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# IKI SOLARPAYBACK TRAINING ON SOLAR PROCESS HEAT IN SOUTH AFRICA

Suitable Solar Technologies and Industrial Processes

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[www.ise.fraunhofer.de](http://www.ise.fraunhofer.de)

# Content

- Suitable Solar Thermal Technologies
- Examples for Installed Plants
- Suitable Industrial Processes
- Outlook for Solar Process Heat

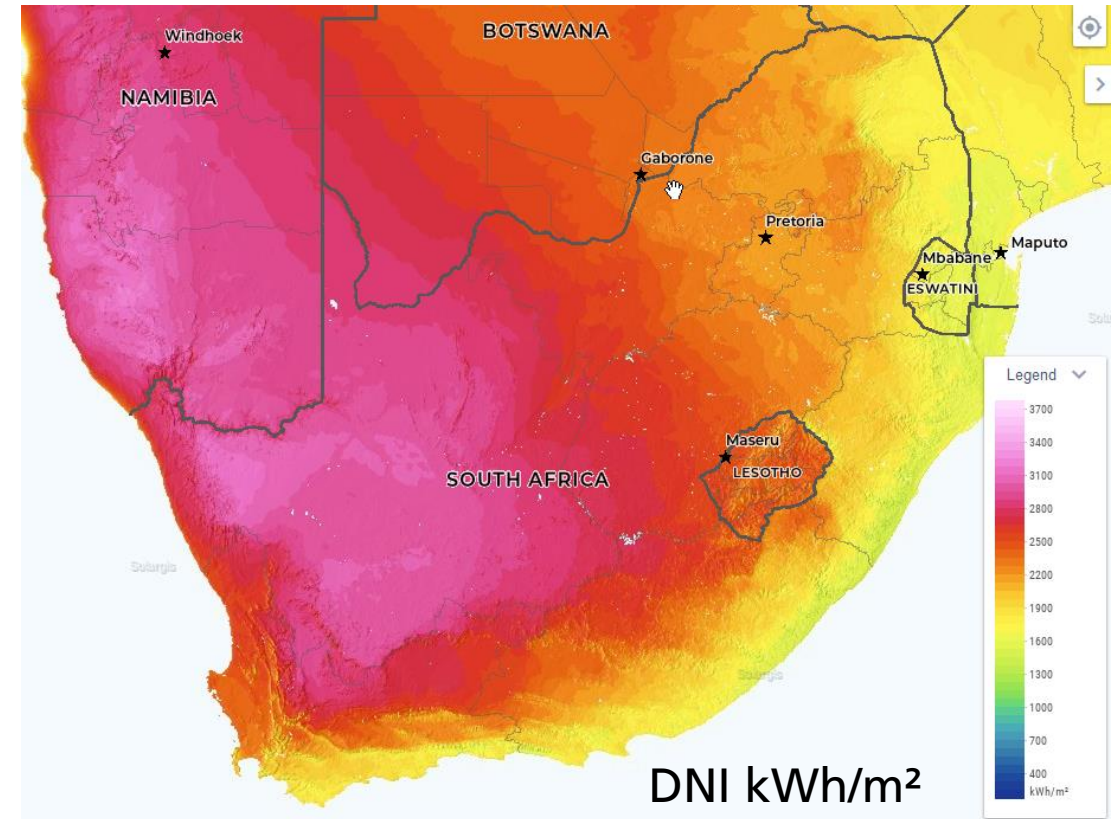
# Content

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# Potential of Solar Process Heat

## Solar Potential in South Africa

- Solar potential GHI: 1'500 – 2'300 kWh/m<sup>2</sup> [1]
- Solar potential DNI: 1'500 – > 3'000 kWh/m<sup>2</sup> [1]
- Highest Irradiation in Northern Cape
- Gauteng Region approx. 2000 kWh/m<sup>2</sup>



GLOBAL SOLAR ATLAS  
GLOBAL WIND ATLAS | ENERGYDATA.INFO

[1]

# Suitable Solar Thermal Technologies

## Available Technologies for SHIP Plants



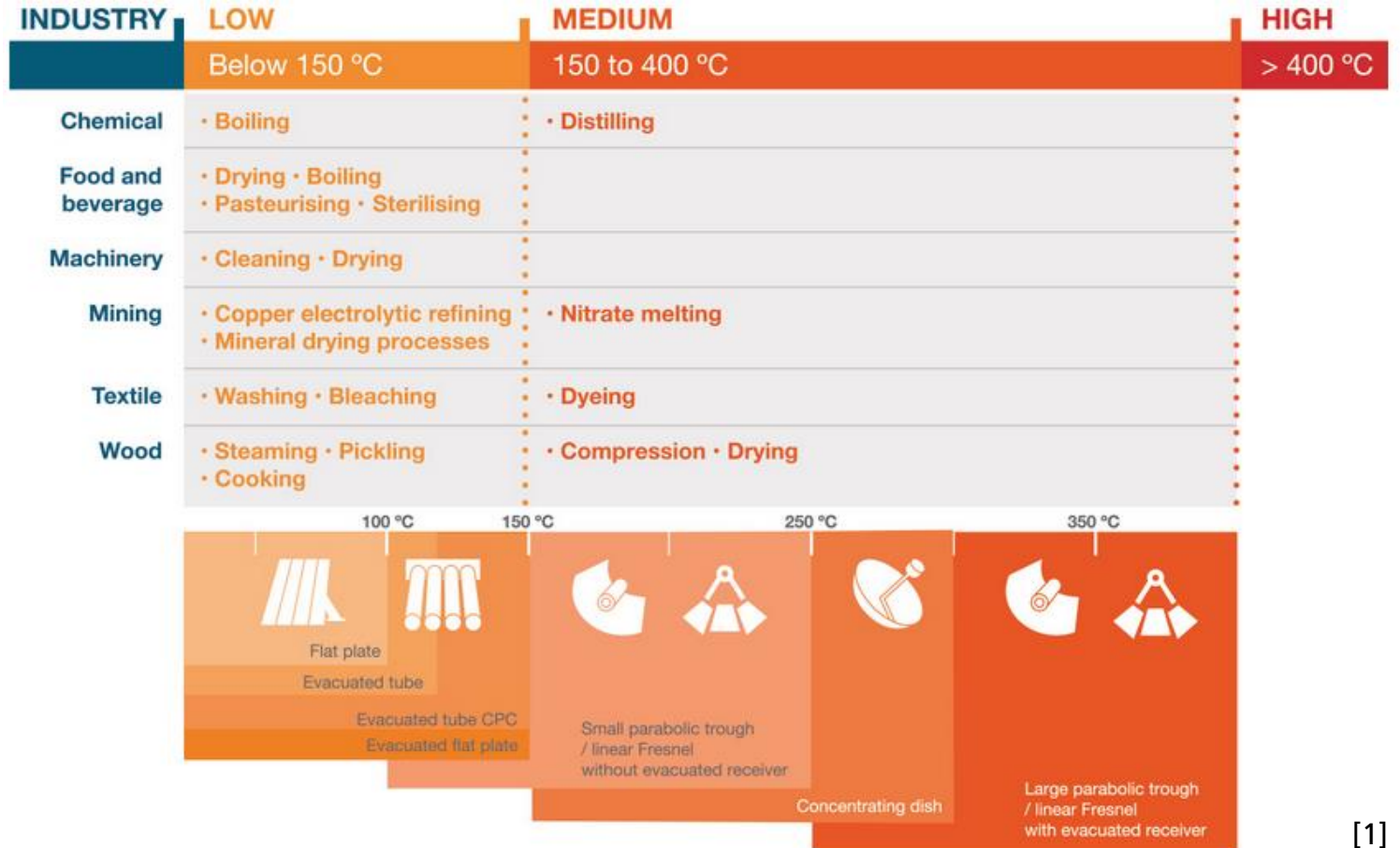
### ■ Types of solar collectors:

- Flat Plate FPC
- Evacuated Tube ETC
- Linear Fresnel LFC
- Parabolic Trough PTC

# Suitable Solar Thermal Technologies

## Collector Technology vs. Temperature Level

- Suitable solar collector technologies



[1]

# Suitable Solar Thermal Technologies

## Potential Supplier of Low-Temperature Systems

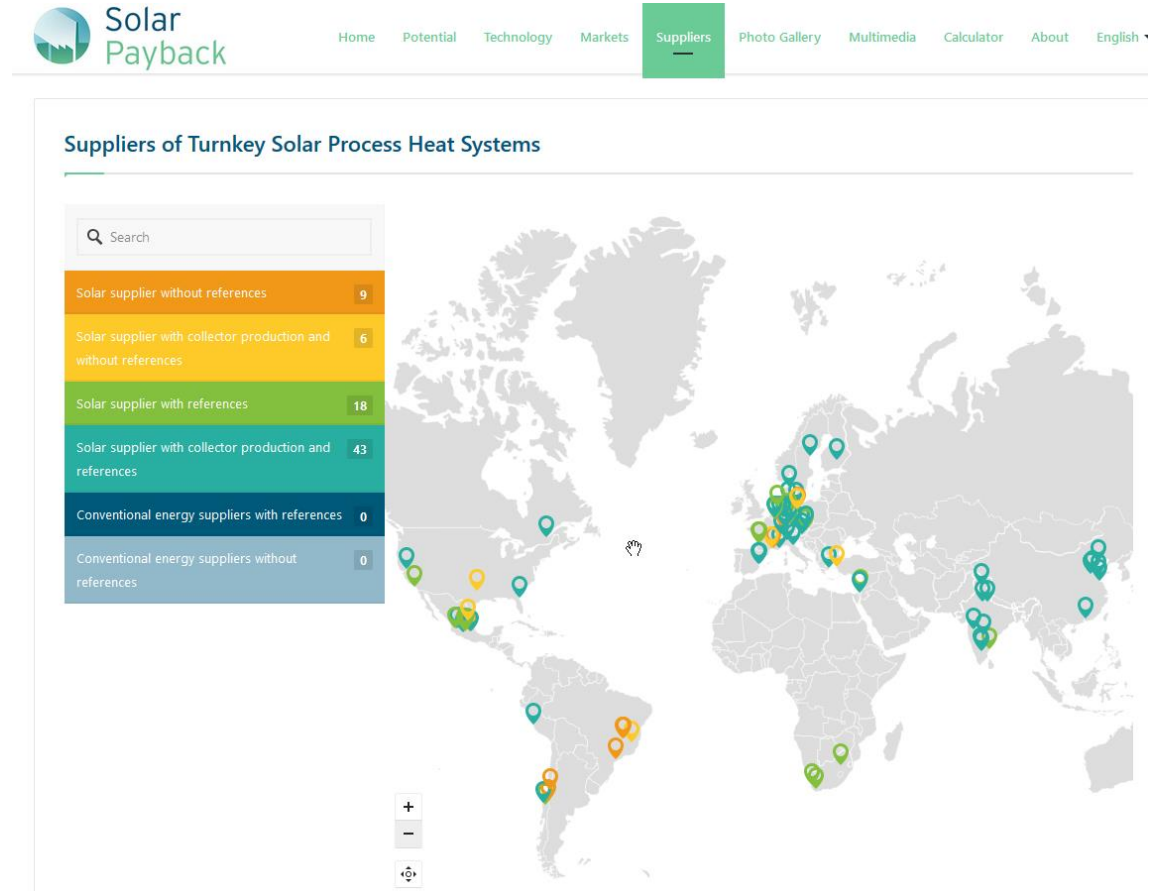
- Certification by Solar Keymark
- Database of certified system / collector / storage supplier  
<http://www.solarkeymark.dk/>
  - Vaillant
  - Wagner Solar
  - KBB Kollektorbau
  - Ritter
  - Viessmann
  - Arcon
  - Solvis
  - ...



# Suitable Solar Thermal Technologies

## Potential Supplier of SHIP Systems

- Database compiled by Solrico [1] based on three surveys 2016, 2018, 2019 and 2020
- <https://www.solar-payback.com/suppliers/>
- Turnkey suppliers that sold SHIP systems with a total of more than 10'000 m<sup>2</sup> [2]
  - S-O.L.I.D (Austria)
  - Pampa Elvira Solar (Chile)
  - Sunrain Group; Vicot Solar Technology; Himin Solar; Linuo Paradigma (China)
  - Aalborg CSP (Denmark)
  - Inter Solar Systems (India)
  - Soliterm Group (Germany)



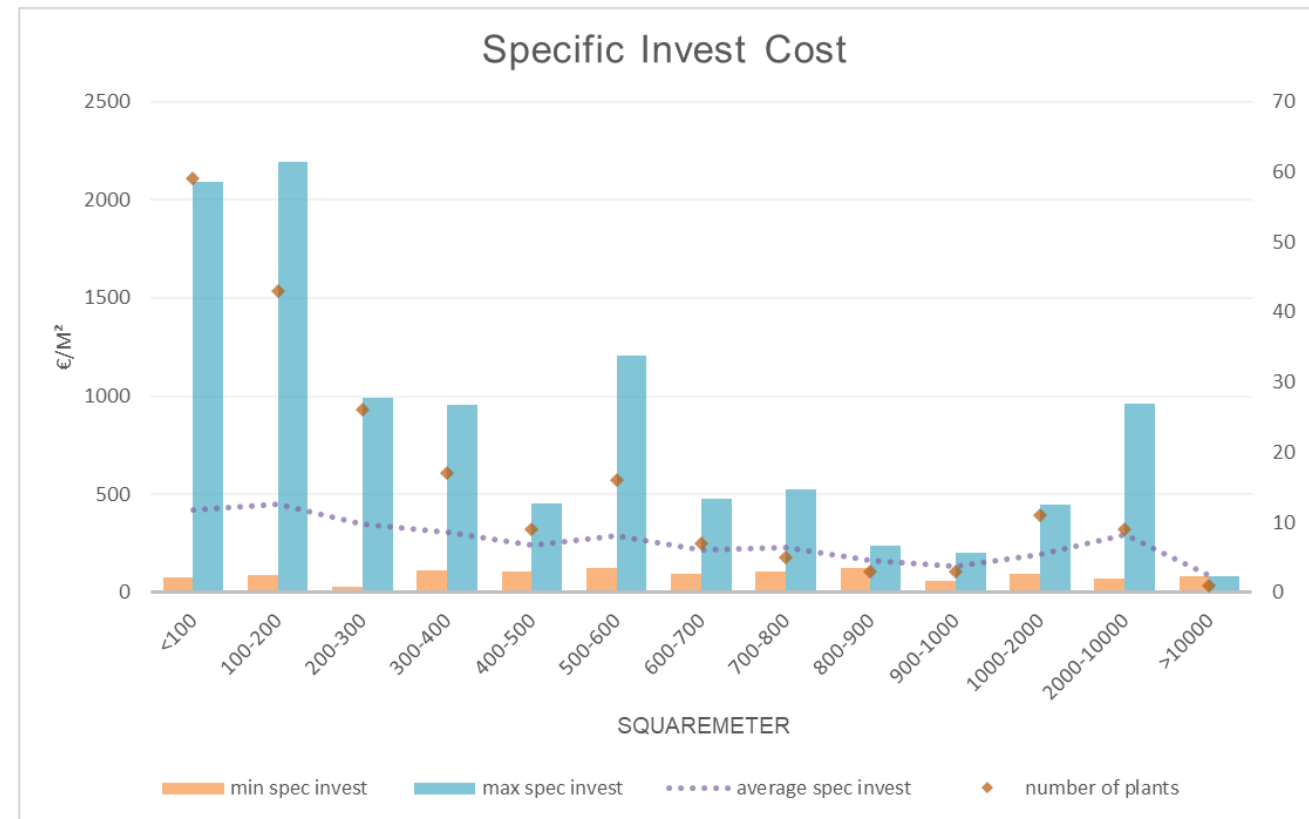


# Suitable Solar Thermal Technologies

## Average Solar Process Heat System Costs

■ Wide range of installed system costs per solar field area depending on

- technology
- temperatures
- storage size
- complexity
- integration point
- ...

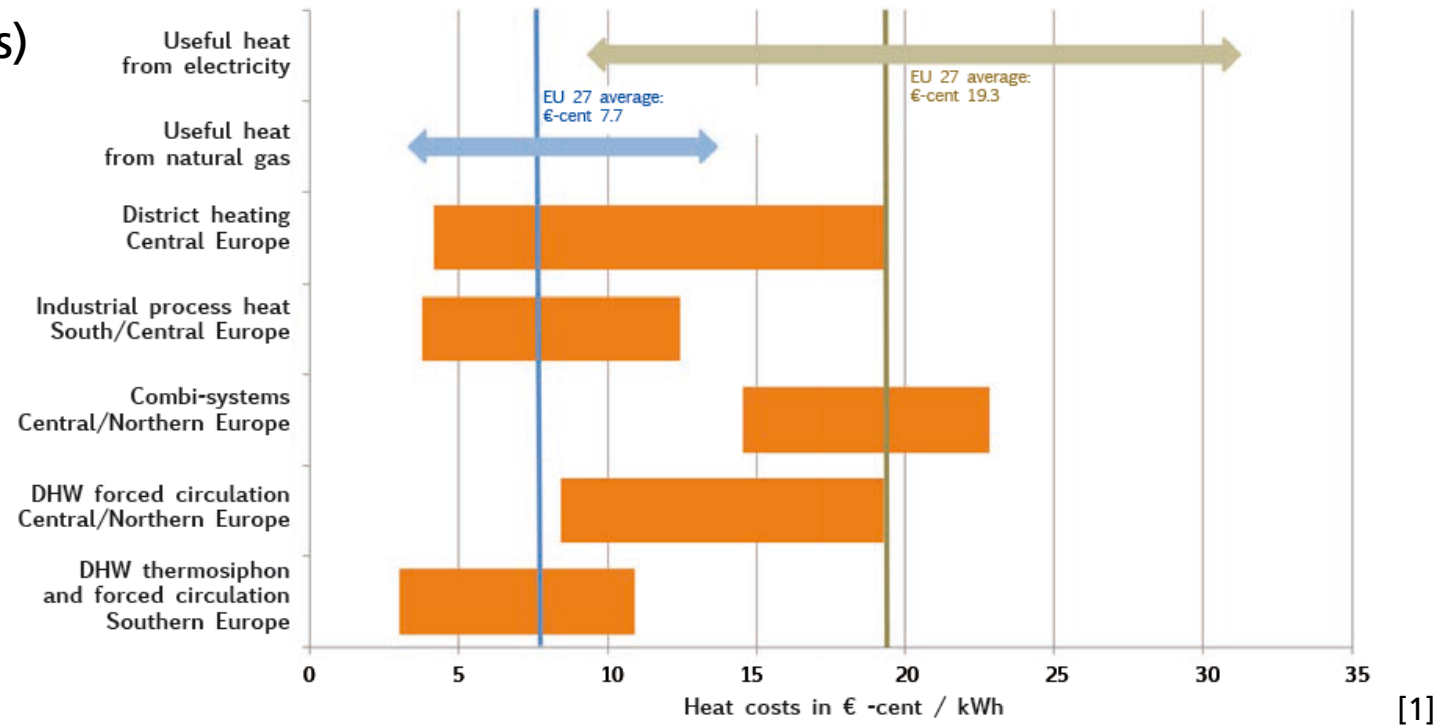


[1]

# Suitable Solar Thermal Technologies

## Range of Solar Heat Costs

- Solar heat production costs depend on
  - quality of solar collectors
  - lifetime of solar system (~20 years)
  - location & irradiance
  - general inflation
  - energy inflation
  - ...



# Content

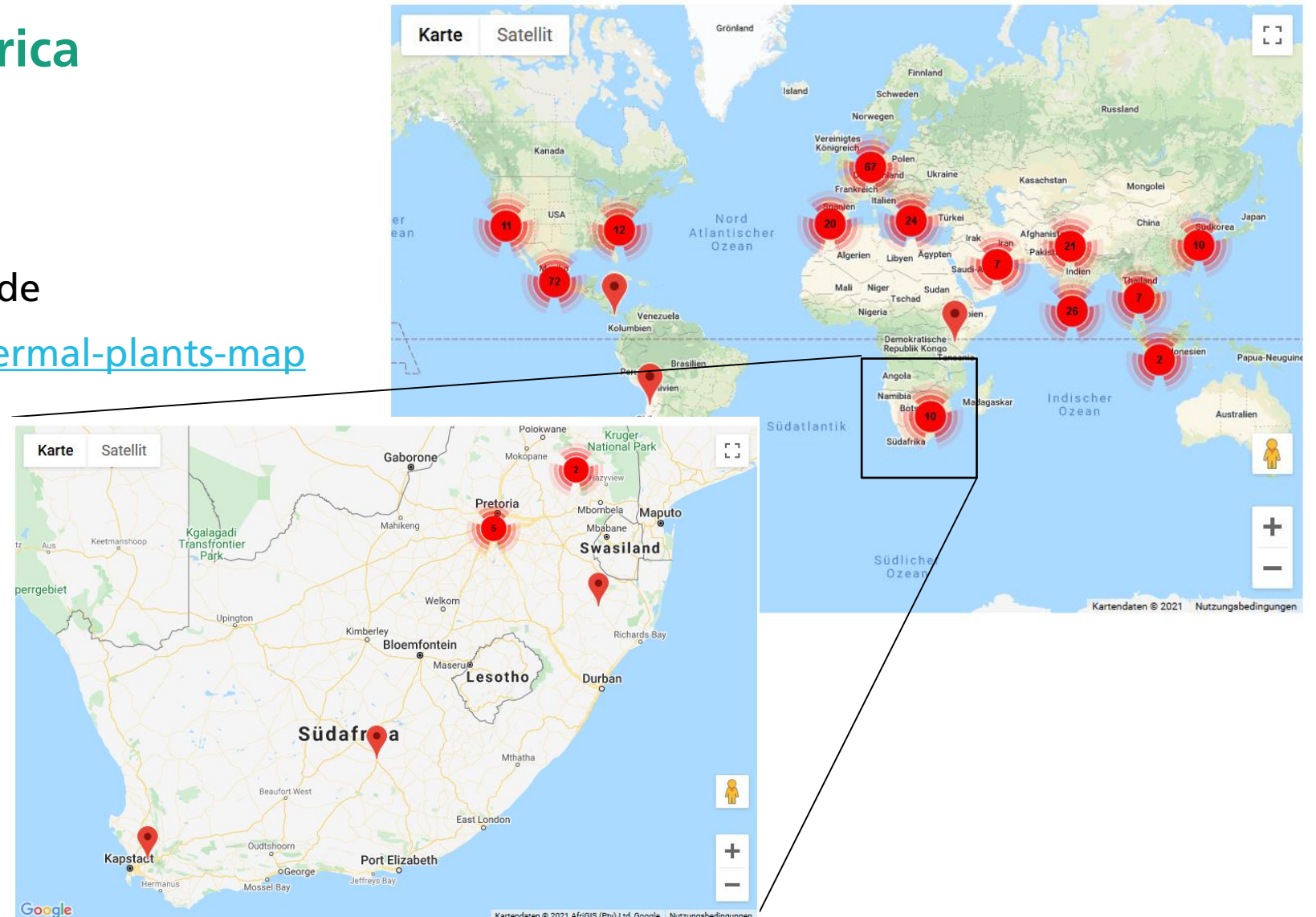
- Suitable Solar Thermal Technologies
- **Examples for Installed Plants**
- Suitable Industrial Processes
- Outlook for Solar Process Heat
- SHIP in South Africa

# Existing Projects

## SHIP systems in South Africa

- SHIP systems database [1]
  - 294 projects listed worldwide

<http://ship-plants.info/solar-thermal-plants-map>



# Existing Projects

## Examples of Stationary Technologies

### Copper mine “Gabriela Mistral”, Chile

Flat Plate

Aperture: 43,920 m<sup>2</sup>

Application: Process water and electrolyte heating

Oper. Temp.: 50°C

Commissioning : 2015



### Textile Jiangsu Yitong, China

Evacuated Tube

Aperture: 9,000 m<sup>2</sup>

Application: process pre-heating

Oper. Temp.: 50°C

Commissioning : 2011



# Existing Projects

## Examples of Stationary Technologies

### La Parrena copper mine, Mexico [1]

Flat Plate Collector

Solar Field: 6270 m<sup>2</sup>

Thermal Power: 4.4 MWth

Solar Field covers 58% of annual heat demand



# Existing Projects

## Examples of Stationary Technologies



### Brewery Göss, Austria

Flat Plate

Aperture: 1375 m<sup>2</sup> / 1064 kWth

Application: Brewing Process

Oper. Temp.: 50-100°C

Commissioning: 2013



# Existing Projects

## Examples of Tracking Technologies

### Services MTN Johannesburg, South Africa

Linear Fresnel  
Aperture: 396 m<sup>2</sup>  
Application: Air conditioning  
Oper. Temp.: 180°C  
Commissioning: 2014



### Dairy El Indio, Mexico

Parabolic Trough  
Aperture: 132 m<sup>2</sup>  
Application: Make-up water pre-heating  
Oper. Temp.: 95°C  
Commissioning: 2012





# Existing Projects

## Examples of Tracking Technologies

### El NASR Pharmaceutical Chemicals, Egypt

Parabolic Trough  
Aperture: 1900 m<sup>2</sup> / 1.33 MWth  
Application: Steam generation, 1.3 t/h  
Oper. Temp.: 170°C, 7.5 bar  
Commissioning: 2003



### Tirumala Tirupati Devasthanams, India

Parabolic Dish  
Application: Steam cooking for 1500 people  
(worlds largest)



# Existing Projects

## Examples for Direct Steam Generation at Supply Level

- Direct Steam Generation
- Steam for sterilization, drying, fermenting
- Saturated Steam 160 °C
- 20 minutes steam storage for increased stability
- Reduction of Diesel: 30.000 liter per year
- <https://www.youtube.com/watch?v=ibiUoACea6o>

**RAM Pharmaceuticals,  
Jordan**

Linear Fresnel  
Aperture: 396 m<sup>2</sup>  
Application: Process Steam  
Operating Temp.: 160°C  
Commissioning : 2015



© Industrial Solar [1]

# Existing Projects

## Examples of Tracking Technologies

Check update

- The largest SHIP project: 5.6 trillion BTUs, 300 kton/year CO<sub>2</sub>

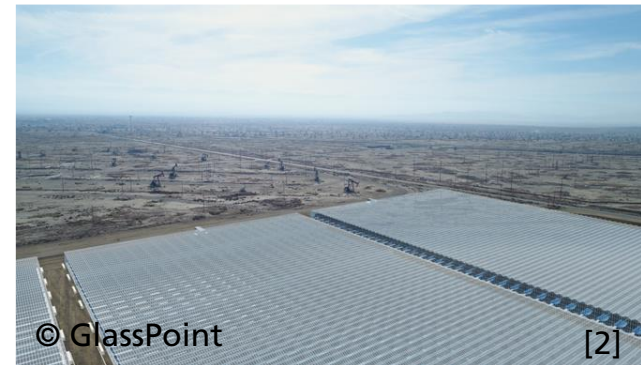
### Miraah Solar EOR Pilot Project, Amal, Oman

Petroleum Development Oman  
Parabolic Trough in greenhouse

Status (autumn 2019): Delivered first steam in 2017, 4 of 36 blocks operational

Pilot: 6 ton steam / day

Full-scale: 1.0 GWth, 6,0 ktons steam/day, 3 km<sup>2</sup> (1.9 km<sup>2</sup> aperture)



# Content

- Suitable Solar Thermal Technologies
- Examples for Installed Plants
- Suitable Industrial Processes
- Outlook for Solar Process Heat
- SHIP in Tunisia

# Suitable Industrial Processes

## Overview on Sectors and Processes

### ■ Main industrial sectors

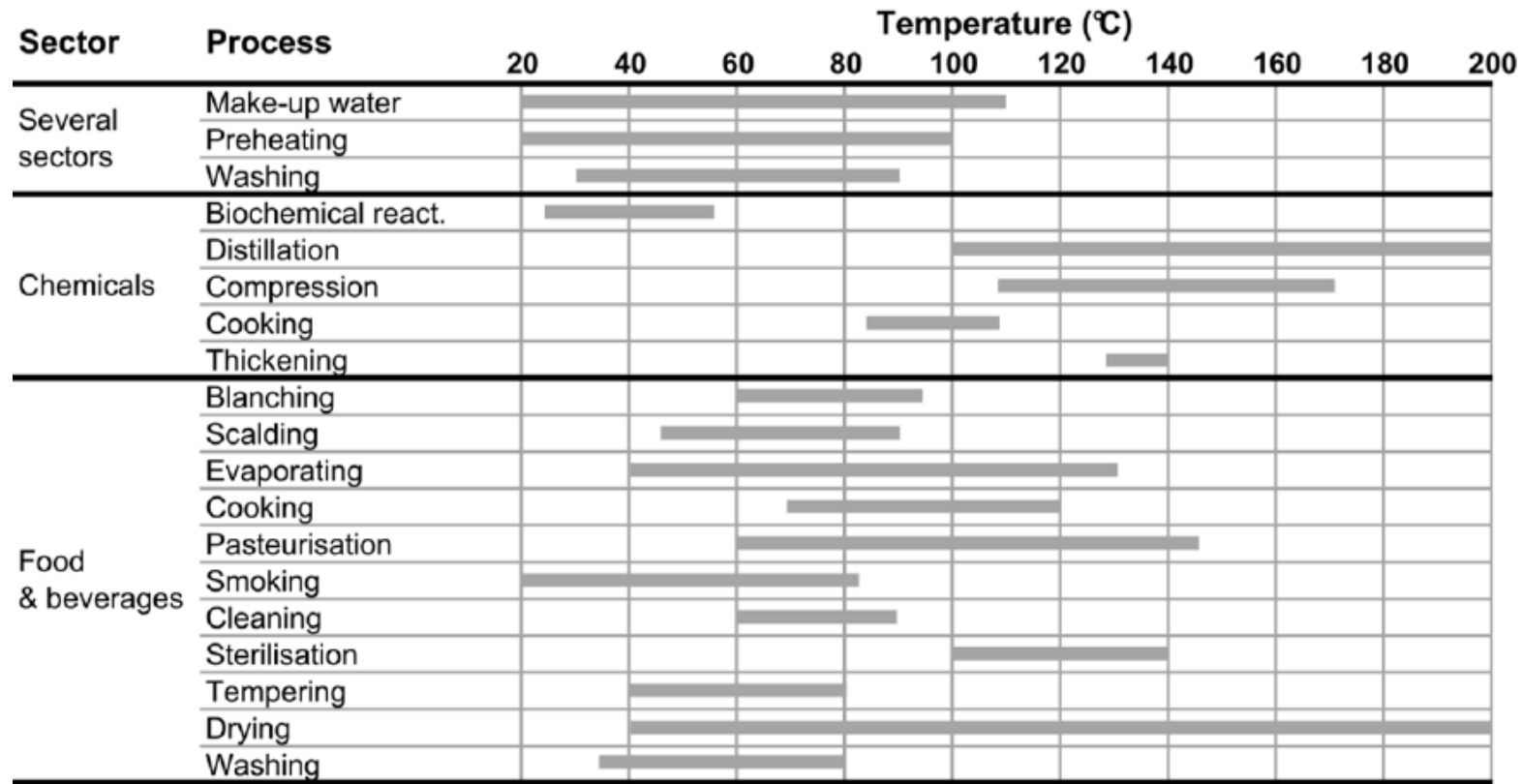
- Chemicals
- Food & Beverages
- Paper
- Fabricated metal
- Rubber & Plastic
- Machinery & Equipment
- Textiles
- Wood

### ■ Suitable industrial processes

- Preheating (input or raw material)
- Pasteurization and Sterilization
- Washing and cleaning
- Chemical reactions
- Surface treatment
- Space heating
- Supply of hot water or steam
- Drying and dehydration (Concentration)

# Suitable Industrial Processes

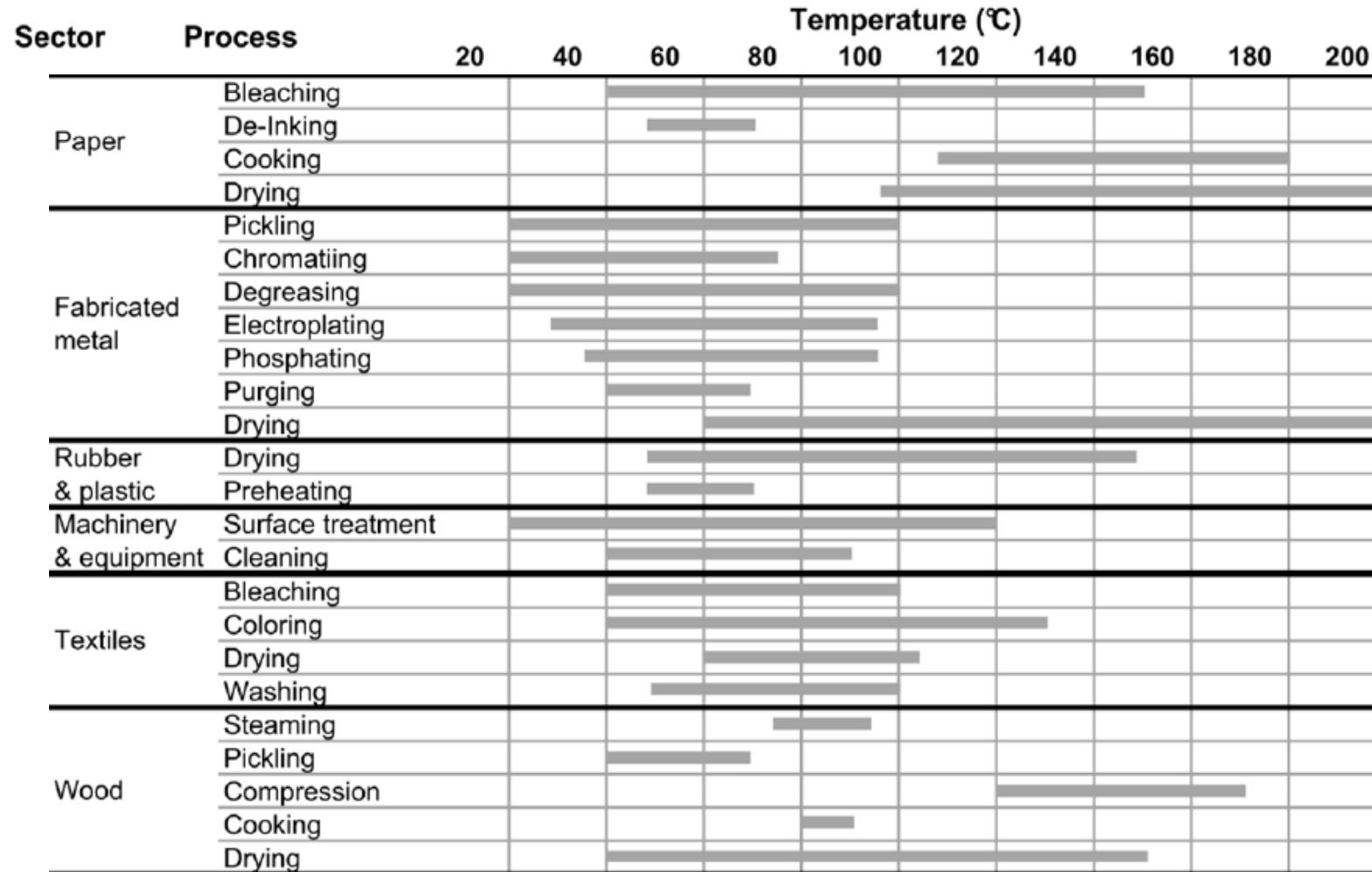
## Temperature Levels of Sectors and Processes



[1]

# Suitable Industrial Processes

## Temperature Levels of Sectors and Processes



[1]

# Suitable Industrial Processes

## Main Characteristics

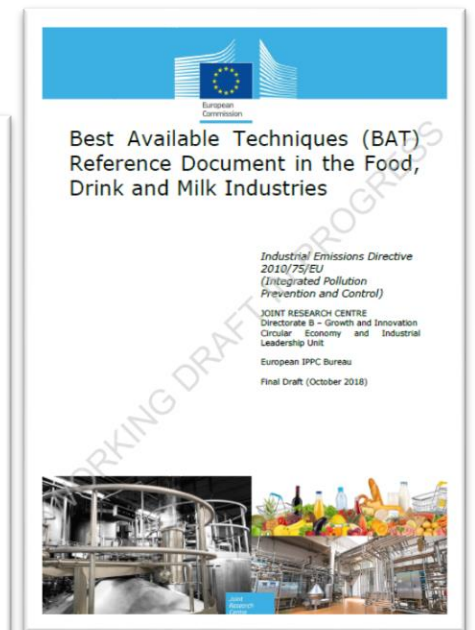
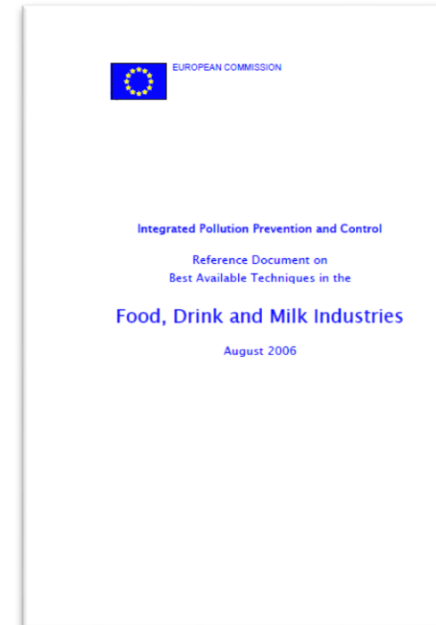
- temperature level (feed and return)
  - heat demand of specific processes
  - load profile per day, week and year
  
  - overall energy demand of plant
  - heat recovery and energy efficiency potential
- solar system should always be based on minimum heat demand (avoiding expensive oversizing during entire lifetime)



# Suitable Industrial Processes

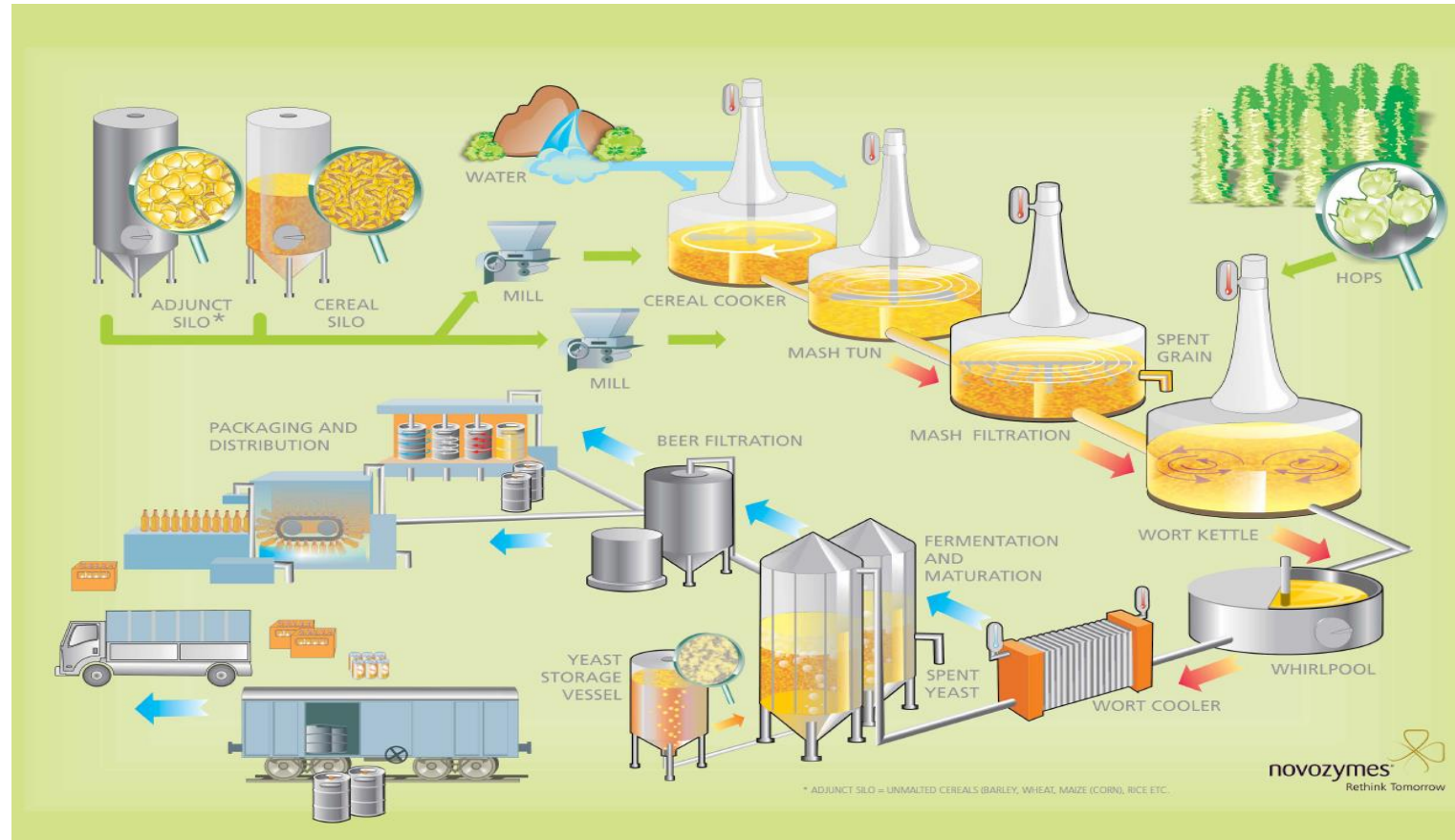
## Best Available Techniques BAT

- Industrial processes descriptions and specific BAT for several branches [1]
  - Ceramic Manufacturing
  - Ferrous Metal Processing
  - Food, Drink and Milk
  - Organic and Inorganic Chemicals
  - Glass
  - Non-ferrous Metals
  - Iron and Steel
  - Pulp, Paper and Board
  - Textiles
  - ...



# Suitable Industrial Processes

## Example of Brewing Process

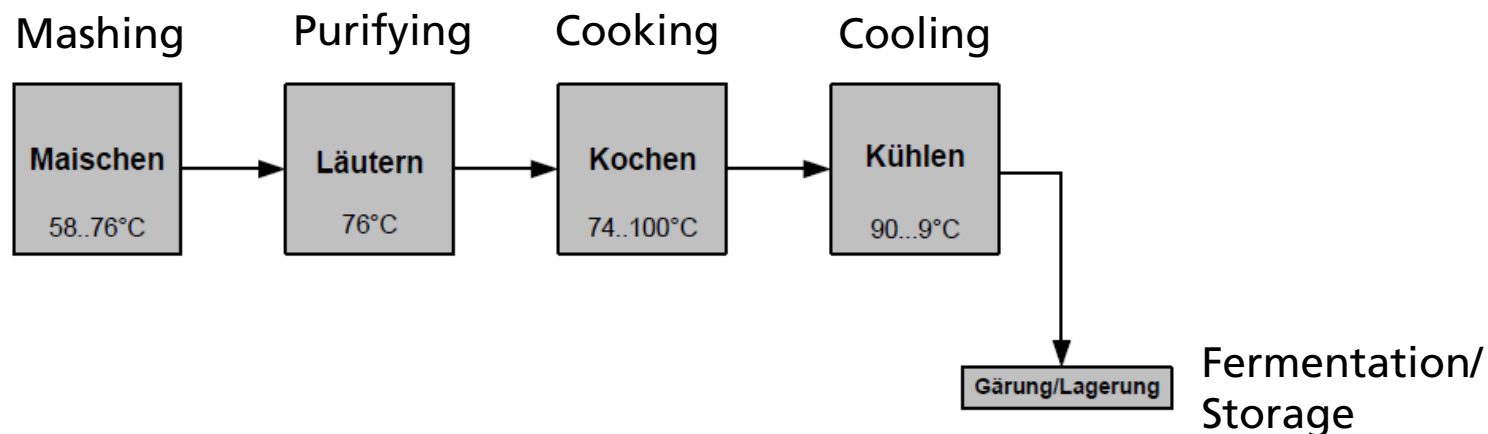


The brewing process uses malted barley and/or cereals, unmalted grains and/or sugar/corn syrups (adjuncts), hops, water, and yeast to produce beer.

# Suitable Industrial Processes

## Example of Brewing Process

- All thermally driven processes in breweries and malting plants require heat at temperature on process level of between 35 and 105°C
- Processes for wort preparation in the brew house:



# Suitable Industrial Processes

## Example of Brewing Process

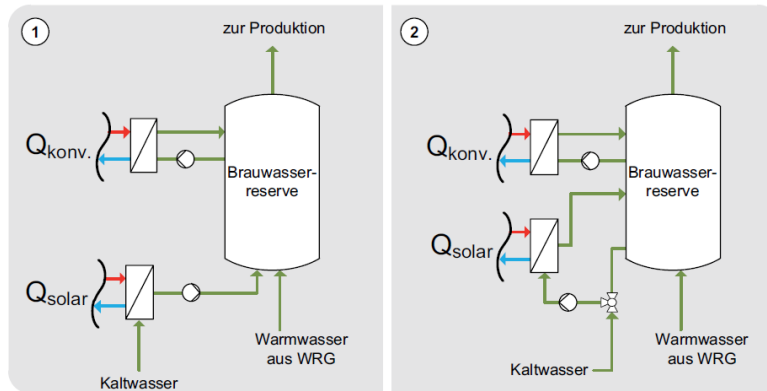
- Integration of solar thermal options in breweries:
  - Solar return temperature of integration (large bar = low return temperature)
  - Effort to integrate the solar heat (large bar = low effort)
  - Running time of the process (large bar = frequent&long running time)

Process or Plant	T [°C]	Rating		
		Temp sol RL	Integration	Running time
Water degassing	70-95	Medium	High	High
Water supply	15-85	High	High	High
Mashing	35-78	Low	High	High
Cook	90-104	Very Low	High	High
Flash heat	68-75	Low	High	Low
Dealcoholization	40-55	Low	Low	High
Bottle cleaning	60-85	Very Low	Low	High
Box cleaning	50-60	Low	Very Low	High
Tunnel pasteurisation	60-65	Low	High	High
Keg cleaning	70-95	Low	Low	High
CIP cleaning	70-90	Low	High	High

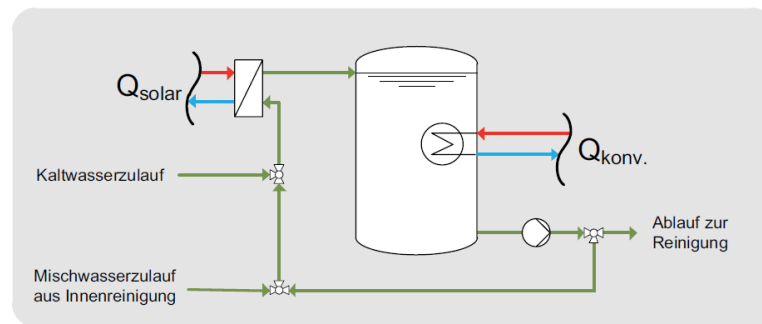
# Suitable Industrial Processes

## Example of Brewing Process

### Hot water supply integration



### Tunnel pasteurisation



Process or Plant	T [°C]	Rating		
		Temp sol RL	Integration	Running time
Water degassing	70-95	■	■	■
Water supply	15-85	■	■	■
Mashing	35-78	■	■	■
Cook	90-104	■	■	■
Flash heat	68-75	■	■	■
Dealcoholization	40-55	■	■	■
Bottle cleaning	60-85	■	■	■
Box cleaning	50-60	■	■	■
Tunnel pasteurisation	60-65	■	■	■
Keg cleaning	70-95	■	■	■
CIP cleaning	70-90	■	■	■

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# Outlook for Solar Process Heat

## SHIP Benefits and Shortcomings

### ■ Benefits

- Supports companies in long-term cost stability of heat supply and contributes to competitiveness
- Opens up new business fields for the renewable energy industry and promotes business development and green jobs
- Contributes to climate and environmental goals of the region

### ■ Shortcomings

- Lack of awareness on technologies
- Upfront investment regarded on the pay back period side
- Faces resistance to changes in existing heat production systems
- Individual assessment of feasibility and layout of solar system

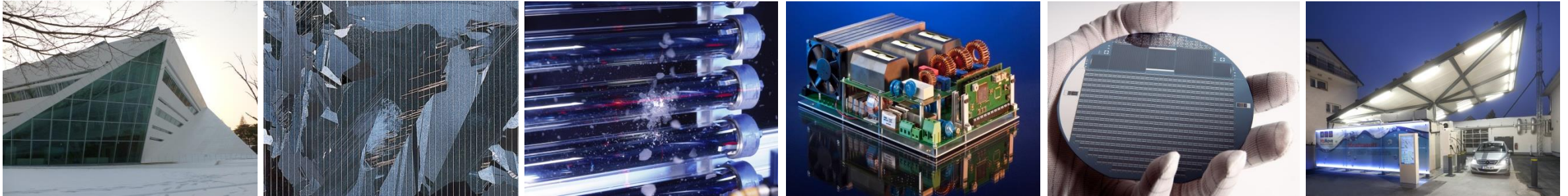
# Outlook for Solar Process Heat

## SHIP Brief Summary

- Solar process heat has a huge potential, however this is not yet tapped
  - Many advanced collectors are available for solar field optimized for certain temperature ranges
  - Using concentrating collectors process steam, absorption chilling, power generation and poly-generation is possible
  - Different plant layouts and integration schemes can be realized and optimized to loads and load profiles
  - Markets in many countries with high direct solar irradiation
- Solar thermal process heat is a **market of the future**



# Thank you for your Attention!



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