Process Mapping of Automobile Sector for CST Intervention

UNDP GEF CSH Project

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Introduction

With a large share of the overall industrial energy use worldwide, the automobile manufacturing sector is the largest energy users in the industry. The sector is faced with the challenge of saving energy primarily for economic and environmental reasons. The automobile manufacturing sector contributes significantly to the Indian economy. The size of the Indian automobile industry as per SIAM estimates stands at around $58 billion for 2010-11. The production volumes in the automobile sector in India stood at around 2.06 crore vehicles for the year 2012-13. The industry comprises of both large vehicle manufacturers and ancillary units supplying components to these large manufacturers. According to a sector study conducted on the Indian automobile sector by Society of Indian Automobile Manufacturers (SIAM) between the years 2008 and 2013, the CAGR of automobile production was 13.70%. The following sections of the document make an effort to estimate the energy requirement of actual processes in sample units where information was gathered by way of structured questionnaires and walk through audits. Selection of concentrating technologies and their indicative techno-economic feasibility is done in order to assist the industry in making an informed choice of concentrating technology based on their understanding as a result of this document.

1 Processes in automobile industry

The processes identified in the automobile industry were done on a sample basis and their energy requirements were mapped to assess the potential of solar thermal interventions. These data were in turn utilised to arrive at techno-economic feasibility as has been highlighted in the subsequent sections.

1.1. Phosphating

The overall objective of this process is to 1) coat phosphate on the metal stampings which helps in bonding of reused vulcanized rubber and 2) reduction of probability of rust formation. The phosphating plant is an eleven tank process and has 5 major stages. The first stage is where oil and grease is removed from the stampings. In the second stage another round of cleaning takes place to completely remove chemical and grease from the stampings. The third stage which is the heart of the entire process involves coating of a phosphate layer on the stamping for reasons illustrated above. The fourth stage of the process is the rinsing process where stampings are rinsed to remove any dirt or impurities from them. The fifth and the final stage involve drying from conventional dryers after which the stampings are sent into further processing. The hot water requirement is mainly in stage 1, 2 and 3 of the process and is at a temperature of 95°C.

1.2. Engine Degreasing

Degreasing is an essential part of the modern automobile or for that matter any industrial production process, particularly in industries fabricating or assembling metal parts. It is widely used to remove oils and oil-borne soils, such as chips, metal fines and fluxes, from objects that have been stamped, machined, welded, soldered, moulded, die-cast, etc.

1.3. Boiler feed water pre-heating

Pre heating of boiler feed water is a simple process where the temperature of input water to the boiler is raised so as to reduce the fuel requirement of the boiler. Boiler feed water pre heating is effective in two ways: a) it reduces the plant operational costs and b) it also reduces the thermal shock to the boiler metal when hot water is introduced instead of water at ambient temperature. This can be done in a number of ways including pre heating it by solar concentrator based thermal systems.

2 Process Information and existing setup

As has been highlighted earlier structured questionnaires and walk through audits were conducted to understand the current fuel dependence of the various units where these processes were identified. The current thermal energy requirements and generation details were captured so as to analyse the same from a solar thermal perspective.

2.1. Phosphating

The thermal energy requirement in the process is currently fulfilled by use of a diesel based boiler. The process for a typical sample unit requires 50 litres of diesel oil for one batch of 7 hours. The thermal energy calculations for the batch are as follows:

Parameter	Value	Unit
Fuel Consumption	50	litres/batch of 7 hours
Fuel calorific value	9500	Kcal/litres
Total calorific output from fuel	475000	kilo calories
Efficiency of boiler	85%	Percentage
Total calorific output for process	~558000	kilocalories

The sample unit uses diesel based generator to generate pressurised hot water for the phosphating process. Solar thermal options are to be explored to satisfy the heat requirements for the process described above.

2.2. Engine Degreasing

The thermal energy requirement in the process is fulfilled by use of diesel in the sample unit. In the process for a typical sample unit the engine degreasing process involves raising the temperature of 11000 litres/day pressurised hot water from 70 °C to 120 °C. The ΔT in this case is 50 °C and the inlet temperature is higher than the ambient temperature as a result of the waste heat recovery employed at the unit. The thermal energy calculations for the batch are as follows:

Parameter	Value	Unit
Fuel Consumption	80	litres/batch of 7 hours
Fuel calorific value	9500	Kcal/litres
Total calorific output from fuel	760000	kilo calories
Efficiency of boiler	70%	Percentage
Total calorific output for process	~532000	kilocalories

The sample unit uses diesel fired boiler system to generate pressurised hot water system. Solar thermal options are to be explored to satisfy the heat requirements for the engine degreasing process described above.

2.3. Boiler feed water pre-heating

The thermal energy requirement in the process is fulfilled by use of diesel in the sample unit. In the process for a typical sample unit the process is done by increasing the temperature of the input water from 25°C to 85°C. Currently in the sample unit there is no provisioning of pre heating of boiler feed water and water at ambient temperature is fed to the boiler and converted to steam/pressurized hot water as the case may be for use in various industrial processes. The unit has a requirement of 1700 litres / hour boiler feed water. The thermal energy calculations for the batch are as follows:

Heat input required for heating 1700 litres/hour water at 25°C to 90°C (ΔT=90-25=65°C)

= 1700*1*65 = 110500 kilo calories/hour

For a 7 hour shift the energy required will be

= 110500*7 = 773500 kilo calories

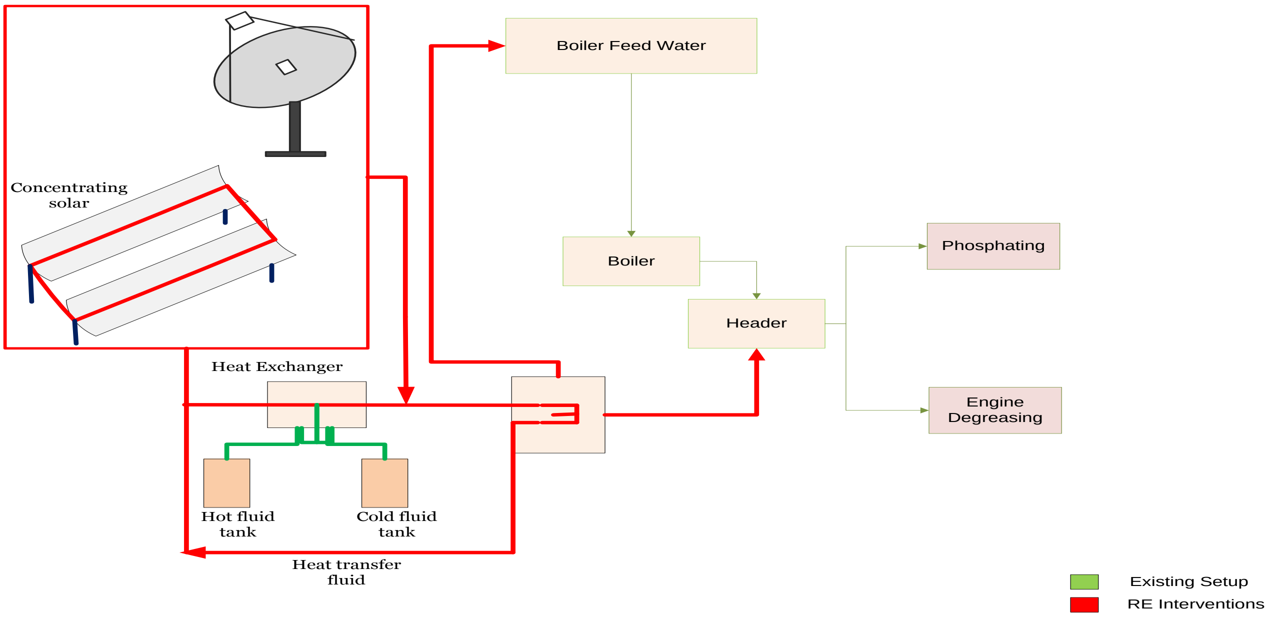
Solar thermal options are to be explored to satisfy the heat requirements for the boiler feed water pre heating process described above. Based on the process study, the new solar concentrator based system is proposed to be integrated with the existing boiler.

3 Solar sizing

For satisfying the heat requirements in the different sample units, solar thermal technologies could easily be integrated in their current setups. The thermal energy requirement in the various processes is continuous and is met through a fossil fuel based boiler (diesel).

The size of the solar system has to be designed so as to optimize the thermal energy production and the current resources in hand. Solar thermal systems need to function so as to satisfy the process requirements of the industry in spite of variability of solar radiation over the days and seasons.

Further, the size of the system must also satisfy the cost constraints and more importantly the space requirements. Also, the system needs to be reliable within acceptable range. In order to overcome these hurdles, it is necessary to develop a design methodology and general integration approach that can be used for optimally sizing the solar concentrators. The different technologies applicable for such process requirement are parabolic trough, parabolic dish and linear paraboloid fresnel dish. The indicative layout of the processes after the integration with solar thermal systems will be as follows:



3.1. Phosphating

The process requires ~558000 kilo calories as illustrated in **Section 2.1** for replacement of 50 litres diesel being currently utilised in the existing boilers. Assuming solar system efficiency of 95% the energy required from the system shall be

= 558000/0.95 = ~590000 kilo calories

Based on this energy assessment the system sizing for different technologies is illustrated as follows:

Parabolic Trough

Parameter	Value	Unit
Calorific output per trough module per day	~75000	Kcal/day
Size of one trough module	35	m²
Shade free area for one module	50	m²
Calorific output required from process	~590000	Kcal/7 hours
Modules of trough required	= (590000/75000) = 8	Nos.
Energy Displaced	75000*8*0.95 = 570000	Kilo calories
Fuel displaced	570000/(9500*0.85) ~= 70	Litres of diesel
Total system size	= 35*8 = 280	m²
Total system area required	= 50*8 = 400	m²

Paraboloid Dish

Parameter	Value	Unit
Calorific output per dish module per day	~300000	Kcal/day

Size of one trough module	90	m^2
Shade free area for one module	100	m^2
Calorific output required from process	~590000	Kcal/7 hours
Modules of dish required	= (590000/300000) ~= 2	Nos.
Energy Displaced	300000*2*0.95 = 570000	Kilo calories
Fuel displaced	570000/(9500*0.85) ~= 70	Litres of diesel
Total system size	= 90*2 = 180	m^2
Total system area required	= 100*2 = 200	m^2

Linear fresnel paraboloid dish

Parameter	Value	Unit
Calorific output per paraboloid dish module per day	~300000	Kcal/day
Size of one trough module	104	m^2
Shade free area for one module	110	m^2
Calorific output required from process	~590000	Kcal/7 hours
Modules of paraboloid dish required	= (590000/300000) ~= 2	Nos.
Energy Displaced	300000*2*0.95 = 570000	Kilo calories
Fuel displaced	570000/(9500*0.85) ~= 70	Litres of diesel
Total system size	= 104*2 = 208	m^2
Total system area required	= 110*2 = 220	m^2

3.2. Engine Degreasing

The process requires almost 532000 kilo calories as illustrated in **Section 2.2** for replacement of 80 litres of diesel being currently utilised in the existing boilers. Assuming solar system efficiency of 95% the energy required from the system shall be

= 532000 /0.95 = ~560000 kilo calories

Based on this energy assessment the system sizing for different technologies is illustrated as follows:

Parabolic Trough

Parameter	Value	Unit
Calorific output per trough module per day	~75000	Kcal/day
Size of one trough module	35	m^2
Shade free area for one module	50	m^2
Calorific output required from process	~560000	Kcal/7 hours
Modules of trough required	= (560000/75000) ~= 8	Nos.

Energy Displaced	75000*8*0.95 = 570000	Kilo calories
Fuel displaced	570000/(9500*0.70) ~= 85	Litres of diesel
Total system size	= 35*8 = 280	m²
Total system area required	= 50*8 = 400	m²

Paraboloid Dish

Parameter	Value	Unit
Calorific output per dish module per day	~300000	Kcal/day
Size of one trough module	90	m²
Shade free area for one module	100	m²
Calorific output required from process	~560000	Kcal/7 hours
Modules of dish required	= (560000/300000) ~= 2	Nos.
Energy Displaced	300000*2*0.95 = 570000	Kilo calories
Fuel displaced	570000/(9500*0.70) ~= 85	Litres of diesel
Total system size	= 90*2 = 180	m²
Total system area required	= 100*2 = 200	m²

Linear fresnel paraboloid dish

Parameter	Value	Unit
Calorific output per paraboloid dish module per day	~300000	Kcal/day
Size of one trough module	104	m²
Shade free area for one module	110	m²
Calorific output required from process	~560000	Kcal/7 hours
Modules of paraboloid dish required	= (560000/300000) ~= 2	Nos.
Energy Displaced	300000*2*0.95 = 570000	Kilo calories
Fuel displaced	570000/(9500*0.70) ~= 85	Litres of diesel
Total system size	= 104*2 = 208	m²
Total system area required	= 110*2 = 220	m²

3.3. Boiler feed water pre-heating

The process requires almost 773500 kilo calories as illustrated in **Section 2.3** for boiler feed water preparation process. Assuming solar system efficiency of 95% the energy required from the system shall be

= 773500/0.95 = ~800000 kilo calories

Based on this energy assessment the system sizing for different technologies is illustrated as follows:

Parabolic Trough

Parameter	Value	Unit
Calorific output per trough module per day	~75000	Kcal/day
Size of one trough module	35	m^2
Shade free area for one module	50	m^2
Calorific output required from process	~600000	Kcal/7 hours
Modules of trough required	= (800000/75000) ~= 11	Nos.
Energy Displaced	75000*11*0.95 = 783750	Kilo calories
Fuel displaced	783750/(9500*0.70) ~= 118	litres of diesel
Total system size	= 35*11 = 385	m^2
Total system area required	= 50*11 = 550	m^2

Paraboloid Dish

Parameter	Value	Unit
Calorific output per dish module per day	~300000	Kcal/day
Size of one trough module	90	m^2
Shade free area for one module	100	m^2
Calorific output required from process	~800000	Kcal/7 hours
Modules of dish required	= (800000/300000) = 3	Nos.
Energy Displaced	300000*3*0.95 = 855000	Kilo calories
Fuel displaced	855000/(9500*0.70) ~= 128	litres of diesel
Total system size	= 90*3 = 270	m^2
Total system area required	= 100*3 = 300	m^2

Linear fresnel paraboloid dish

Parameter	Value	Unit
Calorific output per paraboloid dish module per/ day	~450000 + ~300000	Kcal/day
Size of one trough module	169 + 104	m^2
Shade free area for one module	273	m^2
Calorific output required from process	~600000	Kcal/7 hours
Modules of paraboloid dish required	1 module of each size	Nos.
Energy Displaced	750000*0.95 = 712500	Kilo calories
Fuel displaced	712500/(9500*0.70) ~= 107	litres of diesel
Total system size	= 169 + 104 = 273	m^2

Total system area required	= 180+120 = 300	m^2

4 Financial Analysis

For satisfying the heat requirements in the various units, solar thermal technologies could easily be integrated in the current setup of the sample units. Following the decision on the size of the system to be installed, this exercise has been carried out to assess the indicative financial feasibility of the project, considering all the three technology options. Based on the costs of the systems and the MNRE Benchmarks for subsidy and additional UNDP support, the overall project cost is calculated.

Financial modelling has been done so as to estimate the payback period of the three technologies for the various processes. The results of the model will be instrumental in the capital investment decision. The overall cost (Cost of system-MNRE subsidy-UNDP support) of the system is the upfront investment which brings about significant savings in terms of the fuel saved. Current dependence on fossil fuel for thermal energy production in the four processes, MNRE subsidy of 30%, additional support from UNDP and year around operation of the unit leading to increased utilization will ensure that the payback periods are less. List of assumptions made for preparing the financial models is tabulated below.

Assumptions	
Annual escalation in fuel price	10 %
Debt : Equity for beneficiary's contribution	70:30
Cost of Equity	16 %
O & M as a % of project cost	2 %
Inflation in O&M	1 %
Deration	1 %
Life of Project	20 years
Days of operation per annum	300

Based on this financial modelling exercise, the financial performance indicators of all the three technology options for the four processes are obtained.

4.1. Phosphating

In this process the unit is using diesel (@Rs 65/litres) and the solar thermal intervention is able to bring about savings in the current dependence as described in **Section 3.1**. Based on the financial modelling a summary of the results for the three technologies is tabulated below:

Technology/ Parameters	Parabolic Trough	Paraboloid Dish	Linear Fresnel Paraboloid dish
System size proposed	8	2	2
Surface Area (A)	280 m^2	180 m^2	208 m^2
Footprint	400 m^2	200 m^2	220 m^2
Tracking	Single Axis	Double axis	Double Axis
Total indicative cost of	₹ 60,00,000	₹ 60,00,000	₹ 48,00,000

system (B)#			
MNRE benchmark for subsidy (C)	₹ 5,400/ m²	₹ 6,000/ m²	₹ 6,000/ m²
Total MNRE Subsidy (D=A x C) or (30% of B)	₹ 15,12,000	₹ 10,80,000	₹ 12,48,000
UNDP Grant For Demonstration*	₹ 7,56,000	₹ 5,40,000	₹ 6,24,000
Overall cost (E= B-D)	**₹37,32,000**	**₹43,80,000**	**₹29,28,000**
Fuel Savings per day (7hrs)	70 litres	70 litres	70 litres
Project IRR	34.97%	31.47%	41.14%
Equity IRR	80.99%	68.81%	102.34%
Payback (Years)	3.08	3.46	2.55

4.2. Engine Degreasing

In this process the unit is using diesel (@Rs 65/litre) and the solar thermal intervention is able to bring about savings in the current dependence as described in **Section 3.2**. Based on the financial modelling a summary of the results for the three technologies is tabulated below:

Technology/ Parameters	Parabolic Trough	Paraboloid Dish	Linear Fresnel Paraboloid dish
System size proposed	8	2	2
Surface Area (A)	280 m²	180 m²	208 m²
Footprint	400 m²	200 m²	220 m²
Tracking	Single Axis	Double axis	Double Axis
Total indicative cost of system (B)#	₹ 60,00,000	₹ 60,00,000	₹ 48,00,000
MNRE benchmark for subsidy (C)	₹ 5,400/ m²	₹ 6,000/ m²	₹ 6,000/ m²
Total MNRE Subsidy (D=A x C) or (30% of B)	₹ 15,12,000	₹ 10,80,000	₹ 12,48,000
UNDP Grant For Demonstration*	₹ 7,56,000	₹ 5,40,000	₹ 6,24,000
Overall cost (E= B-D)	**₹37,32,000**	**₹43,80,000**	**₹29,28,000**
Fuel Savings per day (7hrs)	85 litres	85 litres	85 litres
Project IRR	41.37%	37.10%	48.98%
Equity IRR	104.20%	89.39%	130.24%
Payback (Years)	2.51	2.85	2.08

4.3. Boiler Feed Water pre heating

In this process the unit is assumed to be using diesel (@Rs 65/litre) and the solar thermal intervention is able to bring about savings in the current dependence as described in **Section 3.3**. Based on the financial modelling a summary of the results for the three technologies is tabulated below:

Technology/ Parameters	Parabolic Trough	Paraboloid Dish	Linear Fresnel Paraboloid dish
System size proposed	11	3	1 each of 169 & 104 m²
Surface Area (A)	385 m²	270 m²	273 m²
Footprint	550 m²	300 m²	300 m²
Tracking	Single Axis	Double axis	Double Axis
Total indicative cost of system (B)#	₹ 82,50,000	₹ 90,00,000	₹ 61,50,000
MNRE benchmark for subsidy (C)	₹ 5,400/ m²	₹ 6,000/ m²	₹ 6,000/ m²
Total MNRE Subsidy (D=A x C) or (30% of B)	₹ 20,79,000	₹ 16,20,000	₹ 16,38,000
UNDP Grant For Demonstration*	₹ 10,39,500	₹ 8,10,000	₹ 7,60,500
Overall cost (E= B-D)	**₹51,31,500**	**₹65,70,000**	**₹37,55,500**
Fuel Savings per day (7hrs)	~118 litres	~128 litres	~107 litres
Project IRR	49.12%	43.56%	57.99%
Equity IRR	134.50%	115.39%	164.55%
Payback (Years)	2.01	2.29	1.69

5 Case Studies

In this section we are analysing sample case studies which are a combination of two or more processes defined in the previous sections. This task is done to give the readers a better understanding of the technology and the financial feasibility.

5.1. Case Study A

In this sample case study we have assumed that the unit has 1.5 times the requirement of the phosphating process as mentioned in Section 2.1 and 0.8 times the requirement of the engine degreasing process as given in Section 2.2. Thus the overall energy requirement of the industry shall be:

1.2*558000 + 0.8*532000 kilocalories = 1121600 kilocalories

5.1.1. Solar sizing

The process requires ~1121600 kilo calories as illustrated above for replacement of current diesel dependence. Assuming solar system efficiency of 95% the energy required from the system shall be

= 1121600/0.95 = ~~1200000 kilo calories

Based on this energy assessment the system sizing for different technologies is illustrated as follows:

5.1.1.1. Parabolic Trough

Parameter	Value	Unit
Calorific output per trough module per day	~75000	Kcal/day
Size of one trough module	35	m²
Shade free area for one module	50	m²
Calorific output required from process	~1200000	Kcal/7 hours
Modules of trough required	= (1200000/75000) = 16	Nos.
Energy Displaced	75000*16*0.95 ~= 1120000	Kilo calories
Fuel displaced	1120000/(9500*0.85) ~= 140	Litres of diesel
Total system size	= 35*16 = 560	m²
Total system area required	= 50*16 = 800	m²

5.1.1.2. Paraboloid Dish

Parameter	Value	Unit
Calorific output per dish module per day	~300000	Kcal/day
Size of one trough module	90	m²
Shade free area for one module	100	m²
Calorific output required from process	~1200000	Kcal/7 hours
Modules of dish required	= (1200000/300000) ~= 4	Nos.
Energy Displaced	300000*4*0.95 = 11200000	Kilo calories
Fuel displaced	1120000/(9500*0.85) ~= 140	Litres of diesel
Total system size	= 90*4 = 360	m²
Total system area required	= 100*4 = 400	m²

5.1.1.3. Linear fresnel paraboloid dish

Parameter	Value	Unit
Calorific output per paraboloid dish module per day	~300000	Kcal/day
Size of one trough module	104	m²
Shade free area for one module	110	m²
Calorific output required from process	~1200000	Kcal/7 hours
Modules of paraboloid dish required	= (1200000/300000) ~= 4	Nos.
Energy Displaced	300000*4*0.95 = 11200000	Kilo calories

Fuel displaced	1120000/(9500*0.85) ~= 140	Litres of diesel
Total system size	= 104*4 = 416	m^2
Total system area required	= 110*4 = 440	m^2

5.1.2. Financial Analysis

Financial modelling has been done so as to estimate the payback period of the three technologies for the combination of the two processes. In this process the unit is assumed to be using diesel (@Rs 65/litres) and the solar thermal intervention is able to bring about savings in the current dependence as described above. Based on the financial modelling a summary of the results for the three technologies is tabulated below:

Technology/ Parameters	Parabolic Trough	Paraboloid Dish	Linear Fresnel Paraboloid dish
System size proposed	16	4	4
Surface Area (A)	560 m^2	360 m^2	416 m^2
Footprint	800 m^2	400 m^2	440 m^2
Tracking	Single Axis	Double axis	Double Axis
Total indicative cost of system (B)#	₹ 1,20,00,000	₹ 1,20,00,000	₹ 96,00,000
MNRE benchmark for subsidy (C)	₹ 5,400/ m^2	₹ 6,000/ m^2	₹ 6,000/ m^2
Total MNRE Subsidy (D=A x C) or (30% of B)	₹ 30,24,000	₹ 21,60,000	₹ 24,96,000
UNDP Grant For Demonstration*	₹ 15,12,000	₹ 10,80,000	₹ 12,48,000
Overall cost (E= B-D)	**₹74,64,000**	**₹87,60,000**	**₹58,56,000**
Fuel Savings per day (7hrs)	140 litres	140 litres	140 litres
Project IRR	31.71%	27.84%	38.61%
Equity IRR	85.32%	70.85%	110.17%
Payback (Years)	2.90	3.31	2.36

5.2. Case Study B

In this sample case study we have assumed that the unit has a requirement of all the three processes as mentioned in Section 2.1; Section 2.2 and Section 2.3. Thus the energy requirement of the industry shall be:

558000 + 532000 + 773500 kilocalories = 1863500 kilocalories

5.2.1. Solar sizing

The process requires ~1863500 kilo calories as illustrated above for replacement of current diesel dependence. Assuming solar system efficiency of 95% the energy required from the system shall be

= 1863500 /0.95 = ~~1960000 kilo calories

Based on this energy assessment the system sizing for different technologies is illustrated as follows:

5.2.1.1. Parabolic Trough

Parameter	Value	Unit
Calorific output per trough module per day	~75000	Kcal/day
Size of one trough module	35	m^2
Shade free area for one module	50	m^2
Calorific output required from process	~1900000	Kcal/7 hours
Modules of trough required	= (1960000/75000) ~= 26	Nos.
Energy Displaced	75000*26*0.95 ~= 1852500	Kilo calories
Fuel displaced	1852500/(9500*0.85) ~= 230	Litres of diesel
Total system size	= 35*26 = 910	m^2
Total system area required	= 50*26 = 1300	m^2

5.2.1.2. Paraboloid Dish

Parameter	Value	Unit
Calorific output per dish module per day	~300000	Kcal/day
Size of one trough module	90	m^2
Shade free area for one module	100	m^2
Calorific output required from process	~1960000	Kcal/7 hours
Modules of dish required	= (1960000/300000) ~= 6	Nos.
Energy Displaced	300000*6*0.95 = 1710000	Kilo calories
Fuel displaced	1710000/(9500*0.85) ~= 211	Litres of diesel
Total system size	= 90*6 = 540	m^2
Total system area required	= 100*6 = 600	m^2

5.2.1.3. Linear fresnel paraboloid dish

Parameter	Value	Unit
Calorific output per paraboloid dish module per day	~300000	Kcal/day
Size of one trough module	104	m^2
Shade free area for one module	110	m^2
Calorific output required from process	~1960000	Kcal/7 hours
Modules of paraboloid dish required	= (1960000/300000) ~= 6	Nos.
Energy Displaced	300000*6*0.95 = 1710000	Kilo calories

Fuel displaced	1710000/(9500*0.85) ~= 211	Litres of diesel
Total system size	= 104*6 = 624	m^2
Total system area required	= 110*6 = 660	m^2

5.2.2. Financial Analysis

Financial modelling has been done so as to estimate the payback period of the three technologies for the combination of the two processes. In this process the unit is assumed to be using diesel (@Rs 65/litres) and the solar thermal intervention is able to bring about savings in the current dependence as described above. Based on the financial modelling a summary of the results for the three technologies is tabulated below:

Technology/ Parameters	Parabolic Trough	Paraboloid Dish	Linear Fresnel Paraboloid dish
System size proposed	26	6	6
Surface Area (A)	910 m^2	540 m^2	624 m^2
Footprint	1300 m^2	600 m^2	660 m^2
Tracking	Single Axis	Double axis	Double Axis
Total indicative cost of system (B)#	₹ 1,95,00,000	₹ 1,80,00,000	₹ 144,00,000
MNRE benchmark for subsidy (C)	₹ 5,400/ m^2	₹ 6,000/ m^2	₹ 6,000/ m^2
Total MNRE Subsidy (D=A x C) or (30% of B)	₹ 49,14,000	₹ 32,40,000	₹ 37,44,000
UNDP Grant For Demonstration*	₹ 24,57,000	₹ 16,20,000	₹ 18,72,000
Overall cost (E= B-D)	**₹121,29,000**	**₹131,40,000**	**₹87,84,000**
Fuel Savings per day (7hrs)	230 litres	211 litres	211 litres
Project IRR	32.94%	28.66%	39.77%
Equity IRR	89.99%	74.08%	114.37%
Payback (Years)	2.78	3.21	2.28

The above results for different processes/cases are only an indicative assessment based on public information and shall be different for different sites and subject to variation by different manufacturers. Also the UNDP support is subject to certain terms and conditions which may result in lowering of the overall support for hard capital investment.

Disclaimer