a quarterly magazine on **concentrated solar heat**

SUN FOCUS

Volume 3
Issue 2
Oct–Dec 2015

INTERNATIONAL DEVELOPMENTS ON CSTs FOR PROCESS HEAT

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October–December 2015
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Cover image: PolyTrough installation at Emmi Group, Switzerland.

Inside...

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From the editor's desk...

Dear Readers,

I am pleased to share the tenth issue of ***SUN FOCUS*** magazine with you all. Previous nine issues of the magazine were planned so as to cover various aspects of concentrated solar thermal sector in India, such as policy, technology developments, and new applications. These issues have been found to be very useful towards generating awareness about the industry.

The current issue focusses on international developments regarding concentrated solar thermal technology. The issue aims to introduce readers to various technologies and their implementations in various industries.

The special feature article of this issue, gives the overview of CST potential and status in the state of Himachal Pradesh. The article outlines the CST potential in the state while outlining its present status on installations. There is also an article briefing about the long term performance of the oldest CST system installed at Mount Abu, Rajasthan. The system is operational since 1997 and is well maintained till date. There is also an article about low cost CST technology developed by TinyTech, Rajkot.

There are three articles in the issue which present the latest international developments in CST. The first article is about PolyTroughTM parabolic trough technology developed by NEP Solar, Switzerland. The second article is by Solera GmbH, Austria, about the SmirroTM parabolic trough technology and its application in the meat processing industry. Lastly, there is an interesting article by CSP-F solar, Italy about development of the Linear Fresnel Reflector technology and its installation for cheese production in Italy.

In addition to above, for the first time in the country, and international workshop on CSTs for medium and high temperature application was held at Mumbai as part of InterSolar Conference and Exhibition, 2015. A brief report on the workshop is included in the issue.

I hope you will find this issue interesting and informative as usual. I also look forward to your valuable comments, suggestions and most importantly 'contributions' for upcoming issues of the magazine.

Sd/-

Tarun Kapoor

Joint Secretary, Ministry of New and Renewable Energy &
National Project Director, UNDP–GEF CSH Project

CST STATUS AND POTENTIAL IN HIMACHAL PRADESH

Sarita Brara[1] and Bhanu Pratap Singh[2]

CST technology is still new to the hill state of Himachal Pradesh, though the state has an immense potential to make use of it in various applications with DNI levels in the range of 4.5–5.5 kWh/m^2/day. A beginning for CST technology was made only about five years back in Himachal Pradesh and after a lot of efforts by central ministry and state nodal agency, there are at present four operational CST installations. After these successful demonstrations, efforts to create awareness about CST and promote the technology have picked up pace again and there is a lot of excitement amongst various beneficiary sectors, such as industry, community cooking, hotels, and hospitals.

Exploring and Tapping CST Potential

Himachal Pradesh's economy has historically been dependent on agriculture and tourism and hence, there is large presence of food-processing and hotel industries. These sectors provide very good opportunity for the CST sector. The industrial presence in the state is also on the rise gradually after the state government has identified thrust areas for infrastructure development. The following table gives an idea about the presence of industries of various types in the state. It may be seen that CST technology has a good potential in the pharma, textile, and food processing industry sectors.

Sl. No.	Industry Type	No. of Units
1	Pharma	176
2	Textile	98
3	Food processing	85
4	Chemical	34

Along with the food processing industry, there is also a high requirement of cold storage facilities as the state is famous for fruit and vegetable production which are perishable commodities. There are ~13 cold storages operational in the state and the number is expected to increase further. These cold storage facilities present a good opportunity for CST.

There are also numerous opportunities for solar cooking in the state with educational institutes, residential schools and mid-day meal kitchens as well as jails. The following table shows the general potential for solar cooking in the state. It may be seen that there are a significant number of universities, residential schools, and jails which may be suitable for installation of large solar cooking systems. Along with this, there is a kitchen in each school under mid-day-meal scheme. These kitchens typically serve one meal for ~20–300 students each day. Utilization of small solar cooking systems (~1–30 m^2) may be explored for this opportunity.

Sl. No.	Type	Number
1	Universities with hostel facilities	20
2	Jawahar Navodaya residential schools	12
3	Kitchens for mid-day meal scheme	~13,300
4	District jails	12

Government Initiatives for CST

For creating awareness and promoting CST technology in the state, HIMURJA has been organizing workshops for the beneficiaries and other stakeholders. The first two workshops were organized in Shimla and Dharamshala, respectively, which generated a lot of interest and three project proposals; two of them were for solar cooking application in Kanda and Kaithu jails and one is regarding cooking in Shoolini University.

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[2] *Bhanu Pratap Singh, Chief Executive Officer, Himurja, Himachal Pradesh Development Agency*

The third workshop in November 2015 was held in Kullu. This workshop focussed on the hotel industry and space heating application. Efforts are being taken to invite delegates from higher-level decision making positions. The fourth workshop is planned for the stakeholders from industrial sector and is scheduled to be held in January 2016 in Baddi (industrial area).

HIMUJRA is actively pursuing these solar cooking opportunities in the state. It is also interested in space heating application for CST and has identified 40 government buildings for detailed feasibility assessment.

Himachal Pradesh has also been included in the recent MNRE project for 'Preparation of preliminary reports on possible installation of CST-based projects in selected states of country'. A survey team is going to visit thirty potential sites for preliminary assessment and data collection for feasibility of CST installation. Various types of beneficiaries are planned to be covered, such as industries, educational institutes, private universities, and some government establishments.

Current Status of CST Projects

This section presents the status of all four operational CST projects in the state of Himachal Pradesh.

NIT, Hamirpur for Community Cooking

The first CST project for cooking purposes was installed in 2011 at National Institute of Information Technology (NIT) in Hamirpur, a solar city in the state. A solar steam cooking system was installed at the Neelkhanth Boys Hostel of NIT for cooking food for 500 students. The project was supported by the Ministry of New and Renewable Energy. This was the first major initiative taken by NIT-Hamirpur on community solar cooking in Himachal Pradesh.

According to the project coordinator Professor S S Chandel, Centre for Energy and Environmental Engineering (CEEE) at NIT Hamirpur, the institute is able to save 1.5 to 2 LPG gas commercial cylinders per day which translates into a saving of about ₹40,000–50,000 per month. Dr Chandel conveyed that solar steam cooking system was preferred because of its commercial viability as well as its nature as a pollution free, eco-friendly source of energy. Being satisfied with the performance of this system, NIT-Hamirpur is now planning to install such systems in all the hostels in a phased manner.

Parabolic concentrators installed at NIT Hamirpur in 2011 for steam cooking

Shoolini University for Community Cooking

Shoolini University is situated in Bajhol near Solan, a place which receives abundant solar radiation throughout the year. The place receives direct normal radiation of 5.4 kWh/m^2 per day in summer and 4.8 kWh/m^2 per day in winter with ~3,700 annual sunshine hours.

The CST based cooking system at this place was installed in 2012 and is operational since then. Six Scheffler type dishes, each with 16 m^2 aperture area have been installed. The solar field is tracked using central tracking system. The solar system is integrated with existing diesel-fired boiler which now serves as a backup system. The solar steam generation system produces 200 kg of steam daily, for cooking lunch as well as dinner for the girl's hostel, which houses ~1,000 girls. The complete system is manufactured by TSS and all the components have been indigenously procured.

According to Dr Rajesh Kumar, Associate Professor, School of Mechanical & Civil Engineering; Assistant Director (E & D), the

Steam cooking vessels at Shoolini University

installation has helped them reduce consumption of LPG cylinders by half. The institute is able to save one commercial LPG cylinder on a daily basis which is equivalent to a saving of ~₹2,000 a day. The total cost of the project was around ₹5,950,000/- and almost 70 per cent was subsidized by the Ministry of New and Renewable Energy.

With successful installation of the first project, the institute is now planning an installation of CST-based cooking system for boy's hostel as well.

Badu Sahib for Community Cooking

This CST installation is done at Kaligdhar Trust located at Badu Sahib in Sirmour district of the state, about 110 km from the capital, Shimla. The Trust has Eternal University and some other educational and professional institutes in the complex. Since it has a huge campus, the central kitchen is used to cook for a total of 5,500 people including students and staff. The cooking was previously done by thermic oil based cooking system with the diesel fired boiler. The solar system is planned to be integrated with the same system and thermic oil will be heated directly in the solar field. The solar field consists of 28 Scheffler dishes of 32 m^2 aperture area each.

The installation is in the final stage and the commissioning is expected to start in November. According to M P Singh, who is heading the solar department at Badu Sahib, 50 LPG Cylinders were used earlier for cooking the food and by shifting from LPG to thermic oil-based solar assisted cooking system would lead to an annual savings of ₹2.3 crore.

Existing arrangement for cooking at Badu Sahib

Abbot Healthcare, Baddi for Process Heat

The manufacturing processes in pharmaceutical companies are energy intensive and require a lot of thermal energy. Therefore CST technologies can be used to deliver this thermal energy, which is mostly required in the form of steam, hot water, or hot air. Currently there is one CST installation in pharmaceutical industry in the state, which can be used as a successful demonstration site for further promotion of CST technology in the sector. The Abbott Health Care Private Ltd, located in Baddi (Himachal's industrial area) has installed CST technology for water heating application. A total of six dishes of aperture area of

Multiple system installation on rooftop of a pharma company for HVAC application in Baddi Himachal Pradesh

31 m^2 each have been installed by Forbes Solar. In terms of energy, this means a savings of ~520–550 kWh of electricity per day which is equivalent to a saving of ₹3,000 per day. The project (including subsidy) costs about 50 lakh rupees with the simple payback period of ~5–6 years.

Conclusion

Although 170 CST systems have been already installed in the country and thirty more are coming up, as far as Himachal Pradesh is concerned, it is still a new technology for the stakeholders (beneficiaries) in the state Systematic and sustained efforts for awareness generation about the technology would be required to reap the benefits of the technology in the state. According to Himurja CEO Bhanu Pratap Singh, the generation of proposals for CST applications are likely to pick up pace in a year's time and efforts are being accelerated to educate stakeholders to make use of this technology, in a state that has an enormous potential of making use of the CST technology.

FINANCING CSTs IN INDUSTRIAL, INSTITUTIONAL, AND COMMERCIAL ESTABLISHMENTS—TRAINING PROGRAMME FOR BANKS/FIs AT AHMEDABAD, SEPTEMBER 15, 2015

The objective of the workshop was to sensitize bankers about the concentrated solar technologies, their potential and market in India and indulge them in a discussion to devise a lending mechanism that can enable swift and large scale development and implementation of these technologies. To do this, it was planned to invite around 30 participants from 10–12 banks/FIs at Ahmedabad workshop.

The outcome of the workshop was very positive with total attendance of more than 40 participants representing 17 banks, participants from technology providers, and organizing agencies—MNRE, PwC, and BVT.

Ahmedabad workshop was the fourth workshop of the four workshops planned under the assignment on 'Banker's Training on Financing of CST' awarded to PwC. The workshop was organized in association with the Bharathiya Vikas Trust (BVT).

The event was well supported by the industry considering the high solar irradiance in the region. Inputs received from earlier workshops in Bengaluru, Chennai, and Pune were also discussed in this workshop along with a prototype lending product developed by PwC under guidance of MNRE for facilitating lending to CST through banks.

LOW COST SOLAR BASKETS DEVELOPED BY TINYTECH, RAJKOT, GUJARAT

V K Desai[1]

Solar basket is a parabola-shaped solar concentrator which is designed with a focus on small-scale rural applications and can very well be used in large numbers for small-scale applications, such as mass cooking, industrial process heat, and rural applications in farms and villages. Small-scale solar concentrators, such as solar baskets are aptly suitable for various rural and peri-urban industries, such as cotton ginning, cotton spinning, rice milling, oil milling and thus have a huge scope, especially in developing countries like India. The experimental work is currently ongoing for four sizes as follows:

- 4 m dia, 12.5 sq. m aperture area and 21.3 sq. m reflector area.
- 6 m dia, 28 sq. m aperture area and 48 sq. m reflector area.
- 8 m dia, 50 sq. m aperture area and 85 sq. m reflector area.
- 12 m dia , 113 sq. m aperture area and 191 sq. m reflector area.

Design

Solar basket is designed as a two-axis tracking concentrator which will be moving with the sun on horizontal axis and also on vertical axis around the focal point. Heat receiver, fixed with the ground, is fitted on the focal point and not connected with the basket. While the solar basket tracks the sun, the focus remains fixed on the heat receiver for the whole day. Currently, prototypes of these baskets have been designed and developed for 4 m dia, 6 m dia basket, and 8 m dia models. These models are also already erected on the foundation. Heat receiver, i.e., focal boiler of 4 concentric coils of 1" dia pipe has also been fitted. The square pipes of 50 mm x 50 mm x 1.5 mm metal thickness are used for the construction of the paraboloid up to 8 m dia. For 12 m dia, square pipes of 50 mm x 50 mm x 3 mm are used.

6 m dia Solar basket developed by TINYTECH

TINYTECH plants is headed by Mr V R Desai, who has worked for a long time in the field of decentralized, small-scale technologies and appropriate technology. The innovation of solar baskets has stemmed from the same philosophy and therefore, the design and construction has been kept very simple such that even skilled rural welders and technicians can grasp the technology and copy it very easily once they have seen it. Mr V K Desai is also very optimistic that after some time, design could be modified to manufacture solar baskets from wood, bamboos, ropes, and other cheap materials. The main focus of solar baskets is simple technology and low cost. The cost of solar baskets is estimated to be about ₹5,000 per sq. m.

Solar basket being fabricated by skilled rural technician

The experiments for performance data collection are yet to be conducted, but it is currently estimated that the basket will have about 40 per cent overall efficiency. Therefore, at DNI of 800 W/m^2, every sq. m of reflector area is expected to produce an average of 300–320 W heat. Sun tracking on vertical axis and on horizontal axis is currently manual. Meanwhile, development of 12 m dia model of solar basket has also been started.

Possible Applications

With the major focus being on low cost and simple manufacturing, the target industry for this technology could be various agro-processing industries and allied–agro industries which are typically operational in remote and rural areas. Based on the actual performance of the basket, it can be used in the applications of small and medium-scale enterprises in rural and peri-urban areas.

FIELD SURVEY ON POSSIBLE INSTALLATION OF CSTS IN SELECTED STATES

The Project Management Unit of UNDP–GEF CSH Project of MNRE has hired two consulting organizations (MPEn Systems, Mumbai and TERI, Delhi) for doing the field survey on possible installation of CSTs in 20 selected states of the country. The consultants will visit a large number of establishments both in institutional and industrial sector and identify 800 units in these states having potential for installation of CST-based systems. The states have been put in two categories, with minimum 50 establishments covered in bigger states and 30 in smaller states. State-wise reports, one on solar cooking and other on process Heat and Cooling applications will be ready by end of December 2015. The reports will be made available to State Nodal Agencies and also be uploaded on websites for the purpose of generating proposals by the manufacturers. The assignment is expected to generate around 100 ready-to-sanction proposals in 2016.

Category 1 states (50 each)	Category 2 states (30 each)
Punjab, Bihar, Uttar Pradesh, Gujarat, Rajasthan	Himachal Pradesh, Haryana, Uttarakhand, Jharkhand, Jammu and Kashmir
Madhya Pradesh, Maharashtra, Telangana, Karnataka, Andhra Pradesh	Odisha, Kerala, Goa, Puducherry, Chhattisgarh

[1] *Mr V K Desai, Adhunik, Global Energy, TinyTech Plants, Tagore Road, Rajkot; Email: energy@tinytechindia.com*

POLYTROUGH CST TECHNOLOGY FOR INDUSTRIAL PROCESS HEAT IN SWITZERLAND

Dr R P Goswami[1]

PolyTrough concentrated solar thermal technology is parabolic trough type collector developed by NEP Solar, based in Switzerland. NEP Solar manufactures PolyTrough solar collectors and also advises on the system design and applications of renewable energy projects. It currently has offices in Australia and Europe serving the Asia Pacific, European, and Middle Eastern markets. The company also has plans to expand its presence globally as and when market opportunities arise.

NEP solar has identified three types of thermal applications namely; industrial process heat, solar cooling and multi-generation systems for PolyTrough technology which can deliver heat up to a temperature of 220°C.

Integration Scheme

Typical integration scheme for industrial process heat applications is presented in Figure 1. Pressurized water or thermal oil is pumped through the solar field and is heated by the concentrated solar radiation to the required temperature. A buffer thermal storage is included in the system to absorb short term and sudden fluctuations of the solar radiation.

PolyTrough Solar Concentrator installed at Emmi Group, Switzerland

[1] *Dr R P Goswami, Director, Concentrating Solar Technologies, MNRE, Government of India; Email: rp.goswami@nic.in*

Application in Dairy Industry

A 630 m² PolyTrough-1800 collector field has been installed at Emmi Group, the largest Swiss milk processor. The system is used for hot water generation at 130°C for process heating and cleaning at the Tête de Moines Cheese factory at Saignelégier, Switzerland. The system was commissioned in November 2011. The system has been fully operational since then. The technical specifications of the installation are as follows (Table 1):

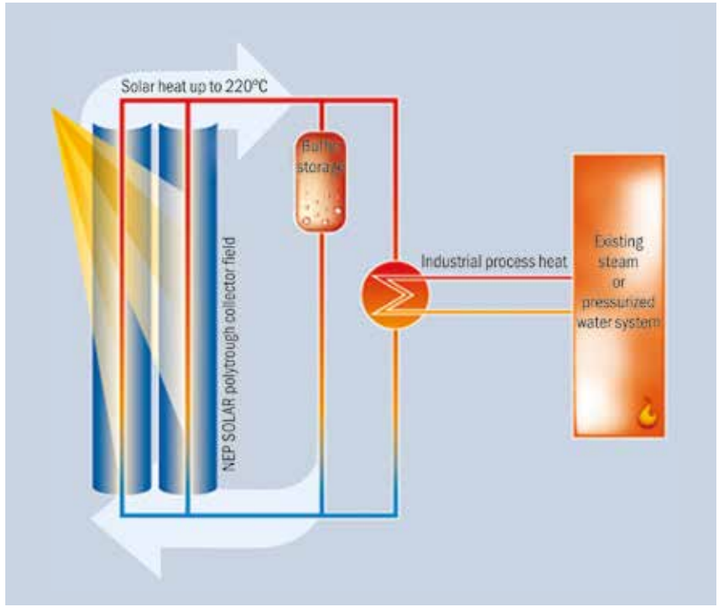

Figure 1: Typical integration scheme for PolyTrough CST technology

Source: http://www.nep-solar.com/applications/process-heat/

Table 1: Technical specifications of installation

Aperture area of solar field	627 m²
Collector dimensions	21 x 1.85 m
Design thermal power	360 kWth
Solar field outlet temperature	120°C
Annual fuel savings (Furnace Oil)	30,000 litre

The tracking system for the collector field includes brushless DC motors, GPS based guidance system and an in-built software for tracking the sun throughout the day. Reflectors are made out of Aluminium reflectors (Alnode make) and are fabricated with foam and backsheet. The average optical efficiency for the collector field is around 65 per cent. Since the weather is clean and it often rains, the cleaning frequency is only once a year. System is three year old and is in excellent condition. Only flexible tube connections often need replacement due to wear and tear and the rest of system can be considered as maintenance-free. The CST system uses water glycol mixture as a heat transfer medium and steam is produced indirectly through the heat exchanger. The overall system design and thermal storage is optimized for winter condition, and therefore storage size is limited to 1–2 hr storage only. The system therefore produces excess heat during peak summer days. The annual solar fraction for the system is around 15 per cent. The average annual thermal efficiency is found to be ~36 per cent during these three years of operation. The system can also be used for air-conditioning and power generation using ORC (Organic Ranking Cycle) turbine technology.

Note: *United Nations Industrial Development Organization (UNIDO) recently organized a seven-day study tour from August 23–29, 2015 to experience off-grid thermal applications especially—concentrating solar technologies (CSTs) across various industries in Austria, Switzerland, and Germany. The tour was carefully designed with the mandate to learn and recognize the points of intervention and innovation from both the consumer and manufacturer side. The tour included visit to three installations of Concentrated Solar Thermal technology for industrial applications. One of the visits was to above installation on PolyTrough technology at the Tête de Moines Cheese factory at Saignelégier, Switzerland.*

CONCENTRATING SOLAR SYSTEM FOR MEAT PROCESSING INDUSTRY IN AUSTRIA

Klemens Jakob[1]

Solera is a medium-sized renewable energy company in the south of Germany, which receives good sunshine. Electricity and heat from renewable energy sources is the core business of the company with solar photovoltaics and alternative heating system as key focus areas. In case of heating systems, the company has a well-established business of flat plate water heaters for hot water systems. In addition to the normal flat plate thermal collectors, the company Solera has its own, small parabolic trough concentrators for higher temperature applications. The high temperatures which can be generated with these concentrators, using various heat mediums such as steam, hot water, and thermic oil, are perfect for applications like industrial processes heat and solar cooling.

Solera's CST Technology

Solera's parabolic trough concentrator is called as 'SmirroTM', which is developed with the focus on modular design and ease of installation. The main advantage of the collector is its simple and robust design. The well-known aerofoil design of aircraft construction was the inspiration behind the development of the smirro collector. The length of the single concentrator is 3 m, with 1.2 m width resulting in the weight of <40 kg. The concentrator is also designed in such a way that it can be installed by only two persons that too without requiring any special machines or tools.

These unique features make 'SmirroTM' concentrator very much suitable for rapid installations as add-on systems in industrial applications. This technology combines an extremely high rigidity of the support with a high precision of the mirrored surface. The concentrator works in the temperature range of 90–250°C with suitability to all three heating mediums, namely: steam, pressurized hot water, and thermic oil.

Initial research and development for concentrator was carried out at an in-house manufacturing facility. Solera has now built a small test field of 25 parabolic troughs at its new corporate premises in the South of Stuttgart. The test field is being used for continuous technology upgradation and development work.

Five collectors are moved by a motor which is controlled by a sun sensor for the purpose of accurately tracking the sun. In addition to the long-term test of the different materials, the test field is used to test different absorber tubes and components.

SmirroTM solar concentrator

Applications

Solera has installed about 300 m^2 of collector area until now, mainly in food and textile industries. The concentrators have been mostly installed as an add-on system with existing fossil fuel-based heating applications. The heat generated by solar thermal system reduces the fossil fuel consumption and thereby fossil fuel bills for the user industries. Similar to the textile industry, steam is required in many industrial processes and so far, this heat is generally generated by fossil fuels such as gas or furnace oil or diesel. Concentrating solar technology can not completely replace these fuels, but in sunny regions they can augment existing process to reduce the fossil fuel consumption.

Food processing industry is one such example which requires large amounts of process heat. Unfortunately, the use of solar thermal technology in industrial processes is still quite unknown in Europe and hence there are very few installations of concentrated solar thermal systems in Europe. The early installations like SmirroTM are very important in this regard as these installations can be used as demonstrations of successful use of concentrated solar thermal technologies in industrial applications.

System for Meat Processing in Austria

Through the funding of the European Union (Seventh Programme for research technological development and demonstration under grant agreement No.: ENER/FP7/296009/InSun), Solera got the opportunity to build a small parabolic trough plant in Austria.

The ham factory, Fleischwaren Berger GesmbH & CO KG is located near Vienna. The factory requires hot water (at 70°C) and steam (at 4 bar, 140°C) for the ham production process. Until 2013, the heat was generated exclusively by oil fired boilers. Since 2013, the hot water generation part of this process is supported by a large solar thermal system with flat panels. Due to the good experience of this solar thermal system, the company decided to further expand solar thermal heat generation for steam generation. It was estimated that 36 parabolic trough collectors would be sufficient for the requirement.

The installation of SmirroTM parabolic trough collectors was started by Solera in July 2015. The first challenge was the rough terrain. One collector-line with ten collectors in series is 33 m long. These 10 collectors must be on the same level so that they can be tracked together by one motor. The installation of parabolic trough collectors is now complete with the piping and control systems also in place. The performance trials and commissioning work is currently in progress. By the end of October, the parabolic trough solar thermal system is expected to be ready for heat generation for ham production process.

The use of parabolic trough collector not only increases the energy efficiency competitiveness of the process but also improves its ecological footprint with the significant reduction of CO_2 emissions. The use of solar thermal system will also make the company more immune from the price fluctuations of the fossil fuels.

The installation of parabolic troughs in the company, Berger, is an important model for those industries with process heat applications. This installation shows to the entire food processing industry as well as other industries in Austria, a country which has moderate availability of solar radiation, that there is enough energy from the sun to support the energy consumption in the country.

SmirroTM collector field in operation

[1] *Klemens Jakob, Chief Executive Officer, Solera GmbH, Germany; Email: k.jakob@solera.de*

LINEAR FRESNEL REFLECTORS IN USE FOR CHEESE PRODUCTION IN ITALY

Lia Maranto[1]

CSP-F is an Italian company belonging to the Fabbrica Energie Rinnovabili Alternative Group, which has been setting up plants for the production and sale of renewable energy since 2001. CSP-F developed its own solar concentrator technology in 2010 and then operated a pilot plant for process heat application between 2010 and 2014. The performance was closely monitored during this period and based on this successful experience, CSP-F started delivering turnkey solutions for Concentrated Solar Thermal (CST) systems. The long testing period was aimed at building a supply chain entirely based in Italy, with a focus on cost reduction and livelihood generation for the local people. As per the policy, the company does not manufacture any components directly, but entrusts subcontractors with it, preferably near the installation site. In a CST system developed by CSP-F, only receiver tube is an item which is bought directly from the market in bulk quantities.

LUCEth Solar Concentrator System with LFR Technology

CSP-F Technology

LUCEth or LUCEFP are CSP-F's solar concentrators which use Fresnel flat mirrors in order to concentrate solar irradiation towards the receiver and thereby producing heat up to 250°C. CSP-F Fresnel technology has been extensively proven in several applications, ranging from process heat production, biomass-solar hybrid system to standalone power plants.

The Fresnel technology uses flat mirrors arranged in a matrix of rows and columns (module) to concentrate solar irradiation onto a receiver tube capable of working with any of the three major heat transfer mediums namely, steam, pressurized water or thermic oil. The generated heat can be used for either power generation application (LUCEFP) or for thermal application, such as industrial process heat (LUCEth). The LUCEth solar concentrator system is a Compact Linear Fresnel type concentrator (C-LFR).

It is designed to meet the energy requirements of the industrial sector. When combined with other industrial equipment, it provides process steam, refrigeration, solar cooling as well as heat for water treatment.

It can generate thermal energy with temperature up to 250°C. Through its intelligent management and control system and proper thermal energy storage, LUCEth can balance the energy demand throughout the day.

It has a modular, simple, and light weight design that makes it compatible with floor or roof installation. With its different product configurations (TH84; TH106; TH126), LUCEth also offers a wide range of customized solutions suitable for variety of industry types.

Typically 1,000 m^2 aperture area of LUCEth system corresponds to savings equivalent to 70,000 m^3 of gas and 55,000 litre of diesel.

Key Features for Technology

- Lightweight and unbreakable mirrors
- Flexibility to use any high-temperature fluid (steam, molten salt, oil)
- Modular design suitable for easy assembly procedure and rapid components production
- Localized procurement and manufacturing of almost the whole solar field materials (flat mirrors, steel, metal sheet, etc.)

LUCEth CST system at Nuovo Sarda Dairy

Case Study: Processing of Cheese

Italian cheese, especially when produced in small and medium dairies in certain areas, is quite well-known all over the world and Sardinia is without a doubt one of these famous regions for cheese production. The cheese has an even higher quality when its production process addresses environmental concerns, for instance, by using a large share of renewables in industrial energy supply.

In the small town of San Nicolò d'Arcidano, in the Oristano Province, the family-owned Nuova Sarda Industria Casearia dairy has been producing organic cheese since 1936. As stated on the company´s website, Nuova Sarda—'believing in a better future'—has invested in renewables by installing a photovoltaic plant in 2010, 'trusting in the further development of renewable energy'.

The 'further development' is the part where solar thermal comes in. After four months of planning, design, and installation, a concentrating solar thermal plant was brought into operation at the end of May 2015, with the goal of providing eco-steam for the heat requirements of the dairy's production processes. Nuova Sarda decided on Fresnel technology from the Italian company CSP-F for its solar thermal installation.

Technical description of the installation at Nuova Sarda Dairy:

Solar Field

The LUCEth solar field consists of 34 mirror modules with gross aperture area of 995 m^2 with a non-evacuated receiver. The design thermal power rating of the system is 470 kWth.

[1] *Lia Maranto, Manager (External Relations), CSP-F Solar, Italy; Email: relazioni_esterne@ferasrl.it*

The CST system generates steam directly at 12 bar pressure and 200°C as per requirement of the cheese production process. The steam from CST system is fed directly into the boiler header at 12 bar pressure. The average annual steam production has been estimated at about 800 tonnes per year with a peak hourly steam generation rate of 600 kg/h. The system operates for around 280 days during the year and has overall solar fraction of 35 per cent. This is equivalent to saving about 50,000 litre of diesel oil per year.

Figure 1 presents the indicative schematic of the integration of CST system with the dairy process. The system will operate according to availability of the sun. Solar collectors will track the sun for the entire day to extract the desired output. The receiver at the focus absorbs the heat of solar radiation and transfers to the heat transfer medium (water). The steam generated from the solar system will be supplied to the outlet header of the existing diesel fired boiler.

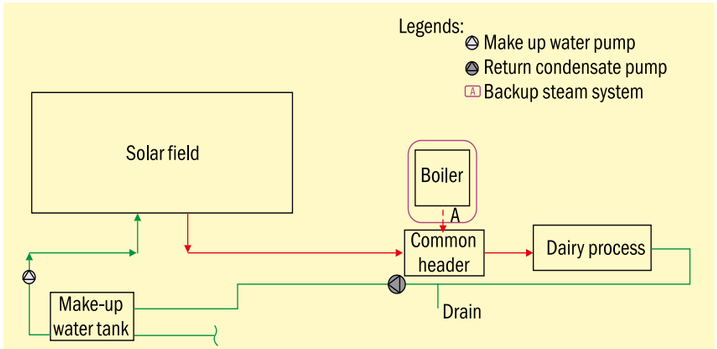

Figure 1: Indicative schematic of the integration of CST system with the dairy process.

Economics

Direct steam generation in the CST system helped to optimize the integration costs for the CST system. The overall investment costs for the CST system were about EUR 400,000 excluding the subsidy from Government of Italy through the Italian incentive scheme for renewable heat (Figure 1). Since the gross mirror area of 995 m^2 is below the subsidy programme cap of 1,000 m^2, the plant profits from Conto Termico. The incentive amounts to EUR 72/m^2 year over a period of five years, meaning the total amount over five years would be EUR 358,200. Still, the support scheme does not permit incentives to exceed 65 per cent of the investment costs, which means that the grant will be limited to EUR 260,000. Hence, the net investment is EUR 140,000.

The company pays about EUR 0.7/litre for diesel, and hence, the solar-assisted production with solar fraction of 35 per cent results in EUR 35,000 per year. Thus the CST system at Nuova Sarda dairy has simple payback period of ~4 years. With such viable and attractive economics, use of CST systems in industrial applications needs to be promoted more in Italy as well as other countries in Europe.

LONGEST FUNCTIONAL SOLAR STEAM COOKING SYSTEM IN INDIA AT BRAHMA KUMARIS GYAN SAROVAR, MOUNT ABU (RAJASTHAN)

B K Jayasimha[1], Aneta Loj[2]

The mid-1990s was the time for early stage of evolution of concentrating solar heat technology in India.

In early 1990s, there were very few solar reflectors, and these were 8 m^2 Scheffler reflectors used for indoor cooking.

As Scheffler reflectors concentrate the sunlight in a small area, they are capable of generating low pressure steam. From this, the idea of Institutional cooking germinated around 1995.

The beautiful complex of Brahma Kumaris Academy for a Better World is situated at Mount Abu, in laps of the highest peak of Aravalli hills. The complex can accommodate around 1,000 people.

Brahma Kumaris is a socio-spiritual organization with 9,000 centres in 140 countries around the world. It teaches Raja Yoga meditation for all walks of the life. Its headquarter is situated at Mount Abu (Rajasthan)

In the early 1990s, the kitchen of Gyan Sarovar complex was already running on steam generated by conventional diesel boilers. As the institute is always open to exploring new renewable energy technologies, it was an ideal set up to install a solar steam cooking system.

Aerial view of Brahma Kumaris Academy

System Design

The design was conceptualized to use 8 m^2 Scheffler reflectors in series, so that the collective energy of the 24 reflectors would be used to generate steam.

The reflectors were installed along the polar axis. The upper reflector faces south while the lower reflector faces north. Thus, the concentration of both reflectors is meeting at one point where the

Scheffler reflectors of the solar steam cooking system

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[2] *Aneta Loj, Research & Development Coordinator, India One Solar Thermal Power Plant, World Renewal Spiritual Trust; Email: aneta@india-one.net*

receiver is placed, so that the energy from both reflectors is absorbed by a single receiver on both sides of its plane.

The initial design was to circulate the soft water in these receivers and transfer the thermal energy into a high pressure hot water accumulator. The flash steam from the accumulator was then transferred to kitchen by means of stainless steel piping, necessary valves, and controls.

Reflector Design

This is the first time that elliptical 8 m^2 Scheffler reflectors were adopted for series of use. A north facing lower stand and a south facing upper stand with the help of an elevated platform was designed to bring the focus at a common place. As there were no proven automatic tracking systems available, the challenge of tracking all 24 dishes was solved by connecting them with wire rope and balancing by counter weights to facilitate a single tracking device.

The electronic timer and a worm gear box with DC motor were used to track the system according to the incoming Direct Normal Irradiance. Daily tracking is automatic whereas seasonal adjustment of dish is manual.

It was a learning curve for the team with regard to usage of reflective materials for the dishes. Initially an aluminium foil pasted on 150 mm × 200 mm aluminium trays was used. But over a period of time they lost their reflectivity. Then the acrylic mirrors were tried that lasted for two years. Normal mirrors were also used. But the final solution arrived when the solar grade mirrors with more than 90 per cent reflectivity were imported and installed.

It took nearly one year to realize the dream to generate the first solar steam. The system was commissioned in early 1997 and delivered expected energy of around 600 kg/day steam up to 10 bar pressure. The kitchen crew was able to cook around 2,000 meals/day by solar energy. There was a big difference in the quality of steam due to flash steam as it was drier and more effective compared to the boiler steam where wetness factor is more. Also, as it was generated by natural energy, pure vibrations and good feelings were experienced.

Upgradation of the System

In 2002, the steam generation part of the system was upgraded. As mentioned above, the first design (Figure 1), which used as a circulating pump to generate steam, was replaced with a steam accumulator placed above the receiver that generates steam by natural siphoning system (Figure 2). Also, the tracking mechanism was simplified to get more precise focus.

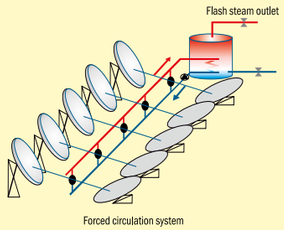


Figure 1: Forced circulation system

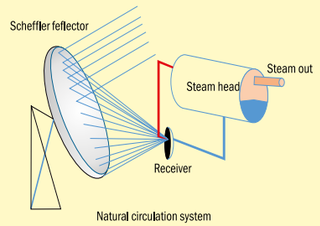


Figure 2: Natural circulation system

The Team and the Partners

The concept of first solar steam cooking system in India was realized by the team consisting of Mr Golo Pilz, Advisor Solar Energy Brahma Kumaris; Mr Wolfgang Scheffler, inventor of the Scheffler dish; and Mr Deepak Ghadia of Ghadia Solar; HTT Gmbh Germany. GTZ (Now GIZ) German development agency funded the project.

Technical Specifications

- Solar reflectors: 24 of 8 m^2 Scheffler design
- Receivers: 400 mm dia each
- Boiler quality plate: 12 no
- Steam accumulator storing around 200 kWh thermal with high pressure hot water system
- Steam generation: 600 kg/day
- Approximate meals cooked: 2,000 meals/day

Conclusion

The project is the longest functional solar steam cooking system in India. The key to this unique achievement is dedicated maintenance and operation, awareness about the precious natural resources, and realization about economic benefits. It is a good example for people who are conservative about the reliability and longevity of a concentrated solar heat system in Indian conditions. The system has already been functioning for the last 18 years, with at least 280 sunny days a year.

INTERNATIONAL WORKSHOP ON CSTs FOR MEDIUM AND HIGH TEMPERATURE APPLICATIONS HELD AT MUMBAI ON NOVEMBER 19, 2015

First time in the country, an International workshop on Concentrated Solar Technologies (CSTs) for medium and high temperature applications was organized by the Ministry of New and Renewable Energy (MNRE) under the banner of its UNDP–GEF CSH Project as part of Intersolar India Exhibition and Conference 2015.

The workshop focussed on the use of CSTs for meeting the heat requirements in industrial, institutional, and commercial establishments for the purpose of process heat, community cooking, space cooling, laundry applications. The establishments include industries like textile, dairy, auto, pharmaceutical, hospitals and hotels, religious bodies, and institutions, e.g., hostels, paramilitary units, prisons, etc. The workshop comprised mainly two sessions: one on Technology, Case Studies and Standard/Policies and the other as Plenary Session to discuss key issues for large-scale promotion of CSTs.

Over 100 delegates from various parts of the country and abroad participated in the workshop. Speakers in the Technical session and Expert panel for the plenary sessions included members from various International and Indian Institutes as well as Industry. These included Dr Anna Heimsath, Head of Team Concentrating Collectors, Fraunhofer Institute of Solar Energy and Mr Tobias Schwind, Director, Industrial Solar Thermal Solutions from Germany and Dr R R Sonde, Chief Technical Officer, Thermax Ltd; Dr Vishal Deshpandey, A T E Enterprises Pvt. Ltd; Dr R P Goswami, Director, Ministry of New and Renewable Energy; Dr A K Singhal, NPM, UNDP–GEF CSH MNRE Project; Prof. Ajay Chandak, Renewable Energy Consultant and Dr S N Srinivas, Programme Oficer, UNDP from India.

Opening and Technical Session of the Workshop

The Expert panel in the Planery Session addressed various

Plenary Session addressing the issues on CSTs

issues with regard to large scale promotion of CSTs in the country which included the following:

- Status on existing technologies in India to generate confidence among potential customers
- Steps required in improving their performance and also the durability of various components, especially the reflectors and heat receivers
- Availability of better technologies abroad for off-grid applications and steps required to be taken for bringing them to India
- Reasons for not picking up the market so fast inspite of high financial support available from MNRE and UNDP/UNIDO
- Role of various stakeholders in taping the vast available potential in India.

The workshop was found to be very useful in addressing the above issues and recommending some solutions. The recommendations are under compilation by the Organizers and will be made available on UNDP–GEF CSH Project website www.cshindia.in very soon.

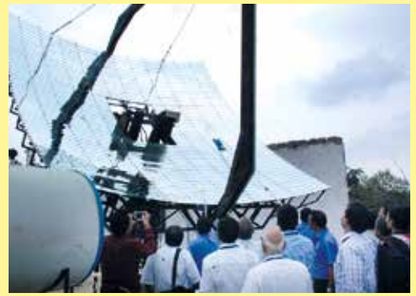
Financial support available for CST based systems under UNDP–GEF CSH Project in addition to 30/60% Government subsidy

Category (Revised)	Type & applications of CSTs	Support under CSHP (Revised w.e.f 1.8.201)
Demonstration	All types and applications with sizes 500 sq. m and above	15% of MNRE benchmark cost to a maximum of ₹75 lakh
Replication	All types and applications with sizes below 500 sq. m (excluding Scheffler dishes for direct cooking)	15% of MNRE benchmark cost but not less than ₹2 lakhs for projects sizes 45 sq. m and above on dish and 64 sq. m and above on other CSTs. Below that ₹1.5 lakh will be available.
Space cooling where new VAM is installed	All types with minimum 30 tonne capacity of VAM	10% of MNRE benchmark cost in addition to above (Maximum 5 projects)
Projects in ESCO mode	All types and applications of CSTs	10% more of MNRE benchmark cost to a maximum of ₹15 lakhs in addition to above
Repair and Renovation	20% of the system cost to a maximum of ₹15 lakh for 5-year old systems subject to the condition that an equal amount is spent by the beneficiary	

Note : Installation of 2 Nos. of Pyranometers; with and without shading ring along with other instruments will be necessary for all demonstration projects of sizes 500 sq. m and above for measuring DNI for the purpose of online performance monitoring. For projects below 500 sq. m only flow meter, temperature and pressure sensors and sim-based data logger will be necessary. Five years AMC for projects above 250 sq. m and 3 years for projects below that (including 1 year warranty) will also be mandatory apart from 5 years warranty for solar mirrors/reflectors.

Contact: Project Management Unit, UNDP–GEF CSHP, MNRE, Ministry of New and Renewable Energy
Block-14, CGO Complex, Lodhi Road,New Delhi-110 003, India. Telefax: +91-11-24363638

A WORKSHOP ON CONCENTRATING SOLAR THERMAL TECHNOLOGY FOR COMMUNITY COOKING & PROCESS HEAT APPLICATIONS IN AURANGABAD, SEPTEMBER 15, 2015



The workshop was organized jointly by the Ministry of New and Renewable Energy (MNRE), Government of India and ATE Enterprises Pvt. Ltd, Pune under the UNDP-GEF CSH programme on September 15, 2015.

The objective of the workshop was to generate awareness about the applicability of CST Technology and promote its usage in organized as well as unorganized sectors. To achieve the objective of creating awareness and promoting CST Technology, a combination of indoor sessions and site visit was planned. Indoor sessions were planned to share knowledge and insights about concentrating solar technology, give information about the support structure from UNDP and MNRE, and generate confidence through sharing user experiences.

Representatives and members from different sectors participated in this workshop. In total, 27 organizations were represented from industrial canteens, community kitchen, industry (process heat), dairy, laundry, and consultants. Participants were mainly from Marathwada (Aurangabad, Beed), northern Maharashtra (Jalgaon) and western Maharashtra (Indapur).

NATIONAL LEVEL WORKSHOP FOR INTEGRATION OF CONCENTRATING SOLAR THERMAL (CST) IN THE DAIRY SECTOR, NEW DELHI, OCTOBER 12, 2015

The first National Level Workshop for the application/integration of Concentrating Solar Thermal (CST) technologies to save cost for fuel in the dairy sector in India was jointly organized by the Ministry of New and Renewable Energy (MNRE) and United Nations Industrial Development Organization (UNIDO) on October 12, 2015 at India Habitat Centre, New Delhi. The Workshop was chaired by the Secretary, MNRE and was inaugurated by the Secretary, Department of Animal Husbandry, Dairying and Fisheries (DAHDF), Ministry of Agriculture. The workshop started with the address by UNIDO Representative and Director, Regional Office South Asia (URO). The workshop focussed on the CST technology which has a wide application in this dairy sector and it was suggested that the cooperation between renewable and dairy sector can to a certain extend remedy the large energy requirements (current and future) of the dairy sector.

There were several intermittent phases of interactive discussions including financial, technical discussion, case studies in dairy sector's, i.e., AAVIN Dairy and Mahananda Dairy were presented by CST installers in the workshop. The workshop was highly interactive and addressed many queries from the dairy sector in going for the CST technologies.

Shri Upendra Tripathy, Secretary, MNRE, addressing the participants

TWO-DAY RESIDENTIAL WORKSHOP ON CSTs AT MT ABU, OCTOBER 8–9, 2015

The first workshop for senior officials of State Nodal Agencies (SNAs) and other government departments was organized in October 2015 to boost and showcase installation of CST based systems for community cooking, laundry, process heat, and space cooling applications in the country.

The two-day residential workshop was held at Mount Abu during October 8–9, 2015 and was co-organized by UNDP-GEF CSH Project of Ministry of New and Renewable Energy (MNRE) along with CST Awareness cum Training Centre established by the World Renewal Spiritual Trust (WRST). There were both, technical sessions and site visits to the existing CST applications organized during the workshop. Thirteen states were represented by senior officials from respective SNAs and other government bodies. All states shared their current status of CST developments, as well as challenges and plans for the future. Key actions were defined which have to be followed up by the identified bodies. Workshop created an interactive, informative, and conclusive platform for sharing and discussing various support available from MNRE, UNDP-GEF assisted CSH Project and updates on new developments, challenges and opportunities from all CST stakeholders, such as beneficiaries, manufacturers, installers, and policymakers.

WORKSHOP ON CSTs FOR COMMUNITY COOKING AND SPACE COOLING APPLICATIONS IN THE EDUCATIONAL SECTOR AT DEHRADUN, OCTOBER 30, 2015

Uttarakhand Renewable Energy Development Agency (UREDA) organized a half-day workshop on Concentrating Solar Technology (CST) based systems for community cooking and space cooling applications in the Educational sector on October 30, 2015 at UREDA, Energy Park Campus, Patel Nagar, Dehradun.

Various Residential Schools, Technical Universities, Engineering Colleges, District and Central Jail, and Mid-day Meal Departments participated in the workshop.

UREDA, United Nations Development Programme (UNDP), different CST manufacturers made presentations on the status of CST programme in the state and on technological-cum-financial aspects. Different schools and institutes discussed on various aspects of technology, financial assistance by MNRE, UNDP and they showed their interest for adopting this technology. Different manufacturers and UREDA is following the users for finalization of proposals.

FORTHCOMING EVENTS

NATIONAL

ENERASIA 2015
December 2–5, 2015 | Mumbai, India | Website: http://www.enfsolar.com

4th Annual Conference on Solar Power in India
December 3, 2015 | New Delhi, India | Website: http://www.infraline.com

3rd International Conference & Exhibition on Energy Storage & Microgrids in India
December 7–9, 2015 | New Delhi, India | Website: www.esiexpo.in

RenewX
December 17–18, 2015 | Hyderabad, India | Website: http://10times.com/renewx

11th Power On International Battery & Alternate Power Sources Exhibition & Conference
January 8–10, 2016 | Gujarat, India | Website: www.batteryfair.co.in

13th International Congress Solar iCon–2016
January 28–30, 2016 | Delhi, India | Website: http://www.sesi.in/events.aspx

INTERNATIONAL

China Energy Storage Innovation & Technology Summit 2015
December 2–3, 2015 | Shenzhen, China | Website: www.eschina.org

SHC (Solar Heating and Cooling) 2015 Conference
December 2-4, 2015 | Istanbul, Turkey | Website: https://www.shc2015.org/home.html

Solar Canada
December 7–8, 2015, Toronto, Ontario Website: http://solarcanadaconference.ca/

Solar Finance & Investment UK
February 1–3, 2016 | London | Website: http://finance.solarenergyevents.com/

Solar Power PV Conference & Expo
February 24–26, 2016 | Boston, MA | Website: http://www.events.solar/pvconferenceexpo/

INTERSOLAR Summit USA 2015
March 24–24, 2016 | Brooklyn, New York | Website: https://www.intersolarglobal.com

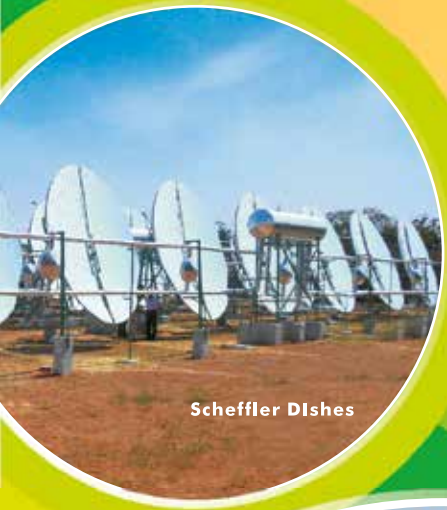
सत्यमेव जयते
Government of India


Paraboloid Dishes

Make your Establishment green by reducing the carbon foot print

CONCENTRATING SOLAR TECHNOLOGIES

can meet a significant amount of your heat requirement for community cooking & Industrial process applications


Scheffler DIshes

SALIENT FEATURES

- Can provide steam / hot oil / pressurized water at 90-350 C
- Integrated with conventional boiler provides trouble free operations during non-sunshine hours. Systems with heat storage also available
- Gives economic return in 3-5 years besides getting a green tag
- Around 200 systems of various capacities working in country.

FINANCIAL SUPPORT

- 30% of benchmark cost as government subsidy
- Higher subsidy in special category states
- 80% accelerated depreciation to profit making bodies
- 15% of cost limited to Rs. 75 lakhs from UNDP-GEF project for specific activities.


Parabolic Trough Concentrators


Arun Dish

Interested Organizations may contact our Channel Partners (**Clique Solar, Mumbai:** 09665055059 / adb@cliquesolar.com; **LeverageNet Solutions, Pune:** 09970319054 / contact@energy-guru.com; **Megawatt Solutions, New Delhi:** 09654451401 / smalik@megawattsolutions.in; **Taylormade Solutions, Ahmedabad:** 09712933390 / dharam@tss-india.com; **Thermax, Pune:** 020-67308880 or 8885 / kdeshpan@thermaxindia.com; **Ultra Conserve, Mumbai:** 09004445530 / vivek@conserve.co.in; **Unisun, Bangalore:** 09880022272 / shivanand.nashi@unisun.net;) and **Consultant- PwC, Gurgaon:** 08130322334 / vibhash.garg@in.pwc.com) For more details, visit our website **www.cshindia.in** or contact at **011-24363638 / singhalak@nic.in**

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