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ENERGY OPTIMIZATION APPROACH BASED MACHINE LEARNING ON LINEAR REFLECTOR SYSTEMS

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ABSTRACT

Solar energy is a renewable and cost-effective energy source that holds great promise for meeting global energy demand. This capability is exemplified in solar-powered cooling systems, which have gained popularity in recent years. Addressing the environmental issues associated with fossil fuel consumption, this study investigates the application of linear Fresnel reflectors (LFRs) in solar-based refrigeration systems A novel approach uses equipment -Uses learning models to optimize LFR output, so that grid-based energy -Increased supply chain efficiency. The study uses Simulink simulations to evaluate the performance of the model, with a particular focus on its energy efficiency compared to other methods. This study addresses the complex challenges posed by sustainable energy and highlights the need for sustainable solutions. Studies focusing on LFRs contribute to the growing knowledge of solar energy efficiency. The inclusion of machine learning techniques demonstrates innovation in improving the performance of solar collectors and offers potential improvements in solving energy consumption problems Simulations in Simulink for testing robust areas, indicate that the proposed machine learning LFR outperforms other methods in terms of energy efficiency. The study highlights the importance of switching to renewable energy sources, especially in cooling systems. The use of linear Fresnel reflectors, together with advances in machine learning, represent a promising approach to energy efficiency. These issues contribute to the ongoing discourse on sustainable energy practices, offering compelling solutions for reducing environmental footprints.

Keywords: *Energy Consumption; Cooling Systems; Machine learning; Linear Fresnel reflectors; Energy Efficiency*

1. INTRODUCTION

Concentrating solar power is the method of transforming solar power, also known as CSP, into electricity through an intermediary process. The vast majority of CSP systems utilise large-area mirrors to concentrate the sun rays onto a relatively narrow receiver aperture. The following types of CSP technology are on the list: the Fresnel, parabolic trough, dish/engine and central receiver. This allows solar power plant dispatchability to be improved by using large-scale thermal storage in conjunction with the first three technologies [1][2][3]. There a maintenance problems, space, changes in water up and down, and connection problems, these will probably be fixed and used more in the future.

Line-focused Concentrated Solar Power (CSP) equipment may include parallel Fresnel collectors and parabolic troughs [4]. A linear Fresnel collector consists of primary reflectors and a receiver assembly have the potential to contain one or more linear receiver tubes as well as a secondary reflector. During the day, the primary reflectors move in a direction that is perpendicular to the path of the sun while the receiver assembly stays put. In contrast to parabolic troughs and large-sized heliostat mirrors for central-receiver systems, the low-profile reflector architecture enables an improvement in the concentration ratio without an increase in wind loads. This is possible because of the reflector's relatively low profile. Because wind torque loads are usually proportional to the square of the mirror height, this is the case here. The height of the mirror is why this is the case [5].

Because of the low-profile architecture, there is a great deal of leeway in determining the concentration ratios, which makes it possible to construct linear Fresnel collectors for a wide range of temperatures at which the light must be collected [6][7]. Since they are so effective at generating heat at low and medium temperatures, linear Fresnel collectors have been the most popular choice on the market for a significant amount of time. When operating at low or medium temperatures, the linear Fresnel is useful for a broad variety of purposes, including the heating and cooling of buildings, the supply of heat for industrial processes, and the treatment of water, among other things [8]. High-temperature heat is most typically produced by SOTA linear Fresnel collectors, which are more commonly constructed [9]. When generating electricity from large amounts of sunlight, it should be stored in batteries if there is no immediate demand for it. Otherwise, you will have to trip it. (Disconnect trip-function). Larger batteries have not been found to date. Buying a battery in the thousands would not be economically viable. To solve this problem, there is something called a pumped storage (hydroelectric power station) funnel power plant. When there is no electricity demand, the solar electricity generated can be pumped to the pump and the river water can be pumped from the bottom to the top of the dam. When the solar is not working when electricity is needed (at night or in the clouds the solar does not work), that electricity can be started by running the funnel power station, as the reservoir is full of water. The same pump can be driven as a turbine. Or you can use a turbine alone, with a normal pump.

One aspect of a solar-powered energy supply is demonstrated by several types of cooling systems. The need for cooling is estimated to account for 10% of all power produced globally [10]. The use of refrigeration cycles also has unfavourable effects on the surrounding ecosystem. When there is an abundance of solar energy, the demand for cooling increases. The fact that solar-powered cooling systems do not require the use of energy and do not contribute to environmental pollution makes them interesting. Recently, improvements have been made to the cooling systems utilised by solar collectors [11]. In particular, sorption refrigeration technologies are becoming increasingly prevalent. This is the case since collectors in cooling systems are able to deliver the required operating temperature [12]. Solar sorption systems, such as adsorption and absorption, have a massive amount of potential for cooling the environment [13]. The number of articles that have been published about utilising solar energy for cooling purposes is increasing. It is great to see that in the most recent year or two, there has been an increase in the number of publications that reference solar-powered air conditioners [14][15].

In this work, linear Fresnel reflectors are investigated in terms of the potential use they have in cooling systems. The study uses a machine learning model to process the generator to provide efficient output from the LFR to the grids. A motor that requires more power A.C. is available in sizes other than refrigerator and water heater. Even better is to set up LED lights in the house. Similarly, solar water heaters can be set up. This will reduce the monthly electricity bill.

2. RELATED WORKS

This section contains a retrospective look at linear Fresnel collectors and their applications throughout the years, as well as some forecasts regarding the foreseeable future of the technology.

Solar collectors, which can be of either a thermal or an electrical type, are what are used to harvest the sun's rays in order to extract usable energy (photovoltaic panels). Explaining the electrical performance of a PV panel can be done with the use of an equivalent circuit consisting of resistors and diodes [16][17][18]. Every solar power system must have at least one collector as one of its components. Using thermal collectors, it is feasible to harness the heat-producing potential of solar radiation and make it usable heat [19][20][21]. The two most common varieties of thermal collectors are known respectively as non-concentrating collectors and concentrating collectors. Non-concentrating types of collectors include flat-plate collectors, also known as FPCs, and evacuated tube collectors [22]. Solar energy gives off its thermal energy for free. We just have to electrify it. Similarly, waterfalls give their kinetic energy for free, and we just convert it into electricity. In the same way, the earth gives its

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petrol for free, we just have to turn it into electricity. The wind gives away its kinetic energy for free, and we just have to electrify it.

When the sun's rays strike the absorber of the collector, it converts the sun's energy into heat, which is then distributed throughout a system of fluid tubes. In the same way that absorber surfaces are handled in flat plate collectors, absorber tubes that are surrounded by an evacuated tube are used in the construction of evacuated tube collectors. Within a parabolic collector, a reflector surface acts as a conduit for the radiation to be reflected onto an absorber tube. Because of their ability to follow the sun along an axis, simple parabolic collectors are more effective than their complex counterparts [23]. The localized production is better in some sectors such as green electricity, agriculture, and construction respectively [24]. DC was electricity at the time electricity was invented. The AC power supply was invented because of the high power loss to transport it to a remote location [25]. The electricity available in the solar panel is low-volt DC electricity. Not suitable for carrying with the parcel.

These collectors suffer from a variety of structural and hydraulic problems, the most notable of which is the higher fabricating reflector cost along with the wind loads. Fresnel collectors do not contain difficulties that were previously noted as being connected with parabolic collectors. This is because Fresnel collectors do not have moving receivers and instead employ flat reflectors. Dish collectors are one method that can be utilised to produce heat. This collector can follow the sun in two dimensions thanks to the point reflector it possesses. Heliostat field collectors, which comprise a large number of reflective panels and direct the sun's rays toward a central receiver, are one method that can be used to gather solar radiation for energy collection [26]. Heat transfer can be improved in concentrating solar collectors by using fins that are hollow and cylindrical in shape [27][28].

There are many different fluids that can be used to transmit heat, such as water, air, nanofluids, thermal oils, and so on. Heat can be collected by collectors and then transferred to other systems. Working fluids are typically made using nanofluids because of the excellent heat transfer efficiency that these fluids possess [29][30]. If you use the direct technique, the fluid will be heated directly, and then it will be circulated via the collector. If you use the indirect method, the fluid will be heated directly, and then it will be circulated through the heat exchanger [31][32][33]. Ethylene glycol is a frequently selected option when it comes to the indirect water system. In addition to this, the utilisation of additional fluids, such as silicone oils and refrigerants, is essential. When it comes to absorption refrigeration systems, water-ammonia and water-lithium bromide are two of the fluids that are utilised for solar cooling more frequently than others. Ammonia is utilised as the coolant, and lithium is put to use in the absorption process [34].

Absorption chillers are a type of cooling system that was explored in [35] in their study of a cooling system for a house with one level. In the calculations, a transient model of a hybrid solar cooling system driven by PDC, and flat plate collector was utilised, but in the experiments, the PDC was the component that was utilised. The sun emits 62,900 kW of energy per square meter. This represents a capacity of approximately 1 million electric lights. Such an image is impressive - the sun is 8,000 billion KW every second on Earth, I.E., many times more than all the power stations in the world. Pre-mission of modern science - to learn solar energy more fully and efficiently as it is safer. Scientists believe reliable use of solar energy - this is the future of man. In order to determine the extent to which time and environmental factors, energy tariffs and flat collecting areas all had an impact on the functioning of the system, these factors were investigated. All of these figures were based on the reduction in energy consumption. Their findings suggest that the suggested system would not be very cost-effective due to the low gas and electricity rates that are prevalent in the research area. As a consequence, the payback period would be quite lengthy. It possible that a workable method would be to replace LFR collectors with more pricey alternatives in order to shorten the payback period [36]. An experiment is found in [37] to investigate absorption cooling cycles utilising PDC in conjunction with three fluids (ammonia, water, and hydrogen), respectively. During the course of the experiment, which lasted for a total of two days, temperature readings were taken from both the generator and the evaporator. When the evaporator was maintained at 23 degrees Celsius and the generator was maintained at 92 degrees Celsius, the coefficient of performance (COP) was measured at 1.6.

An absorption refrigeration cycle is found in [38]that is capable of supplying power in addition to desalinating water. A multi-effect technology that is based on the absorption of ammonia and water is utilised in the desalination portion of the refrigeration system. The amount of cooling power produced by the specified refrigeration cycle was 820.85 kW. We used Aspen Hysys to run simulations and then analysed the results to see how

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the second law of thermodynamics affected each individual component. Heat exchangers and distillation columns were found to be responsible for 86 percent of the total energy rate loss. The system overall energy efficiency and thermal efficiency were both 66 percent and 80 percent, respectively. They calculated that the aforementioned system would have a payback period of 5.783 years and would provide an annual net profit of 6.828 million US dollars.

Cascaded vapour compression-absorption system is developed in [39]. The organic Rankine cycle, also known as the ORC, is utilised in this system, which is driven by solar-biomass energy, in order to create low-temperature cooling. The study performed a thermo-economic analysis to calculate the solar fraction and the point at which PDC and LFR reach a position where they are no longer losing money. Because LFR has a lower yearly efficiency. and a higher cost, the solar fraction and the point at which it is profitable to switch to LFR are both lower. They also made adjustments to the ORC working fluid and determined break-even values as part of their investigation into the effects of the working fluid. When compared to a solar-biomass-powered system, the capital expenses and break-even point for the biomass system were 39 and 30 percent lower, respectively. Furthermore, the biomass system had a 30% lower break-even point.

3. PROPOSED METHOD

The LFR and PTC telescopes also use an approach that is quite similar to this one, in which the mirrors are steered in predetermined patterns in order to minimise the radiation angle of incidence and, as a result, maximise the amount of radiation that can be collected from incident rays. This is done in order to make the most efficient use of the irradiance that is received by the concentrator while it is arranged in an East-West tracking configuration and is being used to generate energy. In order for a Solar power plant to successfully generate electricity, the layout of its solar fields should be given the utmost importance. Because a poor design can result in low operating times, an increase in the thermal energy storage capacity, poor thermal performance, and even the operation of the power block because the concentrated solar energy density is insufficient. The reasons that are explained in this study led to the development of an opto-geometric optimization technique, and a schematic representation of this methodology. Figure 1 shows the Optimization of the LFR using ML.

They use LFR rather than PDC to power their solar-powered system since LFR is more cost-effective. On the other hand, the use of PDC for a single cooling output does not have an economic justification.

A. Problem statement

Prior research examines various aspects of solar energy harvesting, including heat and electronics, with a particular focus on photovoltaic panels The discussion clarifies the energy performance of PV panels through a uniform circuit model so and emphasizes the important role of thermal collectors in harnessing solar radiation for usable heat. Various collectors such as parabolic, Fresnel, dish, and heliostat field collectors are examined for their specific capabilities in capturing solar radiation The research extends to heat transfer using various fluids and explores techniques direct and indirect. Experiments and analyzes of hybrid solar coolers, absorption chillers, and cascaded vapor compression-drying systems provide insights into payback time, energy efficiency, and economic consideration s for the scope of this research this It lies in addressing the identified gaps and provides valuable insight into the economic viability of using parabolic container collectors for cooling applications.

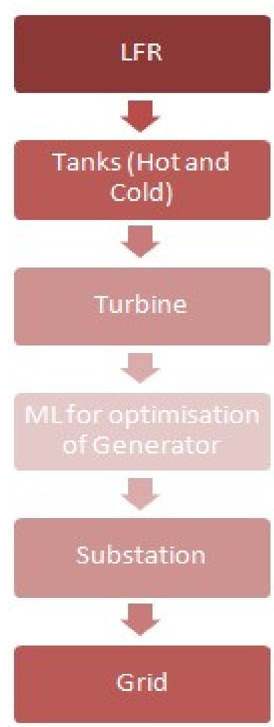

Figure 1: Optimization of the LFR using ML

The first thing that has to be done in order to begin the process of optimization is to determine the precise location of the power plant. Because of these data, a more accurate estimation of irradiation direction and incidence was possible by employing computations that took into account the angle of the sun. After determining the optimal receiver height and criterion, the intercept factor (IFC) and the incidence angle modifier (IAM) are computed once the criterion has been satisfied.

After that, the geometry of the CPC will be specified. A ray-tracing comparison of the flux distribution, and the optimised field is carried out, which is the fourth step. After that, a thermal technique is used to make a comparison between the enhanced field and the FRESDEMO field. The oldest method of passive use is solar power - it is painted on a dark-colored water tank. The darker the color, the more concentrated the sunny energy, the hotter it becomes - the warmer the water. However, there are progressive methods of passive use. The Solar power Construction Techniques When designing building designs, accounting for climatic conditions is used as much as possible in the selection of building materials. With this design, the construction of the building has accumulated a collector.

In order to configure the structure and construction of the LFR in such a way that the reflected solar radiation is directed to the receiver in the most efficient manner possible, the sun angles need to be determined first. In the case of a solar field that runs in a north-south orientation. LFR performance can also be affected by other factors like the positioning of the receiver height. In accordance with Fermat Principle, a target zone is the receiver, will be used to calculate the inclination of each mirror. However, as the distance between the mirrors increases, so does the amount of time it takes for light to travel; as a result, not all light tends to reach the receiver region. The intercept factor is a useful metric for quantifying this circumstance. Solar power solar collectors are used at the heart of active application systems. The collector heats the cooling by absorbing sunny energy cooling, heating the water, and converting the electrical energy. Solar collectors can be used in all activities for industrial, agricultural, and domestic needs.

There will be losses in this captured radiation that should be zero because the intercept factor (A)should have a unit value. This is because the LFR is not an ideal concentrator, where the losses are found in the captured radiation. Despite the vast number of methods that can be used, it is possible to determine the intercept factor by using more straightforward methods. These methods can be used in place of the numerous other methods that can be used. Among these are the direct application of the conservation and the utilisation of an improved ray-tracing technique as in equation (1).

$$FF=A'/A_{il}=a'L_m/(a'_l+a'+a_r)L_m \quad (1)$$

A_{il} - Total lighting area
A' - Receiver area
a_r - Right receiver spillage
a_l - Left receiver spillage
a' - Receiver width
where $0°\leq\alpha_T\leq180°$, if $\alpha_T=90°$ when $\sin\gamma_s=0$.

Based on the immediate examination of the intercept factor, it is possible to draw the conclusion that incidence angles do have a role in determining the value of the intercept factor. Because the amount of irradiance that is received by the receiver will be at its highest point around solar noon, this is the best time of day to perform the intercept factor optimization so that it can be maximised. In the scenario in which the field is assumed to be situated at the equator, the location known as the reference position is the one in which the mirrors are arranged in such a way as to maximise the intercept factor. In order to construct the geometric description of the Fresnel reflector, it is necessary to have the inclination angleψ_i, which varies depending on where the sun is located and shown in equation (2).

$$\tan\alpha_T = \tan\alpha_s\sqrt{1+\frac{1}{\tan^2\gamma_a}} \quad (2)$$

ψ_i- inclination angle of mirror
β_i– inclination angle
α_T- transverse angle of solar altitude

The real focal distance with the primary mirrors h_{fr} is estimated as below as in equation (3):

$$\psi_i=\alpha_T - \beta_i^2$$

$$\beta_i=\arctan(h_{fr}d_i) \quad (3)$$

The inclination does not depend in any way on the position of the mirror; rather, it is entirely dependent on the temporal shift that occurs in the angle α_T. Each row of mirrors has a unique angle location, but they all rotate at the same pace. Despite this, the overall effect is seamless. In theory, a single motor might power all of the mirrors by means of a straightforward mechanical link composed of four bars (a rocker mechanism). On the other hand, contemporary LFRs have come to the conclusion that moving each mirror independently is the most

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effective technique to achieve precise tracking and gradual defocusing. The receiver in FRESDEMO Fresnel field arrangement is placed at a distance of 8 metres from the primary mirrors, with a spacing of 0.6 metres (a') between them (h_{fr}). The FRESDEMO field has a maximum intercept factor of 0.5753 for the point that serves as the reference. Therefore, it is possible to establish the position of the primary mirrors based on the position of the most recent mirror. The position and tilt of the mirrors are determined according to the equation for the reference point (which is solar noon). This is the simplest type of solar collector. Its design is very simple and reminiscent of the effect of a typical greenhouse, which is on any summer cottage. Spend a little experiment. On a winter sunny day, put any item in the sun and let the sun's rays fall on it and after a while put the palm on it. You feel like this item is hot. And can be outside the window.

B. Machine Learning

A Logistic Regression classifier is the most fundamental form of neural network, as there is only one neuron present at each node in this architecture. An output is produced by a computational neuron using a non-linear activation function that takes the sum of weighted inputs as its input and generates the output using that input. Logistic regression is a technique for supervised learning that can be used to tackle classification problems that involve outputs that are discrete (i.e., labels) [40]. Logistic regression and other types of regression modelling that use sigmoid activation functions are able to translate features from an input feature set to a continuous vector. This vector can then be used to indicate the likelihood that the input belongs to one or more of these classes. The following formula can be utilised when modelling data using logistic regression with two classes: There is a relationship between sigmoid function as in equation (4):

$$f(x) = sigmoid(W^T x + b) = \frac{1}{1+\exp(W^T x + b)} \quad (4)$$

Where
W- weight vector
x - feature vector and
b- bias.

The values of W and $b$are produced at random via gradient descent or stochastic gradient descent (SGD) methods, and they are then optimised by minimising a cost function in order to achieve the best possible solution (e.g., negative log-likelihood). Using a model with the optimal parameters, it is possible to make predictions about future inputs even when the labels are unknown. It is a linear classifier, which means that it makes predictions based on a linear combination of the input features. Figure 2 shows the advantages of machine learning.

This combination splits the spaces containing the input characteristics into halves. Because of their low computing complexity and excellent resistance to over-fitting, linear classifiers have the advantage of requiring features that are linearly separable in the feature space. This is typically extremely difficult to achieve in many applications, including medical imaging. Linear classifiers have the advantage of requiring features that are linearly separable in the feature space. Alternately, a Multiple Layer Perceptron (MLP) can be used to generate a non-linear classifier by combining a number of basic neurons.

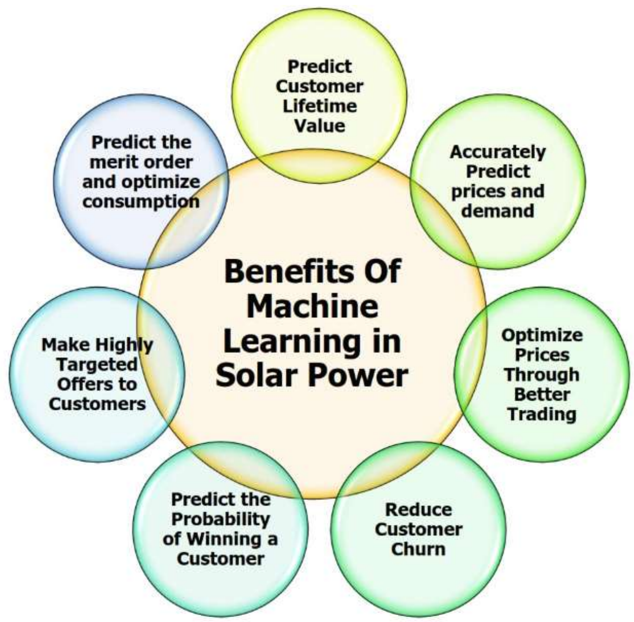

Figure 2: Benefits of machine learning.

The main feature of the collector is a thermocouple insulated plate. The plate is painted in a dark color. Sunlight passes through the exposed surface, heating the plate, and then heating the air flow into the atmosphere. Air passes through due to natural convection or by using a fan, which increases heat transfer. However, the absence of work on this system requires additional costs for fan work. These collectors work through light day, so they do not change the main source of heat. However, if you make a collector the main source of heating or ventilation, its efficiency will increase.

As a result of the limits imposed by hardware and computerised methods, MLPs consist of three layers. To get started, let look at the input layer,

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which is a representation of the feature vectors that are taken in by the network. The second layer is known as the hidden layer because its values are not visible in the training set. This is why the second layer is called the hidden layer. It is possible for the input and hidden layers to be fully coupled thanks to the presence of an output neuron that has a sigmoid activation function and is connected to neurons in both layers. This non-linear mapping is carried out in the expectation that optimised hidden features will be able to be linearly separated, which is the motivation behind the introduction of a hidden layer. The following is the formula for an MLP with two layers as in equation (5):

$$f(x) = G(b^{(2)} + W^{(2)T}(s(b^{(1)} + W^{(1)T}x))) \quad (5)$$

where

$b(1)$ - biasof layer 1,

$W(1)$ – weight matrix of layer 1,

$b(2)$ – bias of layer 2, and

$W(2)$ –weight matrix of layer 2.

G- Activation function used for the output layer that contains a sigmoid function and

s - Activation function used in the hidden layer.

The sigmoid kind of rectified linear unit is very popular and can be found rather frequently (ReLU). For instance, one way to reduce the size of a log-likelihood function is to use the back-propagation algorithm in conjunction with SGD, which is a type of chain-rule derivation. The collector consists of solar energy, coatings (glass with a reduced metal content), a tube and a heated insulation layer. The transparent coating protects the houses from adverse weather conditions. In this case, the solar power supply panel (absorber) is connected to the air conditioner, which circulates through the pipes. The pipe can be both in the form of a ladies and a barbeque. Cooling moves from the entrance to the entrance, gradually heating up. The suction board is made of metal well conductive heat (aluminium, copper).

4. RESULTS AND DISCUSSIONS

It is possible to calculate the intercept factor for systems that have a variable height. Altering the angle at which the mirrors are tilted is required in order to ensure that the absorber tube continues to receive light even after the intercept factor has been optimised for height. The variation in the intercept factor that occurs due to an increase in receiver height is depicted in Figure 3 - Figure 8. It is interesting to notice that the intercept factor does not much increase after 22m, but dealing with receivers at that height would make the installation more difficult.

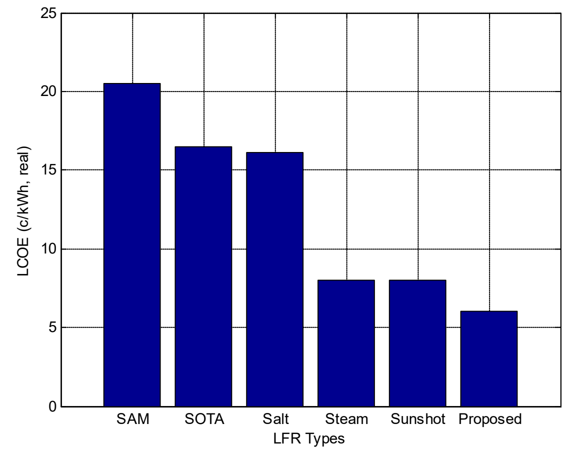

Figure 3: LCOE (c/kWh, real)

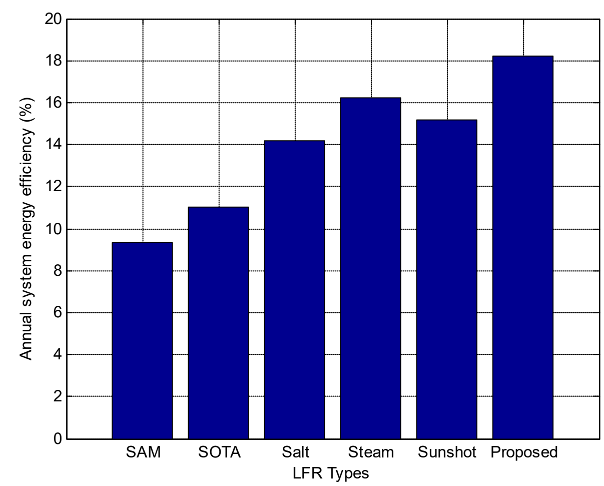

Figure 4: Annual Energy Efficiency (%)

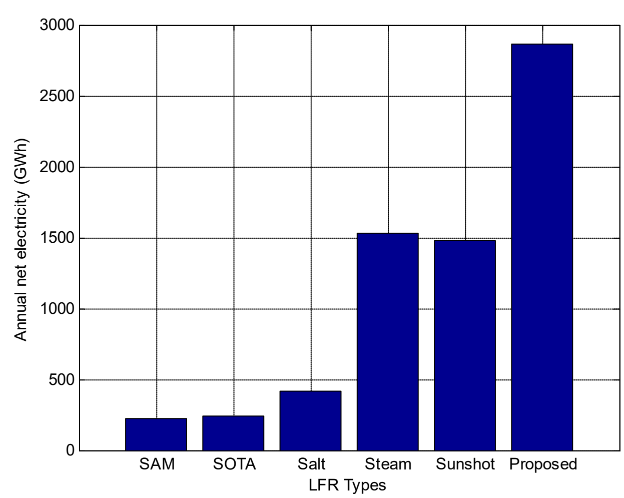

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Figure 5: Annual net electricity (GWh)

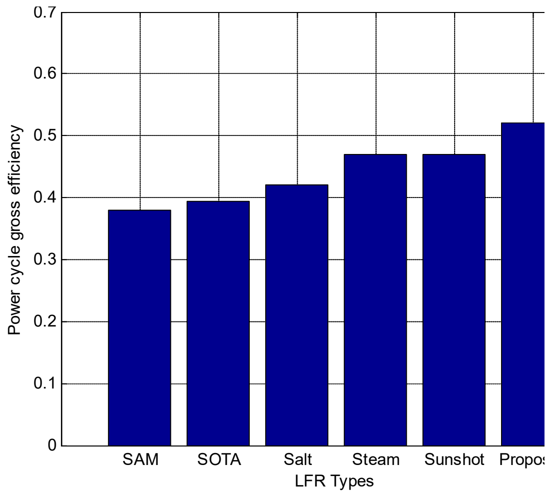

Figure 6: Power cycle gross efficiency

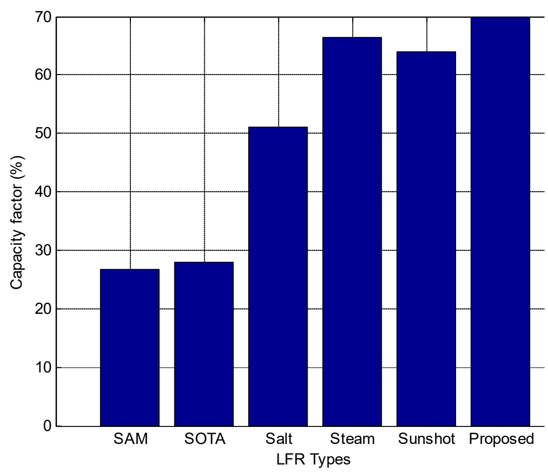

Figure 7: Capacity factor (%)

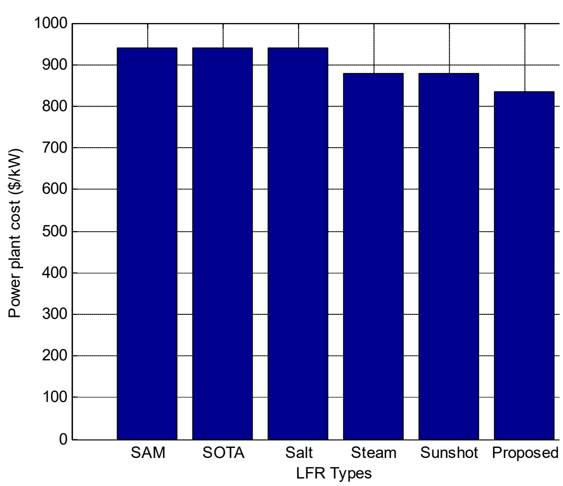

Figure 8: Power plant cost ($/kW)

A single criterion was all that was needed to establish the height. On the curve, an extreme point was found, which refers to the point at which the rate of change no longer increases considerably after reaching that point. The figure comes out to a little more than 15 metres when considering these circumstances. According to the above graph, the intercept factor equals 0.73 when the height of 16 metres is used as an optimization point. Because there is no change in the field width, there is no change in the placement of the mirrors. Following the completion of the calculation for the intercept factor, the next step involves locating an incident angle modifier (IAM). Calculating the IAM requires taking into consideration both the longitudinal and transverse angles, and the formula for this calculation is $IAM=IAM(\theta_l,\theta_t)$. Combining the longitudinal K_l and transverse modifiers K_t to generate the incidence angle multiplier is a standard definition. This multiplier can then be used to acquire both parameters individually.

As was previously mentioned, the architecture of the systems allows for the possibility of a different number of cavity systems and absorber tubes for the receiver. In the most basic configuration, just one tube is used. This tube will most likely be located inside a hollow that has a glass cover on the bottom if you are using a compound parabolic concentrator (CPC). A modified CPC in the receiver in order to increase the geometric concentration coefficient and deflect any radiation that does not contact the absorber directly. As a result, the receiver will only require a single tube to function properly. As a consequence of this, optimising the height of the CPC is not possible due to the fact that the geometric concentration is low. Visit to gain a better understanding of the meaning of the term truncation criterion and the implications it has. Only those photons that are not immediately collected by the absorber will be redirected by the CPC; this contributes to the conservation of energy and the reduction of optical losses. The restriction placed on the half acceptance angle θ_{max} by the principal mirror reflection is as follows: If the angles that enter CPC are going to be absorbed, the geometry of the field requires that they be exactly equal to or less than 33.45 rad. It is not recommended to cut the CPC because, as was explained earlier, θ_{max} = 66 degrees + 1.2 radians.

The provided bar graph illustrates a comparative analysis of power plant costs (in $/kW) for various Low Frequency Resonance (LFR) types, including SAM, SOTA, Salt, Steam, Sunshot, and Proposed. The costs across LFR types exhibit minimal variation, falling within the range of 800 to 900

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$/kW. The research problem centers on identifying the most cost-effective LFR type for power generation, with the chosen evaluation criteria being the cost of power plants in $/kW. The significance of these choices lies in their direct impact on economic feasibility and scalability. In terms of analysis criteria, there is a similarity in the comparable costs among LFR types, yet differences may arise in other crucial factors such as efficiency and environmental impact. The outcome suggests no clear winner based solely on cost, emphasizing the importance of considering holistic factors including efficiency, reliability, and sustainability in LFR selection. It is crucial to acknowledge known facts about performance efficiency to inform decisions effectively. In conclusion, while cost is a vital consideration, a thorough evaluation encompassing multiple dimensions is necessary for optimal LFR selection.

5. CONCLUSIONS

In conclusion, the implementation of an energy efficiency method based on machine learning for linear reflector systems, especially focusing on the effect of increased receiver height, improved the overall system efficiency significantly improved The modification allowed for a larger window through which sunlight could penetrate and be transmitted to the CPC, thereby increasing the light-trapping capacity of the system A key finding of this study is the observed increase in blocking factor from 0.58 to 0.73 due to receiver height, resulting in shorter loops in the field This decrease in total loop length is significant, as it indicates solarization energy is used more efficiently, with less light absorption and heat gain per m2 as a result The total length of the Fresnel zone was effectively reduced from 990 meters to 795 meters, representing a significant reduction in loop length of 22%; This improvement in energy efficiency was achieved while keeping the primary crystal width, filler, and absorber tube diameter constant The results of this study confirm that a machine learning model be used to optimize linear imaging systems, improve solar energy harvesting and utilization These findings of increased potential underline the need for advanced solar a implementation, paving the way for more sustainable and efficient energy solutions.

REFERENCES:

[1] P. Esfanjani, S. Jahangiri, A. Heidarian, M. S. Valipour, and S. Rashidi, "A review on solar-powered cooling systems coupled with parabolic dish collector and linear Fresnel reflector," *Environ. Sci. Pollut. Res.*, vol. 29, no. 28, pp. 42616–42646, 2022.

[2] Z. Said, M. Ghodbane, L. S. Sundar, A. K. Tiwari, M. Sheikholeslami, and B. Boumeddane, "Heat transfer, entropy generation, economic and environmental analyses of linear Fresnel reflector using novel rGO-Co3O4 hybrid nanofluids," *Renew. Energy*, vol. 165, pp. 420–437, 2021.

[3] O. M. Ikumapayi *et al.*, "A Brief Study into Renewable Energy Technologies," in *E3S Web of Conferences*, 2023, vol. 391, p. 1083.

[4] A. Barbón, J. A. Fernández-Rubiera, L. Martínez-Valledor, A. Pérez-Fernández, and L. Bayón, "Design and construction of a solar tracking system for small-scale linear Fresnel reflector with three movements," *Appl. Energy*, vol. 285, p. 116477, 2021.

[5] X. Zhao, S. Yan, N. Zhang, N. Zhao, and H. Gao, "Solar flux measuring and optical efficiency forecasting of the linear Fresnel reflector concentrator after dust accumulation," *J. Therm. Sci.*, vol. 31, no. 3, pp. 663–677, 2022.

[6] A. E. Rungasamy, K. J. Craig, and J. P. Meyer, "A review of linear Fresnel primary optical design methodologies," *Sol. Energy*, vol. 224, pp. 833–854, 2021.

[7] H. Singh, A. Singh, R. S. Mishra, and A. Pal, "A current review on linear Fresnel reflector technology and its applications in power plants," in *International Conference on Recent Advancements in Mechanical Engineering*, 2020, pp. 431–440.

[8] Q. Sun, D. Lin, M. Khayatnezhad, and M. Taghavi, "Investigation of phosphoric acid fuel cell, linear Fresnel solar reflector and Organic Rankine Cycle polygeneration energy system in different climatic conditions," *Process Saf. Environ. Prot.*, vol. 147, pp. 993–1008, 2021.

[9] N. Yuvaraj, K. Praghash, R. A. Raja, and T. Karthikeyan, "An investigation of garbage disposal electric vehicles (GDEVs) integrated with deep neural networking (DNN) and intelligent transportation system (ITS) in smart city management system (SCMS)," *Wirel. Pers. Commun.*, vol. 123, no. 2, pp. 1733–1752, 2022.

[10] M. Sheikholeslami and Z. Ebrahimpour, "Thermal improvement of linear Fresnel solar system utilizing Al2O3-water nanofluid and multi-way twisted tape," *Int. J. Therm. Sci.*, vol. 176, p. 107505, 2022.

[11] M. Ghodbane *et al.*, "Energy, financial, and environmental investigation of a direct steam production power plant driven by linear fresnel solar reflectors," *J. Sol. Energy Eng.*, vol. 143, no. 2, p. 21008, 2021.

[12] J. Surendiran *et al.*, "Segmentation of optic disc and cup using modified recurrent neural network," *Biomed Res. Int.*, vol. 2022, 2022.

[13] S. Kamel, E. B. Agyekum, T. S. Adebayo, I. B. M. Taha, B. A. Gyamfi, and S. J. Yaqoob, "Comparative analysis of Rankine cycle linear Fresnel reflector and solar tower plant technologies: techno-economic analysis for Ethiopia," *Sustainability*, vol. 14, no. 3, p. 1677, 2022.

[14] Z. Ebrahimpour, M. Sheikholeslami, and S. A. Farshad, "Radiation and convection treatment of nanomaterial within a Linear Fresnel Reflector unit," *Eur. Phys. J. Plus*, vol. 136, no. 2, p. 201, 2021.

[15] P. Boito and R. Grena, "Application of a fixed-receiver Linear Fresnel Reflector in concentrating photovoltaics," *Sol. Energy*, vol. 215, pp. 198–205, 2021.

[16] M. Ghodbane, E. Bellos, Z. Said, B. Boumeddane, A. K. Hussein, and L. Kolsi, "Evaluating energy efficiency and economic effect of heat transfer in copper tube for small solar linear Fresnel reflector," *J. Therm. Anal. Calorim.*, vol. 143, pp. 4197–4215, 2021.

[17] J. Ma, C.-L. Wang, Y. Zhou, and R.-D. Wang, "Optimized design of a linear Fresnel collector with a compound parabolic secondary reflector," *Renew. Energy*, vol. 171, pp. 141–148, 2021.

[18] X. Zhao, Z. Chen, S. Yan, T. Ming, Z. Wu, and R. Ma, "Influence of dust accumulation on the solar reflectivity of a linear Fresnel reflector," *J. Therm. Sci.*, vol. 30, pp. 1526–1540, 2021.

[19] N. Khandelwal, M. Sharma, O. Singh, and A. K. Shukla, "Comparative analysis of the linear Fresnel reflector assisted solar cycle on the basis of heat transfer fluids," *Mater. Today Proc.*, vol. 38, pp. 74–79, 2021.

[20] A. Barbón, P. F. Ayuso, L. Bayón, and J. A. Fernández-Rubiera, "Non-uniform illumination in low concentration photovoltaic systems based on small-scale linear Fresnel reflectors," *Energy*, vol. 239, p. 122217, 2022.

[21] J.-J. Men, X.-R. Zhao, Z.-D. Cheng, Y.-K. Leng, and Y.-L. He, "Study on the annual optical comprehensive performance of linear Fresnel reflector concentrators with an effective multi-objective optimization model," *Sol. Energy*, vol. 225, pp. 591–607, 2021.

[22] A. V. Santos, D. Canavarro, P. Horta, and M. Collares-Pereira, "An analytical method for the optical analysis of Linear Fresnel Reflectors with a flat receiver," *Sol. Energy*, vol. 227, pp. 203–216, 2021.

[23] H. Beltagy, "The effect of glass on the receiver and the use of two absorber tubes on optical performance of linear fresnel solar concentrators," *Energy*, vol. 224, p. 120111, 2021.

[24] S. Alam, "Security Concerns in Smart Agriculture and Blockchain-based Solution," in *2022 OPJU International Technology Conference on Emerging Technologies for Sustainable Development (OTCON)*, 2023, pp. 1–6.

[25] M. M. Khubrani and S. Alam, "Blockchain-Based Microgrid for Safe and Reliable Power Generation and Distribution: A Case Study of Saudi Arabia," *Energies*, vol. 16, no. 16, p. 5963, 2023.

[26] Z. Ebrahimpour, S. A. Farshad, and M. Sheikholeslami, "Heat transfer within linear Fresnel unit using parabolic reflector," *Int. J. Numer. Methods Heat Fluid Flow*, vol. 32, no. 8, pp. 2841–2863, 2022.

[27] A. V Santos, D. Canavarro, and M. Collares-Pereira, "The gap angle as a design criterion to determine the position of linear Fresnel primary mirrors," *Renew. Energy*, vol. 163, pp. 1397–1407, 2021.

[28] G. Wang, Z. Ge, and J. Lin, "Design and performance analysis of a novel solar photovoltaic/thermal system using compact linear Fresnel reflector and nanofluids beam splitting device," *Case Stud. Therm. Eng.*, vol. 35, p. 102167, 2022.

[29] H. Mahmood and K. Hossin, "Daily, monthly and annual thermal performance of a linear Fresnel reflector to drive an organic Rankine-cycle system," *Clean Energy*, vol. 5, no. 4, pp. 673–689, 2021.

[30] M. Ghodbane, M. Majdak, and B. Boumeddane, "The efficiency of linear Fresnel reflectors in producing superheated steam for power plant drive," in *E3S Web of Conferences*, 2021, vol. 323, p. 11.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[31] A. C. Montenon, A. V. Santos, M. Collares-Pereira, F. M. Montagnino, R. Garofalo, and C. Papanicolas, "Optical performance comparison of two receiver configurations for medium temperature Linear Fresnel Collectors," *Sol. Energy*, vol. 240, pp. 225–236, 2022.
[32] A. Häberle, "Linear fresnel collectors," in *Solar Thermal Energy*, Springer, 2022, pp. 55–62.
[33] A. Famiglietti, A. Lecuona, M. Ibarra, and J. Roa, "Turbo-assisted direct solar air heater for medium temperature industrial processes using Linear Fresnel Collectors. Assessment on daily and yearly basis," *Energy*, vol. 223, p. 120011, 2021.
[34] B. Raillani, H. A. L. Ouali, S. Amraqui, M. A. Moussaoui, and A. Mezrhab, "Techno-economic impact of optical soiling losses on solar tower and linear Fresnel reflector power plants: Experimental and numerical investigation," *Int. J. Green Energy*, vol. 19, no. 15, pp. 1665–1674, 2022.
[35] S. Kiyaee, Y. Saboohi, and A. Z. Moshfegh, "A new designed linear Fresnel lens solar concentrator based on spectral splitting for passive cooling of solar cells," *Energy Convers. Manag.*, vol. 230, p. 113782, 2021.
[36] S. N. Danish, Z. Almutairi, A. El-Leathy, H. Al-Ansary, Y. Jardan, and S. Alaqel, "Modeling and performance simulation of an innovative concept of linear Fresnel reflector based CSP system," *J. Therm. Sci.*, vol. 30, no. 5, pp. 1614–1624, 2021.
[37] M. Babu, N. Bhuvanesh, S. S. Raj, and E. Elavarasan, "Design and optimization of linear Fresnel reflector concentrating solar system using particle swarm optimization algorithms," *Mater. Today Proc.*, vol. 66, pp. 1038–1043, 2022.
[38] M. Sofiane, "Effect of Design Parameters on The Performance of DSG Linear Fresnel Solar Power Plant," *Int. J. Energy a Clean Environ.*, vol. 22, no. 2, 2021.
[39] Y. Wu *et al.*, "Comparative Study on Heat Flux and Temperature Distribution Performance of Linear Fresnel Collector Based on Uniformity Index," *J. Therm. Sci.*, vol. 31, no. 3, pp. 678–688, 2022.
[40] M. Kirola, M. Memoria, M. Shuaib, K. Joshi, S. Alam, and F. Alshanketi, "A Referenced Framework on New Challenges and Cutting-Edge Research Trends for Big-Data Processing Using Machine Learning Approaches," in *2023 International Conference on Smart Computing and Application (ICSCA)*, 2023, pp. 1–5.