Potential for Solar Thermal in India

The Forgotten Solar: Solar thermal and its development

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V.S.Sharma : General Manager – Renewable Energies

Steag Energy Services India Pvt. Ltd.

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Topics for discussion

- Steag and it's activities
- Advantages of Solar thermal – Surety of potential
- Solar thermal potential areas
  - Power generation
  - Industrial Heating applications - Textiles, Pharma, Dairy, Paper, Metal treatment etc.
  - Desalination applications – Using MED and other processes
  - Hybridization with Conventional plants – Coal fired, Gas fired etc.
  - Cooling applications – Air conditioning, cold storage etc.
- Solar Thermal – Factors for realization of potential

Steag's Activities

Steag Germany - Key figures (as of Dec. 2011)

- External sales **3,066 € m**
- Capital expenditure on fixed assets **1,283 € m**
- Employees **5,800**

Steag India Activities

- Engineering Consultancy
- O&M services – ~ 5000 MW
- System Technology – Simulators and Plant optimization systems
- Training and advisory services

Steag India – Solar activities

- Several DPRs and feasibilities
- Ebsilon Solar – Proprietary thermodynamic design software
- Solar simulator - with Trax
- Owners Engineer NTPC Anta
- Training on Solar – With IITJ

STEAG holds a strong position in the renewable energy market

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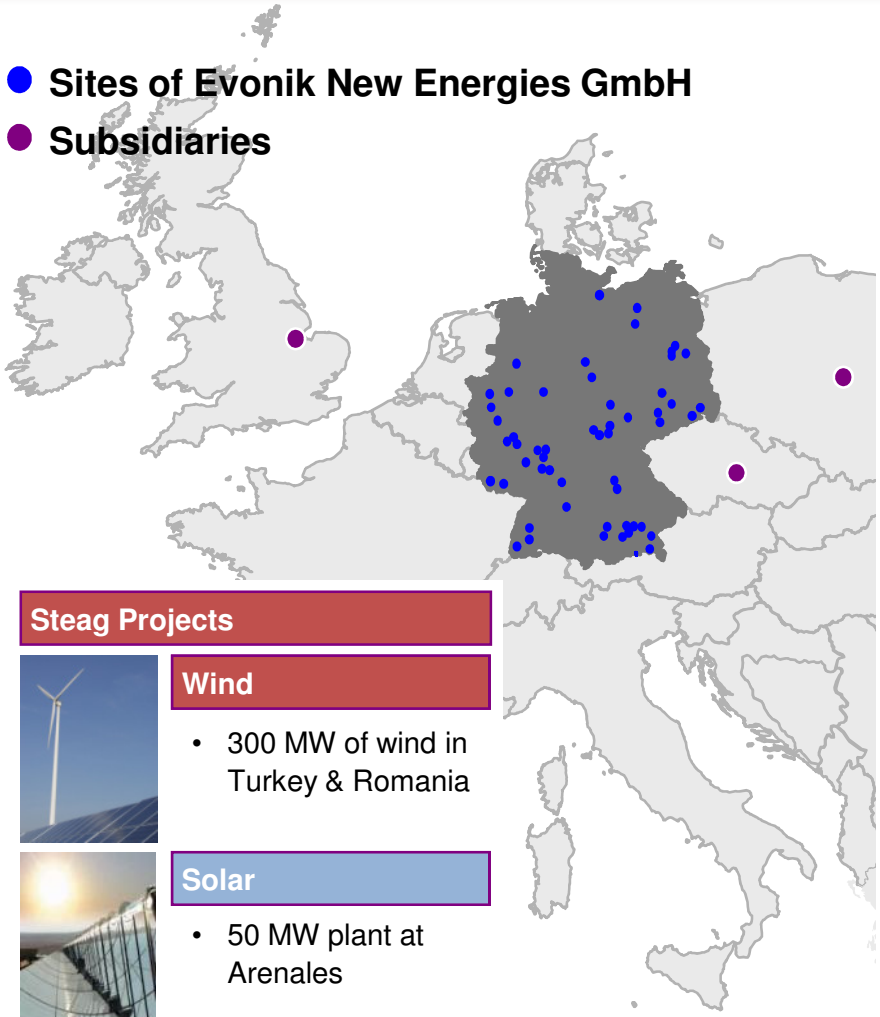
- Sites of Evonik New Energies GmbH
- Subsidiaries



Steag Projects

Wind

- 300 MW of wind in Turkey & Romania

Solar

- 50 MW plant at Arenales

		Installed capacity		Plants
		MW_{el}	MW_{th}	
	**Biomass*** • since 2002 • #3 in Germany	66	154	13
	**Biogas** • since 2007 • First own biogas plant commissioned			
	**Mine gas** • since1908 • #1 in Germany	177	139	108
	**Geothermal** • since 1994 • #1 in Germany	--	71	2
	**Contracting** • since 1961 • #2 in Germany	77	905	100
Total		**319**	**1,271**	**223**

Steag's Arenales 50 MW plant in Spain

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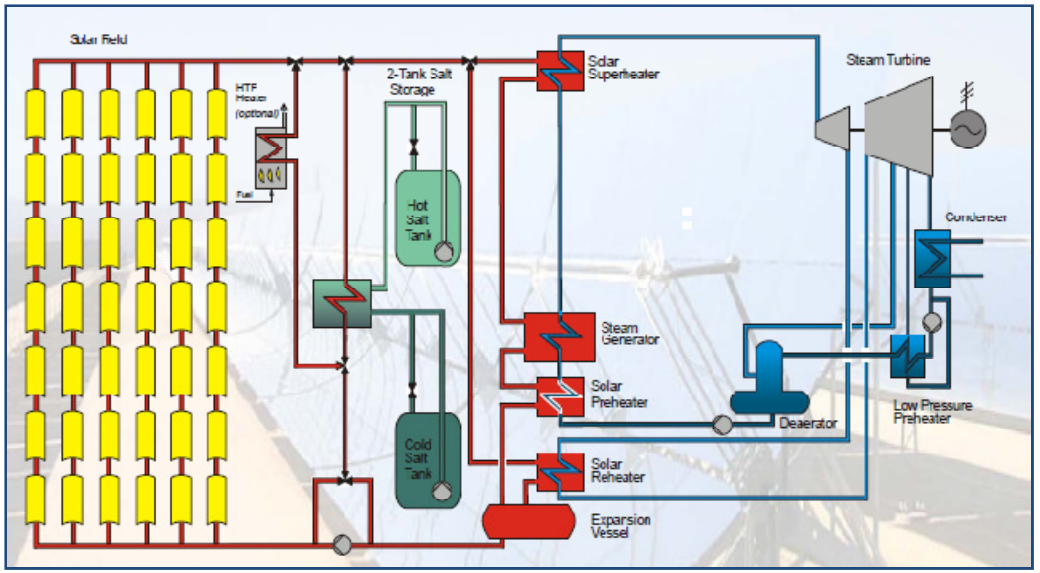
- Steag has a 26% stake
- O&M shall be done by Steag themselves
- Technical concept comparable to Andasol 3
- Capacity of the plant: 49.9 MW
- Wet cooling tower implemented
- Solar field with 156 Loops Parabolic Collectors
- Thermal Storage (salt) for up to 7h of full load operation
- Gross electricity production: about 170 GWhel p.a.
- Planned operation period: 40 years



➢ The implemented technical concept is state of the art for CSP plants in Spain

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Advantages of Solar thermal over other RE sources

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- The only RE power that is fully Dispatch able.
  - Dispatch when you need the most.
  - Big advantage as the peak hours are not necessarily the same as production hours.
- Can act as a base load plant
  - Possible with adequate storage
  - Example – Gemasolar plant
- Storage helps in steady power during the day also.
  - Grid stability. There is a limit on other types of RE power
  - Important for ABT regime.
- Possibility of hybridization with conventional power
  - Better efficiency – no start-up losses
  - Lower cost – no separate power block.

Gemasolar Project

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SOLAR FIELD

Heliostat Solar-Field Aperture Area:	3,04,750 m²
# of Heliostats:	2,650
Heliostat Aperture Area:	120.0 m²
Heliostat Manufacturer:	Sener
Heliostat Description:	Sheet metal stamped facet
Heliostat Drive Manufacturer:	Sener
Tower Height:	140 m
Receiver Manufacturer:	Sener
Heat-Transfer Fluid Type:	Molten salts (sodium and potassium nitrates)
Receiver Inlet Temp:	290C
Receiver Outlet Temp:	565C
Receiver Temp. Difference:	275C

Gemasolar Project

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THERMAL STORAGE

Storage Type:	2-tank direct
Storage Capacity:	15 hour(s)
Thermal Storage Description:	One cold-salts tank (290ºC) from where salts are pumped to the tower receiver and heated up to 565ºC, to be stored in one hot-salts tank (565ºC). Annual equivalent hours = 6,500.

Gemasolar Project

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POWER BLOCK

Turbine Capacity (Gross):	19.9 MW
Turbine Capacity (Net):	19.9 MW
Cooling Method:	Wet cooling
Fossil Backup Type:	Natural gas
Backup Percentage:	15%
TOTAL PROJECT COST	EURO 230,000,000
Construction Job-years	800
O & M Jobs	45

Cost of thermal storage vs Battery storage

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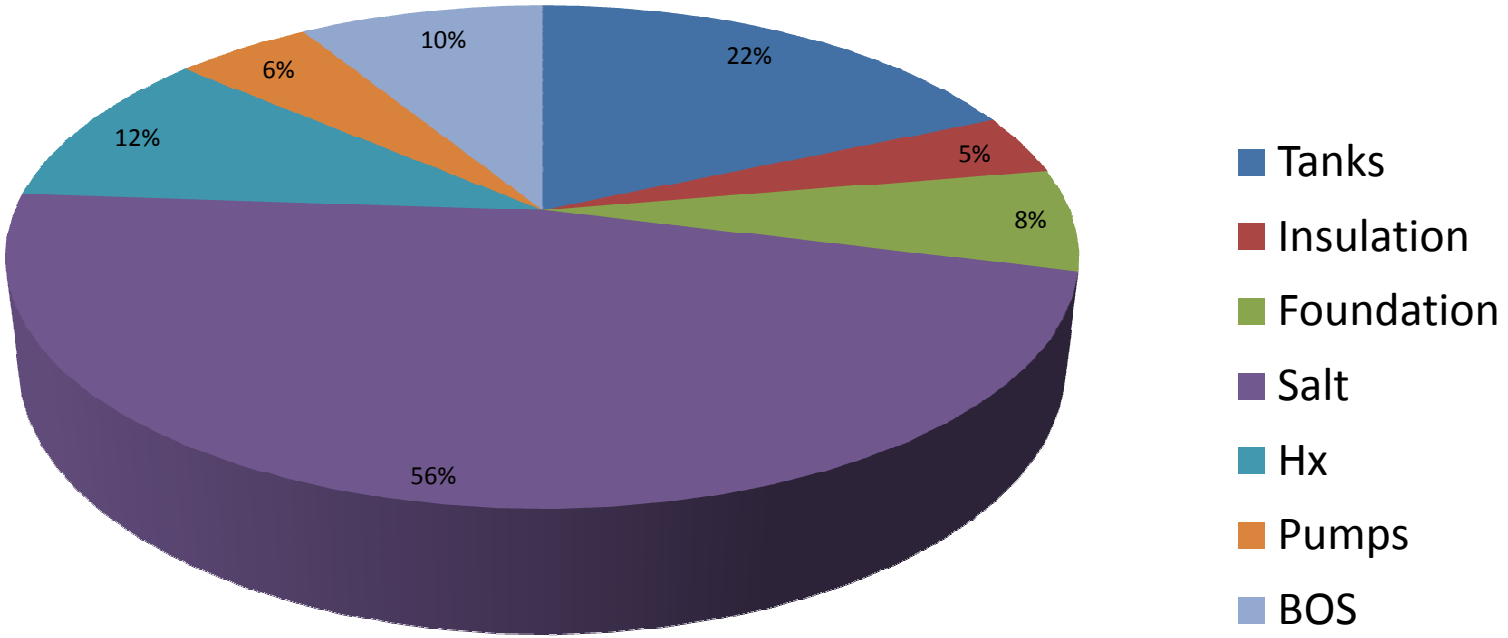

Total Cost	50 MW with 6 hours Storage	$70,000,000 or 450 Crores
Equivalent Battery storage		550 Crores with 7 yrs Lifetime

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Solar Resource in India

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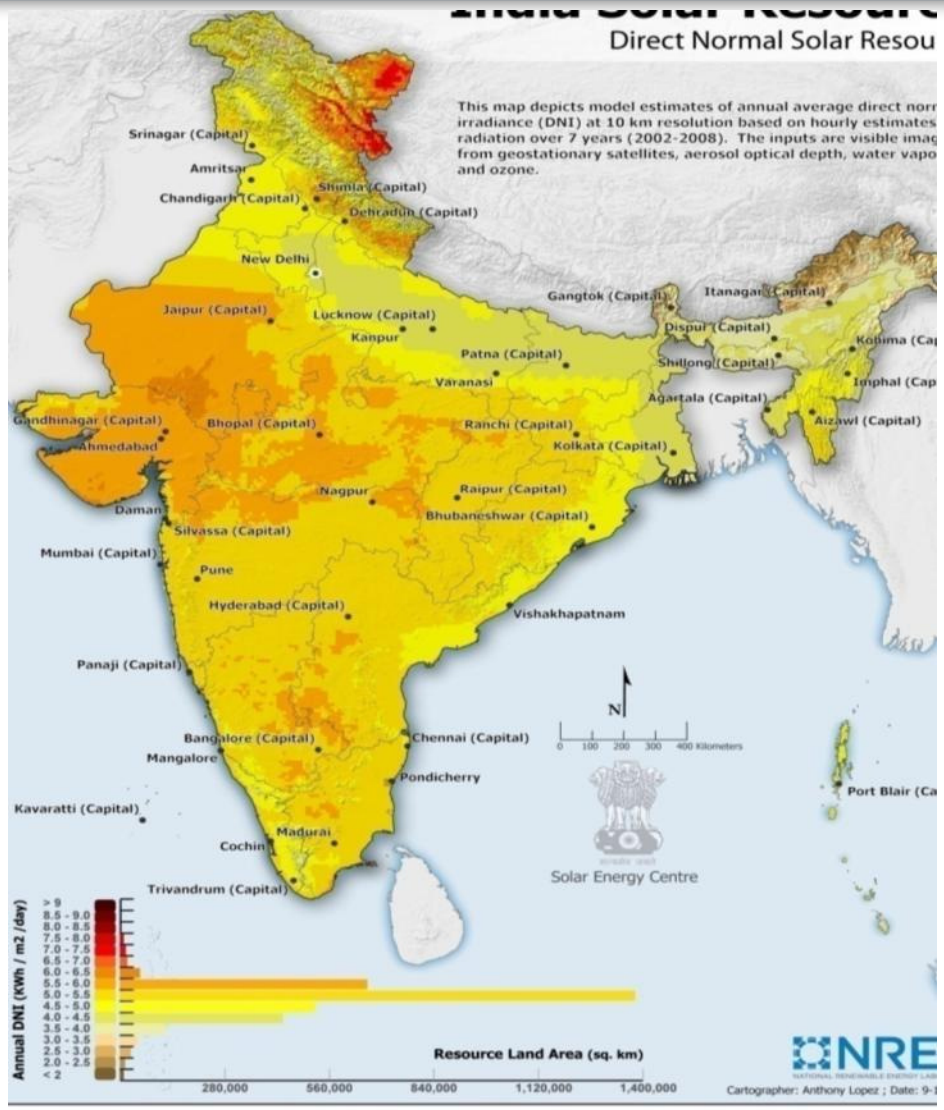

DNI Map

TECHNICAL POTENTIAL – SOLAR THERMAL

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Zones	DNI	Area	Technical Potential	Economic Cost
		Km2	*Billion Units/year*	*Rs. (Crores)*
Zone 1	High	23,185	1,600	14,000
Zone 2	Moderate	175,667	10,500	105,000
Zone 3	Acceptable	444,415	25,000	266,000
Zone 4		151,106		

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Solar potential across processes industry – International figures

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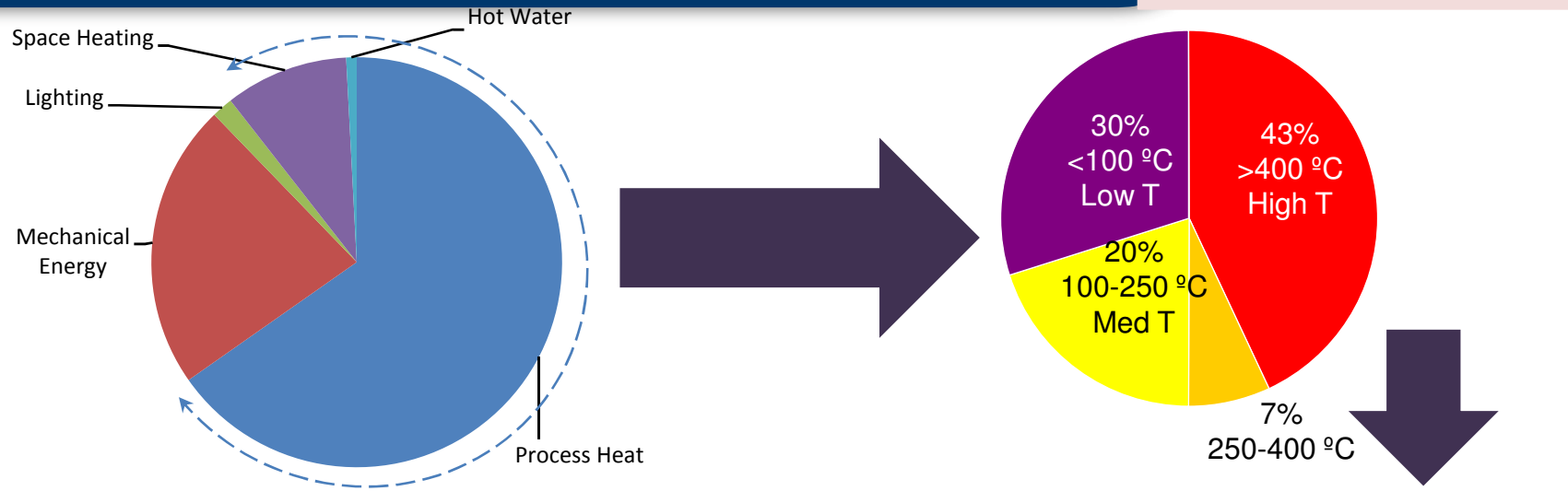
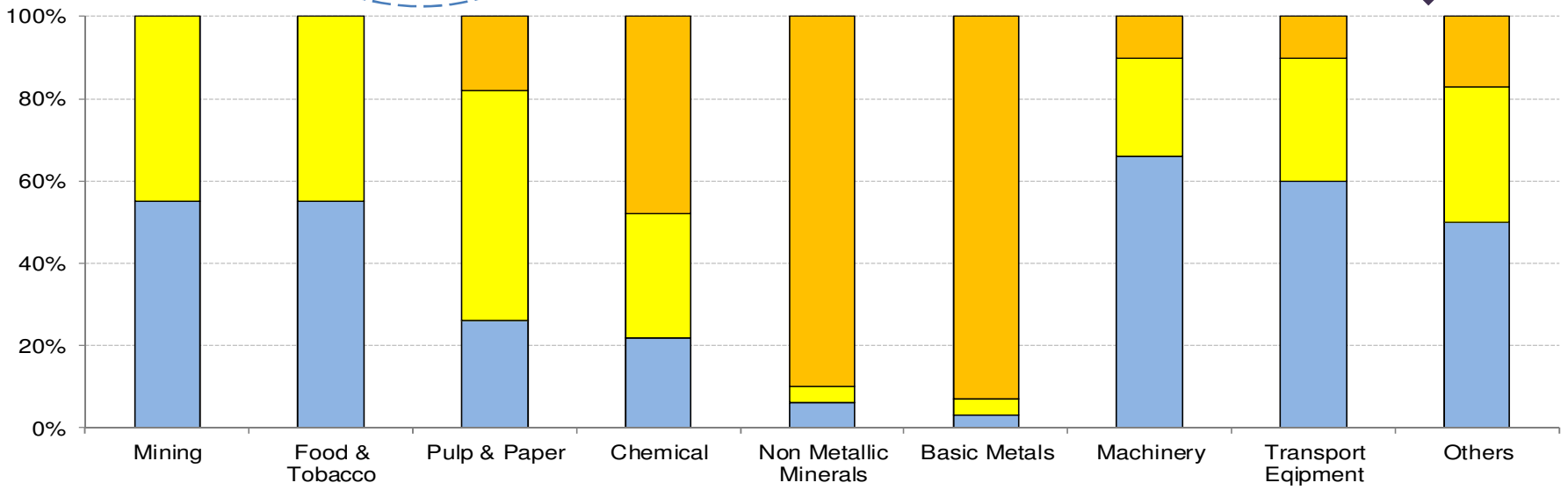
Solar Thermal Potential





Source: ECOHEATCOOL (IEE ALTENER Project), European Solar Thermal Industry Federation

Technological developments and commensurate policy support will give fillip for fast deployment

What this means for India

- 60 TO 70% OF INDUSTRIAL ENERGY USE IS IN THERMAL FORM
- INDIA USES 100 MILLION TONS OF OIL ANNUALLY
- 40% OF THIS OIL CONSUMPTION IS IN INDUSTRY (40 MT)
- About 15 MILL TONS OF OIL IS USED IN INDUSTRY BELOW 250℃.
- 30% OF THIS REQUIREMENT CAN BE MET THROUGH SOLAR THERMAL CONCENTRATORS, LEADING TO SAVINGS OF ABOUT 4.5 MILLION TONS OF FURNACE OIL OR LDO OR DIESEL PER YEAR

Multiple technology solutions in solar thermal for vast applications in industrial sector

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70 °C — 200+ °C

Low Temperature Collectors

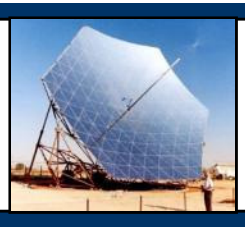
Temperature -70 to 120 °C

- Suitable for flat as well as inclined roof
- No tracking hence low maintenance

Applications

1) Pasteurization
2) Boiler feed water heating
3) LPG Vaporiser

Parabolic Dish Collectors



Temperature -100 to 150 °C

- Dual axis tracking
- Fixed as well as moving focus

Applications

1) Oil Heating
2) Double Effect Cooling
3) Various Process Heating Applications

Mini-Parabolic Troughs

Temperature -160 to 210 °C

- Single axis tracking
- Fixed line focus

Applications

1) Power Generation
2) Triple Effect Cooling
3) Various Process Heating Applications

CLFR

Temperature - > 200 °C

- Single axis tracking
- Fixed line focus

Applications

1) Power Generation
2) Spray Drying
3) Triple Effect Cooling

Industries with Potential to Use Solar Energy – Ranked as per the potential

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Rank	Industry	Energy Saving Potential (ktoe/annum)	Monetary Saving Potential (Rs. Million / Annum)
1	Textile (Finishing)	383	7692
2	Pulp and Paper	45	1700
3	Pharmaceuticals	9	NOT AVAILABLE
4	Leather	17	1026
5	Food processing	80	1782
6	Dairy	27	916
7	Textile (Spinning and Weaving)	20	740
8	Electroplating/Galvanizing	21	NOT AVAILABLE
9	Automobile	10.5	607
10	Agro malls	4.3	160

Source : GIZ - MNRE

Textile Finishing Process

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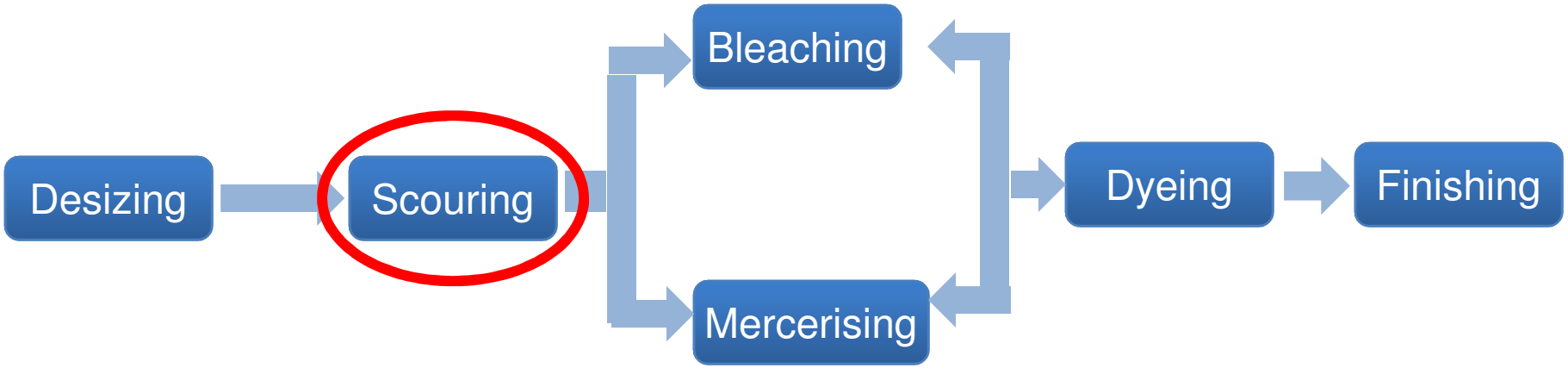

Source : GIZ - MNRE

Pulp & Paper Making Process

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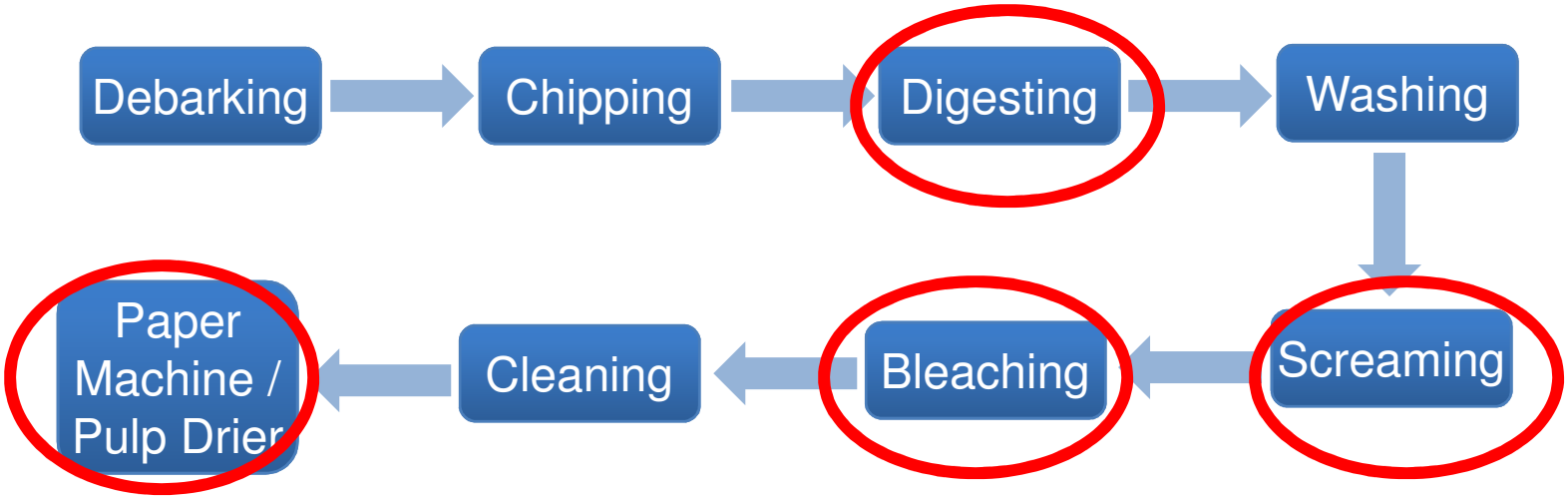

Source : GIZ - MNRE

Dairy

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Source : GIZ - MNRE

Pharmaceutical Process

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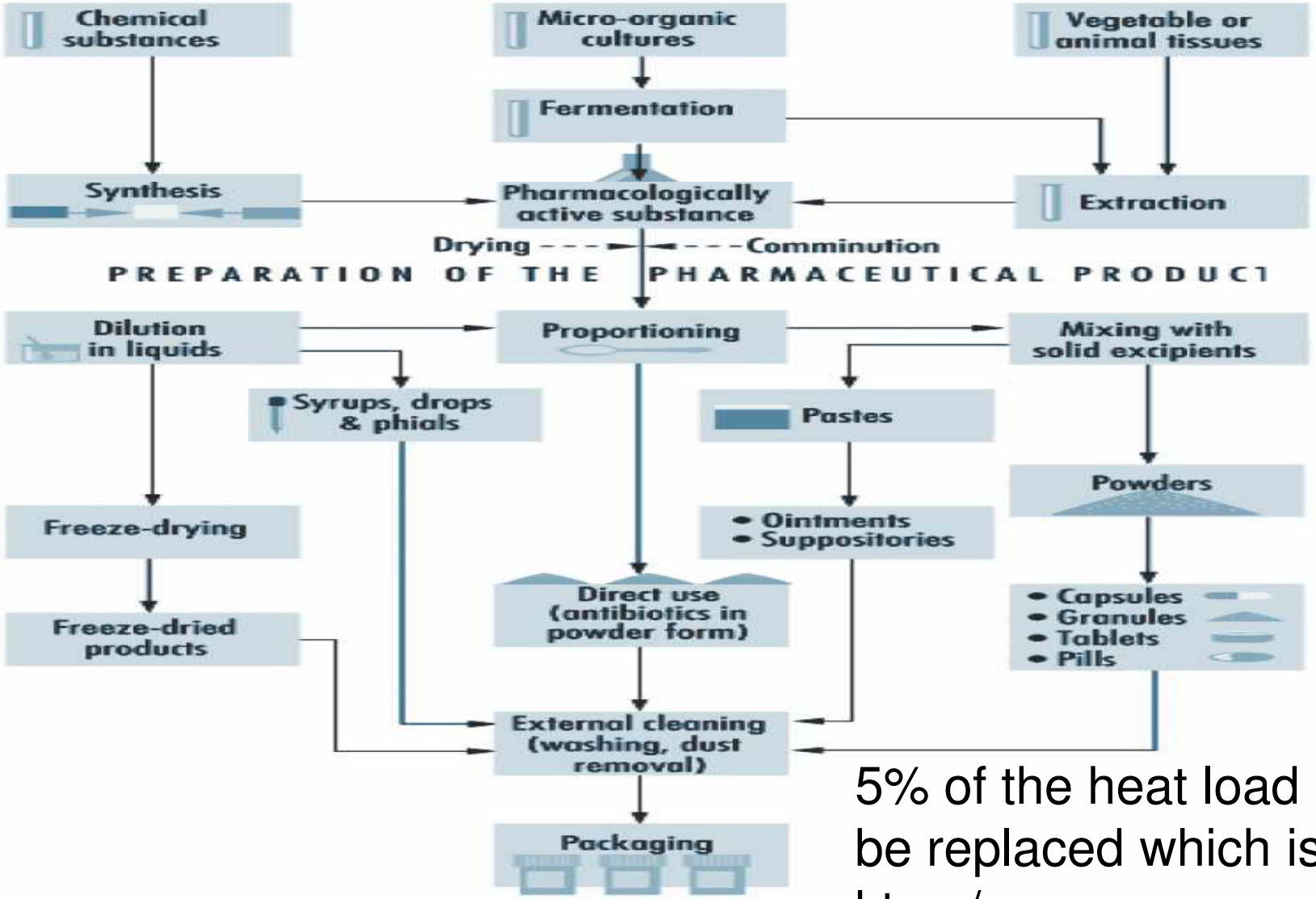

5% of the heat load can be replaced which is 9 ktoe / annum

Source : GIZ - MNRE

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States hit by water scarcity

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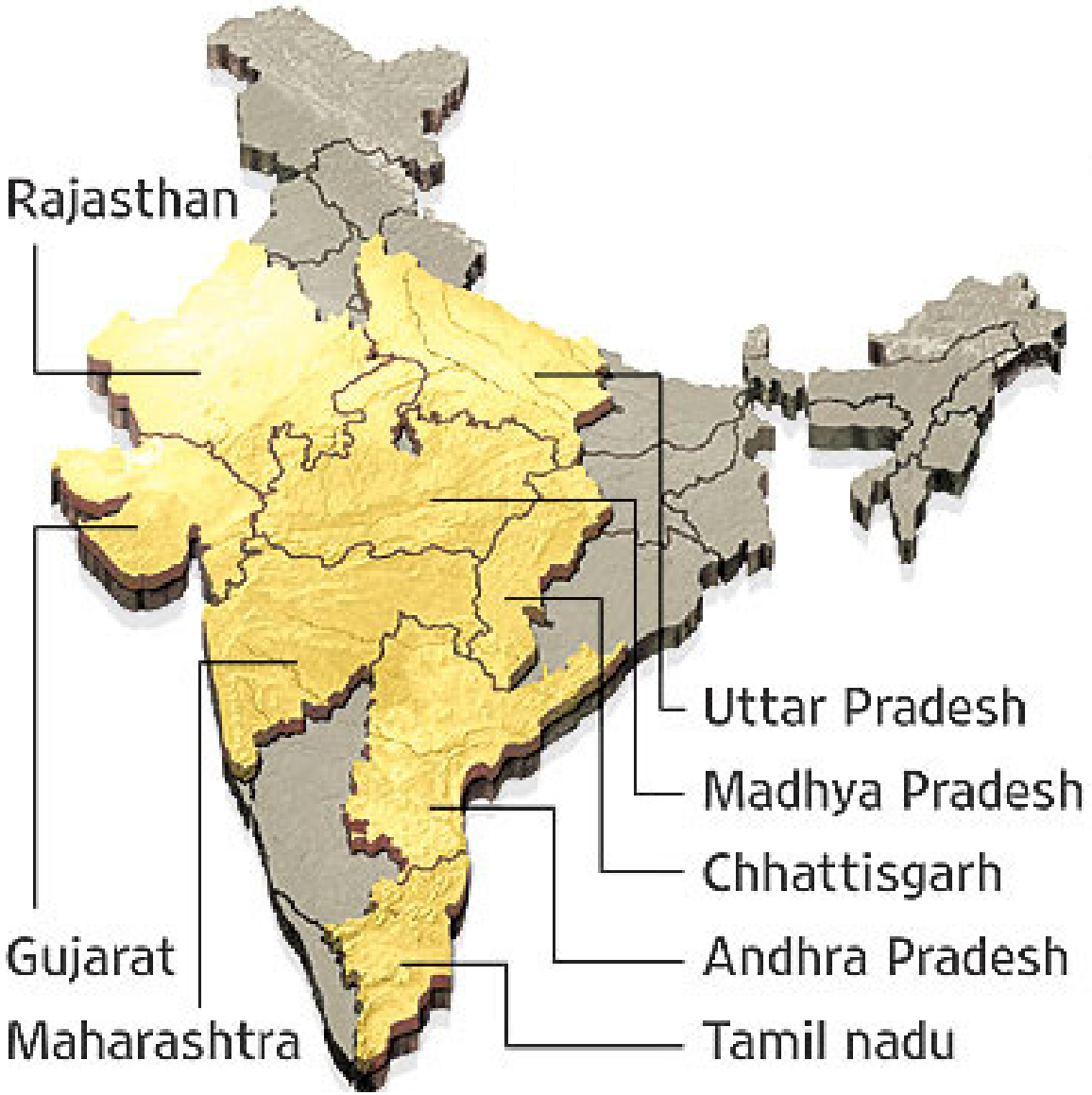

According to the central water commission, the total utilisable water per capita is 1022.7 cubic metres every year. The per capita demand in 2000 was 634 cubic metres and is projected to go up to 1,093 cubic metres by 2025.

Computer model of a 12MWe Combined Solar Biomass Desalination Plant including Air Cooled Condenser – Concept by Steag

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Exterior View of the 12MWe Combined Solar Biomass Desalination Plant from the Solar Field side - Concept by Steag

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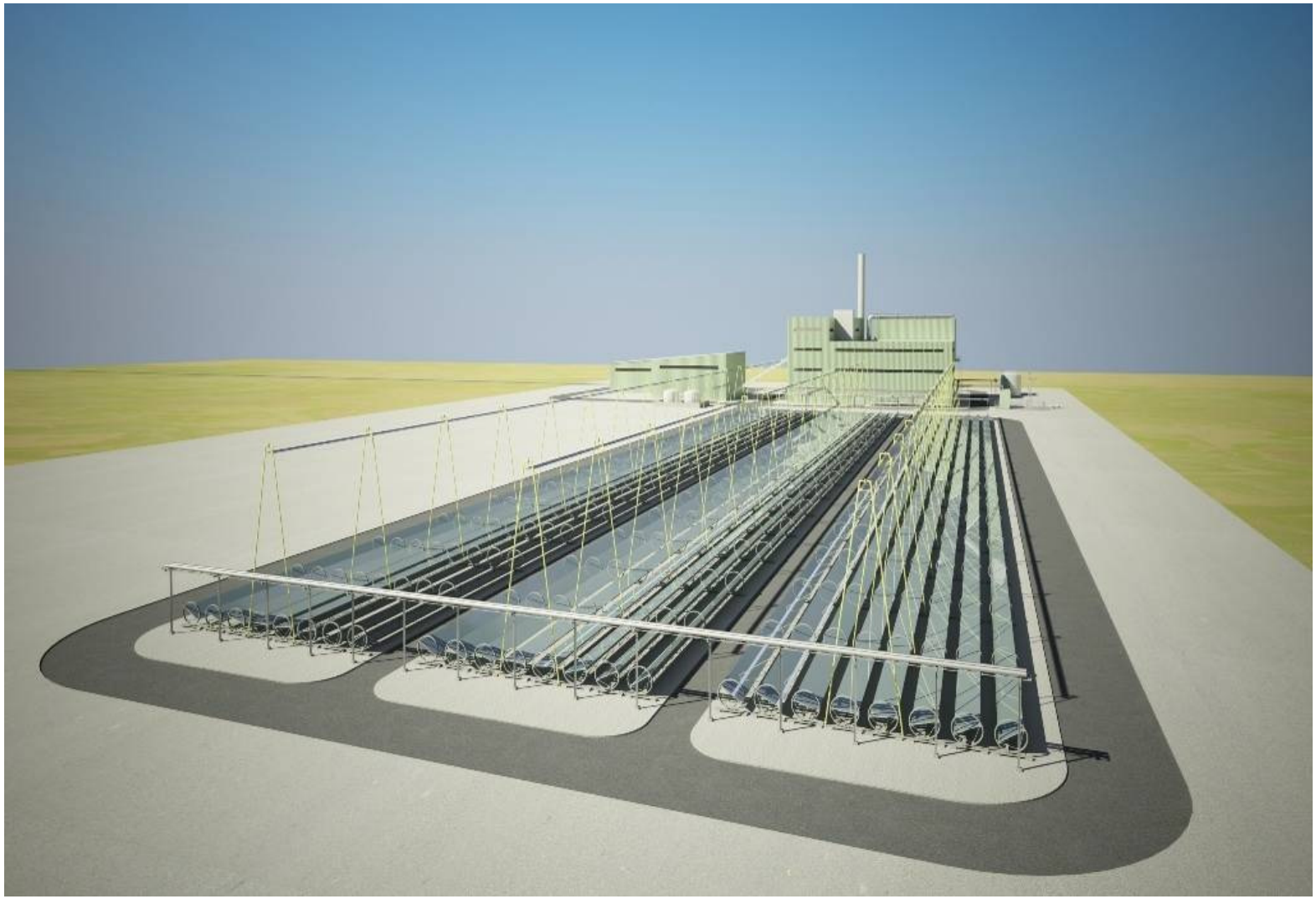

WHAT IS SPECIAL ABOUT THIS PROJECT

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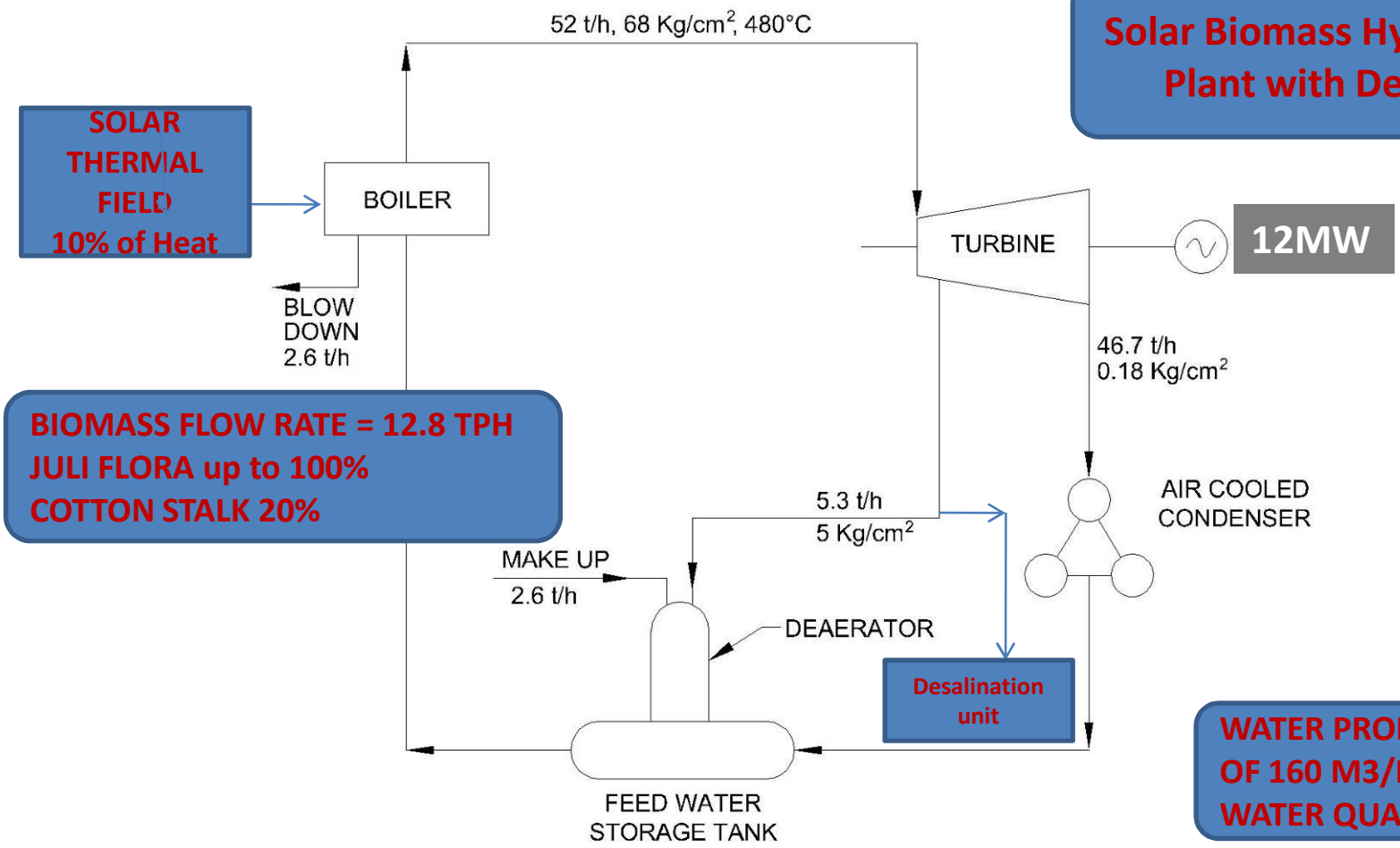
Solar Biomass Hybrid Power Plant with Desal WTP



WATER PRODUCTION OF 160 M3/DAY DM WATER QUALITY

Solar desalination in Ramanathapuram district of Tamil Nadu

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- 1,44,000 litres per day of desalinated water
- Solar field – CLFR 1400 sqm of mirror
- Project developer – KG Design Services Coimbatore
- Source of water – Bay of Bengal
- Purity of water – 2 ppm
- Usage of water – Drinking in nearby villages
- Co-developer – national Institute of Ocean Technologies
- Funding – DST
- Scalability - Good
- One Kg of steam produces approx 8 kg of desalinated water

Solar desalination in Ramanathapuram district of Tamil Nadu

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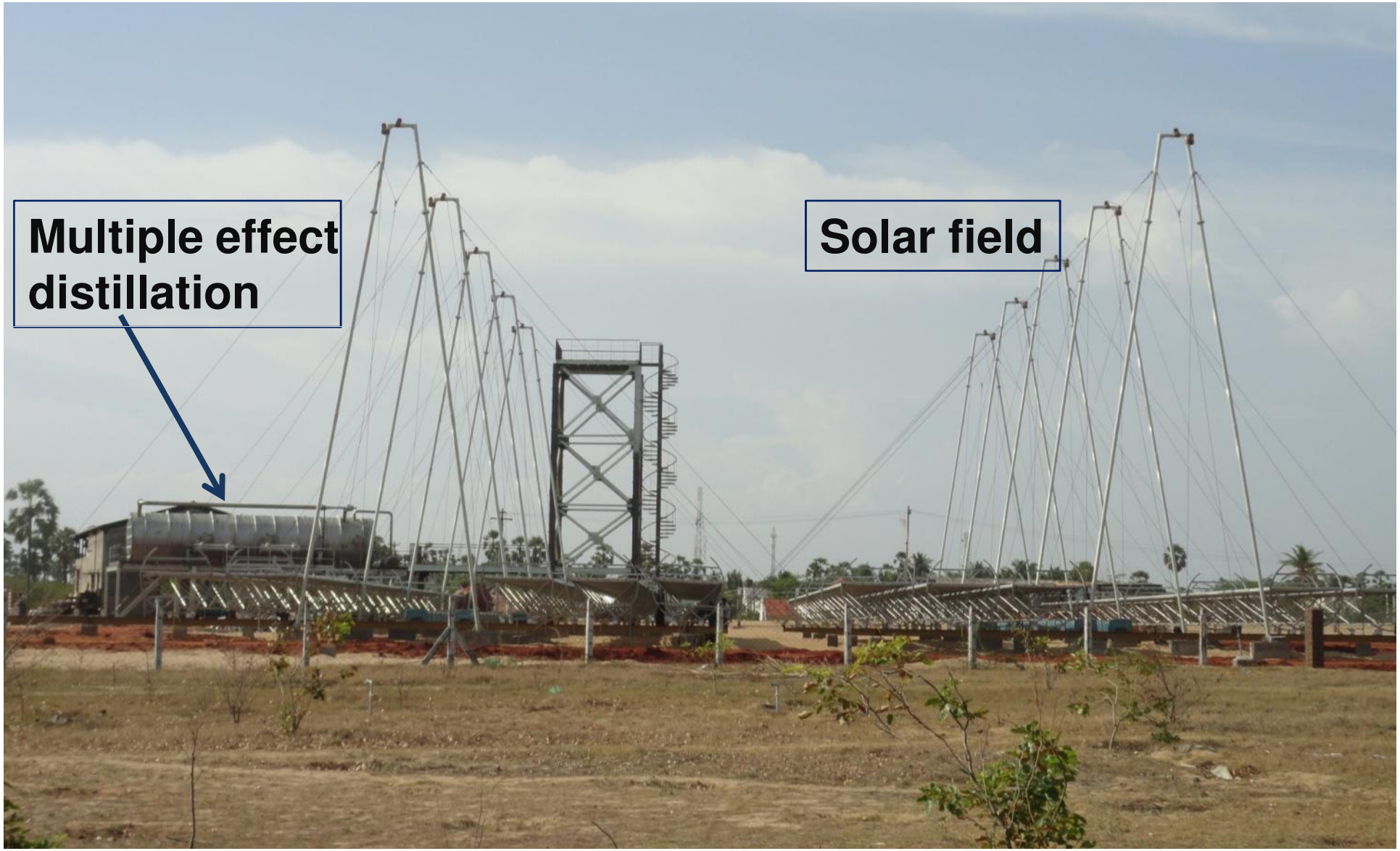

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NTPC ANTA - SOLAR FIELD LAYOUT FOR CCPP INTEGRATION

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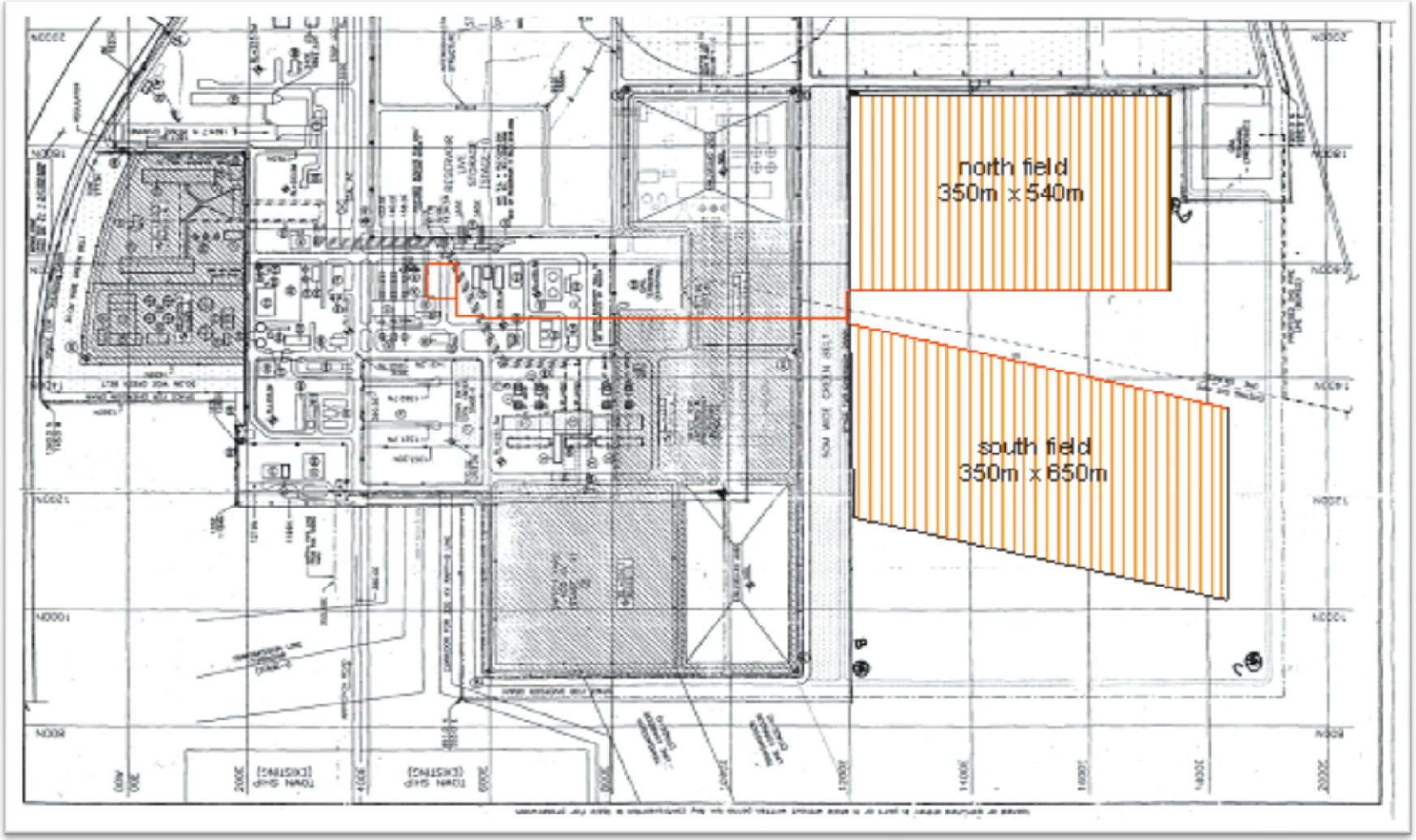

13 MW Capacity, 132 Collectors, Solar Field Size Optimized Based On Margin Available In Existing Anta CCPP

LIMITING BOUNDARY CONDITIONS

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1. Steam Turbine maximum main steam flow limited to 488 tph to HP-Turbine and 601 tph to LP-Turbine as per heat balance diagram “peak load”.

2. Condenser main steam flow limited to 601 tph as per heat balance diagram.

3. ST generator transformer rated at 195MVA

INTEGRATION OPTIONS

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1. Solar Steam integration in to HP Drum of each of 3 existing HRSGs
2. Solar Steam integration in to HP Super Heater of each of 3 existing HRSGs
3. Solar Steam @ 370^0 C integration in to HP Main Steam Header (485^0 C) before Steam Turbine
4. Solar Steam with separately fired Super Heater and Integrating in to HP Main Steam Header before Steam Turbine
5. New BPST integrated at existing LP main steam header
6. New Condensing Steam Turbine Integrated at existing condenser.
7. Standalone Power Plant.

.

5 MW proposed Solar integration at Shree Cement

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Proposal

- Integration of a 5 MW solar field in a 15 MW turbine
- The turbine is fed from six waste heat recovery boilers which get heat from flue gases of the cement kilns
- Injection point is at HP steam header
- The water extraction is either from CEP outlet or BFP inlet

5 MW proposed Solar integration at Shree Cement

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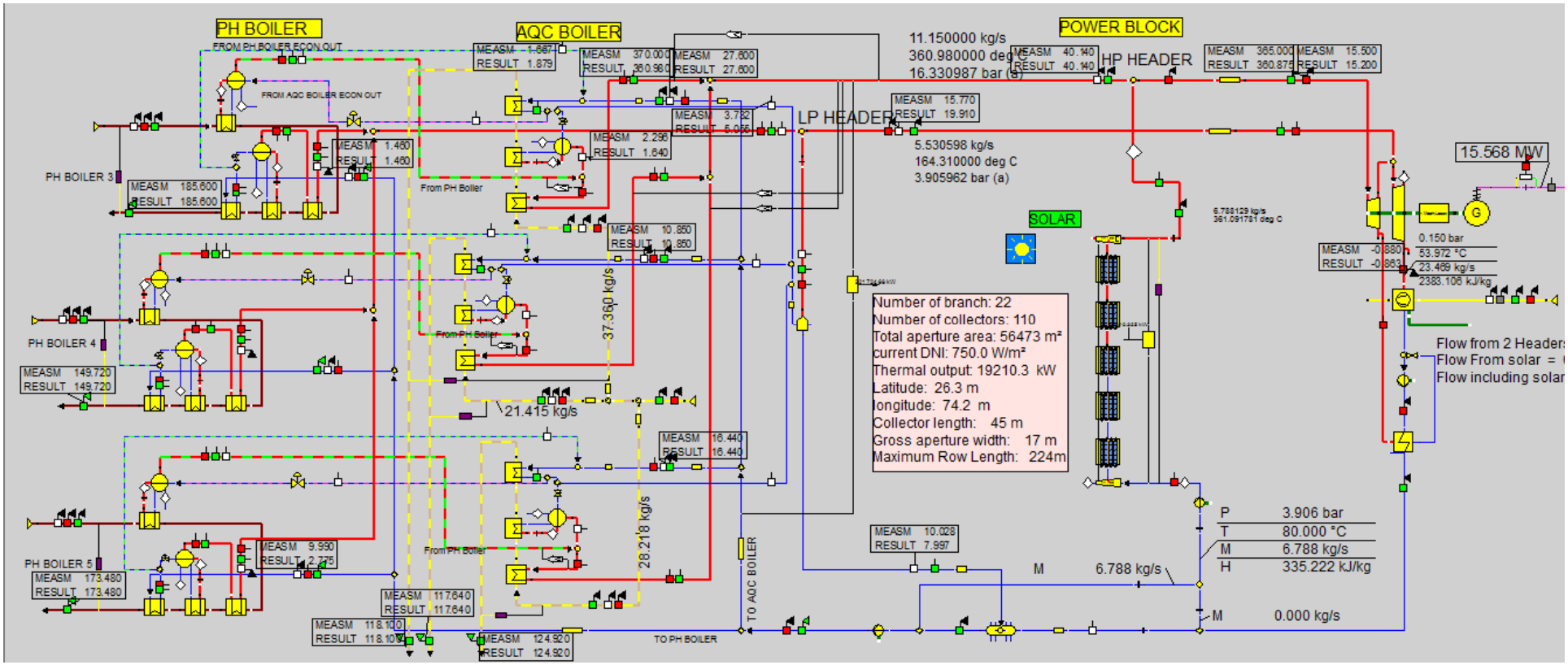

Ebsilon model of the integrated system

Hybridization studies by Steag

Hybridization could become the largest market for CSP. STEAG Energy Services has investigated CSP Topping for the following plants:

- 2 x 660 MW coal-fired power plant Sugözü in Turkey
- 165 MW coal-fired power plant Termopaipa in Colombia
- Coal-fired power plants in Brazil
- 1X15 MW Anta project of NTPC
- 1X5 MW Shree Cement plant at Rajasthan

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Solar AC at SEC (Solar Energy Centre)

- Thermax has designed and commissioned a first-of-a kind solar air conditioning system at the Solar Energy Centre in Gurgaon, Haryana.
- The capacity of solar field is 100 kw
- The solar collectors have been designed to harness sun's energy in an effective manner to provide temperatures from 140 °C to 210 °C.
- Solar Collector area : 288 sq mtr
- This heat is used in Vapour Absorption Machine to generate 7 °C Chilled water which in turn circulates through the Fan coil unit installed in the thirteen rooms.
- A solar cold storage demo is also in progress at SEC

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Solar thermal – Factors for realization of potential

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- Multifarious applications of ST would give economy of scale in mid term future although currently the cost curves are better in PV. Industrial process heat, Solar AC, Desalination, hybrid plants beyond the regular power production.
- Costs will further reduce with indigenization of technology and increase in Domestic content.
- Support from Govt. Capital subsidy, tax subsidy, RECs, state funded demo plants and other favourable policies not only for the developers but for the entire eco-system of Solar thermal
- Positive consideration of financial institutions
- Positive consideration from industry to accept the industrial applications

Indigenization Benefit

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COST SAVING ESTIMATES	/ 100 MW	International Cost	Expected indigenous Cost	Total Cost Saving
Steel (MT)	25,000	$ 4,000 / MT	$ 2 - 2.50 / Kg	$56,250,000
Concrete (CBM)	30,000	$ 50 / CBM	$ 20 - 25 / CBM	$6,75,000
Glass (MT)	15,000	$ 40 / m2	$ 15 - 20 / MT	$2,50,00,000
EPC (% of project cost)	15%	6,00,00,000	7% - 9%%	$3,20,00,000
Manpower (% of project cost)	20%	8,00,00,000	10% - 12%	$3,60,00,000
TOTAL	*Potential cost saving @ $ 1,500 / KW*			$14,99,25,000

Effect of plant size on costing

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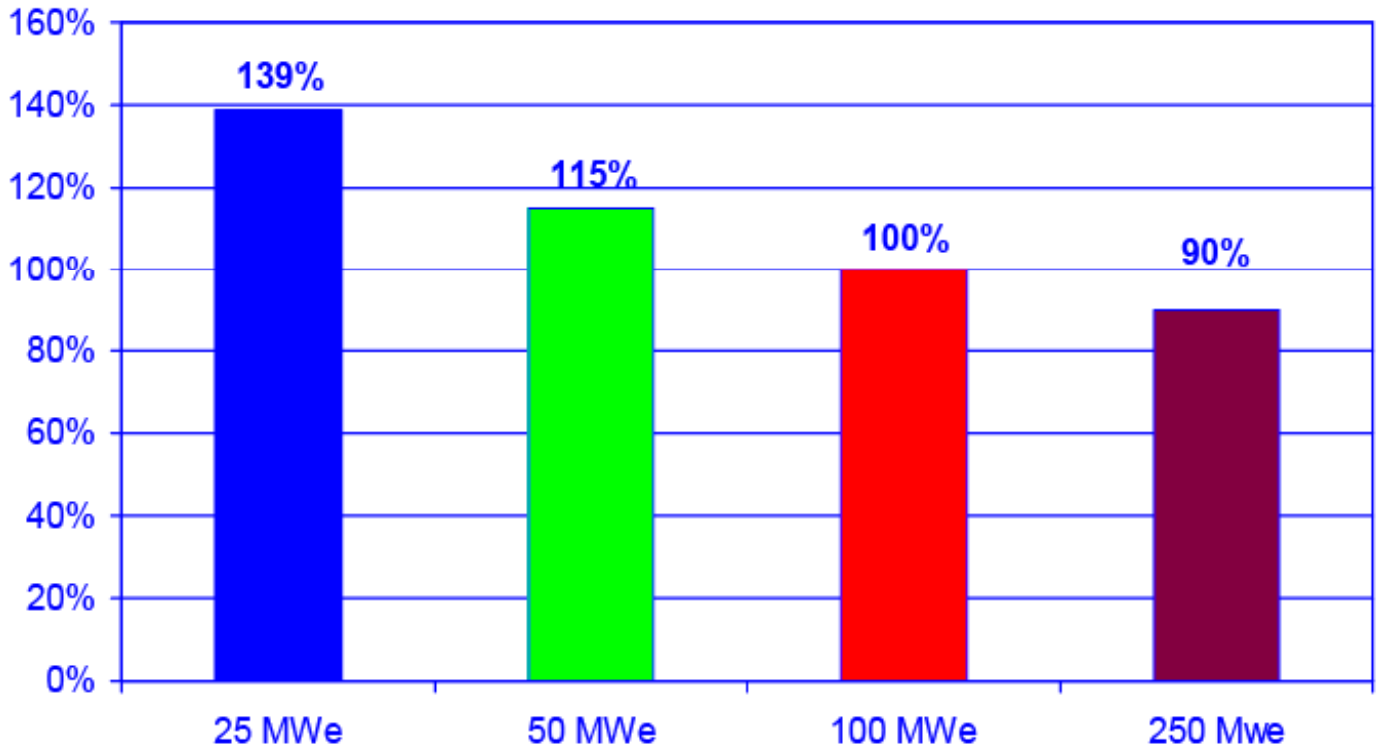

Effect of deployment on costing

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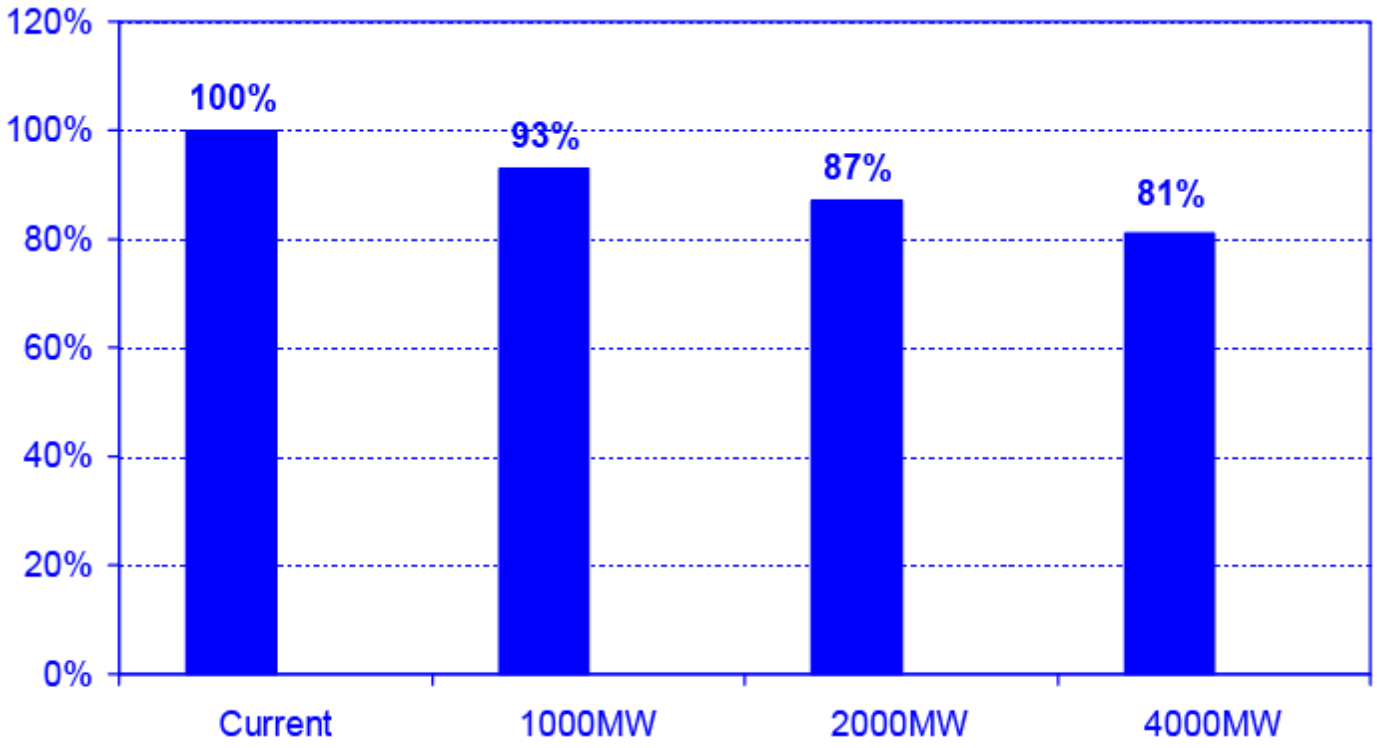

Conclusion

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Solar thermal is a long term player because :

- It is the only RE power that can be dispatched at desired time
- Can act as a base load plant
- Can give steady power during the day also – Grid stability, ABT
- Hybridization with conventional power is easily possible

The following are key to success of ST in India:

- Multifarious applications would give economy of scale
- Indigenization and Domestic content shall reduce the cost
- Support from Govt. Capital subsidy, tax subsidy, RECs, state funded demo plants
- Positive consideration of financial institutions
- Positive consideration from industry

... Ideas & Solutions for Tomorrow

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