

a quarterly magazine on **concentrated solar heat**

# SUN FOCUS

Issue 1 | July–September 2013

## INDIA'S QUEST FOR SOLAR STEAM AND PROCESS HEAT

Concentrating Solar Technologies  
for process heat applications

### TECHNOLOGY FOCUS

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Technology



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**UNDP-GEF Project on CSH**

Ministry of New and Renewable Energy  
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# SUN FOCUS

**Editorial Desk**

**What we require**

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Policies

Case Studies

Technology Focus

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## Jawaharlal Nehru National Solar Mission (JNNSM)

The Jawaharlal Nehru National Solar Mission was launched on 11 January 2010 by the Prime Minister. The Mission has set an ambitious target of deploying 20,000 MW of grid connected solar power by 2022 and is aimed at reducing the cost of solar power generation in the country through (i) long-term policy; (ii) large-scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components, and products, with a target of achieving grid tariff parity by 2022.

The Mission will create an enabling policy framework to achieve this objective and make India a global leader in solar energy. Major objective of the National Solar Mission is to establish India as a global leader in solar energy, by creating policy conditions for its diffusion across the country as quickly as possible. Goals of deployment include:

- 20,000 MW of grid connected solar power;
- 2,000 MW of off-grid solar applications;
- 20 million solar lights in rural homes; and
- 20 million sq. m. of solar thermal collector area in various establishments.

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**concentrated solar heat**

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**O**ur country is short of power and other energy sources. Forty per cent of our population is still not able to access electricity at their homes in rural areas. In urban areas also, the demand is much more than the supply. Oil is being imported to the extent of 80 per cent. We need to conserve them besides tapping new and renewable sources of energy. I am glad to say that my Ministry has done tremendous work in this area during the past many years, especially during the 11th Plan. Over 14 per cent of the power now produced in the country is through renewable energy.

We have abundance of solar energy. We need to tap it and make India a world leader in the field of solar energy. The Jawaharlal Nehru National Solar Mission (JNNSM), launched in 2010, is a step in this direction. One of the achievements of the Mission has been the reduction in cost of solar electricity during the last three years. The price of solar electricity, which was around ₹18 per unit has come down to less than ₹7, which compares favourably with conventional electricity tariffs. But this is in the case of solar photovoltaics. We also need to see that cost of solar thermal comes down. I am told that many CST plants of 50–100 MW capacity are already at various stages of implementation in Rajasthan and Gujarat.

Besides grid-connected power generation, CST has many other relevant applications. I had visited Shirdi about three years back and saw that food for about 20,000 people was being cooked every day using this technology saving significant amounts of fossil fuel. Many such systems are in operation in the institutional and religious sector. CST systems are also being installed for process heat, cooling, and laundry applications in various establishments. However, considering the vast untapped potential, we need to extend them at more and more places. We also need to develop case studies of successful installations for the benefit of the people.

I am happy to note that the Ministry is implementing a UNDP–GEF Project for market development of concentrated solar technologies and a quarterly magazine, *SUN FOCUS* is being started to highlight such studies and success stories, besides providing other relevant information. I am sure the magazine will help various stakeholders in updating their knowledge on CSTs and developing a good market for their promotion in the industrial, commercial, and institutional sectors.

I wish the entire UNDP–GEF project team all success in this endeavour.

Sd/-

**Dr Farooq Abdullah**

Minister, New and Renewable Energy, Govt of India



**T**he Ministry of New and Renewable Energy has been promoting and popularizing several solar technologies. The domain of Concentrated Solar Heat technologies has an immense potential for applicability in institutional, industrial, and commercial outfits. Heat generated at medium and high temperatures could be utilized for the purpose of community cooking, process heat, and space cooling applications; thereby, reducing the use of conventional fuels and GHG emissions into the atmosphere.

There is also a need to develop awareness about these technologies, promote technology partnerships, and to develop testing standards. The Ministry is implementing a UNDP–GEF project to develop a market framework for CSTs in industrial processes. As a part of the project, performance measuring standards, test procedures, and test protocols for CSTs that are to be used in process heat applications are also being developed.

Under the umbrella of the project, a quarterly magazine *SUN FOCUS* is being launched. The magazine will highlight the work being done in the area of CSTs. It will also be a platform for articulating views and opinions on the subject. This publication will be useful for all the stakeholders connected with the programme.

I wish the venture success.

Sd/-

**Ratan P Watal**

Secretary, Ministry of New and Renewable Energy



**U** NDP is pleased to support *SUN FOCUS*, a quarterly magazine on concentrated solar heat, (CSH) which is being published through a partnership between the Ministry of New and Renewable Energy, UNDP, and the Global Environment Facility. The aim of *SUN FOCUS* is to present technical and economic analyses of CSH technology and to share the experiences of users.

CSH technology can play a major role in reducing energy consumption, particularly in the industrial sector. The use of CSH technologies can help to significantly meet the requirements for medium and low temperature processes. India is already a leader in this sector. Of the 100 known global applications of CSH technologies, 70 are in India and two CSH technologies are commercially available, with annual sales of around 2,000–3,000 sq. m. per year. Given the energy requirements for thermal applications in industry, sales of these technologies are projected to rise substantially.

UNDP is committed to helping the Ministry of New and Renewable Energy increase the adoption of CSH technology to meet industrial thermal requirements by five times the baseline of 3,000 sq. m. per year. In order to reach this goal and help expand the market for CSH technology, it will be important to introduce technology options to suit varied climatic conditions, energy needs and energy storage requirements, and to benchmark the performance of these technologies. It will also be important to provide technical assistance to users and to support the fabrication and maintenance of CSH systems. Expanding the market and increasing demand for CSH technologies should help to generate incentives for further development.

CSH is a winning technology, which can help to reduce consumption and emissions. We hope this magazine contributes to the development and use of these important technologies.

Sd/-

**Lise Grande**

United Nations Resident Coordinator and UNDP Resident Representative

# From the editor's desk...



Dear Readers,

**T**onnes and tonnes of fossil fuel is being consumed for thermal applications, such as water/air heating, community cooking, process heat, and space cooling in various establishments. About 15 million tonnes of fuel oil is estimated to be consumed in industries alone for process heat applications requiring temperature below 250 °C. Over 5,000 trillion units of electricity is also being used for hot water and air heating applications. This electricity needs to be conserved for other useful applications in a country like ours where 35 per cent of the population has no access to power and 80 per cent of the fuel oil is being imported. India is full of sun energy and the use of concentrated solar technologies (CSTs) at places of direct utility for such applications can help save significant amounts of fossil fuels.

We are starting a quarterly magazine titled, *SUN FOCUS* under the UNDP–GEF project on “Market development of CSTs for process heat applications”. This magazine will be useful for potential beneficiaries, manufacturers, policy formulators, programme implementers, and other stakeholders involved in market development of CSTs. The magazine will highlight the activities related to CSTs in and outside the country, including developments, events, news, installations, success stories and case studies, popular articles, interviews, government schemes, etc. It will provide updated information on pioneering technologies, latest installations, accredited manufacturers, and projects on which the government is focussing nationwide.

In the inaugural issue of *SUN FOCUS*, we have tried to summarize essential introductory information on CSTs and their uses as observed in India. The issue also provides information on workshops held in various sectors, new technologies, future potentialities, installations, etc. I do hope you will enjoy reading the first issue of this magazine. We would constantly endeavour to bring you all relevant information on CSTs in our subsequent issues. We welcome suggestions and contributions in the form of information, articles, and photographs from the readers.

Sd/-

**Tarun Kapoor**

Joint Secretary, Ministry of New and Renewable Energy

# PRESENT STATUS OF CONCENTRATING SOLAR TECHNOLOGIES IN INDIA

Dr A K Singhal

India receives immense amount of solar energy. Technologies developed for use of this energy can help minimize the fossil fuels inputs in industrial, commercial, and institutional establishments for various applications. A huge amount of fossil fuels, especially electricity and fuel oil are being consumed for thermal applications, e.g., water/air heating, community cooking, process heat, space cooling, etc. At most places, the heat requirement in the form of steam/pressurized hot water/air or oil is between 90 °C to 350 °C. Industry is one of the major consumers of such heat for various processes as mentioned in the table below.

Solar water heating is already an established technology and is being promoted in a major way for providing hot water for various applications. This technology is, however, limited to temperatures below 90 °C. On the contrary, concentrated solar technologies (CSTs) can provide high temperatures in the range of 100 °C to 450 °C or even more. These technologies basically focus on the sunlight at the receiver to achieve higher temperatures for various applications. Since these technologies can focus on direct radiation coming from the sun, they need to track the sun. Thus, these technologies can be based on single axis (E-W) tracking as well as dual axis (E-W and N-S) tracking. Depending on their operating temperatures, they can be placed in the category of medium or high temperature applications.

## Technology Status

A number of CSTs have been developed and demonstrated in the USA and Spain mainly for the purpose of power generation. Popular technologies include parabolic trough concentrators and the central tower receiver. Paraboloid dish and Linear Fresnel Reflector technologies have also been demonstrated at few places. These technologies, have, however, rarely been used for process heat, cooking or cooling applications. Other technologies, such as non-imaging concentrators and heat pipes have also been developed abroad, which have met with positive reviews, particularly with regard to process heat and cooling applications in India.



Industry	Process
Food processing and dairy	Chilling/cold storage, cooking, extraction, baking, pasteurization, sterilization, bleaching, drying, etc.
Breweries	Boiling, mashing, cold conditioning, fermentation, etc.
Rubber	Heating, digestion, vulcanizing
Pulp and paper	Pulping, digestion and washing, bleaching, evaporation and drying
Tobacco	Steam conditioning, drying and softening
Electroplating	Post plating treatment, water heating, drying, etc.
Pharmaceutical	Distillation, drying, evaporation, fermentation, injection, and moulding
Textiles (spinning and weaving, finishing)	Preparing warps, sizing, de-sizing, scouring, bleaching, mercerizing, dyeing, drying, and finishing
Chemicals and fertilizers	Distillation, effluent treatment, primary reforming, ammonia synthesis, CO <sub>2</sub> removal, methanation, steam stripping
Refining	Desalting, cooking, thermal cracking, cleaning, wastewater treatment
Ceramic tile and pottery	Beneficiation, drying, presinter thermal processing, glazing
Desalination	Multiple-effect distillation, multi-stage flash distillation
Others (Plaster of Paris, steel re-rolling, cement, mining)	Augmenting steam to boilers, boiler feed water heating

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In India, mainly three types of CSTs are being promoted: i) Manually tracked dish solar cookers to cook food for 10–40 people; ii) Fixed focus E-W automatically tracked elliptical dishes (Scheffler) for direct indoor cooking for about 50–100 people and for steam generation for the purpose of community cooking, laundry, space cooling, etc., of any capacity; and iii) Dual axis fully tracked Fresnel dishes (Arun) for all such applications. These technologies have been in implementation for the past few years with support from the Ministry of New and Renewable Energy. A few other technologies, e.g., dual axis tracked paraboloid dishes, linear Fresnel reflectors, and non-imaging concentrators have also been developed and are currently at the demonstration stage.

### Present Applications

CSTs have been found to be quite suitable for cooking food for hundreds and thousands of people in community kitchens, especially at religious places and institutional canteens. The world's largest system is functioning at Shirdi, which cooks food for 20,000 people/day. The system comprising 73 fixed focus single axis automatically tracked elliptical dishes, each of 16 sq. m. area, generates about 3,500 kg steam/day. It was commissioned in July 2009 and has been cooking food for pilgrims twice a day since then. A clear saving of around 263 kg of LPG/ day (18–20 cylinders) has been reported by the Shirdi Sansthan on a clear sunny day. Many more such systems have been installed at religious ashrams, boarding schools, and industrial canteens and are functioning well.

These systems are also being installed in industries and commercial establishments, e.g., hotels and hospitals, for process heat and laundry applications. One such system installed at Hindusthan Vidyut Products Ltd, Faridabad, Haryana, comprising 20 parabolic dishes of 16 sq. m. each is able to deliver around 0.4–0.45 million kcal of heat per day for the purpose of vulcanizing of cables, which is essentially done by dipping the cable-core in water for 18 to 24 hours in a heated tank with the temperature maintained up to 85 °C. The system connected to their boiler fired by furnace

oil, heats the water to 125 °C for six hours during the day, thereby, saving a significant amount of fuel oil. A few more such systems are functional in other parts of the country. A system installed at Ahmednagar, Maharashtra, for laundry applications has also been working satisfactorily for last many years.

CST-based systems, along with vapour absorption machines, have also been demonstrated for the purpose of air conditioning. These have been installed at places where incidence of power cuts are high, electricity is expensive, and establishments are using fuel oil for generating cooling. Some of the systems installed include a 212 TR system—a combination of 160 TR with VAM and 52 TR through liquid desiccant—at Civil Hospital, Thane, comprising 184 Scheffler dishes, each of 13.5 sq. m. area. The location being coastal, the combined vapour absorption machine (VAM) and desiccant system makes it cost effective as the desiccant system first takes care of dehumidification of the moist air, which is then cooled using VAM. The system has been integrated with a biomass boiler using briquettes so as to make it run on a 24x7 hour basis. Other examples of solar cooling systems are the 100 TR air conditioning plant at Muni Seva Ashram, Vadodara; 92 TR system at TVS, Suzuki factory near Chennai; 30 TR plant at Magnetic Mareli, Gurgaon; 50 TR system at NTPC, Noida; and 100 TR system at Mahindra & Mahindra, Pune.

### Installations and Fuel Savings

A total of about 144 steam generating systems have been installed so far in the country with a cumulative figure of 28,000 sq. m. of dish area. Another 23 systems with 8,100 sq. m. of CST area are at the execution stage. This includes very small systems of 2 to 3 dishes, which could be 30 per cent of the total number. Most of these have been installed mainly at places where steam generated through conventional boilers is already being used for cooking applications. Installed in hybrid mode, these systems could save a significant amount of fuel oil at such places. A 100-sq. m. system can save 5,000–10,000 litres of diesel/year and 600–1,200 LPG cylinders/year depending on the type of technology used and availability of Direct Normal Irradiance (DNI). Assuming 80 per cent functionality, it is estimated that about 18 lakh litres of fuel oil equivalent would have been saved per year from CST installations in the country, besides reducing around 8,500 tonnes of GHG emission/year in the atmosphere. A list of 16 manufacturers/suppliers of such systems is available at the MNRE website [www.mnre.gov.in](http://www.mnre.gov.in). Industry-wise list of installations is provided in the following tables. Major installations have been reported in those states where steam cooking is already being done using LPG/oil-fired boilers or vapour absorption machines. These states include Karnataka, Maharashtra, Tamil Nadu, and Gujarat.

## Status of installation of CST-based systems

Industry	Installed in last 5 years		Total installed so far		Under execution	
	No.	Sq. m.	No.	Sq. m.	No.	Sq. m.
Aireer Natura, Bangalore	2	112	3	320	1	224
Akson Solar, Pune	1	64	1	64	-	
Bergen Solar, Gurgaon	1	20	1	20	2	740
Bhagwati, Gurgaon	2	77	2	77	1	96
Clique, Mumbai	15	2,470	15	2,470	2	137
Flareum, Mumbai	40	6,118	60	8,875	3	1,808
K Energy, Jodhpur	3	192	3	192	-	-
KG Design, Coimbatore	2	2,800	2	2,800	-	-
Maharishi, Noida	1	316	1	316	-	-
MWS, Delhi	1	90	1	90	-	-
Sharda Invention, Nasik	10	2,800	15	3,000	-	-
Taylormade, A'bad	6	1,092	6	1,092	4	960
Thermax, Pune	15	4,246	15	4,246	9	2,847
Unisun, Bangalore	12	3,294	20	3,600	1	1,280
<b>Total</b>	<b>111</b>	<b>23,691</b>	<b>145</b>	<b>27,162</b>	<b>23</b>	<b>8,092</b>

## Salient Features

Technology	Temp. range	Weight	Other features	Suitability of technology	For Retrofitted system	
					cost / sq. m. **	Payback*
Fixed receiver elliptical dish (Single Axis tracking)	Up to 150°C	400 kg for 16 sq.m. dish	North-South adjustment of each dish to be done manually once in 3-4 days	Suitable for systems with smaller no. of dishes. 32 sq.m. dishes could be useful for high temperature and oil-based systems	Rs 16,000	3.5-6 years
Same with Dual Axis Tracking	Upto 180 °C	-do-	Such adjustments done using photo sensors and motors	Suitable for system of any size	Rs 18,000	3.5-6 years
PTC (Non-evacuated heat receiver)	Upto 180 °C	40 kg/ sq. m. of PTC	-	Can be effective if space available in N-S is more	Rs 16,000	3.5-6 years
PTC (Evacuated heat receiver)	>250 °C	-do-	-	-	Rs 18,000	3.5-6 years
LFR (Single Axis tracking)	>250 °C	-	-	-	Rs 18,000	3.5-6 years
Arun (Dual Axis tracking)	Upto 350 °C	13 tonne for 100 sq. m. and 20 tonne for 169 sq. m. dish	Installed on pillar with footprint of 1-2 sq. m. All piping could be underground.	Suitable for ground installations. Smaller dishes may be installed on the terrace.	Rs 20,000	3-5 years
Dish (Dual Axis tracking)	Upto 350 °C	5 tonne for 90 sq. m.	-	Can be installed on terrace also apart from ground	Rs 20,000	3-5 years

\* Variation is due to varying DNI in different regions. Five per cent of the cost is taken as O&M cost while calculating the payback period. Eighty per cent depreciation benefit to profit making bodies will reduce the payback by 25 per cent or so. This will also be reduced by 30-40 per cent or so in special category states where subsidy is higher.

\*\* For newer systems, the cost towards boiler, utensils for cooking, and VAM and its accessories for air-conditioning, etc., may be extra by 15-30 per cent, respectively. In high altitude areas and difficult terrain, the cost may further increase by 20-25 per cent. The payback period for newer systems will therefore, be somewhat more as compared to that mentioned above.

Note : Land/ swept area required for installation of CST-based system is generally double the reflector/collector area of the system.

## Salient Features and Anticipated Heat Delivery from CSTs

The performance of CSTs depend on various factors, including availability of DNI in a particular region, efficiency of the

technology, and various other climatic and other factors. To make people aware of the salient features of CSTs with anticipated heat delivery from them, the Ministry has placed such information on its website as shown in the table below.

### Anticipated Heat Delivery

Region	Indicative average DNI/ sq. m. / day* (In kWh)	Sunshine days	Fixed focus elliptical dish^ / Non evacuated heat receiver PTC		Evacuated heat receiver PTC/ LFTR		Fresnel reflector/ Paraboloid based dish	
			Efficiency at 150 °C**	Heat delivery***	Efficiency at 150 °C**	Heat delivery***	Efficiency at 150 °C**	Heat delivery***
Leh, Ladakh	6.5	320	35%	6.26	40%	7.15	60%	10.73
Gujarat, Rajasthan, and western MP	6.0	300	40%	6.20	45%	6.97	65%	10.10
North-West and Himalayas	4.5	250	35%	3.39	40%	3.87	60%	5.81
North-East states, Eastern Orissa, and AP	4.0	250	40%	3.44	45%	3.87	65%	5.59
Southern and Central	5.0	280	40%	4.82	45%	5.42	65%	7.83

^ Average effective aperture area of 16 sq. m. fixed focus elliptical dish for receiving normal radiation during whole year is to be taken as 11 sq.m. The heat delivery from a 16 sq. m. elliptical dish in a year in different regions will, therefore, be 11 multiplied by figures given in above table. Also dual axis automatic tracked elliptical dishes may have higher heat delivery by say 5 per cent in comparison to single axis tracked dishes due to avoided errors in manual N-S adjustments.

\* Can vary by +/- 10 per cent at a particular location in the region.

\*\* Its average annualized efficiency is linked with ambient temperature and wind conditions of particular region. It reduces in the regions having lower ambient temperature and high wind velocity. It also reduces marginally for CSTs working at higher temperatures due to higher heat losses, thereby reducing the heat delivery. Temperature range, which can be achieved by various CSTs, their salient features, installed cost, and payback period are given above.

\*\*\* Heat delivery / sq.m / year (in lakhs of Kcal) will:

i) Increase if the fluid temperature goes down due to less heat losses. Likewise it will also decrease if working temperature is raised say upto 350 °C or so, especially in case of Fresnel reflector /Paraboloid dishes, which are designed for such temperatures.

ii) Decrease by 10 per cent or more if the mirrors are not of solar grade quality.

The aforementioned figures are for the purpose for providing guidelines. Please contact experts/ manufacturers for specific projects/sites/applications.

## Further Developments

Under public-private partnership with industry, a 30-tonne solar air conditioning system using indigenously made concentrating parabolic troughs and triple effect vapour absorption machine has been developed and demonstrated at Solar Energy Centre (SEC), MNRE. It is a stand-alone system for day-time use and can take care of intermittent clouds through small storage. The system has been found to be useful for offices and institutions working during day time when solar radiation is available. Smaller systems with air-cooled condensers have also been developed and are in operation at SEC.

A state-of-the-art paraboloid dish of 90 sq. m. aperture area has also been developed in public-private partnership mode and has been successfully demonstrated at the same

100kw solar cooling system at SEC, Gurgaon





*State-of-art Paraboloid dish*

site. The dish concentrates the incoming radiation onto a highly efficient cavity receiver, which heats the working fluid upto 400 °C for either direct applications or indirect applications via heat exchangers. The dish is designed to track the sun in two axis automatically to follow the sun without any manual intervention. The system has one of the highest efficiencies and is expected to address most shortfalls of the existing systems.



*60 sq. m. fully tracked Scheffler dish with heat storage*

To avoid manual errors in N-S adjustments of Scheffler dishes for keeping the focus at centre of the receiver, dual axis automatically tracked dishes of 60 sq.m.have been developed by Brahmakumaris at Mount Abu with required storage of heat in a metallic block for use in non-sunshine hours. The heat stored could be utilized for various applications during evenings and nights by sending water to the metallic block, which converts it to steam/hot water.



*Linear Fresnel Reflector by KG Design, Coimbatore*

East West automatically tracked linear Fresnel reflector technology has also been developed and demonstrated for steam generation by KG Design (P) Ltd. Based on this technology, a 1,400 sq. m. area plant has been installed at Ramanathapuram, Tamil Nadu, for the purpose of desalination of sea water using steam generated from the plant.

### Potential and Constraints

There is huge potential for CSTs in various sectors where heat generated at high temperatures from such technologies could be utilized for the purpose of community cooking in kitchens, laundry in hospitals and hotels, process heat in industries, and also for space cooling applications, thereby, reducing the use of conventional fuels and GHG emissions in the atmosphere. Major constraints in large-scale promotion of CSTs in the country are, however, lack of awareness about the technologies and their benefits, lack of information on successful projects through case studies and video films, import of high quality reflectors, non-availability of evacuated tube receivers for CSTs, fool-proof technology packages for industries, space constraints for installations, non-availability of performance data on CSTs with varying DNI, no test standards or establishments for measuring performance of CSTs, and low returns on investments as compared to SWHs. To address these issues and accelerate the use of CSTs, a UNDP-GEF project on "Market Development of CSTs for industrial process heat applications" is being implemented by the Ministry, which will continue till March 2017.



# UNDP–GEF PROJECT ON CONCENTRATED SOLAR HEAT

Pankaj Kumar



*Project Inception Workshop held on 18 May 2012*

## Background

The industrial sector is the second largest energy consuming sector in India after the residential sector. Most of the energy consumption occurs in industries, such as pharmaceuticals, chemicals, metal treatment, textiles, and food and dairy processing, which have a significant requirement of low-medium temperature heat (upto 250 °C), such as steam, hot water, hot air, and hot oil. Significant quantities of low-medium temperature process heat are also required in the commercial sector, such as in hotels, hospitals, and other institutional buildings for space cooling, cooking, and space heating. This low-medium temperature heat is primarily provided by fuel oil, coal (for larger heat loads), biomass, and electricity for cooling. Low-cost natural gas is not widely available for process heat uses in India, like most major countries.

India has significant solar energy potential of around 5–7 kWh/sq.m./day. A significant part of India's low-medium temperature process heat needs can be met by concentrating solar heat (CSH) technology systems, alongside process integration and suitable heat storage. This would reduce global CO<sub>2</sub> emissions, local air pollution, and India's growing dependence on expensive imported oil.

## Objective

To boost the use of CSH technologies, the Ministry is implementing a UNDP–GEF supported project on "Market

Development and Promotion of Solar Concentrator-based Process Heat Applications in India". The objective is to promote and commercialize the use of CSTs for industrial process heat applications through demonstration and replicated projects besides developing knowledge documents, test standards and test protocols, and removing barriers in promoting CSTs on a large scale in the country. The duration of the project is from April 2012 to March 2017.

## Project Budget

Global Environment Facility (GEF) resources	US\$ 4,400,000
Government (MNRE) - grant subsidy	US\$ 6,000,000
Government (MNRE) - in kind	US\$ 1,350,000
Industries – in cash	US\$ 6,000,000
Financial institutions	US\$ 6,000,000
<b>Total resources</b>	<b>US\$ 23,750,000</b>

## Project Components

### Component-1: Technical capacity development

*Outcome 1.1:* Enhanced understanding of CSH technologies, applications, and markets.

*Outcome 1.2:* Adoption of standards and specifications for guidance of manufacturers and users for assurance of CSH quality, safety, and performance.

*Outcome 1.3:* Adequately capable and operational testing laboratories for verification of manufacturer claims and guidance of CSH users to enable informed decisions.

### Component 2: Enhanced awareness and capacity building

*Outcome 2.1:* Strengthened technical capacity and awareness of stakeholders of CSH systems for industrial/institutional process heat applications.

*Outcome 2.2:* CSH project deliverables facilitated and/or influenced the widespread replication of CSH technology applications in India.

*The author is Deputy Project Manager, UNDP–GEF Project, MNRE; Email: pankaj.kumar74@nic.in*



## Component 3: Pilot demonstration of CSH technologies for various applications

*Outcome 3.1:* Increased number of commercial and near-commercial CSH technologies for diversity of applications.

*Outcome 3.2:* Improved technical and economic performance of commercial and near-commercial CSH technologies in an increased diversity of applications.

## Component 4: Sustainable financial approach in the adoption of CSH technologies and applications in India

*Outcome 4.1:* Enhanced understanding of the financial viability of CSH technologies and measures to mitigate investment risks.

*Outcome 4.2:* Promulgation of favourable financial policies that promote increased use and promotion of CSH for low- and medium-temperature process heat applications.

## Project Implementation

The project is being implemented by the Ministry through a Project Management Unit (PMU) responsible for undertaking all the activities envisaged in the project and achieving the overall goals and targets. The PMU is being guided by a Project Executive Committee (PEC) comprising senior official from MNRE, IREDA, and UNDP chaired by Joint Secretary, MNRE who is also the National Project Director of the Project. The PEC meets very frequently, almost once in two months. A Project Steering cum Advisory Committee (PSAC) headed by Secretary, MNRE, has also been formed for taking management decisions and playing a critical role in project monitoring and its evaluation. It comprises members from MNRE, MoEF, MSME, BIS, BEE, IREDA, UNDP, GEF, DEA, IREDA, NABARD, SEC, Research institutions, Industry Associations, DG Boiler Control, etc. The PSAC meets atleast once in six months or so.

## Inception Workshop

An Inception Workshop on the project was organized on 18 May 2012 at Hotel Ashok, New Delhi, wherein 200

stakeholders participated from across the country. The workshop provided a platform to participants to discuss barriers, limitations, opportunities, and potential for CSTs. Close to 12 manufacturers displayed posters on their technologies, which generated a lot of enthusiasm among participants towards the development and promotion of CSTs. The workshop also helped in understanding various components and activities planned during the project duration of five years. Many institutions, such as TERI; Thermax; NPC; Asahi Glass; ATE Enterprises; SSVPS College of Engg, Dhule; Essential Equipments; SPRERI; IIT Bombay; Enersun Power Tech. Ltd; CII, etc., expressed interest in participating under various activities of the project.

### Expected Outcome

- 45,000 sq. m. of Concentrated Solar Technologies installed in around 90 industries and commercial establishments
- 39,200 tonnes of CO<sub>2</sub> emission reduced in the atmosphere per year
- 3.15 million litres of fuel oil saved per year

## Completion of GSWHP

A UNDP-GEF project on Global Solar Water Heating had earlier been in implementation by the Ministry, which was completed successfully in December 2012 with a National Workshop organized on 23 August 2012 to highlight the achievements of the project. Over 200 stakeholders participated in the workshop. Besides display of various knowledge products/ documents developed during the project, awards and certificates of appreciation were given away by Dr Farooq Abdullah, Hon'ble Minister for New and Renewable Energy to stakeholders who contributed significantly to the project and the MNRE programme. A few booklets, e.g. Guidelines for Installation of Solar Water Heaters in High Rise Buildings, Users' Handbook on Solar Water Heaters, and Training Manual for Installers/ Technicians were also released by the Hon'ble Minister.



# CONCENTRATING SOLAR TECHNOLOGIES FOR PROCESS HEAT APPLICATIONS

Chinmay Kinjavdekar

So far, solar energy utilization in India was limited to small devices, such as cookers, dryers, low temperature water heating systems, and solar photovoltaic plants. Research has been in progress to develop medium temperature CST or Solar Concentrating Thermal technologies suitable for potential applications in the medium or medium high temperature range (100 °C–250 °C). Some important applications are solar industrial process heat (SIPH), solar air conditioning and refrigeration, and solar desalination.

Work on commercially available comparatively large solar concentrators started in India around 1997 when Wolfgang Scheffler began developing the flexible reflector paraboloid dish with 7 sq. m. reflector area with two axes of freedom and one axis automatic tracking with fixed focus on ground. This was a landmark effort, taken ahead commercially into the field of community cooking by Mr Deepak Gadhia. Around the same time, Dr Shireesh Kedare of Clique Developments Ltd, started work on the Fresnel paraboloid reflector. Currently, various organizations are working on indigenous development of technologies, such as parabolic trough, LFR, paraboloid dish, etc. These efforts are mostly in the early development and demonstration phase.

## Energy Consumption Scenario

The industrial sector is the highest consumer of energy amongst all sectors. Typical energy demands for major sectors in India is shown in Figure 1, which highlights that about 14 per cent of the energy is consumed by the industrial sector.

Of this, 60–70 per cent of the energy is used in the form of heat (ESTIF, 2004). Thus, about 10 per cent share of the total energy is consumed in the form of industrial process heat (IPH).

## Solar Industrial Process Heating Systems

Solar thermal systems can be used effectively to supply energy in the form of heat; therefore, huge potential exists for the use of solar energy in this sector. Industrial process

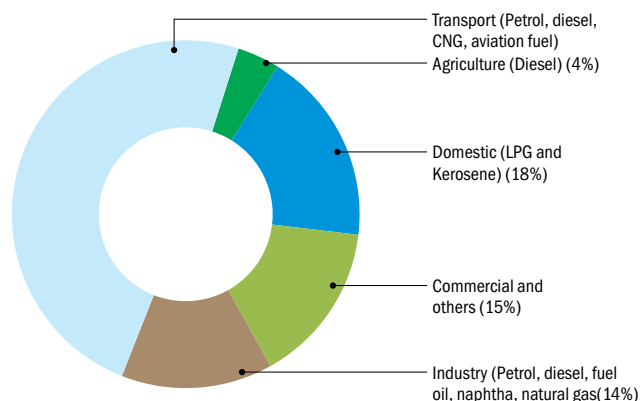


Figure 1: Typical energy demand by various sectors (Kumar et. al, 2012)

applications are also beneficial for solar thermal systems due to following reasons:

- Industrial loads are usually more constant throughout the year, hence, it is easy to integrate with solar thermal system.
- Industrial plants usually have manpower and technical expertise required for regular maintenance and operation of the SIPH system.
- The total impact on the nation's energy mix use would be far greater for SIPH systems.

Most of the industrial processes operate in the temperature range of 100 °C to 250 °C, which can be easily achieved with the variety of solar concentrators available today.

The typical SIPH system consists of solar collector, storage tank, circulating pump, and auxiliary heater. Figure 2 shows schematic of the typical SIPH system with parabolic trough collectors. The solar radiation is absorbed by the solar collector. The heat is transferred to the heat transfer fluid by circulating it through the receiver of the solar collector. The heat is stored in the storage tank and is supplied to the process as per the load profile. The auxiliary heater augments the heat supply when the output of the solar system falls short of demand. The performance of the solar process heat system is dependent on the performance characteristics of these components.

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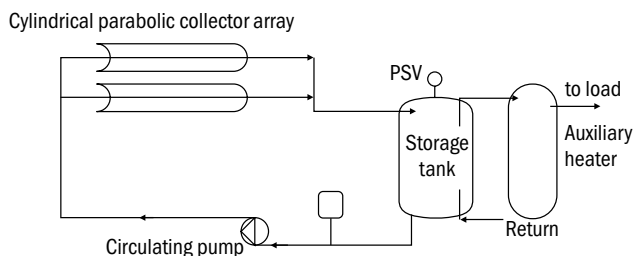


Figure 2: Schematic of typical SIPH system (Eskin, 2000)

Moreover, in most cases of industrial process heating the conventional heat supply system is already present; therefore, the interface between the existing system and solar system needs to be designed properly. Since there is diverse set of application areas with variety of solar collectors available, selection and design of the proper solar system and integration system can ensure flexibility. The sizing of the solar thermal system components is basically dependent on the demand profile and solar radiation at the location. The unpredictable nature of solar radiation makes the modelling and design of the solar thermal system a challenging task.

## Technologies

The solar collectors are mainly classified based on the type of tracking used in the collector. The collectors with tracking mechanism have higher concentration ratios and hence, higher operating temperatures. The typical example of the non-tracking type collectors is flat plate collector. Parabolic trough is the most common example of single axis tracking collector and Paraboloid dish is the collector with two axis tracking mechanism. Table 1 shows the typical examples of all three types of solar collectors with corresponding operating temperatures.

Table 1: Types of solar collectors (Kalogirou, 2004)

Tracking type	Collector type	Concentration ratio (CR)	Operating temperature (°C)
Non-Tracking	Flat Plate Collector	1	30–80
	Evacuated Tube Collector	1	50–150
	Compound Parabolic Collector	1.5	60–200
Single Axis	CLFR	10–50	60–250
	Parabolic Trough	10–50	60–300
Two Axis	Parabolic Dish Heliostat field	100–500 100–1500	100–500 150–2000

## Applications of SIPH Systems

Various studies have been conducted already on the industrial process heat demand at various temperature levels.

Several industrial sectors have been identified as suitable for the application of solar energy. The major part of the process heat used in the industrial applications is required at a temperature less than 250 °C. Recent study in Europe (ESTIF, 2004) confirms that about 50 per cent of the total industrial energy demand is utilized in the heat form upto 250 °C.

There are numerous industrial processes within this wide operating temperature range from 100 °C to 250 °C, which can be easily integrated with the solar energy. The main application areas for the SIPH systems are the food, dairy, textile, paper, manufacturing, and chemical industries. There are versatile processes in these industries that require processed heat as the major energy input. Table 2 presents the overview of the various industries and processes that are suitable for SIPH systems (ESTIF, 2004; Kalogirou, 2003). Though there is a wide range of the potentially suitable application areas, applicability and feasibility in real practice is dependent on a number of parameters, such as solar system configuration, scale of the system, type of conventional fuel in the existing system, etc. The economics of the SIPH system plays a crucial role for the projects to become viable for actual installation. The sizing of the SIPH systems needs to be done carefully to maximize system performance.

Table 2: Applications of SIPH systems

Industry	Processes	Temperatures (°C)
Food	Drying	60–90
	Washing	40–80
	Boiling	95–105
	Sterilization	110–120
Dairy	Drying	120–180
	Washing	90–110
	Boiling	60–80
	Sterilization	100–120
Textile	Washing	40–80
	Bleaching	60–100
	Drying	100–130
	Dyeing	100–160
Manufacturing	Washing	40–60
	Cleaning	60–80
	Degreasing	80–90
Chemical	Boiling	95–105
	Distilling	110–300
	Synthetic rubber	150–200
	Soaps	150–200

Sources:

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# INDIGENOUSLY DEVELOPED ARUN<sup>®</sup> CONCENTRATING SOLAR TECHNOLOGY

Abhishek Bhatewara

*Installation at TVS Group, Chennai*



Realizing to the fullest the potential of solar concentrator technology in reducing the levels of use of conventional energy sources, a great step has been taken with the installation of a unique technology that harnesses the power of the sun for industrial process heating. With financial support from MNRE and technical support from IIT-Bombay, Clique Solar has developed solar boilers/heaters, which can be used for generating steam, hot water or hot oil with solar energy as a fuel. The patented ARUN<sup>®</sup> solar concentrator technology can be used for various applications, such as mass cooking, process heating in hotels, laundries, industries as well as for comfort cooling applications. Not only is ARUN<sup>®</sup> one of the only two technologies recognized as commercially proven in India by MNRE-UNDP-GEF, it accounts for majority of the solar concentrator installations for industrial process heating in India. ARUN dishes have been installed by reputed companies, such as NTPC, Mahindra, ITC Maurya Hotel, Chitale Dairy, TVS Group, and Akshardham temple, amongst others.

## Overview

ARUN technology is based on the basic principles behind a magnifying glass (or a parabola) and a sunflower. It uses an ingenious, two dimensional, fresnelized mirror arrangement scheme to get the parabola effect. Like a sunflower, ARUN automatically tracks the sun from sunrise to sunset on both the East-West and North-South axes to intercept maximum sunlight throughout the year, irrespective of the installation location. ARUN dish is mounted on a single column, thus, occupying ground area of less than 3m x 3m. The lifespan of an ARUN dish is more than 25 years.

ARUN is India's first IBR-approved solar boiler. Its dual-axis, completely automated tracking based on both, chronological tracking as well as light sensing tracking mechanism, ensures tracking accuracy of more than 99.5 per cent. Optics, receiver, and integration scheme are the three most crucial components in any solar concentrator system. Optics of ARUN is based on the Fresnel concept, allowing simplicity

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in structure, while maintaining maximum accuracy. The moving cavity-shaped receiver is designed to withstand high temperatures and minimize losses. Clique Solar is particularly skilled in integrating ARUN with a variety of industrial processes ensuring very high efficiencies of 60–65 per cent, the highest in the Indian solar industry.

The basic operation philosophy of an ARUN steam generation system is very simple. The receiver at the focus of the dish transfers the heat of solar radiation to a heat transfer medium, such as water. Once the water is converted into steam, and desired pressure and temperature achieved, the steam is delivered to the application area or the common boiler header.

## Applications

ARUN can be operated in various thermic media, including steam, water, hot oil, hot air, etc., and reach temperatures and pressures of up to 300 °C or 20 bars, respectively. Since it can reach high temperatures, storage of solar energy for use during hours is also possible and has been demonstrated successfully. These factors have resulted in the application of ARUN technology in a wide array of processes. This includes industrial applications in sectors, such as food processing, textile processing, pharmaceutical, pulp and paper, chemical, auto component, etc., which have large requirement of thermal energy in their manufacturing plants. Many religious places and schools/colleges across the country provide meals to devotees and students, respectively. A number of them have community cooking facilities, which utilize high-cost fuels, such as LPG. Solar energy can be used to substitute the use of these fuels. Moreover, with ARUN's storage capability, early morning and late night cooking of dinner can be catered to by solar energy.

Further, hotels and hospitals require steam for laundry and cooking, and hot water for washing, bathing, etc. Technologies, such as ARUN can assist conventional methods as it requires little ground area. Another interesting application is the use of solar for cooling purposes. Solar-assisted cooling systems use the thermal energy of solar radiation captured through solar concentrators to power thermally driven cooling machines.

## Key Features

The key features of ARUN technology help tackle some of the challenges as per below that the user industry faces in the adoption of solar technology.

Challenges		How ARUN® technology overcomes the challenges
Space and land profile	Biggest challenge in solar adoption is the large space and flat land requirement.	ARUN is mounted on a single column of 1m diameter. Height of the dish can be increased to allow area below the dish to be utilized for other purposes. It does not need flat land and can be installed in congested areas.

Thermal energy storage	Many industries have 24x7 energy need, while sun is available only for 8–10 hours a day.	ARUN can deliver very high temperatures and pressures. As a result, efficient and practical thermal energy storage solutions are possible and have been demonstrated using ARUN technology.
Temperature delivery accuracy	Industrial processes need accurate temperatures.	The control mechanism of ARUN system is such that it can deliver thermal energy in any form with +/-1°C accuracy.
Performance	Most solar technologies don't deliver as promised.	Clique Solar is the only company in the solar thermal domain that gives written performance guarantees on the performance characteristics of the ARUN system.
Government subsidies	Industries do not want to take responsibility for getting subsidies.	Clique Solar is a channel partner with MNRE and takes complete responsibility for availing subsidy. The clients are charged net of subsidy.

## Economic Benefits

The financial feasibility of investing in any solar technology is driven by three factors—cost of substitute fuel currently in use; availability of solar radiation (depends upon geographical location); and financial incentives by government like capital subsidies and taxation benefits like accelerated depreciation. The tentative payback periods for ARUN technology are indicated in the table below:

Sectors	Tentative payback periods
Cooking (substituting LPG @ Rs. 90/kg)	3 years
Industrial process heating	
Substituting Furnace oil, Diesel, LDO, PNG, etc.	Between 3 to 4 years
Substituting Coal, Biomass, Wood, etc.	Between 5 to 8 years
Cooling	5 to 6 years if retrofitted and 7-9 years if standalone new system



# SOLAR STEAM COOKING AT SHIRDI

## MAKING A DIFFERENCE

Dr M G Takwale



*Solar steam cooking system at the Shirdi Prasadalay*

Steam cooking is known to be one of the cleanest forms to prepare food, especially when food is being prepared for a large number of people. Not only is steam cooking clean, it is more efficient and hygienic, the only drawback being that steam can only be used to cook items, which require boiling or steaming, such as rice, dal, vegetables, idly, etc. Frying, roasting, and chapatti making is not possible with steam. Cooking with steam, therefore, is popular in southern and eastern states of India—states where rice is eaten more frequently. These installations include religious places/ashrams, schools, students' hostels, canteens, etc. In order to generate steam, boilers are run on diesel, furnace oil, or LPG by these institutions. Steam generated from these boilers is then passed through big vessels containing food items, each being cooked in an hour or less for hundreds and thousands of people.

### CSTs for Community Cooking

India receives sunshine for most part of the year. Solar radiation available during the daytime can be harnessed for generation of steam using automatically tracked solar

concentrators. The concentrators focus the sunlight on receivers which convert water into steam flowing through them for use in the kitchen. The system comprising such concentrators is hooked up with existing boilers so as to take care of cloudy days and non-sunshine hours. The system can help in saving 70–80 per cent of the conventional biomass fuel being used for cooking. Over 140 systems covering dish area of about 28,000 sq. m. have been supported by the Ministry so far for various applications, such as various industries, laundry, sterilization, air conditioning, etc., though the major application under consideration is large-scale cooking. Some of the largest solar steam cooking systems installed include those at Mount Abu in Rajasthan catering to 10,000 people a day, at Tirupathi in Andhra Pradesh and Satyabhama University in Chennai, each for 15,000 people every day.

### System at Shirdi

The system installed at the Sri Saibaba Sansthan Trust, Shirdi for 20,000 people per day is one of the most prestigious systems of MNRE for community cooking. Installed at the

*The author is former Vice Chancellor, Shivaji University, Kolhapur.*



Prasadalaya in June 2009, it is the world's largest solar steam system for cooking food for pilgrims visiting the shrine. The Sansthan has been involved in the development and installation of the system from the design stage itself. This has helped the Sansthan avoid pipelines exposure, also giving the entire system an aesthetic appeal. Designed and installed by the M/s Gadhia Solar Energy System (P) Ltd from Valsad in Gujarat, the project was completed within a record short time of ten months.

### System Details

The system comprises 72 automatically tracked solar dishes, each of 16 sq. m. aperture area, placed in series and parallel combination. About 3,000 kg of steam is being generated at the desired pressure and temperature from this system every day, sufficient to cook 1,200–1,400 kg of rice for 20,000 people per day. Complete with an ingenious design, the system can generate enough amount of steam to cook food for the required number of people even if the electricity is not available to run the feed water pump for circulating water in the system. It has a steam header connected with a large number of receivers where water can be stored in the morning when electricity is available. During daytime, the system runs on the thermo-syphon principle, which eliminates the need for electricity. This helps in generating steam and storing it in the header till the time it is used for cooking in the kitchen.

The steam generation from the system starts every day by 10 am and continues up to 4 pm. The steam remaining in the header is then used for heating 10,000 litres of water. This water is used for cleaning utensils, etc. Specially designed vessels (double jacketed) have been installed in the kitchen, wherein heat from the steam is transferred to the food being cooked. Presently, dal and rice are cooked in the kitchen using solar steam. This system is integrated with conventional boiler being run on LPG to take care of cloudy as well as non-sunshine hours. With a cost of Rs 133 lakhs, subsidized by



the MNRE to the tune of Rs 58.40 lakhs, the system is being currently maintained by the contractor for a period of five years after the completion of which it will be handed over to the temple trust. Maharashtra Energy Development Agency (MEDA), the state nodal agency for Maharashtra is involved in monitoring and evaluating the performance of the system. Owing to the successful installation and operation of the solar steam system, the annual fuel saving, particularly of LPG, is expected to be around 100,000 kg.

### Benefits

In an earlier attempt, a smaller system for 3,000 people, with 40 dishes each of 10 sq. m. area was installed at the old prasadalaya in 2001, which served the Sansthan in a satisfactory manner. The present system is based on the results and learning drawn from the earlier system, with an expanded dish size of 16 sq.m. This has reduced the covered area for installation of the system as well as operational and maintenance requirements. According to the CEO Mr Kishor More, besides environmental benefits the solar kitchen proved cheaper in the long run and offered the advantage of uninterrupted cooking. Since the installation of the steam system, devotees have enjoyed the food being served, said Sushma Singh, a devotee from Delhi, "Between 10,000–20,000 people consume the *Prasad* every day and food is distributed from morning till night."



\*Source: "Shirdi's Sai Baba temple goes green with solar steam cooking system", Yahoo News, 20 October 2010.



# WORKSHOPS AND BUSINESS MEETS HELD UNDER UNDP—GEF PROJECT

**7 March 2013, Pune**

## **INSTITUTIONS AND RELIGIOUS SECTOR**

About 66 organizations participated in the workshop with a total participation trend of 138. The workshop resulted in generating about ten enquiries for CST projects. Six technology providers made presentations and explained the technical features of their products.



**14 March 2013, Delhi**

## **HOSPITALS AND HOSPITALITY SECTOR**

The workshop for hospitals and hospitality industry was attended by 52 participants. About 24 institutions showed interest in CST systems. Three manufacturers made presentations while two films showing use of CST for laundry and cooking applications were played. A field visit to installation at ITC Maurya was also organized.

**23 March 2013, Dehradun**

## **INSTITUTIONS AND RELIGIOUS SECTOR**

Besides detailed presentations by MNRE experts and consultants, the workshop included a field visit to Shakti Kunj, Haridwar, where the management demonstrated the system with ten Schefflers of 16 sq. m. each mounted on rooftop, with a direct steam generating system. Food cooked with the help of the system was served to the participants.



**9 April 2013, Mysore**

## **INDUSTRIAL SECTOR**

The workshop covered presentations on various technologies, such as Arun dish, 16 sq. m. area parabolic dish and 9 sq. m. area parabolic trough technology from Airier Natura, various technologies being developed by Thermax Pvt. Ltd, besides presentations by MNRE—UNDP team. The workshop was attended by around 100 participants.



**4 May 2013, Bhilwara**

## INDUSTRIAL SECTOR

The workshop focussed on CST applications for industries in Bhilwara industrial area, which mainly consist of textile, cement, vegetable oil, and so on. The response from industries was good with participation from around 40 industries. The workshop covered technical presentations from manufacturers and suppliers of CST technologies. Industries showed keen interest in understanding technical solutions for integration of CST with existing systems.

**20 May 2013, Guntur**

## INDUSTRIAL SECTOR

Guntur has three major industries, namely, tobacco, textile, and cold storages apart from dal, soap, and other industries. All the three associations took keen interest in organizing the workshop. About 100 people participated. The participants discussed various issues, including technical feasibility, ESCO scheme, and implementation issues.



**10 May 2013, Bangalore**

## HOSPITALS AND HOSPITALITY SECTOR

The workshop focussed on hotel and hospitality sector and was attended by 29 participants. Close to 15 institutions showed interest in installing CST systems at their establishments. The presentations covered video film on solar cooking and technology presentations by two manufacturers besides presentations by MNRE-UNDP team.

**16 April 2013, Thane**

## HOSPITALS AND HOSPITALITY SECTOR

Highlights included informative presentations by stakeholders and beneficiaries, which focussed on the potential for cost saving. A site visit was organized at the Shri Chhatrapati Shivaji Maharaj Hospital, Thane, to observe the CST system for cooling, laundry, sterilization and chilled drinking water applications.



## FORTHCOMING EVENTS

### Intersolar Europe 2013

Munich, Germany, 17–20 June 2013  
[www.intersolar.de](http://www.intersolar.de)

### Intersolar USA 2013

San Francisco, USA, 8–11 July 2013  
[www.intersolar.us](http://www.intersolar.us)

### Solarcon India 2013

Bangalore, India, 1–3 August 2013  
[www.solarconindia.org/](http://www.solarconindia.org/)

### CSP TODAY SEVILLA 2013-7th International Concentrated Solar Thermal Power Summit

Seville, Spain, November 2013  
[www.csptoday.com](http://www.csptoday.com)

### International Conference on Solar Heating and Cooling for Buildings and Industry

Freiburg, Germany, 23–25 September 2013  
[www.shc2013.org](http://www.shc2013.org)

### CSP Today USA 2013

Mandalay Bay, Las Vegas, Nevada, 26–27 June  
[www.csptoday.com/usa/](http://www.csptoday.com/usa/)



## About MNRE

The Ministry of New and Renewable Energy (MNRE), is the nodal ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country. Its mission is to ensure energy security, increase in the share of clean power, energy availability and access, energy affordability, and energy equity. The long-term vision of the Ministry is to develop new and renewable energy technologies, processes, materials, components, sub-systems, products, and services at par with international specifications, standards, and performance parameters, in order to make the country a net foreign exchange earner in the sector and deploy such indigenously developed and/or manufactured products and services in furtherance of the national goal of energy security. Its major function is to facilitate research, design, development, manufacture, and deployment of new and renewable energy systems/devices for transportation, portable, and stationary applications in rural, urban, industrial, and commercial sectors



Empowered lives.  
Resilient nations.

## About UNDP

UNDP partners with people at all levels of society to help build nations that can withstand crisis, and drive and sustain the kind of growth that improves the quality of life for everyone. On the ground in 177 countries and territories, global perspective and local insight is offered to help empower lives and build resilient nations. UNDP's network links and coordinates global and national efforts to reach the Millennium Development Goals. This focus of UNDP is helping countries build and share solutions to the challenges of: Poverty Reduction and Achievement of the MDGs, Democratic Governance, Crisis Prevention and Recovery, Environment and Energy for Sustainable Development. UNDP also helps developing countries to attract and use aid effectively. The protection of human rights, capacity development, and the empowerment of women are encouraged at all levels by UNDP.



## About GEF

The Global Environment Facility (GEF) unites 182 countries in partnership with international institutions, non-governmental organizations (NGOs), and the private sector to address global environmental issues while supporting national sustainable development initiatives. An independently operating financial organization, the GEF provides grants for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. Since 1991, GEF has achieved a strong track record providing US\$9.2 billion in grants and leveraging US\$40 billion in co-financing for over 2,700 projects in over 168 countries.



## About TERI

A dynamic and flexible organization with a global vision and a local focus, TERI was established in 1974, with the initial focus on documentation and information dissemination. Research activities, initiated towards the end of 1982, were rooted in TERI's firm conviction that efficient utilization of energy and sustainable use of natural resources would propel the process of development. All activities in TERI, the largest developing country institution working towards sustainability, move from formulating local and national-level strategies to shaping global solutions to critical issues.



Empowered lives.  
Resilient nations.

## UNDP–GEF Project on Concentrated Solar Heat Ministry of New and Renewable Energy

**Inviting proposals from industries, institutions, and commercial establishments  
for installation of Concentrated Solar Technology (CST) based systems for  
process heat, community cooking, and space cooling applications**



### Salient Features of CSTs

- Can provide steam/hot oil/pressurized water at desired temperatures for various applications in industries, hotels, hospitals, religious places, institutions, etc.
- 100 sq. m. concentrator area can save 5,000 to 10,000 litres of fuel oil per year depending on type of technology used
- A number of technologies suitable for various applications are available
- Around 140 systems of various capacities installed in country so far

30% support from Ministry and 10% from UNDP–GEF project available for developing Demonstration Projects at users places.  
80% accelerated depreciation benefit also available to profit-making bodies.

For details please visit home page of Ministry's website [www.mnre.gov.in](http://www.mnre.gov.in) and click at 'Revised document on Inviting Expression of Interest... the Ministry' in 'What is New' or Contact Project Management Unit, Concentrated Solar Heat Project, Ministry of new and Renewable Energy, Block 14, CGO Complex, Lodi Road, New Delhi–110003.  
Telefax: 011–32314365/24363638, Email: [singhalak@nic.in](mailto:singhalak@nic.in) and [pankaj.kumar74@nic.in](mailto:pankaj.kumar74@nic.in)

**Proposal format, list of consultants and manufacturers/suppliers of CSTs available in EOI document**

**Toll Free Helpline No. 1800 2 33 44 77 could also be accessed during Monday to Friday  
Between 9.30 am to 6.30 pm and on Saturday: 9.30 am to 1.30 pm**