



Solar Thermal Solutions for Engineering Sector



1. Industry Overview

Engineering industries such as automobile-component manufacturing, metal fabrication, machine shops, surface treatment and general engineering have thermal-energy demand in washing, degreasing, phosphating, pickling, plating, drying, paint curing, preheating and utility hot-water systems. Heat is commonly supplied by electricity, LPG, natural gas, diesel, furnace oil, biomass or steam, depending on the process and site.

Solar Heat for Industrial Processes (SHIP) can supply a portion of suitable low- and medium-temperature loads. The most attractive opportunities are generally stable daytime loads where solar heat can be integrated through a hot-water loop, heat exchanger, boiler-feedwater preheating, thermal-oil circuit or hybrid process-heating system.

2. Typical Thermal Applications

Table 1: Engineering sector applications, indicative temperature range and typical heat medium

Engineering sector application	Indicative temperature	Typical heat medium
Component / parts washing	50–90°C	Hot water
Degreasing / alkaline cleaning	60–95°C	Hot water / steam
Phosphating / surface preparation	50–85°C	Hot water
Pickling / chemical baths	50–95°C	Hot water / suitable HTF
Electroplating / process baths	40–80°C	Hot water / HTF
Drying / hot-air systems	80–160°C	Hot air / steam / thermal oil
Paint / powder-coating curing	120–220°C	Hot air / thermal oil / steam
Preheating of metal / components	100–300°C*	Hot air / thermal oil / CST
Boiler feedwater preheating	60–120°C	Hot water / suitable HTF

Table 2: Priority Opportunities by Engineering Sub-sector

Sub-sector	Potential solar-heat applications	Typical medium	Preliminary potential
Automobile components	Parts washing, degreasing, phosphating, rinsing, drying, paint-shop utilities	Hot water / steam / hot air	High
Metal fabrication	Cleaning, preheating, drying, coating preparation	Hot water / hot air	High
Machine shops	Parts washing, aqueous cleaning, cutting-fluid cleaning and utility hot water	Hot water	High
Surface treatment / plating	Cleaning, pickling, phosphating, plating baths, rinsing	Hot water / HTF	High
Foundry / forging	Feedstock or component preheating, drying	Hot air / thermal oil / CST	Medium
Heat treatment	Preheating and auxiliary heating	Hot air / HTF / CST	Medium - High
Paint / powder coating	Drying and curing	Hot air / thermal oil	Medium - High

3. Solar Thermal Technology Options

The appropriate technology should be selected based on required process temperature, heat-load profile, available area, solar resource and integration point.

Table 3: Solar thermal technology options, indicative applications and temperature range

Solar thermal technology		Indicative application	Temperature range
Non-concentrating solar thermal	Flat Plate Collector (FPC)	Hot water, washing and low-temperature cleaning	30–80°C
	Evacuated Tube Collector (ETC)	Hot water, washing and preheating	40–100°C
Non-imaging concentrating	CPC/evacuated-tube CPC/xCPC	Low/medium-temperature process heat	60–120°C
Concentrating Solar Thermal	Scheffler / parabolic dish	Steam, drying, process heating	100–250°C
	Parabolic Trough Collector (PTC)	Thermal oil, steam and medium-temperature process heat	100–250°C
	Linear Fresnel Reflector (LFR)	Steam and medium-temperature process heat	100–250°C
	Higher-temperature systems CST	Selected preheating / high-temperature duties	250–400°C+

Thermal storage can improve the utilisation of solar heat where the solar resource and process demand do not coincide.

Potential storage options include:

- Hot-water tank: Low-temperature processes
- Pressurised water: Processes above 100°C
- Thermal-oil storage: Medium-temperature applications
- Phase-change materials: Specific temperature ranges
- Molten salt: Higher-temperature applications

4. How Solar Heat Can Be Integrated

A key principle in industrial solar thermal design is to identify the most technically and economically suitable integration point rather than simply connecting the solar field to the main boiler. IEA SHC specifically highlights process integration and selection of the appropriate integration concept as a critical part of SHIP project design.

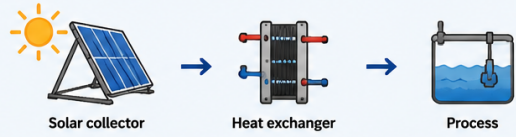
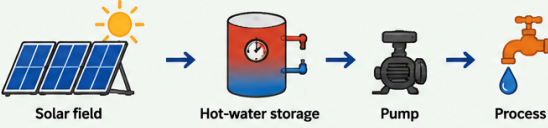
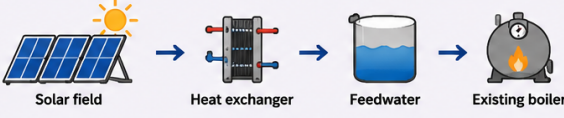
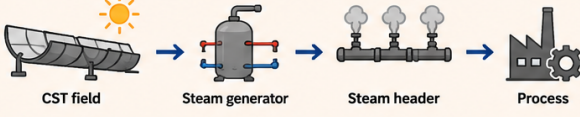
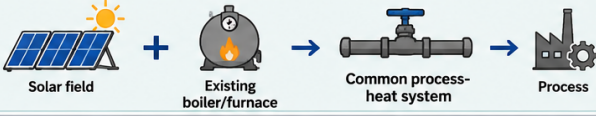
CONFIGURATION	TYPICAL CONCEPT	SUITABLE FOR
A Direct / indirect process heating 	 Solar collector → Heat exchanger → Process	 Washing, cleaning, surface-treatment baths and other low/medium-temperature duties.
B Solar hot-water system 	 Solar field → Hot-water storage → Pump → Process	 Parts washing, degreasing, phosphating, rinsing and utility hot water.
C Boiler feedwater preheating 	 Solar field → Heat exchanger → Feedwater → Existing boiler	 Reduces boiler duty while retaining conventional backup.
D Solar steam generation 	 CST field → Steam generator → Steam header → Process	 Steam-based cleaning, drying and other processes where pressure/quality requirements can be met.
E Solar + conventional hybrid 	 Solar field + Existing boiler/furnace → Common process-heat system → Process	 Low-solar periods, peak loads and continuous production requirements.

Figure 1: Illustration of solar heat integration to engineering sector industries

5. Key Benefits for Engineering MSMEs

For preliminary screening, a solar contribution of approximately 20–50% of suitable process heat may be considered where solar resource, process temperature, operating schedule and collector area are well matched. Actual solar fraction and fuel displacement should be established through project-specific hourly heat-load and solar-yield analysis. Key economic indicators include annual

solar heat delivered, fuel displaced, annual cost savings, O&M costs, LCOH, NPV, IRR and payback period.

Table below presents key benefits for engineering sector MSMEs.

Table 4: Key benefits for engineering sector MSMEs

BENEFIT		KEY BENEFITS	
	ENERGY	✓ Reduces consumption of LPG, natural gas, diesel, furnace oil, biomass or electricity for suitable thermal loads; ✓ Reduces conventional boiler/furnace duty; ✓ Provides renewable daytime process heat.	
	ECONOMIC	✓ Reduces exposure to fuel-price fluctuations; ✓ Can reduce long-term thermal-energy costs; ✓ Can lower specific energy consumption per unit of production.	
	ENVIRONMENTAL	✓ Reduces fossil-fuel consumption and associated GHG emissions; ✓ Can reduce local air-pollutant emissions where combustion is displaced.	
	OPERATIONAL	✓ Can be integrated with existing boilers, furnaces and hot-water systems; ✓ Storage can improve solar utilisation; ✓ Hybrid operation maintains reliability.	
	PRODUCTION	✓ Controlled preheating can stabilise process temperatures and reduce thermal variability where the solar system is properly controlled and integrated.	

6. Indian Case Example

A documented Indian example demonstrates solar thermal integration in an automobile manufacturing facility. At MVML's Chakan facility near Pune, an ARUN®160 solar concentrator was installed to provide pressurised hot water for cleaning/degreasing of engine components. The system was designed as a hybrid arrangement so that the existing electrical heating remained available when solar heat was insufficient.

Parameter	Reported project information
Project	Solar thermal system for engine-component washing / degreasing
Location	Mahindra Vehicle Manufacturers Ltd. (MVML), Chakan, Pune, Maharashtra
Installation year	2010
Solar technology	1 × ARUN®160 Fresnel-paraboloid solar concentrator
Installation arrangement	Dish installed approximately 8 m above ground, allowing the area below to remain usable as a vehicle test-track area
Solar heat output	Pressurised hot water at approximately 120°C
Process	Engine-component cleaning / washing
Integration	Solar-heated water transferred through a plate heat exchanger to the process-water loop; existing electrical heating retained as backup

Parameter	Reported project information
Reported annual electricity saving	≈175,000 kWh/year
Reported GHG reduction	≈164 tCO ₂ /year
Key lesson	A stable medium-temperature cleaning load can be a practical first target for solar thermal integration in automobile and engineering plants.

7. Sources and References

- 1) MNRE, Concentrated Solar Thermal – CST for Heat Generation.
- 2) The installation year and system configuration are reported by CII/Clique Solar case-study material.
- 3) The annual electricity saving of about 175,000 kWh and GHG reduction of about 164 tCO₂/year are reported in the published case study by Pathak et al. (2017). These are project-specific reported results and should not be used as generic performance guarantees for other engineering plants.
- 4) IEA SHC Task 49 / Task 64 resources on Solar Heat for Industrial Processes (SHIP).