SMALL AND MEDIUM ENTERPRISES: ENERGY EFFICIENCY KNOWLEDGE SHARING

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SAMEEEKSHA NEWSLETTER

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Promoting Energy Efficiency in SMEs

SAMEEEKSHA

VISION

SAMEEEKSHA envisages a robust and competitive SME sector built on strong foundations of knowledge and capabilities in the development, application, and promotion of energy-efficient and environment-friendly technologies.

Bureau of Energy Efficiency

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Creating Innovative Solutions for a Sustainable Future

MSME
MICRO, SMALL & MEDIUM ENTERPRISES

A PLATFORM FOR PROMOTING ENERGY EFFICIENCY IN SMEs

IN THIS ISSUE...

This issue continues to focus on solar thermal technology, which in essence enables the conversion of sunlight to heat energy that can then be used for a range of applications including industrial process heat.

The theme article presents the highlights of a two-day training program on concentrated solar thermal (CST) systems, held during 26–27 June 2025 at the National Institute for Micro Small and Medium Enterprises (NI-MSME), Hyderabad. The program was organized jointly by UNIDO and Ministry of MSME, Government of India, under the GEF–UNIDO–MoMSME project titled 'Promoting business models for increasing penetration and scaling up of solar energy', and was attended by entrepreneurs and operators from a range of industry sub-sectors, technology experts, consultants, and representatives from academic institutions, R&D institutes and government agencies. The training program provided foundational and advanced knowledge of CST systems, including their design, functionality, and industrial applications, through a combination of interactive technical sessions led by domain experts along with practical demonstrations and exercises.

The subsequent article presents snapshots of three techno-economic studies conducted by TERI on pharmaceutical units/medical establishments in Goa, under the GEF–UNIDO–MoMSME project. In each case, it was recommended that the unit install an extended compound parabolic (xCPC) solar thermal system to generate thermal energy for preheating water and delivering the hot water to the existing boiler, thereby helping to meet process hot water needs at a much lower cost.

SAMEEEKSHA Secretariat

TRAINING PROGRAM ON CONCENTRATED SOLAR THERMAL (CST) SYSTEMS

Under the GEF-UNIDO-MoMSME project titled 'Promoting business models for increasing penetration and scaling up of solar energy', a two-day training program on concentrated solar thermal (CST) systems was held during 26–27 June 2025 at the National Institute for Micro Small and Medium Enterprises (NI-MSME), Hyderabad. The program was organized jointly by UNIDO and Ministry of MSME, Government of India, and attended by about 50 participants comprising entrepreneurs and operators from a range of industry sub-sectors, technology experts, consultants, and representatives from academic institutions, R&D institutes and government agencies. The training program was structured to provide foundational and advanced knowledge of CST systems, including their design, functionality, and industrial applications, through a combination of interactive technical sessions led by domain experts and practical demonstrations and exercises.

Opening session

In his welcome address, Mr Konkala Surya Prakash Goud, Director, School of Enterprise Development (SED) at NI-MSME, mentioned the long-standing partnership between NI-MSME and UNIDO, dating back to the late 1990s, when collaborative efforts were first initiated to support the MSME sector through structured strategies and initiatives aimed at improving energy efficiency (EE) and reducing carbon emissions through low/zero carbon technology options. Mr Goud cited, as recent examples, energy audits conducted in rice mills in Karnal and grinder units in Coimbatore, and a baseline survey conducted of six energy-intensive MSME clusters to improve EE in industrial boilers through structured interventions. The present training program on CST technology, too, was a significant step in the same direction.

Mr K Madhukar Babu, Joint Director (MSME), Directorate of Industries, Hyderabad, mentioned the various incentives incorporated into the new Telangana State Renewable Energy Policy 2024, and encouraged MSMEs to explore and benefit from these provisions. Mr Kiran Kumar Alla, Senior Fellow & Director, Institute of Energy Transition, TERI, Hyderabad, underlined that while quality was once perceived as expensive and complex, the adoption of quality standards over time has led to reduced rework, better customer satisfaction, and enhanced competitiveness. A similar trajectory may be envisaged for sustainability, where clean energy and environmental stewardship can evolve into standard high-efficiency practices within every enterprise.

Mr Debajit Das, National Project Coordinator (NPC), UNIDO presented an overview of the GEF-UNIDO-MoMSME project which was targeted at MSME manufacturing units, hospitals, and common steam facilities. Its key aims were to increase awareness and institutional capacity for CST technologies, enhance the market reach of CST solutions, achieve significant emission reductions, and establish a self-sustaining CST market in India. Partnerships were pursued with technology suppliers and key industry stakeholders; financial incentives were introduced to encourage the adoption of CST systems; awareness creation and business meets were conducted in various industrial clusters; and technical support and training programs have been rolled out to build local expertise. He provided an overview of the training program and its relevance and importance in the context of accelerating the decarbonization of Indian industry through RE solutions.

UNIDO–IREDA–MNRE financing scheme for solar thermal technology

UNIDO partnered with Indian Renewable Energy Development Agency (IREDA) to develop and implement an innovative finance/loan scheme to further promote the deployment of concentrating solar thermal (CST) projects in India for heating and cooling applications in potential industries to reduce energy consumption and greenhouse gas (GHG) emissions. The key financial incentives included the following:

- The beneficiary's or project developer's contribution was 25%.
- The financial incentives provided for CST installation included CFA (Central Financial Assistance) from Ministry of New and Renewable Energy (MNRE) at 30% of the benchmark solar project cost, and accelerated depreciation benefit.

- Additional support was available from the UNIDO project in terms of technical feasibility and soft loan from IREDA.
- Bridge loan against subsidy and at normal interest rate was available.
- Support was also available for improving the manufacturing of CST system/components.

Loan for the CST project was provided at an interest subvention of 5% from the current rates using funds under the project. Both the loan and MNRE subsidy were bundled in the form of a financial package by IREDA.

Technical sessions

Introduction to Solar Thermal Technologies & Technology Selection Criteria for Specific End-Use Applications

—Mr Deepak Gadhia, Chairman & Managing Director, Sunrise CSP India

Mr Gadhia traced the development of solar thermal technology starting with the basic box-type solar cooker, to domestic water heating through flat plate collectors and the introduction of evacuated tube collectors which have greatly expanded the scope for using solar thermal energy for a wide range of applications. Current solar thermal technologies are capable of producing water temperatures ranging from 100°C to 120°C, and in certain industrial configurations, significantly higher. He outlined the principles of solar thermal technology and emphasized the potential to introduce solar thermal systems in industries such as textiles, pharmaceuticals, laundries, and hospitals, as nearly 50% of energy use in these sectors is for heating or cooling, making solar thermal technology a viable alternative to fossil fuels.

Various solar thermal configurations were described along with the principles of their working, including flat plate collectors, compound parabolic collectors, Fresnel lenses, parabolic troughs, and dish concentrators. Each was explained in the context of temperature needs, cost, and land availability. A comparison of solar photovoltaic (SPV) and solar thermal systems was made, to illustrate that the latter often prove more efficient for heating applications. Notably, SPV systems require inverters to convert DC to AC power, while solar thermal systems provide direct usable heat.

Flat plate collectors are simple systems painted black to absorb heat, with copper or aluminum tubes for conduction.

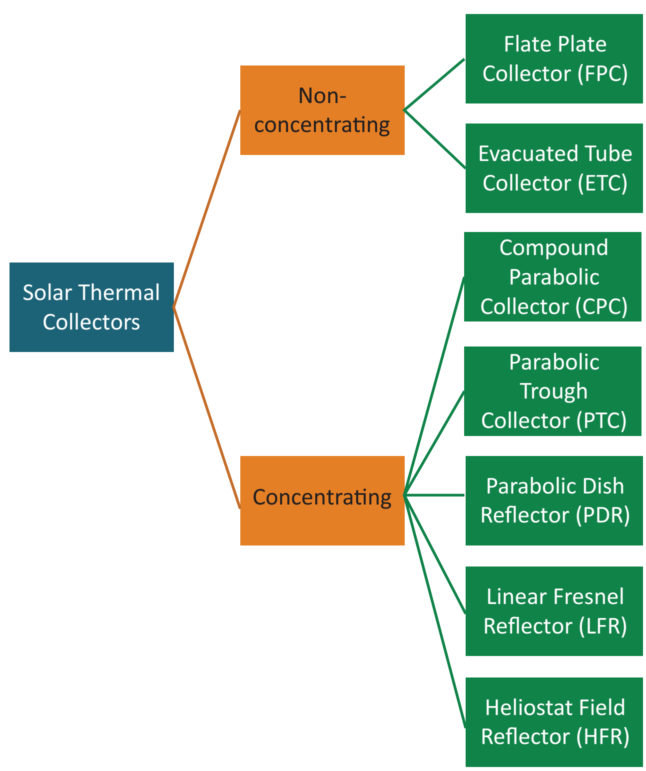
Vacuum tube collectors, primarily manufactured in China, are noted for their insulation and high efficiency.

Parabolic troughs concentrate light onto a central pipe, heating oil or water to generate steam.

Fresnel reflectors use series of precisely angled flat or subtly curved mirror segments to simulate the function of a large, curved parabolic or cylindrical mirror, thereby reducing cost.

Dish concentrators focus sunlight to a point, achieving very high temperatures.

Heliostat systems use multiple mirrors to focus sunlight onto a tower receiver, typically for large-scale applications.



Motion	Collector type	Absorber type	Concen-tration	Indicative temperature range (°C)
Stationary	Flat Plate Collector (FPC)	Flat	No	30–80
Stationary	Evacuated Tube Collector (ETC)	Tubular	No	50–130
Stationary	Compound Parabolic Concentrator (CPC) Collectors	Tubular / Flat	Yes	80–200
Single axis tracking	Linear Fresnel Reflector (LFR)	Tubular	Yes	60–400
Single axis tracking	Parabolic Trough Collector (PTC)	Tubular	Yes	100–450
Two axes tracking	Parabolic Dish Reflector (PDR)	Point	Yes	100–500
Two axes tracking	Heliostats Field Collector (HFC)	Point	Yes	150–2000

The concentration ratio—which is in essence the measure of sunlight intensity focused on a receiver—is a key factor in the selection of solar thermal technology for a specific application. Basic collectors operate at a 1:1 ratio; compound parabolic concentrators (CPCs) can achieve ratios up to 5:1; Fresnel lenses and parabolic troughs can reach ratios of 8:1 to 80:1; and advanced central receiver systems are capable of achieving ratios of up to 8000:1, producing extremely high temperatures.

Parabolic trough collector

The Scheffler dish offers a practical solution for large-scale cooking, especially in institutions. The world's first solar concentrating steam cooking system was cited as an example: implemented at the Muni Sewa Ashram (Gujarat)[1], it has demonstrated scalability and practicality for mass cooking needs. CST systems can also meet industrial and other large-scale refrigeration applications; for example , a vapor absorption chiller, driven by solar thermal energy, had been installed in a hospital.

Parabolic dish reflector system

While solar thermal systems face challenges related to land availability in industrial areas, vertical solar concentrator installations can overcome these challenges; an example is the 'big dish' CST system from Australia, which significantly reduces land requirements while producing high-temperature, high-pressure steam.

Installation and Commissioning of CST

—Mr Raj, EMSOL

1 See SAMEEEKSHA 16(2), June 2025

EMSOL is involved in the development and implementation of advanced cross-component parabolic solar thermal systems. Mr Raj described a high-performance, fixed-position solar thermal collector system—EMSOL's XCPC (Cross Compound Parabolic Collector) system—which has been engineered to operate without sun-tracking mechanisms while being mounted in a fixed position on the ground or rooftop, unlike traditional systems in which dual-axis tracking is required for optimal efficiency: east to west daily and north to south seasonally. This innovative characteristic of the XCPC system allows for significant reductions in operational complexity and maintenance. Also, the modularity of the system enables its scalability, as additional capacity can be installed incrementally, i.e., without altering the existing setup. A system as small as 10 kW can be expanded gradually to larger capacities, including megawatt-scale applications, thus providing a major advantage in diverse industrial settings. The XCPC technology provides 60–70% thermal efficiency and continues to perform even under diffused or cloudy conditions—unlike conventional parabolic systems, whose performance drops to near zero under cloud cover. With only 2 m^2 of area required per kilowatt, a significant improvement in land use and space efficiency is achieved.

Several case studies were shared. In one installation, an XCPC system has been mounted on a lightweight metal rooftop to heat 25,000 liters of water per day to around 90–95°C. and feed it into the boiler system, reducing the boiler's load. When sunlight is not available, the same system continues to deliver water at ambient temperatures (~30°C), ensuring seamless integration with existing operations. Installations in Dubai and Abu Dhabi were mentioned, where the system was used in low-pressure applications for HVAC and industrial preheating.

The XCPC system has been tested and certified by reputed agencies, including the Tamil Nadu Water Investment Company. In a field trial, several technologies were installed side-by-side and tested independently. EMSOL's system was certified with a performance efficiency of 78%. Collaborations with Anna University in Chennai were also highlighted as part of EMSOL's academic partnerships.

The system's core design was explained in detail. Constructed with aluminium and copper, the design minimizes corrosion while maximizing heat transfer efficiency. Each module provides approximately 2.5 kW (1.8 usable kW depending on application and time of day). For 24/7 operations, hot oil can be heated during the day and stored in insulated tanks for later use. This allows the system to deliver heat even at night. Simple tank-based hot water storage can be effective for domestic and light industrial applications, while pressurized steam storage requires more complex infrastructure.

Application and Potential of Solar Thermal Systems in Industrial Heat Processes: Case Study

—Dr N K Ram, Senior Fellow, TERI

Dr Ram focused his session on the application of solar thermal systems in industrial heating processes, with particular emphasis on steam and hot water generation through boilers. The replacement of conventional fossil-fuel boilers with solar thermal systems presents a viable strategy for reducing carbon emissions in a wide range of industries. Solar thermal energy can also be extended to applications such as hot air generation, drying, and industrial cooling.

Substantial potential has been identified for the adoption of CST systems in industrial clusters across India, including the textile processsing hubs of Tirupur, Ludhiana, Surat, Pali, and Kanji where numerous units are engaged in energy-intensive processes such as bleaching, dyeing, calendaring, and printing which require hot water and/or steam. These clusters currently depend on a variety of fossil fuels to meet their energy needs, depending on local availability and price, ranging from piped natural gas (PNG) and coal to agro-residues like husk or coconut shells. Estimates were presented of daily and annual fuel consumption as well as the carbon emissions produced in these industrial clusters, and of the potential for achieving energy savings and emission reductions through the deployment of CST systems.

Dr Ram discussed the use of steam in dairy and pharmaceutical industries in greater detail. In dairies, steam is utilized for pasteurization, sterilization, and equipment cleaning, while pharmaceutical industries rely on thermal energy for various high-temperature operations.

In dairy operations, approximately 70% of energy consumption is thermal while the remaining 30% is electrical—indicating a substantial opportunity for introducing CST systems to reduce the usage of fossil fuels for heat. He also mentioned the fruit and vegetable processing industry, where seasonal operations create significant, though time-bound, thermal energy demands. In the food processing industry, fuels such as coal, biomass, and LPG are commonly used, with choices dictated by price and operational needs.

It is important to ensure that solar thermal systems are appropriately tailored to specific industrial energy demands. Not all processes require steam; in many instances, hot water suffices. This makes it possible to deploy simpler and more space-efficient systems. Technology selection should be based on the temperature requirement of the process. For hot water applications, basic flat plate or evacuated tube collectors can be used. For higher temperatures or steam production, tracking concentrators or parabolic systems are recommended.

Considerations such as land use compatibility, capacity range, capital expenditure, and payback period were carefully examined. A financial analysis model was used to assess the viability of solar thermal projects. Assumptions included system efficiencies ranging from 55% to 75%, a project lifespan of 20 years, annual fuel price inflation of 5%, and operation and maintenance costs at 1.5% of capital cost. Scrap value was conservatively estimated at 10% of the capital cost. Taxation and depreciation effects—including accelerated depreciation benefits—were incorporated into the model, along with a financing structure assuming a 70:30 debt-to-equity ratio.

One case study involved a hospital where diesel-fired boilers (2.4 TPH) operated for eight hours a day, seven days a week, consuming about 56 tonnes of diesel annually. Implementation of a CST system resulted in significant reduction in CO_2 emissions. The payback period for the system was calculated at 2.2–2.5 years without subsidies, and 1.8 years when tax and subsidy incentives were applied.

In the textile sector, where bleaching and dyeing dominate thermal energy consumption, thermal energy accounts for an estimated 53% of total energy use and electricity the remaining 47%; in the pharmaceutical industry, the share of thermal energy is estimated at 75% of the total energy use. It was suggested that CST systems could effectively meet thermal energy requirements in these sectors, and PV systems could address the electrical load.

Challenges related to seasonal underutilization were highlighted, especially where solar thermal systems may be operated only 5–6 hours per day during off-peak periods. Although the environmental benefits remain positive, financial benefits are slower in such cases compared to round-the-clock industries. For instance, fruit and vegetable processing facilities operate 6 to 8 months annually (according to seasonal cycles), and as a result, longer payback periods are expected for CST systems in this sector.

Key influencing factors on the performance and economics of solar thermal systems were summarized. These included annual operating hours, fuel type and cost, technology choice, and maintenance quality. The importance of trained manpower for ongoing operations was strongly emphasized.

On-site demonstration/ hands-on training on a CST model

—Mr Srinivasa Rao, Sunrise CSP India Pvt. Ltd.

In the concluding session, Dr Rao guided the participants through an on-site demonstration/hands-on training with a model CST system. The following aspects were covered:

- Installation
- Performance monitoring
- Trouble shooting and maintenance
- Safety measures

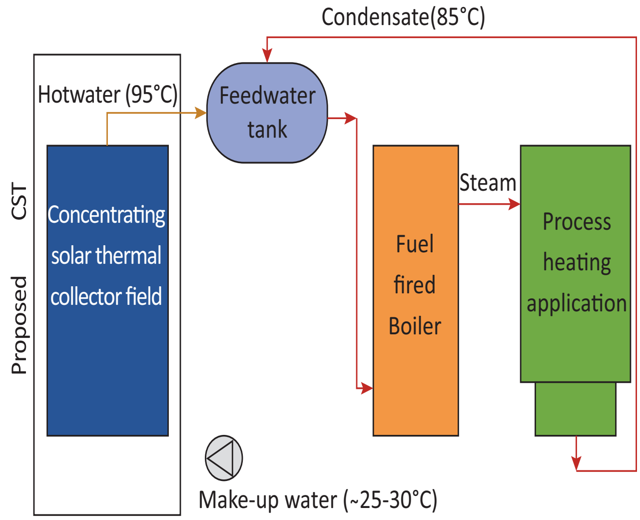
SOLAR THERMAL SYSTEMS FOR HOT WATER AND STEAM APPLICATIONS IN PHARMACEUTICAL INDUSTRIES AND HOSPITALS

Among the many different kinds of CST technologies available for thermal applications, systems based on compound parabolic collectors (CPC) are particularly suitable for meeting low-temperature heating needs up to 200°C. Industrial sectors such as textiles, pharmaceutical, and food processing, and establishments like hospitals, laboratories, hotels, community kitchens, etc., typically require hot water or steam at temperatures up to 200°C for various processes, presenting an opportunity to explore the implementation of CPC-based CST systems to reduce or eliminate the use of fossil fuels that are currently used for providing the process heat.

In essence, a CPC uses two curved mirrors (parabolic shapes) to funnel sunlight falling over a broad area on to an absorber with much smaller area, thus concentrating the solar energy and heating up the absorber to high temperature. A CPC system typically takes the form of a series of troughs whose curved walls act as the mirrors, with evacuated, coated, glass-covered tubes running along the base of the troughs serving as absorbers. Fluids like water or thermic fluids are circulated through the tubes to absorb the incident solar heat and convey the heat for various applications. An 'extended' CPC (xCPC) builds on the standard CPC design by adding extra reflective surfaces (like wings or fins) to enhance light capture, especially from diffuse sources, allowing for higher energy yields. CPC and xCPC systems do not need complex sun-tracking mechanisms, and function effectively in both direct and diffused sunlight. They are relatively simple in design compared to other solar concentrators, thus reducing cost and maintenance.

CPC system

Under the GEF-UNIDO-MoMSME project titled 'Promoting business models for increasing penetration and scaling up of solar energy', TERI conducted techno-economic studies in a large number of industries/establishments across India in order to identify and recommend the implementation of CST options that could bring reductions in energy costs, fossil fuel consumption and CO_2 emissions. Presented below are snapshots of three such studies conducted on pharmaceutical units/medical establishments in Goa. In each case, it was recommended that the unit install an xCPC system of appropriate capacity to generate thermal energy for preheating water and delivering the hot water to the existing boiler, thereby helping to meet process hot water needs at a much lower cost. An xCPC system generally requires a relatively large area for the solar collectors; but each of the three units was found to have sufficient roof-top area for installation of the proposed xCPC system.



Unit A

This unit manufactures pharmaceutical compounds for injections and ophthalmic drops. The unit was using a biomass-based boiler of 0.6 tonnes per hour (tph) rated capacity to meet its daily hot water requirements, of about 6 tonnes at 95°C. The annual consumption of biomass fuel was about 526 tonnes.

Recommended CST system and benefits

- xCPC system with capacity to generate about 59 MWth yearly to preheat water from about 30°C to 95°C.
- Saves 21 tonnes of biomass fuel each year, equivalent to annual cost saving of Rs 1.49 lakhs.
- Lowers net CO_2 emissions by 38 tonnes of annually.
- Estimated capital cost of the CST system: Rs 25 lakhs,
- Discounted payback period on investment: about 8.4 years with accelerated depreciation and 30% capital subsidy provided by UNIDO.

Unit B

This is a medical college with a large campus that includes a fully equipped hospital with over 1500 beds, laboratories, kitchens, hostels, and other related facilities. The establishment was using a diesel-fired boiler of 2 tph rated capacity to meet its daily hot water requirements of about 19.6 tonnes at 95°C. The annual consumption of diesel was about 547 tonnes.

Recommended CST system and benefits

- xCPC system with capacity to generate about 381 MWth yearly to preheat water from about 30°C to 95°C.
- Saves 41 tonnes of diesel each year, equivalent to annual cost saving of Rs 43.4 lakhs.
- Lowers net CO_2 emissions by 126 tonnes of annually.
- Estimated capital cost of the CST system: Rs 162.4 lakhs.
- Discounted payback period on investment: about 2.3 years with accelerated depreciation and 30% capital subsidy provided by UNIDO.

Unit C

This is an export-oriented pharmaceutical unit manufacturing solid oral and topical formulations.

The plant was using a biodiesel-fired boiler of 0.6 tph rated capacity to meet its daily hot water requirements of about 10.8 tonnes at 95°C. The annual consumption of biodiesel was about 300 tonnes.

Recommended CST system and benefits

- xCPC system with capacity to generate about 81 MWth yearly to preheat water from about 30°C to 95°C.
- Saves 9.1 tonnes of biodiesel each year, equivalent to annual cost saving of Rs 7.3 lakhs.
- Lowers net CO_2 emissions by 126 tonnes of annually.
- Estimated capital cost of the CST system: Rs 34.4 lakhs.
- Discounted payback period on investment: about 2.3 years with accelerated depreciation and 30% capital subsidy provided by UNIDO.

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