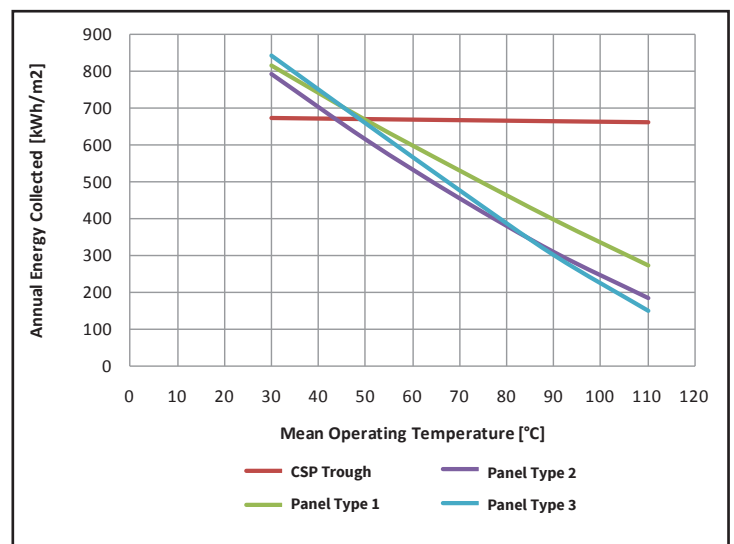




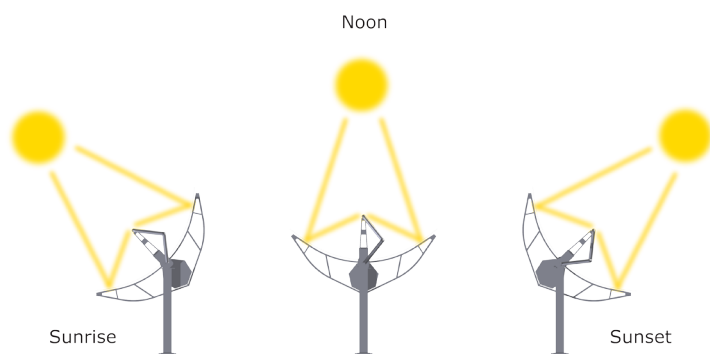
## Solar district heating using CSP troughs

The Concentrated Solar Power (CSP) technology applies sun-tracking, parabolic shaped mirrors to maximize the sun's energy and consequently the efficiency of district heating. The parabolic troughs reflect the sun's rays onto a receiver pipe where the concentration of energy occurs and a significant better utilization of solar energy is obtained.

The CSP technology for district heating performs the most efficiently at higher temperatures and it ensures more energy production/m<sup>2</sup> hence requires less land area for technology placement. It provides stable energy production even at middle temperatures as the receiver pipe - in which the water or thermal oil is heated - is surrounded by a special glass vacuum tube ensuring minimal heat loss.



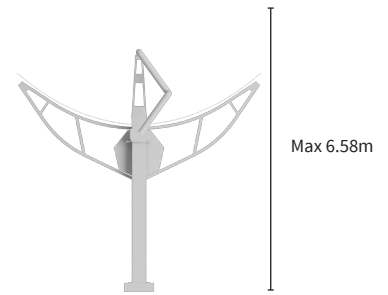
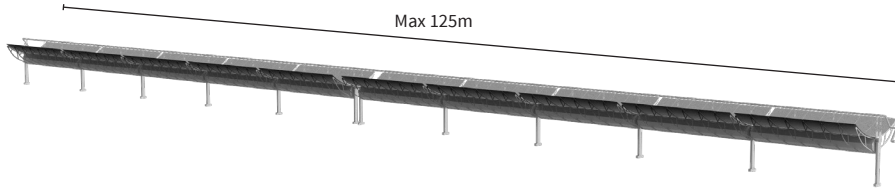
Energy production above 50 °C compared to conventional solar-thermal panels. Verified by "DTU Civil Engineering Report R-292 (UK)"



Parabolic trough tracking system - following the sun's path

### Sun-tracking

The parabolic troughs use a custom designed sun-tracking technology, wherein a computer calculates and calibrates the troughs into the required position to receive full radiation of sunrays throughout the day.

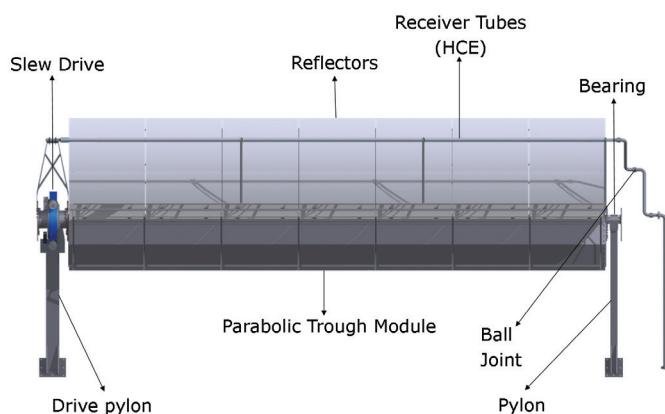


CSP PARABOLIC TROUGH - SPECIFICATION	
Dimensions	L: 12m, W: 5.7m, H: 3.4m (bearing)
Construction	Twisting stable torsional body and wing design
Weight	3,300kg
Parabolic mirrors	<ul style="list-style-type: none"> <li>• 28pcs.</li> <li>• 67.4m<sup>2</sup></li> </ul>
Receiver tube	<ul style="list-style-type: none"> <li>• 70 x (2-4) mm AISI</li> <li>• Metal pipes surrounded by a special glass vacuum tube</li> </ul>
Heat loss in the receiver tube	<ul style="list-style-type: none"> <li>• &lt; 10% 400°C</li> <li>• &lt; 1% 100°C</li> </ul>
Fluid charge	40 liters
Heat transfer media	<ul style="list-style-type: none"> <li>• District heating water</li> <li>• Thermal oil</li> </ul>

CSP PARABOLIC TROUGH - ROW SPECIFICATION	
Max number of troughs per row	10pcs.
Max length	125m
Max height	6.58m
Max aperture area	674m <sup>2</sup>
Max performance	500kW
Solar-to-thermal efficiency	> 65%
Type of drive system	Hydraulic mechanically driven
Trough rotation speed	<ul style="list-style-type: none"> <li>• Tracking 1.8°/min</li> <li>• Fast 7°/min</li> </ul>
Total rotation angle	220° (appr. 16 min)
Operation mode	<ul style="list-style-type: none"> <li>• Automatic operation</li> <li>• Stopped</li> <li>• Local control</li> </ul>
Safety system	Automatic defocus

DESIGN SPECIFICATIONS	
Design temperature	Up to 400°C
Design pressure	Up to 36 bar
Max wind speed (operation)	54km/h mean wind speed
Max wind speed	130km/h, 3 sec gust
Power failure	Automatic defocus using hydraulic pressure

SCOPE	
District heating or industry	<ul style="list-style-type: none"> <li>• District heating water &lt; 110°C</li> <li>• Hot water &lt; 180°C</li> <li>• Steam maximum 36 bar</li> </ul>
Process / power generation	HT-oil < 400°C



The sun-tracking technology is calibrating the troughs to obtain maximum solar radiation, but the mirrors can also be defocused or the system can be shut down entirely if required. By doing so, the CSP technology is avoiding typical problems like heat overproduction. Therefore, CSP plants for district heating can be overdimensioned thereby allowing better heat distribution throughout the entire year, without the use of seasonal storage. This is unique compared to conventional flat panels that do not allow the system to be defocused.