



Solar Thermal Solutions for Paper Industries



1. Industry Overview

Small-scale paper industries in India include recycled-paper mills, agro-residue based units, handmade-paper producers, board and specialty-paper manufacturers and converting units. Depending on feedstock and product, thermal energy is used in raw-material preparation, pulping, screening and washing, bleaching, paper making, drying, finishing and utility services. Small units may rely on biomass, coal, diesel, furnace oil, LPG, natural gas or electricity for process heat.

Solar Heat for Industrial Processes (SHIP) can provide part of the low- and medium-temperature thermal demand. MNRE identifies paper and pulp among Indian industrial sectors with good potential for CST deployment. Published Indian studies have assessed paper-industry solar process heat in approximately the 50–250°C range, with particular opportunities in hot-water generation, boiler-feedwater heating, steam/process heating and drying.

2. Typical Thermal Applications

Table 1: Paper industry applications, indicative temperature range and typical heat medium

Paper industry application	Indicative temperature	Typical heat medium
Raw-material preparation / washing	40–60°C	Hot water
Pulp washing / screening	>60–90°C	Hot water / steam
Bleaching	60–100°C+	Hot water / steam
Paper-making process water	50–90°C	Hot water
Paper drying	100–150°C+	Hot air / steam
Finishing / specialty-paper drying	80–180°C	Hot air / thermal oil / steam
Boiler feedwater preheating	60–90°C	Hot water / suitable HTF
Steam generation	>120°C	Steam / CST

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 2: Solar thermal technology options, indicative applications and temperature range

Solar thermal technology		Indicative application	Temperature range
Non-concentrating solar thermal	Flat Plate Collector (FPC)	Warm process water, washing and boiler feedwater	30 - 80°C
	Evacuated Tube Collector (ETC)	Hot water, washing and preheating	40 - 100°C
Non-imaging concentrating	CPC/evacuated-tube CPC/xCPC	Medium-temperature process water and preheating	60 - 120°C
Concentrating Solar Thermal	Scheffler / parabolic dish	Steam and selected process heating	100 - 250°C
	Parabolic Trough Collector (PTC)	Medium-temperature heat, thermal oil and steam	100 - 250°C
	Linear Fresnel Reflector (LFR)	Steam and medium-temperature process heat	100 - 250°C
	Higher-temperature CST systems	Paper and board drying	Up to 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.

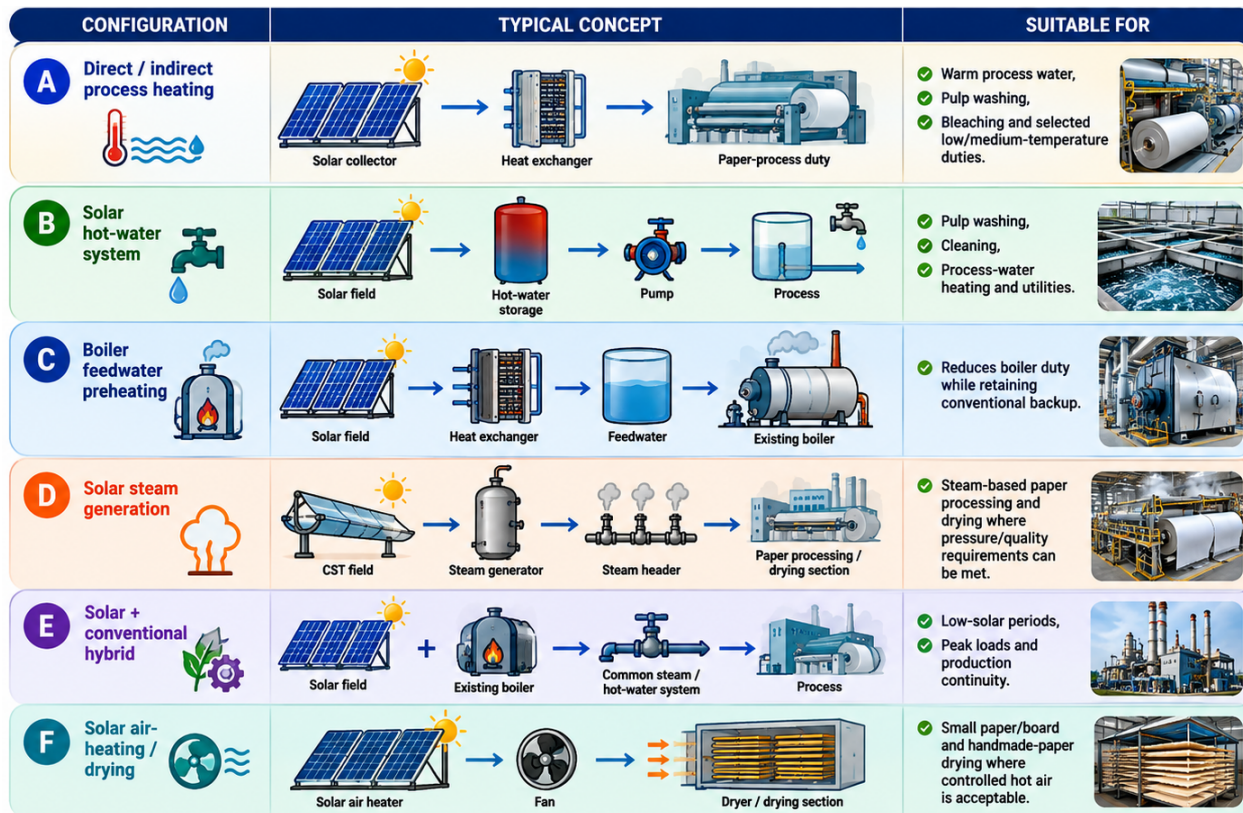


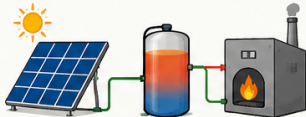
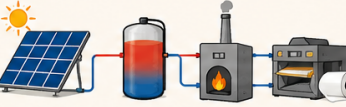
Figure 1: Illustration of solar heat integration to paper industries

5. Key Benefits for Paper Industry MSMEs

For a small paper unit, the most attractive starting point is usually the solar-eligible low/medium-temperature load rather than the entire thermal demand. A preliminary screening contribution of about 20–50% of suitable process heat may be considered where solar resource, operating schedule, temperature and collector area are well matched. Actual solar fraction and fuel displacement should be established through project-specific hourly or sub-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 paper industry sector MSMEs.

Table 3: Key benefits for paper industry MSMEs

BENEFIT	KEY BENEFITS	WHAT IT MEANS FOR YOU
 ENERGY Use clean energy. Improve efficiency.	- Reduces biomass, coal, LPG, diesel, furnace-oil or gas use for suitable thermal loads; reduces boiler duty; - Supplies renewable daytime heat. 	 LESS FUEL USE LOWER BOILER DUTY
 ECONOMIC Better savings. Stronger business.	- Reduces exposure to fuel-price fluctuations; - Can reduce process-heat cost and improve utilisation of existing boilers and dryers. 	 LOWER COSTS BETTER PROFITABILITY
 ENVIRONMENTAL Cleaner operations. Better planet.	- Reduces fossil-fuel consumption and associated GHG emissions; - Can reduce combustion-related local air pollutants. 	 LOWER EMISSIONS CLEANER AIR SUSTAINABLE FUTURE
 OPERATIONAL Flexible. Reliable.	- Can be integrated with existing boilers, hot-water loops and dryers; - Storage can improve solar utilisation; - Hybrid operation preserves reliability. 	 EASY INTEGRATION HIGHER RELIABILITY CONTINUOUS PRODUCTION
 PRODUCT QUALITY Consistent quality. Satisfied customers.	Controlled drying and preheating can provide more stable thermal conditions and reduce dependence on uncontrolled open-sun drying. 	 BETTER QUALITY MORE CONSISTENCY HAPPIER CUSTOMERS

6. Indian Case Example

A directly relevant small-scale example is the greenhouse solar dryer developed and tested at Kalpana Handmade Paper Industry in Sanganer, Jaipur. The published study evaluated controlled solar drying of handmade paper, addressing the long drying times and large space requirements associated with shade drying in small handmade-paper units.

Parameter	Reported project information
Location	Sanganer, Jaipur, Rajasthan
Industry	Handmade paper
Technology	Greenhouse solar dryer with solar-assisted forced/natural convection
Study / installation	Prototype installed and tested at Kalpana Handmade Paper Industry
Dryer size in 2024 study	1.82 m × 1.52 m
Paper loading tested	75–150 sheets
Paper thickness tested	100–200 GSM
Initial / final moisture	~60% → 8–10% wet basis
Drying time	~3–8.5 h, depending on paper type/loading
Open sun / shade comparison	~4–10 h / 19–29 h

Parameter	Reported project information
Economic payback	~0.61 years in the reported study

7. Sources and References

- 1) IEA SHC Task 49 / Task 64 resources on Solar Heat for Industrial Processes (SHIP).
- 2) MNRE, Concentrated Solar Thermal – CST for Heat Generation; MNRE identifies paper and pulp among Indian sectors with good CST potential.
- 3) Sharma et al. (2015), 'Potential of Solar Energy Utilization for Process Heating in Paper Industry in India: A Preliminary Assessment', Energy Procedia 79, 284–289.
- 4) Sharma et al. (2016), 'Carbon mitigation potential of solar industrial process heating: paper industry in India', Journal of Cleaner Production 112, 1683–1691.
- 5) Morya et al. (2024), 'A medium-size greenhouse solar dryer for drying eco-friendly handmade papers', Solar Energy 274, 112609; study conducted at Kalpana Handmade Paper Industry, Sanganer, Jaipur.
- 6) Morya et al. (2026), comprehensive assessment of a 5 m³ greenhouse solar dryer for handmade paper drying; reported CO₂ mitigation and economic payback.
- 7) Delhi Energy Efficiency & Renewable Energy Management material on mapping solar technologies to pulp and paper processes.