A STUDY INDAIRY INDUSTRY FINANCIAL VIABILITY OF THE HEATING PROCESS IN INDIA

[1]Sundar.S, [2]Dr.C.Dhanasekaran

[1]Research Scholar

Vels Institute of Science, Technology and Advanced Studies,Pallavaram,

Chennai,India.

[2]Professor Department of Mechanical Engineering,

Vels Institute of Science, Technology and Advanced Studies,Pallavaram,

Chennai,India.

Abstract:

The energy plays anessential role for the development of a region. Based on the resource availability the energy harvest is done. The environment friendly and sustainable energy alternatives are explored due to the fossil fuels perish. Viable alternatives such as the solar and wind energy sources are promising for the demand of energy growth. The analysis of the financial feasibility results of the dairy industries using the biomass gasification which also includes the carbon emission mitigation cost is discussed in this paper. The payback period of the gasification is higher when compared the values of internal return rate and net profit value. The carbon emission of the biomass gasifier is evaluated with the thermal gasifier and the result is shown. Therefore, by using the biomass gasifier the benefits in terms of the environment and economic development is higher.

Keywords: Biomass gasifier, internal return rate, carbon emission cost, net present value

1. Introduction:

The production of milk and milk products has a sustainable development globally. Over the next ten years, a 1.8% of growth rate average will be increased in the world production of milk. In 2017 Food and Agriculture Organization in UK studied that dairy products in developing countries will increase by 0.8% to 1.7% and in developed countries 0.5% to 1.1%. Dairy industries in India achieved a spectacular growth which reached a million tonnes where current is 116 million tonnes [7, 13 and 18].

The problems such as energy availability, efficiency and safe operation are due to the unremitting growth of the energy utilization globally. The supplies of the energy are accepted to reach its limits when a larger part of it is required, which also causes local air pollution and numerous problems in environment [6 and 10]. So in order of pact with these tribulations, the concepts of renewable energy resources such as hydro, solar, biomass are introduced. Myriad human needs and energy can be meeting through the Biomass which produces and consumes the carbon dioxide in a neural basis [1,2,3 and 9]. For the two decades the technologies of the renewable energy utilization are increased in India.

The energy used in the dairy production is increased due the automated systems of various processing steps [5]. The heating process for a required temperature demands a substantial amount. Among the renewable energy in India, the one which has availability of wide range and uniform distribution will be the biomass-based energy.A conversation of 60% to 90% of the biomass energy is converted into gas energy which is done during the gasification in the dairy industry. The product gas calorific value depends on the gasifying agent. The carbon to hydrogen mass ratio is reduced by the biomass gasification [12].

2. Literature review

[13] studied the concentrated animal feeding operations for the thermal gasification process in which a large amount of manure is used. By coal blending process the quality of the gases are improved even though it has lower heat content. Dairy Biomass-Wyoming coal blend (DBWC) counter flow gasification of air stream fixed bed is dealt. Based on the experimental results the peak temperature is decreased but the production of H_2 and carbon dioxide is increased and carbon monoxide is decreased.

[14] presented a comprehensive review for the pasteurization of milk using solar which also covers the aspects of solar water heating system, heat exchanger and flat plate collector. The gasifier thermal process heating financial feasibility of the dairy industries is studied in [4].

[15] reviewed the solar water heating systems and their uses in the dairy industries in India. The entrepreneurs can able to benefit in an economical way using the solar water heating system. The applications of the solar energy in the dairy industries are elaborated and the various collectors of fuels are stated.

An overview of the biomass gasification advances are presented by [12]. For the biomass gasification tar formation and cracking, feedstock types, different operating parameters impact and approaches for modeling are delivered as an assessment. Multi-generation strategies of the gasifier along with their unique characteristics are discussed. The technological advancement and the minimization of socio-environmental effects are strategized for the improvisation of the sustainability and feasibility of the biomass gasification. Using the advanced gasification technology the willow biomass is used to produce the farm based power [16]. Disposition of wastages and the nutrient flow management are offered by this co-gasification method.

Based on the financial viability analysis the biomass technology is proved. Using the available data the levelized unit cost is analyzed. From the papers [11 and 17] the financial analysis procedure is followed which includes the internal rate, payback period and net present value.

3. Methods and Attitude

The dairy industries financial viability of the biomass gasifier heating process (BGHP) is investigated in this study. Figure 1 shows the flow chart of the biomass heating process.

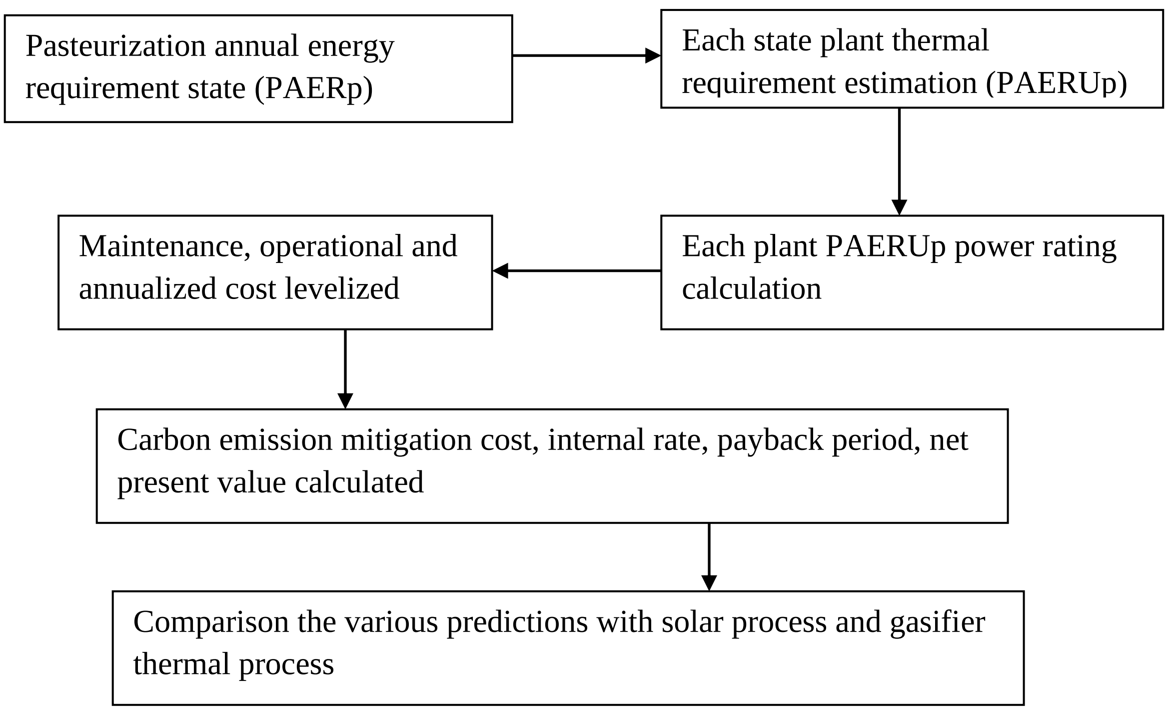

Figure 1: Flowchart of the thermal process

3.1 Location Selection

The location in India for the study of the biomass gasifier heating process in India is selected from the [4]. A variation range of 28,467 to 689,440 GJ is obtained for varies biomass requirement of energy.Depend on the milk quantity, seasonal variation and temperature used for the processing of milk the energy variation differs. The pasteurization annual biomass energy and the processing plants of milk are shown in table 1.

Table: 1. Pasteurization annual biomass energy

State	Pasteurization annual energy requirement state (PAERp) (GJ)	No of plants in each states [8]	Pasteurization annual energy requirement of each unit PAERUp (GJ)
Orissa	28,467	4	7,116.75
Maharashtra	360,700	161	2,240
Madhya Pradesh	237,765	18	13,209
Kerala	76,125	10	7,612.5
Karnataka	229,196	31	7,393.41
Himachal Pradesh	29,890	4	7,472.5
Haryana	149,860	33	4,541.21
Gujarat	689,440	45	15,320.88
Bihar	51,570	6	8,595
Andhra Pradesh	372,600	33	11,290.90

Realistic prediction is estimated by using the number of available processing plants of milk for the different states. The study of the financial feasibility of the biomass gasifier process is carried out by using the various requirements such as temperature, boilers flow rate and pressure [19]. Table 2 states the biomass energy for the gasification annual amount, capital cost and the rating of powers. The levelized unit cost of biomass energy is obtained using the below listed values and in a day of the pasteurization the gasifier running time is assumed as 20 hours.

Table: 2. Biomass energy gasifier power rating and cost

Power evaluation	Capital rate (Co)	Biomass energy delivered by gasifier annual amount BTED (GJ)
110	3,502,102	2721
170	4,327,298	3822
250	6,280,135	5543
360	9,812,876	7918
550	14,129,987	13280
700	20,259,754	17112

3.2 Fuel estimation

The biomass energy required can be calculated using the equation 1 as follows [4].

$$Feedstockrate = \frac{PG_{out} \times CV_g}{\delta_g \times CV_f} \qquad (1)$$

where PG_{out} is the gasifier producer gas output, CV_g is the producer gas calorific value, δ_g is gasifier efficiency and CV_f is the biomass calorific value.

3.3 Financial feasibility measures of biomass gasifier

The financial status of the biomass gasifier in dairy industry can be identified using the payback period, levelized cost of useful biomass energy (LCUBE), internal rate of return,net present value, return rate of the internals and cost of carbon emissions mitigation expressions are described below.

$$AUBED_j = AUBED_1(1-\beta)^{j-1} \quad (2)$$

$$ACOM_j = ACOM_1(1+\propto)^{j-1} \quad (3)$$

$$ACC = C_0\left[\frac{d(1+d)^n}{(1+d)^n-1}\right] \quad (4)$$

$$UCBE_j = \frac{ACC+ACOM_j}{AUTED_j} \quad (5)$$

$$LCUBE = \left[\sum_j^n \frac{UCTE_j}{(1+d)^j}\right]\left[\frac{d(1+d)^n}{(1+d)^n-1}\right] \quad (6)$$

$$\sum_{j=1}^{DPP} \frac{B_j-ACOM_j}{(1+d)^j} = C_0 \quad (7)$$

$$UP_{f,j} = UP_{f,1}(1+\gamma)^{j-1} \quad (8)$$

$$B_j = \frac{(AUBED_j)(UP_{f,j})}{(CV_f)(n_f)} \quad (9)$$

$$NPV = \left(\sum_{j=1}^n \frac{B_j-ACOM_j}{(1+d)^j}\right) + \frac{S}{(1+d)^n} - C_0 \quad (10)$$

$$\sum_{j=1}^n \left[\frac{B_j-ACOM_j}{(1+IRR)^j}\right] + \frac{S}{(1+IRR)^j} - C_0 = 0 \quad (11)$$

$$C_{cem} = \frac{ACC+ACOM-\left(\frac{AUBED}{(CV_f)(n_f)}\times UP_f\right)}{\frac{(FC_0)(AUBED)(CF_f)(\frac{44}{12})}{(CV_f)(n_f)}-\left(\frac{E_e}{n}\right)} \quad (12)$$

where $AUBED_j$the annual amount of useful biomass energy is in jth year, performance of annual duration is β which is implicit as 0.005, $ACOM_j$ is the annual increase in maintenance and operation cost in jth year, ACC is the annual capital cost, $C_0$is the capital cost, d is the discounted rate, $UCBE_j$ is the unit wise cost of biomass energy, $LCUBE$ is the levelized unit cost of biomass energy, B_j is the annual benefit, γ is the rate of annual appreciation, $UP_{f,j}$ is the fuel unit price, CV_f is the calorific value of fuel, n_f is the fuel utilization competence in the boiler, S is the total sum connected with the system life, NPV is the net present value, IRR is the internal rate of return, fraction of carbon oxidized is represented as FC_0 on burning of fuel, E_e is the embodied carbon emissions, C_{cem} is the cost of carbon emissions mitigation.

The equation (2), (3) and (4) describes the annual amount of energy used, the operational maintenance cost of the gasifier system and capital cost respectively. The unit and levelized unit cost of biomass energy are delivered in equation (5) and (6). Equation (7) describes the discounted payback period which is used for calculating the profit of the system where the capital cost equals to the total cumulative benefits of present value. The future investment cash flow which is the non-uniform cash flow series is represented in (10) and when the discount value of the investment is zero gives the internal rate of return.Ratio of the equivalent annualized cost of the biomass gasifier system to the mitigation emissions of carbon dioxide net amount annual is the unit cost of the carbon migration which is stated in equation (12).

4. Results and Discussion

Matlab software is used for the analysis of the biomass gasifier heating process. The financial viability of the biomass gasifier heating process is discussed using the results of the levelized unit cost, internal return rate, net present value and discounted payback period.

Table 3: Milk power plants required power rating

State	**No of plants in each state [8]**	**Pasteurization requirement of eachunit annual amount PAERUp (GJ)**	**Required gasifier power rating (KW)**
Orissa	4	7,116.75	360
Maharashtra	161	2,240	110
Madhya Pradesh	18	13,209	550
Kerala	10	7,612.5	360
Karnataka	31	7,393.41	360
Himachal Pradesh	4	7,472.5	360
Haryana	33	4,541.21	170
Gujarat	45	15,320.88	700
Bihar	6	8,595	550
Andhra Pradesh	33	11,290.90	550

Table 3 states the gasifier required power rating of plants in each state where the rating varies from 110 KW to 700 KW. The financial feasibility of the biomass gasifier process which includes the internal return rate, net present worth, levelized unit cost biomass energy and discounted payback period is indicated in table 4 which is illustrated in figures 2, 3 and 4. Table 5 indicates the carbon mitigation cost of the gasifier biomass process.

Table 4: Financial feasibility of the biomass gasifier process

Location	**LCUBEMinimum value (Rs/GJ)**	**Discounted payback period (years)**	**Net present worth (Rs)**	**Internal return rate (IRR)**
Orissa	243	8	966,067	8.12
Maharashtra	89	6	1,160,125	10.36
Madhya Pradesh	339	8.7	514,124	6.64
Kerala	229	8.1	914,345	9.25
Karnataka	233	7.8	878,125	8.36
Himachal Pradesh	229	7.5	813,741	9.23
Haryana	100	7	1,010,300	9.15
Gujarat	471	8.8	417,353	6.35
Bihar	325	8.3	623,656	8.65
Andhra Pradesh	327	7.6	610,625	8.15

Figure 2: Discounted payback period and Internal return rate

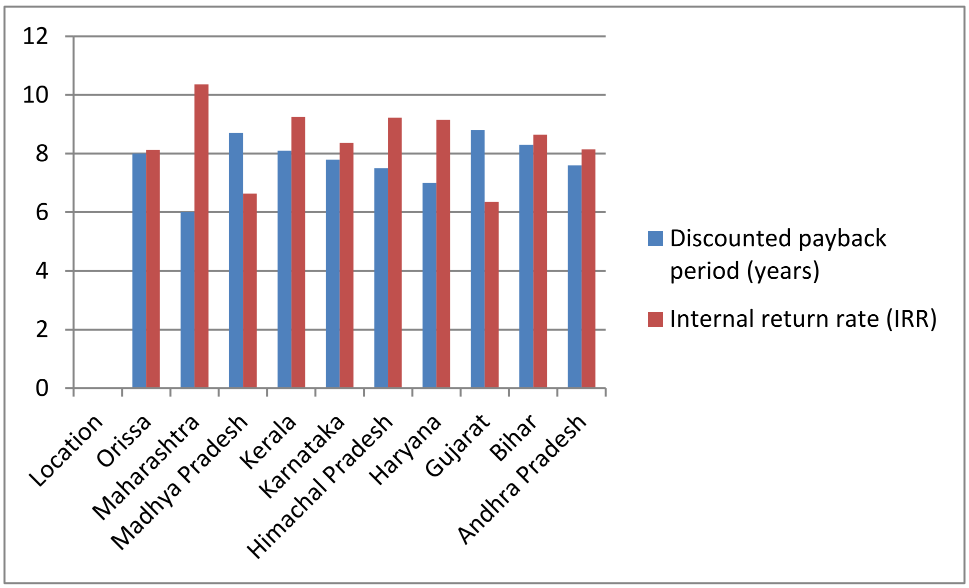

Figure 3: LCUBE values

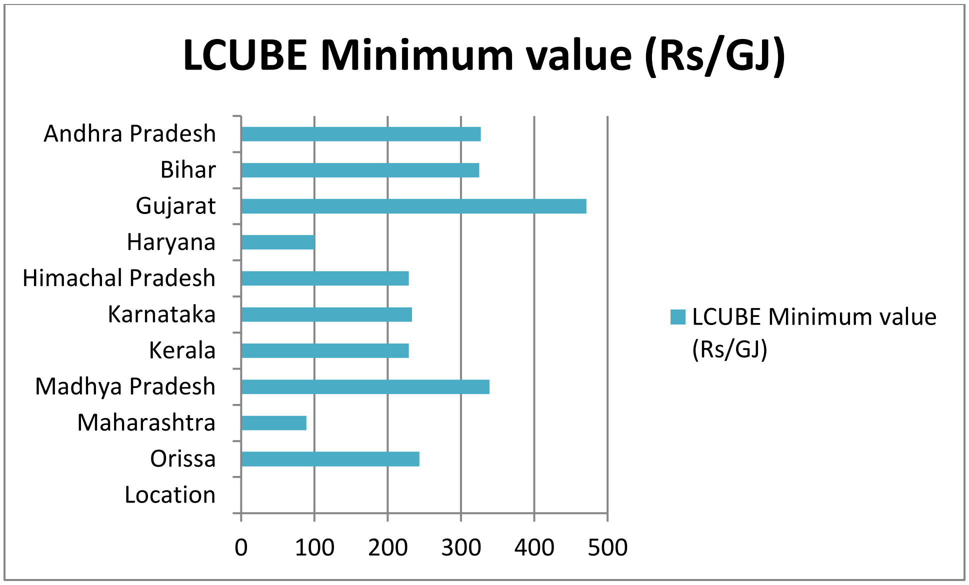

Figure 4: Net present value

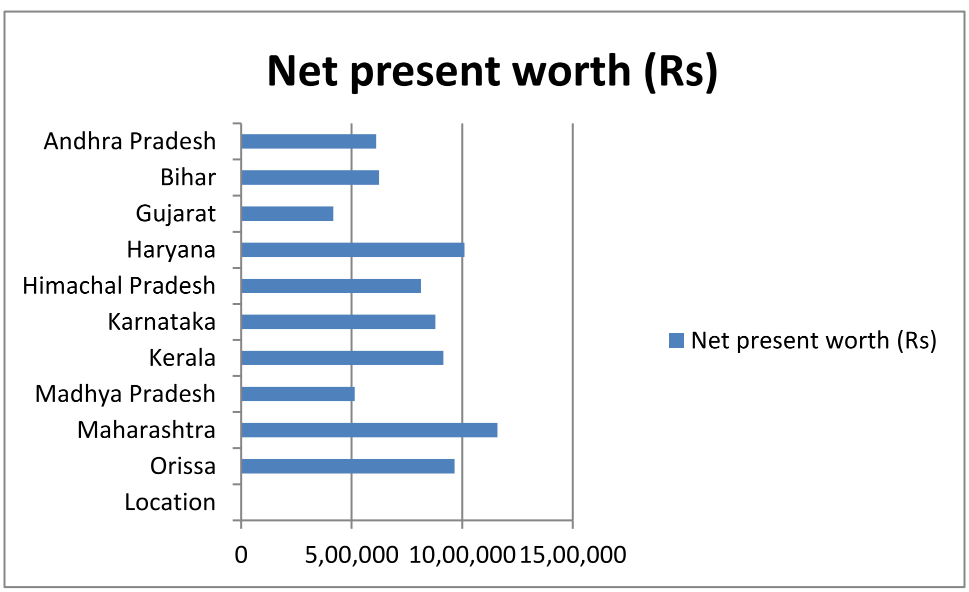

Table 5: Carbon mitigation cost

Location	Carbon mitigation cost (Rs/tonne of CO_2)

in India	
Orissa	767
Maharashtra	345
Madhya Pradesh	1024
Kerala	759
Karnataka	788
Himachal Pradesh	750
Haryana	390
Gujarat	1730
Bihar	974
Andhra Pradesh	981

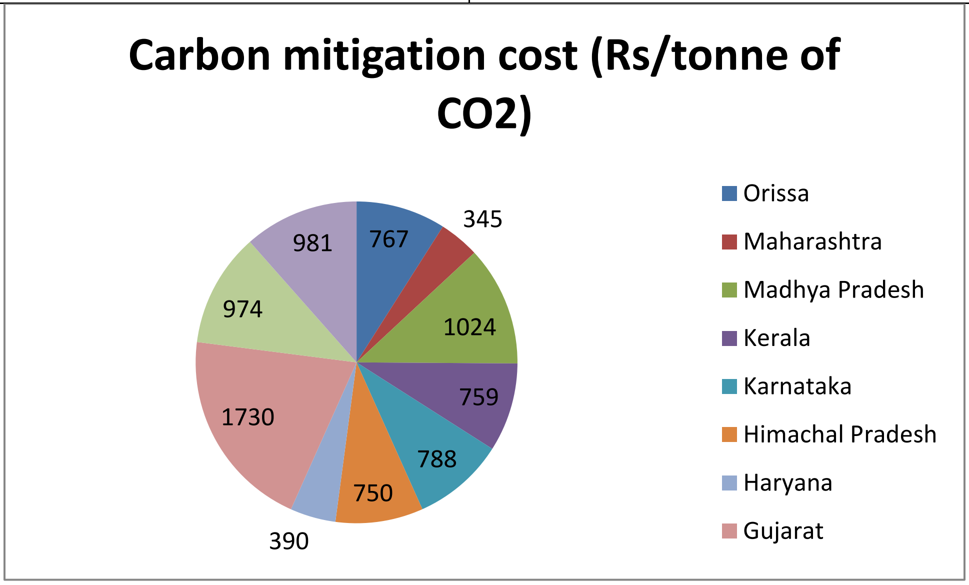

Figure 5: Carbon mitigation cost

5. Conclusion

The pasteurization of the milk using the biomass gasifier system financial revise is performed and the theoretical analysis finale is drawn. Within the temperature range of 60 degree Celsius the heating system is beneficial for all the other systems. Based on the internal return rate, net present value, discounted period payback are studied for the financial feasibility and compared to the solar process heating discussed above this gasifier system is advantageous. The limitation of these technologies is when compared with thermal gasifier the biomass gasifier carbon emission is high and requirement of fuel is high.

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