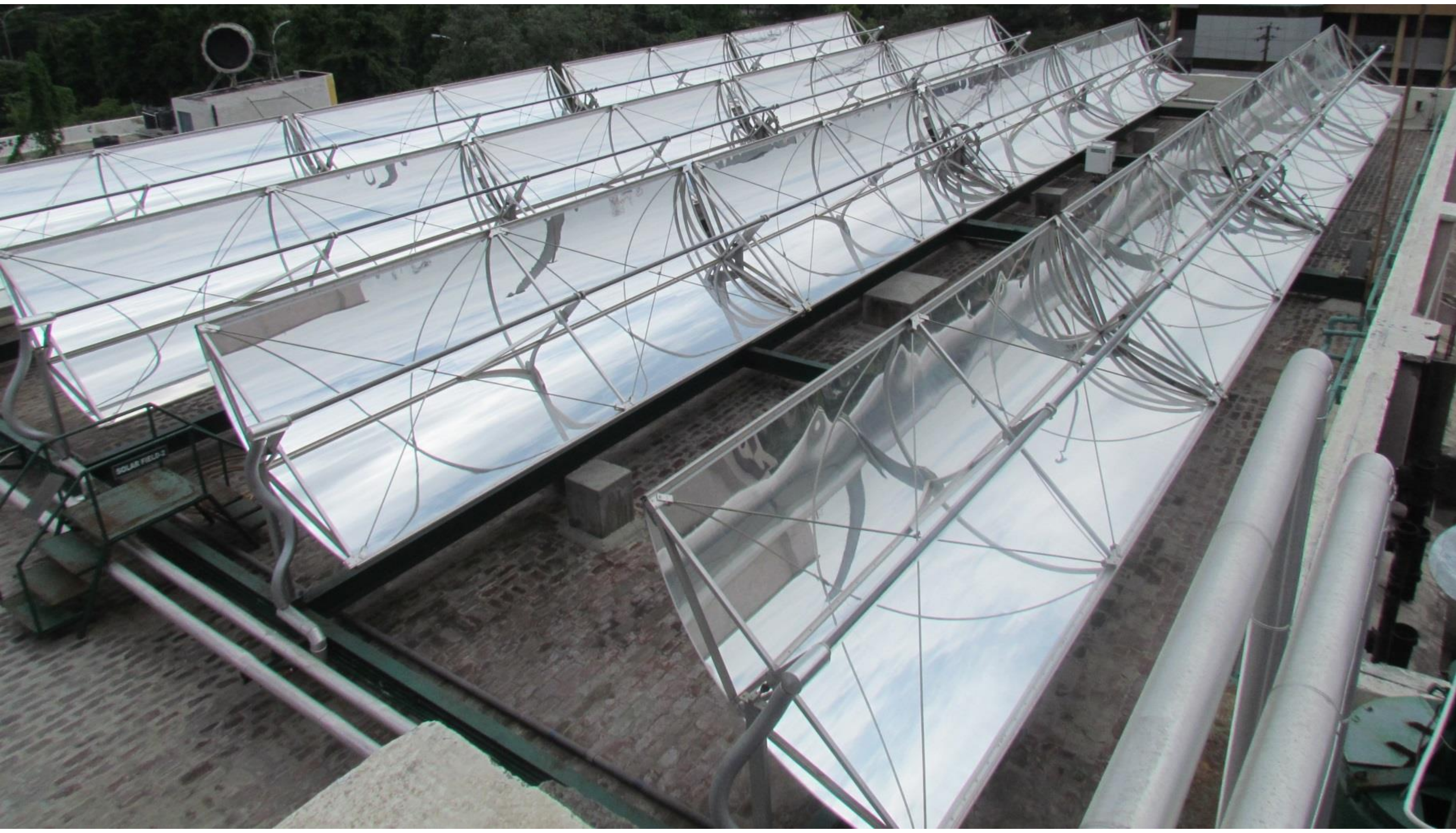

Awareness and Preparation of DPR for pilot projects on solar energy applications in selected Food Processing sector

Commercialisation of Solar Energy in Urban and Industrial Areas – ComSolar

On behalf of

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

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Executive summary

Project background

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH has undertaken the project "Commercialisation of Solar Energy in Urban and Industrial Areas (ComSolar)" in India, under the International Climate Initiative which is supported by the Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU), Germany. This project is being implemented in cooperation with the Ministry of New and Renewable Energy (MNRE), Govt. of India and it focuses on solar energy applications in urban and industrial areas. This includes support in the commercial deployment of solar thermal energy systems to meet industrial process heat requirements in India.

During the first phase of the ComSolar project, a study was carried out to identify industrial sectors which hold promising potential for the application of solar technologies. The food processing sector was identified as one such sector holding good promise. In the second phase, it was specifically targeted with three other sectors for developing pilot projects. The present assignment aimed at developing pilot projects in food processing industries by raising awareness on solar technologies, conducting feasibility studies, preparing detailed project report for potential industries and identifying obstacles being currently faced in deployment of these technologies in the sector.

Indian food processing sector

The food processing industry is one of the largest industrial sector and an important contributor to GDP, employment and investment in India. The sector contributes 9-10% of GDP in the agriculture and manufacturing sector[1]. The food processing sector is a highly fragmented industry comprising of sub-segments like fruits and vegetables, milk and milk products, beer and alcoholic beverages, meat and poultry, marine products, grain processing, packaged or convenience food and packaged drinks.

The food processing sector had a total primary energy consumption of 4.70 Mtoe per annum for the year 2007-08[2]. Primary energy consumption in this sector has a fuel mix of electricity (48%), petroleum fuel (25%), coal (8%) and other fuels including biomass (19%). As the thermal energy demand of this industry is that of medium temperature steam, it can be easily met by solar technologies, especially solar concentrators which can complement their existing steam systems. Due to the high consumption of petroleum fuels by the industry and the technological suitability of solar technologies, the food processing sector remains one of the best suited industries for the adoption of solar technologies.

The processes in the food processing industry require energy in the medium of steam, hot water, hot air (mainly for drying purpose), and electricity. Solar technologies can provide most of these mediums of energy with appropriate technology, and have been captured in the table below.

Industrial Application	Application Media	Temp. (˚C)	Recommended Solar Technology	Temp. Achieved by Solar Technology (˚C)
Washing and Cleaning	Hot Water	40-60	FPC/ETC	Up to 80°C
Cooking, Extraction, Mashing, Brewing and Baking	Process Heat	80 – 100	FPC/ETC	Up to 80°C
Pasteurization / Blanching	Process Heat	70	FPC/ETC and Solar Concentrators	Up to 80°C for SWH Up to 350°C for Solar concentrators

[1] Source: Annual report 2012-13, Ministry of Food Processing Industries, Government of India
[2] Source: Annual Survey of Industries (ASI) database, 2007-08

Sterilization / Bleaching / Hydrogenation	Process Heat	100-120	Solar Concentrators	Up to 350°C for Solar concentrators
	Boiler Feed Water	60-70	FPC/ETC	Up to 80°C
Drying / Dehydration	Hot Air	70-80	ETC (Air Based)	Up to 80°C

Approach and methodology

The first task under this assignment was to raise awareness and generate interest by providing an overview of relevant solar technologies and their applications in food processing industry. The awareness raising activity was followed by shortlisting of suitable interested industries for conducting feasibility studies. The shortlisting was performed on the basis of preliminary data collected from the interested industries. These studies aimed at identifying the best suited solar technologies that could be integrated with their existing system. Technical and financial details of proposed solar technologies were also included in the feasibility report. Based on the results of the feasibility reports, the project team in consultation with GIZ and MNRE, further shortlisted the industries best suited for the preparation of detailed project report (DPR). A further detailed analysis and project development activities including organizing visits to reference solar system installations, site visits by the technology provider, technical detailing of the proposed systems and detailed financial estimations were carried out for the selected industries. These detailed estimations were used to generate revised feasibility reports – to be presented to higher management of the selected industries. It was envisaged that based on the findings of revised feasibility report, the selected industries would sign a memorandum of understanding (MoU) for the implementation of the solar technology at their premises and thereafter a DPR would be prepared. The figure below gives the activities for each task.

Organizing awareness generation seminar	• Preparing modules on solar technologies and systems • Identification of industrial clusters & interaction with industrial associations • One-to-one meetings with key industries
Selection of industries for feasibility study	• Request from industries for carrying out pre-feasibility • Preparation of shortlisting criteria • Shortlisting industries for preparation of PFR
Conducting feasibility studies	• Visit to the individual industries for data collection • Identification of all feasible solar technology interventions • Techno-economical analysis of identified solar technology interventions
Shortlisting of industries for project development	• Presenting the overall findings of industries to GIZ & MNRE • Revision in PFRs • Presentation of findings of PFR to the industries for gauging their interest
Project development	• Visit of industries to reference solar system installations • Presentation on PFR to the top management of industries • Detailed quotation from solar technology providers • Resolution of technical queries & updating of the PFR • Details of project execution
Signing of MoU and DPR preparation	• Signing of MoU • DPR preparation

Awareness generation seminars

Two awareness seminars were organized during this assignment for the food processing sector.

- The first seminar was based on a cluster approach and Baddi (Himachal Pradesh) was identified as a high potential cluster for organising a seminar.

- The second seminar was organized with an industrial association (All India Food Processors' Association, AIFPA) at Delhi, which had participants from different parts of India.

The total number of participants for these seminars was around 70 and they represented around 35 industries. Overall these seminars resulted in:

- Raising awareness on solar technologies in around 35 food processing industries.
- Developing an understanding of the industry's perspective on solar technologies, which includes their awareness of solar technologies and their concerns regarding the performance of solar systems, system integration, subsidy disbursal and availing carbon credit benefits.
- Collecting preliminary information from the participants about their plant which was used to identify potential industries for feasibility studies.
- **Receiving interest from 10 industries for conducting the feasibility study** for their plant.

Feasibility study

The primary objective of the feasibility study was to check the suitability/viability of various solar technologies and provide the techno-economics of the viable solar technologies. The findings of feasibility study helped the industry to take decision on setting up a solar system at their unit.

Preliminary data was collected from the interested industries during the seminars and based on this a ranking framework was developed which includes resource availability (shadow free space, solar radiation), fuel replacement and GHG saving potential, replication potential and management interest and previous experience with renewable energy/ energy efficiency. The five most promising industries were selected for feasibility studies.

The project team visited the shortlisted five industries to gather detailed data on the plant's thermal and electrical energy demand, present energy supply system and availability of area for solar system installations.

A demand assessment, capturing the seasonal variation in the energy demand, was performed on the basis of present thermal and electrical energy supply. The quantity of thermal energy supplied in the form of steam or hot water and the cost of the this (i.e. Rs./ kg of steam or water) was calculated based on the data collected on fuel consumption, steam/hot water generation, boiler efficiency, calorific value of the fuel and the cost of the fuel. Similarly, the effective cost of electricity (Rs./kWh) was calculated based on the share of grid electricity consumed, the electricity tariff, share of electricity consumed from a diesel generator and the cost of diesel. A resource assessment was carried out to identify the suitable areas in the plant for a solar system installation. Also, solar radiation data was collected from secondary data (NASA website and the MNRE website) for the respective locations of all the industries.

In each of the industries, all the feasible solar technologies were identified and solar technology solutions were proposed to be integrated on the supply/utility side to avoid any changes on the process side. These solutions were further filtered based on their technical viability and the interest of the industry. Finally, the suitable solar technologies were shortlisted for a detailed analysis.

System sizing for each of the proposed solar technology was performed considering the no/minimal storage requirements, maximum utilization of available space and energy generated from solar system. The performance of the proposed solar system was estimated using solar radiation data and efficiency of the solar system. Fuel and/or electricity savings and the share of annual energy demand replaced by the proposed solar system (solar fraction) were also calculated.

A detailed financial analysis taking into account all the expenses (capital cost along with the applicable MNRE subsidy and operation and maintenance cost) and all the savings (tax benefits due to accelerated depreciation and savings due to reduced fuel/electricity consumption) was conducted to calculate key financial indicators – project IRR, simple and equity payback period and the levelized cost of energy from solar systems. Escalation in the fuel/electricity price and maintenance cost along with degradation in solar system performance over time were also considered in the financial analysis.

The key findings for five feasibility studies are shown below:

Industry and location	Major products	Fuel	Energy Medium	Energy cost	Techno-economics of proposed solution					
					Technology	System size	Annual average energy output	Solar fraction (%)	Project IRR (%)	Simple payback period (y)
Wrigley India Pvt. Ltd., Baddi, HP	Gum, mints, candies, lollipops, and chocolate	HSD	Steam	Rs.4.4/ kg of steam	FPD	845 m²	3.2 t/d	24.9	24	4.6
		Electricity	Electricity	Rs.6.05/ kVAh	SPV	100 kW_p	440 kVAh/d	2.3	18	6.7
Govind Milk and Milk Products Pvt. Ltd., Phaltan, MH	Pasteurized milk, milk powder, ghee, butter, curd etc.	Coal	Steam	Rs.1.53/ kg of steam	FPD	1,690 m²	5.8 t/d	6.5	21	5.9
					PTC	416 m²	1.4 t/d	2.0	24	5.6
					SD	1,024 m²	2.6 t/d	2.9	20	7.1
		Electricity	Electricity	Rs.7.00/ kWh	SPV	15 kW_p	66 kWh/d	0.6	21	5.7
Dabur India Ltd. (Hajmola Unit), Baddi, HP	Hingoli, Gulabari, Honitus, etc.	Furnace Oil	Steam	Rs.4.5 /kg of steam	FPD	338 m²	1.26 t/d	34.9	54	2.4
					SC	416 m²	1.26 t/d	34.6	56	2.4
					FPC	52 m²	36.2 MWh/y	3.7	60	2.2
					ETHP	39 m²	35.2 MWh/y	3.6	61	3.1
Gits Food Products Pvt. Ltd., Pune, MH	Ready Mix and Instant Food	HSD	Steam	Rs.5.0 /kg of steam	FPD	338 m²	1.17 t/d	35.4	48	2.5
		Electricity	Electricity	Rs.7.00/ kWh	SPV	20 kW_p	88 kWh/d	3.0	22	7.6
Kandhari Beverages Pvt. Ltd., Baddi, HP	Bottling of coca cola drinks	Furnace Oil	Steam	Rs.4.8 /kg of steam	FPD	338 m²	1.26 t/d	21.6	56	2.3
					FPC	40 m²	18.7 MWh/y	1.2	46	3.1
					ETHP	39 m²	18.0 MWh/y	1.1	47	3.1
		Electricity	Electricity	Rs.5.70/ kWh	SPV	100 kW_p	440 kVAh/d	0.8	19	9.1

Project development

The findings of the feasibility study were presented to the GIZ and MNRE team and revised based on their inputs. The revised reports were shared to the industry top management as well as the plant team.

The industries preferred to visit a reference solar systems installation in similar industries. Visit was organized to the following solar system installation.

Fresnel paraboloid dish at Chitale dairy, Sangli, Maharashtra

Chitale dairy is a medium sized dairy located in Sangli, near Pune, Maharashtra. There are two fresnel paraboloid dishes installed at their plant by Clique Solar. The dishes have been installed on the roof of a four storied building. The steam generated from these dishes is used for the pasteurization of milk and for other processes.

The visit was coordinated by Clique Solar and was attended by representatives from Gits, Wrigley, Govind Milk, GIZ and GKSPL. The dishes and their operation were demonstrated, along with the automatic sun tracking and dish parking mechanism. The control logic of the dishes was explained in detail and the balance of systems and steam integration were shown. The management of Chitale shared their experience with solar system and responded to queries from the participants.

This visit provided the industries a better understanding of solar systems and helped in building confidence in the technology by demonstrating successful installations.

Following the visit, the project team contacted the industries to fix meetings with the higher management so that the solar projects could be taken forward. Out of five industries, three showed positive interest and were taken up for extensive project development activities.

The findings of the PFR were presented to the management. Although the management had limited knowledge and awareness about solar technologies, their initial response was positive about adopting solar technologies. However, the decision making process required thorough analysis and the project was sent back to the engineering team for internal review.

The internal review of the engineering team raised concerns regarding high capital cost and solar system performance. Other issues like load bearing capacity of existing roof for the solar system installation and integration with the existing system were also raised

System performance concerns and its impact on payback period turned out to be one of the major barriers in convincing the management about the project. The management perceived it as a high risk, high investment project and wanted to know of mechanisms in place to address these issues. The project team encountered all these issues during the extended project development activities and tried to address these through the various discussions with the industries and technology providers.

The extended project development activities provided the project team with good insight into corporate decision making process and the ecosystem that is needed to be developed to speed adoption of solar technologies in industries.

Lessons learnt and major barriers

During the course of the project, the team carried out a myriad of activities beginning from awareness generation seminars to feasibility studies and interacting with the leadership of companies for project development. In addition, it involved working in close partnership with the technology providers, industry associations, MNRE, GIZ, etc. These activities provided a deep insight into the suitability of solar technologies for industries and the major barriers in their adoption.

Techno-economic feasibility is paramount for project approval. For technical viability, the plant should have sufficient area available on a concrete roof or on the ground as well as the system should provide a considerable portion of energy requirement (solar fraction in the range of 10 – 30 %). Plants using petroleum fuels like diesel and furnace oil offer attractive return on investment as the cost of fuel saved is the highest. Replacing petroleum fuels typically gives project IRR in the range of 20 – 30% and payback period in the range of 2.5 - 4 years. Financial suitability decrease as we move to natural gas or solid fuels like coal and biomass. Replacing natural gas will return a project IRR in the range of 15 – 22% and payback period of 3-4 years. Replacing solid fuels result in project IRR of 12 - 18% and payback period between 5 and 7 years.

Solar water heaters find limited applications as most plants either have good condensate recovery or use waste heat recovery for pre-heating. The integration of SWH systems directly in to processes is not accepted by most industries as they do not want to make changes in their processing. Smaller Solar Photovoltaic systems offer high payback periods and consequently find few takers.

Despite good technical feasibility in the studied industries, only those projects which offer good economic value are approved by the management. Most companies expect any investment to payback within 3 years and an IRR of more than 20%. In some cases, payback period up to 5 years and IRR above 15% might be accepted but anything more than that has extremely low chances of management approval. However, while evaluating sustainability projects based on IRR, it should be appreciated that these projects provide low returns initially but they lead to high savings over the total period of ownership.

Industries set up in tax-free zones and enjoying the tax benefit cannot avail the benefits of accelerated depreciation and in these cases the payback period increases significantly. Major barriers identified in adoption of solar technologies are shown in the figure below.

Sustainable growth is currently not on the agenda of most Indian companies. Some multinationals and large Indian firms might have developed a company-wide sustainability mandate but renewable energy based manufacturing practices is rarely a part of it. For companies which do not have such mandates, these concepts are fairly new and face a lot of resistance.

The solar technology sector faces some major barriers which have hindered its growth and need to be addressed urgently. On the supply side, the biggest concern is the limited number of reference installations, especially of solar concentrators in industries. Independent system monitoring has not been performed and no such reports are available in the public domain. These lead to serious doubts about the technology among prospective end-users. Matters are not helped by the fact that the sector is fragmented, with small players working independently.

On the demand side, high capital investment and system performance risk are the two biggest concerns. Also, there is very low awareness about solar technologies and the management is not sensitized to sustainable growth.

Way forward

Based on the lessons learnt and the barriers identified future activities have been proposed which aim to help this sector achieve its identified potential. High capital investment and the associated risk can be addressed by developing and promoting innovative business and financing models. Also, a system performance risk guarantee mechanism needs to be developed to safeguard investments in solar technologies. A platform needs to be created to unite all the stakeholders of this sector and build a common vision and mission to accelerate adoption.

Innovative business models can be the missing link between the existing technology and their widespread adoption. Alternative debt financing models need to also be explored along with the development of business models based on the concept of energy as a service. Risk sharing mechanisms, like performance guarantee insurance, can encourage the influx of capital in to solar thermal projects.

All stakeholders: technology providers, end-users, finance institutions, the MNRE and development agencies, need to be brought together on a common platform to adopt a united approach. A common vision and a roadmap for the sector should be drafted in consultation with all stakeholders. This will help them direct their limited resources in a collective effort for maximum returns. A nationwide training programme to educate the plant engineering teams should be conducted in major industrial belts of the country. To sensitize the company management to sustainability and renewable energy technologies, awareness programmes should be conducted in the major cities of the country.

The key activities which have been envisioned are:

1. Developing innovative business models
2. Developing system performance risk mitigation mechanism
3. Uniting all stakeholders on common platform
4. Building a national level roadmap for the off-grid solar thermal sector
5. Compiling independent reports on existing system's performance
6. Conducting nationwide awareness generation and sensitization programs

The ComSolar project has been at the forefront of promoting solar technology applications in industries and has contributed significantly towards the development of this sector. Based on the experiences gathered till now, the project has identified some high impact activities which can catalyse the development of this sector. Two of the above stated six key activities needs to be taken up immediately for speeding up solar technology adoption in industries and should be considered as high priority by the stakeholders, especially MNRE and interested development agencies. These activities are: (i) a study to design innovative business and financing models and system performance risk guarantee mechanism, and (ii) developing a "Solutions Platform" to bring all stakeholders together and develop a national roadmap for industrial solar heat. These activities will provide the much needed thought leadership to the solar sector in India and help it achieve its true potential.