# Solar particle technology for high temperature process heat

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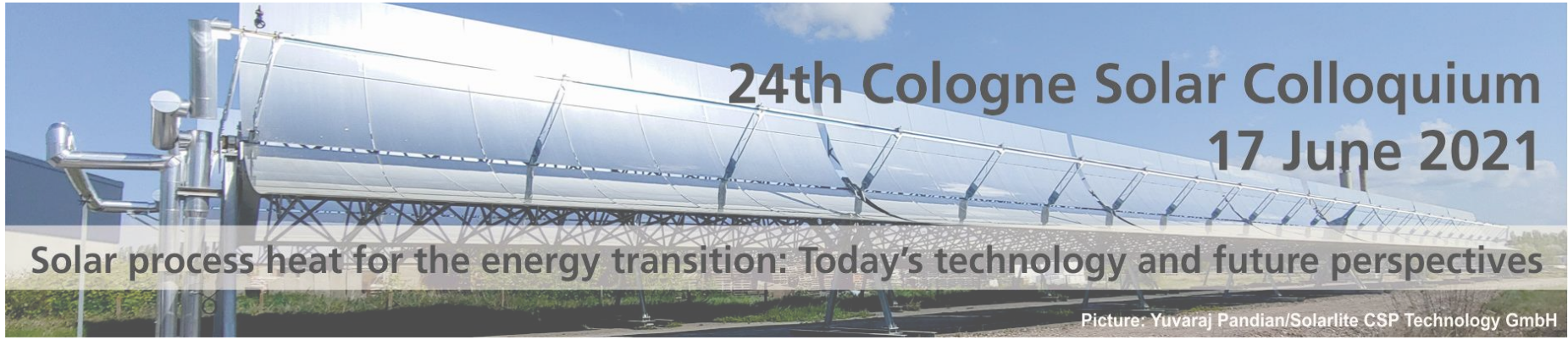
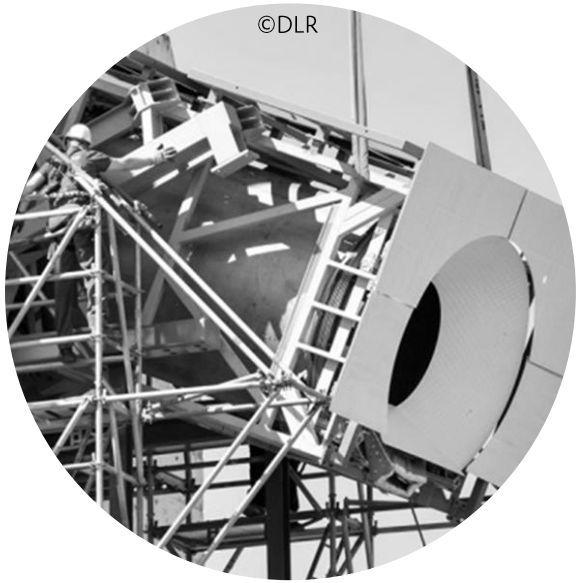



DLR

# Company

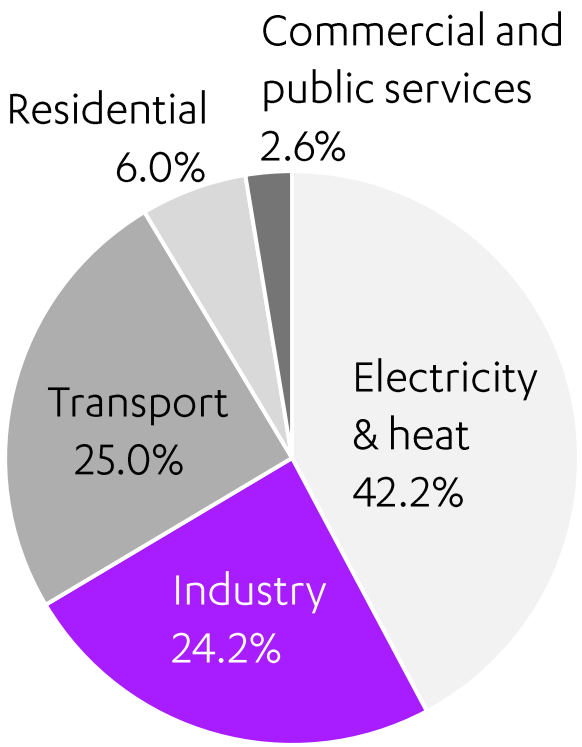
Founded in 2017 as DLR spin-off;
based in Offenburg, Germany

Team:
6 engineers and 1 economist




Core technology:
Centrifugal Particle Receiver

# Problem




$CO_2$ emissions from fuel combustion by sector in 2019

74%

of total energy demand in industry is needed for **heat**

NO

energy technology can economically deliver **renewable heat around-the-clock**

48%

of total heat demand in industry is needed for **high-temperature heat**

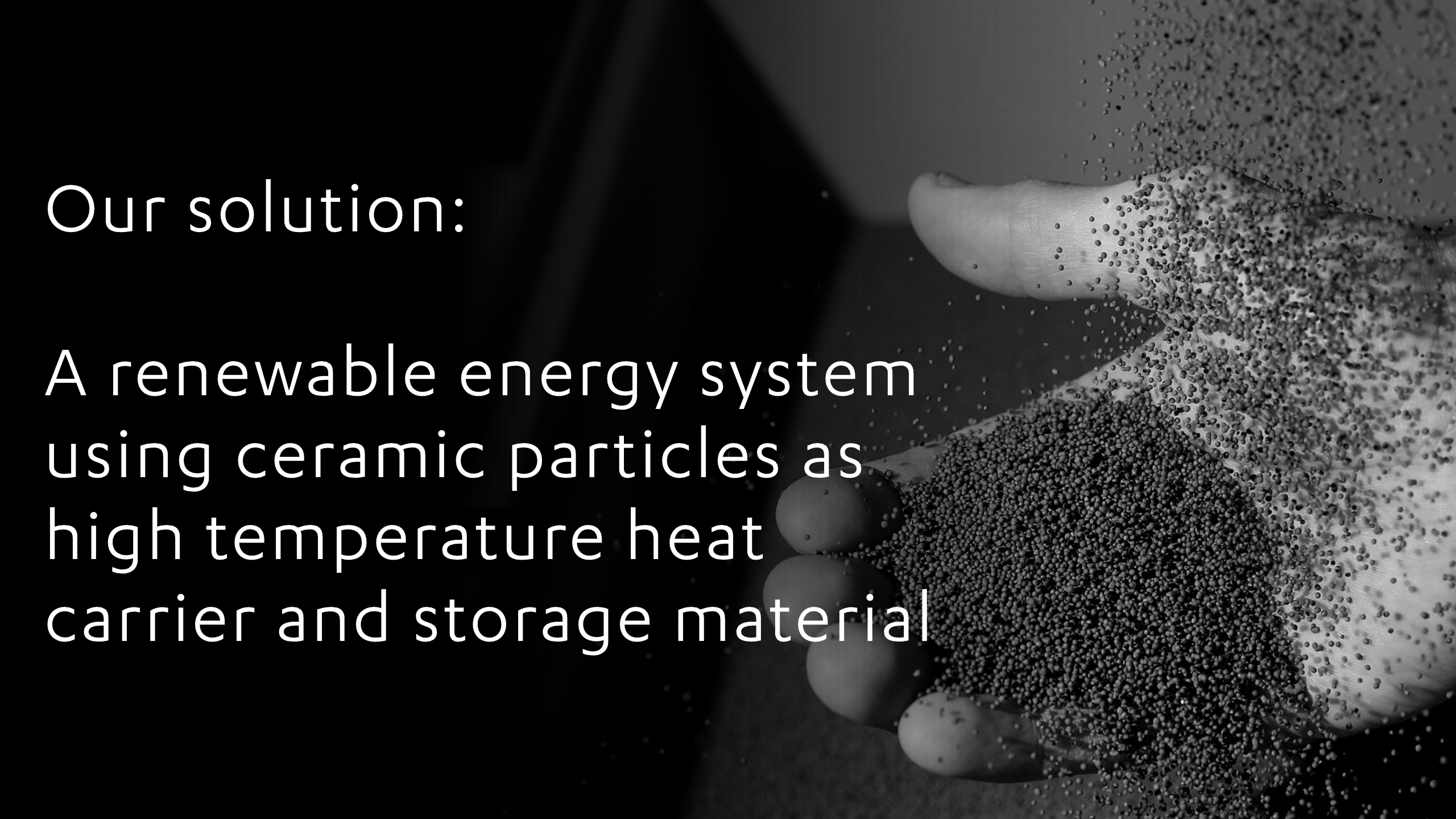
NO

energy technology is economically available for **renewable high-temperature heat**

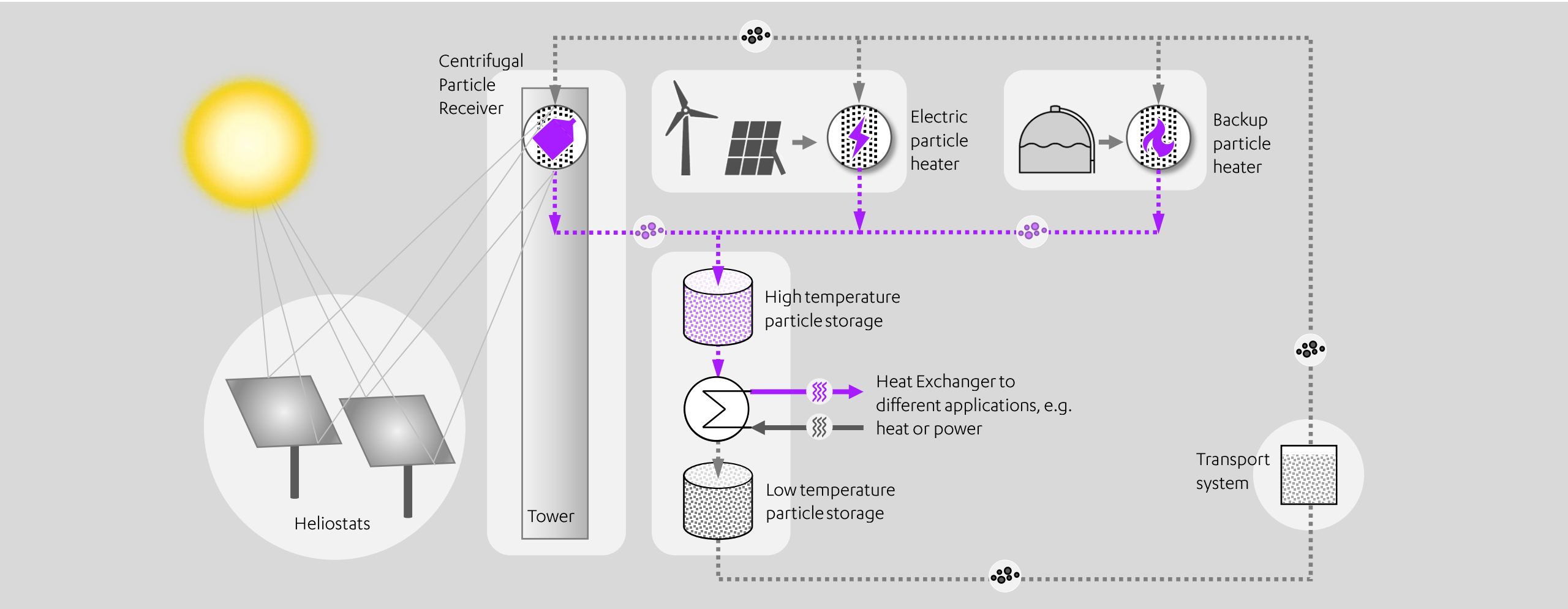
Source: IEA (2019), $CO_2$ Emissions from Fuel Combustion

# Our solution:

A renewable energy system using ceramic particles as high temperature heat carrier and storage material



# Particle system for Concentrating Solar Power plants



# Receiver prototype testing at Solar Tower Jülich


# PEGASUS receiver (first receiver delivered by HH)

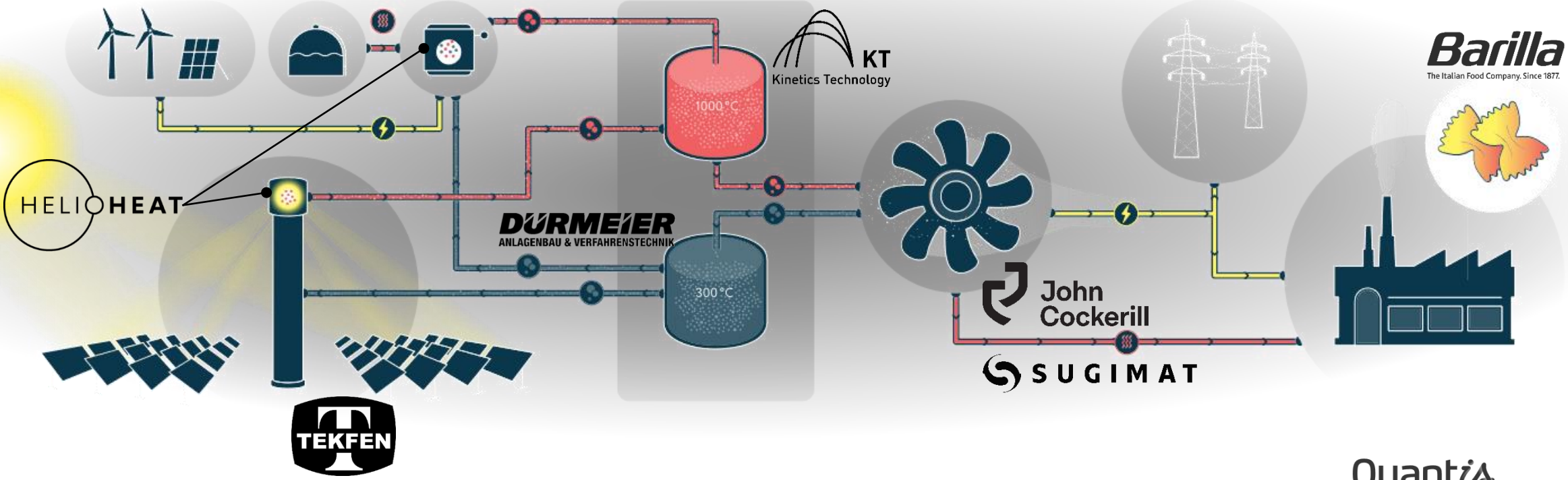
Before delivery

Installed at Synlight, Jülich, Germany

# Market entrance:

# EC-funded demonstration project HiFlex

# HiFlex: Pre-commercial CSP plant demonstrating 24/7 delivery of energy for pasta drying



# HiFlex Status

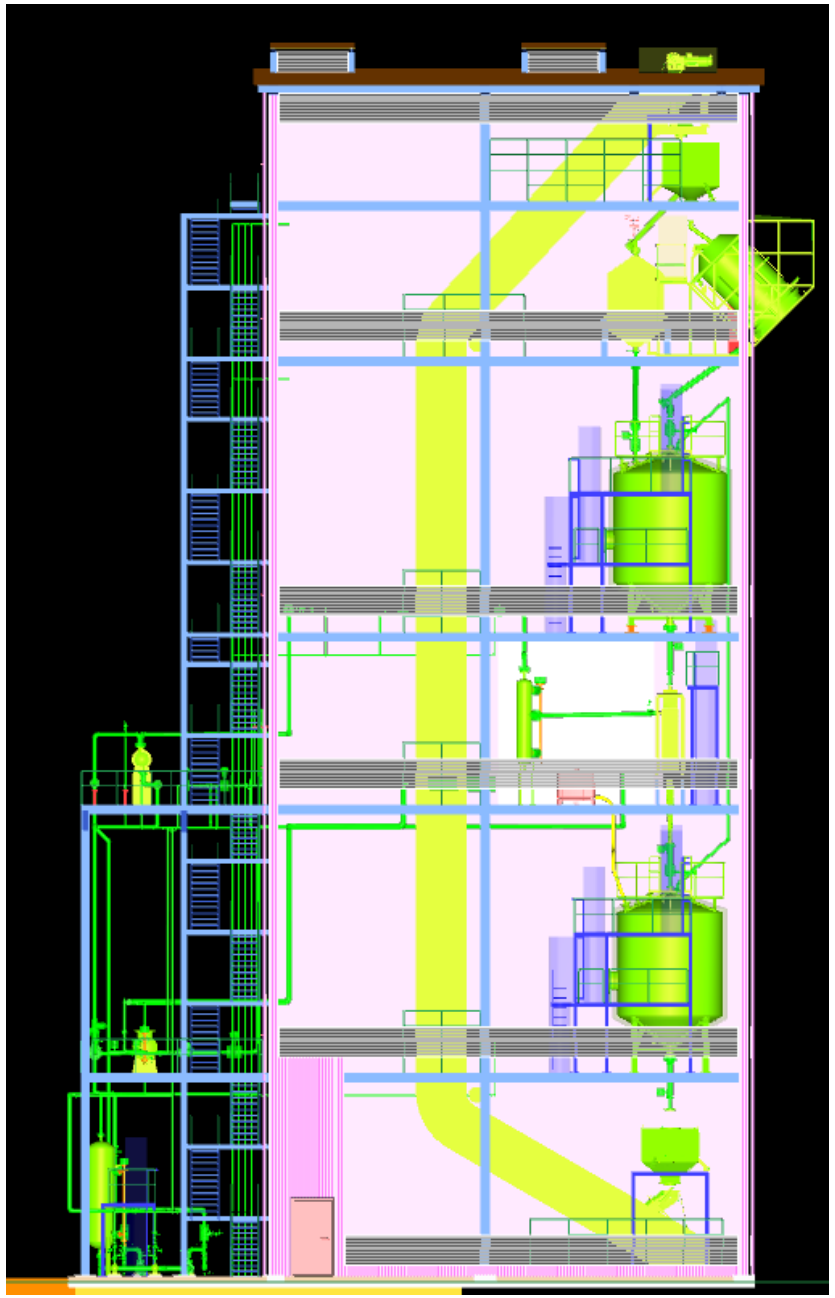
Tower layout completed

ENAC (Italian flight authority) permitting obtained

Further permitting ongoing, preliminary positve feedback

HAZOP on the way

Expected groundbreaking end 2021/begin 2022



# Expected costs: methodology

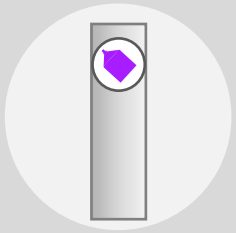
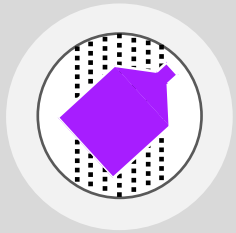
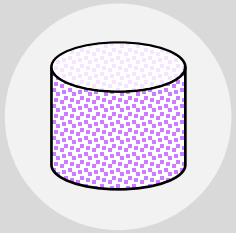
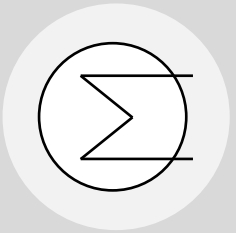
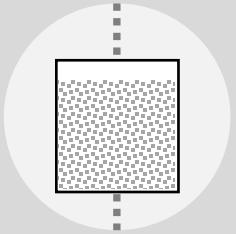
$$\text{Return on Investment} = \frac{\text{net profit}}{\text{investment costs}}$$

$$\frac{S}{C_0} = \frac{(1+\text{ROI})^t \cdot \text{ROI}}{(1+\text{ROI})^t - 1}$$

| | |
|---|---|
| $S$ | **Annual savings in €/yr,** $S = C_f \cdot P - C_e$ |
| $C_0$ | Total investment in € |
| $t$ | Financing period in yr |
| $\text{ROI}$ | Return on investment |
| $C_f$ | Fuel costs in €/$MW_{th}$ |
| $P$ | Annual power generation⁺ in $GW_{th}$/yr [1] |
| $C_e$ | Annual expenses* in €/yr |

⁺ Amsbeck et al., SolarPACES 2014
* include O&M, insurance and parasitic costs

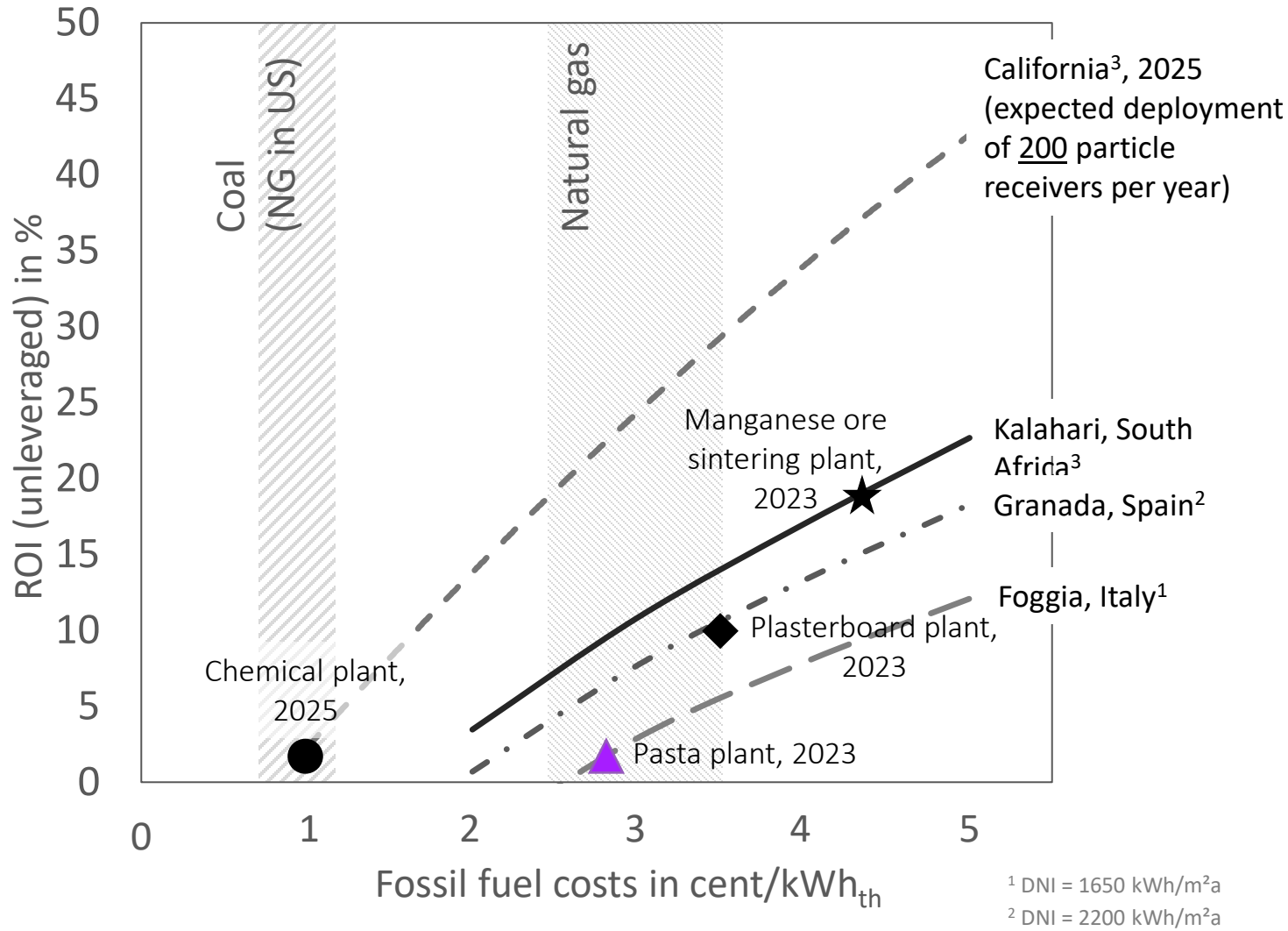
# Expected costs: main assumptions

| | Specific invest | Heliostats | Tower | Receiver | Storage (15h) | Heat exchanger | Transport system |
|---|---|---|---|---|---|---|---|
| *2023** | 380 €/$kW_{th}$ | 75 €/$m^2$ | 2000 €/m | 40 €/$kW_{th}$ | 12 €/$kWh_{th}$ | 50 €/$kW_{th}$ | 120000 €/pc |

* 100 $MW_{th}$ plant with 20 x 5 $MW_{th}$ receivers

# Expected economic competitiveness for solid particle CSP system




[1] DNI = 1650 kWh/m²a
[2] DNI = 2200 kWh/m²a
[3] DNI = 2730 kWh/m²a

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# Our technology: Centrifugal Particle Receiver (CentRec®)