ARTIFICIAL INTELLIGENCE BASED DAIRY FARM INDUSTRY WITH IMPROVED FINANCIAL ANALYSIS

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Abstract

Hydropower consumption in the dairy industry is a critical task. Estimation of hydropower consumption in the dairy industry, use of solar energy, greenhouse gas emissions and their impact on financial improvement are presented in this paper. The hybrid approach to energy conservation is developed using solar and hydro connectivity and monitoring through the Internet of Things and Artificial Intelligence. Daily monitoring data is used to study the performance of the hybrid energy technique, and the annual performance with the impact of the design value for direct normal irradiance is evaluated. In the proposed method, the connection between solar plant and hydro plant is first established. Using the IOT module, power and milk yield are monitored in real time. Based on electricity and productivity, threshold technology is used to switch between hydropower and solar energy. Monitoring and simulation results show that the proposed method is robust in reducing power and has high productivity.

Keywords: Milk production, Solar energy, hydro power, internet of things.

1. INTRODUCTION:

In dairy industries energy saving is difficult task, different input energy sources are required for plant. The establishment of new milk production plants are very low in India from the last 10 years due to most expensive energy sources is required. Generally, three types of energy sources are used in dairies, namely fossil energy, electrical energy, and solar energy. Fossil energy is based

on steam to produce steam and dry milk[1]. In such cases, electrical energy is used to drive production equipment and pump products that require heat. Solar energy is used for production equipment when enough energy is generated to reduce electricity costs (Shine et al., 2020)[2].

For the development of the social and economic status of a country, energy is one of the basic requirements. in [1 and 4], energy consumption has been scientifically and analytically predicted, which is an important factor for the policy and planning strategies of energy use. For adequate nutrition and food supply, the energy consumption of the agricultural sector is increased [2]. in [3], it is stated that the reduction of climate change and emissions is achieved through energy efficiency, where efficiency is preferred when the amount of resources needed is small, which have the potential to increase production. In the world, the production of milk is higher in India than other countries where 1.2 tin ECM per year is the average milk yield [5].

Dairy processing plants must plan and critically optimize their production processes because dairy products spoil quickly. Depending on the dairy product, the fat content of the milk is varied [6], and depending on the fat content of the milk, it is sold to consumers. Global trade is achieved through the development of milk powders, which makes the milk is not a local product. After the liberalization of India, there is a huge increase in the dairy sector [7]. Day by day the demand for milk and milk products is increasing which is also boosting the Indian economy. Based on demographic and economic factors such as urbanization, cultural, social and relative prices, income level determines the per capita consumption of dairy products [8].

Energy consumption in the dairy industry is based on renewable and non-renewable resources. Of course, the energy consumption in dairy industry increases when the production of dairy industry increases [9]. By analyzing the profitability, viability and stability of a company's financial position, financial analysis is evaluated [10]. The financial situation should be constantly analyzed and monitored in order to make important strategic decisions in any business [11]. Therefore, the financial situation of dairy products must be considered.

The use of renewable energy in India has increased dramatically in the last two decades, benefiting the socioeconomic status of the country [12, 13]. In dairy industry, seventy percent of energy for process heat is consumed from fossil fuels [14], which leads to the use of renewable energy in the heating process of dairy industry. Renewable energy includes solar energy, wind

energy, biomass, thermal energy, hydropower, etc. In this study, hydropower for process heating is investigated and its financial feasibility is examined.

In traditional methods[15-21], dairy industry data is based on manual records. Monitoring systems for dairies use the Internet of Things for process management in the industry to enable smoother and easier monitoring. The demand for dairy products is increasing day by day due to population growth, demand for dairy products and usage. Some of the latest techniques using artificial intelligent systems for dairy management include energy management, dairy farm yield, and milk production from plants [16]. Even if power consumption is good, milk yield depends on the feeding technique of the dairy farm. More artificial intelligence (AI)-based systems are being developed for dairy herd management and monitoring. AI-based dairy farms effectively monitor individual cows' health, fertility, feeding behaviour and milk yield by collecting and analysing comprehensive statistics [17].

In this work, AI based dairy monitoring system, IOT based power consumption, and AI based financial analysis is introduced. The proposed AI based dairy farm monitoring system estimates, how much feed is required, growth and health of the animal, milk yield. IOT based power monitoring system reduce the power requirement in the plant by smart switching between the solar energy and electrical energy. AI based financial analysis is introduced to estimate power requirement, production yield, market demand, sales and financial analysis and improvement.

2. LITERATURE SURVEY

Artificial intelligence plays important role in dairy farm industry. The major applications in dairy from monitoring are Automated Milking Systems, herd management, predictive analytics, quality control, precision feeding, Reproductive Management, robotic herd monitoring. The latest advancements in AI systems based dairy business are revolutionized. By using power of AI, dairy farmers can increase their herd milk yields by maintaining wellbeing of their herds, data-driven decisions, enhance milk quality, and cut costs[22].

Shine et al. (2021) surveyed AI applications in diary farm, and problems that appeared in between the years 1991 and 2021[23]. This survey addressed the problems based on cow health's, featured data by sensors, and algorithms involved in development of milk production. Mahmud et al. (2021) surveyed on cattle farming (beef and dairy). In that study deep neural network models

implementation in dairy farms by addressing the challenges such as image quality, data set size, data processing speed, motion of the cattle during data acquisition and redundant information. Jensen et al. (2016) was to develop a set of algorithms to detect clinical mastitis using the many emerging data sources automatically collected on the dairy farm[24]. Data were collected for each cow at each milking on yields of milk, fat, protein, and lactose; conductivity; blood; and BW. The data set also included parity, DIM, SCC category, season, and mastitis history[25].

AI systems in the dairy industry are being developed to strengthen them in three different cases. The first case is the regular collection of data such as quantity, frequency and heterogeneity for genomic testing. Real-time monitoring of animals is done through mental monitoring of animals, milk proteins, milk yield, and recorded video data (Eckelkamp, 2019)[26]. The second case is an AI system that uses decision trees and convolutional neural networks (Pugliese et al., 2021) [27]. In general, the second case is used for visual recognition and natural language processing. The third case is the real-time execution of AI algorithms in online and edge computing performance [28-32].

The main objectives of this methodology are monitoring animal behavior, plant data, and industrial yield. The first objective is to monitor dairy form using AI and IOT techniques. The second objective is to develop a smart circuit based on power consumption. The third goal is to develop a good product yield using AI and IOT.

3. PROPOSED METHODOLOGY

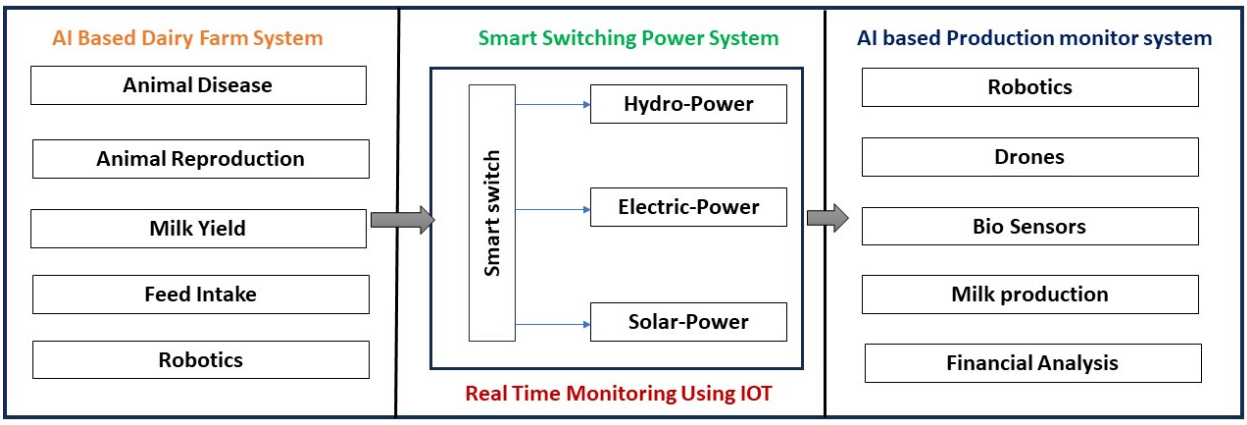

Figure.1 Proposed smart dairy monitoring system

The proposed intelligent dairy farm monitoring system will be developed in three stages: Dairy Farm Monitoring, Intelligent Switching between Different Energy Sources, and Dairy Farm Monitoring System. In the first stage, machine learning will be used to detect cow diseases such as metritis and ketosis. Automatic disease detection is introduced to detect early stage of disease in cows and reduce human error. Automatic disease detection reduces labour,

To achieve better milk yield from cows, it is necessary to monitor and suggest AI management decisions regarding nutrition, regrouping, culling, and reproduction. Good milk yield in the future depends on genetics, health and nutrition factors. Using artificial neural networks and regression techniques, AI and ML techniques are used to estimate future milk production. These techniques are also used to analyze individual cows. The intelligent switchable power system is implemented among the available renewable energy sources for effective energy utilization. When solar energy produces enough power for the plant, it automatically turns on, and hydroelectric power is also used. In the final stage, AI and IOT techniques will be used to monitor milk production in real time and keep the corresponding profit and benefit of the industry in balance.

The most often used renewable energy resource for the electricity generation is hydropower which is used thousands of years ago for the paddle wheel method. In 1880, the electricity generation is occurred using the hydro power in our nation [15]. Since the water is the main purpose of the hydropower, the location of the dairy industry should be near by a water source, which is a main drawback of this energy.

For a better understanding of water power, the process of the water cycle should be understood. The process of the cycle will be: The water is evaporated by the solar energy. Then it condenses as clouds and falls back as precipitation. The water flows through the river and then into the ocean, where the cycle of evaporation is repeated.

Dams and reservoirs are built to secure the water. Hydropower is characterized by its widespread use, advanced technology, low operating costs, renewable energy, long plant life, etc. [16] has studied that hydropower can reduce thirteen percent of greenhouse gas emissions. The country's energy supply can be independent with hydropower because it is not subject to market fluctuations [17]. [18, 19 and 15] studied the process of hydropower utilization.

This study examines the financial viability of the hydro gas heating process (HGHP) for the dairy industry. Figure 2 shows the flow chart of the hydro heating process.

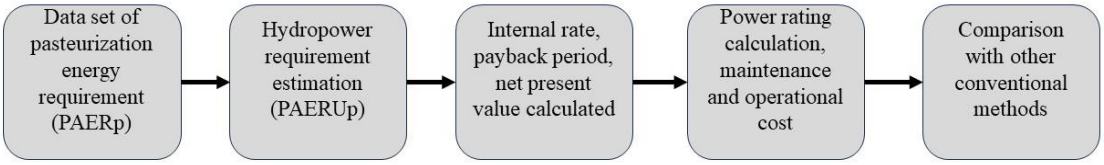

Figure 2: The hydropower process methodology

4. Results and Discussion

The site in India for the study of hydro gasifier heating process in India is selected from the [20]. The annual biomass energy for pasteurization and milk processing plants are shown in Table 1. Table 2 states the hydropower energy for the gasification annual amount, capital cost and the rating of powers. The levelized unit cost of biomass energy is determined using the values listed below, assuming a gasifier operating time of 20 hours for one day of pasteurization. Matlab software is used to analyze the hydro gasifier heating process. The financial viability of the hydroelectric gasifier heating process is discussed using the results of the levelized unit cost, internal rate of return, net present value, and discounted payback period. Table 3 shows the required gasifier capacity of the plants in each state, varying from 105 KW to 630 KW. The financial feasibility of the hydropower gasification process, which includes the internal rate of return, net present value, unit energy cost, and discounted payback period, is shown in Table 4. Figures 3, 4, and 5 illustrate the discounted payback period and internal rate of return, hydroelectric power generation cost, and net present value. Table 5 shows the carbon reduction costs of the gasifier hydropower process, which are shown in Figure 5. The overall estimation using artificial intelligence market analysis shows that proposed method will improve financial deviations in industries.

Table: 1. Pasteurization annual biomass energy

State	Pasteurization annual energy requirement state (PAERp) (GJ)	No of plants in each state [21]	Pasteurization annual energy requirement of each unit PAERUp (GJ)
Orissa	27,467	4	6,866.75
Maharashtra	361,700	161	2,246.58
Madhya Pradesh	237,005	18	13,166.94
Kerala	75,765	10	7,576.50
Karnataka	228,646	31	7,375.68
Himachal Pradesh	29,230	4	7,307.50
Haryana	142,860	33	4,329.09
Gujarat	687,440	45	15,276.44
Bihar	51,870	6	8,645.00
Andhra Pradesh	372,357	33	11,283.55

Table: 2. Hydropower energy gasifier power rating and cost

Power evaluation	Capital rate (Co)	Hydro energy delivered by gasifier annual amount HTED (GJ)
110	3,502,002	2675
170	4,333,298	3901
250	6,280,345	5345
360	9,812,045	7898
550	14,129,765	13187
700	20,259,322	17109

Table 3: Milk power plants required power rating

State	No of plants in each state [21]	Pasteurization requirement of each unit annual amount PAERUp (GJ)	Required gasifier power rating (KW)
Orissa	4	6,866.75	320
Maharashtra	161	2,246.58	105
Madhya Pradesh	18	13,166.94	530
Kerala	10	7,576.50	340
Karnataka	31	7,375.68	340
Himachal Pradesh	4	7,307.50	340
Haryana	33	4,329.09	160
Gujarat	45	15,276.44	630
Bihar	6	8,645.00	520
Andhra Pradesh	**33**	**11,283.55**	**520**

Table 4: Financial feasibility of the hydropower gasifier process

Location	LCUHE Minimum value (Rs/GJ)	Discounted payback period (years)	Net present worth (Rs)	Internal return rate (IRR)
Orissa	237	8	966,067	8.89
Maharashtra	84	6	1,160,125	10.65
Madhya Pradesh	329	8.7	514,124	7.32
Kerala	227	8.1	914,345	9.25
Karnataka	227	7.8	878,125	8.92
Himachal Pradesh	227	7.5	813,741	9.54
Haryana	99	7	1,010,300	9.78
Gujarat	467	8.8	417,353	6.76
Bihar	323	8.3	623,656	8.72
Andhra Pradesh	325	7.6	610,625	8.19

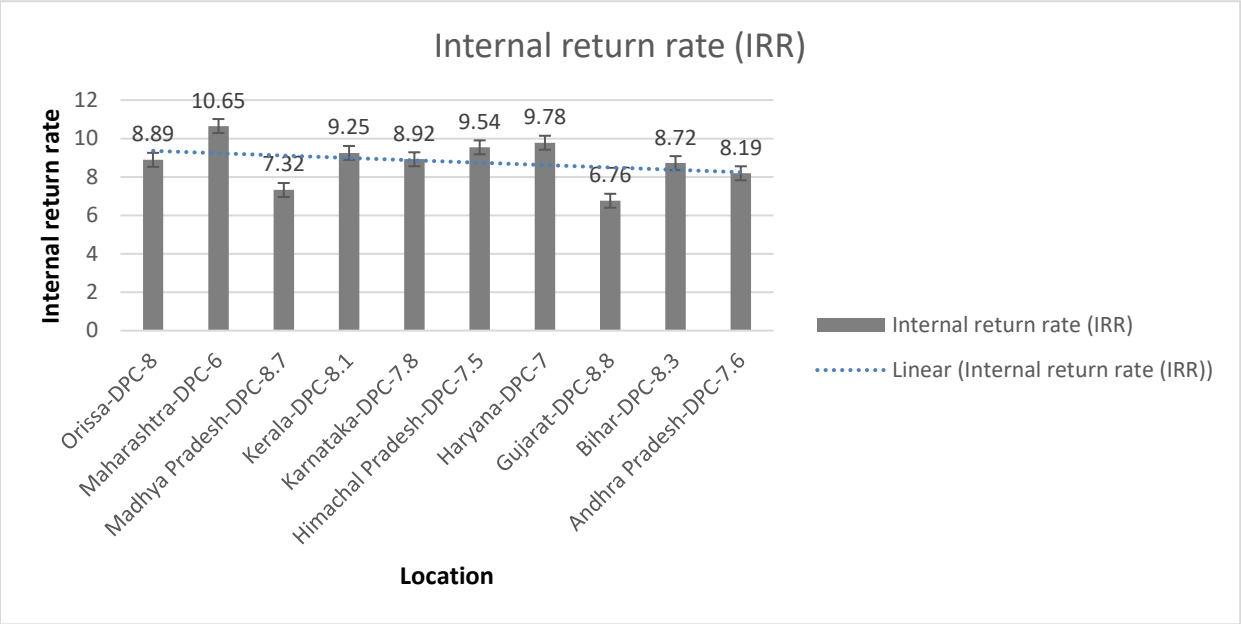

Figure.3 Discounted payback period and Internal return rate

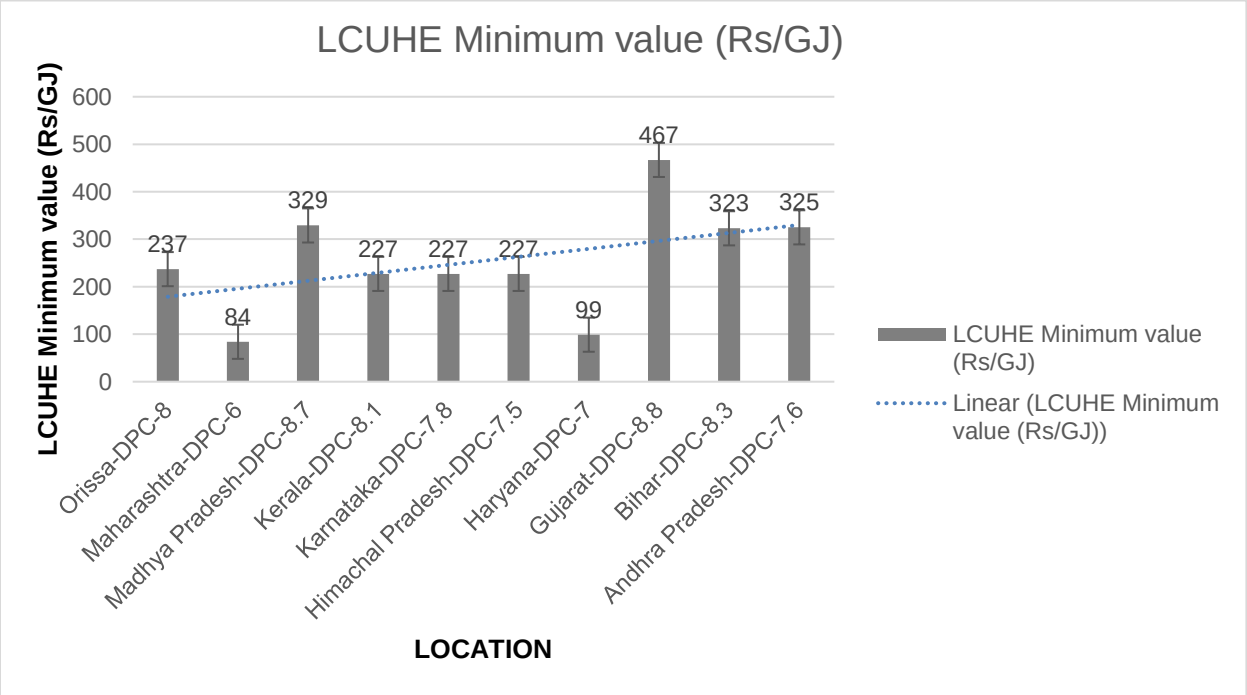

Figure 4. LCUHE values

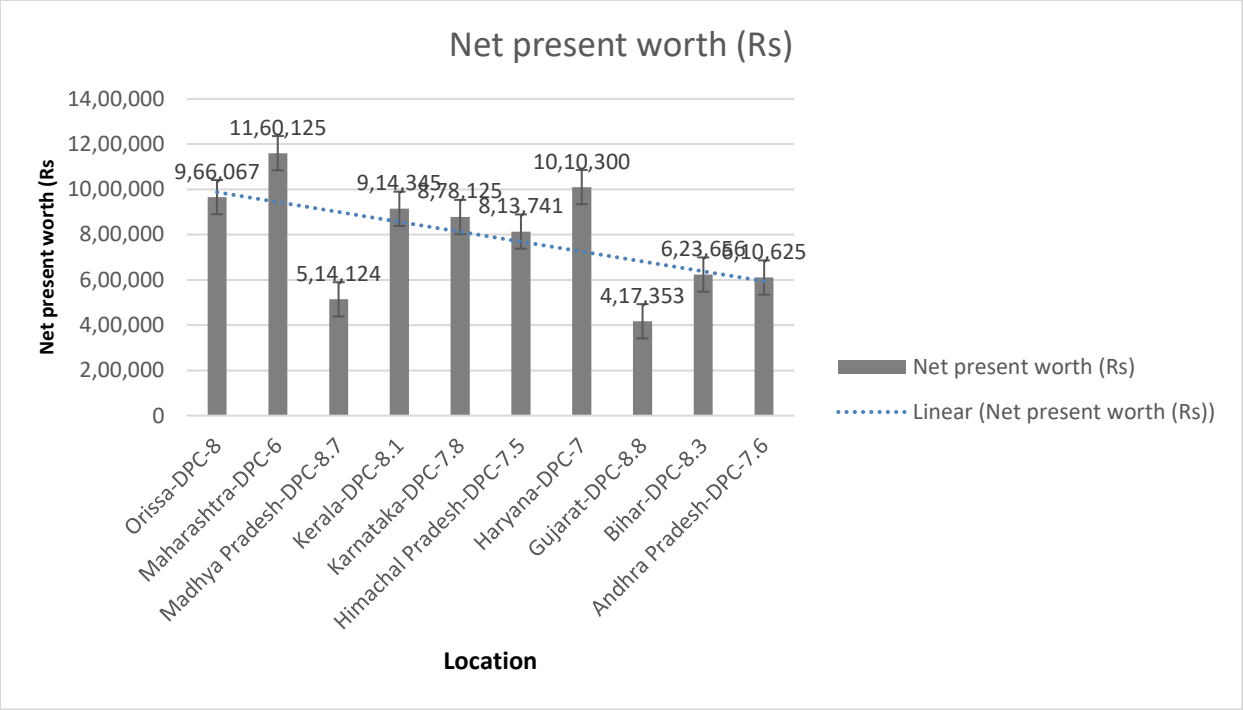

Figure 5. Net present value

Table 5: Carbon mitigation cost

Location in India	**Carbon mitigation cost (Rs/tonne of CO_2)**
Orissa	762
Maharashtra	342
Madhya Pradesh	987
Kerala	749
Karnataka	749
Himachal Pradesh	749
Haryana	358
Gujarat	1430
Bihar	958
Andhra Pradesh	953

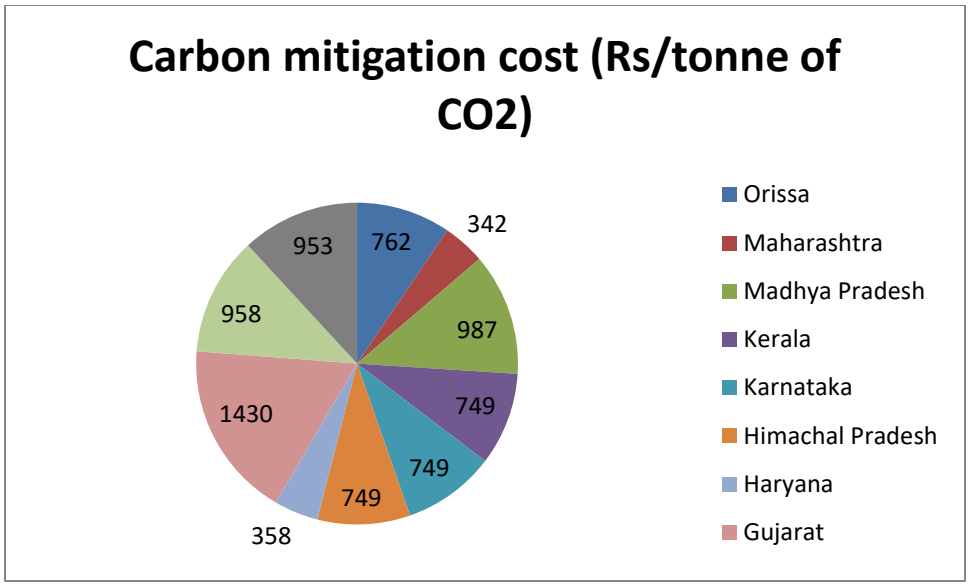

Figure 5: Carbon mitigation cost.

5. Conclusion

This paper presents an artificial methodology for dairy farm monitoring using IOT. The AI analysis of pasteurization of milk using smart switching of solar, electric and hydro gasifiers and its financial improvement. The proposed method is implemented in three stages: Dairy farm analysis, energy analysis, and industry market and revenue analysis. The result for the industry depends on the use of electrical energy. So, in this paper, chemical and biological mass and solar energy systems are included. In the future, the proposed method can also be used for the chemical impact of dairy farms on the environment.

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