APPLICATION OF SOLAR ENERGY IN DAIRY INDUSTRY

INITIATIVE BY NDDB

#SUPPORTED BY MNRE, UNDP
UNDERSTANDING SOLAR ENERGY

SOLAR ENERGY ORIGINATES DUE TO THERMONUCLEAR FUSION REACTION OCCURRING IN THE SUN.

SPECTRUM OF SOLAR INCIDENCE AT EARTH SURFACE IS SPREAD MOSTLY FROM INFRARED RANGE, VISIBLE AND SMALL PART IN ULTRA-VIOLET REGION.
HOW MUCH SOLAR ENERGY?

Global Energy Potential

- Solar 23,000 TW
- Tidal 0.3 TW
- Wave 0.2–2 TW
- Geothermal 0.3–2 TW
- Hydro 3–4 TW
- Biomass 2–6 TW
- Wind 25–70 TW
- Natural gas 215 TW-yr
- Oil 240 TW-yr
- Uranium 90–300 TW-yr
- Coal 900 TW-yr

World Energy consumption (power demand of 16 TW)
• ABOUT HALF THE INCOMING SOLAR ENERGY REACHES THE EARTH'S SURFACE.
ABOUT 5,000 TRILLION KWH PER YEAR
ENERGY IS INCIDENT OVER INDIA'S LAND AREA
WITH MOST PARTS RECEIVING 4-7 KWH PER SQUARE METER PER DAY.

Solar radiation on India
Source: TERI
VARIATION OF SOLAR RADIATION IN A YEAR

Comparison of different available solar data for Uttara Kannada
TECHNOLOGIES FOR CONVERSION OF SOLAR ENERGY

- **SOLAR PHOTOVOLTAIC**: η ~ 16-20%
- **SOLAR THERMAL**: η ~ 50-65%
- **COMBINED HEAT & POWER**: η ~ 75%
WHY RENEWABLE ENERGY FOR THERMAL REQUIRED?

• DEPLETING FOSSIL FUEL.
• SIDE EFFECT FOR GENERATION OF GHG CAUSING GLOBAL WARMING.
• CLEAN ENERGY WITH NO SIDE EFFECTS LIKE EMISSIONS.
• ALWAYS AVAILABLE FOR NEXT MILLION YEARS
• HIGHER OPERATING EFFICIENCY & PROFITABLE
COMBUSTION OF FOSSIL FUEL IS THE LARGEST SOURCE OF GREENHOUSE GAS EMISSIONS

CO$_2$ emissions by region

Source: International energy agency (IEA) 2009
WHY SOLAR ENERGY IS TO BE UTILIZED IN INDIA?

GOI HAS COMMITTED TO REDUCE THE EMISSION INTENSITY OF GDP LEVELS BY 30-35% BY 2030, AS COMPARED TO 2005 LEVELS.

• GOI THROUGH SOLAR MISSION IS TRYING TO INVOLVE/ENGAGE ALL INDUSTRY/SECTORS FOR REDUCTION IN FUEL DEPENDENCE FOR THERMAL REQUIREMENTS.

• MNRE IS THE MINISTRY GIVEN THE RESPONSIBILITY FOR IMPLEMENTATION.

• NDDB HAS AGREED TO PROACTIVELY INITIATE DISCUSSIONS WITH MILK UNIONS & FEDERATIONS FOR IMPLEMENTATION.
HOW DID IT START?

• IN 2015, LOOKING INTO THE IMMENSE BENEFITS OF CONCENTRATED SOLAR THERMAL (CST), NDDB DECIDED TO INITIATE PROCESS OF IMPLEMENTATION OF CST IN DAIRY INDUSTRY, CONSIDERING AFFORDABILITY OF THE TECHNOLOGY AND LONGTERM BENEFIT TO FARMERS.

• NDDB CALLED FOR A MEETING IN NOV 2015 OF ALL STAKEHOLDERS I.E. DAIRY FEDERATION, UNIONS AND AFFILIATE ORGANIZATIONS, FOR A CONSENSUS FOR IMPLEMENTATION OF CST.
20TH NOV 2015 MEETING
OWING TO AN OVERWELMING RESPONSE FROM STAKEHOLDERS, NDDB DECIDED TO IMPLEMENT CST IN DAIRIES.

TO START WITH, GENERATION OF LOW PRESSURE STEAM (< 3.5 BAR) WAS CONSIDERED FOR IMPLEMENTATION IN DAIRY.

MNRE AND UNDP AGREED TO EXTENDED SUPPORT TO PROJECT IMPLEMENTATION FOR SPEEDY, HASSLE-FREE APPROVAL WITH FINANCIAL ASSISTANCE
IMPORTANT QUESTIONS

• WHETHER THERMAL ENERGY DELIVERY IS REQUIRED IN THE FORM OF HOT WATER OR STEAM.

• HOW TO MAKE THE SYSTEM COST EFFECTIVE & COMMERCIAL VAILABLE
## UNDERSTANDING REQUIREMENT

Generally, dairy requires thermal energy for the following applications:

<table>
<thead>
<tr>
<th>S No.</th>
<th>Temperature / Media</th>
<th>Application</th>
<th>Source of Heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>85°C / Water</td>
<td>Can washing, crate washing, CIP system, boiler feed water tank, pasteurization, butter melting, indigenous products</td>
<td>LP Steam</td>
</tr>
<tr>
<td>2.</td>
<td>140°C / Steam</td>
<td>Ghee boiling, sweets</td>
<td>LP Steam</td>
</tr>
<tr>
<td>3.</td>
<td>165°C / Steam</td>
<td>UHT milk</td>
<td>HP Steam</td>
</tr>
<tr>
<td>4.</td>
<td>200°C / Air</td>
<td>Air heater for spray drier</td>
<td>HP Steam</td>
</tr>
</tbody>
</table>
APPROXIMATE THERMAL USAGE PATTERN IN DAIRIES

STEAM LOAD DISTRIBUTION

- MILK POWDER: 20%
- UHT MILK: 5%
- GHEE MAKING, SWEETS: 10%
- [CATEGORY NAME], BOILER FEED WATER: [PERCENTAGE]
CONCENTRATING SOLAR THERMAL TECHNOLOGIES

PARABOLOID DISH

LINEAR FRESNEL COLLECTOR

COMPOUND PARABOLIC CONCENTRATOR

SCHEFFLER DISH

PARABOLIC TROUGH

FRESNEL DISH
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parabolic trough</th>
<th>Paraboloid / Fresnel Dish</th>
<th>Linear Fresnel</th>
<th>Scheffler Dish</th>
<th>Compound Parabolic Concentrator</th>
</tr>
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<tbody>
<tr>
<td>Working temp</td>
<td>120 - 300°C</td>
<td>120 - 400°C</td>
<td>Upto 400°C</td>
<td>90 - 200°C</td>
<td>Upto 140°C</td>
</tr>
<tr>
<td>Aperture Area/Module</td>
<td>10 - 50 m²</td>
<td>4 – 250 m²</td>
<td>20 - 500 m²</td>
<td>5 - 20 m²</td>
<td>2 - 10 m²</td>
</tr>
<tr>
<td>Advantages</td>
<td>Long time proven reliability &amp; durability</td>
<td>High temperatures, high efficiency</td>
<td>Simple design, lower investment &amp; operating cost</td>
<td>Many installation in India</td>
<td>Uses diffused radiation in addition to direct</td>
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<tr>
<td></td>
<td>Storage options available</td>
<td>High tolerance of variation in land slope</td>
<td>Tolerance for slight slopes</td>
<td>Suitable for remote area, easy assembly</td>
<td>Stationary &amp; low maintenance</td>
</tr>
<tr>
<td></td>
<td>Direct steam generation proven</td>
<td>High modularity</td>
<td>Direct steam generation proven</td>
<td></td>
<td>Collectors are concentrators</td>
</tr>
<tr>
<td>Application</td>
<td>Process heat, power generation</td>
<td>Process heat, power generation</td>
<td>Power generation</td>
<td>Steam Cooking, wet steam application</td>
<td>Process heat</td>
</tr>
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<tr>
<td>Disadvantages</td>
<td>Limited temp of heat transfer fluid</td>
<td>Higher cost/m² and high precision required.</td>
<td>Large Area requirement</td>
<td>Higher temp applications not possible</td>
<td>Cannot be defocussed</td>
</tr>
<tr>
<td></td>
<td>Complex structure, precision required during construction</td>
<td>Repair &amp; maintenance relatively expensive</td>
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<td></td>
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<tr>
<td></td>
<td>Requires flat land</td>
<td></td>
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<tr>
<td>Approx. cost of solar field with BOP</td>
<td>20,000 – 27,000/m²</td>
<td>20,000-30,000 /m²</td>
<td>17,000 – 20,000/m²</td>
<td>18,000 – 22,000/m²</td>
<td>19,000 – 24,000/m²</td>
</tr>
</tbody>
</table>

**SOURCE**: NATIONAL LEVEL WORKSHOP CONDUCTED BY MNRE IN NOV 2015 FOR DAIRY SECTOR AND TENDERS RECEIVED
SHORTLISTED TECHNOLOGIES FOR 85° C WATER GENERATION

- **Paraboloid Dish (Dual Axis Tracking)**
- **Parabolic Trough (Single Axis Tracking)**
- **Compound Parabolic Concentrator (Non Tracking)**

Installation at: Mahindra (MVML), Chakan
Application: Hot water for degreasing
FEATURES OF CST PROJECT IMPLEMENTATION

• FOR THE FIRST TIME IN INDIA, OPEN TENDER SUITABLE FOR 85°C WATER GENERATION HAS BEEN CALLED.

• BASED ON AVAILABLE TERRACE AREA AND THE PROCESS HEAT UTILIZATION, HEAT DELIVERY WAS DEFINED:

  CAPACITY RANGE 5 – 40 LAKH KCAL/DAY.

• ALMOST FULLY AUTOMATED SYSTEM, EXCEPT FOR CLEANING REFLECTORS

• ELIGIBILITY CRITERIA FINALISED BASED ON ACCREDITATION FROM MNRE FOR SELECTED TECHNOLOGY

• REALTIME PERFORMANCE DATA TRANSMISSION FOR REMOTE MONITORING
SOME HIGHLIGHTS

- IMPLEMENTATION OF 13 CST PROJECTS BY SEPTEMBER 2017
- ADD 7800m\(^2\) OF APERTURE AREA IN NEXT 4 MONTHS, AS AGAINST 40,000m\(^2\) IMPLEMENTED THROUGH MNRE IN LAST 5 YEARS
- TOTAL PROJECTS ESTIMATE ~ INR 16 CRORES.
- ALL CST PROJECTS BEING IMPLEMENTED IN EXISTING DAIRIES.
- ABOUT 5 - 15% OF PROCESS THERMAL HEAT FROM BOILER BEING REPLACED WITH HEAT FROM CST ON YEARLY AVERAGE.
- ABOUT 30% OF ESTIMATED COST IS FINANCIALLY ASSISTED BY MNRE & UNDP.
- NDDB EXECUTING PROJECTS ON PRO-BONO BASIS.
FINANCIAL ASSISTANCE

**MNRE** SUBSIDY – 30% ON BENCHMARK COST

**UNDP** SUBSIDY – 20% ON BENCHMARK COST  (SCHEME ENDED ON 31ST MAR 17)

**BENCHMARK COST:**
- TWO AXIS TRACKING SYSTEMS – INR 20,000/m².
- SINGLE AXIS TRACKING SYSTEMS – INR 18,000/m².
- NON TRACKING SYSTEMS – INR 12,000/m²

**UNIDO** (UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION) EXTENDS FINANCIAL ASSISTANCE IN FORM OF LOAN FOR IMPLEMENTATION OF SANCTIONED CST PROJECTS UPTO 75% OF PROJECT COST.

- 40% SOFT LOAN @ 7% INTEREST RATE (5% SUBVENTION).
- 30% BRIDGE LOAN @ 12% INTEREST RATE ON MNRE SUBSIDY.
- REMAINING 25% SHALL BE PROMOTER’S CONTRIBUTION

**NOTE:** SUBSIDY BASED ON INSTALLED APERTURE AREA OF CST
<table>
<thead>
<tr>
<th>Location</th>
<th>Total Aperture Area</th>
<th>Total project estimate</th>
<th>Approx. subsidy</th>
<th>investment</th>
<th>Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kolhapur (6 projects)</td>
<td>2700 m²</td>
<td>INR 6.23 Crores</td>
<td>INR 1.6 Crores</td>
<td>INR 4.62 Crores</td>
<td>4–5 years (FO as fuel)</td>
</tr>
<tr>
<td>Punjab (Mohali, Jalandhar, Ludhiana)</td>
<td>2450 m²</td>
<td>INR 5.32 Crores</td>
<td>INR 1.47 Crores</td>
<td>INR 3.85 Crores</td>
<td>4–5 years (FO as fuel)</td>
</tr>
<tr>
<td>Gujarat (Vidya Dairy)</td>
<td>380 m²</td>
<td>INR 93 Lakhs</td>
<td>INR 38 Lakhs</td>
<td>INR 55 Lakhs</td>
<td>4–5 years (FO as fuel)</td>
</tr>
<tr>
<td>Karnataka (3 projects)</td>
<td>2250 m²</td>
<td>INR 4.92 Crores</td>
<td>INR 1.57 Crores</td>
<td>INR 3.35 Crores</td>
<td>4–5 years (FO as fuel)</td>
</tr>
</tbody>
</table>

**NOTE:** FO COST @ 32/LITRE
PROCESS FLOW DIAGRAM OF CST

- PHE
- MAKEUP WATER
- BOILER FEED WATER TANK
- THERMAL STORAGE TANKS
- SOLAR FIELD
- PUMP
- BOILER
- CRATE WASHER
- CIP TANKS
- BOREHOLE
- PUMP
- SOLAR THERMAL STORAGE
- PHE
PERFORMANCE OF 5 LAKH KCAL/DAY CST INSTALLATION

AVERAGE HEAT DELIVERY: 5,80,000 KCal/day
FURNACE OIL SAVING WITH CST: (80 – 100 LITRES/DAY) ~ Rs. 3000/Day

RESULTS OF LAST 15 DAYS

INSTALLATION AT CHANDGADH CHILLING CENTRE (KOLHAPUR)
Performance of CST system on 02.05.2017

- FLO
- SIT
- SOT
- PIT
- POT
- T1T
- T2T
- AMT
- GHI
CONCLUSION

• INDIA DUE TO GEOGRAPHICAL LOCATION IS SUITABLE FOR IMPLEMENTATION OF CST & SOLAR PV SYSTEMS.
• CST, SPV IMPLEMENTATION IS ECONOMICALLY VIABLE IN DAIRY INDUSTRY
• IMPLEMENTATION OF CST, SOLAR PV SYSTEM IN DAIRY IS BECOMING A NECESSITY TO BRING DOWN OPERATING COST & BEING MARKET COMPETITIVE