Economic evaluation of a business model of selected solar thermal devices in Thar Desert of Rajasthan, India

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Abstract: Business of fabricating solar thermal devices can play an important role in the economic growth of the country. These technologies can create more employment opportunities in rural as well as urban areas and supplement conventional energy sources in addition to reducing carbon emission. For starting a new business, economic feasibility needs to be assessed in terms of break-even analysis and economic attributes. Banks provide loans only on the basis of economic attributes of the project. Therefore, an attempt has been made to determine the various economic indicators for a unit of three novel solar thermal devices namely, animal feed solar cooker, non-tracking solar cooker and solar dryer for guiding new entrepreneurs. The different economic parameters such as break-even point, net present value, pay back period, benefit-cost ratio, annuity and internal rate of return were determined and found highly profitable while judging the economic viability of the solar devices business. On the basis of break-even-analysis, fabrication and sale of only 37 units annually is sufficient to reach a state of no profit and no loss. The net average annual benefit accrued from this business fabricating 100 units annually is INR 189 800 ($ 2 673). In addition, this business can play a vital role in providing employment to four persons. It also has a great potential to reduce CO_2 emission.

Keywords: Techno-economic evaluation, business model, solar thermal devices

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1 Introduction

The energy demand is increasing with fast growing population and rapid development. It is projected that world conventional energy sources will be exhausted in 50 to 100 years. Since the development of any region is reflected in its energy consumption pattern, it is essential to search for alternative source of energy. In this context, renewable sources of energy such as solar, wind, biogass and efficient utilization of biomass offer several advantages to arid region (Thar desert) for its sustainable development. Solar cooking and drying have proved to be one of the simplest, viable and attractive options for solar energy utilization and also found environment-friendly and cost-effective. Even the solar cooker and dryer are very useful for common people in developing world specifically because of very low drudgery involved in operation. A major portion of total available energy resource in rural areas of developing world is utilized for cooking and is mainly supplied by non-renewable energy sources e.g. fuel wood, agricultural waste, cow dung, kerosene, liquid petroleum gas etc. It is generally observed that in rural areas people use biomass fuel for preparing animal feed, which is full of drudgery

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(Panwar et al., 2013). Human food is also prepared by using biomass and fuel wood. Drying of fruits and vegetables is generally carried out through open sun drying. Although this method of drying is cheap, yet it is associated with the problems like, dust contamination, insect infestation and spoilage due to rains as well as uneven drying (Poonia et al., 2018). The environmental effects of fuel wood burning have been reported in several literatures (Elliott, 2004; Tingem and Rivington, 2009; Panwar et al., 2011; Huttunen, 2009). The fuel wood requirement is 0.4 tons per person per year in India. In rural areas, firewood crisis is far graver than that caused by a rise in oil prices. One third of India's fertilizer consumption can be met if cow dung is not burnt for cooking and instead it is used as manure. The arid and semi-arid parts of the country receive much more radiation 6.0 kW h m^{-2} day^{-1} mean annual daily solar radiation having 8.9 average sunshine hours a day at Jodhpur as compared to rest of the country (Poonia et al., 2019).

To create more employment opportunities in rural as well as urban areas, the development of solar thermal technology-based business can play an important role in the economic growth of the state in particular and nation in general. These technologies can supplement conventional energy sources in addition to reducing carbon emission. General perception of people about green entrepreneurship does not go beyond solar water heaters and solar rooftop power generation. However, there lies immense potential for entrepreneurship in many other areas like solar cooking for domestic and community applications. India has 12 lakh rural schools where mid-day-meal is served, and this solar cooker market can be worth 10 000 crore rupees. Further, it was estimated that solar energy of 1 per cent of land area, wind power of 5 per cent of land area and biogas (80 per cent collection efficiency) could provide 1504 kW h $year^{-1}$ energy per capita in arid region while the average per capita total energy consumption of India was 1122 kW h $year^{-1}$. In this context, renewable sources of energy like solar energy, wind power and biogas need to be harnessed for the sustainable development in general and catering the farmers requirements in particular. For starting a new business, economic feasibility needs to be assessed in terms of break-even analysis and economic attributes. Banks provide loans only on the basis of economic attributes of the project. Therefore, an attempt has been made to determine the various costs and economic indicators of fabricating three novel solar thermal devices namely animal feed solar cooker, non-tracking solar cooker and solar dryer taken as a unit for evaluating the feasibility of investment on fabrication of solar thermal devices to guide new entrepreneurs.

2 Meterials and methods

2.1 Economic analysis of solar devices

The different economic parameters of manufacturing solar devices such as break-even point, net present value (NPV), pay back period (PBP), benefit-cost ratio (BCR), annuity (A) and internal rate of return (IRR) were determined for judging the economic viability of the solar devices (Chandell et al., 2017; Barnwal and Tiwari, 2008; Singh et al., 2017; Poonia et al., 2018; Sodha et al., 1991). Two types of cost i.e. fixed or ownership costs and variable or operating costs were associated with fabrication of solar devices. The main components of the fixed costs were depreciation, average annual interest on investment, taxes, insurance and housing/rent cost. Variable or operating cost were expenditure incurred on electricity, materials, repair and maintenance, operational and labour wages associated with devices fabrication. The total annual cost of operation for a unit of three solar thermal devices was obtained by adding fixed and variable cost. The fixed cost and variable or operating cost were calculated by using standard formulae as given in Table 1.

Table 1 Formulae and prevailing rate used to calculate fixed and variable cost

Type of cost	Component of cost	Formula	Remarks	Source
ixed cost	Depreciation / yr.	$D=\frac{C-S}{L}$ D = INR 6 250	C = Initial cost of solar devices = INR 104 000 Salvage value (S) = 10% of initial cost Life of devices (L) = 15 years	Kepner et al. (2005)
	Interest on average Investment / yr.	$I=\left(\frac{C+S}{2}\right)\times\frac{i}{100}$ I = INR 8 008	i = 14% per annum (Interest)	Kepner et al. (2005)
	Insurance & taxes	$I_n=\left(\frac{C\times in}{100}\right)$ I_n = INR 2 080	in = 2% per annum	IS:9164 (1979)
	Housing/rent	Rent / INR	12 × 8000 = INR 96 000	IS:9164 (1979)
	Fixed cost (FC) = D + I + In + Rent Fixed cost (FC) = 6 250+8 008+2 080+96 000 = INR 112 338			
Variable cost	Electricity	5 kW h/unit = 5 × 8 = INR 40/-	Unit (x) is number of units (non-tracking solar cooker, animal feed solar cooker and solar dryer) fabricated per year	
	Repair and maintenance (R&M)	(R and M) = INR 60 per unit		Kumar et al. (2013)
	Materials	INR 21 500/-		
	Operational and labour charges	25% of material cost = INR 5 375/-		Kepner et al. (2005)
	Variable cost (VC)= Electricity+ R&M+ Materials+ Operational and labour charges/unit Variable cost (VC)= 40 + 60 + 21 500 + 5 375 = INR 26 975 Income per unit sale = INR 30 000			

Note: Where, D = Depreciation, I = Interest on average investment, I_n = Insurance & taxes, RM= Repair and maintenance, P= Purchase price, S= Salvage value.

2.2 Break-Even Point (BEP)

The analysis of BEP was carried out to determine the minimum number of units for ensuring the profitability to the entrepreneur with minimum scale of operation. BEP was determined as the level of operation where total income from sale of the units is equal to total expenses (both fixed cost and variable cost). It was calculated by using formula given below in terms of the fixed costs, variable costs and revenue from sale of units:

Fixed cost/yr. = x (Income/unit – Variable cost /unit)

$$BEP\ (x)=\frac{Fixed\ \cos t\,(Rs./\ yr)}{(Income\ \ from\ sale/units-Variable\ \ \cos t\ /\ unit)} \quad (1)$$

2.3 Economic attributes

The economic analysis of fabrication of solar thermal devices was carried out and NPV, PBP, BCR, A, and IRR were taken into account for economic assessment.

2.3.1 NPV

NPV was calculated by using 14% interest rate (based on State Bank of India interest rate for agriculture loan) which was considered as capital cost of a firm. This is the present value of expected return likely to be earned by the entrepreneur during the entire life of the project. To find out the present value of cash flow expected in future periods. All the cash outflows and cash inflows were discounted at the above rate. The net present value of solar devices was worked out using following equation:

$$NPV=\frac{(E-M)}{a}\left[1-\left(\frac{1}{1+a}\right)^{n}\right]-C \quad (2)$$

Initial cost (C) = INR 104000, a = (0.14) and n = 15 years.

Gross benefits from sale of one hundred units (E) = 30000 × 100 = INR 3 000 000

Cost of hundred units (M) = Electricity cost + Repair and maintenance + Materials cost + Operational and labour charges + Annual rent= (40+60+5 375+21 500+96 000) × 100= INR 2 793 500

where, C is initial cost of project (INR), a is the rate of interest of bank loan (%), n is the project life (years), b = inflation rate (fraction

When we take inflation into account the NPV is calculated by following formula and inflation rate of 0%, 0.05% and 0.10% is shown in Table 3.

$$NPV = \frac{(E-M)\left(\frac{1+b}{1+a}\right)\left[1-\left(\frac{1+b}{1+a}\right)^{n}\right]}{\left(1+\frac{1+b}{1+a}\right)} - C \tag{3}$$

Where b is the inflation rate (%)

2.3.2 BCR

BCR was expressed as the ratio of sum total of initial cost and net present value to the initial cost as given below,

$$BCR = 1 + \frac{NPV}{C} \tag{4}$$

2.3.3 Annuity (A)

The annuity (A) of the project indicates the average net annual returns. This term can be given as,

$$A = \frac{NPV}{\sum_{t=1\,to\,n}\left(\frac{1}{1+a}\right)^{n}} \tag{5}$$

2.3.4 PBP

Payback period was worked out as the length of time required to recover initial investment through net average annual cash inflows generated by investment. The payback period formula was used to determine the length of time it will take to recoup the initial amount invested on a project or investment. PBP was calculated by equation:

$$PBP = \frac{\log\frac{(E-M)}{a} - \left(\log\frac{(E-M)}{a} - C\right)}{\log(1+a)} \tag{6}$$

2.3.5 IRR

At 100% interest rate, the NPV is INR 161 000 and at 200% rate of interest the NPV is INR 28,500. However, the NPV is negative at 250% interest rate (i.e. NPV = INR –21 400). The IRR can be determined using the following relationship and taking low discount rate as 200% and higher discount rate as 250%.

$$IRR = lower\ discount\ rate + \frac{Difference\ of\ discount\ rate\ x\ NPV\ at\ lower\ discount\ rate}{(NPV\ at\ lower\ discount\ rate - NPV\ at\ higher\ discount\ rate)} \tag{7}$$

2.3.6 Energy saving

Annual energy saving from use of these solar units was computed by using the following formula (Panwar et al., 2013).

$$Useful\ energy\ gained\ (MJ) = \frac{A \times efficiency \times average\ daily\ insolation \times 3600 \times days\ of\ use}{1000} \tag{8}$$

Where A is aperture area of solar device (m^2) and average daily solar insolation is 6 $kwhm^{-2}day^{-1}$ for Jodhpur.

3 Results and discussion

In this business, all land used for business activities, whether in the form of land or buildings, is assumed to taken on rent. Machines and tools calculated in the cost component are all machinery and tools, whether purchased or self-made equipment by the entrepreneur, which is equivalent to some currency. The land and building area for this solar devices' manufacturing centre is 441 m^2 and 81 m^2 of the building (Figure 1). Figures 2-4 show the configuration of the fabricated animal feed solar cooker, non-tracking solar cooker and solar dryer. The number of working days in a year is 300 days and the production capacity 100 units/year. The investment cost in this fabrication centre of combined unit business is allocated to start the business covering land and building lease, and machinery and tools. Table 2 presents the components of the fabrication centre of combined unit of solar devices business investment cost.

Operational costs or variable costs always depend on the size of the production per period. These operational costs include the cost of purchasing raw materials, operational equipment, machine maintenance and labour costs. The most significant of the operational cost expenditure was the purchasing of raw material for fabrication of animal feed solar cooker, non-tracking solar cooker and solar dryer, technical skilled/unskilled labour as presented in Table 3-6. The purchase price of raw material of combined unit of animal feed and non-tracking solar cooker and solar dryer is INR 21 500/unit (Table 4-6), while selling price of fabricated combined unit of solar devices is INR 30 000/unit.

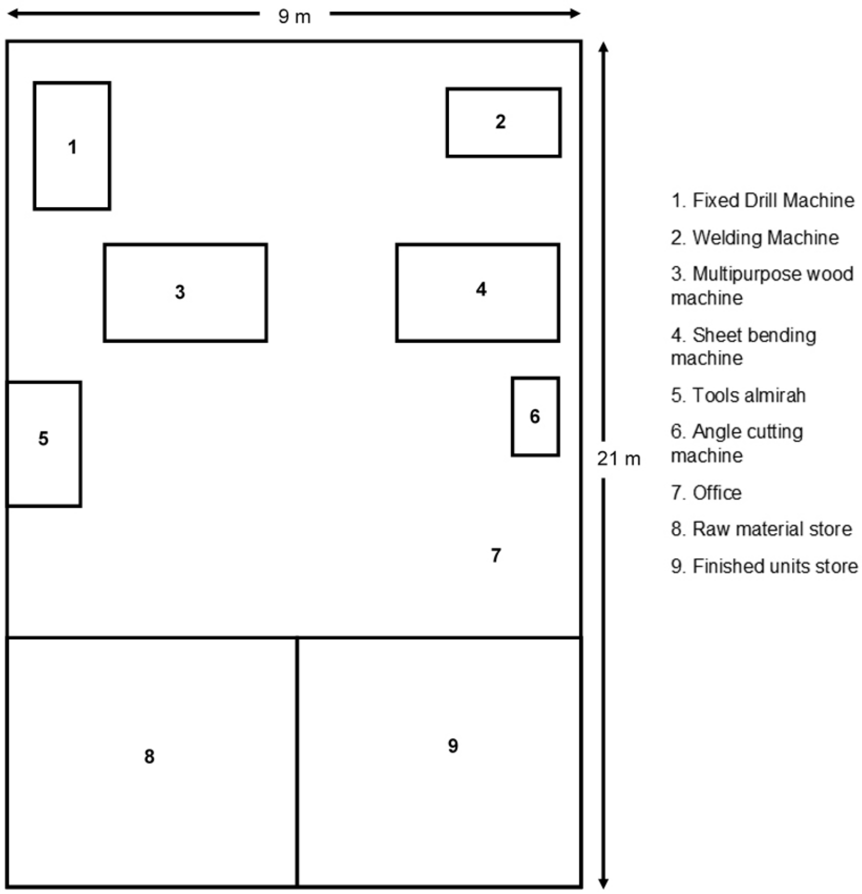

Figure 1 Layout of Solar devices manufacturing centre

In this analysis, total fixed cost and variable cost were calculated. The purchase price of fabrication machinery and tools of animal feed and non-tracking solar cooker and solar dryer is INR 104 000 and an appropriate discount rate 14% (based on State Bank of India interest rate for loan 2017) was selected to reflect the time value of money. The discount rate chosen reflected the minimum acceptable rate of return for an investment. The break-even point was determined as the level of operation where total income from sale of the units is equal to total expenses (both fixed cost and variable cost). The fixed cost per year is depreciation, interest, insurance and taxes and housing/rent of the fabrication centre of combined unit of solar devices business is INR 112 378 and variable cost is the sum of the electricity cost, repair and maintenance, raw materials and operational and labour charges amounting to INR 26 975. Equation 1 has been used to compute the break-even point analysis of fabrication of combined unit of solar thermal devices and it reveals that the BEP of the devices is 37 unit.

Figure 2 Improved animal feed solar cooker

Figure 3 Non-tracking solar cooker

Figure 4 Solar dryer

Table 2 Details of investment costs

S. No.	Machines/tools	Quantity (numbers)	Total cost (INR)
1.	Sheet-bending machine	01	20 000
2.	Wood planner-cum cutter with gauge	01	40 000
3.	Portable welding machine	01	10 000
4.	Hand drill with stand	01	5 000
5.	Cut off machine for angle cutting	01	7 000
6.	Hand cut-off machine	01	2 000
7.	Scissor	02	
8.	Small size hammer	02	
9.	Medium size hammer	02	
10.	Screw driver set	01	
11.	Centre punch	01	
12.	wooden chisel	01	
13.	Tri-square	02	20 000
14.	L-square	02	
15.	Wooden hammer	02	
16.	Measuring tape	02	
17.	Silicon machine	01	
18.	Spanner set	01	
19.	Drill bit set	01	
20.	Manual wooden planer	01	
21.	Glass cutter	01	
	Total		**INR 104 000**

Table 3 Details of operational cost

S. No.	Cost	(Volume/month)	Total cost (INR)
1.	Rent of land and building/month	One	INR 8 000
2.	Carpenter/month	One	INR 18 000
3.	Sheet metal cutter-cum-welder/month	One	INR 18 000
4.	Store keeper cum sales executive/month	One	INR 18 000
5.	Unskilled labour/month	One	INR 8 000
		Total	**INR 70 000**

Table 4 Raw material for animal feed solar cooker

S. No.	Material	Quantity	Approx. price (INR)
1.	Stone Chaps / bricks / cement concrete 0.15 m thick cement concrete 5.30 x 0.30 x 0.15)	1.59 m^2 0.2385 m^3	2 500
2.	Aluminium angle (35 mm x 12 mm) 2 (1.87 + 1.87 + 0.68 + 0.68) Aluminium flat (35 mm wide) 2 x (0.68)	10.2 m 1.36 m	700 300
3.	Mirror (4 mm thick) for reflector 2 x 0.60 x 0.90	1.08 m^2	750
4.	Plain glass (4 mm thick) 4 x (0.60 x 0.90)	2.16 m^2	1000
5.	Aluminium handle (130 mm long)	4 Nos.	120
6.	Iron angle (25 x 25 x 6 mm) (1.87 + 1.87 + 0.95 + 0.95)	5.64 m	550
7.	G.I. Sheet (24 gauge)	2.11 m^2	400
8.	Wooden batten (2 nos.)	2×0.00783 cum	950
9.	Rubber gasket (25 mm wide)	5.1 m	80
10.	Silicon	for 5.1 m	150
11.	Nut bolts/screws	100 g	100
15.	Fevicol	200 g	100
16.	Black board paint	0.5 lit.	150
17.	Synthetic Enamel paint	0.5 lit.	150
	Total (INR)		**8 000**

Table 5 Raw material for non-tracking solar cooker (960 x 320 x 150 mm)

S.No.	Material	Quantity	Approx. price (INR)
1.	G.I. Sheet (24 gauge)	1.301 m^2	1 200
2.	Plain glass (2 x (235 x 890 mm)	0.4183 m^2	300
3.	Mirror(235 x 890 mm)	0.20915 m^2	250
4.	Rubber gasket (25 x 3 mm)	2.5 m	50
5.	Glass wool insulation	0.0306 m^3	-
6.	Aluminium sheet (22 gauge)	0.3096 m^2	500
7.	M.S. Flat Kamani (25 mm x 6 mm)	1 m	150
8.	Wooden batten frame (Double glazing)	0.009962 cum	1 200
9.	M.S. angle (25 x 25 x 3 mm)	3.16 m	400

10.	Nut bolts/screws	100 g	100
11.	Fevicol	200 g	100
12.	Black board paint	0.5 lit.	50
13.	Zinc Chromate Primer	0.5 lit.	100
14.	Synthetic Enamel paint	0.5 lit.	100
15.	Cooking utensil (stainless steel) (200 mm ϕ)	4 Nos.	-
	Total (INR)		**4,500**

Table 6 Raw material for solar dryer

S.No.	Material	Quantity	Approx. price (INR)
1.	G.I. Sheet (24 gauge) 2.20 x 1.500	3.30 m^2	2 500
2.	Plain glass (1.28 x 0.980 m)	1.25 m^2	700
3.	M.S. angle (37 x 37 x 6 mm)	4.65 m^2	1 200
4.	Kamani (25 mm wide x 3 mm thick)	1.12 m	175
5.	PVC chuck nut	6 Nos.	75
6.	PVC pipe (13 mm ϕ) 6 x 0.800	4.8 m	300
7.	Aluminium angle (25 mm x 25 mm)	4.52 m	350
8.	Wooden batten (0.025 x 0.025 x 0.980 x 2)	0.00122 m^3	-
9.	Drying tray (i) S.S. channel (50 mm x 50 mm) – 3.1 x 2 (ii) Wire mesh (stainless steel) (1.10 x 0.60) x 2 (iii) Hinges (100 mm long)	6.2 m 1.32 m^2 10 Nos.	3 000
10.	Nut bolts/screws	250 g	100
11.	Fevicol	250 g	100
12.	Black board paint	1.5 lit.	100
13.	Zinc Chromate Primer	1.0 lit.	150
14.	Synthetic Enamel paint	1.0 lit.	175
15.	Rubber gasket (25 mm x 3 mm)	4.52 m	75
	Total (INR)		**9 000**

The net present value of total cash inflow and outflow for fabrication of solar thermal devices was calculated by the sum of all discounted net benefits throughout the project. The initial cost of machinery and tools of animal feed and non-tracking solar cooker and solar dryer is INR 104 000, a = 14% and the life of devices is 15 years. The gross benefit of selling of 100 units is INR 3 000 000 and the fabrication cost of 100 units is INR 2 793 500. Equation 2 has been used to determine the NPV of solar devices and it reveals that the NPV of investment made on solar devices is INR 1 164 358. When we take inflation into account the NPV is calculated by using Equation 3 and the inflation rate of 0%, 5% and 10% is shown in Table 7. Risk analysis reveals that above 1.92% (≈ 2%) rise in material cost price of solar thermal devices should be revised (Table 8).

Table 7 Effect of inflation on net present value (NPV)

S. No.	Inflation	NPV (INR)
1	$e_b = 0\%$ $e_c = 0\%$	1 164 358
2	$e_b = 5\%$ $e_c = 5\%$	1 603 496
3	$e_b = 10\%$ $e_c = 10\%$	2 251 445

Note: Where b is for benefit and c is for cost

Table 8 Risk analysis of solar thermal devices

S. No.	Inflation	NPV (INR)
1	$e_b = 0\%$ $e_c = 0\%$	1 164 358
2	$e_b = 0\%$ $e_c = 2\%$	-448 590
3	$e_b = 0\%$ $e_c = 1.92\%$	0

Note: Where b is for benefit and c is for cost

The benefit cost ratio for the fabrication of solar thermal devices has been calculated by dividing present worth of benefit stream with the present worth of cost stream by using Equation 4 and it comes out as 12.2. Equation 5 has been used to determine the annuity of the solar thermal devices indicates the average net annual returns from devices is INR 189 820. The payback period is 0.56 years which is lower than the expected life of the animal feed and non-tracking solar cooker and solar dryer i.e. about 15 years. Entrepreneurs may prefer to invest on machinery with shorter payback period because the invested funds can be recovered sooner as investments with longer payback periods are considered more risky and full of uncertainties (Chandel et al., 2017). Barnwal and Tiwari (2008) analyzed the cost of a hybrid photovoltaic greenhouse dryer and the system payback period was about 1.25 years with initial investment of INR 27 400.

A linear relationship between NPV and discount rate (i) was shown in Table 9 and established with a R^2 = 0.996 and given as, $i = -8 \times 10^{-4}$ (NPV) +228.6 (Figure 5). Putting the NPV as zero, i becomes IRR which comes to 228.64% in the present case, which is very high for a project to be economically viable.

Table 9 Values of NPV for different rates of discount/interest (*i*)

NPV (INR)	161 000	28 500	-21 400
Interest rate *i* (%)	100	200	250

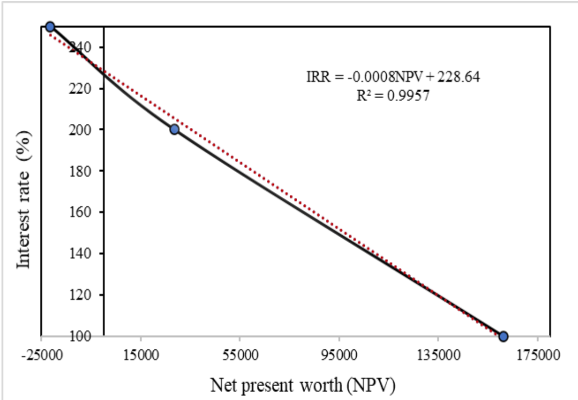

Figure 5 Net present value v/s interest rate curve

Sherrick et al. (2000) observed that the capital budgeting practices employed by large firms to make decisions were mainly IRR (88% firms) and NPV methods (63% firms). Therefore, the IRR was the main decision making parameter , which was found to be the highest for (228.56%) The IRR is greater than the cost of capital (14%). Other things being equal and using IRR as the decision criterion, the one with the highest IRR may be considered as the better choice. One reason for this conclusion is that a higher IRR indicates less risk (Chandel et al., 2017).

The values of five economic attributes, namely, BCR, NPV, A, IRR and PBP are presented in Table 10. The capital budgeting method based on NPV, IRR, Payback Period and BCR can be used by the entrepreneurs to derive a confident decision on investment (Baker, 2000).

Table 10 Economic attributes of solar thermal technologies

S. No.	Attributes economics	Values
1	BCR	12.2
2	NPV	INR 1 164 358
3	A	INR 189 820
4	IRR (per cent)	228.5
5	PBP (years)	0.56 years

A unit of three solar devices, namely animal feed solar cooker, non-tracking solar cooker and solar dryer will save 5035 MJ of conventional energy annually considering the efficiencies of solar cooker and solar dryer as 30% and 20%, respectively. A combined unit of animal feed and non-tracking solar cooker and solar dryer is in a position to replace the 100 percent biomass and save about 3189.80 kg of CO_2 on annual basis, if it replaces firewood. Considerable amount of CO_2 reduction is also seen in case of coal (1701.11 kg), kerosene (750.00 kg), LPG (529.51 kg) and electricity (830.37 kg). The annual CO_2 emission saving for various types of fuel is presented in Table 11. In view of the above mentioned points, the policy makers and Indian Government should encourage such devices by providing small subsidies, which will address social, economic and environmental issues to a great extent.

Table 11 Annual CO_2 emission saving of a unit of animal feed and non-tracking solar cooker and solar dryer for various types of fuel

Type of Fuel	Calorific Value (MJ kg^{-1})	Annual fuel saving	Efficiency (%)	CO_2 emission (kg MJ^{-1})	Annual CO_2 emission (kg)
Firewood	19.89 MJ kg^{-1}	1463.25 kg	17.3	0.1098	3189.80
Coal	27.21MJ kg^{-1}	660.00 kg	28.0	0.0946	1701.11
Kerosene	45.55MJ L^{-1}	230.29 L	48.0	0.0715	750.00
LPG	45.59MJ kg^{-1}	184.07 kg	60.0	0.0631	529.51
Electricity	3.6 MJ kW h^{-1}	1840.28 kW h	76.0	0.217	1437.62

Thus, the use of combined unit of animal feed and non-tracking solar cooker and solar dryer would help in conservation of conventional fuels, such as firewood in rural areas of India, and LPG, kerosene, electricity and coal in the urban areas. Conservation of firewood would help in preserving the ecosystem thereby increasing the forest area. It is evident from Table 7 that firewood is the highest CO_2 intensive fuel (3189.90 kg CO_2 yr^{-1} of firewood) whereas, LPG is the lowest CO_2 intensive fuel (529.51 kg CO_2 yr^{-1} of LPG). Moreover, the use of the animal feed and non-tracking solar cooker and solar dryer would result in the reduction of the release of CO_2 to the environment.

3 Conclusion

On the basis of high values of BCR, NPV, Annuity and low value of PBP while fabricating 100 units annually, the business of solar thermal technologies has a great potential. Also, on the basis of break-even-analysis fabrication and sale of only 37 units is sufficient to reach a state of no profit and no loss. The net average benefit accrued from this business is very high. A combined unit of animal feed solar cooker and non-tracking solar cooker and solar dryer is in a position to replace the 100 percent biomass and save about 3189.80 kg of CO_2 on annual basis, if it replaces firewood. Thus, the business of fabrication of solar thermal technologies will not only supplement conventional sources of energy but also reduce CO_2 emission considerably besides being a highly profitable business. Therefore, energy policy for transition from conventional energy sources to renewable energy sources (solar thermal) is urgently needed and it will lead to mitigating climate change.

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