

# Solar Thermal Solutions for Silk Processing Sector



## 1. Industry Overview

Silk processing has thermal-energy requirements from post-harvest cocoon treatment through reeling, re-reeling, dyeing, finishing and printing. Important heat-consuming operations include cocoon stifling and drying, cocoon cooking, reeling-water heating, hot-water preparation, drying of reeled silk, dyeing and selected steam-based finishing/printing operations.

The Central Silk Board recommends controlled hot-air drying for cocoons because it helps harden sericin uniformly, kill the pupa and remove moisture while preserving cocoon quality. Solar thermal systems can supply part of this heat through solar hot air, hot water, boiler-feedwater preheating or solar steam..

## 2. Typical Thermal Applications

*Table 1: Silk processing applications, indicative temperature range and typical heat medium*

| Silk processing application        | Indicative temperature | Typical heat medium              |
|------------------------------------|------------------------|----------------------------------|
| <b>Cocoon stifling / drying</b>    | 55 - 115°C             | Hot air                          |
| <b>Cocoon partial drying</b>       | 90 - 110°C             | Hot air                          |
| <b>Cocoon cooking</b>              | 90 - 100°C             | Hot water / steam                |
| <b>Reeling-basin water heating</b> | 40°C                   | Hot water                        |
| <b>Re-reeling / silk drying</b>    | 35 - 40°C              | Warm air / steam heating surface |
| <b>Silk dyeing / washing</b>       | 50 - 100°C             | Hot water / steam                |
| <b>Silk finishing / printing</b>   | 100 - 160°C            | Steam / hot air                  |
| <b>Boiler feedwater preheating</b> | 50 - 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)       | Reeling water, washing, low-temperature hot water | 30 - 80°C         |
|                                 | Evacuated Tube Collector (ETC)   | Hot water, reeling and preheating                 | 40 - 100°C        |
| Non-imaging concentrating       | CPC/evacuated-tube<br>CPC/xCPC   | Low/medium-temperature process heat               | 60 - 120°C        |
| Concentrating Solar Thermal     | Scheffler / parabolic dish       | Cocoon stifling/drying, silk drying               | 50 - 115°C+       |
|                                 | Parabolic Trough Collector (PTC) | Steam, cooking, dyeing and finishing              | 100 - 250°C       |
|                                 | Linear Fresnel Reflector (LFR)   | Solar steam and medium-temperature process heat   | 100 - 250°C       |
|                                 | Higher-temperature CST systems   | Steam and medium-temperature process heat         | 100 - 250°C       |

Thermal storage can improve the utilisation of solar heat where the solar resource and process demand do not coincide. For silk processing applications below 100°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.

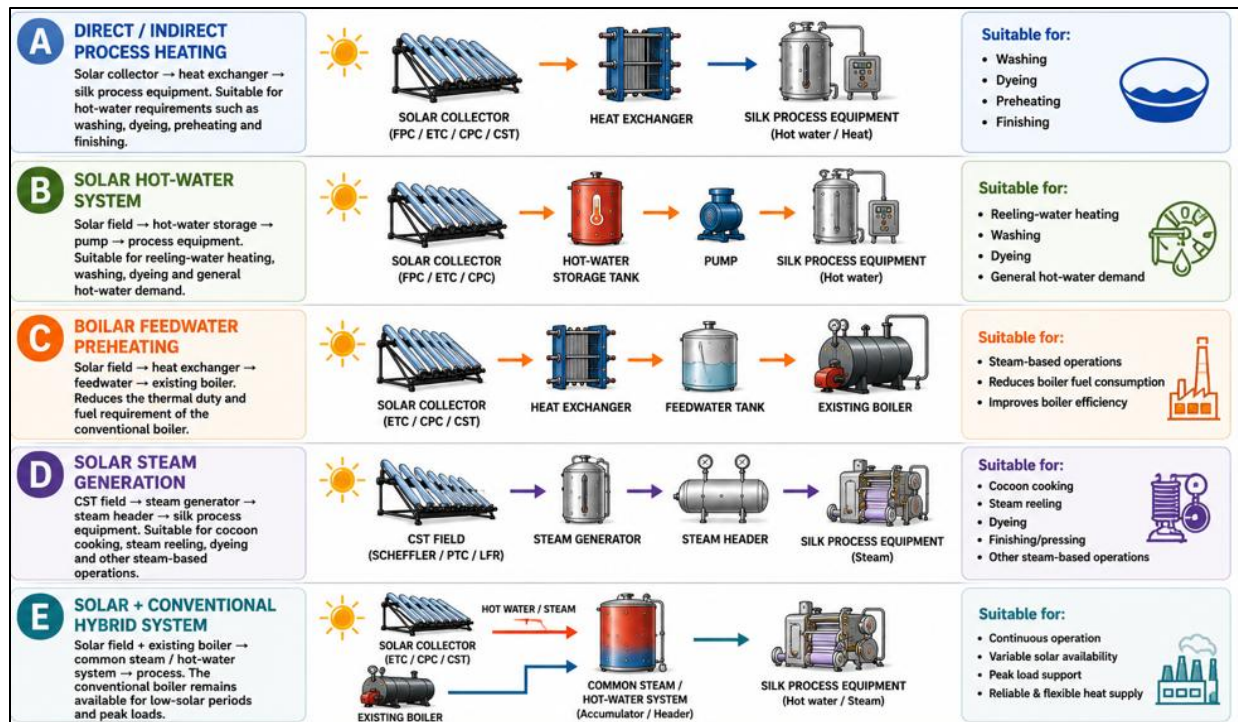


Figure 1: Illustration of solar heat integration to silk processing units

## 5. Key Benefits for Dairy Processing MSMEs

Silk processing offers several solar-thermal opportunities because substantial heat demand occurs below about 120°C, while steam can be required for higher-temperature operations. As a preliminary screening approach, a solar contribution of approximately 20–50% of suitable process heat may be considered. Actual solar fraction and fuel displacement should be established from measured hourly demand and annual solar-yield simulation. Key indicators include useful solar heat, fuel displaced, annual savings, CAPEX, O&M, etc.

Figure below presents key benefits for silk processing MSMEs.

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

Figure 2: Key benefits for silk processing sector MSMEs

## 6. Indian Case Example

The Government Silk Factory, Mysore, provides an early Indian example of concentrating solar thermal process steam in a silk-processing environment. A parabolic-trough system supplied steam to the factory steam main for processes in the printing section.

| Parameter                    | Reported project information                               |
|------------------------------|------------------------------------------------------------|
| <b>Project</b>               | Parabolic-trough system at Government Silk Factory, Mysore |
| <b>Location</b>              | Government Silk Factory, Mysore, Karnataka                 |
| <b>Installation</b>          | 1989                                                       |
| <b>Technology</b>            | Parabolic trough solar thermal system                      |
| <b>Number of collectors</b>  | 30                                                         |
| <b>Collector area</b>        | 192 m <sup>2</sup>                                         |
| <b>Heat-transfer medium</b>  | Pressurised water                                          |
| <b>Steam generation</b>      | Flash boiler                                               |
| <b>Fuel used</b>             | Firewood                                                   |
| <b>Steam condition</b>       | 150°C; 4.56 bar                                            |
| <b>Steam production</b>      | 120 kg/h in commissioning report                           |
| <b>Application</b>           | Steam main for printing processes                          |
| <b>Collector efficiency</b>  | ~45–53%                                                    |
| <b>System efficiency</b>     | ~33.5%                                                     |
| <b>Fuel saving potential</b> | 30.6 tonnes/year tonnes of firewood per year               |

| Parameter                              | Reported project information                                                                                                                      |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO<sub>2</sub> emission avoided</b> | 54 tCO <sub>2</sub> /year (considering IPCC default emission factor of 112 kg CO <sub>2</sub> /GJ and net calorific value 15.6 GJ/tonne for wood) |

## 7. Sources and References

- 1) Central Silk Board, Ministry of Textiles, Government of India - processing guidance for mulberry cocoons.
- 2) CSTRI Technology Descriptor — efficient energy management in multi-end silk reeling; solar flat-plate collector water heating and Ushma Shoshak; reported 46% firewood saving.
- 3) Thomas, A. (1992), Operation and performance of the solar steam generation system installed at the Government Silk Factory, Mysore, Energy Conversion and Management, 33(3), 191–196.
- 4) Design, Construction, Erection and Commissioning of a Solar Steam Generation System, Advances in Solar Energy Technology (1988).
- 5) Applied Energy (2011), Silk cocoon drying in forced convection type solar dryer.
- 6) IEA SHC Task 49 / Task 64 resources on Solar Heat for Industrial Processes.