



Solar Thermal Solutions for Rubber Industries



1. Industry Overview

Small-scale rubber industries in India include natural-rubber sheet processing, latex dipped goods, rubber components, hoses, seals, footwear, belts, molded products, extruded products and reclaimed rubber. Thermal energy is used in rubber preparation, drying, moulding, vulcanisation/curing, hot-water services and, in some products, steam or thermal-fluid systems.

The rubber sector is specifically identified by MNRE as an Indian industrial sector with good potential for Concentrated Solar Thermal (CST) deployment. For small units, the most practical opportunities are usually low- and medium-temperature drying, hot-water duties, boiler-feedwater preheating and selected curing/moulding duties rather than attempting to replace every high-temperature process.

2. Typical Thermal Applications

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

Rubber industry application	Indicative temperature	Typical heat medium
Latex washing / hot-water preparation	50–90°C	Hot water
Latex dipped-goods drying	60–100°C	Hot air / hot water
Latex-goods curing	~90°C	Hot air / steam
Rubber mixing / warm-up	100–165°C	Hot water / thermal oil / electric
Compression moulding	150–170°C	Thermal fluid / steam / hot water
Injection moulding	165–200°C	Thermal fluid / electric
Tyre / component vulcanisation	140°C and above	Steam / hot water / thermal fluid
Boiler feedwater preheating	60–100°C	Hot water / suitable HTF
Reclaimed-rubber devulcanisation	180–210°C	Steam / thermal fluid

The MNRE-UNIDO/ISID process-mapping work identifies rubber as a suitable sector for CST and maps LFR, PTC, paraboloid dish and Fresnel-reflector-based dish technologies to rubber processes. The mapped applications include vulcanisation, latex curing, injection moulding, compression

moulding and devulcanisation. MNRE currently lists rubber among Indian industrial sectors with reported good potential for CST implementation.

Table 2: Indian Rubber industry CST potential

Process	Mapped thermal requirement / opportunity
Latex-based dipped goods curing	~90°C; solar-assisted hot air / hot water / steam
Tyre vulcanisation	~140°C; CST can support steam/hot-water/thermal-fluid systems
Injection moulding	~165–200°C; high-temperature solar heat may support suitable thermal-fluid circuits
Compression moulding	~150–170°C; suitable for selected CST/HTF integration
Devulcanisation	~180–210°C; technically possible with higher-temperature CST, but economics and process control need careful assessment

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 drying	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 hot water and process heat	60 - 120°C
Concentrating Solar Thermal	Scheffler / parabolic dish	Steam, hot water and selected process heating	100 - 250°C
	Parabolic Trough Collector (PTC)	Curing, moulding support, thermal oil and process heat	100 - 250°C
	Linear Fresnel Reflector (LFR)	Steam, curing and medium-temperature process heat	100 - 250°C
	Higher-temperature CST systems	Selected specialised rubber/reclaiming duties	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.

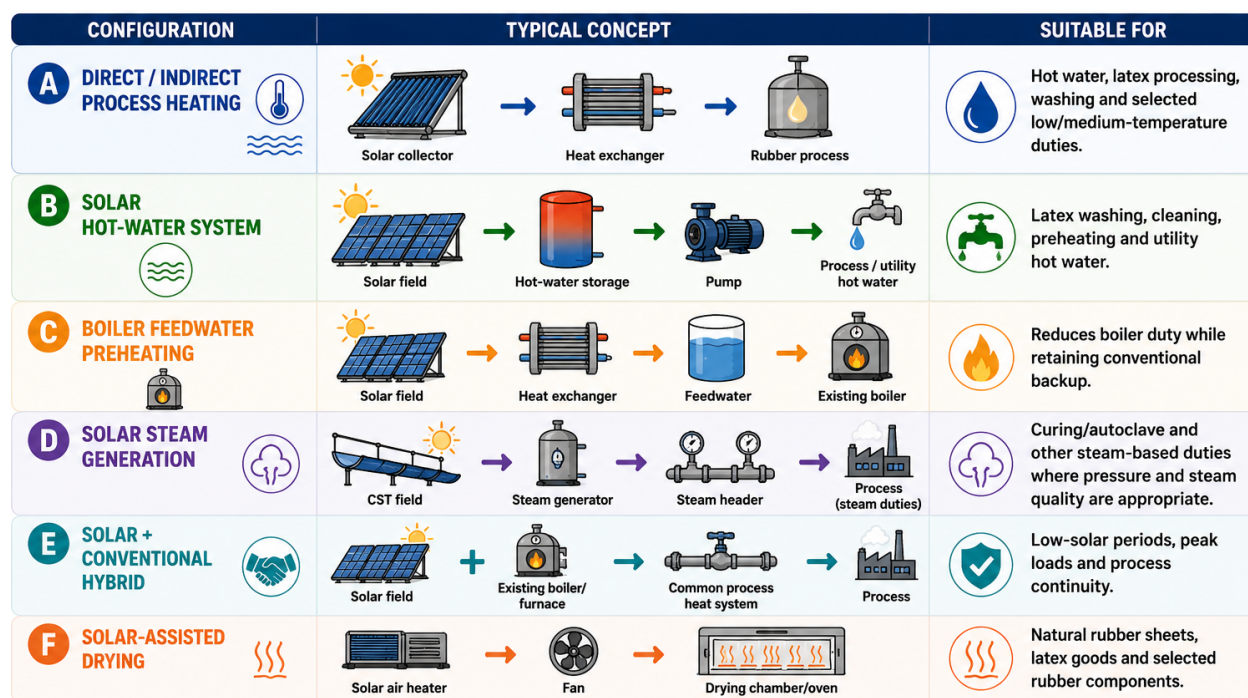


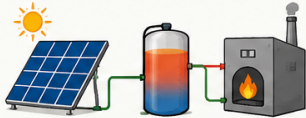
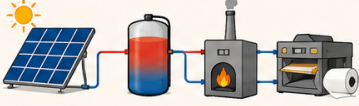
Figure 1: Illustration of solar heat integration to rubber industries

5. Key Benefits for Rubber Industry MSMEs

For small rubber units, the most attractive starting point is normally the solar-eligible low/medium-temperature load. A preliminary screening contribution of about 20–50% of suitable process heat may be considered where solar resource, operating schedule, process temperature and collector area are well matched. Actual solar fraction and fuel displacement should be established using project-specific 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 rubber industry sector MSMEs.

Table 4: Key benefits for rubber 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 particularly relevant small-scale Indian demonstration is a mixed-mode solar thermal dryer developed and installed at Agartala for drying natural rubber sheets. The study was motivated by the difficulty faced by small-scale rubber producers in achieving consistent drying during unpredictable weather. The system provides a direct solar-thermal pathway for rubber-sheet drying rather than a CST steam system.

Parameter	Reported project information
Location	Agartala, Tripura
Application	Natural rubber sheet drying
System	6 kg/batch mixed-mode solar thermal dryer
Study / installation	Developed and installed for performance investigation; published in 2020
Initial moisture	~40% wet basis
Final moisture	~4% wet basis in solar dryer; ~11% reported for open-sun comparison
Drying time	~3 days in solar dryer versus ~7–8 days conventional drying
Average energy efficiency	9.09%
Average exergy efficiency	2.48%

Parameter	Reported project information
Product quality	Solar-dried sheets reported superior to open-sun dried sheets in colour and other physical properties
Reported payback	~2.2 years
Fuel saving / GHG reduction	Not reported; do not assume a fuel-saving value without a defined displaced baseline

7. Sources and References

- 1) IEA SHC Task 49 / Task 64 resources on Solar Heat for Industrial Processes (SHIP).
- 2) MNRE, Concentrated Solar Thermal — identifies rubber among Indian industrial sectors with reported good potential for CST implementation.
- 3) ISID/UNIDO/MNRE, Mapping CST Technologies for Industrial Process Heating & Cooling — rubber industry process descriptions, temperature requirements and CST technology mapping.
- 4) Andharia, Bhattacharya & Maiti (2020), Solar Energy 208, 'Development and performance analysis of a mixed mode solar thermal dryer for drying of natural rubber sheets in the north-eastern part of India' — 6 kg/batch Agartala demonstration, drying performance and 2.2-year reported payback.
- 5) ISID Technology Information Package — Indian CST case studies including SKF Technologies, Mysore, a rubber-component manufacturing facility with a PTC system serving metal phosphating process heat.
- 6) UNDP India documentation on SKF Technologies, Mysore — reports approximately 12,000 L/year diesel saving and 32 tCO₂/year reduction for its solar heating system.