Experiences from solar fields in Belgium and outlook on solar district heating

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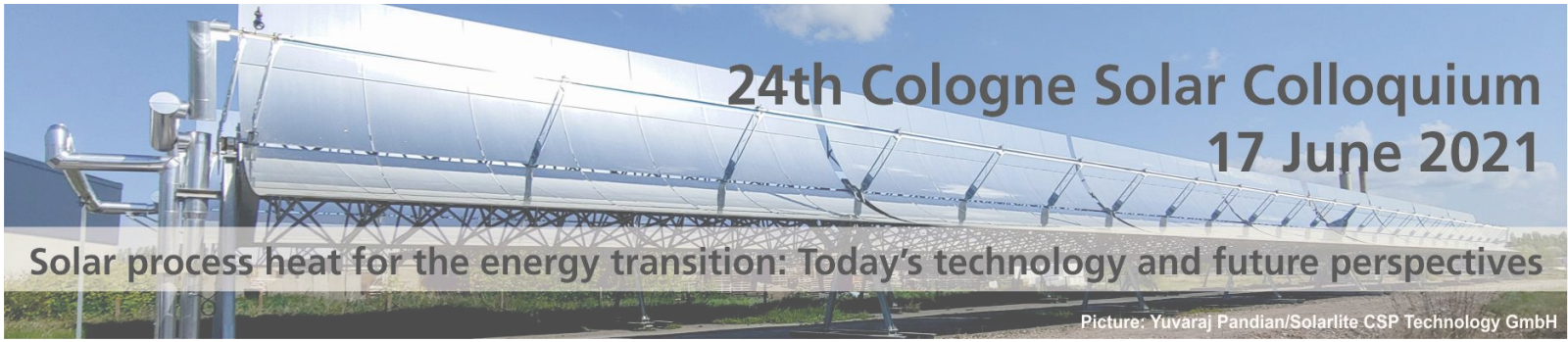


DLR

COMPANY BACKGROUND

- Competence: 20 years of EPC experience in parabolic trough collectors (CSP/CST) for power and process heat production
- Innovation: Direct Steam Generation (DSG), parabolic trough collectors with composite body and thin glass mirrors → light-weight design, solar cogeneration/multi generation
- Product: SL5770 high precision parabolic trough collector for application up to 550 °C
- Advantage: CO_2-free energy production, low energy production cost (LCOE/LCOT), modular design, automated operation
- Research Partners: German Aero Space Center (DLR), University RWTH Aachen, Research center Jülich, CIEMAT Spain, PSA – Plataforma Solar Almeria, University Rostock, Technical University Berlin, Humboldt University

WIDE RANGE OF APPLICATIONS FOR INDUSTRIES

POWER

- Solar thermal power plants from 500 kWe up to 100 MWe
- Heat Storage for 24x7 supply
- Hybridisation

PROCESS HEAT

- Up to 400 °C heat & steam generation for 1 MW – 100 MWth
- Breweries, Food & Beverage, Chemical, Paper & pulp
- Integration with existing boilers

DESALINATION

- Solar desalination using MED/MSF technologies – applied for sea & brackish water
- 100 to 100,000 m³/day capacities

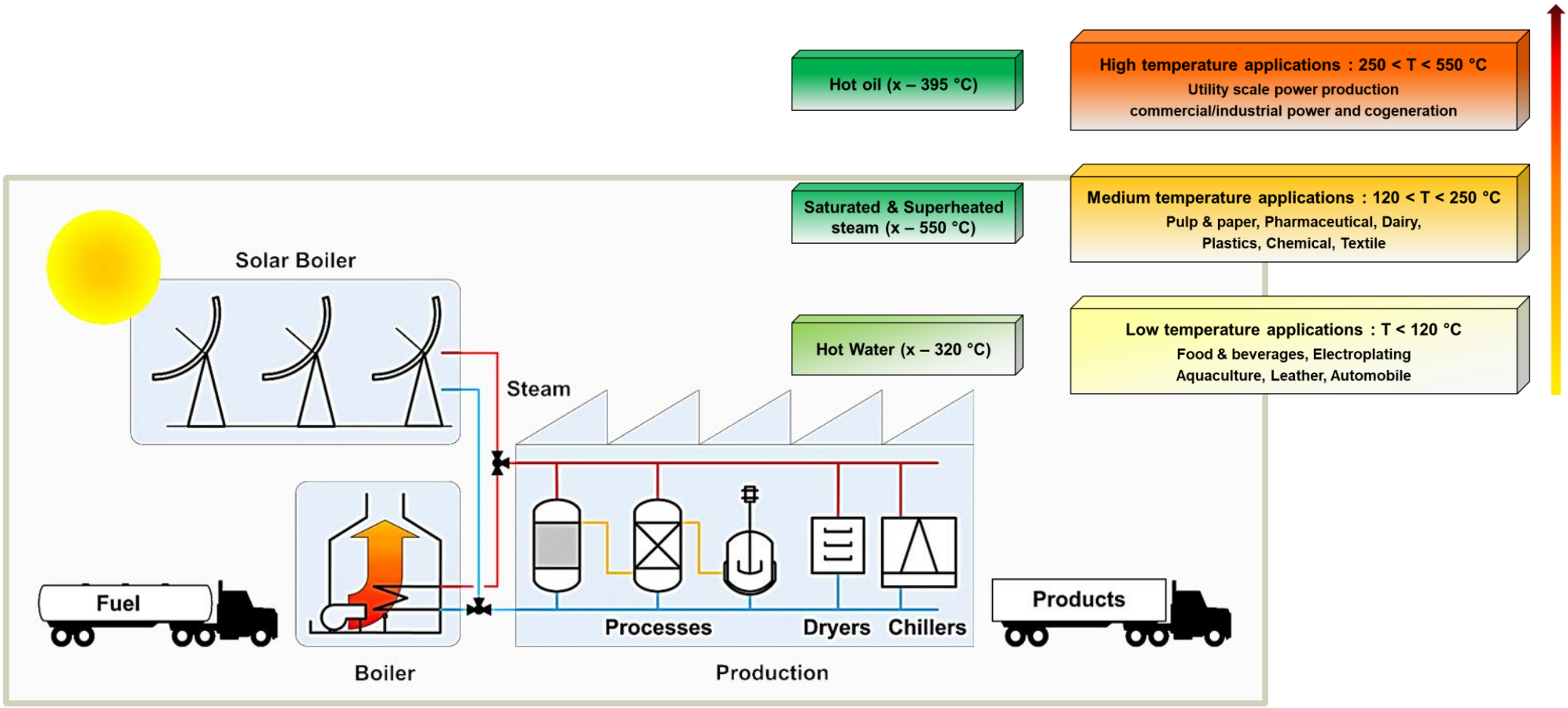
COOLING

- Single/multiple stage absorption chillers, Turbine driven centrifugal chillers
- 200 to 100,000 RT capacities for large commerical /district cooling

EOR

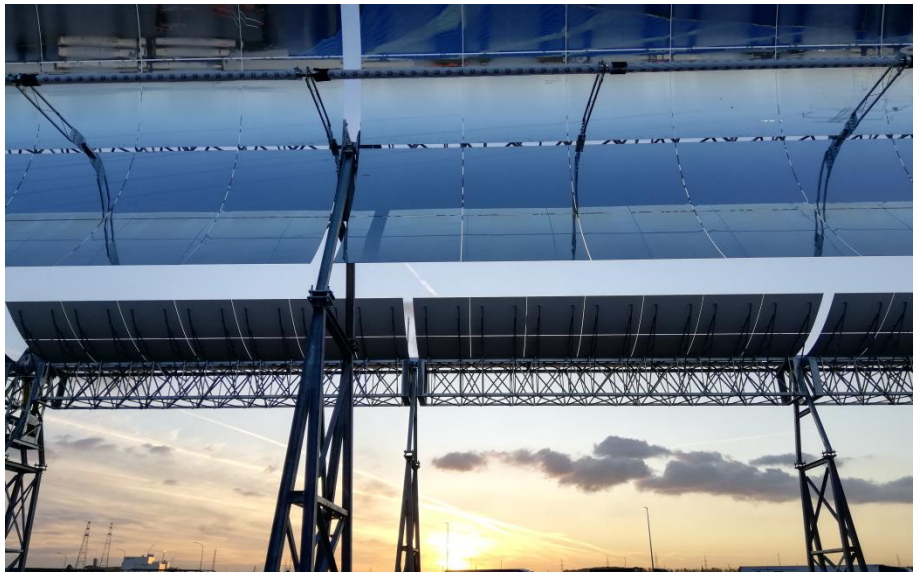
- Eco friendly EOR approach for heavy oil fields
- High pressure DSG up to 100 bar
- Integration with existing OTSG‘s

WIDE RANGE OF APPLICATIONS FOR INDUSTRIES



Simple integration principal without interfering in existing production processes
Solar field is directly connected to the existing boiler interface

PROCESS STEAM SUPPLY FOR CHEMICAL INDUSTRIES



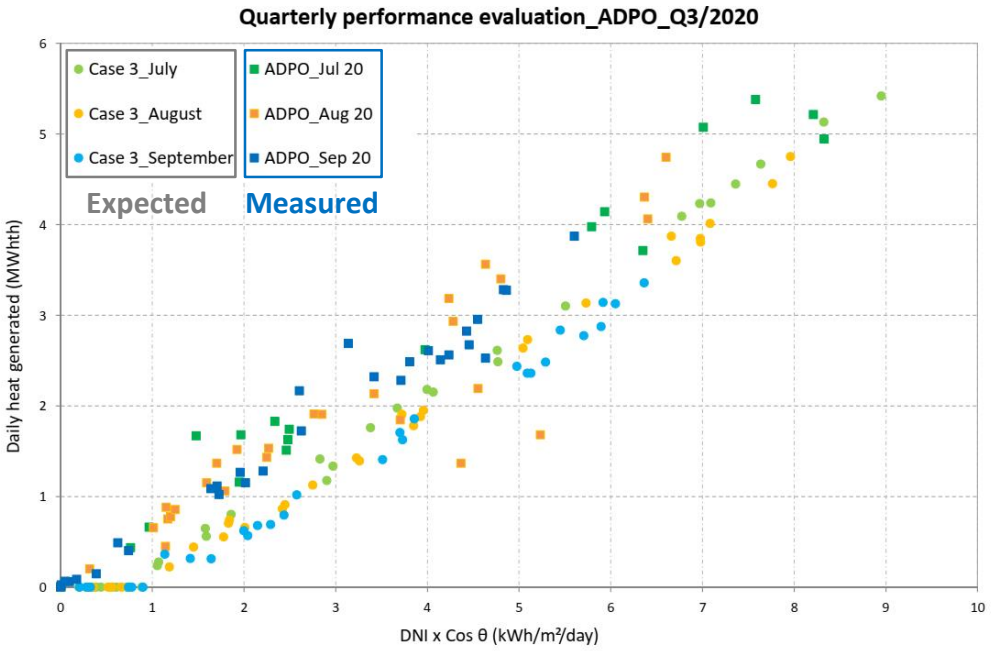
ADPO, Port of Antwerp, Belgium

- 1,100 m² aperture area; 500 KWth capacity
- Helisol as heat transfer fluid operating up to 300 °C in primary oil circuit
- Steam generation at **5 bar, 152 °C**
- 100 tons CO_2/a savings
- Elevated over a railway track and truck parking area

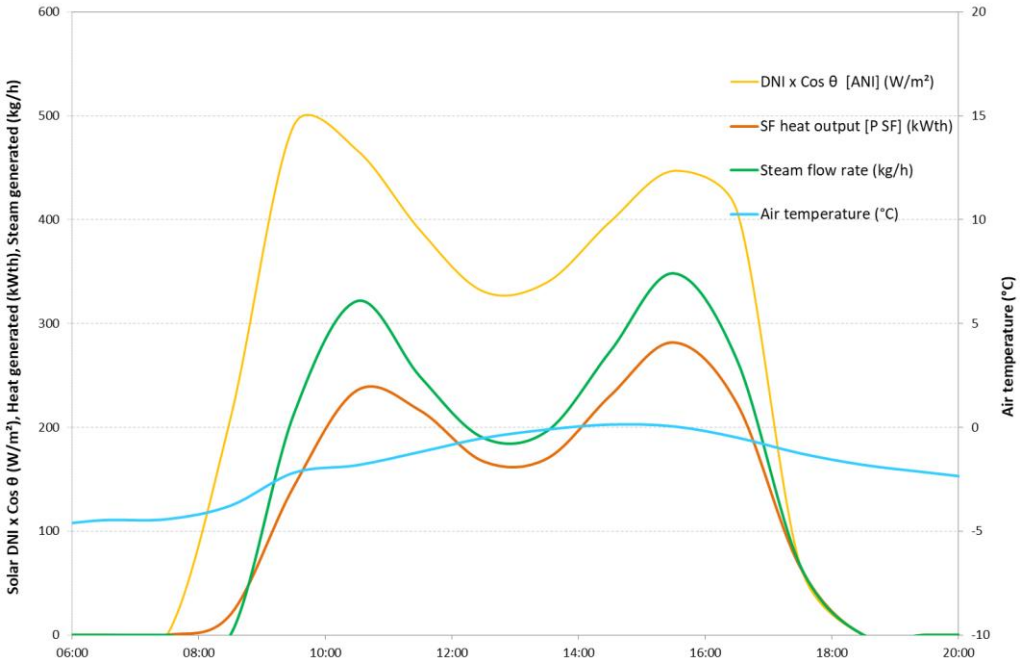
Proviron chemicals, Oostende, Belgium

- 1,100 m² aperture area; 500 KWth capacity
- Helisol as heat transfer fluid operating up to 330 °C in primary oil circuit
- Steam generation at **11 bar, 185 °C**
- 105 tons CO_2/a savings
- Located within client premises

EXPERIENCE FROM THE BELGIAN INDUSTRIAL CST PLANTS



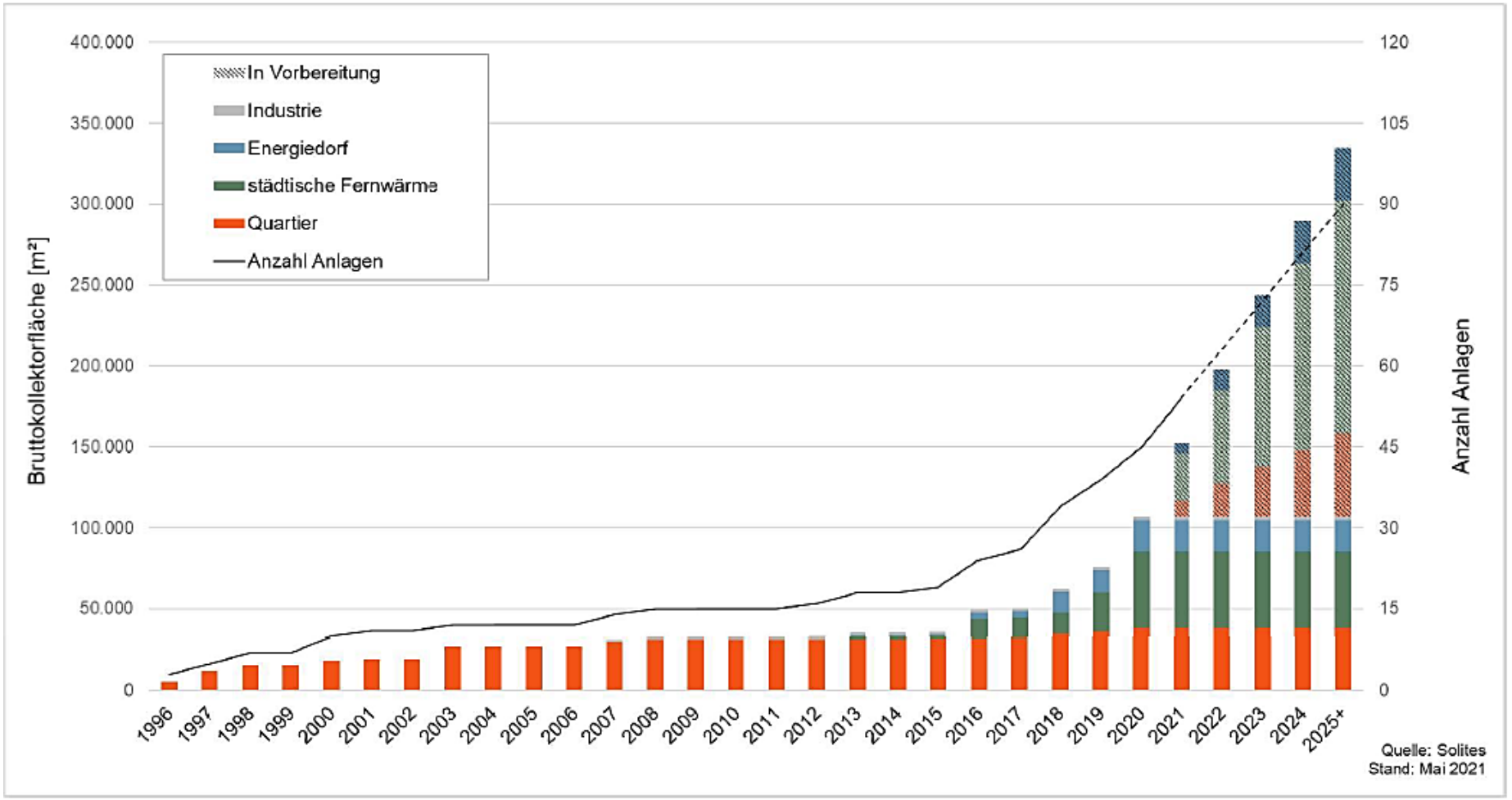
- Solar heat/steam generation successfully demonstrated in low DNI locations (950 – 1,100 kWh/m²/a)
- Measured performance has been always at or above the expected performance
- Stable operation even on winter days with low DNI
- Reliable interaction with existing heat generators



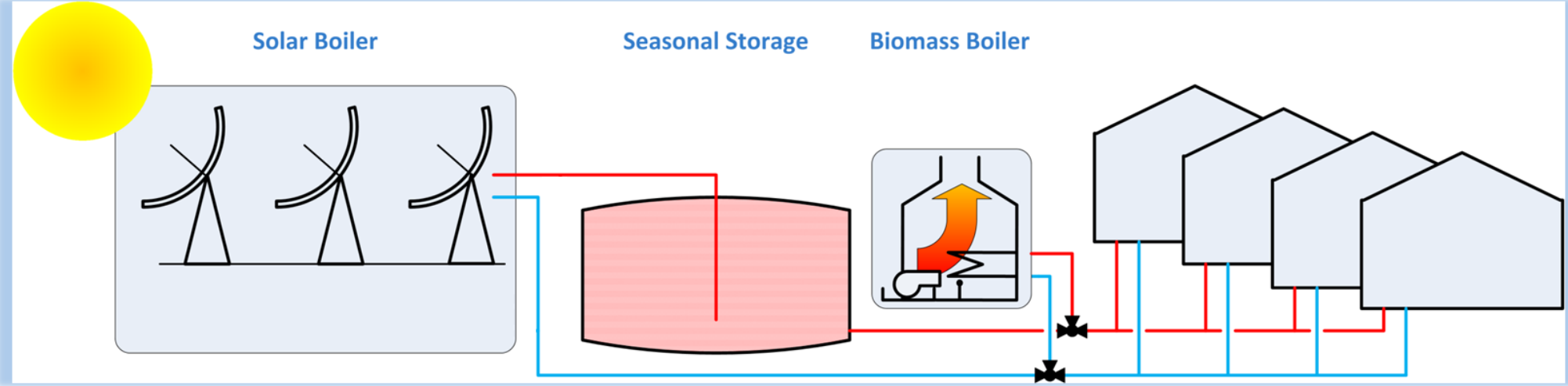
- Unmanned operation successfully demonstrated increasing level of confidence in clients/investors
- Remote monitoring and control helps to optimize performance, better maintenance scheduling
- Far lesser mirror washing cycles than planned – thanks to rain water washing of mirrors
- Can be compactly adopted into industrial premises

CST SOLAR FIELD

DISTRICT HEATING CAN BECOME AN IMPORTANT CST MARKET IN GERMANY

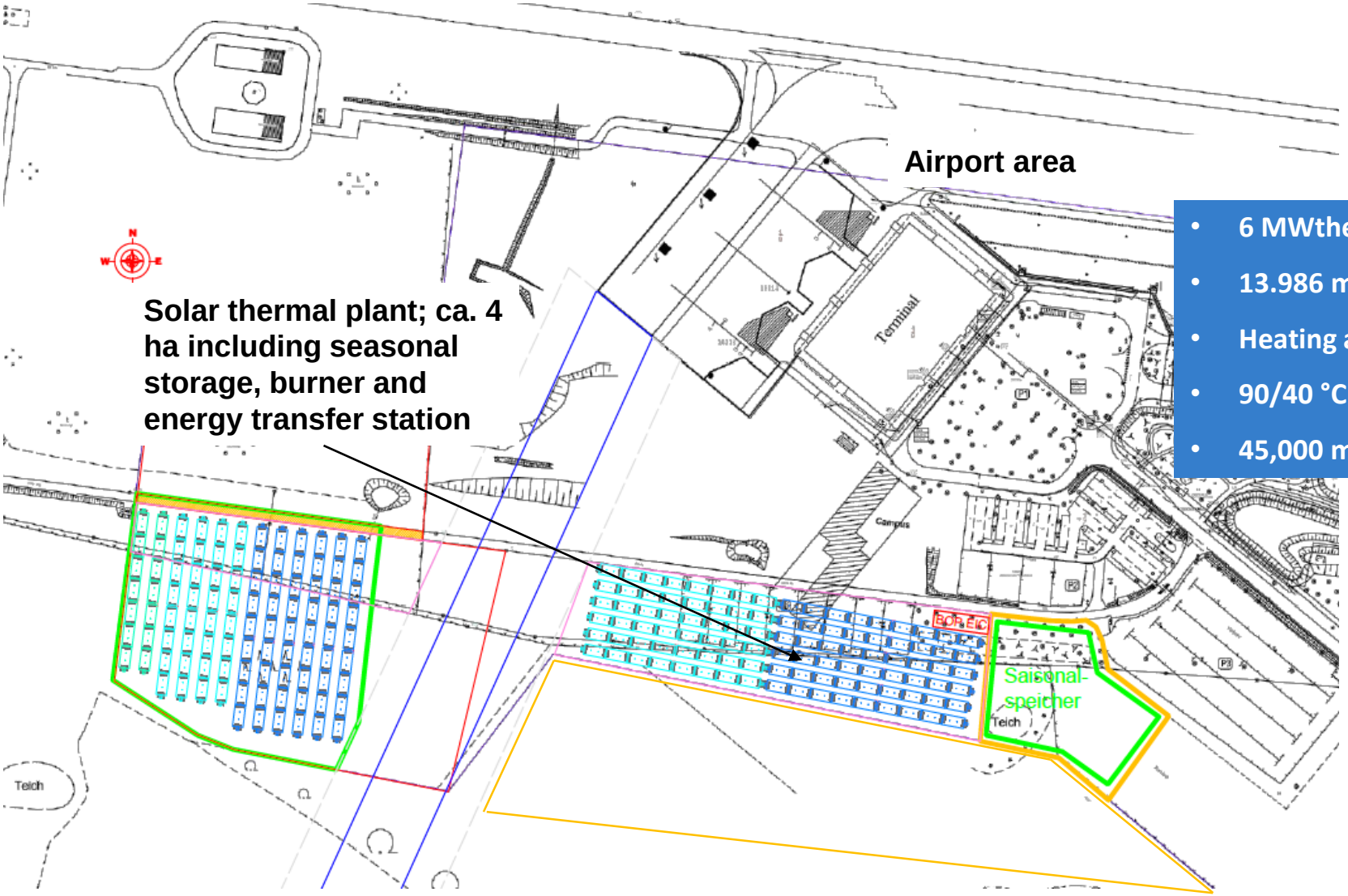


SOLAR PROCESS HEAT FOR UTILITIES (CITY WORKS)



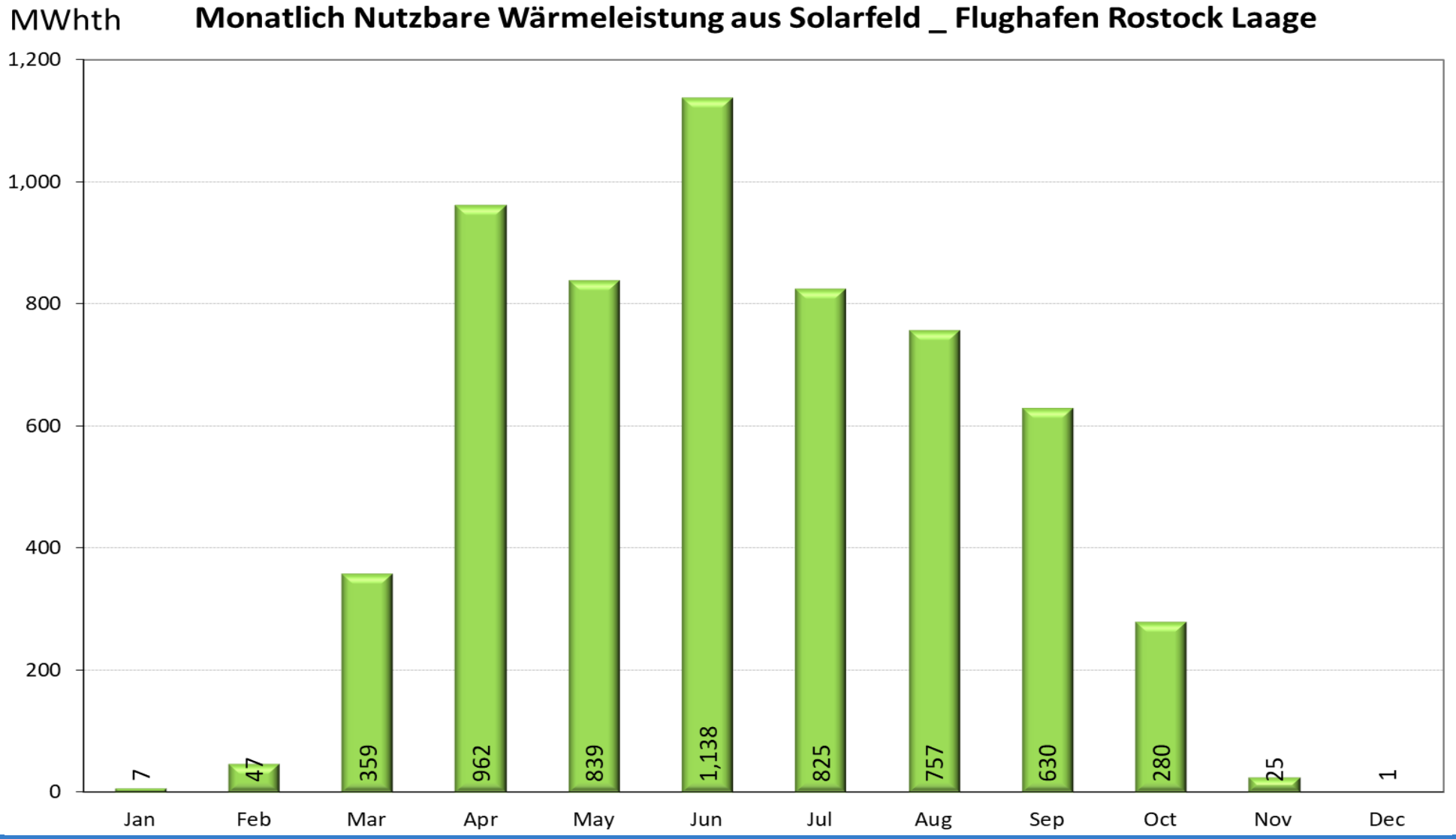
- City works in Europe have the responsibility to provide stable heat to most residential/commercial clients
- Large scale district heating networks are usually high temperature network carrying heat up to 160 °C
- Non concentrating solar technologies are either not able to reach these temperatures (especially during winter) or do so at the cost of efficiency; CST systems are best suited to address the high temperature heat supply
- Concentrated solar systems are “controlable” and can be operated at different temperatures as required
- A second heat source (biomass or gas boiler) is required as back up to ensure heat supply safety
- Concept in use for decades in Denmark; can be replicated economically worldwide
- Combined district heating and cooling systems with high solar fractions (>80%) are our goal for future development
- Solarlite is currently preparing such projects for various European city works in the range of 4 MWth to 14 MWth

GERMANY´S FIRST CST DISTRICT HEATING PLANT

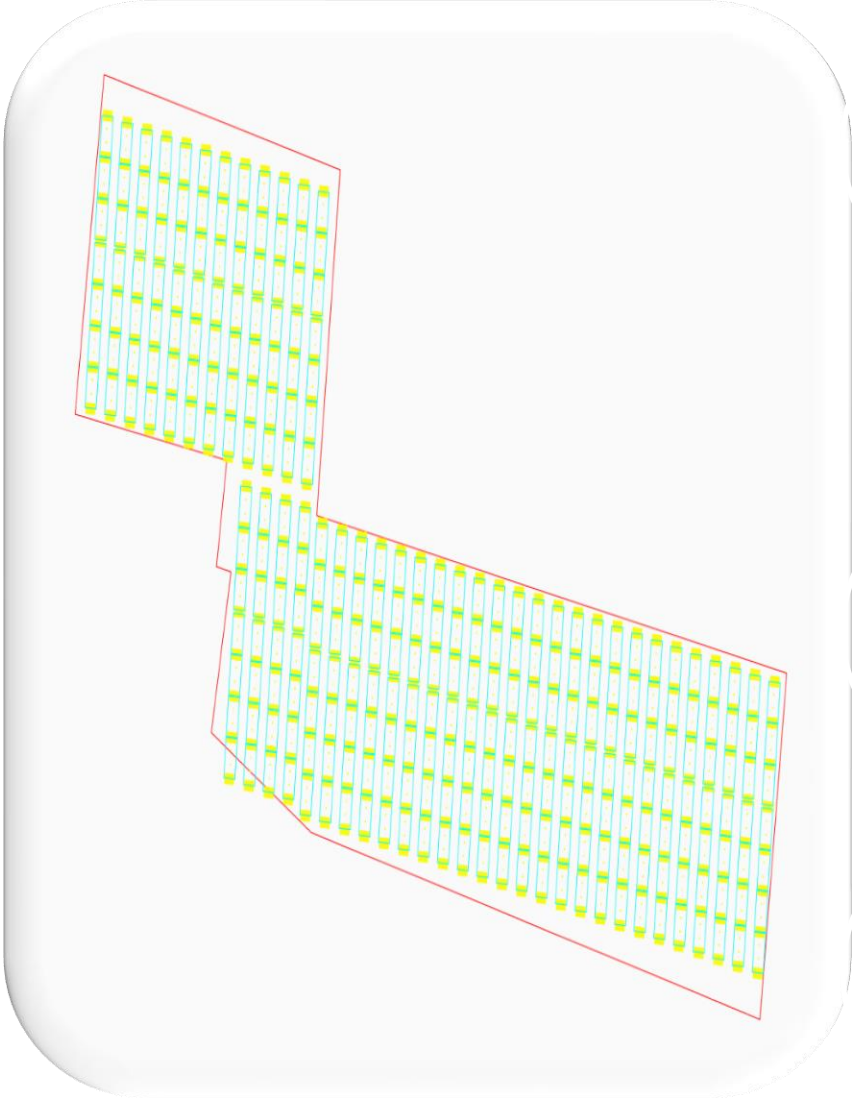


- 6 MWtherm
- 13.986 m² mirror surface
- Heating and cooling
- 90/40 °C heating cycle
- 45,000 m³ seasonal storage

STABLE HEAT GENERATION IN LOW RADIATION REGIONS

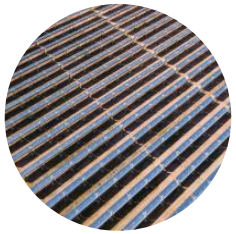


SOLAR FIELD CONFIGURATION (EXAMPLE COASTAL AREA MV)



40 SL5770 collectors with a mirror surface of 19,387 m² oriented in North-South direction

75% optical peak effciency,
70% thermal collector efficiency at 130 °C with Solarlite DSG Vaccuumabsorbers



3,5 ha / 35,000 m² required total area for solar field, peripheric installations (BOP) and control room

8.450 MWh_{th} are produced annually and are ready for use

SOLAR HEAT FOR A DISTRICT HEATING SYSTEM (EXAMPLE COAST MV)

SOLARLITE CST SOLUTION	
Capacity (kW_{th})	10.000
No. collectors	40
Aperture area (m^2)	19.387
Total area (m^2)	35,000
Own energy consumption (kW_e)	100
Temperature in (°C)	80
Temperature out (°C)	130
Transfer fluid	Hot water
Annual heat production (kWh_{th})	**8.450.000**

- **Invest: 6.3 Millionen €**
- solar collectors, peripheric installations (BOP, piping, earth works, foundations, control), engineering, construction, commissioning

- **OPEX: 66.000 €/a**
- Cleaning, maintenance, spare parts, consumables, remote control

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