

Solar Thermal Solutions for Dairy Sector



1. Industry Overview

Dairy processing has significant thermal-energy requirements for milk preheating, pasteurisation, cleaning-in-place (CIP), can and crate washing, sterilisation, hot-water generation, evaporation, drying and other process operations. Thermal energy may be supplied by biomass, coal, natural gas, furnace oil, LPG or other fuels. Solar Heat for Industrial Processes (SHIP) can supply a portion of this demand and can be integrated directly with process equipment, hot-water circuits, boiler feedwater or steam systems.

In India, MNRE identifies the dairy sector as having good potential for concentrated solar thermal (CST) deployment. The most attractive opportunities are generally processes with regular thermal demand and temperatures that can be matched by available solar thermal technologies.

2. Typical Thermal Applications

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

Dairy application	Indicative temperature	Typical heat medium
Milk preheating	40 - 70°C	Hot water / regenerative heat
Pasteurisation	63 - 75°C	Hot water / steam
Cleaning-in-place (CIP)	60 - 85°C	Hot water
Can / crate washing	60 - 90°C	Hot water
Hot-water generation	50 - 90°C	Hot water
Sterilisation / UHT-related heating	120 - 150°C+	Steam / pressurised hot water
Evaporation / concentration	100 - 150°C+	Steam
Drying / spray drying	120 - 200°C+	Hot air / steam
Boiler feedwater preheating	60 - 120°C	Hot water / suitable HTF

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)	Low-temperature hot water, washing, preheating	30–80°C
	Evacuated Tube Collector (ETC)	Hot water, washing, preheating	40–100°C
Non-imaging concentrating	CPC/evacuated-tube CPC/xCPC	Hot water and low/medium-temperature process heat	60–120°C
Concentrating Solar Thermal	Scheffler / parabolic dish	Hot water, steam and process heating	100–250°C
	Parabolic Trough Collector (PTC)	Medium-temperature process heat and steam	100–250°C
	Linear Fresnel Reflector (LFR)	Steam, thermal-oil heating and boiler integration	100–250°C
	Higher-temperature CST systems	Selected specialised dairy processes	Up to 400°C

Thermal storage can improve the utilisation of solar heat where the solar resource and process demand do not coincide. For dairy industry applications below 120°C, hot-water storage can be a relatively simple option. 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.

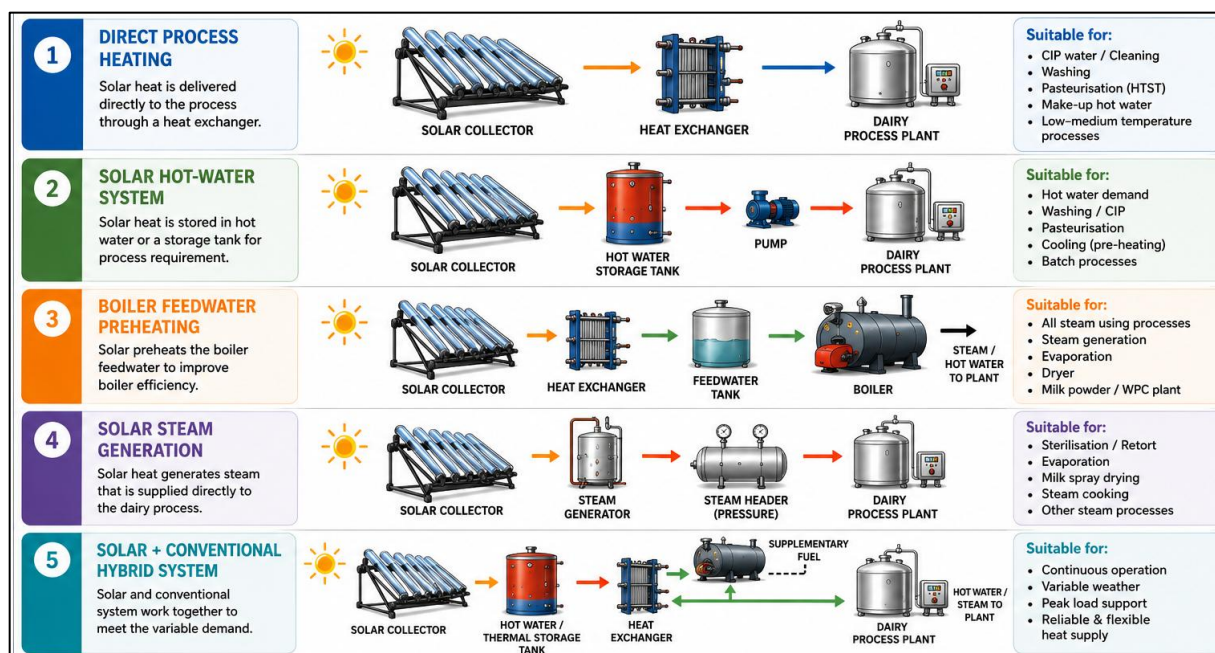


Figure 1: Illustration of solar heat integration to dairy industries

5. Key Benefits for Dairy Processing MSMEs

Solar thermal systems can potentially supply a significant share of suitable dairy process-heat demand where the solar resource, process temperature, operating schedule and collector area are well matched. As a preliminary screening range, a solar contribution of approximately 20–50% of suitable process heat may be considered; actual solar fraction and fuel displacement must be established through project-specific hourly heat-load and solar-yield analysis. Key indicators include annual solar heat delivered, fuel displaced, annual cost savings, O&M costs, LCOH, NPV, IRR and payback. Table below presents key benefits for dairy processing MSMEs.

Table 3: Key benefits for dairy sector MSMEs

 ENERGY	- Reduces consumption of biomass, LPG, diesel, furnace oil or natural gas. - Reduces boiler fuel requirement. - Provides renewable thermal energy for daytime production.
 ECONOMIC	- Reduces exposure to fuel-price fluctuations. - Can reduce long-term thermal-energy costs. - Can extend the useful role of existing boiler infrastructure.
 ENVIRONMENTAL	- Reduces fossil-fuel consumption and associated GHG emissions. - Can reduce local air-pollutant emissions where fossil or poorly controlled biomass combustion is displaced.
 OPERATIONAL	- Can be integrated with existing boilers. - Thermal storage can improve solar utilisation. - Hybrid operation maintains process reliability.

6. Indian Case Example

Mahanand Dairy, Latur installed ARUN-160 paraboloid concentrating dishes of 160–169 m² aperture area for dairy process heat. The system saves approximately 20,000 litres of furnace oil per year. The system was commissioned in 2006 and supplies pressurised hot water for milk pasteurisation. A 4.5 m³ pressurised hot-water storage tank enables operation beyond solar hours.

This case demonstrates solar thermal integration with an existing dairy process. Published sources report different collector-area and fuel-saving figures; these should therefore be treated as reported project values and verified with original project documentation before being used as a performance benchmark.

Parameter	Reported project information
Project	Solar process-heat system at Mahanand Dairy
Location	Latur, Maharashtra
Year	2006
Technology	ARUN paraboloid concentrating dish
Collector area	160–169 m ² aperture area
Application	Hot water / thermal energy for milk pasteurisation
Milk processing	20,000–30,000 litres/day
Storage	4.5 m ³ pressurised insulated hot-water storage tank
Conventional fuel displaced	Furnace oil
Furnace oil saving	20,000 litres/year (19,000 kg/year considering density of 0.95 kg/L)
CO₂ emission avoided	59.4 tCO ₂ /year (considering IPCC default emission factor of 77.4 kg CO ₂ /GJ and net calorific value of 40.4 GJ/tonne for furnace oil)

7. Sources and References

- 1) Ministry of New and Renewable Energy (MNRE) - Concentrated Solar Thermal – CST for Heat Generation.
- 2) Technology Information Package, Solar System for Process Heat using Arun Dishes at M/s Mahananda Dairy, Latur, Maharashtra.
- 3) UN/regional renewable-energy case-study material on Mahanand Dairy, Latur.
- 4) IEA SHC Task 49 / Task 64 resources on Solar Heat for Industrial Processes (SHIP).
- 5) Sharma et al., Potential of solar industrial process heating in dairy industry in India and consequent carbon mitigation, Journal of Cleaner Production.