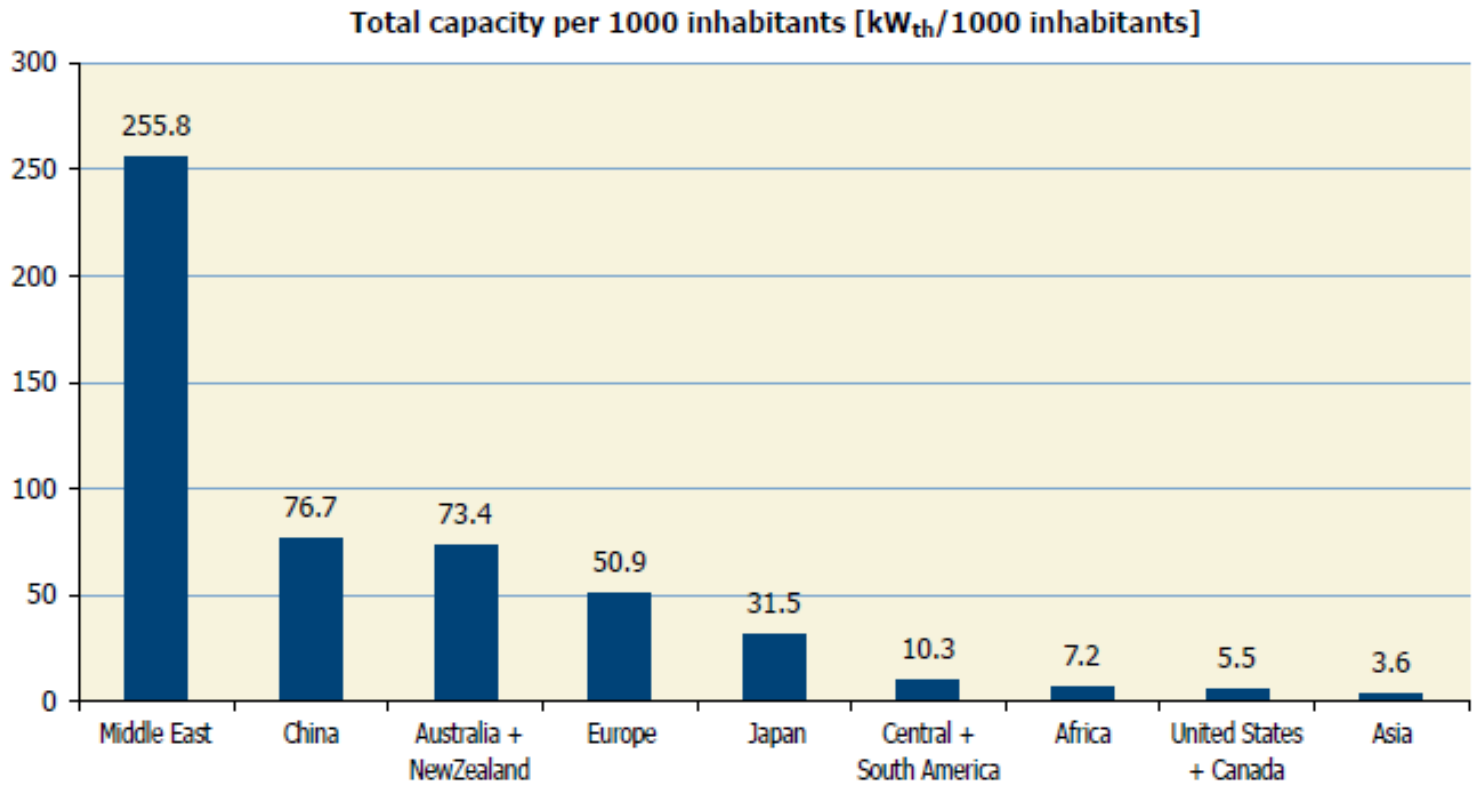
- **115 solar supported district heating networks & 11 solar cooling** systems each > 350 kW_{th} (= 500 m^2) are in Europe. Total 166 MW_{th}
- **World's largest system** with 25 MW_{th} (36.305 m^2) for Princess Nora University in Riyadh, Saudi Arabia, built in April 2011
- Largest **district heating** plants in Europe in Marstal, Denmark (18,300 m^2)
- **World's largest solar cooling plant** is at UW College in Singapore.
  - 1.6 MW absorption cooling combined with 3.900 m^2 solar thermal collector field to supply 2,500 people at the university campus with air - conditioning and domestic hot water. Operated as BOOT scheme by an ESCO concept.
- **Largest solar process heat** is Hangzhou, China. The 13,000 m^2 of solar collectors on the roof of a **textile factory** provide hot water for a **dyeing process** run at a favorably **low supply temperature of 55°C**.

Large-scale solar heating and cooling systems in operation in Europe by the end of 2009



Source: Solar Heat Worldwide, SHC 2011

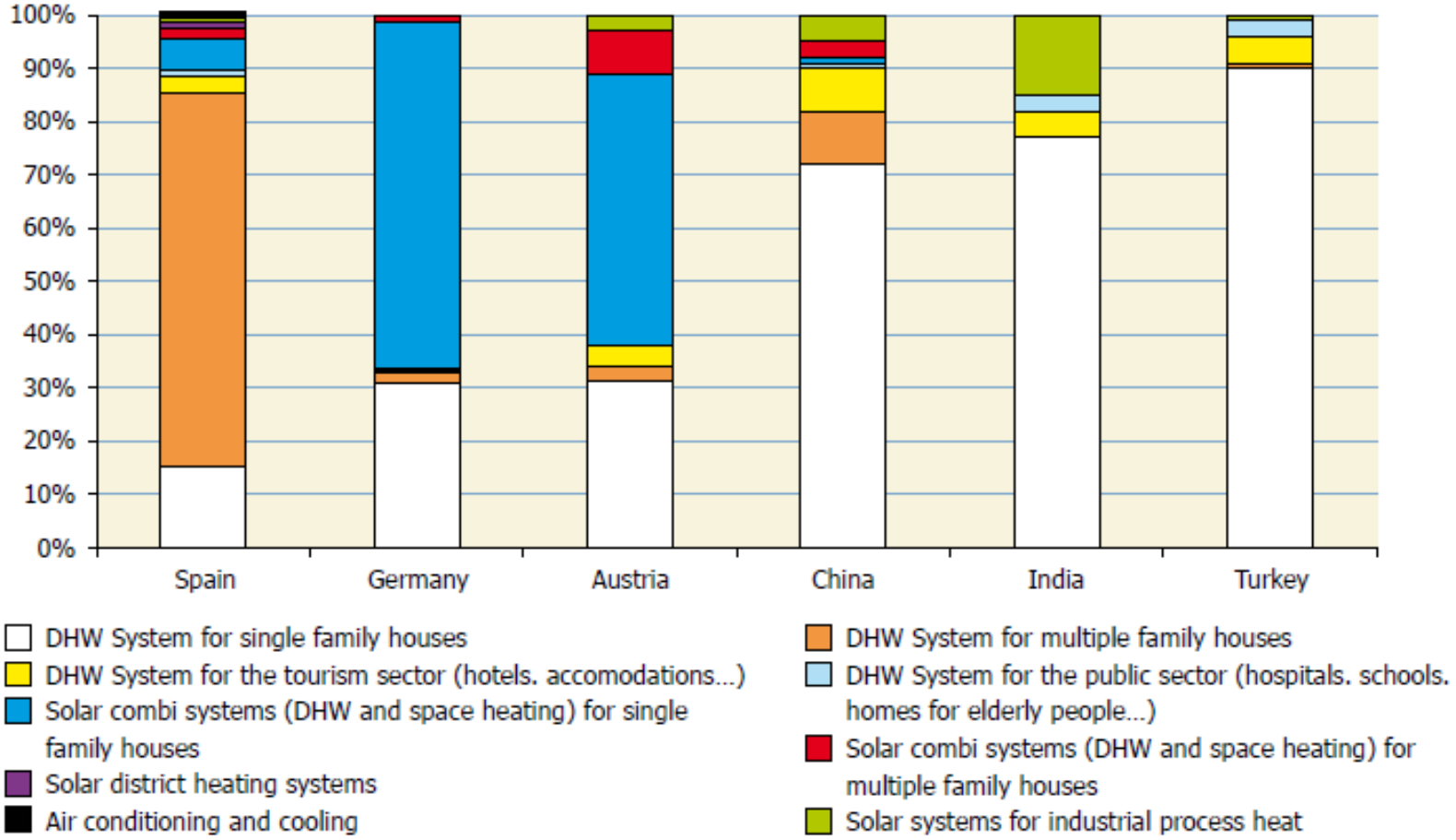
Total capacity of glazed flat-plate and evacuated tube collectors by economic region and in kW_{th} per 1,000 inhabitants by 2009



Africa:	Namibia, South Africa, Tunisia, Zimbabwe	Europe:	EU 27, Albania, Former Yugoslav Republic
Asia:	India, South Korea, Taiwan, Thailand		of Macedonia, Norway, Switzerland, Turkey
Central + South America:	Barbados, Brazil, Chile, Mexico, Uruguay	Middle East:	Israel, Jordan

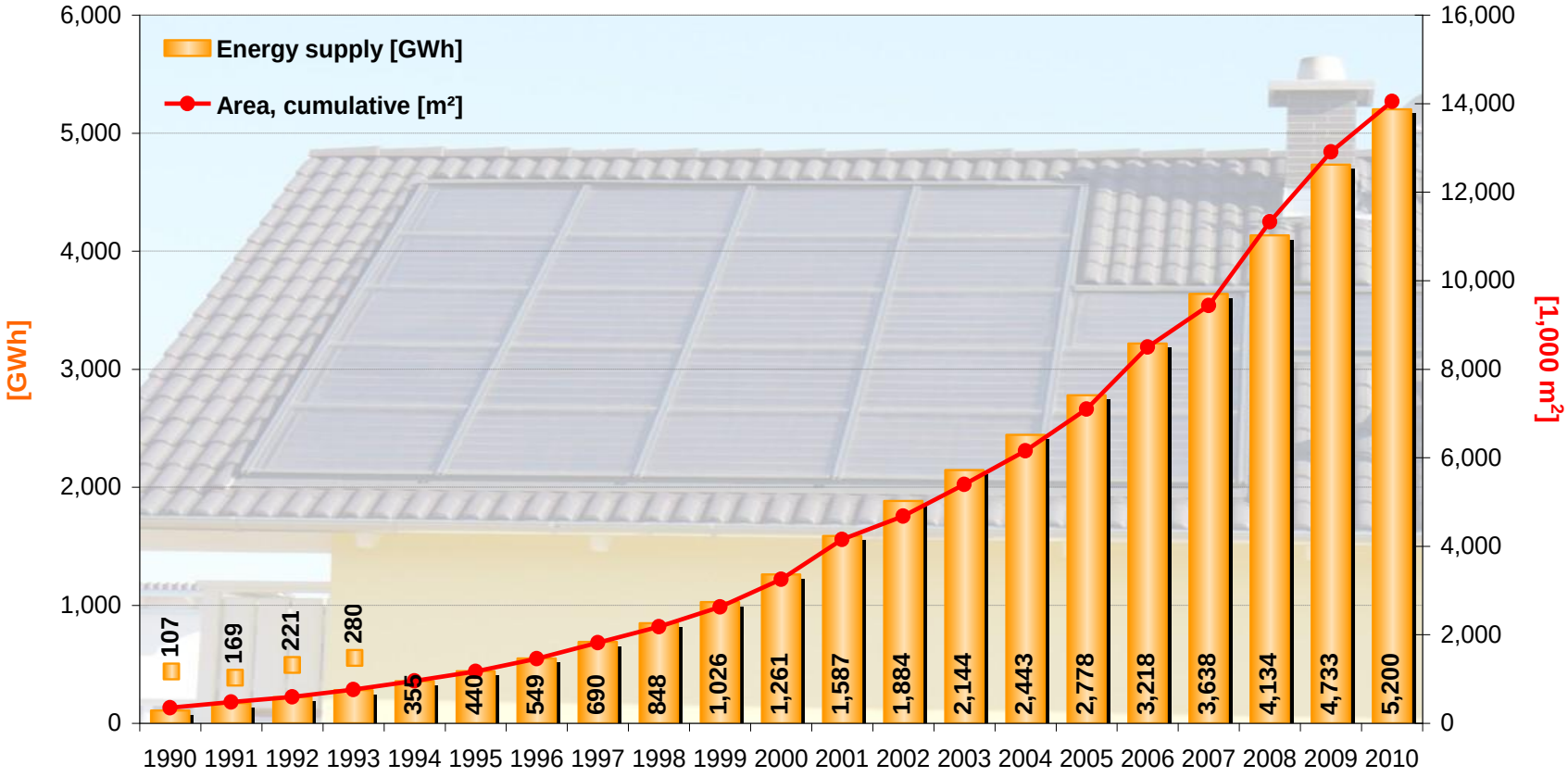
Source: Solar Heat Worldwide, SHC 2011

Distribution of applications of glazed water collectors in the 6 leading countries worldwide in 2009



Source: Solar Heat Worldwide, SHC 2011

Development of collector area and energy supply of solar thermal installations for heat supply in Germany



1 GWh = 1 Mill. kWh;
Source: BMU-KI III 1 according to Working Group on Renewable Energy-Statistics (AGEE-Stat) and ZSW; image: ZSW / Ulrike Zimmer; as at: December 2011; all figures provisional

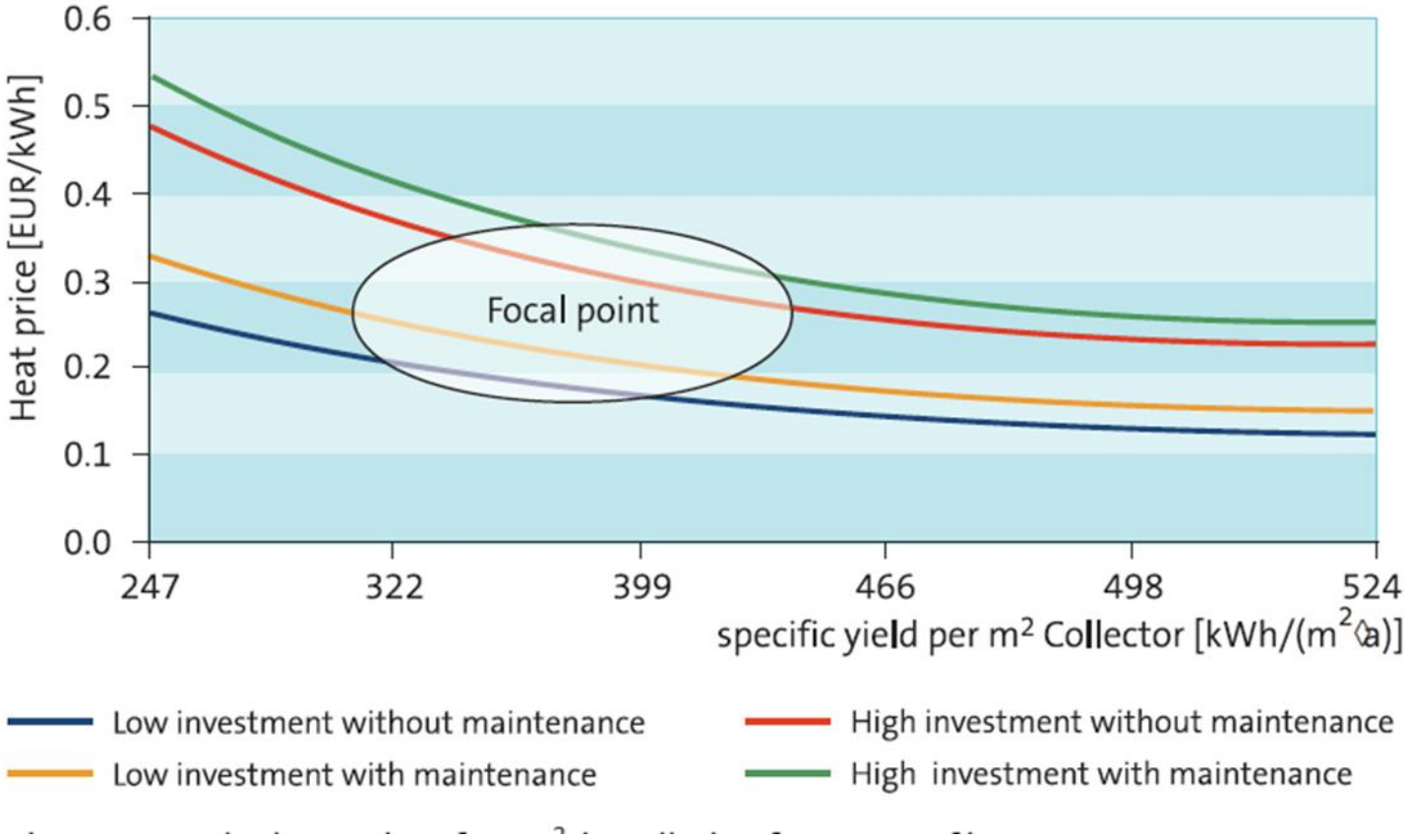
R&D&D: Solarthermie 2000 and Solarthermie 2000Plus – Results

- from 1993 to 2009: 60+21+19 pilot installations, research projects with > 100 m² collector were realized
- purpose was to **analyze the installed system configurations in terms of operating behavior and cost effectiveness**

Results:

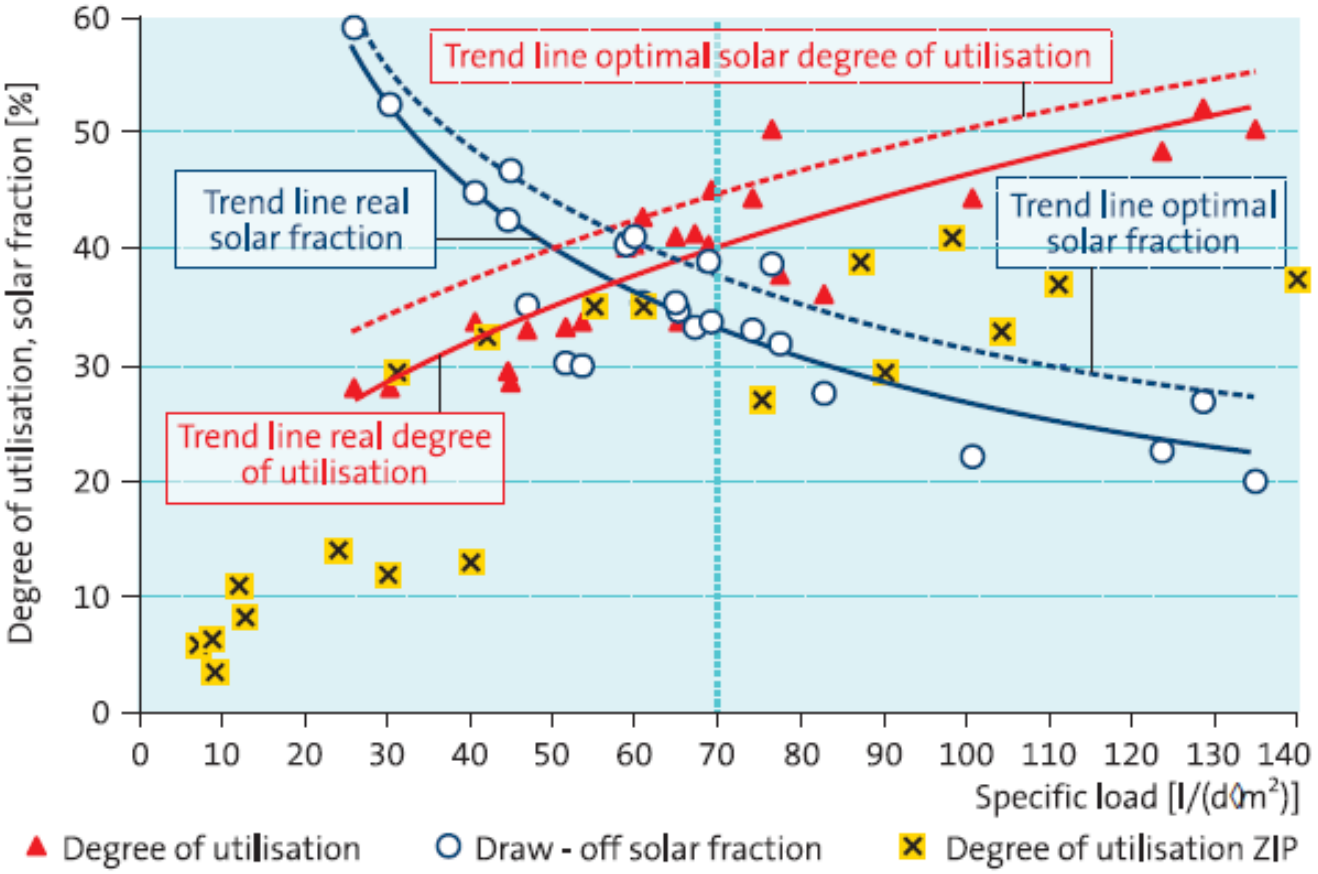
- **optimized solar thermal system concepts & study of achievable (realized) solar yields**
- **VDI 6002-2:** Solar heating for domestic water – Application in students accommodations, senior citizens residence, hospitals, swimming baths and camping sites

Solarthermie 2000 and Solarthermie 2000Plus – Results
Cost of solar energy: Germany



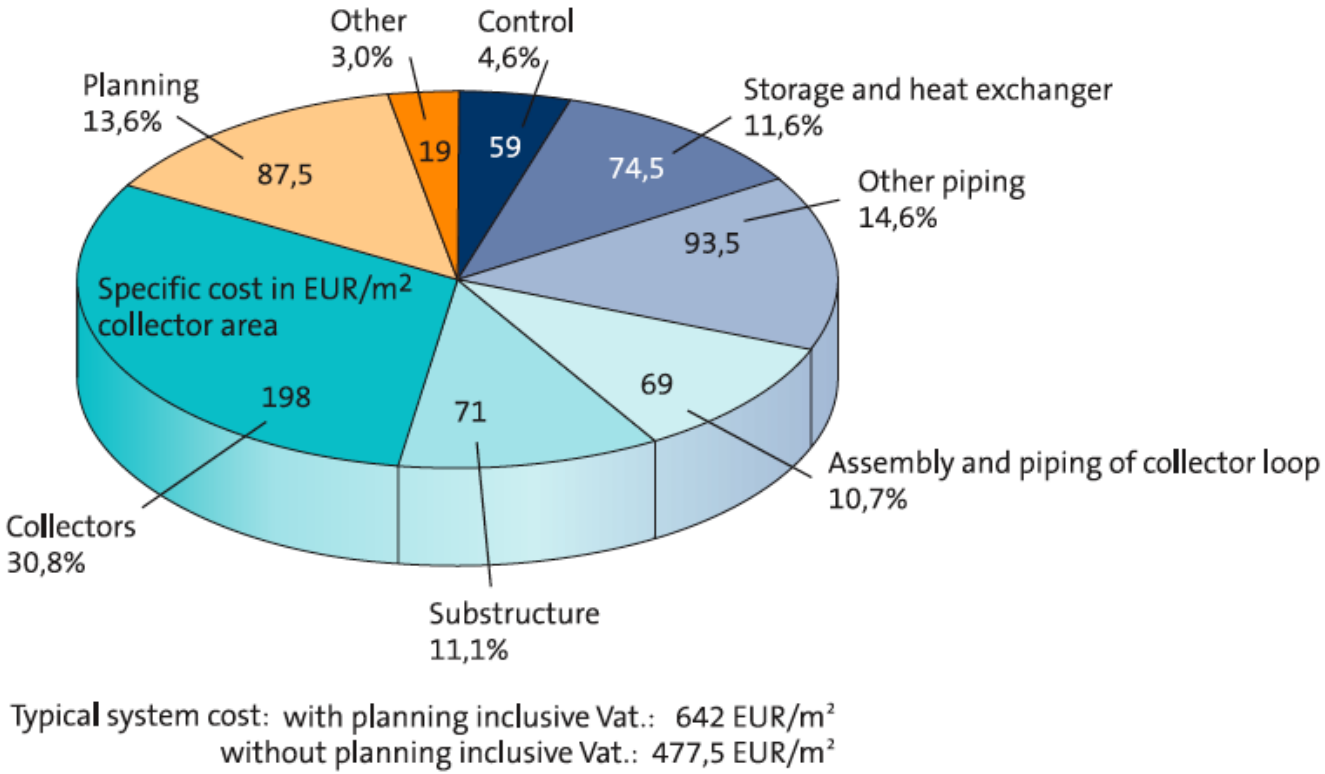
(Source: Peuser, Dr. Felix A.; Remmers, Karl-Heinz; Schnauss, Martin : Solar Thermal Systems, Expert Knowledge for Successful Planning and Construction)

Solarthermie 2000 and Solarthermie 2000Plus – Results
Annual degree of utilization and annual solar fraction



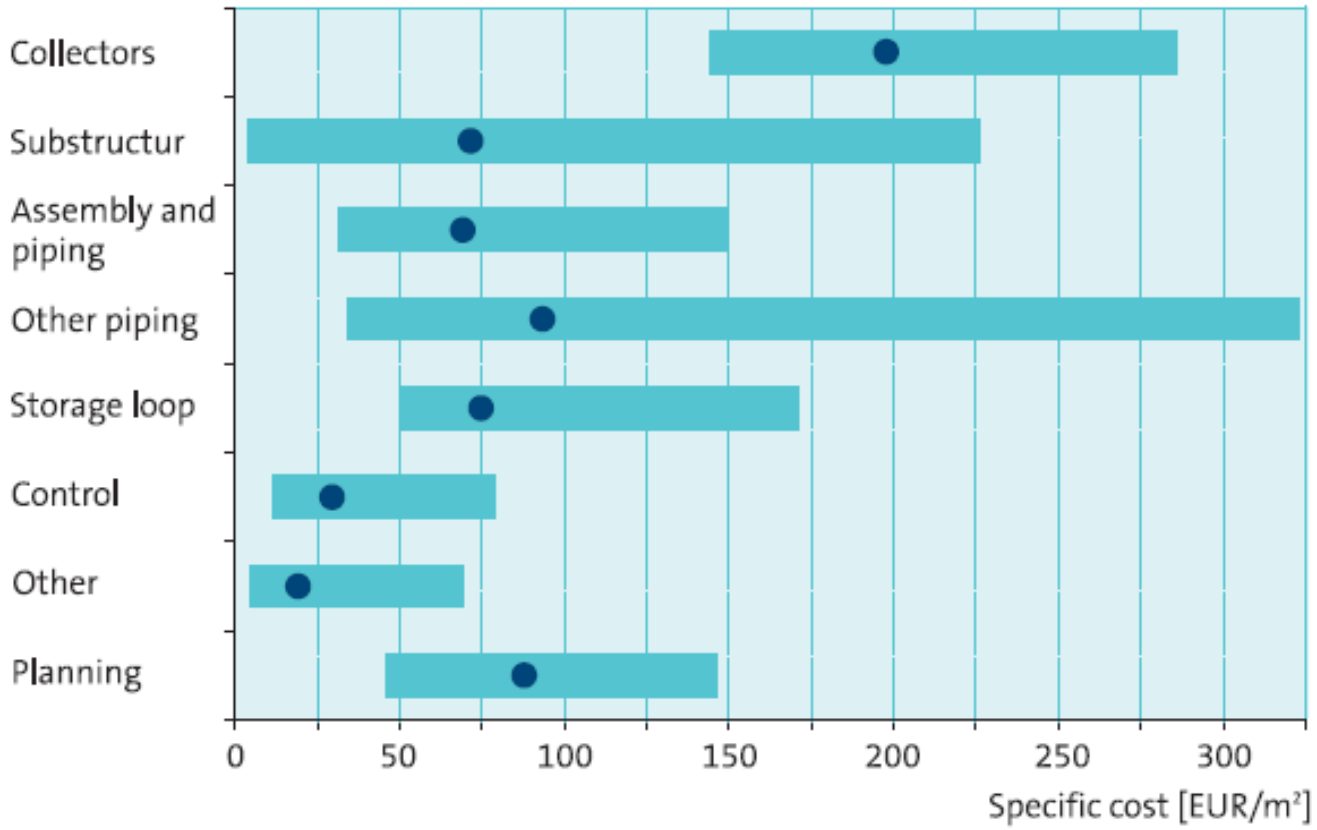
(Source: Peuser, Dr. Felix A.; Remmers, Karl-Heinz; Schnauss, Martin : Solar Thermal Systems, Expert Knowledge for Successful Planning and Construction)

Solarthermie 2000 and Solarthermie 2000Plus – Results
Investment cost: large system



(Source: Peuser, Dr. Felix A.; Remmers, Karl-Heinz; Schnauss, Martin : Solar Thermal Systems, Expert Knowledge for Successful Planning and Construction)

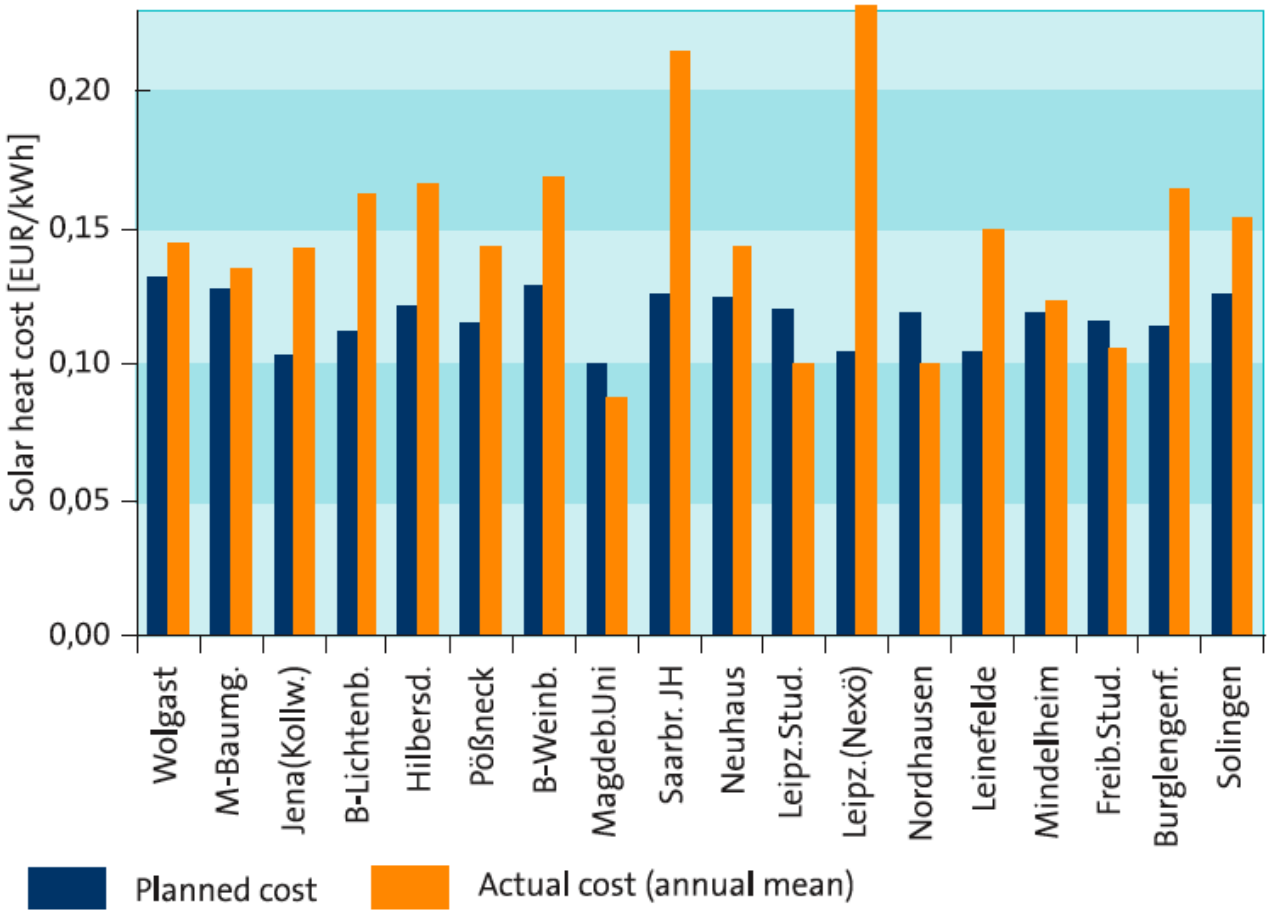
Solarthermie 2000 and Solarthermie 2000Plus – Results
Spread of the specific costs



Spread of costs of large solar systems within the »Solarthermie 2000« programme; Average values are marked with a dark dot

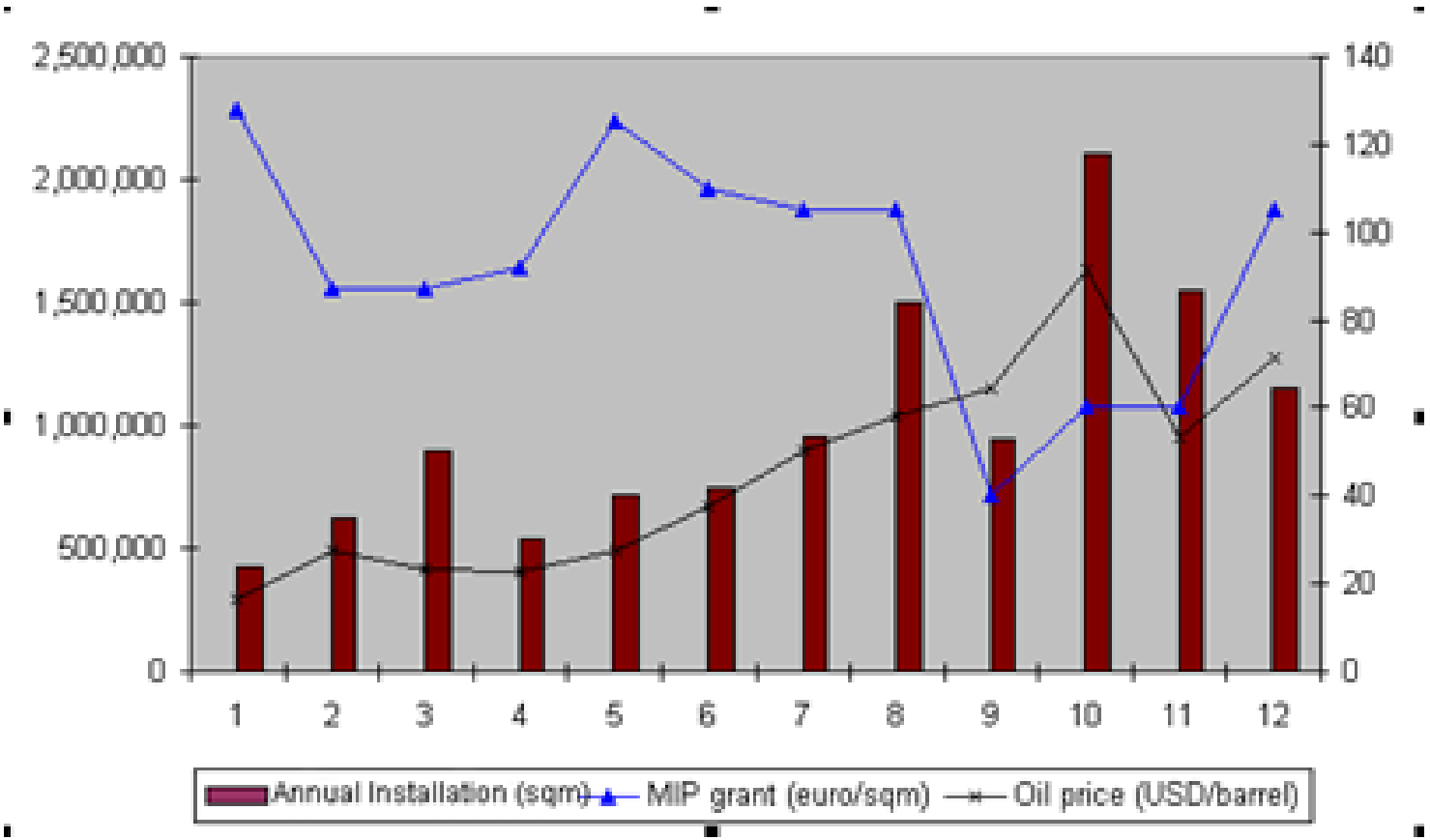
(Source: Peuser, Dr. Felix A.; Remmers, Karl-Heinz; Schnauss, Martin : Solar Thermal Systems, Expert Knowledge for Successful Planning and Construction)

Solarthermie 2000 and Solarthermie 2000Plus – Results
Achieved cost of usable solar heat



(Source: Peuser, Dr. Felix A.; Remmers, Karl-Heinz; Schnauss, Martin : Solar Thermal Systems, Expert Knowledge for Successful Planning and Construction)

Policy: Annual installation and MIP grant level in Germany

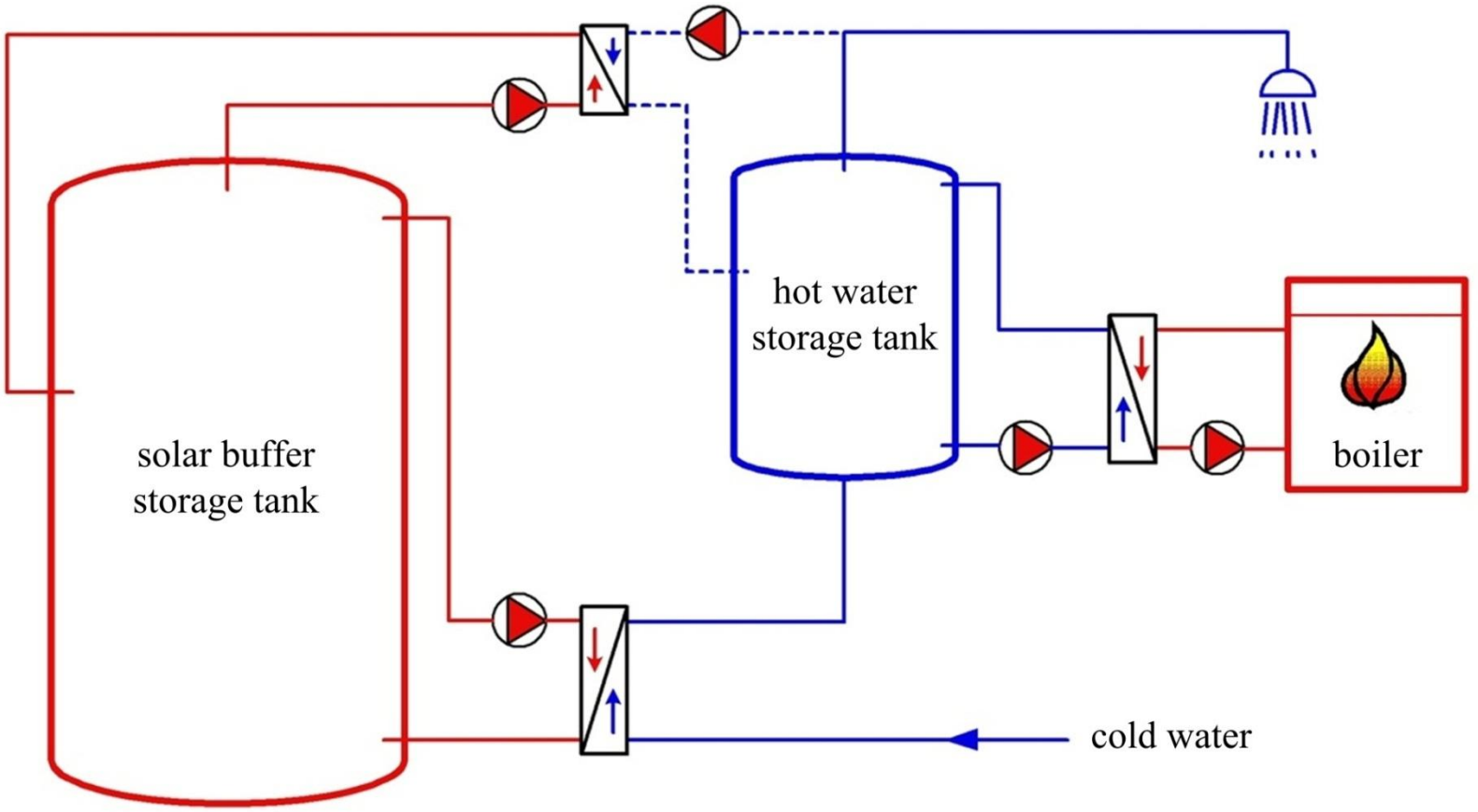


Source Prasitpianchai, S. 2011. Solar Heat in Agro Industrial Process – Final Report. Bangkok, Deutsche Gesellschaft für international Zusammenarbeit (GIZ) GmbH

Issue: Legionella prophylaxis – DVGW W551 and W552

- large-scale DHW systems are subjected to detailed guidelines to **ensure water hygiene and especially legionella prophylaxis**
- large-scale DHW systems are defined as:
  - systems with volumes of hot water storage tanks filled with potable water **exceeding 400 litres** or
  - systems with volumes in the hot water piping between storage tank and furthest draw-off point **exceeding three litres**
- these systems are subjected to different regulations, e.g. hot water storage tanks must be **heated to a minimum of 60 degrees Celsius once a day**
- in order to avoid negative influences through the required guidelines to the solar yield**, buffer storages** are installed to **reduce the volume of potable water that needs to be stored in tanks**

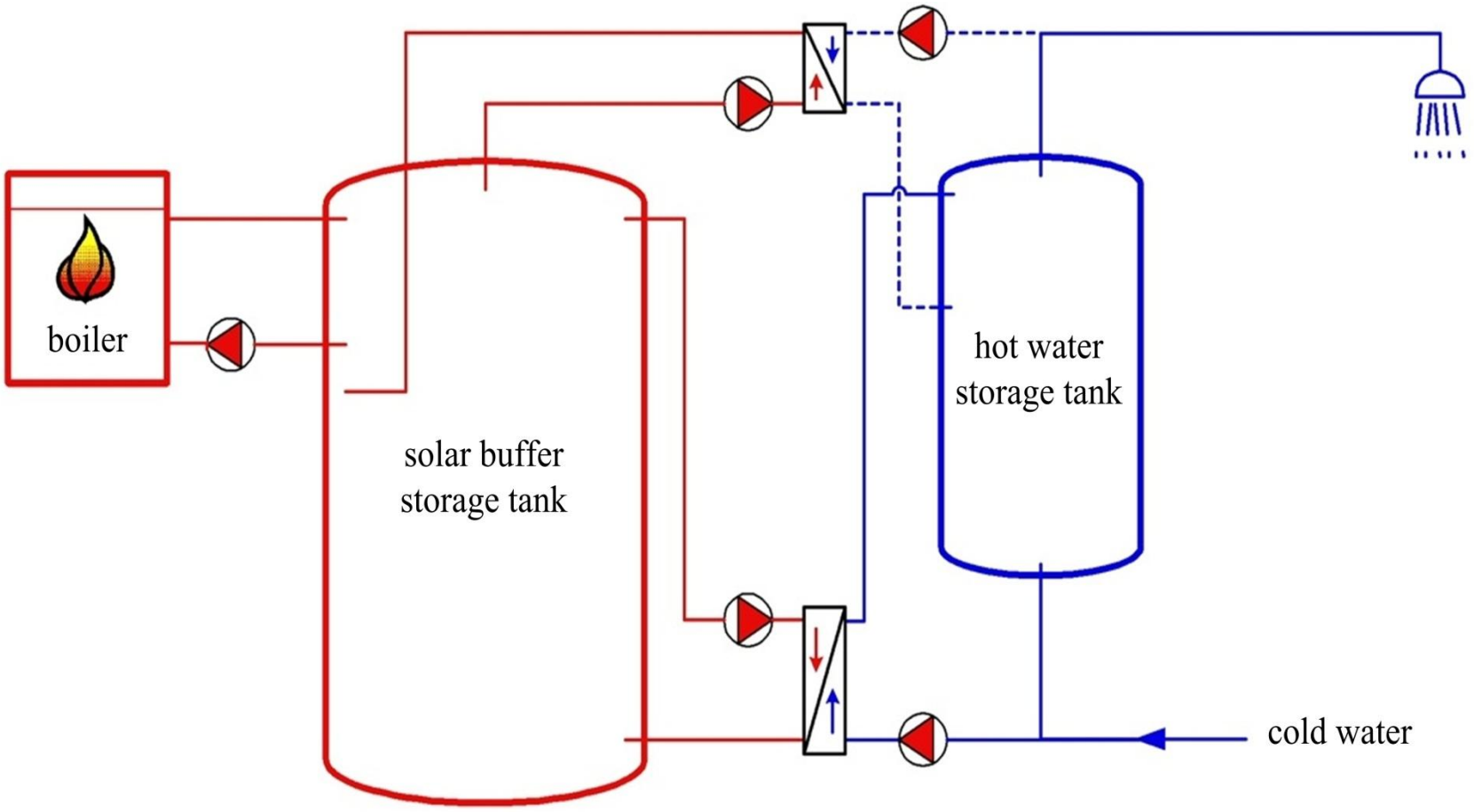
Solution for legionella issue: Buffer system with pre-heating



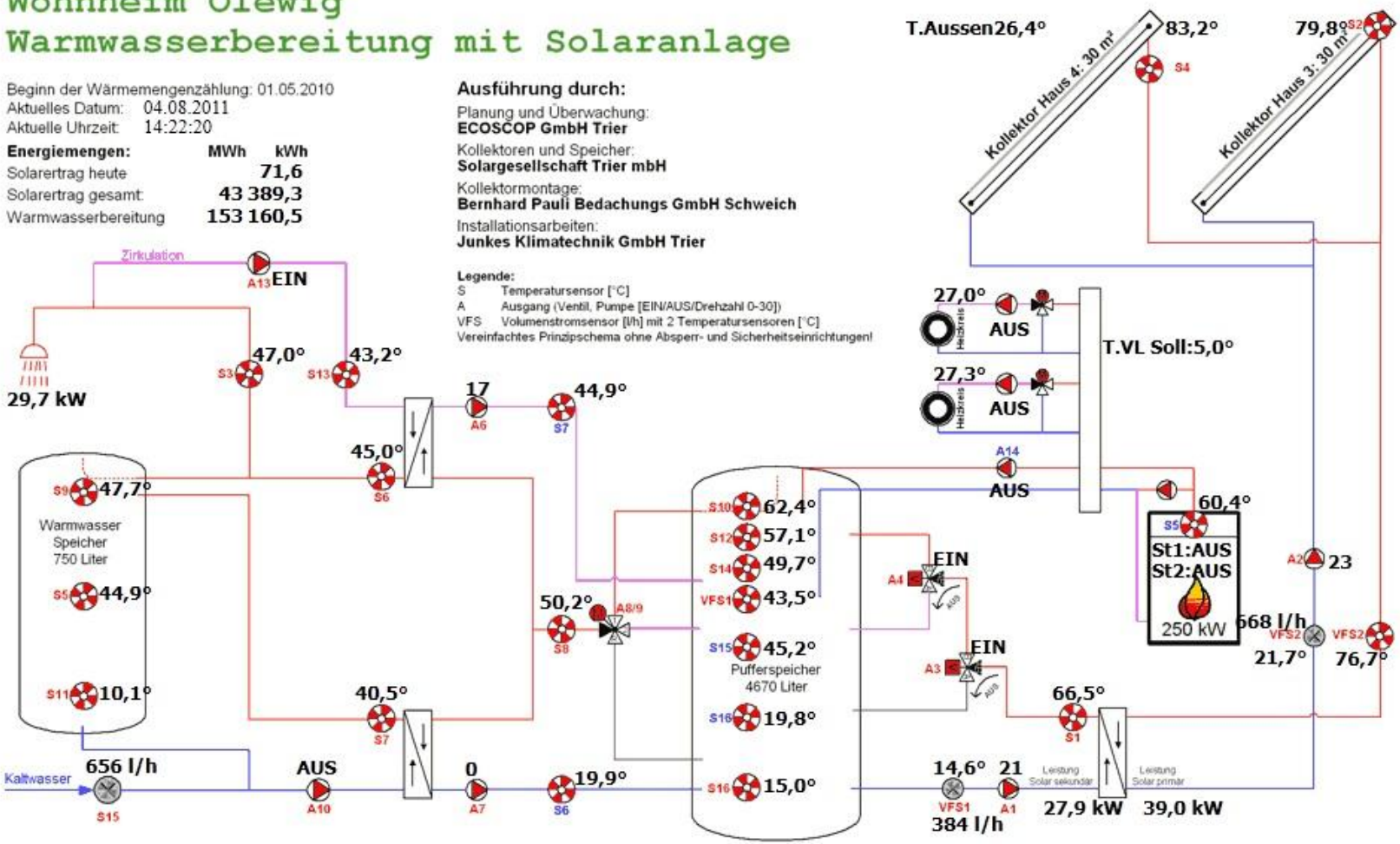
Solution: Buffer system with pre-heating

- **Advantages**
  - **low temperature** level in the lower part of the solar buffer storage tank
  - easier and cheaper system design
  - **easy retrofitting to existing conventional systems**
- **Disadvantages**
  - **charging of solar energy only possible when hot water is tapped**
  - complicated control for optimal discharging of the solar buffer storage tank and tap water heating
  - **difficult heat exchanger design** in large buildings with dynamic tap water flow rates

Solution: Buffer system with integrated auxiliary heater



Requirement for Optimization: System Monitoring of large Solar Systems : www.olewig-solar.de



Potential of Solar Water Heater in Thailand

Sectors	Energy demand in low-medium temperature (ktoe)	% penetration	Potential of solar hot water (ktoe)	Electricity (GWh)	LPG (kg)	Fuel oil (liter)	Collector area (m^2)
Residential	314	20	62.8	730.36			608,637
Commercial	18.5	20	3.7	12.91	2,158,333		22,872
Industrial	874	10	87.4			92,856,232	847,052
Total	**1206.5**		**153.9**	**743.27**	**2,158,333**	**92,856,232**	**1,478,561**

Source Prasitpianchai, S. 2011. Solar Heat in Agro Industrial Process – Final Report. Bangkok, Deutsche Gesellschaft für international Zusammenarbeit (GIZ) GmbH

Temperature Ranges for different Food Industrial Processes

Industry	Process	Temperature (°C)
		80 100 120 140 160 180
Dairy	Pressurization	
	Sterilization	
	Drying	
	Concentrates	
	Boiler feed water	
Tinned Food	Sterilization	
	Pasteurization	
	Cooking	
	Bleaching	
Meat	Washing	
	Sterilization	
	Cooking	
Beverages	Washing	
	Steriliation	
	Pasteurization	

Source: Kalogiron, S.: The potential of solar energy in food-industry process heat applications, Nicosia, Cyprus.

Thailand: Overview of subsidy program 2008 until 2011

Targets/Year in m²/year	2007	2008	2009	2010	2011	2007-2011	2012-2022	2007-2022
Originally Planned	-	5,000	7,500	10,000	17,500	40,000	260,000	300,000
Actual Plan	-	5,000	3,000	10,000	10,000	28,000		
Results	-	3,972.52	2,910	10,000	10,000 *	27,000		

- 3000 Baht/m² (74 Euro/m²) for solar collectors with solar yield < 800 kWh/m²/a, but > 500 kWh/m²/a per year
- 4500 Baht/m² (111 Euro/m²) for solar collectors with average energy collection > 800 kWh/m²/a

Source Prasitpianchai, S. 2011. Solar Heat in Agro Industrial Process – Final Report. Bangkok, Deutsche Gesellschaft für international Zusammenarbeit (GIZ) GmbH

Thailand: Installation and economics of DEDE Subsidy Program in 2010

Applications	No. of system	Collector area (m^2)	Simple payback	
			Without subsidy (year)	With subsidy (year)
Hotel	19	2,953	3.81	2.74
Industry	11	2,960	2.94	1.94
Farm	3	2,595	4.98	3.09
Hospital	2	166	4.98	3.77
Academic Institute	4	956	4	3.01
Office building	2	370	4.41	3.13
Total	*41*	*10,000*	*3.75 (average)*	*2.57 (average)*

Source Prasitpianchai, S. 2011. Solar Heat in Agro Industrial Process – Final Report. Bangkok, Deutsche Gesellschaft für international Zusammenarbeit (GIZ) GmbH

Thailand: DEDE Subsidy Effects on the Solar Market

- **Simple payback period:** In combining solar heat system with **waste heat recovery**, the pay back period can be reduced by 30%
- **Lower prices of collector and system:** higher market volume as a result from the subsidy has increased market competition
- Average **sale price of large scale solar system**: 21,500 baht/m^2 (512 euro/m^2) in 2008. The sale price of system was reduced to 16,000 baht/m^2 (380 euro/m^2) in 2010 (source: DEDE surveys).
- **Market size and sector:** Subsidy for large scale solar system has increased the market share in industrial sector as well as double the market volume.
- The **market share** has changed from domestic and commercial sector dominated to industrial sector.

Source Prasitpianchai, S. 2011. Solar Heat in Agro Industrial Process – Final Report. Bangkok, Deutsche Gesellschaft für international Zusammenarbeit (GIZ) GmbH

Conclusion and lessons learnt for Vietnam

- Solar Thermal is the forgotten **Renewable Energy Source**
- **Hugh Potential** in household, commercial, industrial energy supply
- **Economics** depend on competitive fuel prices
- Countries need a **long-term investment support program** to start their national solar thermal industry
- **Capacity Building** of technicians / engineers is required
- Legionella issue in commercial sector important
- **Quality** in planning, system design and materials matters: **20 years of operation** are possible with Solar Yields of more than 800 -1000 $kWh_{th}/m^2/a$ (PV system < 300 $kWh_{el}/m^2/a$)

Thank you for your attention!

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