# Concentrating collectors for Central Europe

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DLR

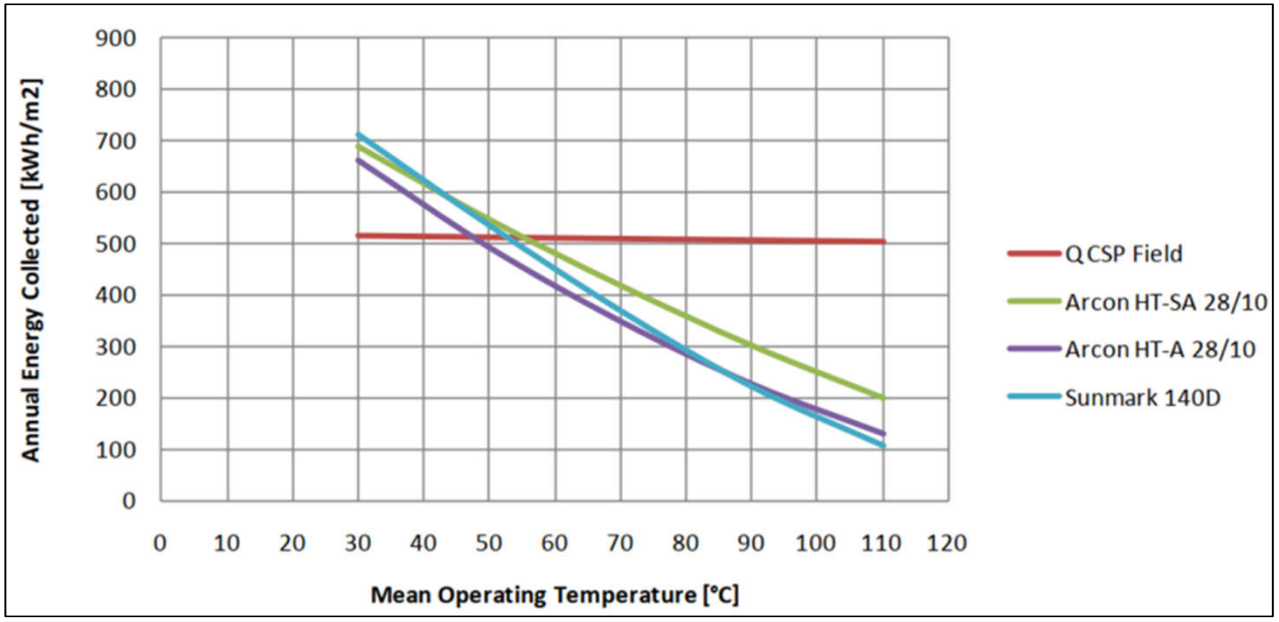
# Status of concentrating collectors for process heat in Europe

Several publications with yield calculations
Very few installations erected

Sufficent Irradiation?
Little known about
- thermal yields
- costs
- operation

⇒ Benchmarking of parabolic troughs with established collector technologies

⇒ Alternatives: Fresnel and tower

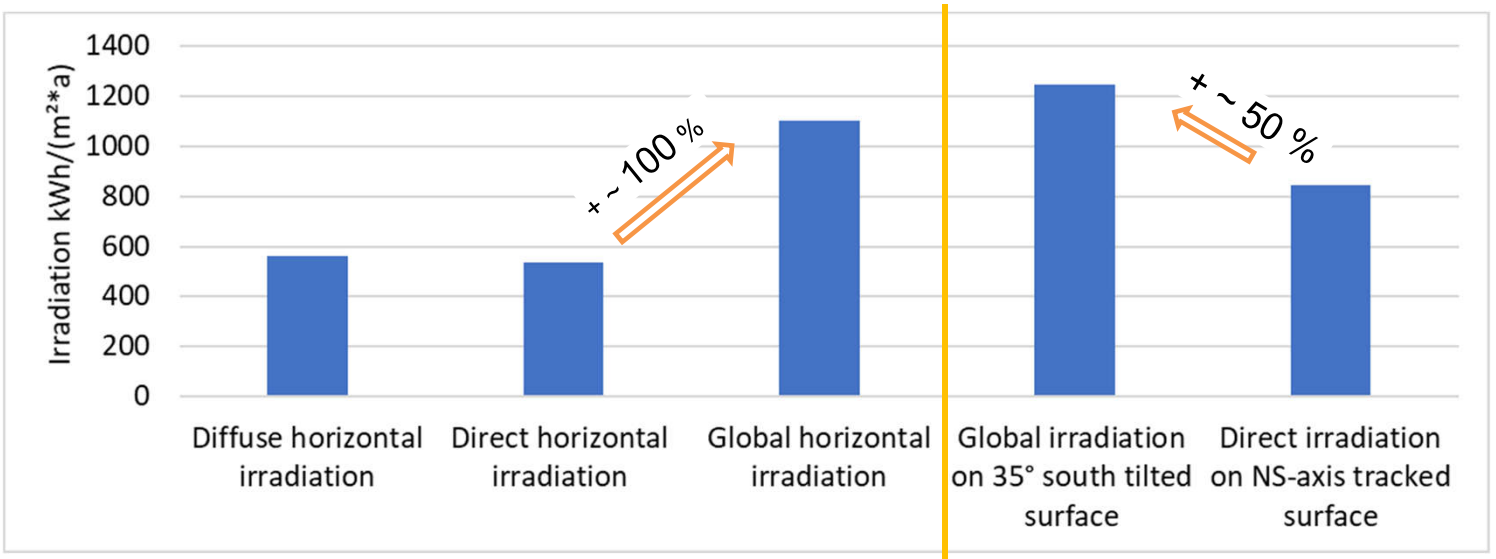



Calculated annual yields of a parabolic trough collector related to flat plate collectors for a Danish climate

Reference: DTU Civil Engineering Report R-292 (UK), 2013

# Relations of irradiations on different surfaces

Radiation for the site of Würzburg, Germany, a typical spot in Central Europe



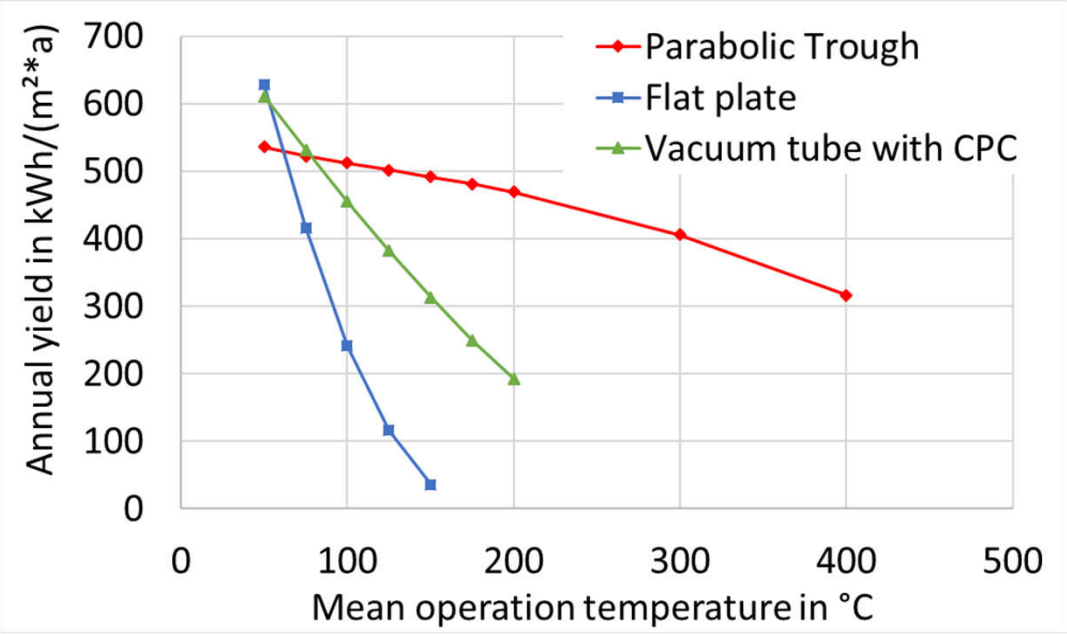

Related to the horizontal the global irradiation is twice as high as the direct irradiation
Usable irradiation on collector surface is ~ 50% higher for stationary collectors

# Results calculated with Greenius

Energy yield in dependency of collector operating temperature for parabolic trough, vacuum tube and flat plate collectors calculated with greenius

- Losses in piping and heat capacities included
- Shading and 2% soiling included for troughs
- Orientation North-South axis

→ Break-even point 50…80 °C
→ Parabolic trough still attractive for temperatures above 100 °C

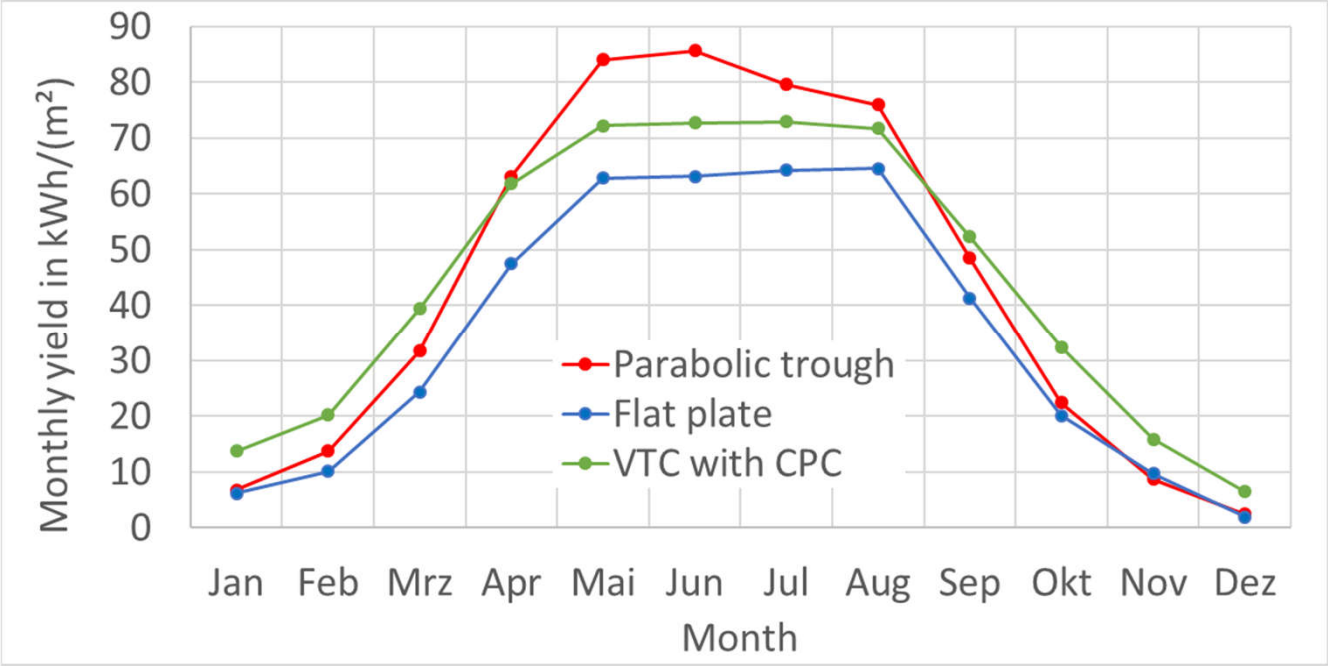



Annual yields as a function of mean operation temperature for Potsdam

References for graphs: D. Krüger, S. Fischer, T. Hirsch, J. Iñigo Labairu: Concentrating Solar Systems in moderate climates, Proceedings of SolarPACES 2020, submitted
D. Krüger, S. Fischer, P. Nitz, J. Iñigo Labairu: Chancen für den Einsatz konzentrierender Kollektoren in Mitteleuropa, Solarthermie Symposium 2021, submitted

# Seasonal characteristics

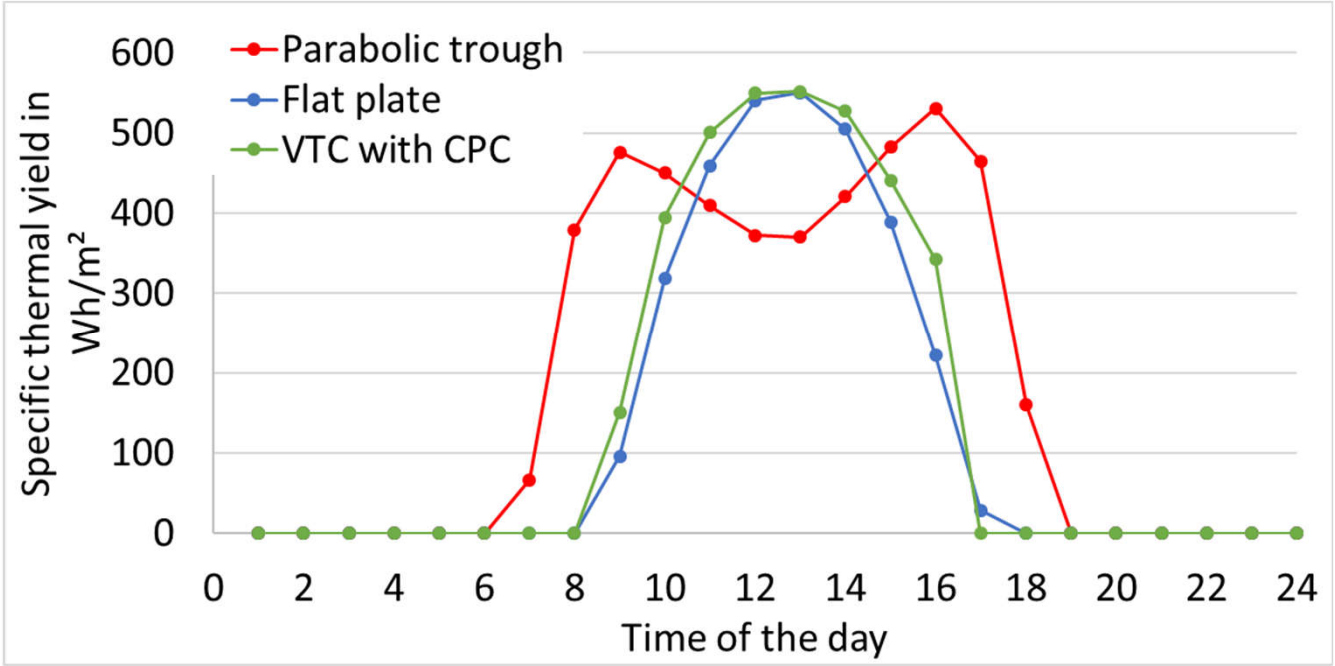
Parabolic trough collector: Stronger peak in summer
Vacuum tube collector with CPC: Better distribution along the year




Seasonal thermal yield at 75° C mean operation temperature

# Characteristics in the course of a day

Parabolic trough during morning and evening in better position to the sun than at noon
Production interval for PT 3 hours longer




Hourly yield on 14th of September for Potsdam at 75° C
and a North-South axis of the parabolic trough collector

# Investments and solar heat costs thermal technologies

Few installations of parabolic trough and Fresnel collectors have been installed worldwide in process heat and district heating. In Central Europe little experience exists with the technologies.

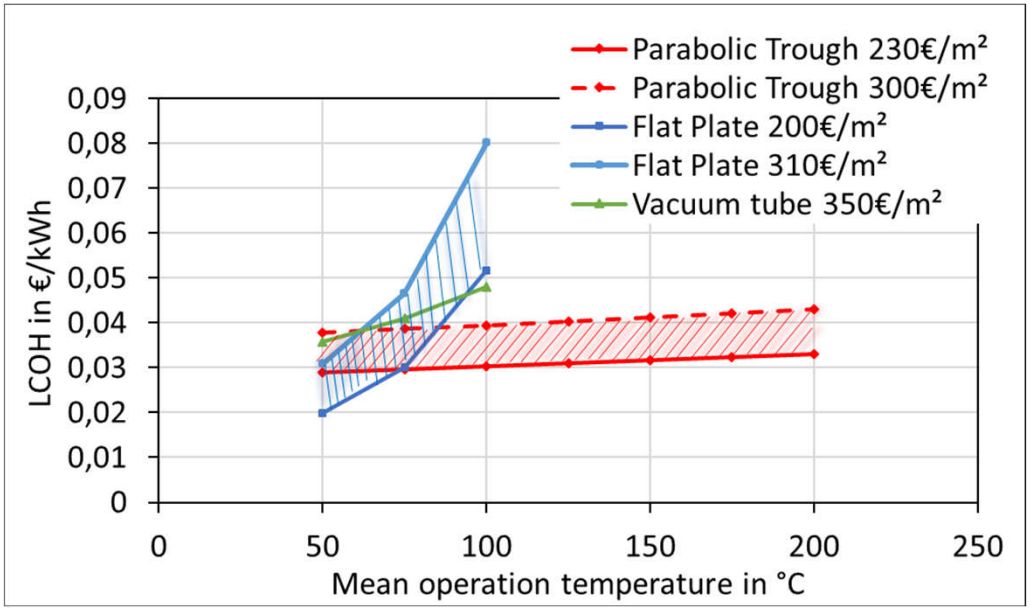
Related to field size of 10.000 m²

According to the parabolic trough manufacturers protarget and Solarlite, the price for planned, fully installed and commissioned solar fields including the power transfer station is between 230 and 280 €/m².

Vacuum tubes Standard values for realised outdoor systems: 350 €/m²

Flat plate collectors assumption: 200 to 310 €/m²

| | |
|---|---|
| Financial parameters: | |
| Discount rate | 3% |
| Life time | 25 years |
| Operating costs: | |
| Parabolic trough | 1% |
| Flat plate | 0,50% |
| VTC | 0,50% |




LCOH for Potsdam

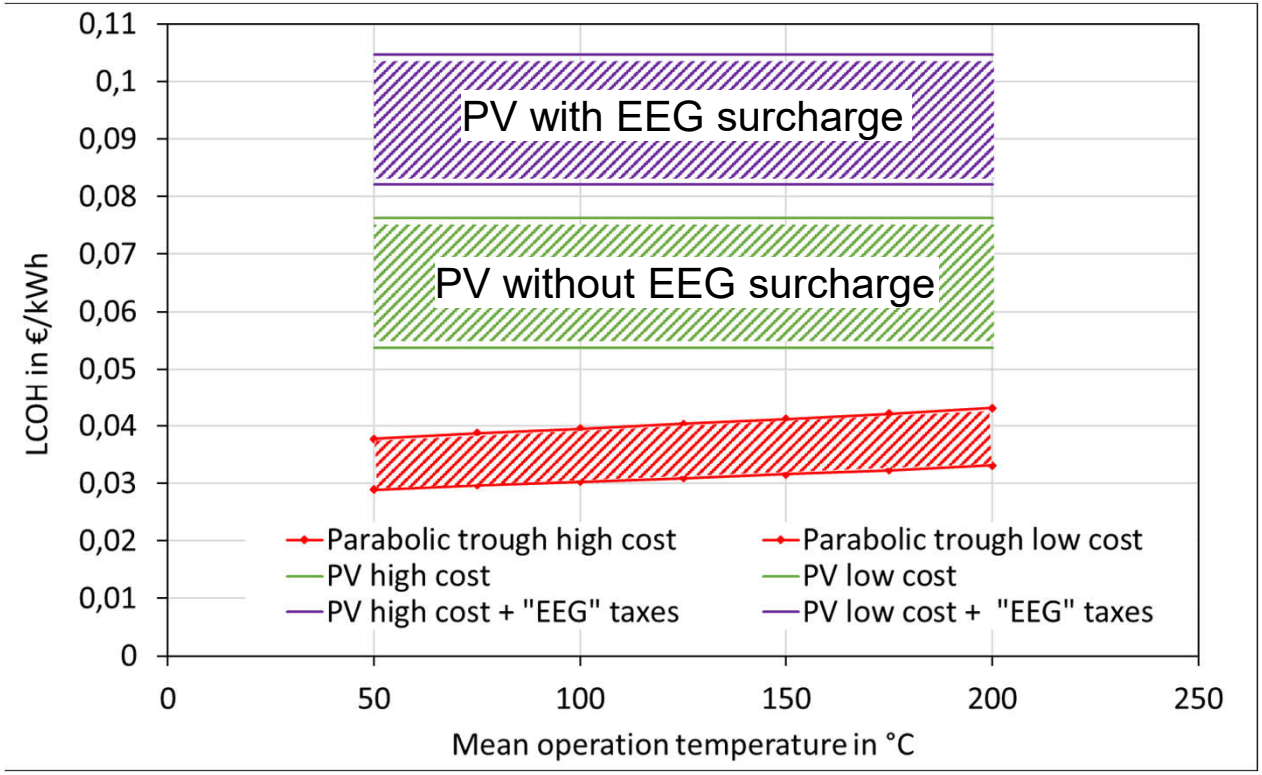
# Investment and heat costs - comparison with PV + electrical heater

**Assumptions PV**

Related to field size of 9400 m²

| | | High | Low |
|---|---|---|---|
| PV Field | €/kW_DC | 700 | 500 |
| Inverter | €/kW_AC | 70 | 55 |
| Electrical heater | €/kW_AC | 100 | 100 |
| EPC surcharge | % | 32 | 32 |
| Total Costs PV heat | €/kW_AC | 1192 | 858 |
| O&M & Insurance | % | 1,0 | 0,5 |

**Installed power several dimensions higher for PV => Higher cost reduction by economies of scale achieved**

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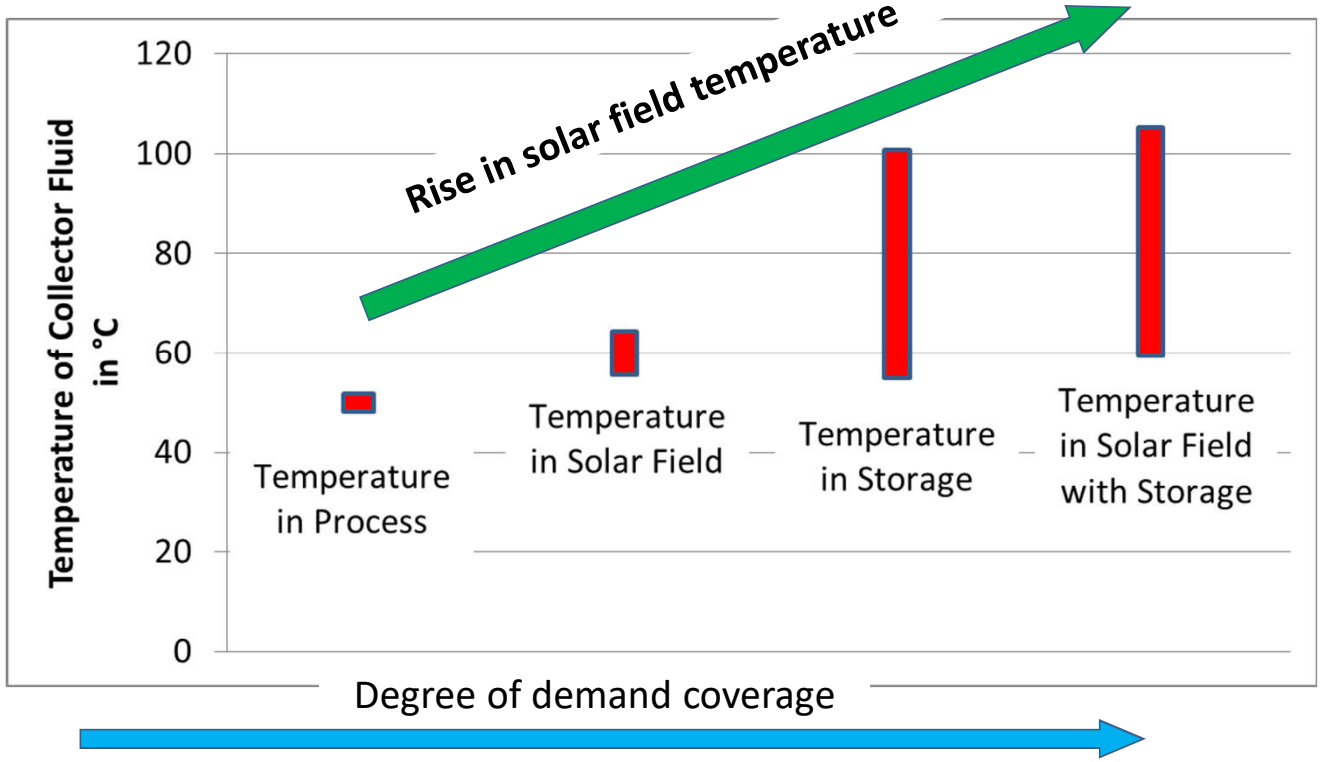
# Effects of storage on temperature level

To cover significant amounts of demand, storage will be necessary.

- higher collector operation temperatures
- can be covered well with concentrating solar systems
- reduced storage volume possible



# New opportunities

Process and district heating can be supplied efficiently between 70 and 300°C

Small dependency of operation temperature allows simple processes and planning

Simple loading of storages

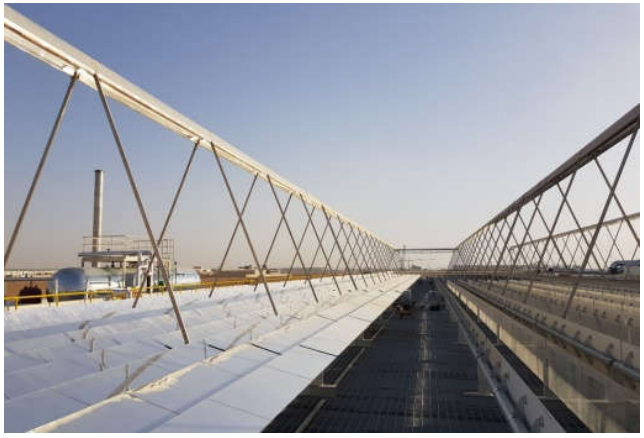
Enables higher demand coverage

Opens opportunities for new storage technologies above 100°C

Development of new collector constructions

Other technologies as Fresnel and tower open further possibilities

Parabolic trough, Turkey
Soliterm



Fresnel collector, Jordan
Industrial Solar

Parabolic trough, Cyprus
protarget

Parabolic trough
Oostende, Solarlite

Parabolic trough
Baden, itcollect

# Developments in the Netherlands

Support scheme under preparation: Stimulation of sustainable energy production and climate transition (SDE++)

Solar thermal energy above 1 MWth: may apply for a maximum base rate of 0.08 [EUR/kWh]

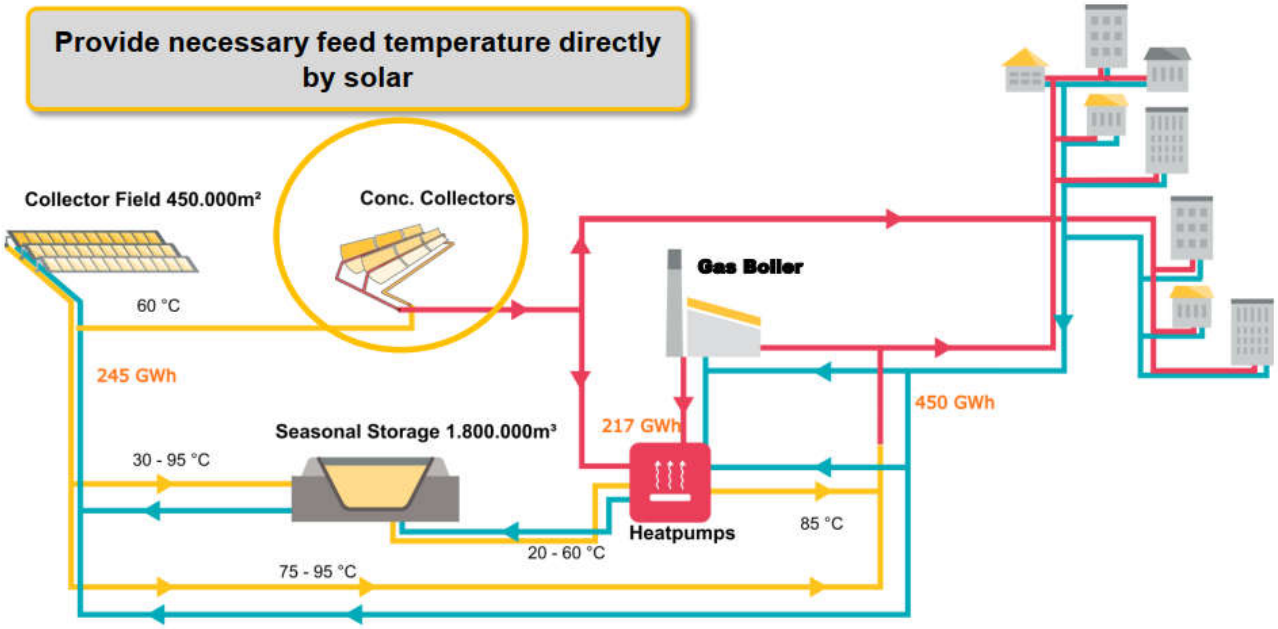
The [SDE++] reference systems for solar heating are based on the use of flat plate collectors for hot tap water preparation in the built environment. For application in industry, however, the required temperature level is often higher than what this type of collector delivers, and this is also the case with heat networks. Concentrating collectors could be used for this, for example. We would like to know what cost and performance figures would apply to systems with concentrating collectors, as well as their potential for cost reduction.

https://www.pbl.nl/publicaties/conceptadvies-sde-2022-zonne-energie

$CO_2$ certificate costs are not covered in the base rate and therefore add to the revenues

# Preparation IEA SHC Task 55 Follow-up – strong focus on concentrating collectors

## Solar District Heating (SDH)
## ➔ feed temperature directly by solar



# Summary

Discussion primary for great solar fields of more than 1.000 m²

Parabolic trough collectors in moderate climate can deliver solar heat up to 300 °C

Break-even point for parabolic trough at ~60°-80 °C (both in terms of efficiency and cost of heat)

Higher operating temperatures allow better integration of thermal storage and in consequence higher solar share and demand coverage

**The technology opens new opportunities for solar process heat and district heating in moderate climates**