



Solar heat for industrial processes – Technology and potential

1. Potential and application areas
2. System integration and collectors
3. Existing solar process heat systems
4. Conclusion

Institute of Thermal Engineering

- Department of Solar and Systems Engineering
 - at Kassel University since 2001
 - 2 Professors
 - 20 Scientists + diploma students/assistants
- FSAVE solar technology (spin-off; www.fsava.de)



Research on solar process heat:

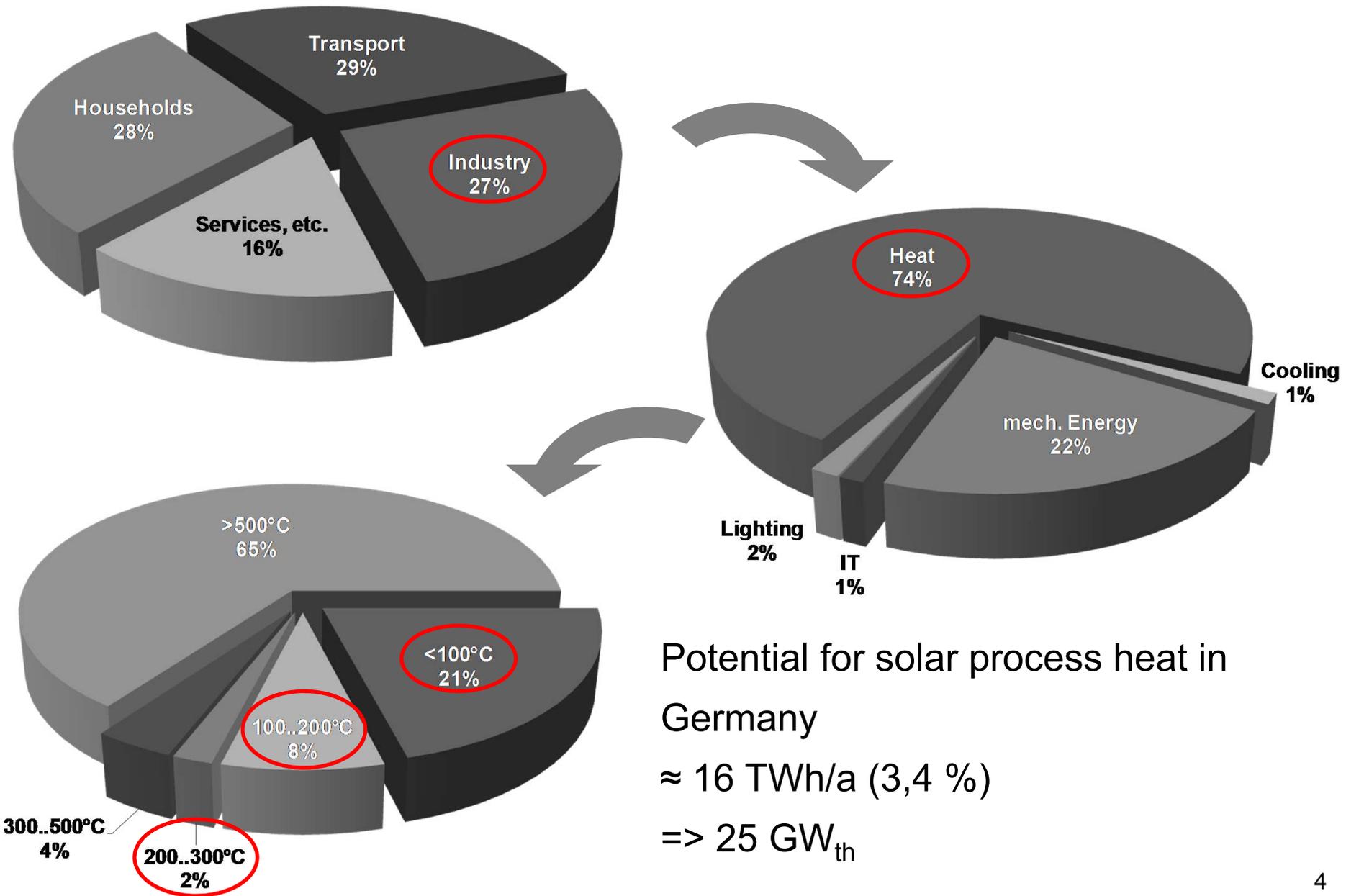
- integration of solar thermal energy in industrial processes
- combination of solar thermal energy and energy efficiency
- design of solar thermal systems for industrial applications

=> Aim: facilitate integration, design and implementation

Outline

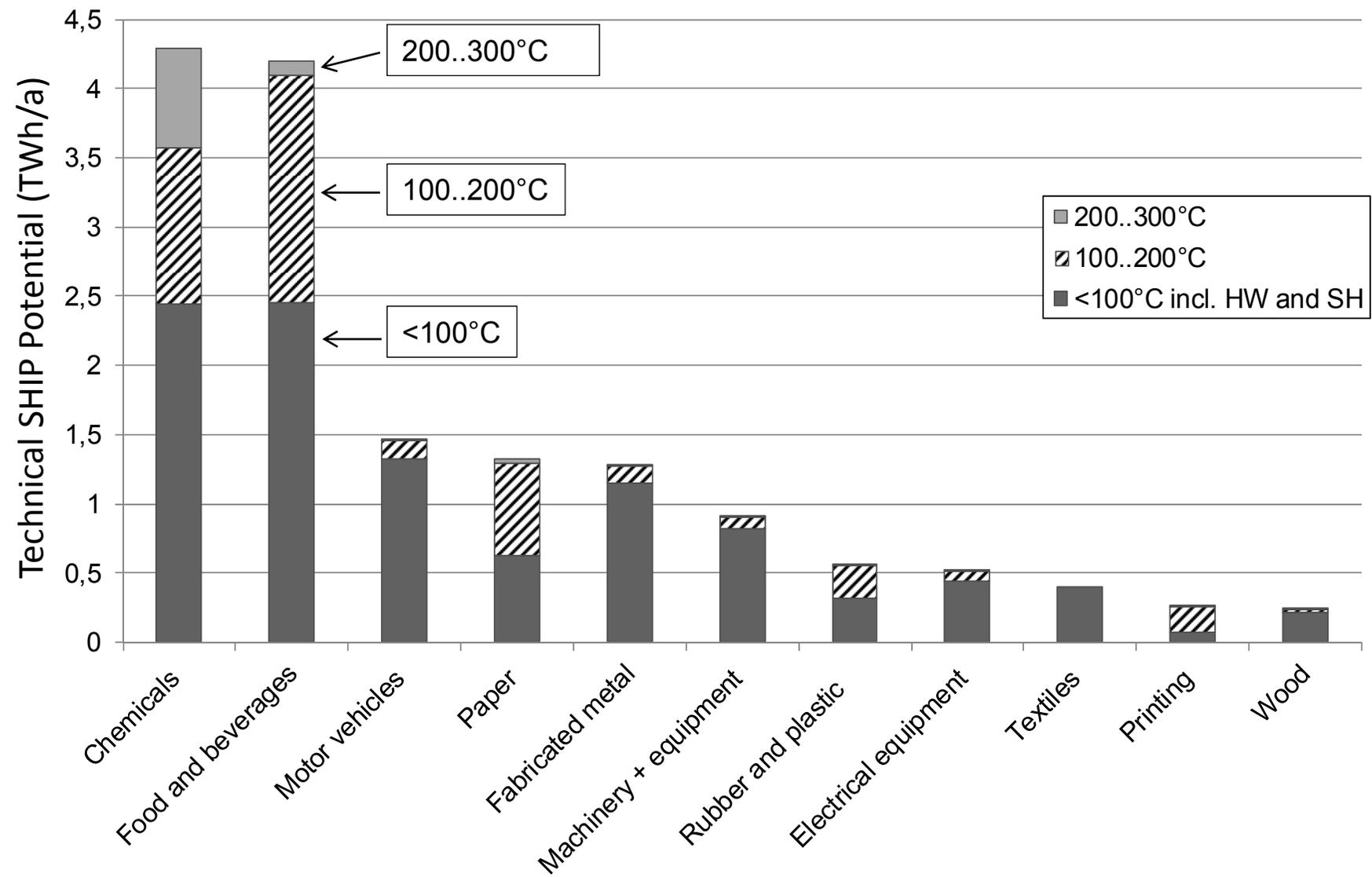
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Potential for solar process heat in Germany



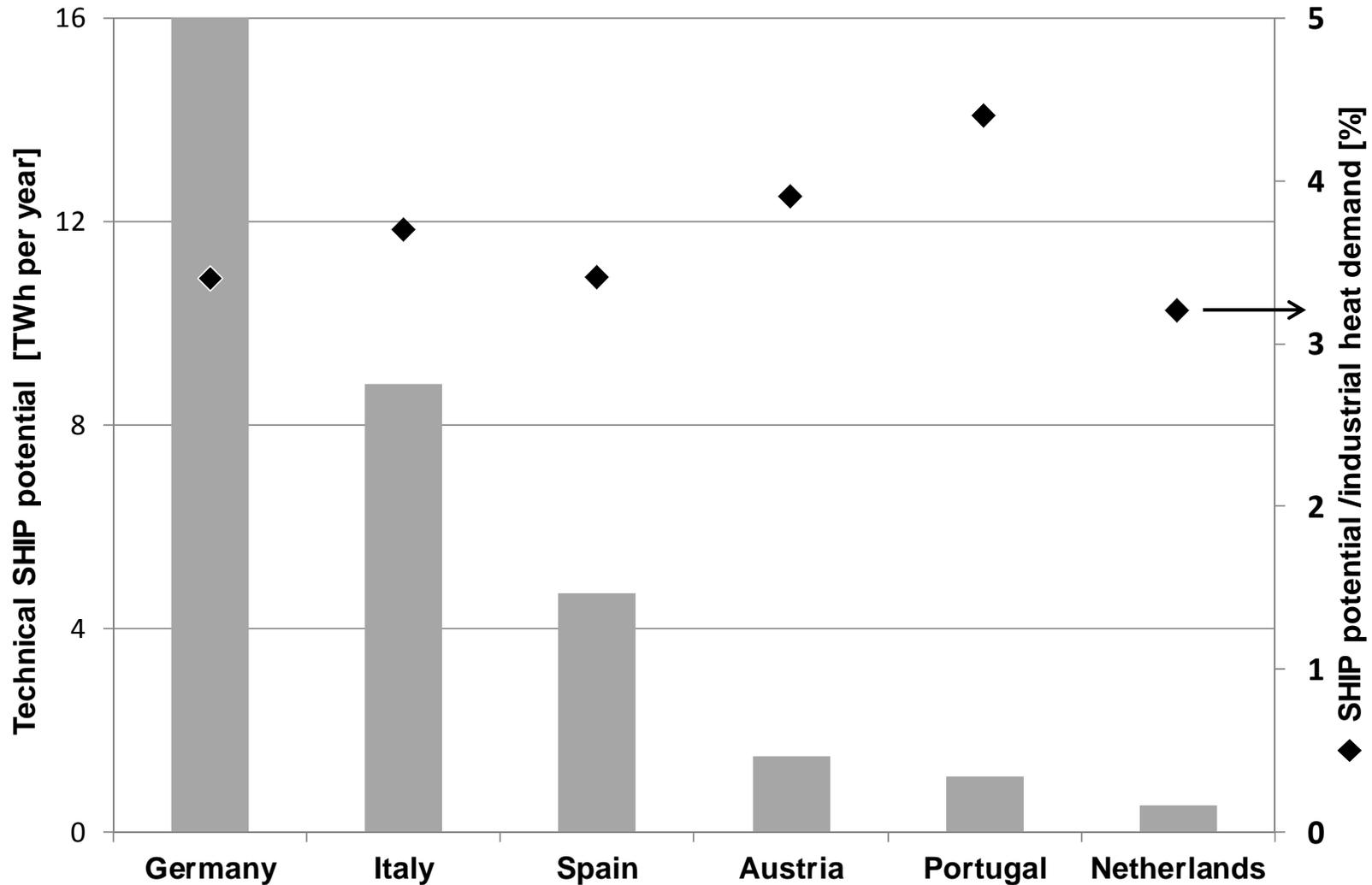
Potential for solar process heat in Germany
 ≈ 16 TWh/a (3,4 %)
 => 25 GW_{th}

Potential of industrial sectors in Germany



(Source: Lauterbach et al., The potential of solar heat for industrial processes in Germany, Renewable and Sustainable Energy Reviews, in print)

Potential in European countries



SHIP Potential for EU 25 \approx 70 TWh/a

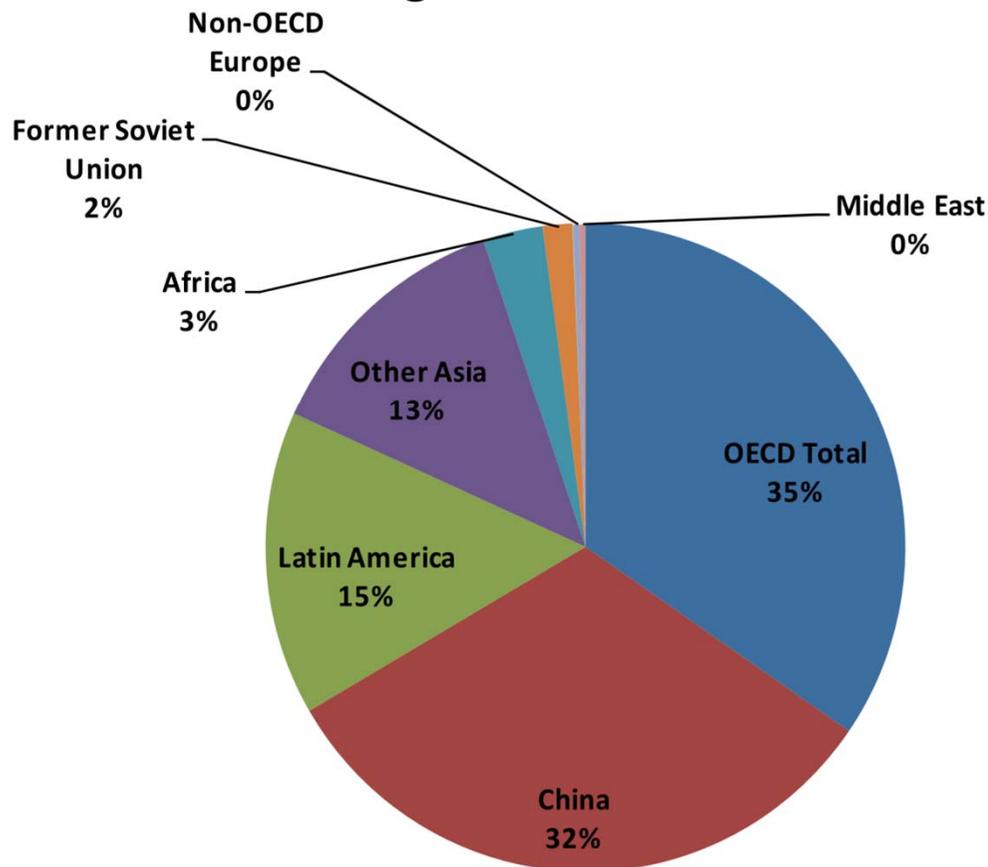
=> approx. 110 GW_{th}

(Source: IEA SHC Task 33/IV)

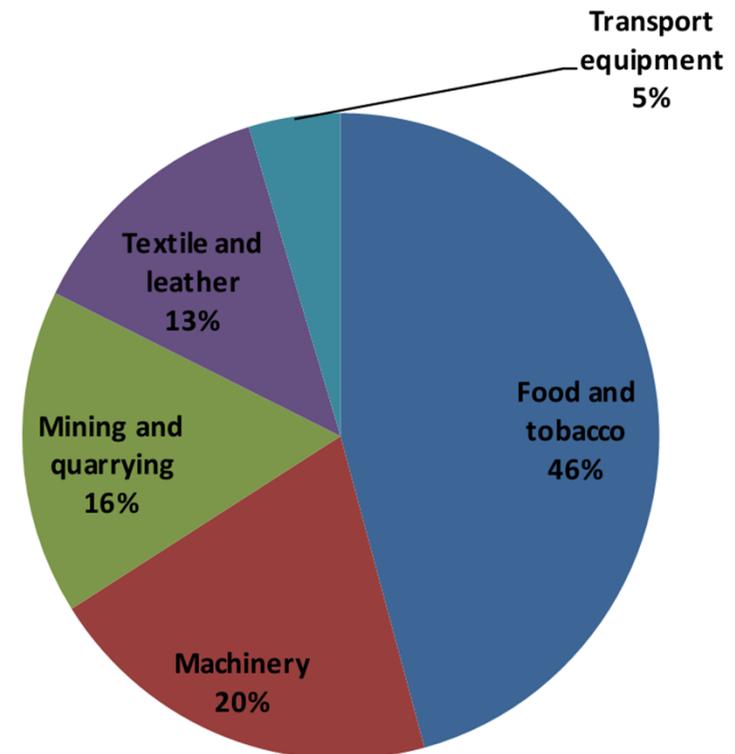
Global potential

- solar thermal can produce 1,556 TWh of process heat for industry in 2050

Regional breakdown



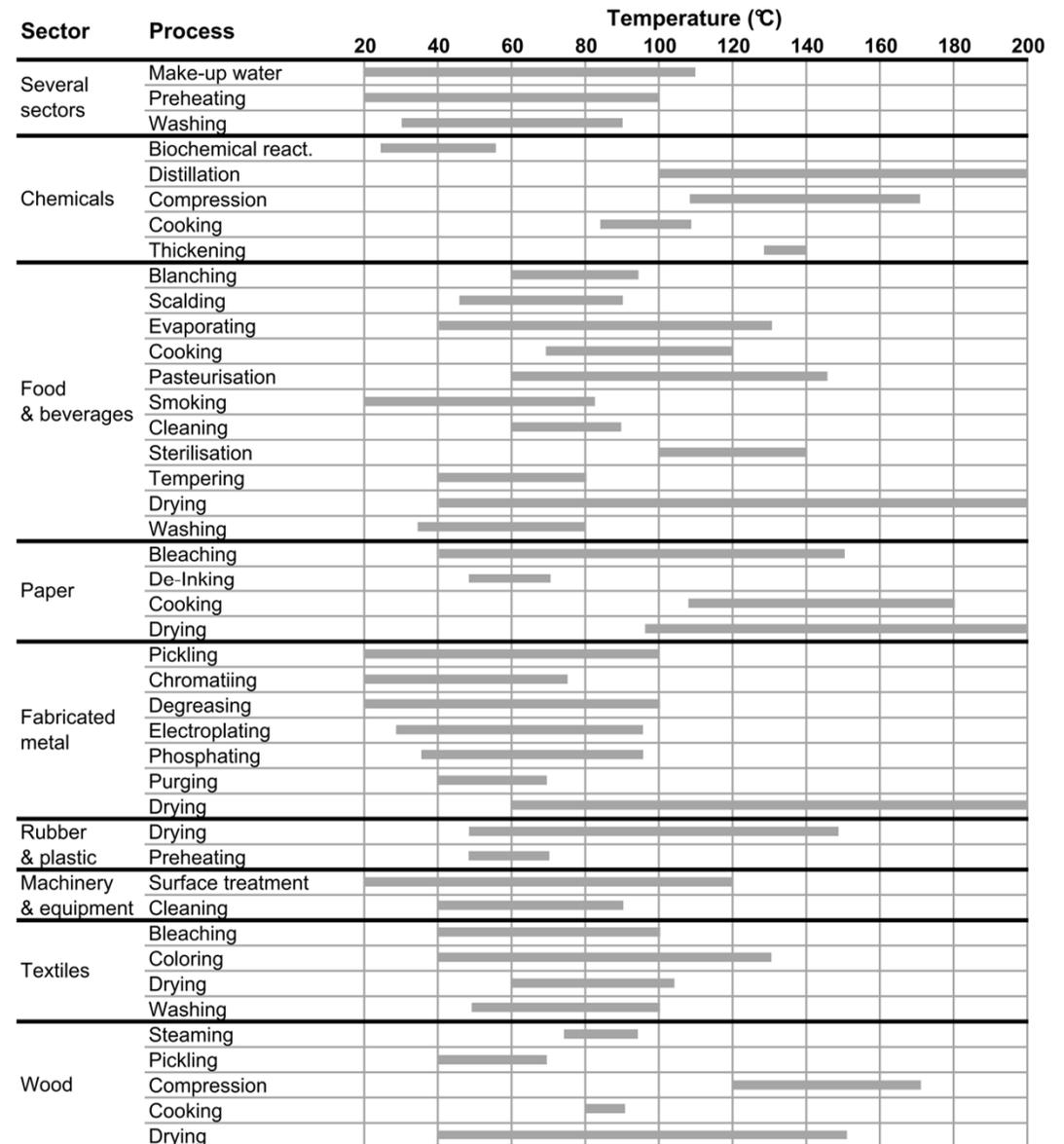
Sectoral breakdown



(Source: Renewable Energy in Industrial Applications, UNIDO)

Suitable processes

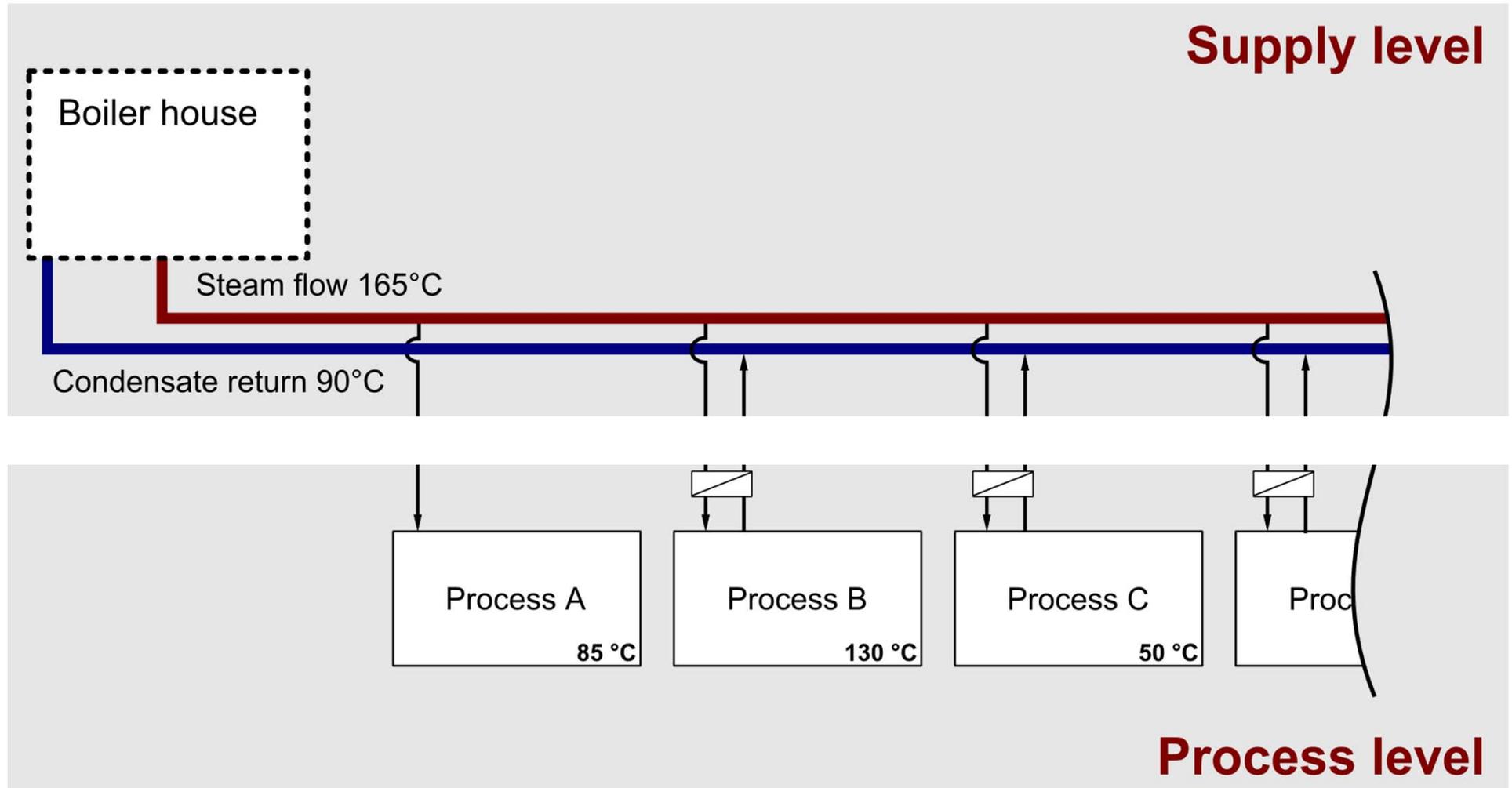
- Pre-heating of raw materials
- Cleaning and washing
- Pasteurization, sterilization
- Surface treatment
- Drying
- Boiler feed water
- Supply of hot water or steam
- ...



Outline

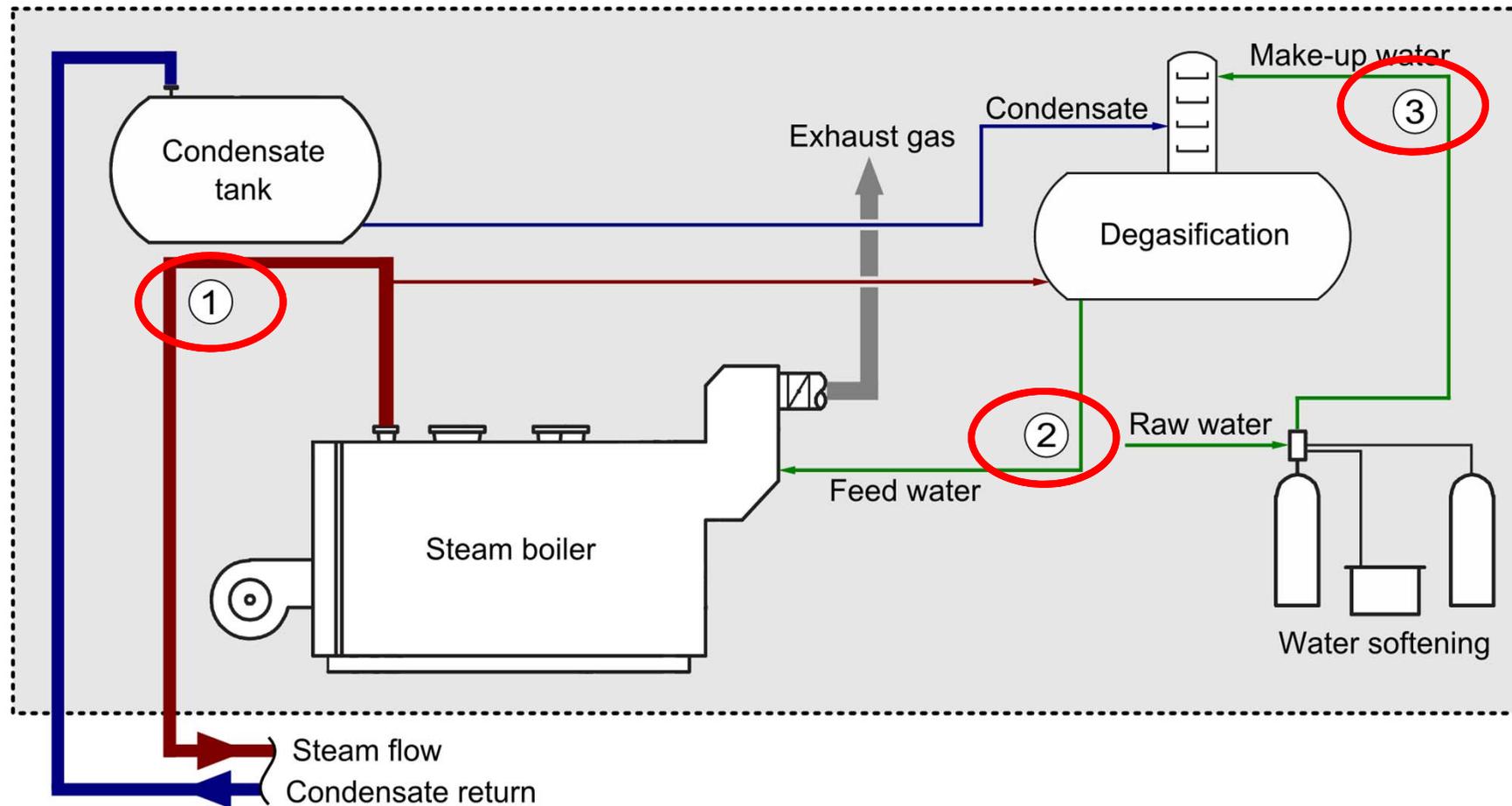
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Principles of system integration

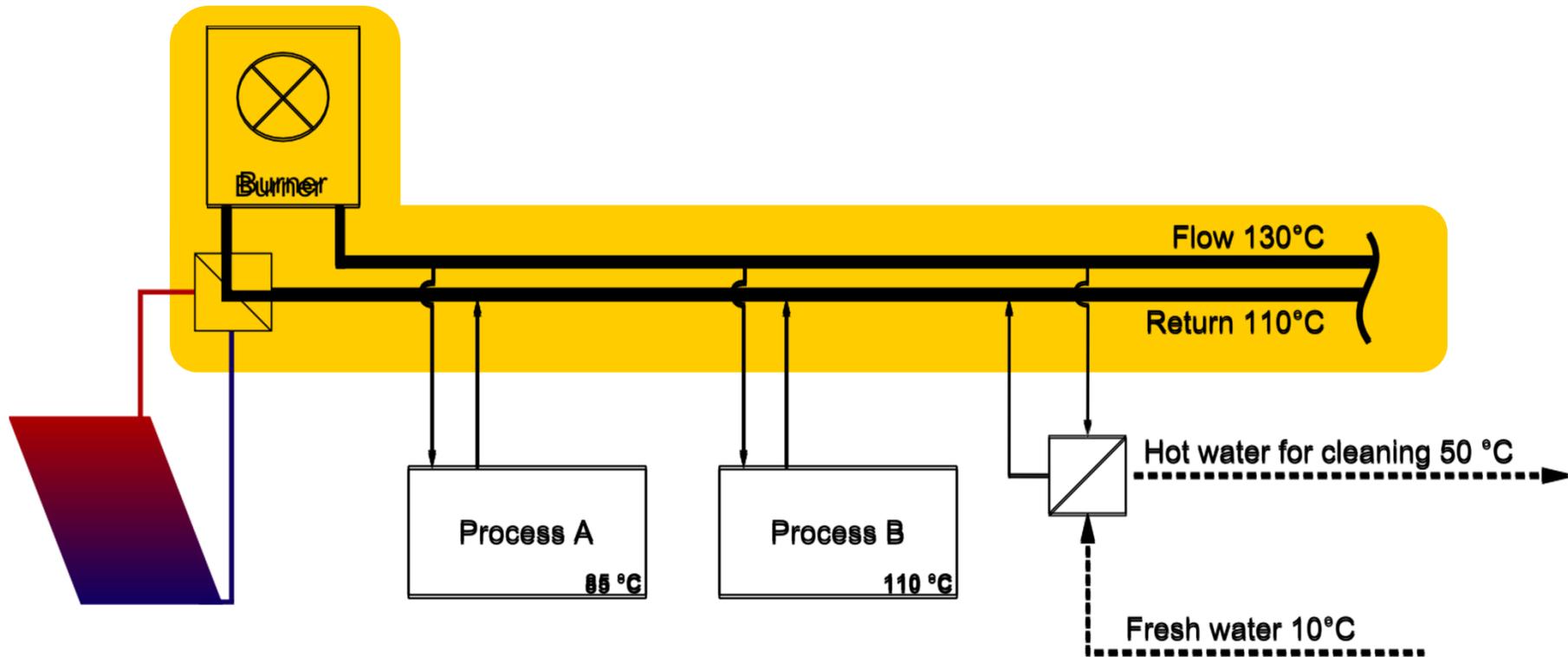


Integration on supply level - steam

- Parallel integration or increase of return temperature

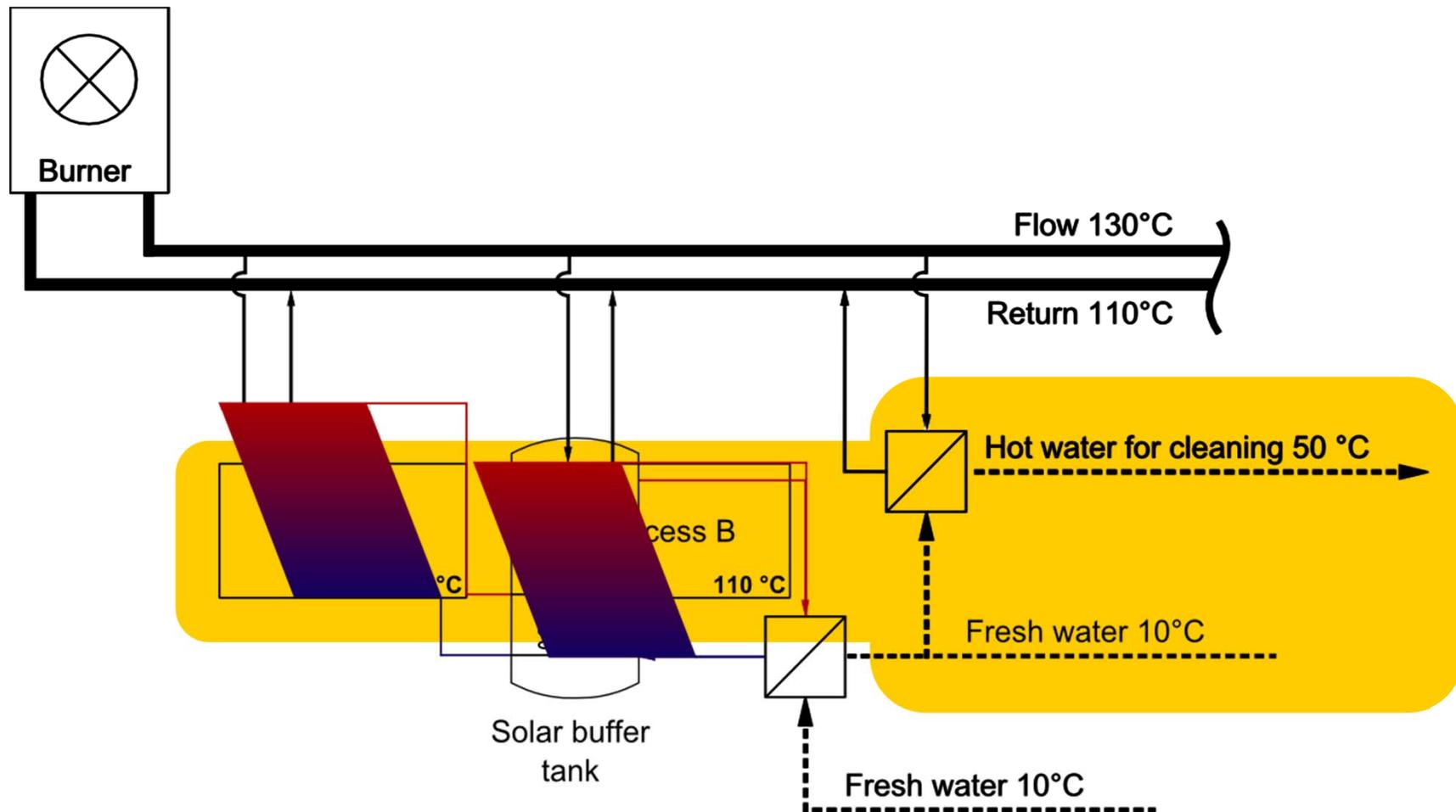


Integration on supply level – hot water



- Feed-in solar energy in heating circuit
- High set temperature
- Simple system integration
- Small number of system layouts

Integration on process level



- Solar energy is directly used for the process
- Different system layouts possible
- Often complex system integration

Collectors for process heat applications

Up to 80 °C

Flat plate collectors



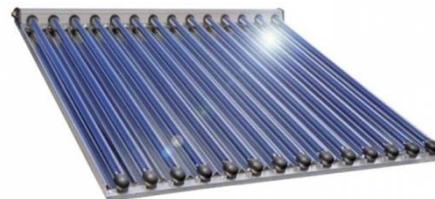
80..120 °C

Vacuum tube
Advanced flat plate
collectors



120..250 °C

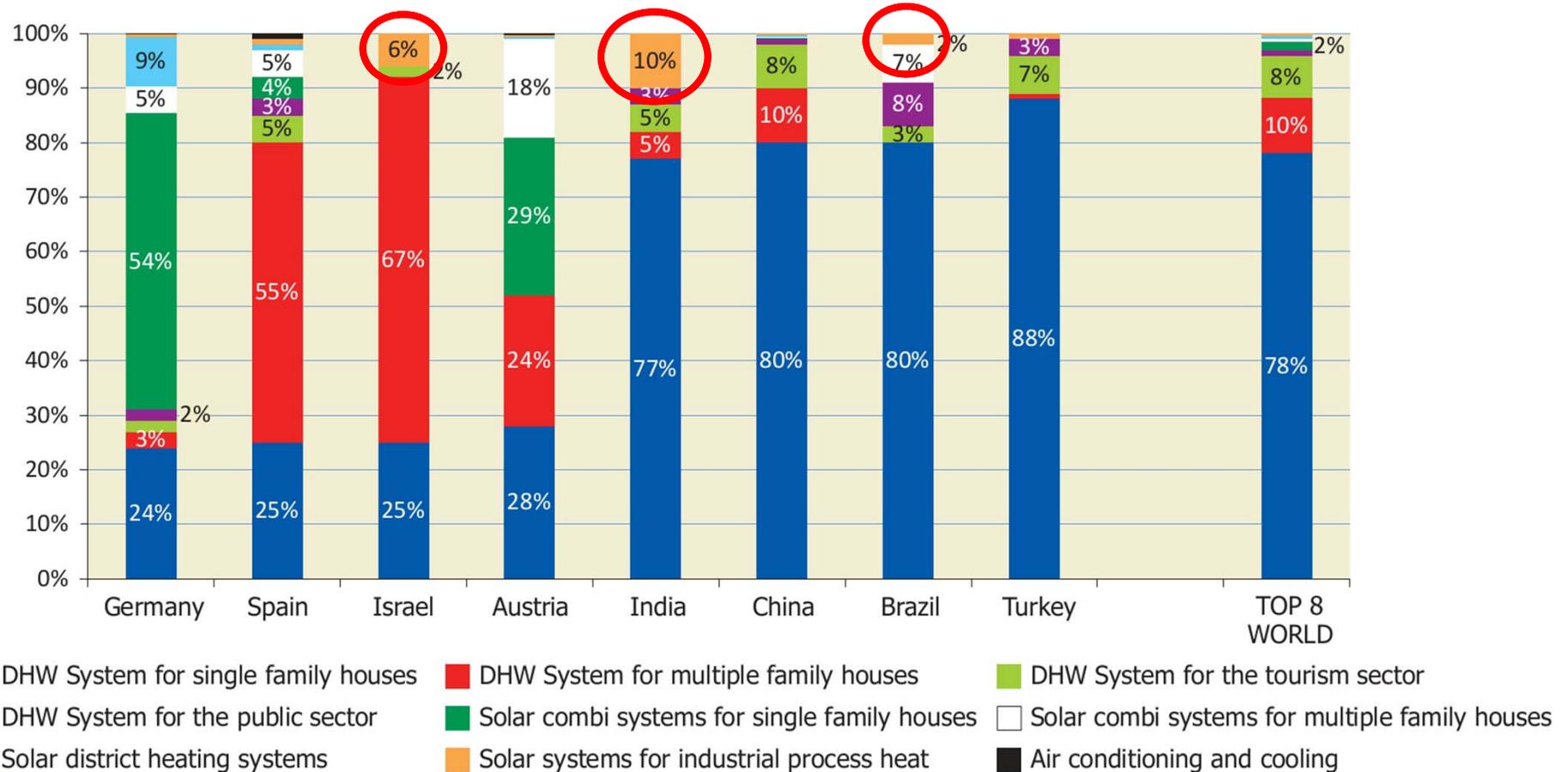
CPC-, Fresnel-,
parabolic through
collectors



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Application of 2010 installed systems



- approx. 200 solar process heat systems worldwide
- total capacity until 2010: 42 MW_{th}

Pilot plant - Hütt Brewery

- Mid-sized brewery
 - Heat consumption: 4 GWh
 - Pre heating of brewing water
- => Optimization of heat recovery
=> Solar thermal system



(155 m² FPC, 10 m³ storage)

- Expected solar yield 480 kWh/m²a
- System costs 300 €/m² (incl. 50% subsidy)

Components / installation: ThüSolar GmbH, 2010

Electro-plating Hustert

- Simple system integration, but high return flow temperature
- Solar thermal system:
 - Heating of the baths by return flow boost (65 °C / 80 °C)
 - 221 m² vacuum-tube collectors
 - No solar buffer storage
 - Expected solar gains: 450 kWh/m²
 - Expected solar fraction: 40 %



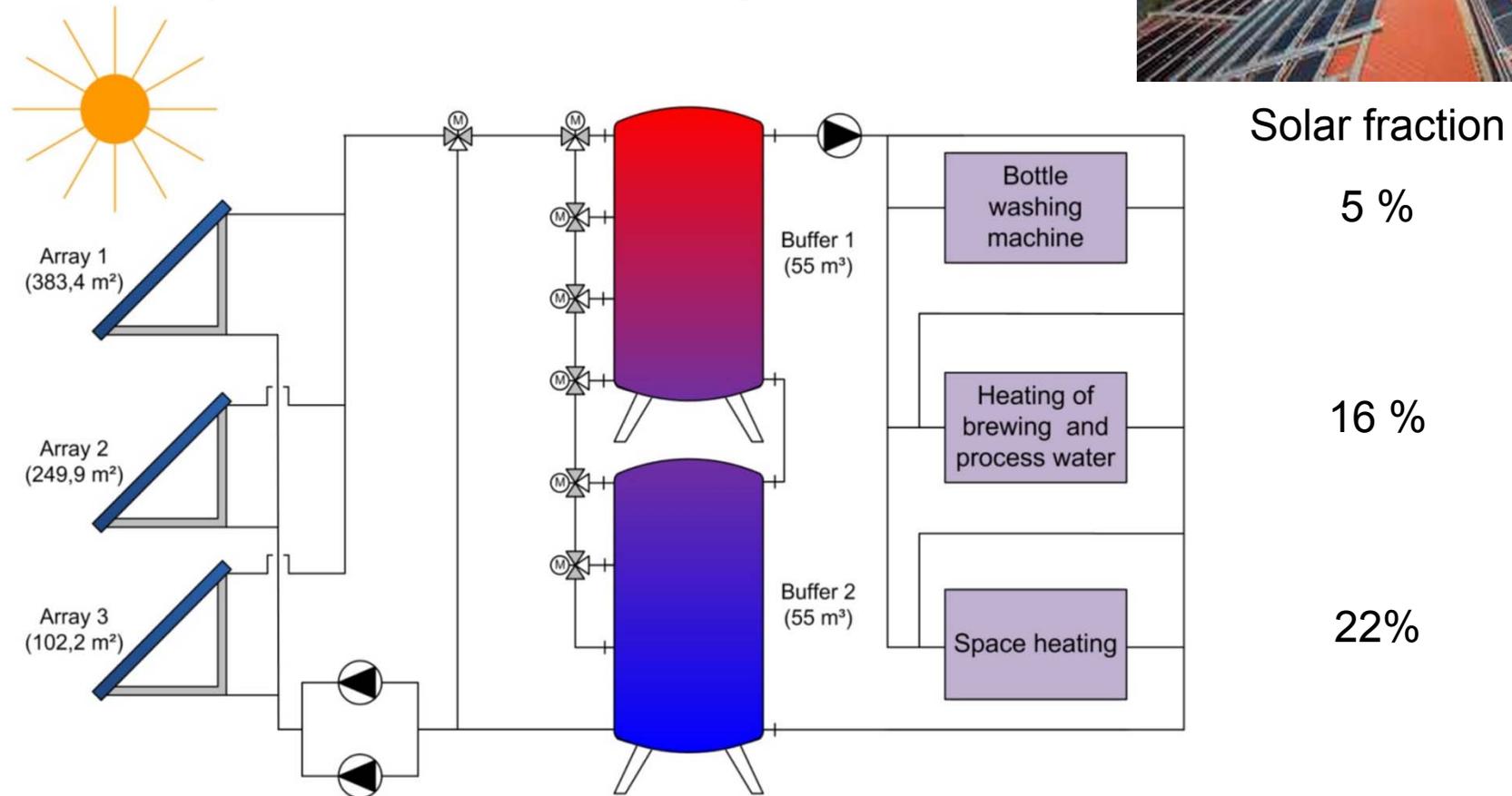
(Source: www.solar-process-heat.eu)

Components / installation: Ritter XL Solar / Schapka Haustechnik, 2011

Hofmühl Brewery



- Combination of different consumers
- 735 m² CPC ETC, two 55 m³ solar buffer tanks
- Water system with active freezing protection



Alanod factory

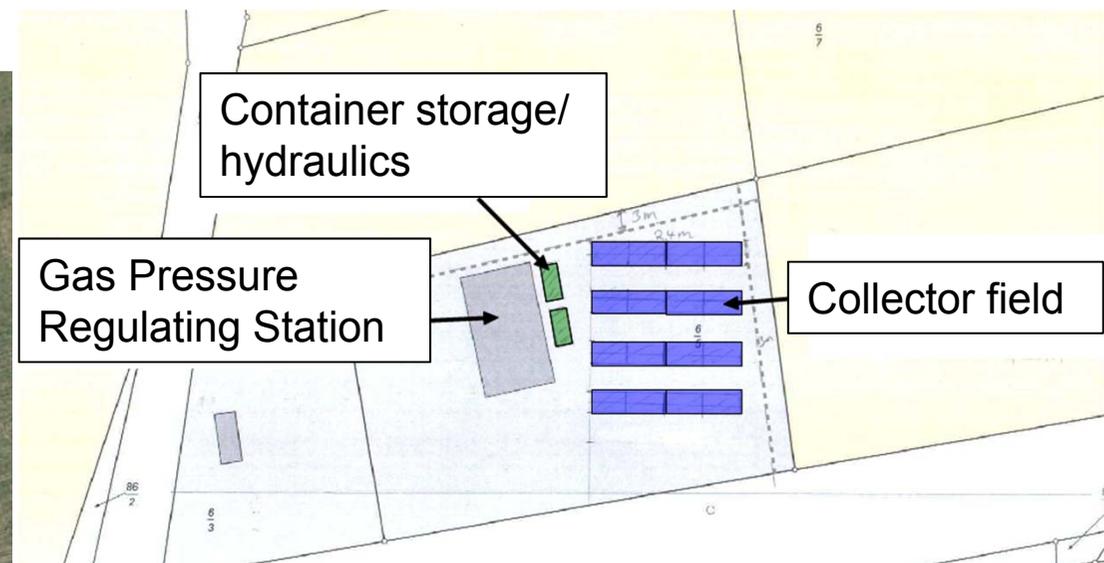
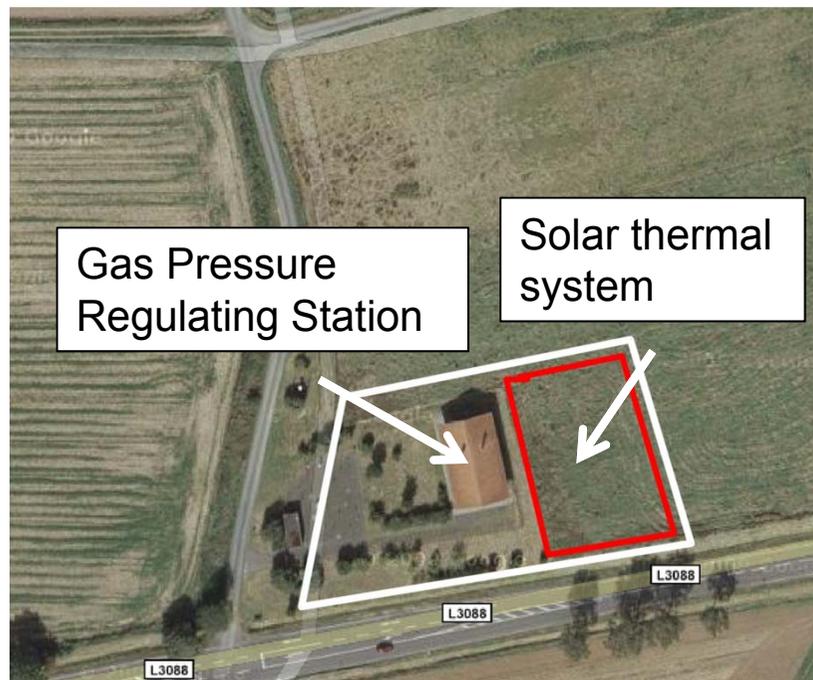
- Production of saturated steam
- 108 m² of Parabolic trough collectors
- consumer: steam line of 4 bar, 143°C



(Source: DLR)

Gas Pressure Regulating Station

- reduce the pressure in long distance grids to the consumer level
=> temperature decrease up to 25 K & risk of freezing
- low temperature level (≈ 20 to 40°C); almost constant heat demand
- Solar thermal system (355 m^2 FPC, 25 m^3 storage)
- Expected solar gains/fraction: $450 \text{ kWh/m}^2 / 15 \%$



Components/installation: Wagner&Co/ FSAVE

Financing: Enertracting GmbH

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Conclusion



- SHIP has a large potential
- Important, upcoming market for solar thermal
- Choice of integration point very important
- Collectors for all temperature levels available
- Higher yields than in domestic applications
- Ambitious economic expectations within industry
- Lack of awareness
- Lack of specialised planners and planning/design tools

Thank you very much !

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