clean industry solutions

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CEO Clean Industry Solutions Holding Europe AB

16 December 2021

clean energy

clean water

clean industry

CIS clean industry solutions

100%

100%

INDUSTRIAL SOLAR
renewables onsite

SolarSpring membrane solutions

Industrial Solar GmbH is an international leading technology and solution provider, which develops projects mainly based on its innovative Fresnel collector technology suitable for fulfilling an expected growing market of **solar process heat**. As a one-stop-shop Industrial Solar offers turnkey solutions for customers in several industries.

Founded in 2009 as a spin-off of the Fraunhofer ISE, **SolarSpring GmbH**, has evolved into an international pioneer in the field of membrane distillation offering innovative **waste- and drinking water treatment** technology.

Engineering

District / Process Heating

Cooling / Heating / Steam

Heating & Cooling

Solar Process Heat Systems /
Heat Pumps / Absorption
Chillers / Storages

Consultancy

CO_2 Reduction

Energy Optimization

ISO 50001

Power Generation

Photovoltaic

PV Carports

Process Water

Water Treatment

Resource Recovery

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SolarSpring membrane solutions

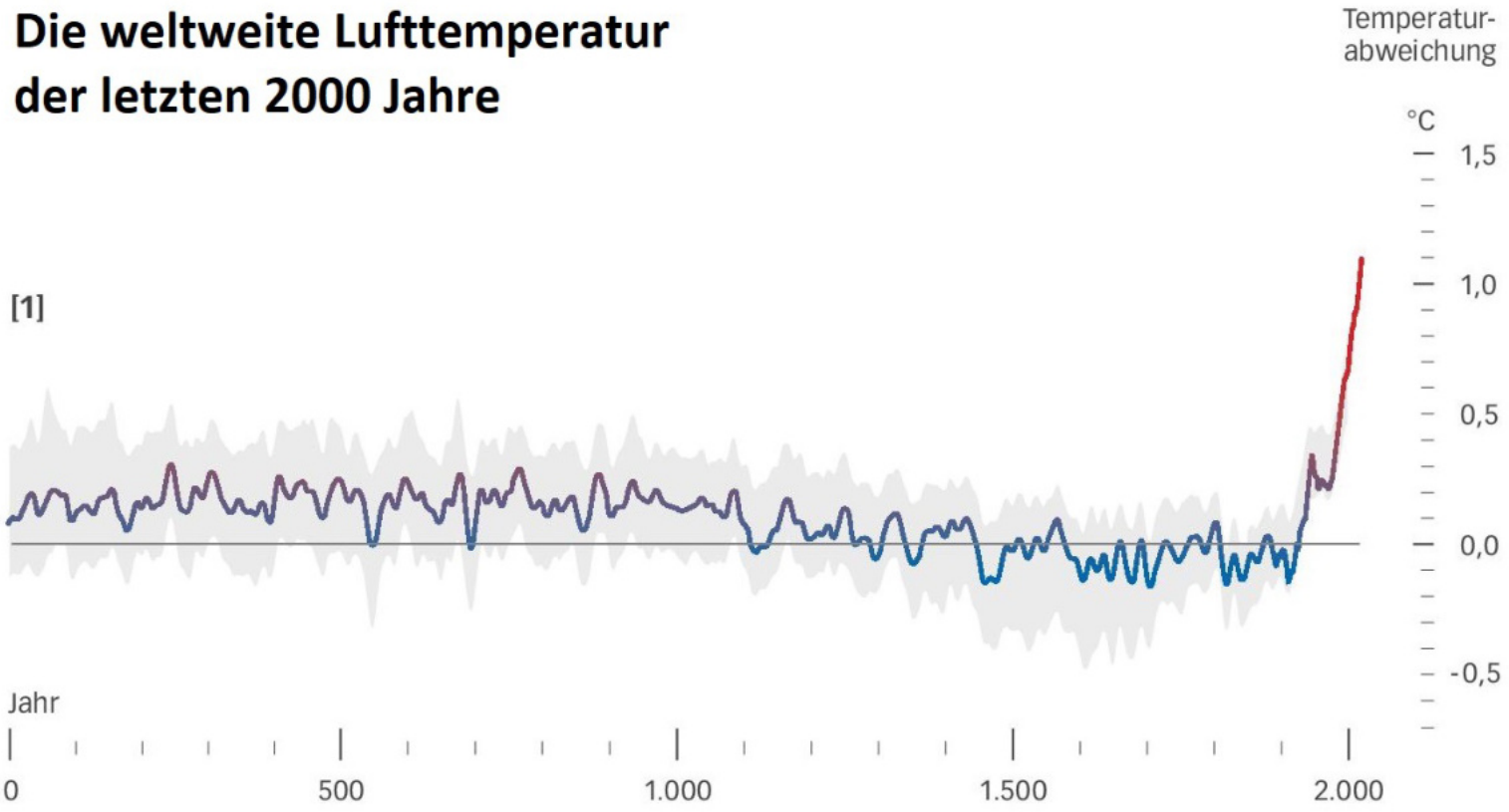
CIS clean industry solutions

Seattle 1906, © www.pauldorpat.com

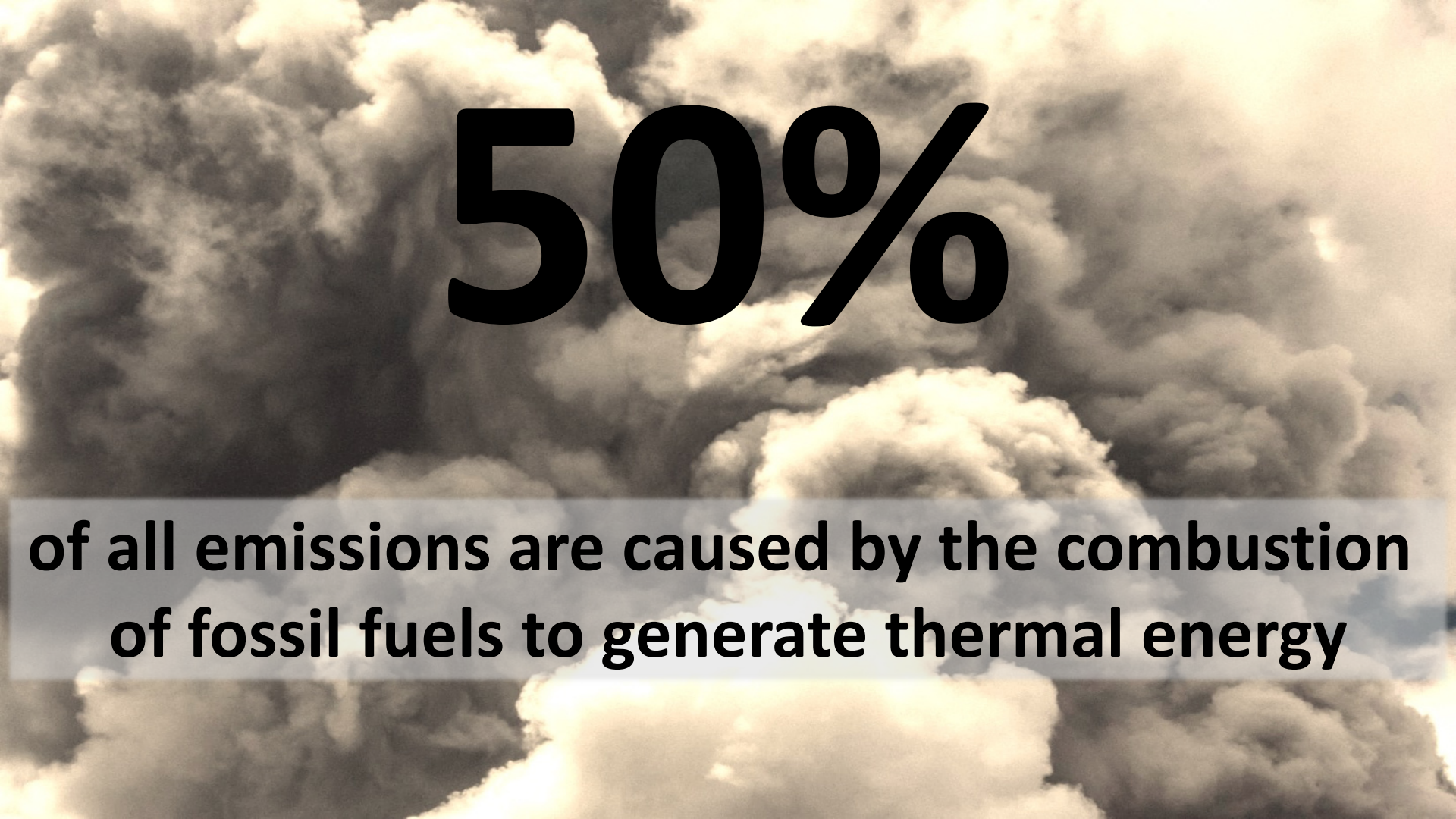
Muscatine, Iowa 2010

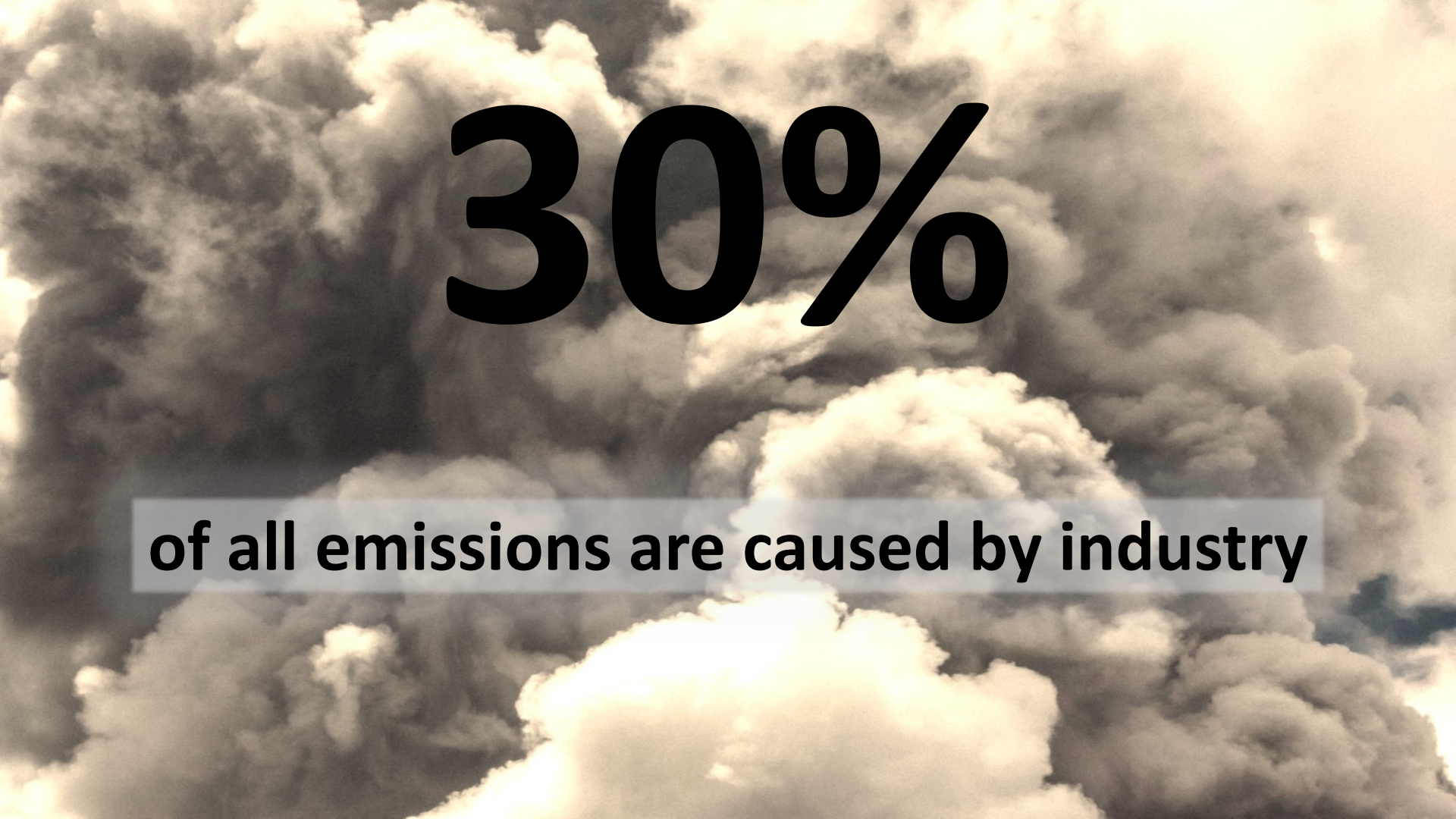
Photograph by Kyle Jeffery, My Shot

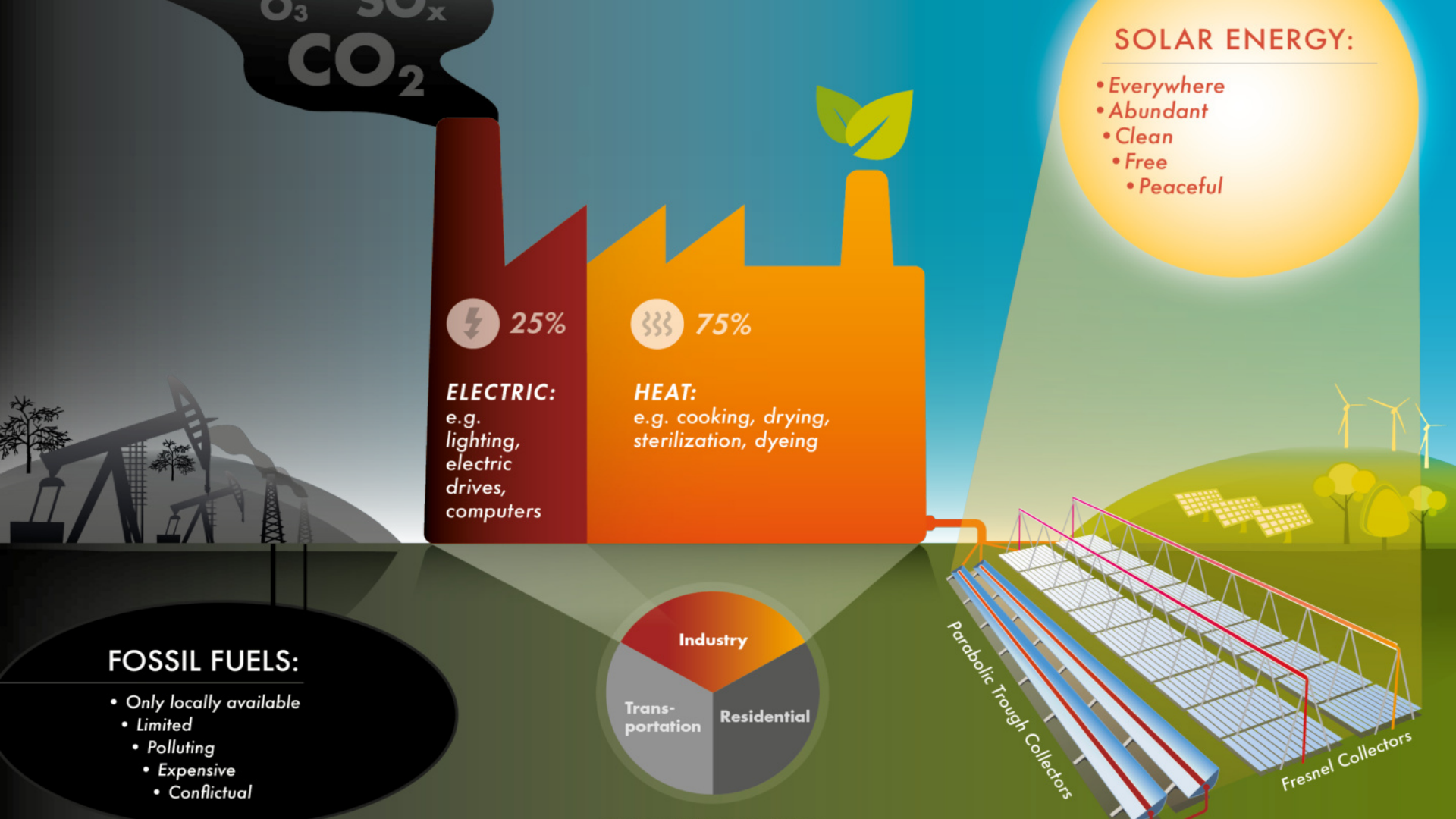
Die weltweite Lufttemperatur der letzten 2000 Jahre



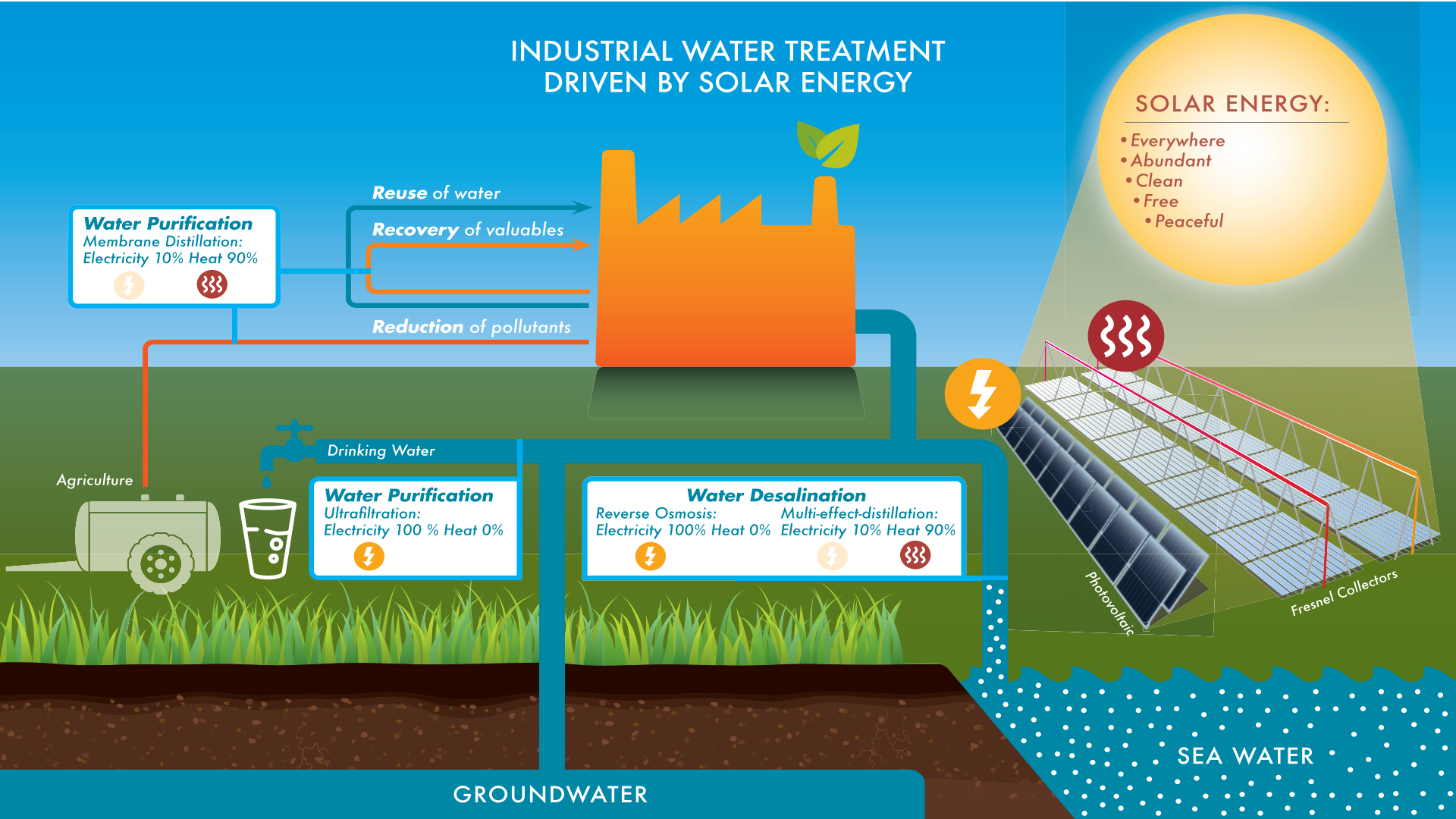
Quelle: nach IPCC AR6, WG I (2021)


50%
of all emissions are caused by the combustion
of fossil fuels to generate thermal energy

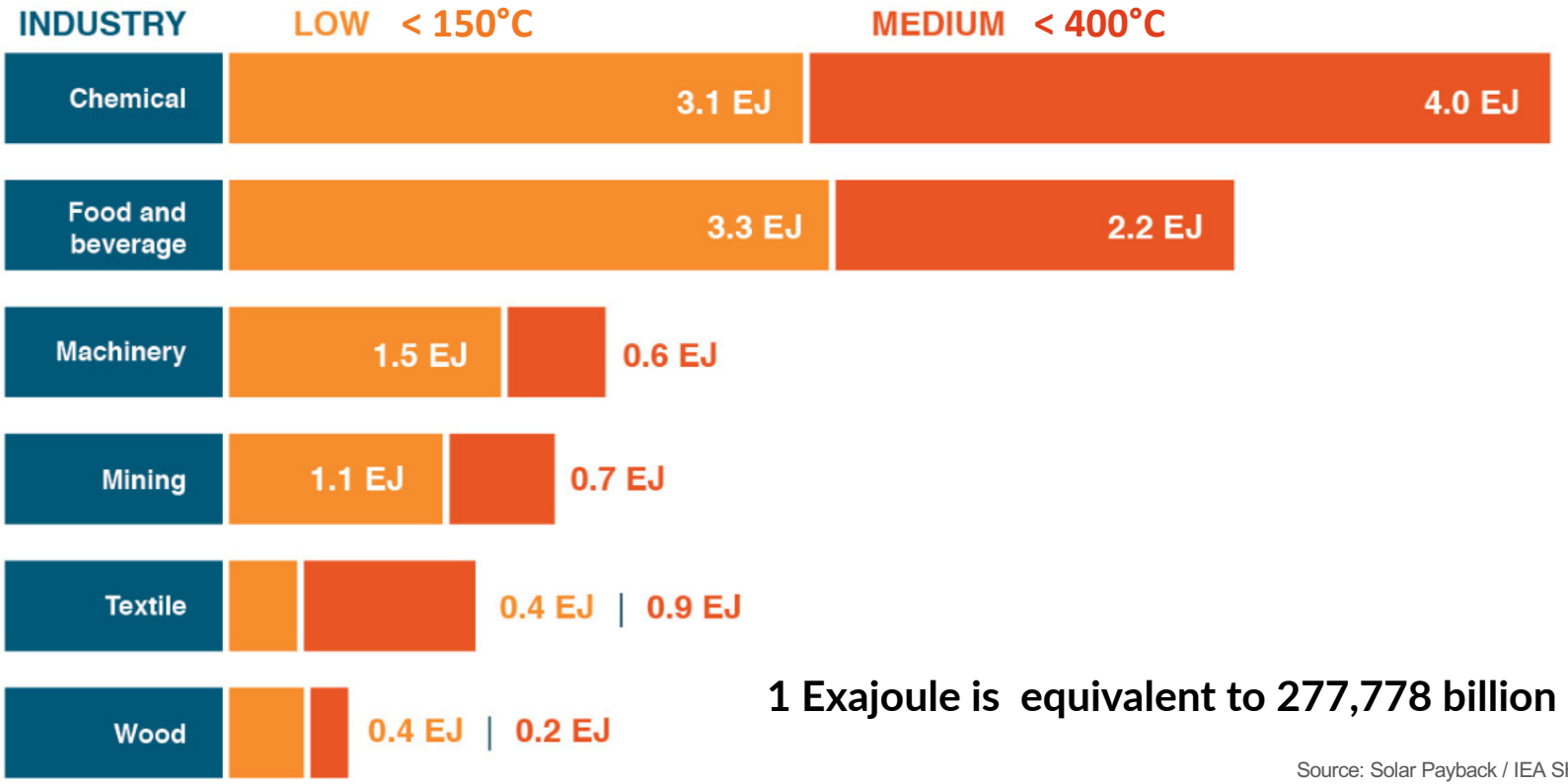

30%
of all emissions are caused by industry


O_3 SO_x
CO_2
25%
ELECTRIC:
e.g. lighting, electric drives, computers
75%
HEAT:
e.g. cooking, drying, sterilization, dyeing
SOLAR ENERGY:
• Everywhere
• Abundant
• Clean
• Free
• Peaceful
FOSSIL FUELS:
• Only locally available
• Limited
• Polluting
• Expensive
• Conflictual
Industry
Trans-portation
Residential
Parabolic Trough Collectors
Fresnel Collectors


80%
of all industries that require heat for their production also use water


INDUSTRIAL WATER TREATMENT
DRIVEN BY SOLAR ENERGY
SOLAR ENERGY:
• Everywhere
• Abundant
• Clean
• Free
• Peaceful
Water Purification
Membrane Distillation:
Electricity 10% Heat 90%
Reuse of water
Recovery of valuables
Reduction of pollutants
Agriculture
Drinking Water
Water Purification
Ultrafiltration:
Electricity 100 % Heat 0%
Water Desalination
Reverse Osmosis:
Electricity 100% Heat 0%
Multi-effect-distillation:
Electricity 10% Heat 90%
Photovoltaic
Fresnel Collectors
SEA WATER
GROUNDWATER

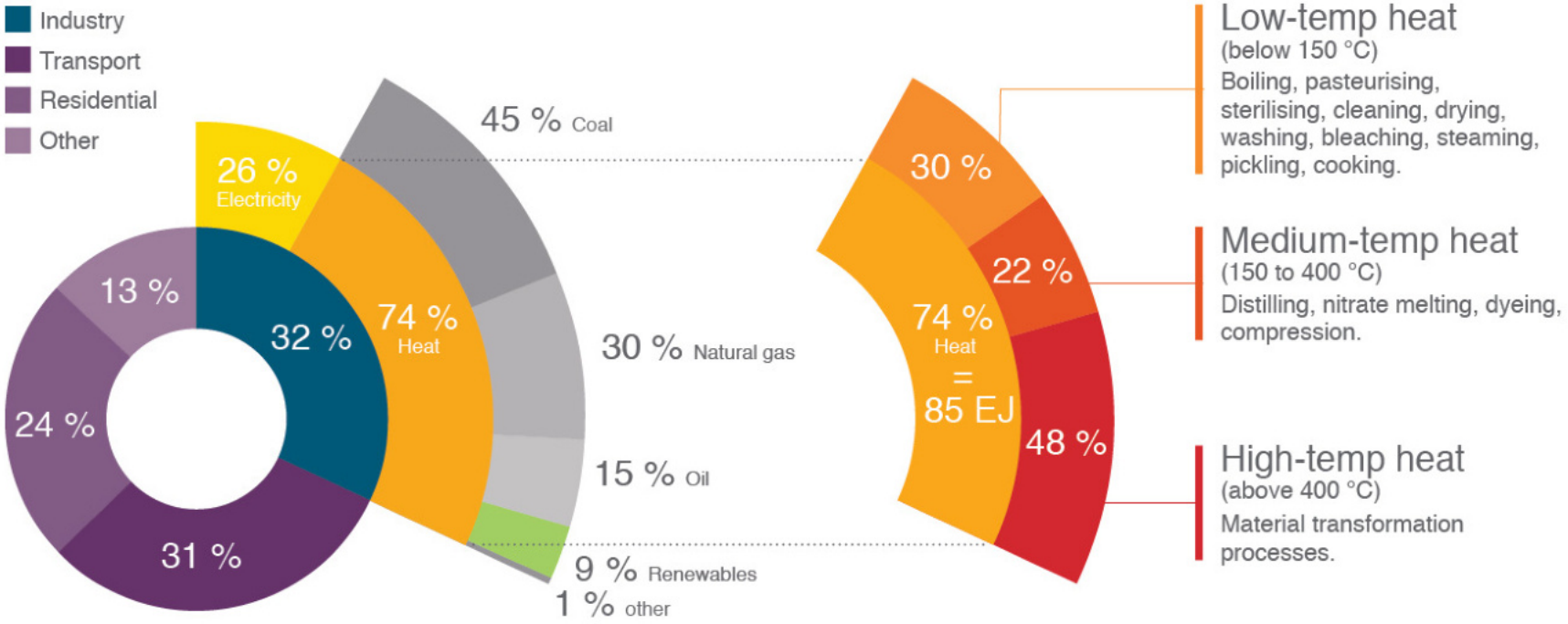
Industrial Heat Demand



1 Exajoule is equivalent to 277,778 billion kWh

Source: Solar Payback / IEA SHC Task 49

Industrial Heat Demand

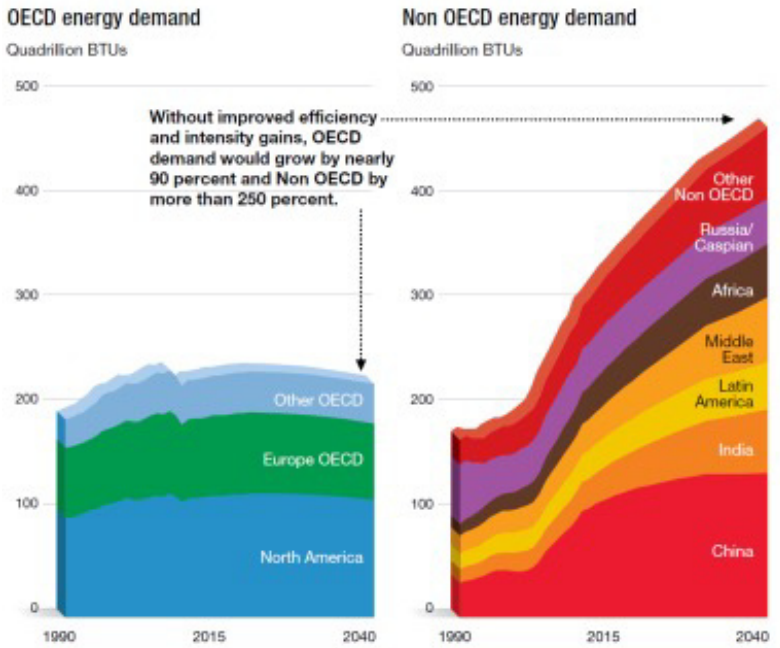


Source: Solar Payback / IEA SHC Task 49

In 2020 fossil fuel companies were benefitting from global subsidies of **$5,900,000,000,000 (5.9 tn) a year**, equivalent to **$11,200,000 a minute** every day, according to a startling new estimate by the International Monetary Fund.

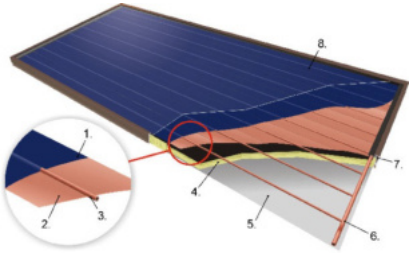
Industrial Energy Demand

Industry is expected to grow by **up to 400% until 2050** with the largest share to take place in **emerging markets.**



Source: Exxon Mobile – Outlook for Energy, A Perspective to 2040

Collector Technologies



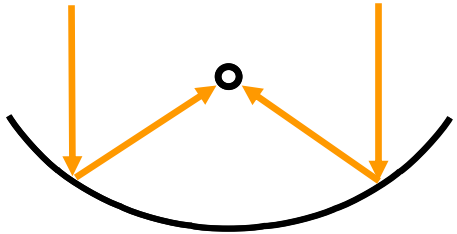
T < 80°C…130°C

→ ? ←

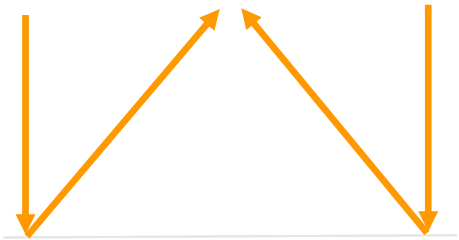
100°C < T < 400°C
100kW < P < 10MW

T > 300°C…550°C

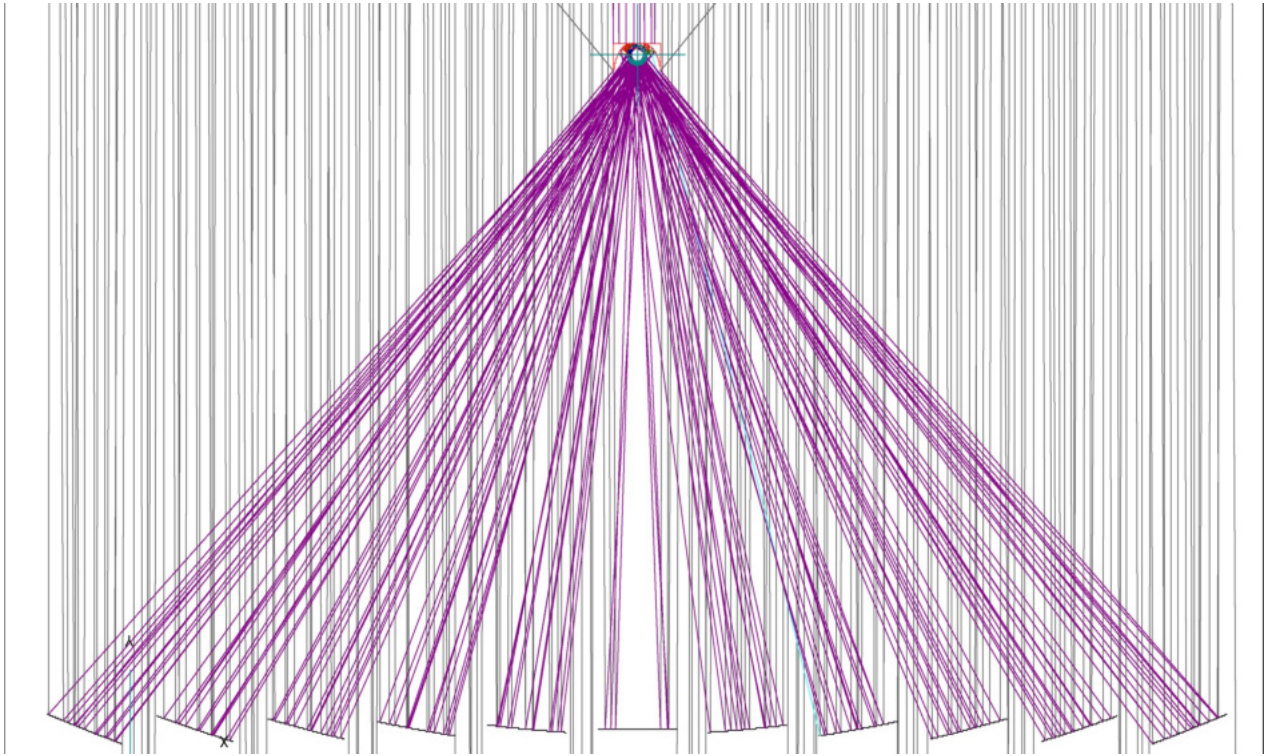
Fresnel - Basic Principle



Parabolic Trough Collector

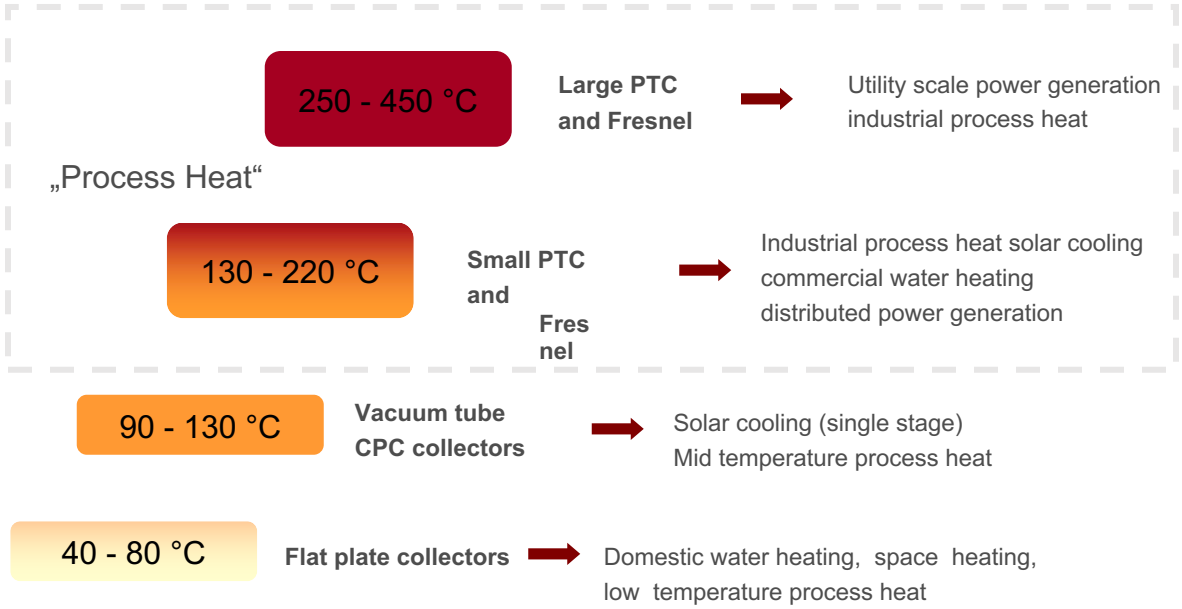


Fresnel - Basic Principle

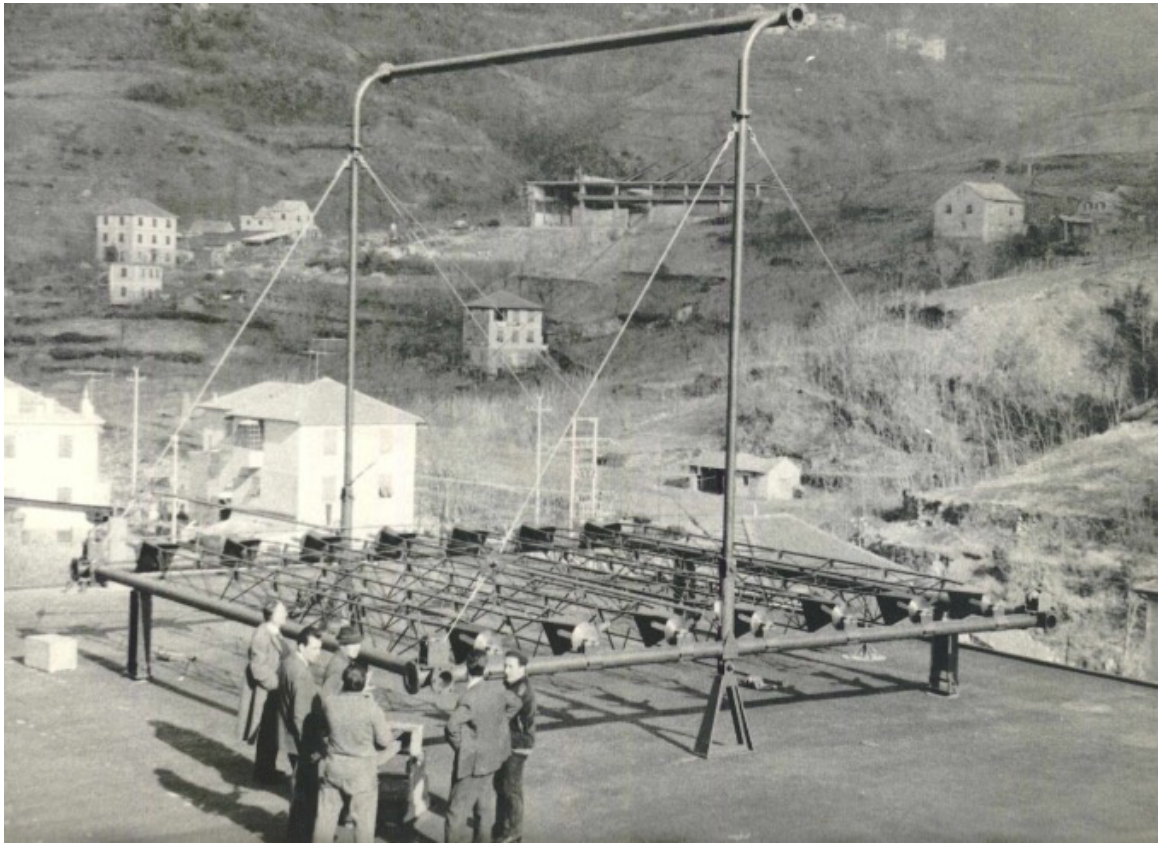


Technology Introduction

Industrial Solar Fresnel collectors are designed to generate heat at 130 - 400 °C



Early days of Fresnel collectors



Source: Cesare Silvi, private archive of Giovanni Francia

Solar Steam Generation

Fresnel Collector

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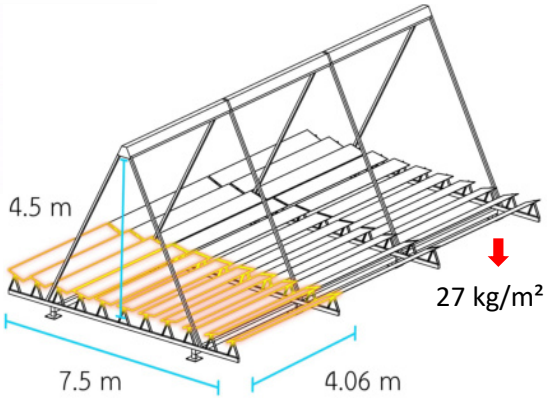
Uniaxially tracked mirrors concentrate sunlight onto an absorber where heat is generated

Generates steam, superheated water or thermal oil



Modular solution
Generates heat up to 400°C and 120 bar
Capacity from 500 kW_{th} to 30 MW_{th}

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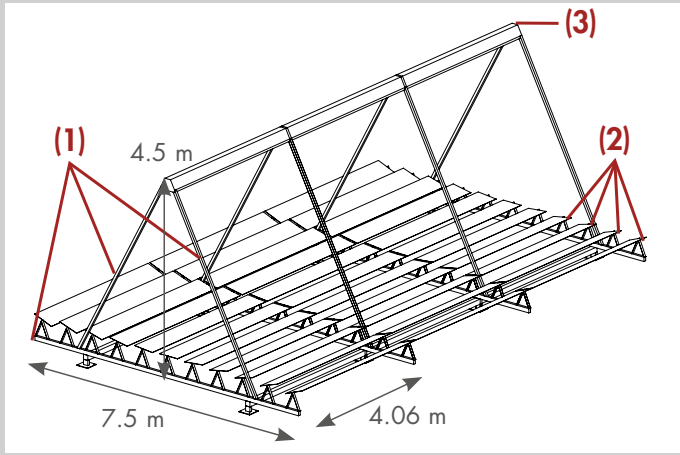
General data of a single module

- Module width: **7.5 m**
- Module length: **4.06 m**
- Aperture surface of primary reflectors: **23 m²**
- Ground surface of a single module: **30.45 m²**
- Receiver height above primary reflector: **4.0 m**
- Height of primary reflector above ground level: **0.5 m**
- Minimum clearance between parallel rows: **0.2 m**
- Specific weight: **26.2 kg/m² (per installation area)**
- Maximum operational wind speed: **100 km/h**
- Maximum wind speed in stow position: **180 km/h**
- Life expectancy: **+25 years**



- *1. Support structure*
- *2. Primary reflectors*
- *3. Receiver, consisting of secondary reflector and vacuum absorber tube*

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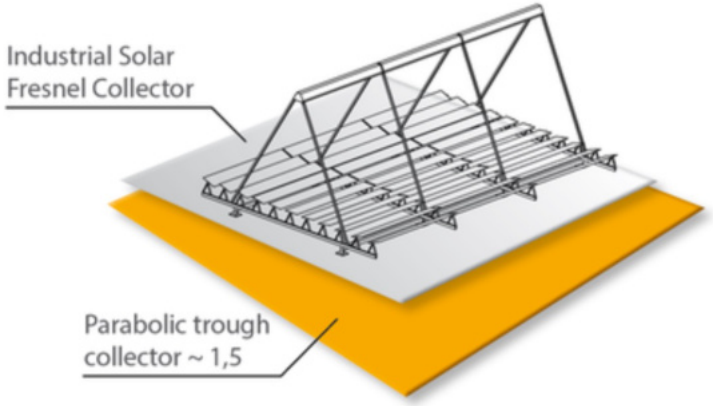

Optical performance characteristics

Angle-independent optical efficiency *(with 100% clean primary and secondary reflectors and receiver glass tube)*

- η_0 = 0.686 (for sun in zenith)
- η_{max} = 0.709 (for sun at 5° transversal zenith angle)

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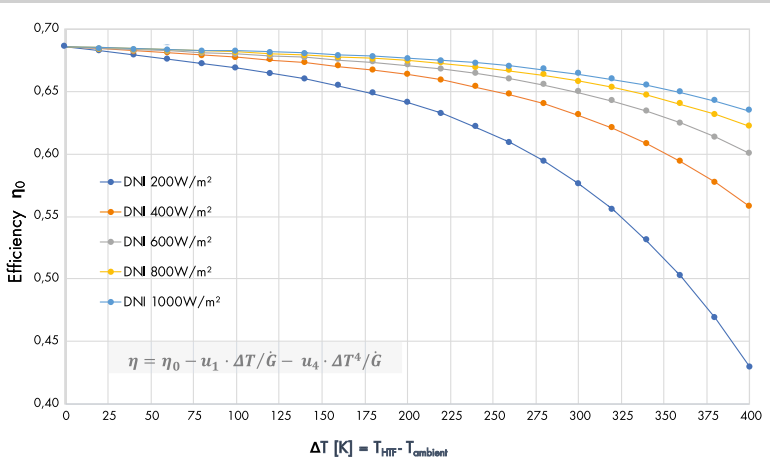
Thermal performance characteristics

Due to the vacuum absorber tube, thermal performance is independent of wind speed.

- ✔ **Maximum operating temperature: 400°C**
- ✔ **Thermal loss per m² of primary reflector** (according to DLR):
  - **u1 = 0.032913 W/(m²K)**
  - **u4 = 1.4838 x 10^{-9} W/(m²K⁴)**
- ✔ **Thermal output (under reference conditions*)**
  - **13.82 kW per standard module**
  - **601 W/m² in terms of aperture surface area of primary reflectors**
  - **454 W/m² in terms of total installation surface area**

reference conditions:

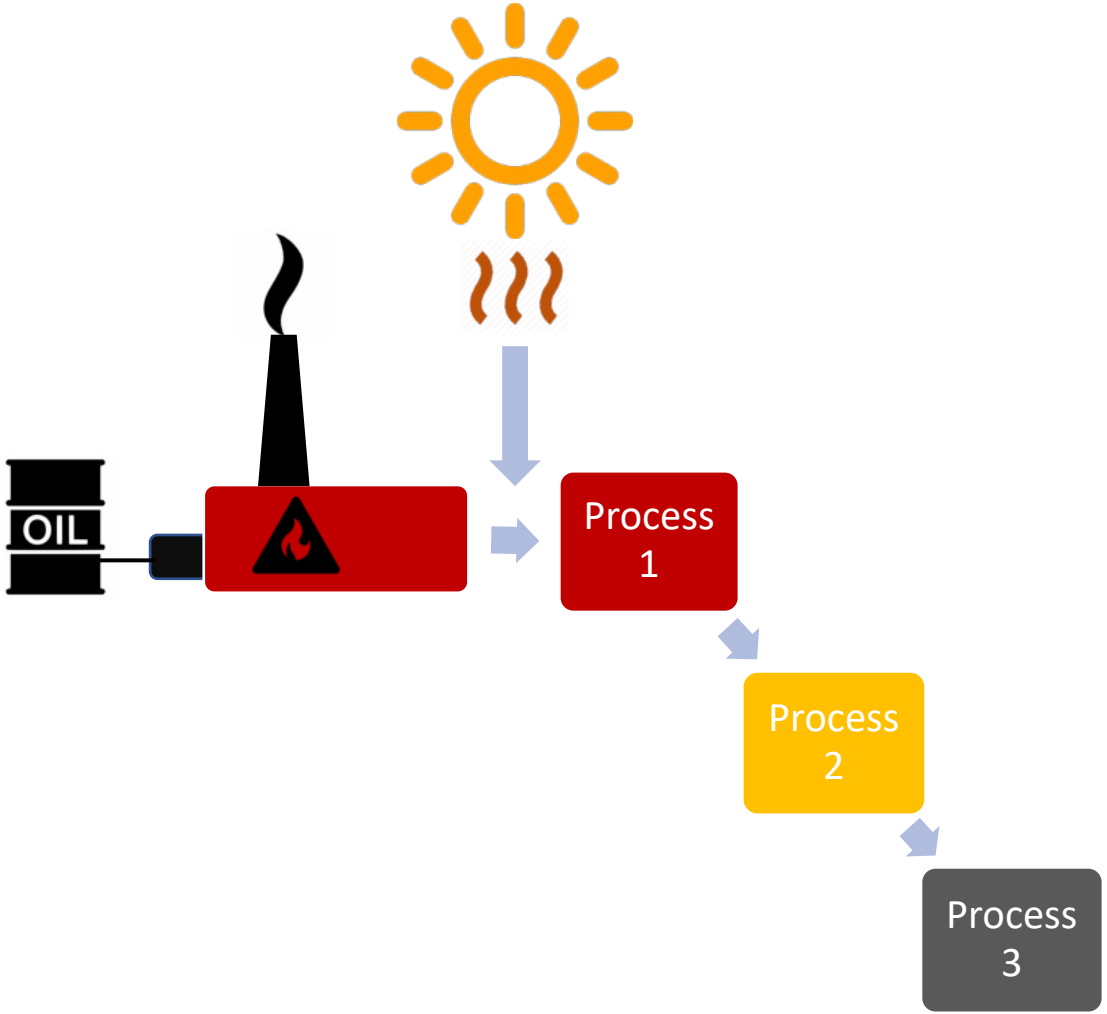
30°C ambient temperature
160°C inflow temperature
180°C outflow temperature
900 W/m² direct normal radiation
Azimuth angle 90°
Zenith angle 30°



Characteristic curve of the LF-11 Fresnel collector

Integration on supply temperature level

System integration on supply temperature level is much simpler and the production line / process remains untouched.



Technologies and Options

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Photovoltaic

5 MW

100 kW

Power Generation

Electric Heating

Absorption Chiller

-30 °C

+70 °C

Heat Recovery & Cooling

+90 °C

Solar Process Heat

Evacuated Tube Collector

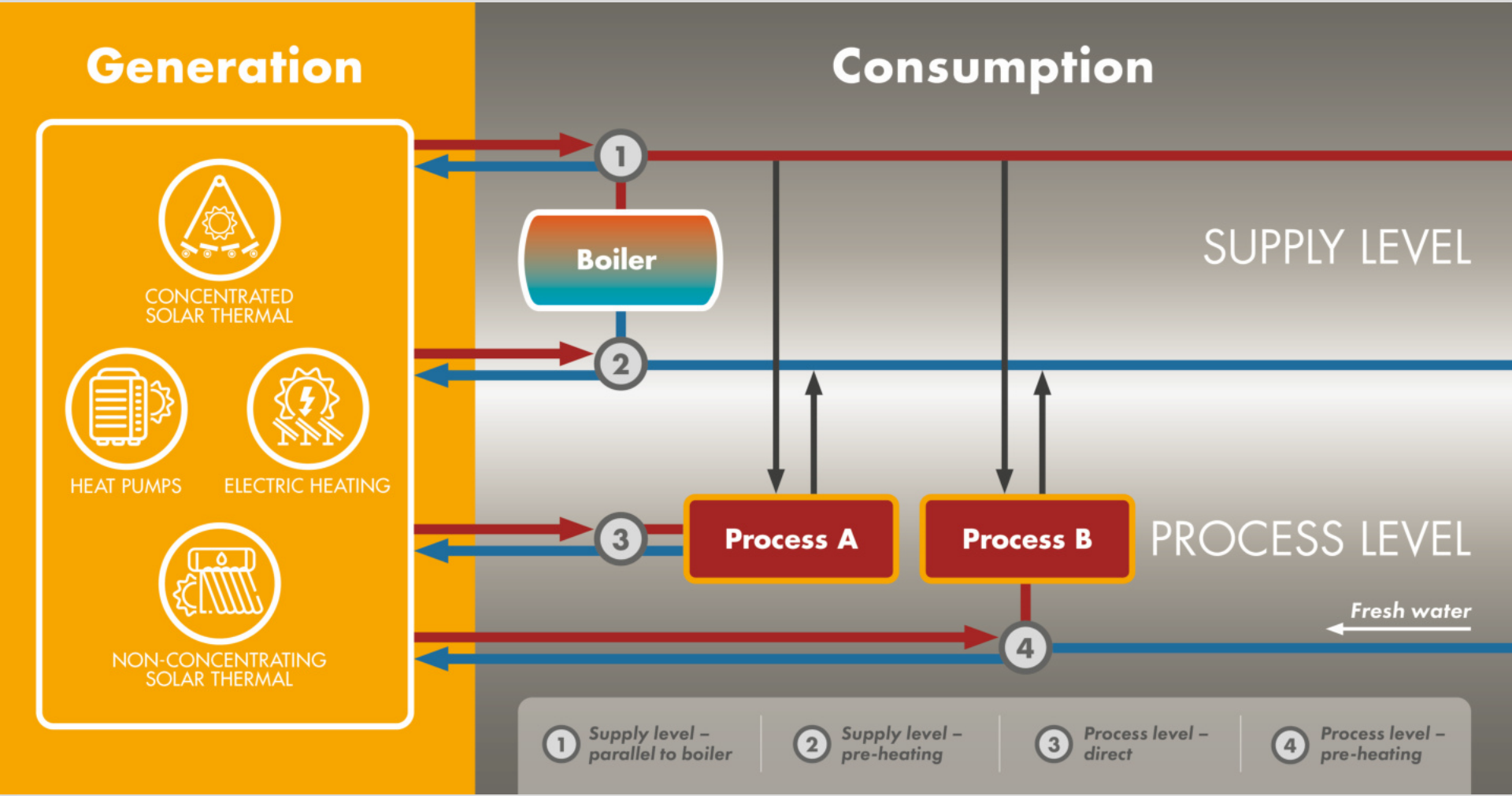
Flat Plate

500 kW to 30 MW

Heat Pumps

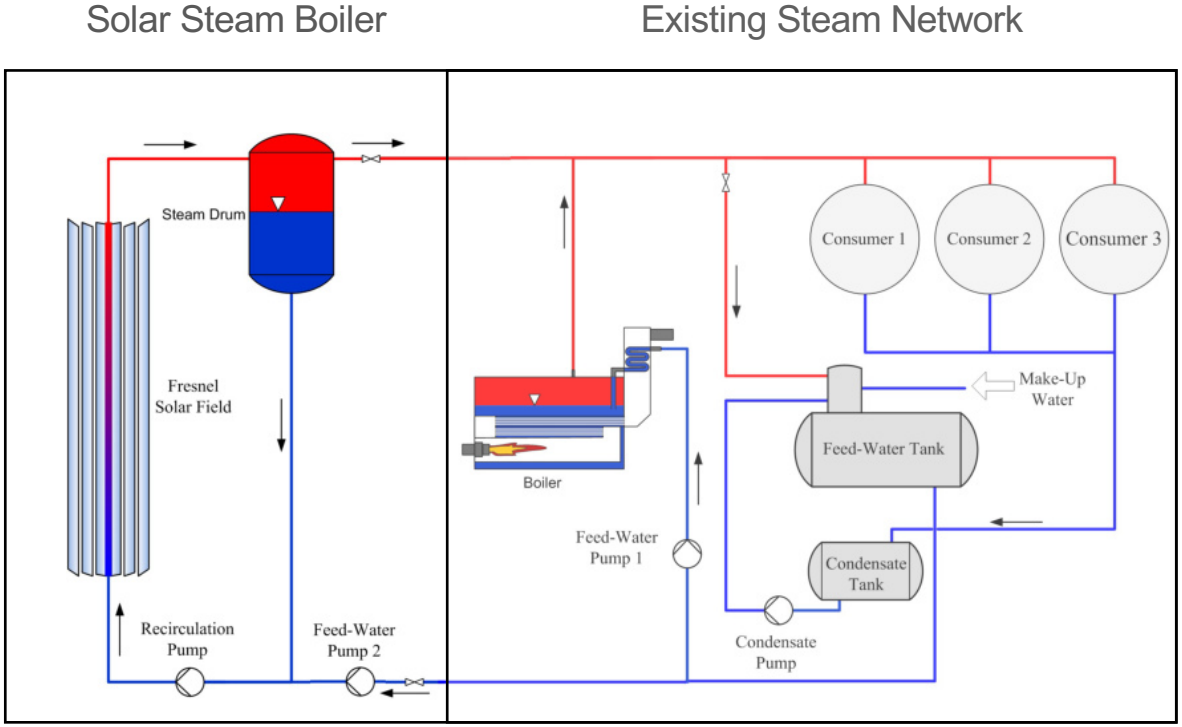
+400 °C

Fresnel

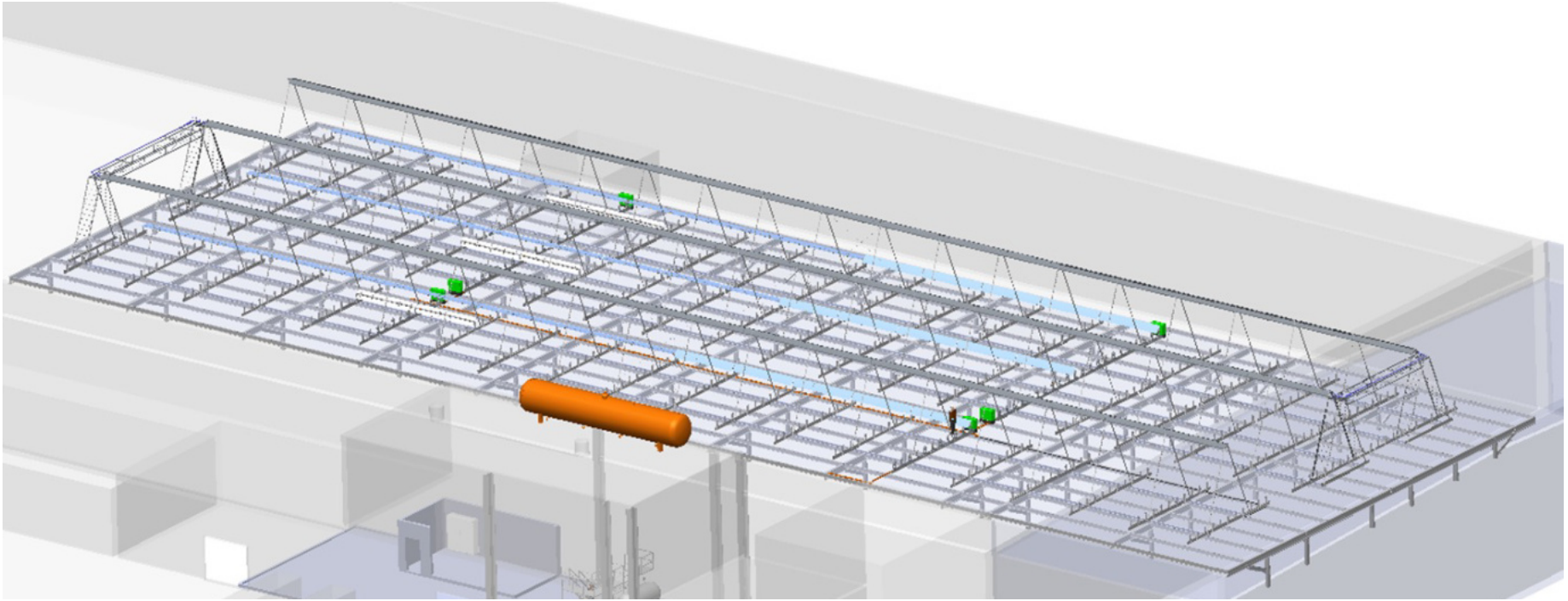

Generation
Consumption
CONCENTRATED SOLAR THERMAL
HEAT PUMPS
ELECTRIC HEATING
NON-CONCENTRATING SOLAR THERMAL
1
Boiler
2
SUPPLY LEVEL
3
Process A
Process B
PROCESS LEVEL
Fresh water
4
1 Supply level – parallel to boiler
2 Supply level – pre-heating
3 Process level – direct
4 Process level – pre-heating

System integration

Solar Steam generation systems can easily be integrated in steam grids with fossil fired boilers.



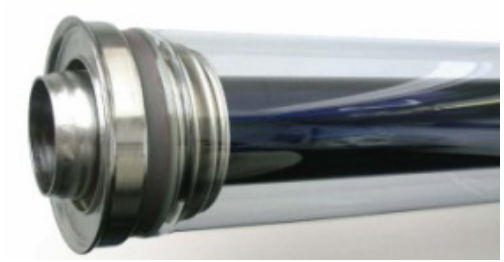
Sample Fresnel system layout



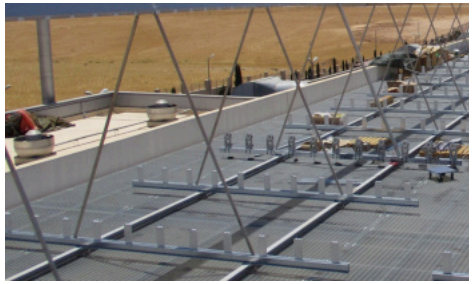
Technology – Collector Components

Mirror system (robust)

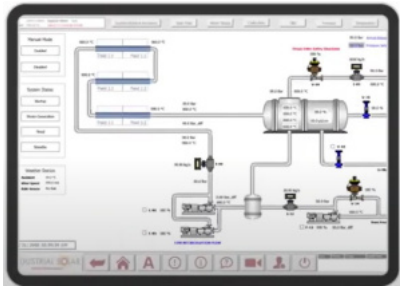
Absorber tube (high efficiency)



Support Structure (lightweight)



Control system (smart control)



Good reasons for Fresnel technology

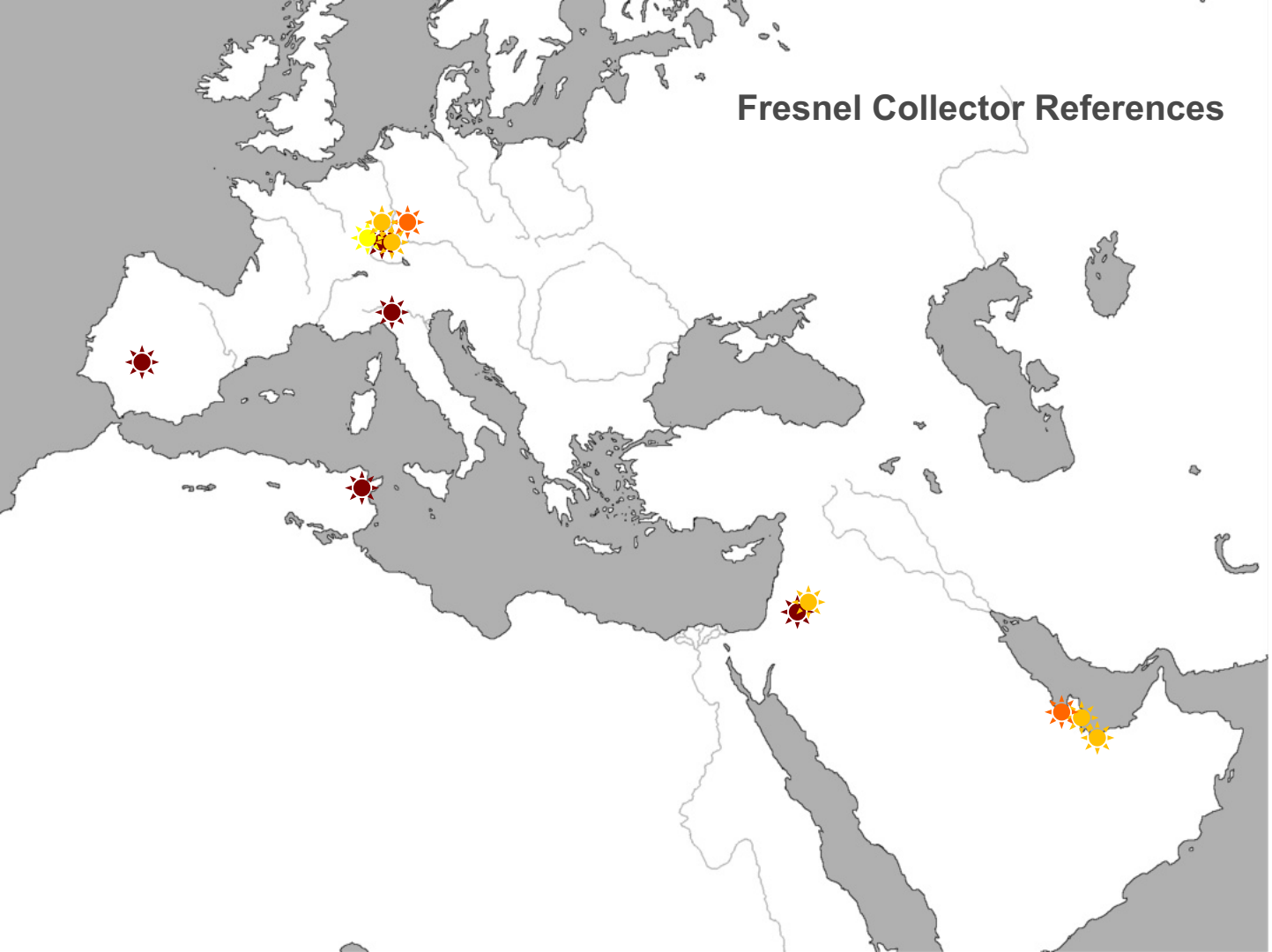
- Rooftop installation possible
- Meets industry requirements
- Best for direct steam generation
- Low O&M cost

- **High ground usage factor**
- **Low wind load**
- **Good weight-spread**
- **Primary mirrors made of flat glass vs. aluminum → higher durability and reflectivity**
- **More m² aperture area per m of absorber tube allows usage of high-quality vacuum receiver**
- **Precise temperature- and power control**
- **Stationary receiver, no flexible connections**
- **Concentrated sunlight always hits absorber tube from below**
- **Easy cleaning (flat glass / good access)**
- **Low water demand for cleaning**

Reference: Solar Steam Generation & Solar Cooling
Country: Jordan

- Tobacco Industry
- Fresnel collector
- 1254 m² collector area
- 705 kW_{th} thermal power
- 225°C saturated steam
- Absorption chiller

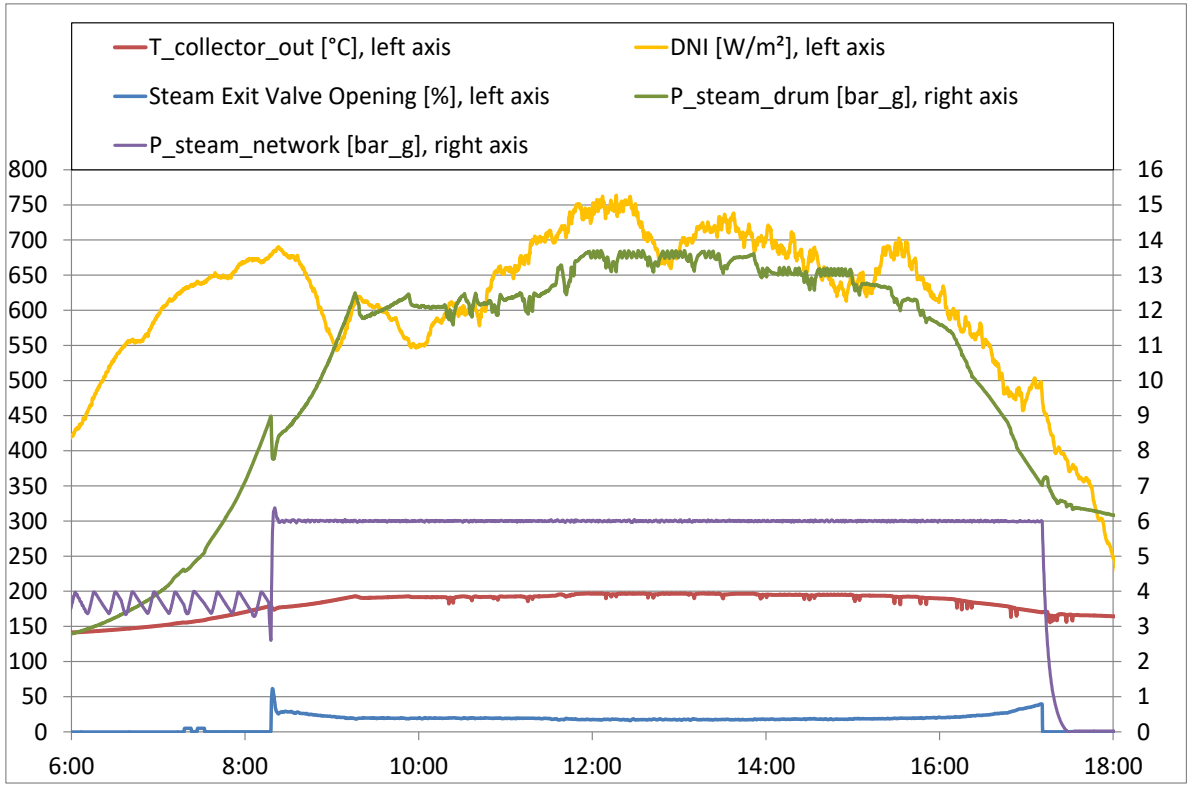
Fresnel Collector References



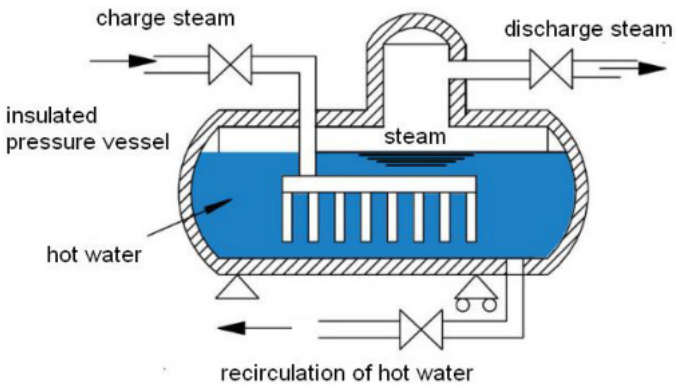
1. Freiburg (Germany)
2. Bergamo (Italy)
3. Sevilla (Spain)
4. Grombalia (Tunisia)
5. Freiburg 2 (Germany)
6. Abu-Dhabi (UAE)
7. Doha (Qatar)
8. Stuttgart (Germany)
9. Umkirch (Germany)
10. Karlsruhe (Germany)
11. Doha (Qatar)
12. Johannesburg (South-Afri
13. Amman (Jordan)
14. Amman (Jordan)

Solar Steam Generation

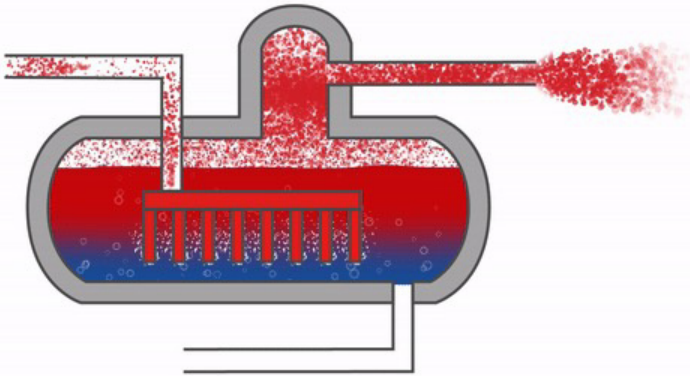
Despite fluctuating solar irradiation, the solar steam generation system can maintain the target steam pressure of 6 bar from 8:30 until 17:15.



Steam Drum Storage concept



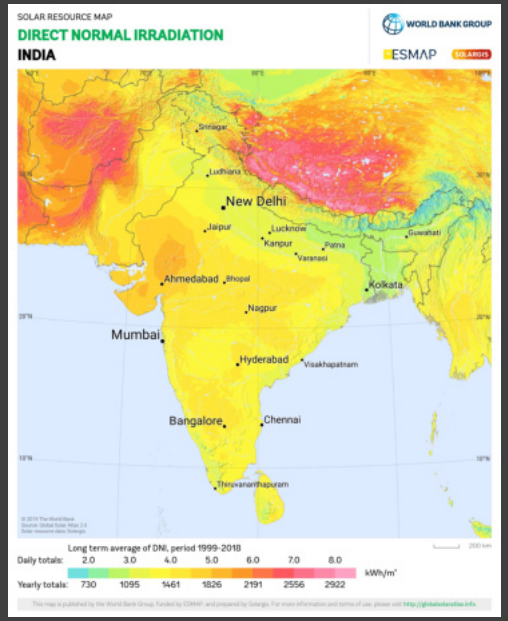
- Large pressure vessel
- mainly filled with liquid water (80% of volume)
- partly filled with steam (20% of volume)



Additional Functions of Storage

- Two-phase separation
- Expansion Vessel
- Steam pressurization
- Blow-down
- De-Aeration
- Anti-Freeze protection

Local Value & Local Partners



- Industrial Solar is working with local partners in India, e.g. with

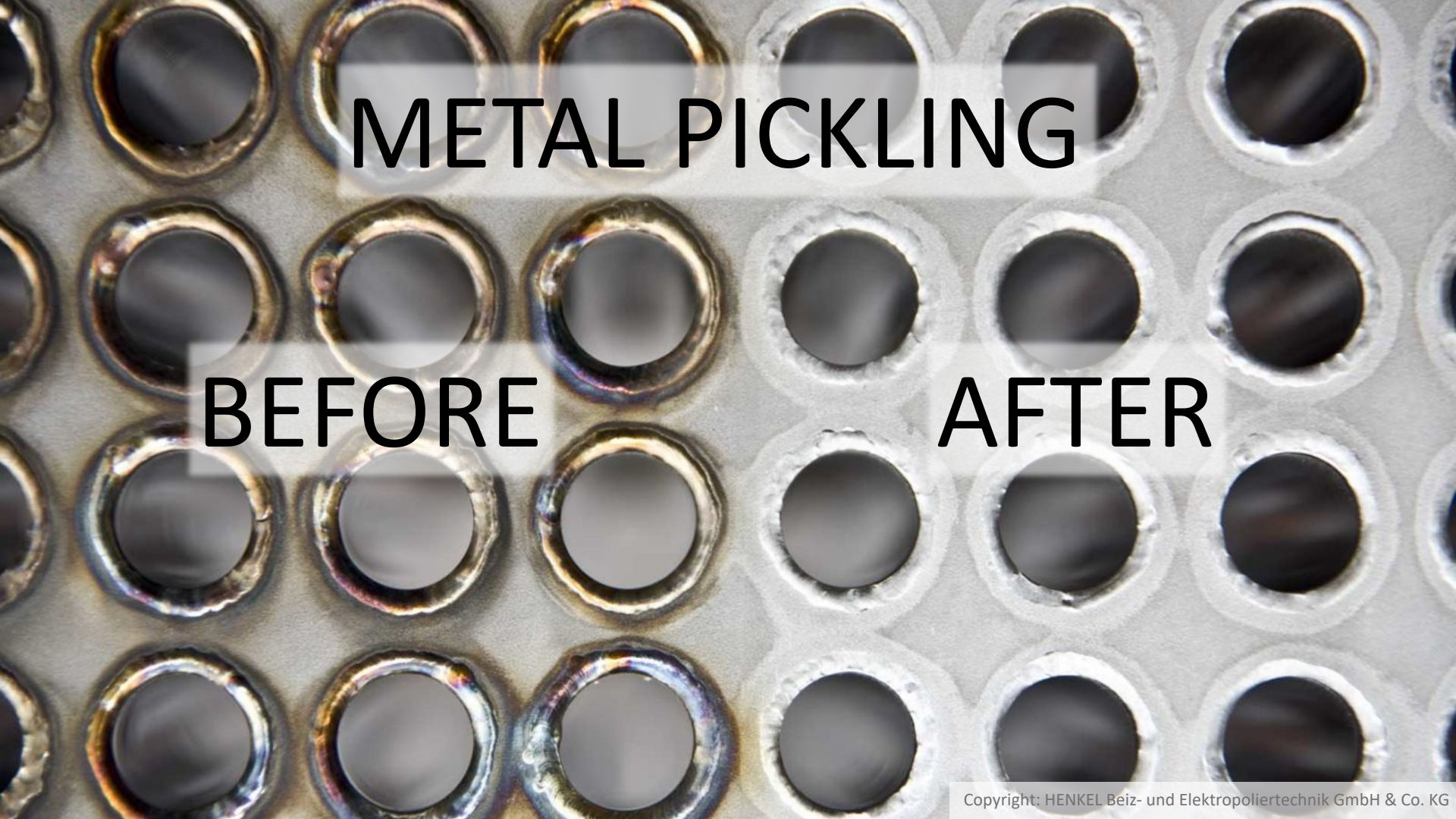
VCare Engineering Private Limited
Vadodara / Gujarat
https://vcare-global.com

Together with our local partners we can quickly achieve a high local value!

METAL PICKLING

BEFORE

AFTER



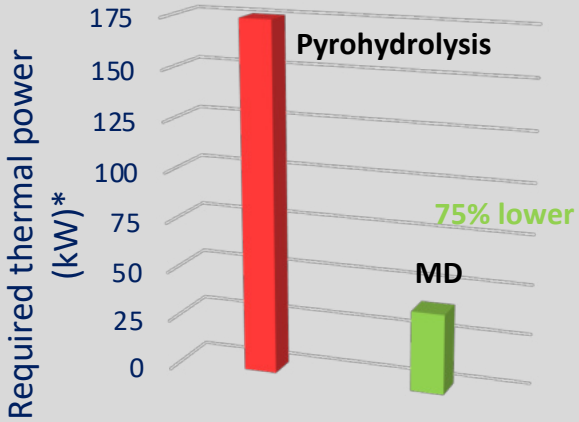
Treatment and Reuse of HCl from Metal Pickling Baths with Membrane Distillation

SolarSpring membrane solutions

- Pickling of ferrous metals and alloys generates wastewater containing acid, Iron and sometimes Zinc
- The treatment and recycling of the wastewater via Pyrohydrolysis is generally a very energy intensive and expensive process

Spent Pickling Liquor treatment and recycling with SolarSpring Membrane Distillation (MD)

- Energy savings of up to 75% compared to pyrohydrolysis; significant reduction in Carbon emissions
- Easy integration into current production process; treatment and recycling on-site
- Waste heat can be directly used to power MD
- Expected return on investment is less than 2 years

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Le distributeur automatique d'eau fournit une eau traité
technologie de filtration moderne et un processus qui incl
1. Filtration à micro particule de 150 um (particule visible)
2. Membrane ultrafiltration 0,02 um (particule non visible, mi
3. Filtre à charbon actif (bactéries , odeur , goût)
4. Stérilisation par ultraviolet (Stérilisation à 100%)
Ce processus est conçu spécifiquement pour produ
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