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Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Ministry of New and Renewable Energy
Government of India

Solar Applications in Industries

Energy Management Workshop for Textile, General Engineering Sector and Buildings

Madurai, 25th July 2011

Indo-German Energy Programme (IGEN)

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Overview

- ComSolar project objectives
- Challenges and Opportunities in Commercialization of Solar Energy in Urban and Industrial Areas.
- Solar Technologies
- Industrial Sectors Promising for Solar Energy Applications
- Case examples Solar Energy applications in Textile Sector

Indo German Energy Programme (IGEN)

Energy Efficiency (EE)
Ministry of Power (BEE/CEA)

- EE in thermal Power plants
- Implementation of Energy Conservation Act
- Capacity development/ EE for state designated agencies
- Clean Development Mechanism CDM
- Indo-German Energy Symposium
- Excellence Enhancement Center
- Trigeneration (TRIGEN)
- Support and Permanent office IGEF

Renewable Energy (RE)
Ministry of New and Renewable Energy

Rural / poverty focused

- IGEN-Renewable Energy Component BMZ 2010-2013
- Renewable Energy Supply for Rural Areas (RESRA) BMU 2008- 2011

Industrial / urban

- Commercialisation of Solar Energy in Urban and Industrial Areas (ComSolar) BMU/ 2009-2013
- Solar Mapping and monitoring (SolMap) BMU/ 2010-2014

support

support

Indo-German Energy-Forum (IGEF)
MoP (CEA, BEE), MNRE
BMWi, BMZ, BMU, (BMBF, AA, BMVBS)

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ComSolar: Commercialisation of Solar Energy in Urban and Industrial Areas

Main objective of the project:

To develop and demonstrate commercially viable models for commercialisation of solar energy in urban and industrial areas, developed and tested through pilot projects.

Challenges and Opportunities





Cost of solar energy

- Energy Efficiency
- Replace costly fossil fuels (DG)
- Substitute heating cooling
- Scale-up to bring down costs

Variable source of supply

- Matching demand-generation.
- Innovative storage

Technical barriers

- Management of low voltage grid.
- Technology transfer and adaptation.
- Testing and Certification.

Complex policy frameworks

- Simplified framework for small roof top grid connected

Low awareness/ penetration

- Pilot demonstration.
- Business models for commercializati on.
- Awareness and capacity building of key stakeholders

Implementation Strategy

Approach

Develop action-plan for country-wide dissemination jointly with stakeholders

Country-wide Dissemniation

Remove barriers, incentives, information dissemination, capacity development, Website

Demonstrate technical and commercial viablility

Pilot Project

Monitoring case study

Target groups

Buildings

- **Roof top PV** (diesel replacement, captive power and selling to the grid).
- **Solar assisted heating and cooling**
- **Integrated solar energy application with energy efficiency.**

Industries

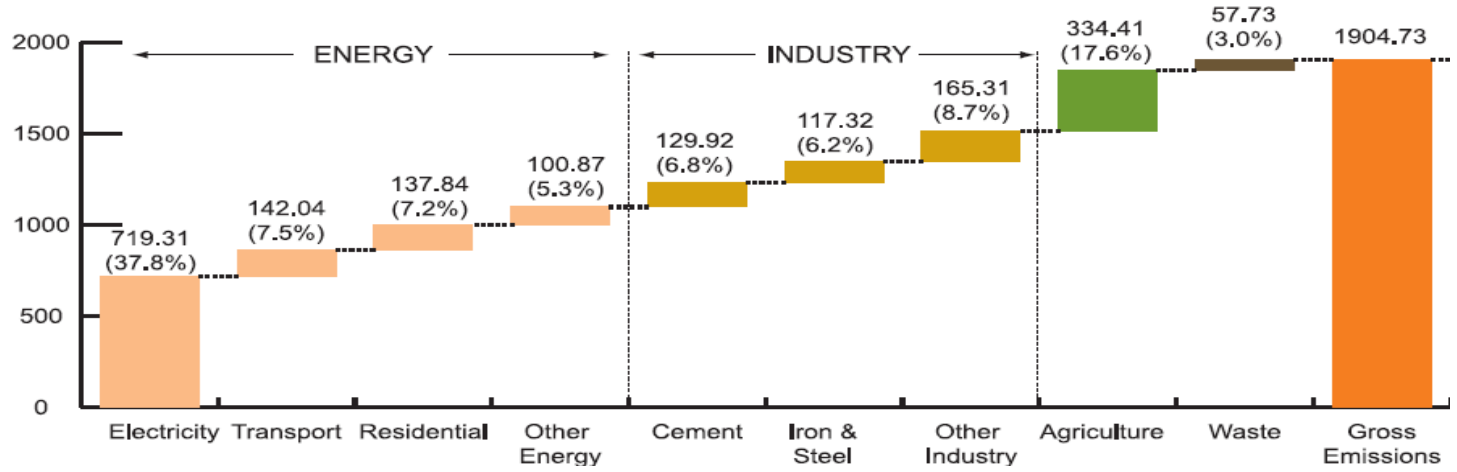
- **Low/high temperature process heat (<100 C), solar preheating and drying**
- **Solar assisted cooling**
- **PV systems to substitute DG captive power and for grid connection**
- **Customer tailored solar application with energy efficiency improvement of the production process**

Solar thermal power generation

- **Reduction of manufacturing cost for major components of solar thermal power plants**
- **Efficiency improvements and testing of major components for thermal power generation**

Energy Consumption in Industries

- India's total primary energy requirement -**400 MTOE**
- **52% from coal.**
- **34%** of primary energy is **consumed by Industries** leading to **22%** of **GHG emissions (406 Mt eCo_2)**
- Another 15% of total GHG emission are contributed thorough consumption of electricity



GHG emissions by sector in 2007 (million tons of CO2 eq). MoEF, 2009,

Background- Solar Applications in Industries

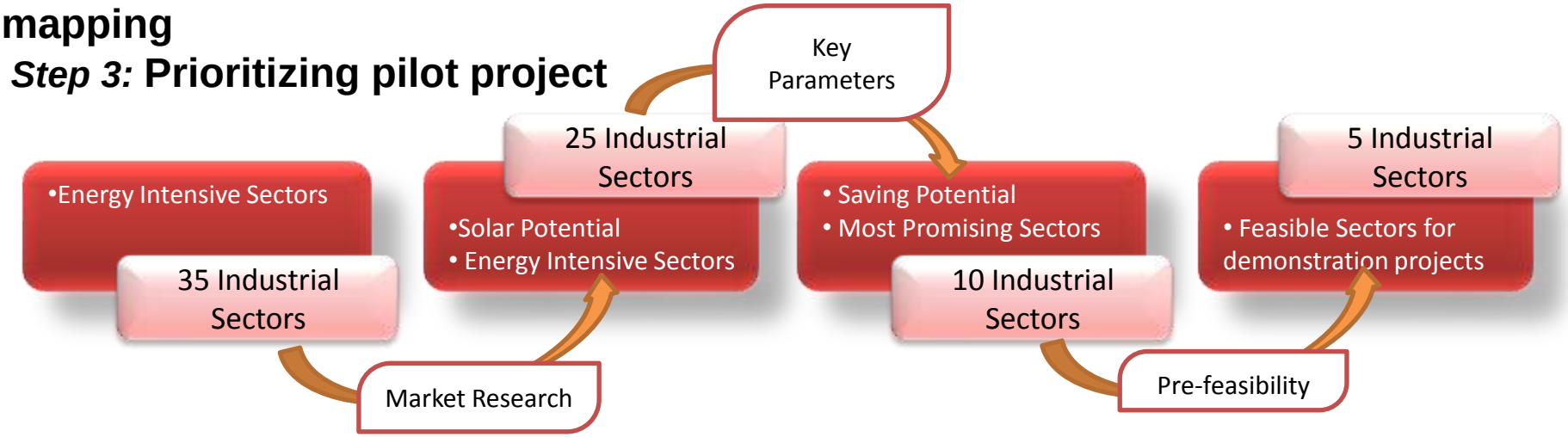
- Country receives **high solar irradiance** 1900 kWh/m^2
- National Solar Mission target**– 20 GW, 20 million m^2 of solar thermal collector area by 2022.**
- **Large percentage of industrial heat demand is at temperature levels below 100°C**
- **Solar thermal applications focused almost exclusively on domestic or institutional hot water requirements**
- **Solar energy applications in industries is limited**
- **Limitations: High Initial investment, lack of investors confidence and limited successful example and uncertainties in the regulatory framework**

Industrial Sectors Promising for commercialization of Solar Energy

Step 1: **Identifying industrial sectors promising for commercialization of solar energy in the country**

Step 2: **Solar technology and industrial application mapping**

Step 3: **Prioritizing pilot project**



Step 4: **Investment requirements and cost-benefit analysis**

Step 5: **Market and replication potential for scaling up pilot projects**

Key parameters affecting use of solar energy in Industries

Pros

- **Energy consumption by the whole sector (in MTOE)**
- **Heating Load as %age of the total energy consumption**
- **Cooling Load as %age of the total energy consumption**
- **Number of units in the sector**

Cons

- **Dispersion of sector**
- **Past solar experience in the sector**

What solar technology is applicable in an industrial process

- Identify the various applications across sectors of solar energy and match with various energy processes of the industry
- About 30% of the total industrial heat demand is below 100°C,
- In several industrial sectors, such as food, textile, pulp and paper, the share of heat demand at low and medium temperature (below 250°C) is about, or even above, 60%.
- Technologies available for medium temperature (80-250 °C) are:
  1) Improved flat plate collectors (FPC)
  2) Evacuated tube collectors (ETC)
  3) Other – concentrating collectors (Parabolic trough collectors -PTC)

Solar Technology Landscape

Photovoltaic

PV cells usually silicon based convert solar energy into electricity

10kW to > 10 MW

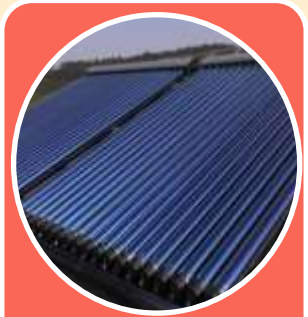
PV

Mirrors or lenses focus sunlight into multi-junction PV cell

100kW to > 100 MW

CPV

Solar Thermal



Flat plate (FPC)or Evacuated Tubes collectors, (ETC) commercially available, most common ly used for heating water

Hot water up to 00°C

ETC/ FPC

Dual axis radial concentrator collector made of curved mirrors tracks and focus sun light onto sterling engine

100kW to > 100 MW or Temp up to 500°C

SOLAR DISH

Rows of through shaped mirror direct concentrated radiation onto receiver tube

50kW to > 100 MW or Temp up to 300°C

THROUGH

Similar to trough but uses flat (Fresnel) mirrors to concentrate light

50kW to > 100 MW or Temp up to 250°C

FRESENEL

Source: Sterlingenergy.com

Process Mapping and Solar Technology Applicability

Sectors	Solar Technology		
	FPC **<80˚C**	ETC **<100˚C**	PTC **<100-400˚C**
Textiles (Finishing)	Mercerizing, Dying,	Desizing, Scouring, Bleaching, Finishing	Scouring
Pulp & paper	Debarking & Chipping, boiler feed water, Bleaching	Digesting, washing	Digesting, washing, pulping
Food Processing	Washing, Cleaning, Pasteurization / Blanching, Sterilization / Bleaching / Hydrogenation	Drying / Dehydration, Cooking, Extraction, Mashing, Brewing and Baking, Chilling / Cold Storage	Steam, chilling
Leather	Pre Tanning/Beam House Operations – Soaking, Liming and Pickling etc.	Tanning (Chrome and Vegetable), Finishing, Drying	
Dairy	Washing and Cleaning, Pasteurization	Chilling / Cold Storage, Sterilization / Evaporation, Spray Drying	Chilling / Cold Storage, Sterilization / Evaporation
Textiles (Spinning & weaving)	Sizing,	Sizing,	Steam
Electroplating	Cleaning & Washing, Plating,		
Automobile	Paint Shop – Pre Treatment	Paint Shop – Air Conditioning, Paint Shop – Evaporation and Drying	
Pharmaceuticals	Boiler feed water	Chilling	Steam, Chilling

Ranking of the sectors

Sectors			Solar Technology		
	Conventional fuel replacement TOE (in 000)	Weighted Price (Rs./ MCal.)	FPC <80˚C	ETC <100˚C	PTC <100-400˚C
Textiles (Finishing)	384	2.01	**	****	*
Pulp & paper	45	1.45	***	**	**
Food Processing	8	3.21	*******	*******	**
Leather	17	4.26	*****	****	_
Dairy	30	4.19	***	*****	****
Textiles (Spinning & weaving)	20	4.31	*	*	*
Electroplating	21	5.81	***	_	_
Automobile	10	4.58	*	***	_
Pharmaceuticals	9.3	3.73	*	*	**

Ranking of the 10 sectors based on the framework

Sectors	Mtoe Saving	Weighted Price (Rs./ MCal.)	Solar Insolation
Food Processing	0.0800	3.21	5.50
Electroplating	0.0210	5.81	5.28
Automobile	0.0105	4.58	5.33
Textiles Spinning & Weaving	0.0200	4.31	5.30
Dairy	0.0300	4.19	5.30
Textiles Finishing	0.3840	2.01	5.30
Pulp & Paper	0.0450	1.45	5.47
Agro malls	0.0043	3.70	5.52
Leather	0.0170	4.26	5.19
Pharmaceuticals	0.0093	3.73	4.97

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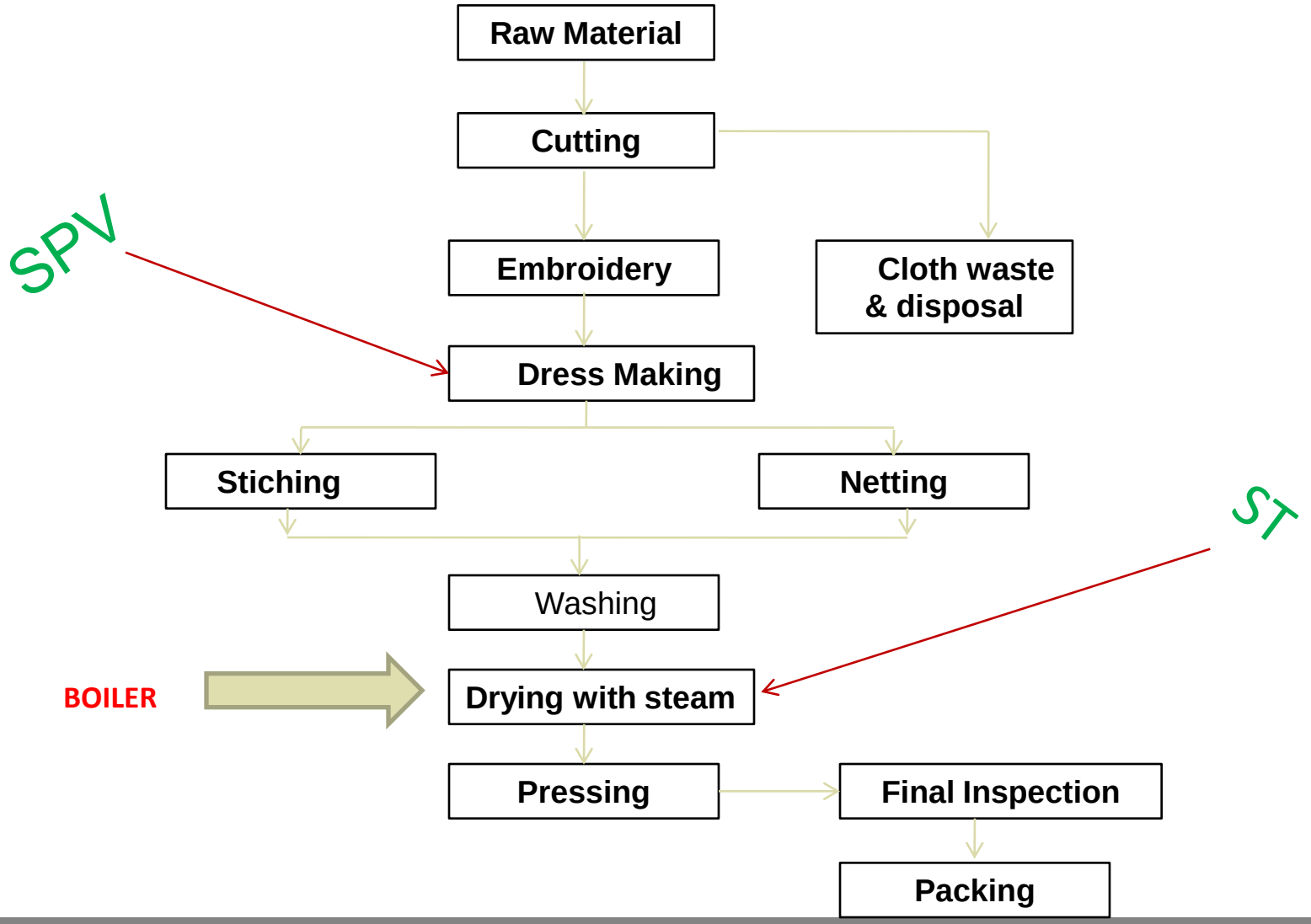
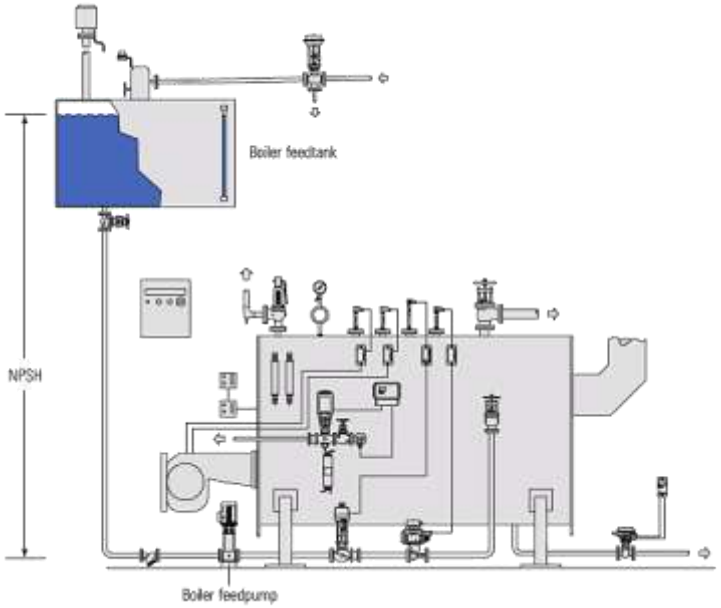
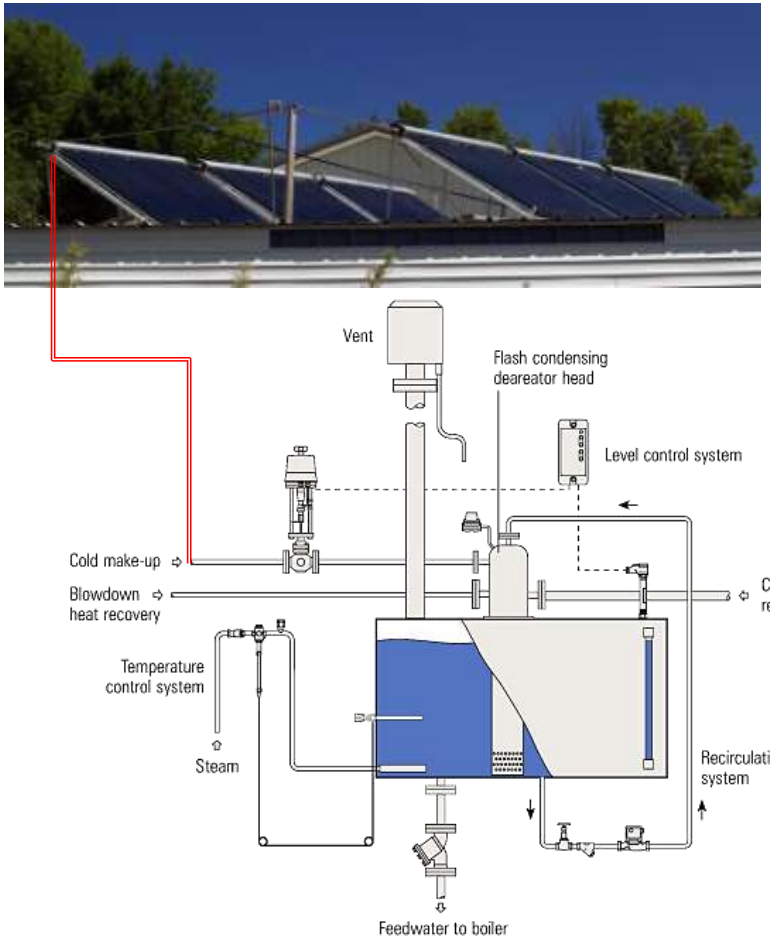
Case Example 1- Apperal Industry



Process through Solar Water Heating System



Boiler Feed Water



Feed Water Tank

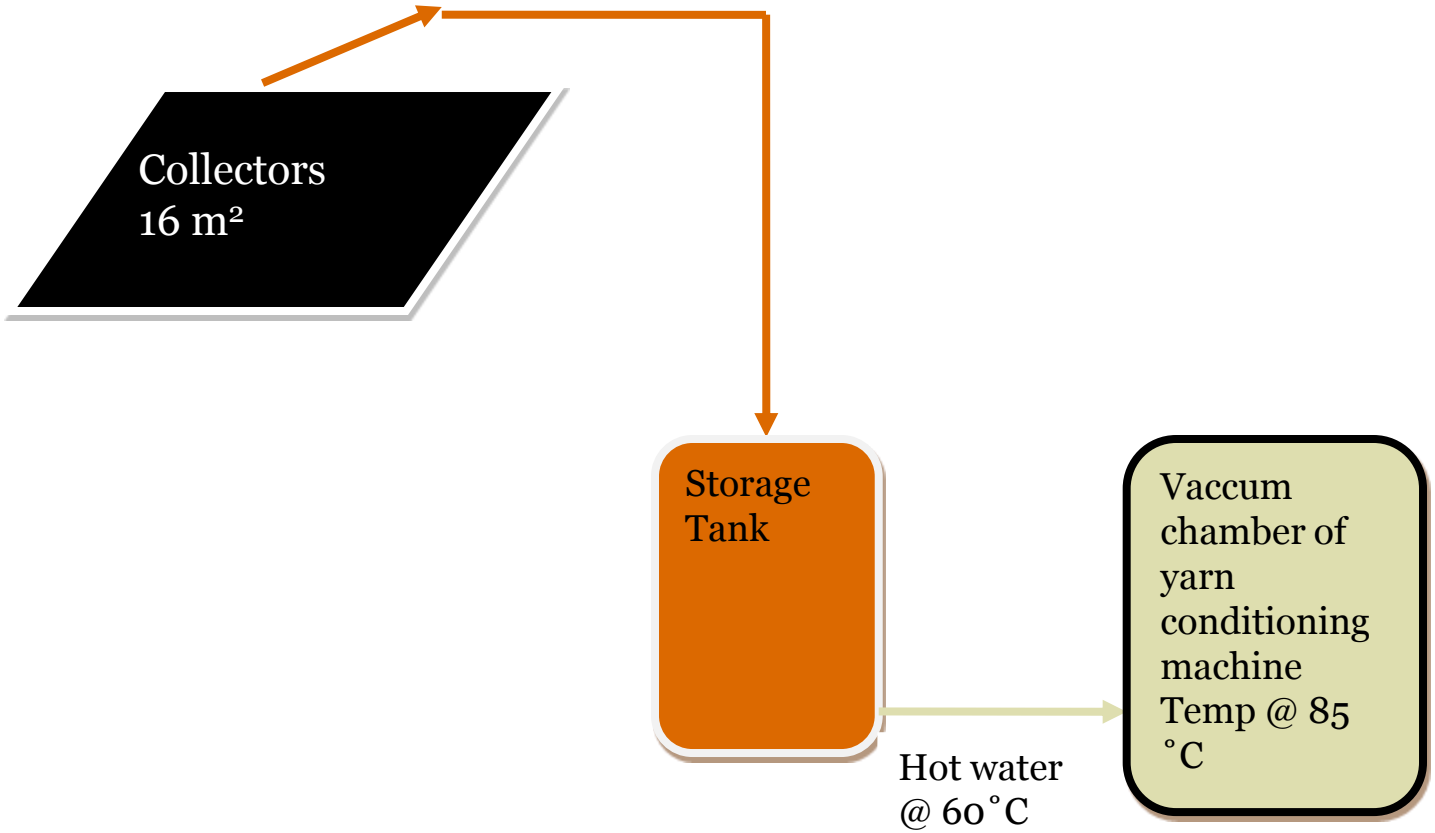
Pre-feasibility analysis of 5 sample Apparel Industries

- **% Energy consumed for process heat** : 25-30 %
- **Process heat temp ranges-** up to 100^{o}C
- **Boiler sizes** : 100-500 Kg/hr (set of 2-3 boilers)
- **Annual diesel consumption in boilers**: 50,000 – 70,000 ltr/yr
- **Applicable solar technology-** FPC and ETC
- **Solar system capacity** : 10,000 L – 15,000 L
- **Area required for installation of the solar system** : 350 – 500 m^2
- **Replacement of diesel through solar** : 20,000 – 25,000 ltr/year
- **Investment** : 30 – 35 lac
- **Payback** : 3 – 3.5 year

Solar Application
Textiles Spinning & Weaving

Unit	Particulars	Details
Unit-1	Product	Yarn and fabric
	Present Application to be replaced	Yarn conditioning unit uses water vapours for increasing the moisture contents of yarn
	Possible Solar Application	SWH system for generating hot water
Unit-2	Product	Yarn
	Present Application to be replaced	Yarn conditioning unit uses water vapours for increase the moisture contents of yarn
	Possible Solar Application	SWH system for generating hot water

Schematic Diagram



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Financial Analysis for Textile Spinning & Weaving – Unit 1

Particulars	FPC	ETC
System Proposed (LPD)	800	800
Capital Cost (Rs)	160000	112000
Average replacement of Electricity (kWh)	15000	15000
IRR (%) with Subsidy	52	80
IRR (%) without Subsidy	37	52
Payback period (Years)(with subsidy)	1-2years	1-2 years

Financial Analysis for Textile Spinning & Weaving – Unit 2

Particulars	FPC	ETC
System Proposed (LPD)	1000	1000
Capital Cost (Rs)	2,00,000	140000
Average Saving of Electricity (kWh)	15000	15000
IRR (%) with Subsidy	42	64
IRR (%) without Subsidy	30	42
Payback period (Years)(with subsidy)	1-2 years	1-2 years

Findings

- Hot water required at around 55-600C for use in yarn conditioning process.
- Open loop system with Flat Plate Collectors or Evacuated Tube Concentrators is applicable
- Major load is electrical
- Roof area can be utilized for solar PV but the sheets are not capable of taking the loads.
- Energy replacement potential on national level – 0.019 Mtoe
- Potential up to 2.85% of energy consumption of the total thermal load

Conclusions

- Solar applications in Industries could substantially **contribute to the JNNSM targets**.
- Solar energy could **replace 620,000 TOE (450 million$) of conventional fuels** each year in the selected sectors. (17 million m^2 collector area)
- This amounts to **about 8% of the total heat demand or 3% of total energy consumption** in the selected sectors.
- Non-concentrating solar thermal collectors for various applications **provide a good economic case**.
- Commercial viability is much higher for industries using furnace oil, coke or captive diesel based electricity.
- Due to their high average weighted price of energy consumption economic viability is higher in electroplating, automobile, textile (spinning and weaving), dairy and leather sectors

Cont…

- Concentrating solar thermal technologies demonstrate an attractive economic potential, but the high initial investment costs, space requirements, perceived risks by the stakeholders as limiting factors.
- Relevant for business interested in innovative technologies, lowering their emissions and wanting to establish competitive advantage in longer term.
- **Challenges –**
  - lack of awareness,
  - industry confidence only in long-term proven technologies,
  - limitation in standardising the systems due to large variety of industrial applications,
  - lack of technical manpower and financing of such projects.

Thanks !

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Feasibility screening for solar thermal applications:

"KO-Kriterium (Knockout criteria)"	Yes	No
Does the industry require heat at temperature levels below 120°C for any process?		
Is sufficient space available to install solar thermal collectors at the company site (roof or land)?*		
Does the available space is largely shadow free and oriented towards south/south-east/south-west or on a flat roof?		
Does the Industry use furnace oil, coke, coal or fossil fuels for process heat production?		

Source: Adapted from EC funded SoPro project

*Each 2 m2 collector area provide aprox 4000 kCal/day, not necessary to have area available to replace total heat demand.

OK Kriterium- more 'yes' answers below the better the economic and technical feasibility for solar process heat are

OK Kriterium	Yes	No
Does the company require process heat during **day hours (10am to 4.00 pm)?**		
Is the process **heat required daily**?		
Is the temperature level of the process heat mostly **below 80°C?**		
Is the **use of waste heat or heat recovery** from other processes (e.g. from chillers, compressors or economisers) technically or economically not possible?		
Is a **payback period upto 5 years** for energy-related investments acceptable?		
Are energy costs an important factor for the business profitability?		
Is there a general interest in the use of renewable energy sources (e.g. for environmental or climate protection reasons, motivated by image considerations, market (both national or international) demand for the low carbon products or CO2-reduction targets)?		

Source: Adapted from EC funded SoPro project