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SOLAR HEAT INTEGRATION

DECARBONIZE YOUR INDUSTRY

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https://www.absolicon.com/how-to-decarbonize/decarbonize-industrial-production/

In the face of energy market uncertainty and increasingly stringent sustainability regulations, the industrial production landscape is undergoing transformative changes globally.

A transition to renewable energy sources has emerged as a key aspect of our quest for a sustainable future, and to thrive in this evolving environment, companies must shift towards renewable heat, embracing decarbonization to ensure their competitiveness.

The heavy reliance on heat for energy-intensive industrial processes presents challenges but also opportunities to decarbonize and dramatically reduce CO_2 emissions, optimize energy use and minimize costs.

Solar Heat for Industrial Processes - SHIP

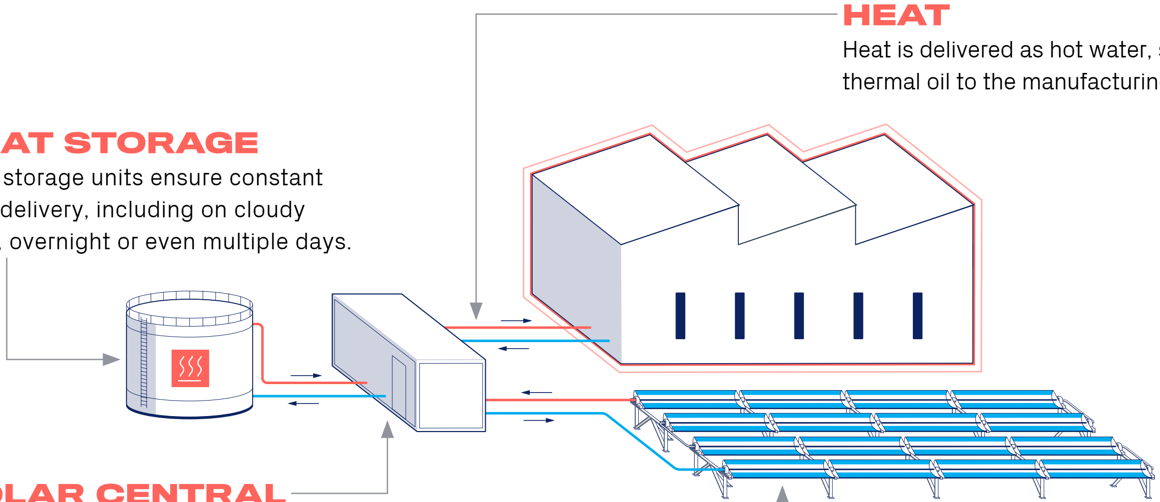
Industries often rely on substantial amounts of thermal energy, which is typically produced using fossil fuels. SHIP aims to replace or supplement this conventional energy with renewable solar energy, reducing carbon emissions and enhancing sustainability.

HEAT

Heat is delivered as hot water, steam or thermal oil to the manufacturing site.

HEAT STORAGE

Heat storage units ensure constant heat delivery, including on cloudy days, overnight or even multiple days.



SOLAR CENTRAL

Containing heat exchangers, pumps, and a monitoring system to get a full overview of the heat delivered to the industrial processes.

SOLAR FIELD

Solar collectors are installed next to the production site and/or on extisting roofs and produce heat.

THE AVARAGE PLANT CASE

In this virtual case scenario, we have a plant requiring 20 tonnes of steam per hour at 5 bar and 152 °C, a yearly demand of 95,000 MWh steam.

Solar Heat Europe* has, by consultation with its members, provided the data in the chart below based on typical prices in 2024. Another contributing factor is of course that Solar thermal technology receives substantial subsidies in many European countries. The numbers are indicative and may vary depending on many factors, but it gives you a good overview.

Case description

SOLAR IRRADIATION

The solar irradiation is based on a typical meteorological year, ranging between 1800 kWh/m² in Spain to 1100 kWh/m² in Sweden.

EFFICIENCY

The efficiency of the system is influenced by various factors, in this virtual case it ranges from 60 % in Spain (Option A) to 30 % in the Swedish scenario (Option B).

RENEWABLE FRACTION

The renewable fraction is the amount of process heat covered by solar thermal. This is influenced by location and storage capacity. For this purpose, an average daily storage has been assumed.

CAPITAL EXPENCES

The range of capital expenses (CAPEX) for ***Option A*** are 500 – 643 €/kW, and ***Option B*** 643 – 857 €/kW.

LEVELIZED COST OF HEAT

The levelized cost of heat (LCOH) is based on 25 years lifetime, 5% discount, and yearly operational costs (OPEX) of 1% of the initial CAPEX.

INTEGRATION OPTIONS

This case has two integration options:

A
Hot water system preheating at 95°C can cover 50% of the preheating demand.

B
Steam at 152°C can cover 25% of the total demand.

	REGIONS	**OPTION A** Hot water at 95°C	**OPTION B** Steam at 152°C
Requred land area [ha]	Southern Europe (Madrid, Spain)	0.8	6.7
	Central Europe (Graz, Austria)	1.4	11.9
	Northern Europe (Stockholm, Sweden)	2.0	14.5
LCOH €/MWh incl. 0% subsidy	Southern Europe (Madrid, Spain)	25 - 32	52 - 69
	Central Europe (Graz, Austria)	39 - 51	87 - 116
	Northern Europe (Stockholm, Sweden)	56 - 73	104 - 139
LCOH €/MWh incl. 30% subsidy	Southern Europe (Madrid, Spain)	19 - 24	38 - 51
	Central Europe (Graz, Austria)	28 - 37	63 - 84
	Northern Europe (Stockholm, Sweden)	40 - 52	75 - 100

***Source:** *Solar Heat Integration – Solutions for the decarbonisation of the pulp and paper industry, page 4*
http://solarheateurope.eu/wp-content/uploads/2024/04/EESF-Solar-heat-factsheet-f.pdf

KEY PARAMETERS TO CONSIDER[1]

KEY PROCESS PARAMETERS	VALUE	
	NON-CONCENTRATED SOLAR THERMAL	CONCENTRATED SOLAR THERMAL
Supported temperature	Up to 180 °C with ideal applications under 120 °C	Up to 310 °C
Heat demand profile	• Year-round heat demand • Heat demand during the daytime is ideal but thermal storage is commonly used to cover demand during other times of the day	
Energy storage integration	• Primarily hot water storage tanks but other types of thermal storage are possible as well.	
Process integration	• Optimal: Integration of heat supply directly at the industrial process • Alternative: Integration of heat supply into existing steam or hot water network	
Waste heat utilization & hybridization	• Solar thermal can upgrade the available waste heat and be used to preheat water for a heat pump or boiler.	

KEY LOCATION PARAMETERS	VALUE	
	NON-CONCENTRATED SOLAR THERMAL	CONCENTRATED SOLAR THERMAL
Required space	1.6-1.9 m^2/kW	2.1-4.2 m^2/kW
Minimum plant size	In principle, there is no minimum plant size.	
Distance between solar thermal plant and heat sink	• Up to 300 m – preferred • Up to 500 m – feasible • 500 m to 1 km – needs further assessment	
Geographical location:	All around the world, with added advantage for locations with high solar irradiance level	
• Locations with high irradiance	1700 – 2200 Global Horizontal Irradiance (GHI)	2000 – 2500 (Direct Normal Irradiance) DNI
• Other viable locations	700 – 1700 GHI	1000 – 2000 DNI
Local infrastructure	No specific requirements	

KEY COMMERCIAL PARAMETERS	VALUE	
	NON-CONCENTRATED SOLAR THERMAL	CONCENTRATED SOLAR THERMAL
Capital expenditure	400-1000 €/kW	600-1200 €/kW
Operational cost[2]	0.5-1% of CAPEX annually	0.5-3% of CAPEX annually
Levelized Cost of Heat	20-50 €/MWh	30-70 €/MWh[2]
Carbon savings when replacing:[3]		
• Natural gas boilers	205-250 kg CO_2-eq per MWh	
• Coal fired boilers	319-450 kg CO_2-eq per MWh	

1 ***Main source: WBCSD, Renewable industrial heat navigator brief - Solar thermal solutions***
https://www.wbcsd.org/resources/solar-thermal-solutions/

2 ***IEA SHC (2024), Update on SHIP Technology Costs & SHIP Business and Financing Models***
https://doi.org/10.18777/ieashc-task64-2024-0005

3 ***Values based on 'WBCSD, Concentrated solar heat***
https://wbcsdpublications.org/wp-content/uploads/2020/07/WBCSD_Business_Case_Concentrated_solar_heat.pdf

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