Solar thermal energy technologies for industrial applications - India's experience

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Outline

- Introduction
- Indian industry overview
- Potential application areas
- Solar energy potential in India
- Solar thermal technological options
- Case studies
- Policy and regulatory support
- Barriers
- Way forward

Introduction to TERI

- Vision – “We will work towards global sustainable development, creating innovative solutions for a better tomorrow”
- Independent, not-for-profit energy research institute
- 700 employee (450 research professionals)
- Higher education initiative:TERI University
- ISO 9001
- Headed by Dr R K Pachauri, Director General, TERI and Chairperson, Intergovernmental Panel on Climate Change (IPCC), Nobel Peace Prize Winner 2007

Presence of TERI

- **Head office** at New Delhi, India
- **Regional centers in India**: Bangalore, Mumbai, Goa, Guwahati and Mukteshwar
- **Affiliate institutes:** Washington and London
- **Presence** in Tokyo, Kualalampur, and Dubai
- **Africa centre** in Adisababa, Ethiopia

Indian industry overview

- Composition and
- Energy requirements

Industrial applications

- TERI is working on UNIDO funded project on ‘RETs for Industrial Sector in Developing Countries’.

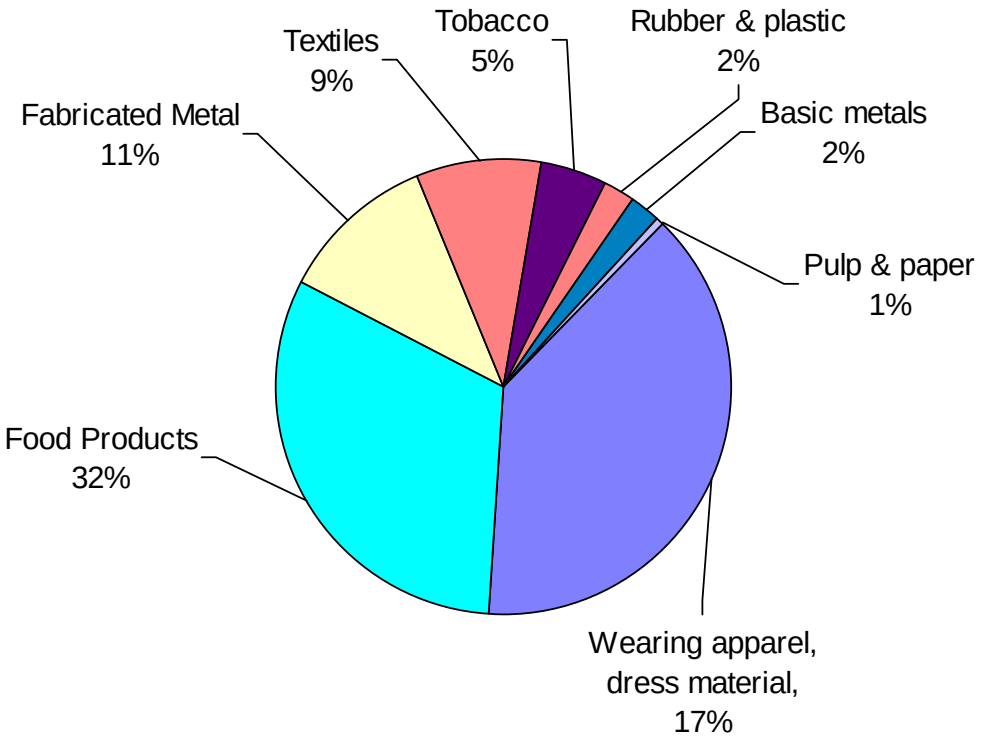
Potential industries selected

1. Pulp & Paper
2. Textile
   - Silk, wool & cotton yarn
3. Food Processing
   - Diary
   - Bakery
   - Cardamom
   - Meat processing
   - Marine foods
   - Tea
4. Plaster of Paris
5. Rubber
6. Steel re-rolling
7. Tobacco
8. Ceramic tile & pottery

MSMEs in India

Selected Industries	No. of SSI Units (registered & unregistered) Functioning (as on 31/3/06)
Manufacture of Wearing Apparel, Dressing & Dyeing of Fur	2145505
Manufacture of Food Products	1786890
Manufacture of Fabricated Metal Products	637740
Manufacture of Wood and Wood Products	606761
Manufacture of Textiles	451304
Manufacture of Other Non-Metallic Product	331415
Manufacture of Tobacco Products	190510
Manufacture of Rubber and Plastic Products	135638
Manufacture of Basic Metals	102279
Manufacture of Paper & Paper Products	31648
Total Number of Industries in India	**12,341,665**

Details of selected industries



Percentage of industries under selected categories = 45%

Industrial processes & thermal energy requirements

- Pulp & paper industry
  - Pulping: 130-80^{o}C
  - paper drying: 90-100^{o}C
  - pulp bleaching: 70-90^{o}C
- Textile industry
  - Silk
    - Reeling: 50-90^{o}C
    - Dyeing: 90-110^{o}C
  - Cotton dyeing: 90-110^{o}C
  - Wool dyeing: 90-110^{o}C

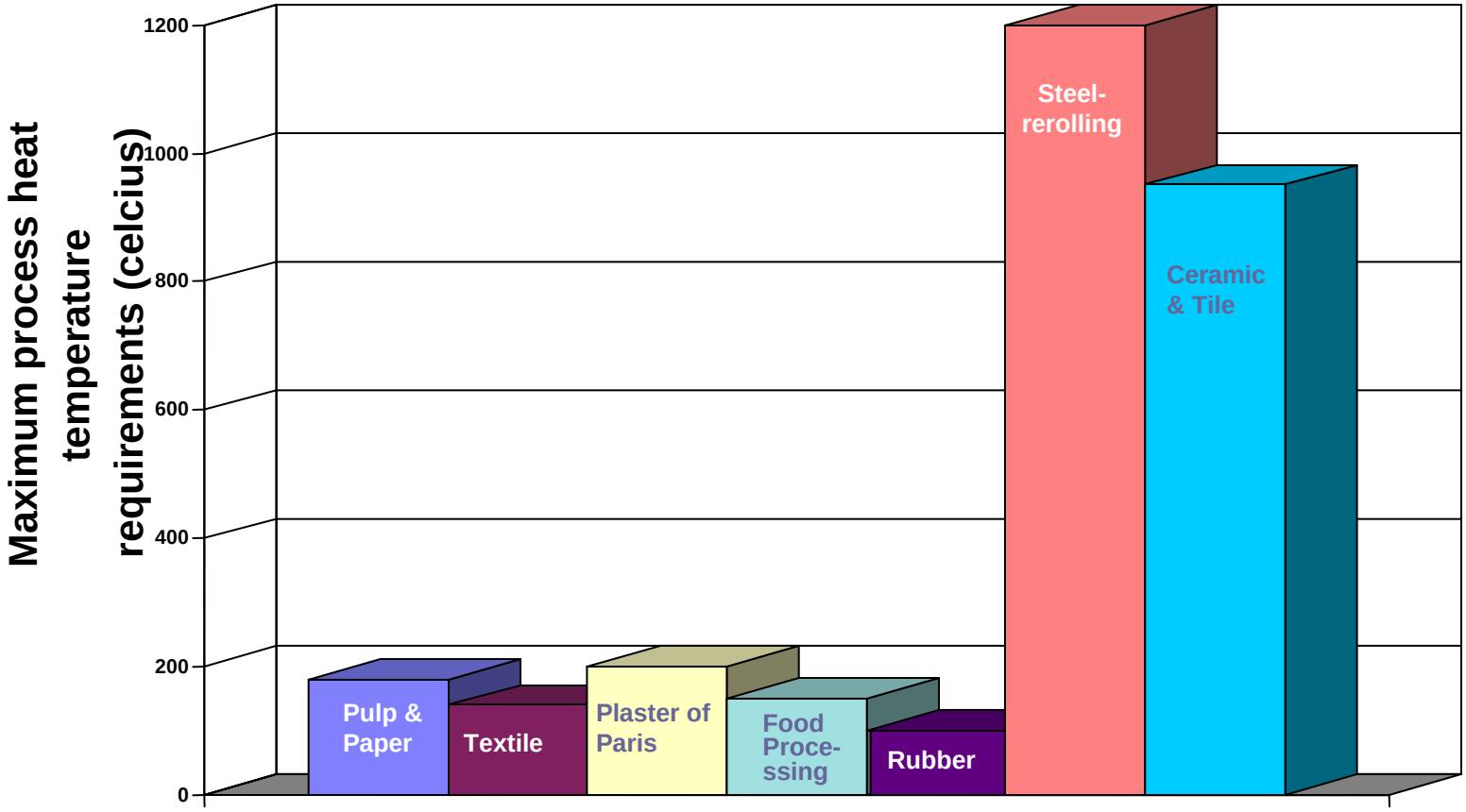
Industrial processes & thermal energy requirements - contd…

- Cardamom curing: 70-90^{o}C
- Bread/biscuit baking: 90-110^{o}C
- Dairy
  - Liquid milk-pasteurization: 80-90^{o}C
  - Butter making-drying/evaporation: 70-110^{o}C
  - Milk Powder- drying/evaporation: 130-150^{o}C
- Tea leaf-drying: 50-80 ^{o}C
- Meat processing-drying/sterilization: 100-120^{o}C
- Sea food-drying/sterilization: 100-120^{o}C

Industrial processes & thermal energy requirements - contd…

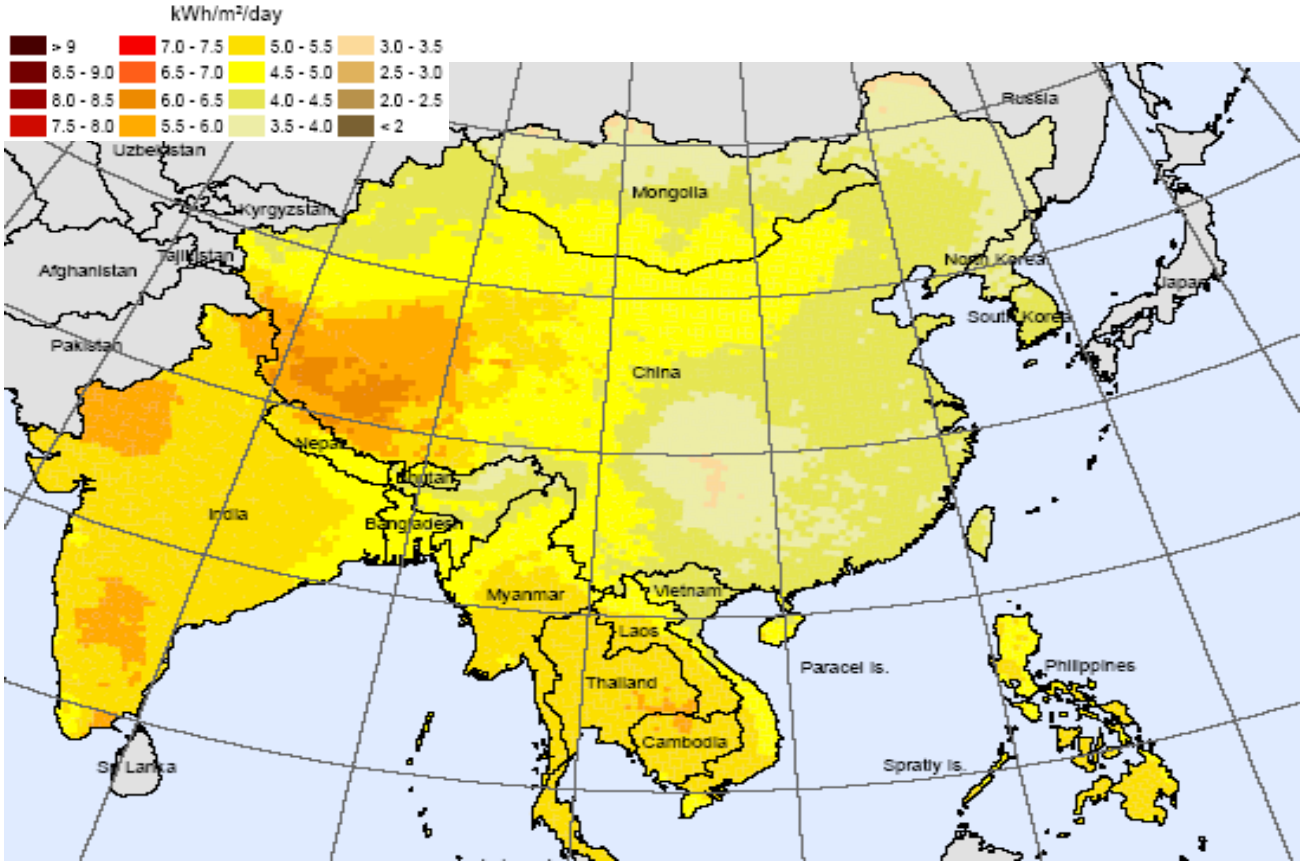
- Steel re rolling-billet reheating: 850-950^{o}C
- Gypsum-Calcination (Plaster of Paris making): 1000-1200^{o}C
- Tile-drying/evaporation: 500-600^{o}C
- Pottery products-drying/evaporation: 500-600^{o}C
- Rubber drying: 100-300^{o}C
- Tobacco drying: 50-80^{o}C

Thermal energy requirements



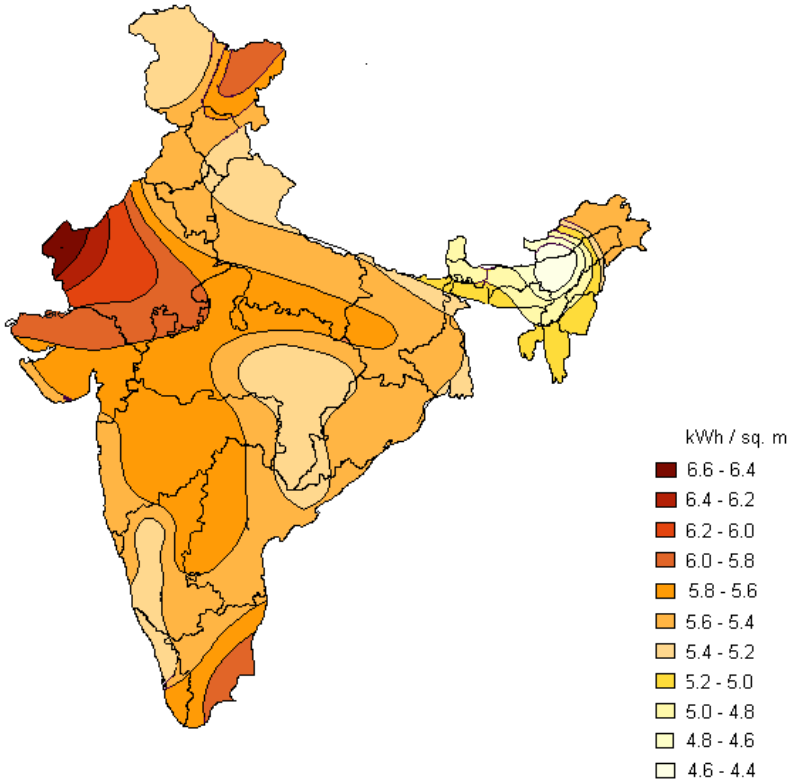
Solar energy applications

Solar radiation levels over Asia



http://swera.unep.net/

Solar radiation map of India



If one percent of the land is used to harness solar energy for electricity generation at an overall efficiency of 10%; 492 x 10^6 MU/year electricity can be generated

Some applications vs technology

- Heating/drying (low-med temperature)
  - Solar thermal
  - Biomass/biogas combustion
- Drying, melting, calcination (high temperature)
  - Biomass/biogas combustion
  - Geothermal
- Direct shaft-power
  - Small wind turbines
  - Small-micro/pico hydro turbines

Annual fuel replacement possible

- Pulp & paper industry
  - Pulping: 100%
  - paper drying: 100%
  - pulp bleaching: 100%
- Textile industry
  - Silk
    - Reeling: 50%
    - Dyeing: 100%
  - Cotton dyeing: 100%
  - Wool dyeing: 100%

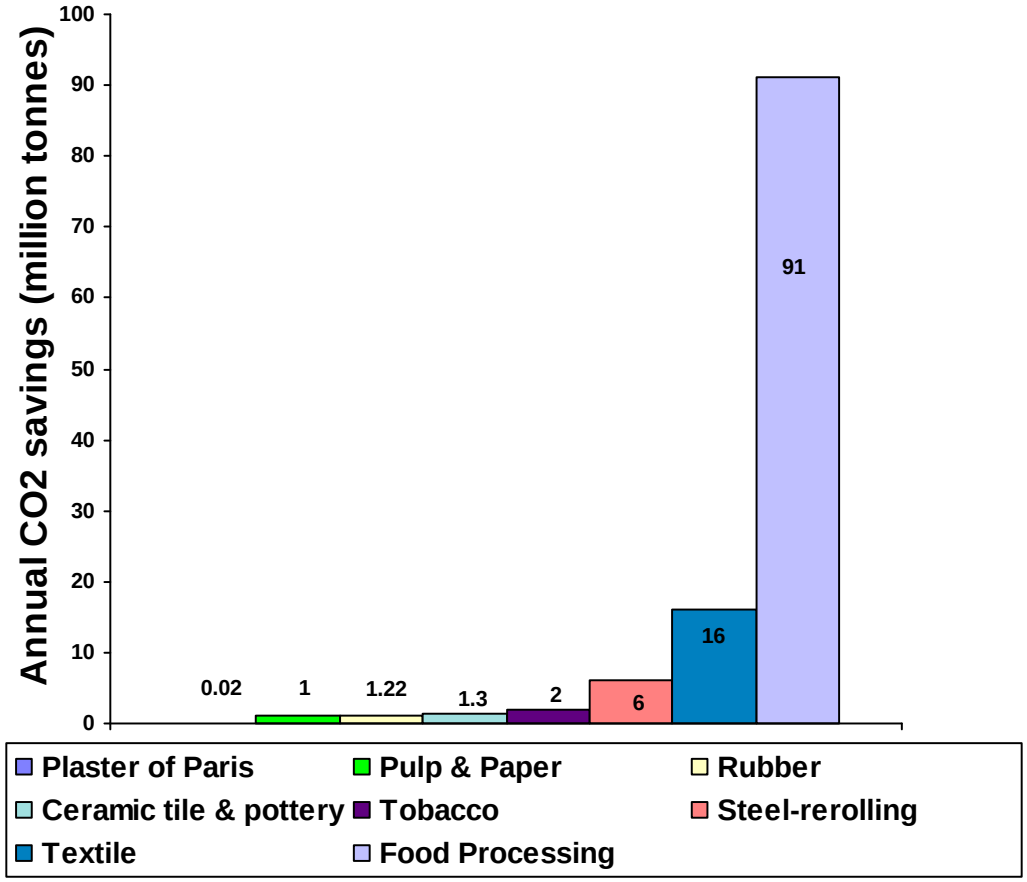
Annual fuel replacement possible – contd…

- Cardamom curing: 70%
- Bread/biscuit baking: 100%
- Dairy
  - Liquid milk-pasteurization: 70%
  - Butter making-drying/evaporation: 70%
  - Milk Powder-drying/evaporation: 70%
- Tea leaf-drying: 100%
- Meat processing-drying/sterilization: 50%
- Sea food-drying/sterilization: 50%

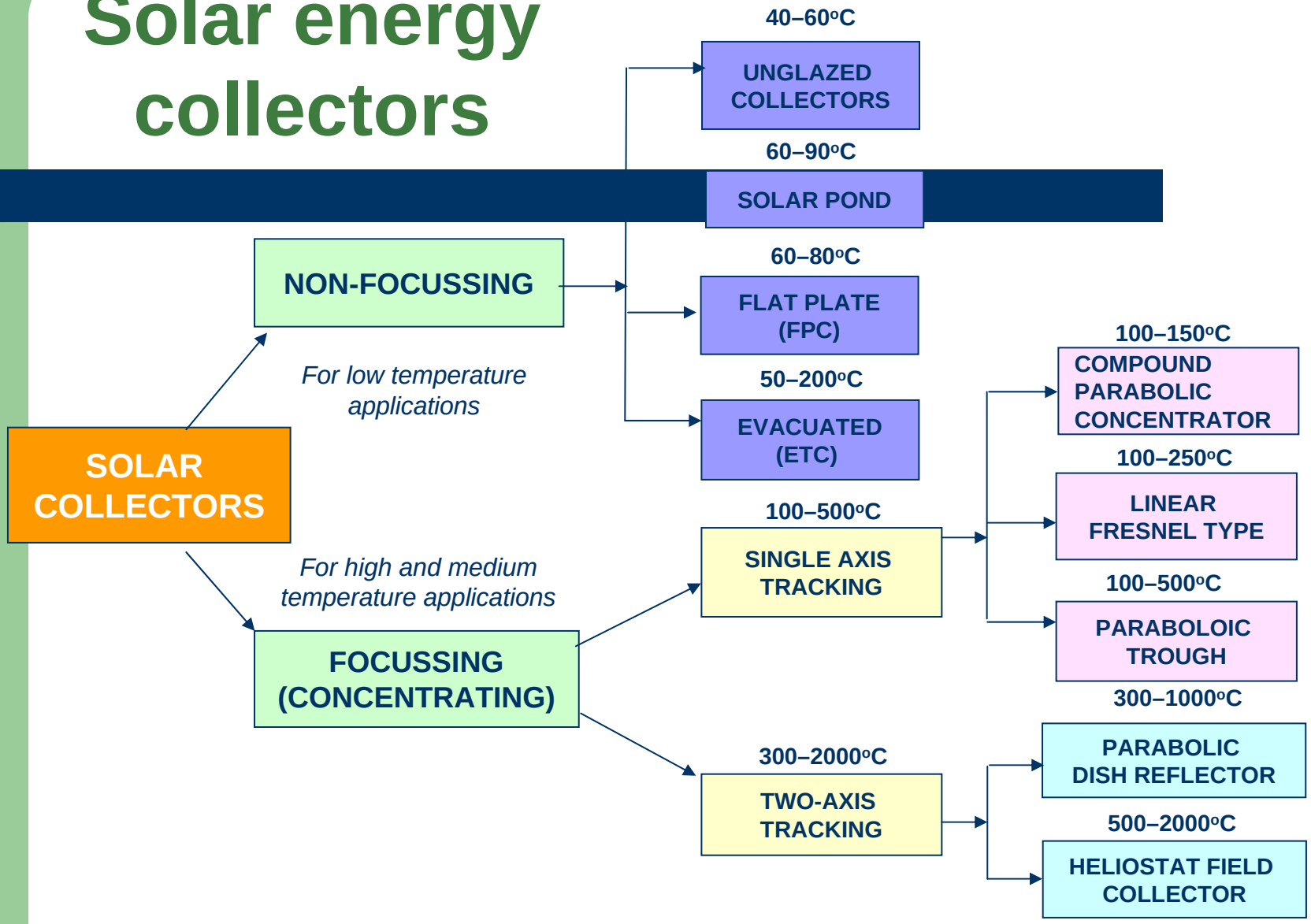
Annual fuel replacement possible – contd…

- Steel re rolling-billet reheating: 80%
- Gypsum-Calcination (Plaster of Paris making): 50%
- Tile-drying/evaporation: 50%
- Pottery products: drying/evaporation- 100%
- Rubber drying: 100%
- Tobacco drying: 100%

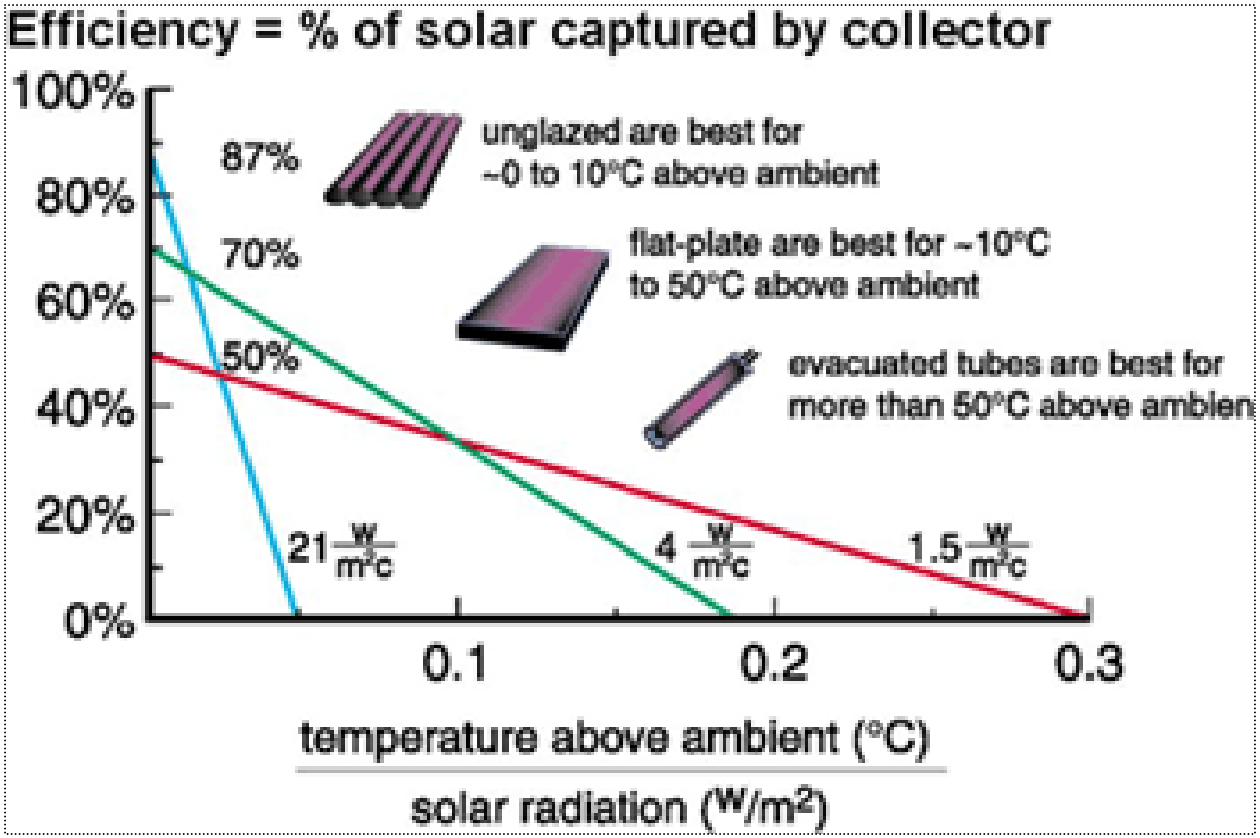
Annual CO_2 savings (million tonnes)



Solar energy collectors



Non tracking collectors' thermal performance



Industrial hot water systems

One of the World's largest industrial solar water heating system

- Working since: 1997.
- GHG emissions saved: 700 t CO_2 per annum
- Energy savings 22GJ per day
- Payback period:5 years

Capacity: 1,20,000 lit /day

Application: Boiler feed water pre-heating

Installed at: M/s GFCL ltd, Kakinada

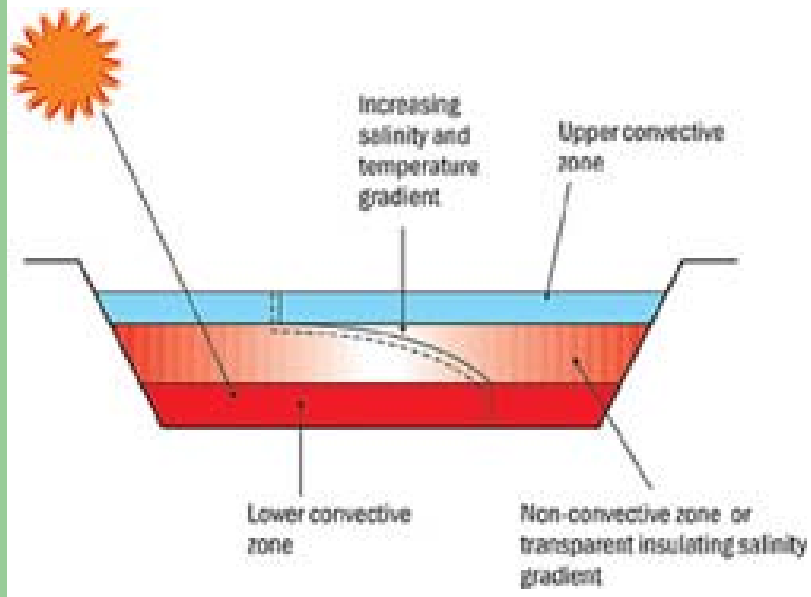
Area: 60m × 80m (1309 collectors)

Solar water heating for hotel industry

Hotel Fishermans' cove, (Taj Group), Chennai

Capacity: 20000 lit /day

Solar pond



6000m^2 Solar pond at Bhuj dairy, Bhuj, Gujarat

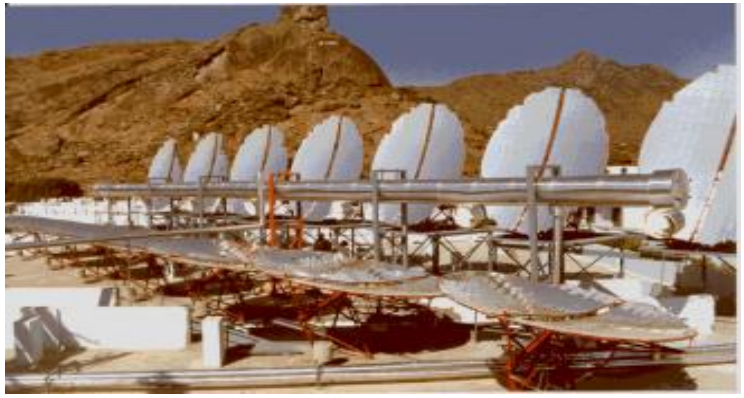
Designed and installed by TERI

Source: *www.teriin.org*

Solar steam systems

A view of solar steam cooking system installed at Tirupathi, Andhra Pradesh

The system has been designed to generate over 4000 kg. of steam/day at 180 ^{0}C and 10 kg/cm^{2} which is sufficient to cook two meals for around 15,000 persons.



Solar steam cooking system in Leh

Source: www.gadhia-solar.com/

India Innovates

ARUN160: Fresnel Paraboloid concentrator with cavity receiver with 2-axes tracking having
160 m^2 aperture area installed under IIT-Bombay - Clique R & D Project sponsored by MNRE for milk pasteurization at Mahanand Dairy, Latur, Maharashtra, INDIA

ARUN160: Solar dish

Source: M/s Clique Technologies, Mumbai

Solar drying applications

- Men-Tsee-Khang, (A pharmaceutical company) based in Dharamsala
- Application - Drying of herbs - 100Kg/day
- Moisture need to be reduced to 4%
- Operation hours
  - 1000 to 1530 hrs during winter
  - 0930 to 1600 hrs during summer

Solar drier for fish processing

- Processing of fish experiences a large wastages – solar dehydration leads to low cost and longer shelf life for fish
- The system consists of 23m^2 solar air heating sections V-Corrugated aluminum absorber air flow below the absorber, 4mm tempered glass and rock wool insulation and 180 W blower.

Source: Planters Energy Network, Coimbatore

Solar drier for fish processing–
contd…

Source: Planters Energy Network, Coimbatore

Solar pre-heating for tea leaf processing

- A 212 m^2 solar air heating system consists of 4 numbers of 53m^2 sections with air overflow system. Glazing by 4mm tempered glass, 20 degree tilt angle, black paint metals absorber is used. The hot air is pumped to the coal operated hot air generator at the inlet point using 5.7 kW blower.
- Typically the system operates for 1545 hours per annum, saving 71 tones of lignite coal leading to annual CO_2 reduction of 121 tones. An average 25% fuel savings is achieved.

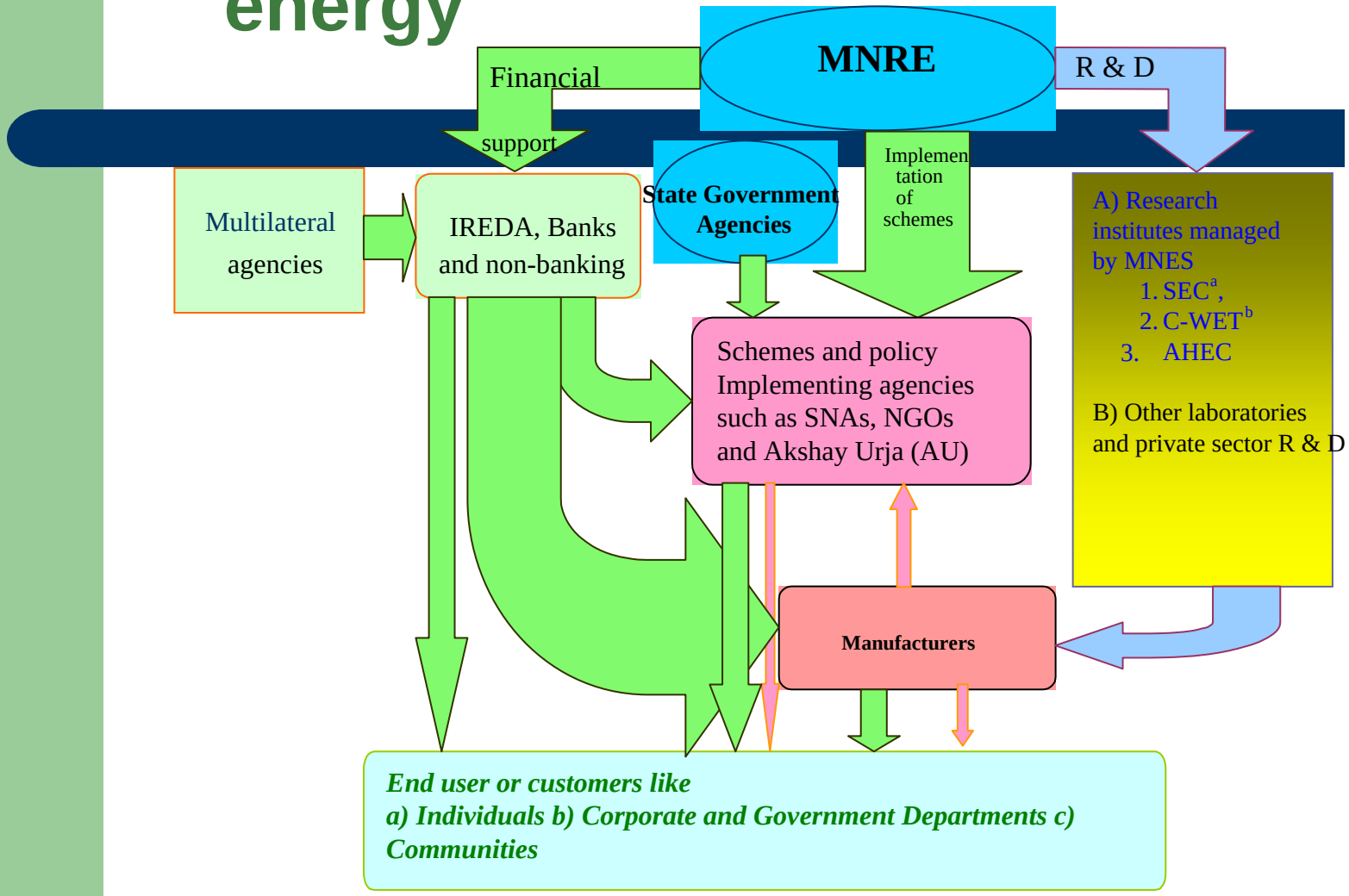
Solar pre-heating for tea leaf processing – contd...

Source: Planters Energy Network, Coimbatore

RE Institutional Development

- **1981- Commission for Additional Sources of Energy**
- **1982- Department for Non-conventional Energy Sources (DNES)**
- **1987- IREDA Established**
- **1992- DNES upgraded to Ministry of Non-Conventional Energy Sources (MNES)**
- **2006- MNES renamed as Ministry of New and Renewable Energy (MNRE)**

Institutional structure -Renewable energy



Policy and regulatory support

- Policy support since 1982
- Concessional import duty for critical components till indigenous development takes place
  - Support to R & D
- Variety of fiscal and financial benefits
  - Capital subsidy
  - Low interest loans
  - Reduction/Removal of taxes and duties
  - Tax benefits
    - 80% depreciation in the first year

Barriers

- Site constraints
  - Shadow free area for installation
  - Factory layout
  - System integration with existing system
- Awareness and willingness to invest
- System designers and manufacturers
  - Limited technical capacity
  - Lack of instrumentation and controls

Way forward- south-south cooperation

- India can offer simple affordable technologies
- Its important for us to share the experience
- Capacity building of manufacturers and system designers
- Need to develop technical solutions and demonstration projects for industrial applications

Thank you for your attention!

Contact

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www.teriin.org